

**DRAFT FINAL**

**BIOLOGICAL ASSESSMENT**

**NW NATURAL “GASCO” SITE**

**REMOVAL ACTION**

**Prepared for submittal to**

U.S. Environmental Protection Agency, Region 10  
1200 Sixth Avenue  
Seattle, Washington 98101

**For Coordination with**

National Oceanographic and Atmospheric Administration, Fisheries  
510 Desmond Drive SE, Suite 103  
Lacey, Washington 98503-1723

**Prepared by**

Anchor Environmental, L.L.C.  
1423 Third Avenue, Suite 300  
Seattle, Washington 98101

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## List of Acronyms and Abbreviations

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BO	Biological Opinion
BRT	Biological Review Team
BTEX	Benzene, toluene, ethylbenzene, xylene
CQAP	Construction Quality Assurance Plan
CR	Columbia River
CRD	Columbia River Datum
cy	cubic yards
DMEF	Dredged Material Evaluation Framework
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DRET	dredging elutriate test
Ecology	Washington State Department of Ecology
EE/CA	Engineering Evaluation/Cost Analysis
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESU	Evolutionarily Significant Unit
LCR	Lower Columbia River
MCR	Middle Columbia River
MSFMCA	Magnusson Stevens Fisheries Management Control Act
msl	mean sea level
NOAA	National Oceanic and Atmospheric Association
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OHW	ordinary high water
OLW	ordinary low water
Order	Administrative Order on Consent
PCB	Polychlorinated biphenyls
PCE	Primary Constituent Element
PEC	Probable Effects Concentration
PFMC	Pacific Fisheries Management Council
RAEPP	Removal Action Environmental Protection Plan
RAPP	Removal Action Project Plan
RAWP	Removal Action Work Plan



## List of Acronyms and Abbreviations

---

RI/FS	Remedial Investigation/Feasibility Study
RM	River Mile
SAP	Sampling and Analysis Plan
sf	square feet
SFA	Sustainable Fisheries Act
SR	Snake River
SRF	Snake River Fall
SRSS	Snake River Spring/Summer
the Services	collectively, USFWS and NOAA Fisheries
TPAH	total polycyclic aromatic hydrocarbons
TPH	total petroleum hydrocarbons
TSS	total suspended solids
UCR	Upper Columbia River
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Department of Fish and Wildlife
UWR	Upper Willamette River
WBZ	water bearing zone
WQMP	Water Quality Monitoring Plan



## 1 INTRODUCTION

NW Natural entered into an Administrative Order on Consent (Order) with the U.S. Environmental Protection Agency (EPA) on April 28, 2004 to perform a removal action at the “Gasco” Site (EPA 2004a). The Order requires that NW Natural perform a number of actions associated with removing a tar body from the site. The scope of this early action is to remove the tar body, dispose of the tar off site, and place a clean sand cover on the dredged surface (Anchor 2004a). In order to comply with the requirements of the Endangered Species Act (ESA), EPA is consulting with the National Oceanic and Atmospheric Administration (NOAA) Fisheries and the U.S. Fish and Wildlife Services (USFWS), together referred to as the Services, prior to making a final determination on the proposed project. This technical information has been prepared to assist EPA in its review of this project under the Superfund program.

The purpose of this document is to identify listed and/or proposed species which are, or are likely to be, affected by the proposed construction project. A species list was requested from USFWS on June 11, 2004, and was provided on June 29, 2004. The species list was requested for that portion of the action area in the Willamette River only, as the location of the off-loading area was unknown at that time. This list is attached to this document (Appendix A). Federally listed endangered, threatened, proposed, and candidate fish and wildlife species that may occur in the action area and that are addressed in this document pursuant to Section 7(a)(2) of the ESA are listed below in Table 1.

It should be noted that on November 30, 2004, NOAA Fisheries proposed critical habitat for 20 salmon and steelhead evolutionarily significant units (ESUs) on the West Coast, including most of the listed ESUs discussed in this document. Critical habitat for these species is currently proposed for re-designation on August 15, 2005. Consequently, potential critical habitat issues are addressed in this Biological Assessment (BA).

**Table 1**  
**Threatened, Endangered, and Candidate Species that May Occur in the Project Area**

Species	Status	Agency	Effects Determination
Bald eagle ( <i>Haliaeetus leucocephalus</i> )	Threatened	USFWS	NLTAA
Bull trout ( <i>Salvelinus confluentus</i> )	Threatened	USFWS	NLTAA
Chinook salmon ESUs: ( <i>Oncorhynchus tshawytscha</i> )			
Lower Columbia River Chinook	Threatened	NOAA Fisheries	LTAA
Upper Willamette River Chinook	Threatened	NOAA Fisheries	LTAA
Upper Columbia River Chinook	Endangered	NOAA Fisheries	NLTAA
Snake River Spring/Summer Chinook	Threatened	NOAA Fisheries	NLTAA
Snake River Fall Chinook	Threatened	NOAA Fisheries	NLTAA
Columbia River Chum salmon ( <i>Oncorhynchus keta</i> )	Threatened	NOAA Fisheries	LTAA
Steelhead trout ESUs: ( <i>Oncorhynchus mykiss</i> )			
Lower Columbia River Steelhead	Threatened	NOAA Fisheries	LTAA
Upper Willamette River Steelhead	Threatened	NOAA Fisheries	LTAA
Upper Columbia River Steelhead	Endangered	NOAA Fisheries	NLTAA
Middle Columbia River Steelhead	Threatened	NOAA Fisheries	NLTAA
Snake River Basin Steelhead	Threatened	NOAA Fisheries	NLTAA
Lower Columbia Coho salmon ( <i>Oncorhynchus kisutch</i> )	Proposed	NOAA Fisheries	LTAA
Snake River Basin Sockeye salmon ( <i>Oncorhynchus nerka</i> )	Endangered	NOAA Fisheries	NLTAA

LTAA - Likely to Adversely Affect

NLTAA - Not Likely to Adversely Affect



## 2 CONSULTATION HISTORY

NW Natural provided a draft BA to EPA in July 2004. The draft BA found that the proposed action was not likely to affect listed or proposed species. The Services advised NW Natural and EPA that they were unable to make a final determination until final design documents for the proposed action were available for the Services to review, but were unlikely to find that the proposed action would not likely affect listed or proposed salmonid species. See EPA September 24, 2004 Comments on the Biological Assessment (EPA 2004b). This draft final BA has been revised accordingly.

Since submittal of the draft BA, a disposal facility and off-loading area have been identified at the Port of Morrow in the Columbia River. As a result, the action area identified in this document was expanded to include this facility, and listed species that may occur in the Columbia River have been added to this document. Confirmation of this list has been requested of the Services in the cover letter to this document. It should be emphasized that no in-water work or discharge of any material (water, solid, or otherwise) will occur in the Columbia River and that these additional species would only be affected in the event of an accidental spill during transportation or off-loading.

The November 16, 2004 draft BA recommended performing the removal during the summer in-water work window, rather than the winter in-water work window, in response to concerns from the Services regarding impacts to aquatic life and the environment, as well as in response to containment implementation issues. EPA accepted that recommendation by letter dated December 14, 2004, and this draft final BA has been revised accordingly.

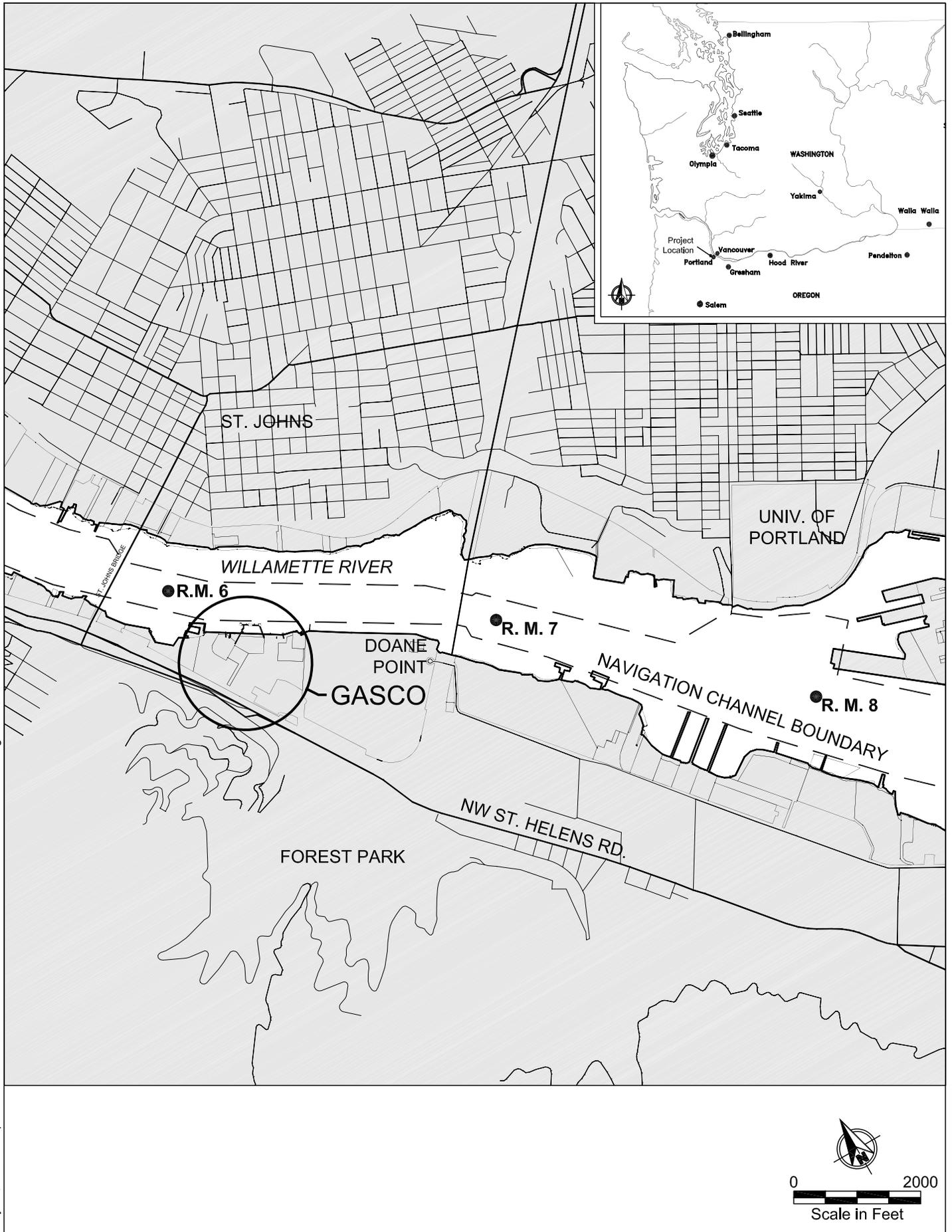
Finally, in February 2005, EPA determined that the removal planning process would exceed six months and therefore would require preparation of an Engineering Evaluation/Cost Analysis (EE/CA)(40 C.F.R. 300.415(b)(4)). Consequently, EPA requested that NW Natural prepare an EE/CA consistent with a Non-Time-Critical Removal Action process. The draft EE/CA was submitted to EPA in March 2005. The EE/CA reviews five removal action alternatives which included measures such as capping, dredging, construction containment (both rigid and non-rigid), transport methods, treatment, and disposal locations. The EE/CA recommends Alternative C, which proposes the physical removal of tar, a non-rigid containment system, barge transport to an upland transfer facility, and truck transport to a Subtitle C disposal

facility, as the best alternative to meet the removal action objectives of the Statement of Work (SOW). The EE/CA was submitted to EPA for public comment in May 2005 (Anchor 2005). Once the public comment period ends, EPA will select a preferred design alternative. NW Natural's contractors will then prepare a final Removal Action Project Plan (RAPP) and associated design documentation prior to construction of the removal action. The potential effects of Alternative C, the currently recommended alternative by EPA and NW Natural, are discussed in this document. It should be noted that due to lengthy previous design efforts and discussions with EPA, the understanding of the design and construction of this approach far exceeds the level of detail normally contained within an EE/CA or similar documents. Consequently, if public comment does not result in a change in the recommended alternative, this document (with supporting documentation) contains sufficient detail to complete a full biological assessment of the project. The design will be finalized upon completion of the public review process.

### 3 PROJECT DESCRIPTION

The proposed project is a removal action (as defined by Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Superfund regulations and guidance) within the initial study area of the Portland Harbor Superfund project, located approximately at River Mile (RM) 6 on the west bank of the Lower Willamette River (Figure 1). A Final NW Natural "Gasco" Site Removal Action Work Plan (RAWP) was submitted to EPA on August 30, 2004 describing the activities that will be performed to implement the removal action required by the Order. The RAWP states that the scope of the project is to remove a tar body from the riverbank and adjacent sediment, dispose of the tar off site, and place a clean sand cover on the dredged surface (Anchor 2004a). A RAPP Draft Preliminary Design was submitted to EPA in September 2004, and a Draft Final RAPP was submitted in November 2004 prior to preparation of the EE/CA. The Draft Final RAPP (Anchor 2004b) and Alternative C in the EE/CA (Anchor 2005) provide details regarding the sampling results and design information summarized in this document.

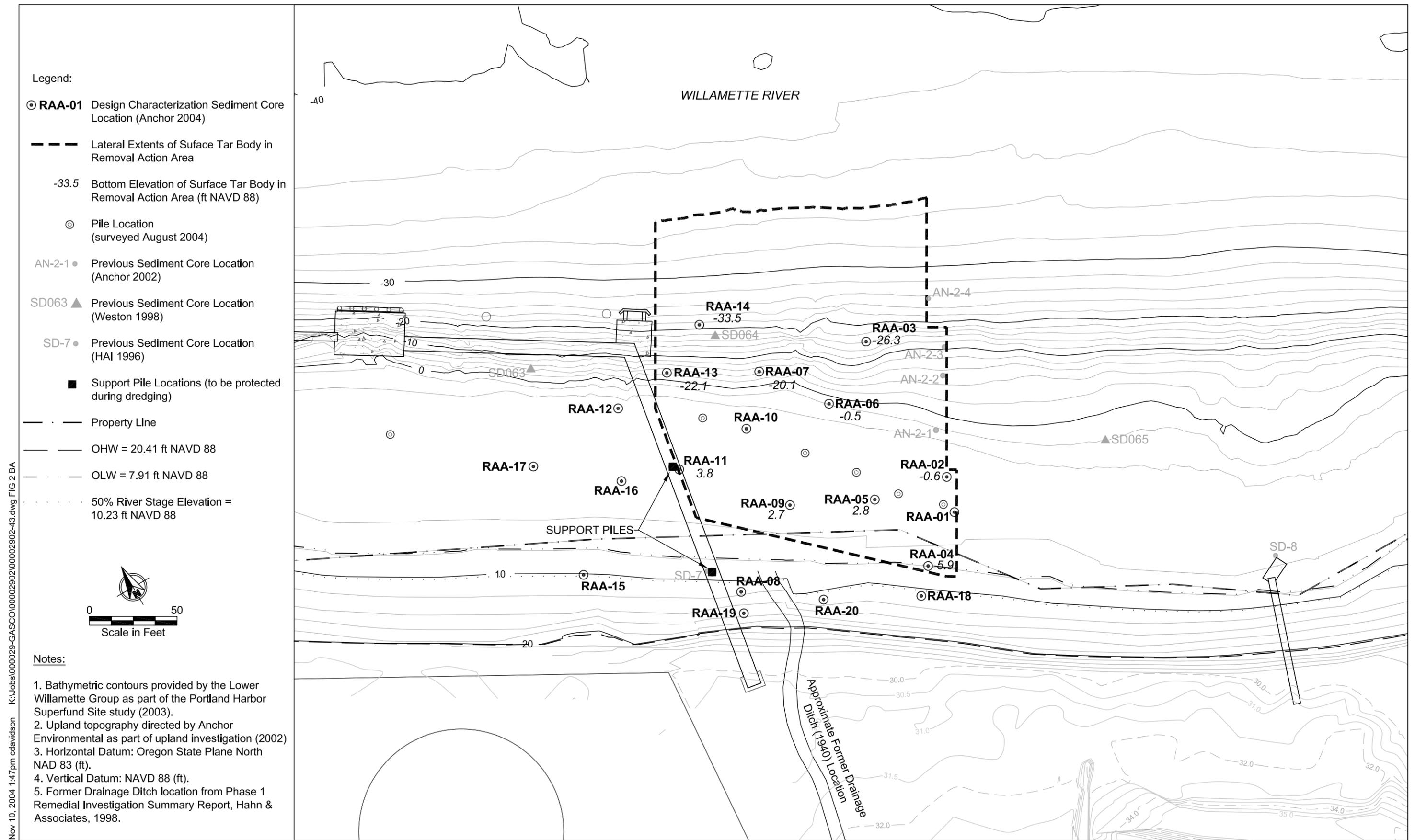
May 12, 2004 5:05pm sdekleva K:\Jobs\1000029-GASCO\100002902\100002902-01.dwg FIG 1



**Figure 1**  
Vicinity Map  
Northwest Natural "Gasco" Site

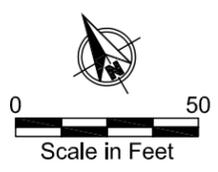
### 3.1 Design Characterization

Field sampling was performed in July 2004 in general accordance with the EPA-approved RAWP and the Sampling and Analysis Plan (SAP) appendix to that document, and is described in detail in the Draft Final RAPP (Anchor 2004b). Previous investigations delineated the tar body as an irregular shape approximately 100 feet long by 200 feet wide. The primary objective of the design characterization sampling was to further define the lateral and vertical extents of the surface tar body in the removal action area through visual observations (Figure 2). Following discussions with EPA, 19 cores were advanced to a depth of 20 feet, and one core was advanced to a depth of 40 feet. During evaluation of the cores, Anchor and EPA reached consensus on the depth(s) of three physically-different zones present at each sampling location. These zones were identified and labeled on a consistent basis as: tar body, visually contaminated, and visually uncontaminated. Tar body zone observations include continuous tar ranging from thin tar laminations bounded by sediments, lenses of tar, soft masses of tar, and dense brittle fragments of tar containing little or no sediments. Visually contaminated zone observations include sediments containing large amounts of tar or tarry substances (or very dense sticky non-flowing oil-like materials) but composed primarily of sediments, as well as sediments containing heavy sheen, blebs of sticky non-flowing oil/tar, and slight sheen. The results of this sampling event and subsequent design information are presented in greater detail in the Draft Final RAPP and its appendices (Anchor 2004b).



**Legend:**

- ⊙ **RAA-01** Design Characterization Sediment Core Location (Anchor 2004)
- Lateral Extents of Surface Tar Body in Removal Action Area
- 33.5 Bottom Elevation of Surface Tar Body in Removal Action Area (ft NAVD 88)
- ⊙ Pile Location (surveyed August 2004)
- AN-2-1 Previous Sediment Core Location (Anchor 2002)
- ▲ SD063 Previous Sediment Core Location (Weston 1998)
- SD-7 Previous Sediment Core Location (HAI 1996)
- Support Pile Locations (to be protected during dredging)
- Property Line
- OHW = 20.41 ft NAVD 88
- OLW = 7.91 ft NAVD 88
- 50% River Stage Elevation = 10.23 ft NAVD 88



**Notes:**

1. Bathymetric contours provided by the Lower Willamette Group as part of the Portland Harbor Superfund Site study (2003).
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002)
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD 88 (ft).
5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report, Hahn & Associates, 1998.

Nov 10, 2004 1:47pm cclavison K:\Jobs\000029-GASCO\00002902\00002902-43.dwg FIG 2 BA



**Figure 2**  
Lateral and Vertical Extents of Surface Tar Body in Removal Action Area  
NW Natural "Gasco" Site

### 3.2 Extent of Surface Tar Body

Based on the physical definitions discussed above, the lateral and vertical extents of the tar body were delineated. Based on these elevations and thicknesses of tar, a dredge prism was identified. No tar body zone was identified in the cores (i.e., RAA-12, RAA-16, and RAA-17) (Figure 2) located downstream from the existing dock and pipeway structures. Thus, the vast majority of the surface tar body is upstream of the existing pipeway structures, with only a small portion underneath the pipeway. Sampling underneath the dock itself was not possible, and the presence or absence of tar in the area immediately under the dock is not known.

The presence of tar has been also noted in subsurface layers in two cores collected immediately upstream (AN 2-1 through AN 2-4) and two cores shoreward (RAA-19 and 20) of the surface tar body. Generally, the tar in these cores is covered by 1.5 to several feet of sediment or soil type material and the tar itself is approximately 1.5 to 5 feet thick. However, it is notable that tar was not present in RAA-18 and RAA-15, which are slightly upstream and downstream of RAA-19 and RAA-20. Further, this tar is not present in RAA-08, which is just riverward of RAA-19.

Upon removal of the surface tar body, it is likely that a layer of tar material approximately 1.6 feet to a maximum of 5 feet thick may be bisected by the cut line in a few locations. However, the entire area, including any exposed tar material, will be covered with sand (as described below). Removal and capping will result in a substantial net reduction in the exposure to surface tar, and its removal will meet the objectives of the SOW.

As noted in the core logs (Anchor 2004b), there was a lack of recovery in a number of cores. Where there were gaps in core recovery, the entire core was examined for the deepest location of observed tar. In these cases, it was assumed that tar was present in all unrecovered segments above this level. Where a gap existed below the observed tar within a single 4-foot core tube, it was assumed that tar was present through the end of that tube. This method provides the maximum possible estimate of the vertical extent of continuous tar that may be present at locations where tar was observed at that station.

### 3.3 Construction Methods

The project will remove tar and related sediments defined by the design characterization as shown in the dredge prism (Figures 3 and 4), and place a clean sand pilot cap on the dredged surface. Based on the information summarized in Section 3.2, approximately 5,000 cubic yards (cy) of tar material and approximately 10,000 cy of visually contaminated sediments will be removed to achieve a stable post-removal slope.

#### 3.3.1 Dredging

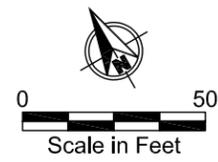
As discussed in the RAPP, information collected regarding the tar body composition indicates that a conventional clamshell bucket will be the most efficient technology for removal. This type of bucket has the capability to remove a range of sediments from soft silt-like materials to stiff and/or firm materials more similar to sands. Because approximately 75 percent of the surface tar is relatively stiff, initial removal work will likely be accomplished using a large (e.g., 8 cy) clamshell bucket. However, due to the range of Site conditions, several other bucket types and sizes (e.g., 15 cy closed Cable Arm bucket and/or a 9 cy “flat lip” bucket) will be available for potential use. Use of a closed bucket to remove these types of materials is likely infeasible and if attempted, may even increase the resuspension of material and potential water quality impacts (Anchor 2004b).

The dredging operation will use one of these buckets mounted on a derrick to remove the tar from the bottom sediments. In this operation, the clamshell bucket is lowered by a cable to the substrate with its jaws open and closes as it penetrates, enclosing a volume of material. The full bucket is then raised to the surface, and material is placed directly onto a sealed haul barge. The contractor will perform daily surveys to monitor the progress of the dredging. After dredging is complete, the contractor will conduct a bathymetric survey of the dredge cut surface to confirm that the design cut elevations have been obtained. Material will be dredged, as appropriate, to achieve the design elevation requirements. The estimate of the total volume of material to be removed is approximately 15,000 cy (i.e., 5,000 cy of tar and 10,000 cy of visually contaminated sediments) including an allowable overdredge of 6 inches.

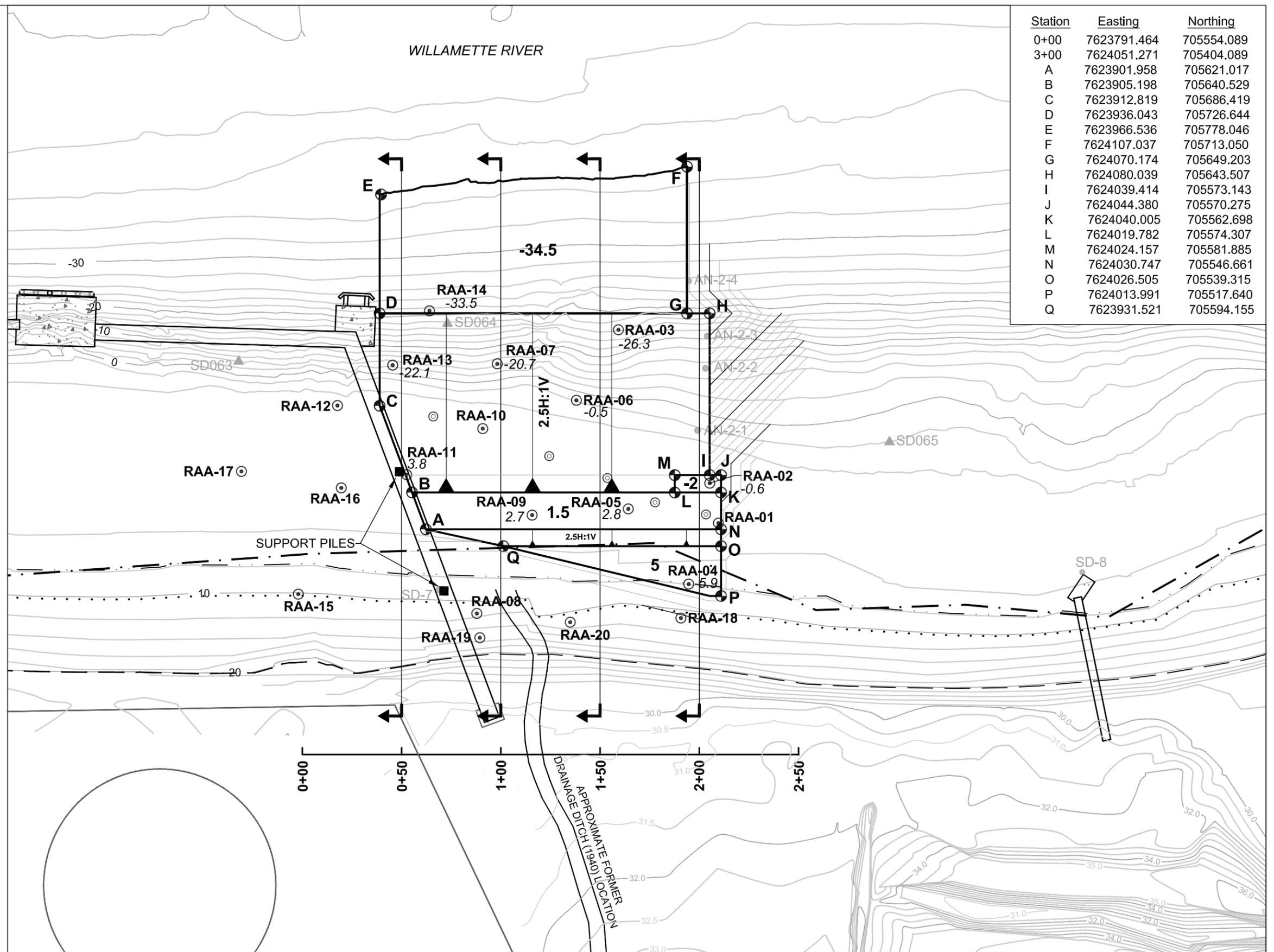


Nov 10, 2004 1:50pm cclavison K:\Jobs\000029-GASCO\00002902\00002902-46.dwg FIG 3 BA

- Legend:**
- 1.5 Dredge Prism and Dredge Elevation
  - ⊙ **RAA-01** Sample Location and Number (July 2004, Anchor)
  - 33.5 Bottom Elevation of Surface Tar Body in Removal Action Area (ft NAVD 88)
  - AN-2-1 ● Previous Sediment Core Location (Anchor 2001)
  - SD063 ▲ Previous Sediment Core Location (Weston 1998)
  - SD-7 ● Previous Sediment Core Location (HAI 1996)
  - ⊙ Pile Location (To be removed during dredging)
  - Support Pile Locations (to be protected during dredging)
  - · — Property Line
  - — — OHW = 20.41 ft NAVD 88
  - · — · — OLW = 7.91 ft NAVD 88
  - · · · · 50% River Stage Elevation = 10.23 ft NAVD 88



- Notes:**
1. Bathymetric contours provided by the Lower Willamette Group as part of the Portland Harbor Superfund Site study (2003).
  2. Upland topography directed by Anchor Environmental as part of upland investigation (2002)
  3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
  4. Vertical Datum: NAVD 88 (ft).
  5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report, Hahn & Associates, 1998.



Station	Easting	Northing
0+00	7623791.464	705554.089
3+00	7624051.271	705404.089
A	7623901.958	705621.017
B	7623905.198	705640.529
C	7623912.819	705686.419
D	7623936.043	705726.644
E	7623966.536	705778.046
F	7624107.037	705713.050
G	7624070.174	705649.203
H	7624080.039	705643.507
I	7624039.414	705573.143
J	7624044.380	705570.275
K	7624040.005	705562.698
L	7624019.782	705574.307
M	7624024.157	705581.885
N	7624030.747	705546.661
O	7624026.505	705539.315
P	7624013.991	705517.640
Q	7623931.521	705594.155

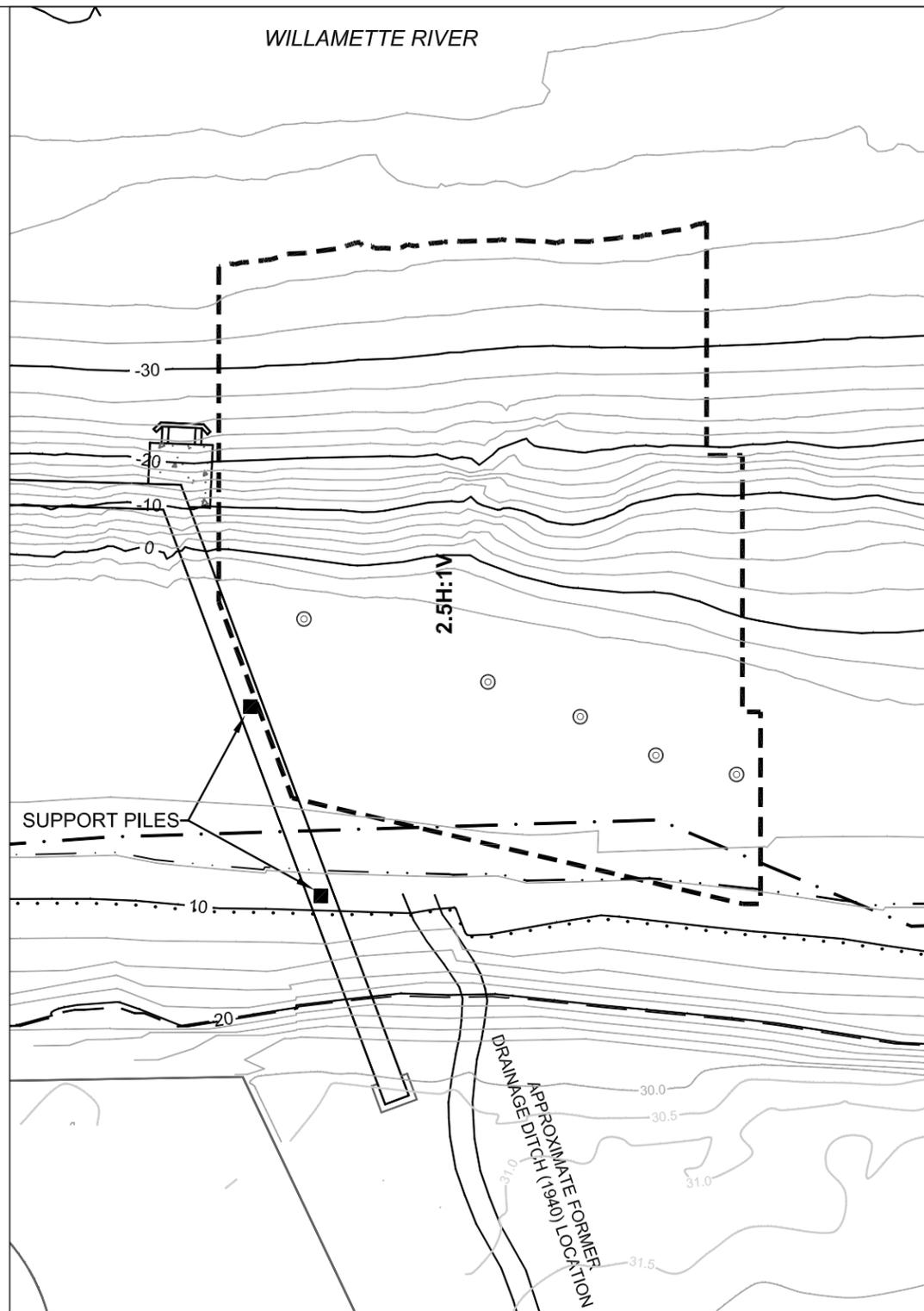


**Figure 3**  
Dredge Plan and Cross Section Locations  
NW Natural "Gasco" Site

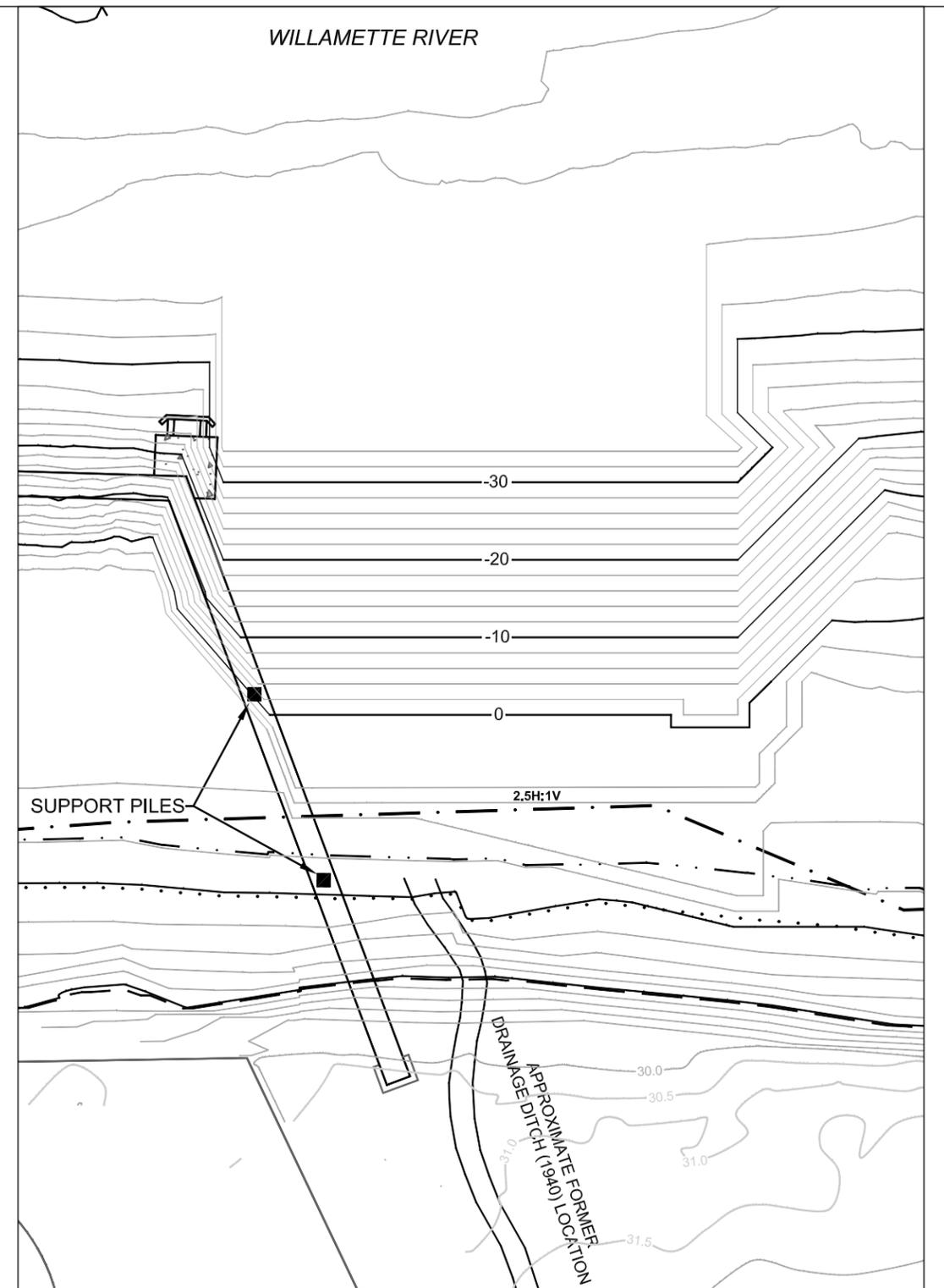
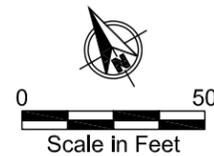
Nov 10, 2004 1:51pm cclavison K:\Jobs\000029-GASCO\00002902\00002902-45.dwg FIG 4 BA

**Legend:**

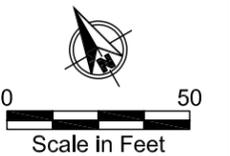
- ⊙ Pile Location  
(To be removed during dredging)
- Support Pile Locations  
(to be protected during dredging)
- · — Property Line
- — — — — OHW = 20.41 ft NAVD 88
- · · · — OLW = 7.91 ft NAVD 88
- · · · · 50% River Stage Elevation = 10.23 ft NAVD 88
- - - - - Removal Action Area



**Pre-Dredge Bathymetry**



**Post-Dredge Bathymetry**



**Notes:**

1. Bathymetric contours provided by the Lower Willamette Group as part of the Portland Harbor Superfund Site study (2003).
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002)
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD 88 (ft).
5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report, Hahn & Associates, 1998.

The only identified in-water obstructions include five clusters of wood piling. There are three piles at four of the locations and two piles at the fifth location totaling 14 piles. It is assumed that pilings have been treated with creosote. Piling will be pulled by the dredge bucket from within the containment barriers (discussed in Section 3.3.3) and after salmonids are excluded. Efforts will be made to remove piling whole, but if a pile breaks at or below the mudline, the remainder of the pile may be removed during the dredging operation. Piling will be placed directly on the barge, but in a separate area from where sediment is placed. Broken woody debris will be captured and removed.

Best Management Practices (BMPs) and other conservation measures such as containment barriers that will be implemented during dredging, are discussed in detail in Section 3.3.3.

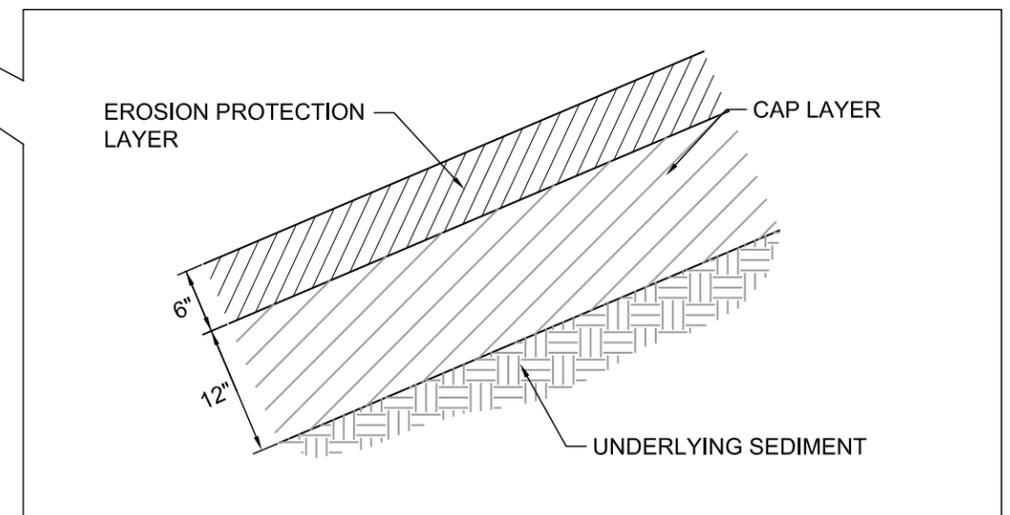
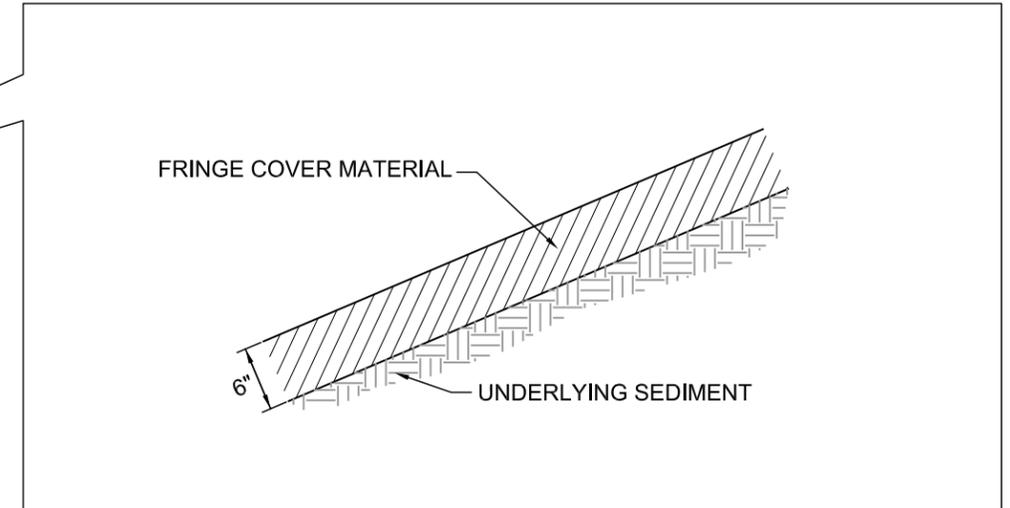
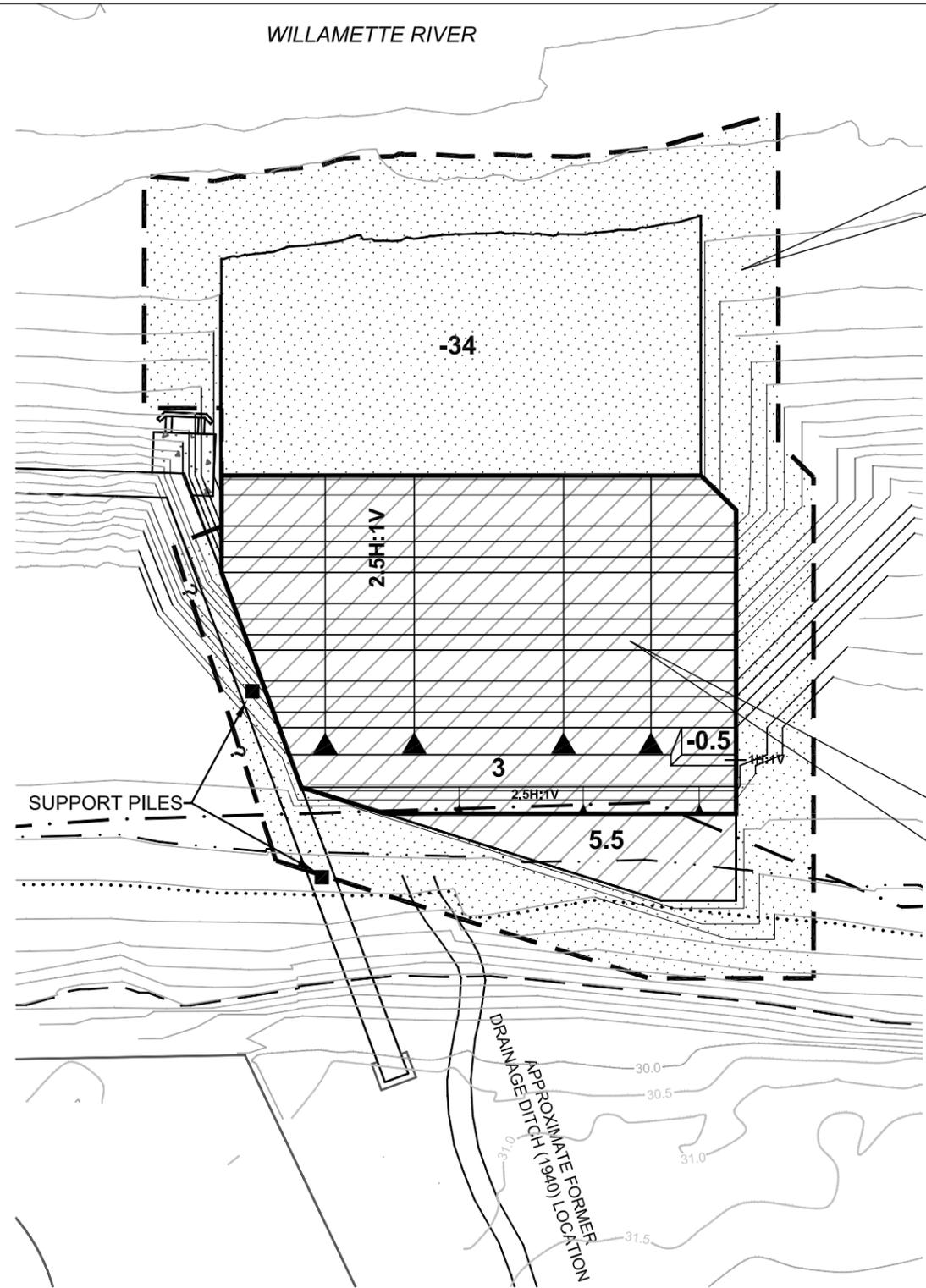
### **3.3.2 Capping**

After removal of tar and sediments, cover/capping material will be placed over the removal area. A pilot cap will be placed in the center of the removal area and “fringing” cover material will be placed on the slopes surrounding the capping area (Figure 5). All materials used in cap/cover placement will meet the requirements established in the December 2003 Technical Plans and Specifications (Ecology and the Environment 2003) for the McCormick & Baxter sediment cap located within the Willamette River. Material to be used for construction of the sediment cap will be imported, clean, granular material free of roots, organic material, contaminants, and all other deleterious material.

May 11, 2005 12:22pm cdauidson K:\Jobs\000029-GASCO\00002902\00002902-566.dwg FIG 5

**Legend:**

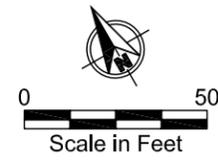
- Support Pile Locations  
(to be protected during dredging)
- · — Property Line
- OHW = 20.41 ft NAVD 88
- · - · - OLW = 7.91 ft NAVD 88
- 50% River Stage Elevation = 10.23 ft NAVD 88
-  Extent and Elevation of 18 in Thick Cap
-  Extent and Elevation of 6 in Thick Cover



**Notes:**

1. Bathymetric contours provided by the Lower Willamette Group as part of the Portland Harbor Superfund Site study (2003).
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002).
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD 88 (ft).
5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report (HAI 1998).
6. Slope beneath pipeline support structure allowed to settle to angle of repose - shown at 1H:1V.

**Post Cap and Cover Bathymetry**



### 3.3.2.1 Pilot Cap Materials

The purpose of the pilot cap is to provide a clean surface and minimize any potential exposure to underlying residual sediment contaminants until a final cleanup for the site is accomplished. Monitoring information collected from the cap and the removal area will be used to help understand the potential effectiveness or ineffectiveness of capping as a more long term remedial action for portions of the Gasco sediments. The pilot cap is designed (as discussed below) to withstand erosive forces that might reasonably be expected over the next five years. It is not intended as a final remedy. However, if capping is selected as a feasible option for the long term remediation of the site, the pilot cap design described here could be made permanent by the addition of a coarser erosion layer.

The area of the pilot cap is approximately 18,600 square feet (sf). It will comprise a 12 inch “filter” layer overlain with a 6 inch “erosion” layer. The 6-inch erosion layer will ideally be crushed (angular) material, but other materials may be accepted at the discretion of the design engineer. The following criteria will be used for grain size gradation:

- 100 percent passing 1.5 inches (with flexibility on this percentage)
- A maximum of 50 percent passing 0.5 inch (no flexibility)
- Less than 20 percent passing #10 sieve (with flexibility)
- Less than 5 percent passing #200 sieve

The material for the erosion layer was selected to be protective for the 25 year flow event (82 percent chance of non-exceedence in a 5 year period) in the river. The estimated grain size stability and river velocities under various return events is discussed in detail in RAPP, Appendix H, Attachments A and B.

The pilot cap 12 inch filter layer will consist of:

- 90 to 100 percent passing 4 inches
- 50 to 90 percent passing .75 inches
- 35 to 65 percent passing #4 sieve
- 15 to 45 percent passing #10 sieve
- 2 to 10 percent passing #40 sieve

- 0 to 2 percent passing #200 sieve

The finer grain size portions of this material will provide a chemical isolation layer and the coarser portions will provide a stable bed for the erosion layer to rest on.

### 3.3.2.2 *Fringing Cover Materials*

The purpose of the fringe cover material is to place a sand layer over the outer lateral edge of the dredged surface and side slopes to provide a new clean surface over top of any dredge residuals. The fringe cap area is approximately 32,400 sf. The sand used in the fringe cover may be mixed in and incorporated with new surface sediments in these areas over time. Even with some amount of mixing, this new clean surface will reduce the level of chemical exposures in the biologically active zone. The sand that will be placed (described below) is similar in grain size to much of the sediments present in the area, and is expected to be as stable as these existing sediment deposits.

The 6-inch-thick fringing cover layer will consist of:

- 100 percent passing #10 sieve
- Less than 5 percent passing #200 sieve

### 3.3.2.3 *Cap/Cover Construction*

The construction contractor will place the pilot capping erosion material in one 6-inch lift, filter material in two 6-inch lifts, and fringing cover material in one 6-inch lift. The materials will be placed mechanically from a barge using a clamshell bucket while containment barriers are still in place. For each lift, the bucket will be cracked above the water surface while moving side to side to spread the material. The material will be placed with sufficient control to meet the design thickness for that layer. Lead line measurements, as well as set volume or tonnage over the surface area, will be used to verify adequate coverage during the placement of each layer.

Following the placement of the cover/pilot cap, the construction contractor will perform a bathymetric survey to document that the cover meets the specifications and provide a record of the as-built contour of the completed removal action.

Anchor will monitor the placement of the cover/pilot cap. The Construction Quality Assurance Plan CQAP (RAPP, Appendix C) provides specific details about the responsibilities for quality control and quality assurance during the placement of the cover/pilot cap.

BMPs and other conservation measures, such as containment barriers that will be implemented during capping, are discussed below.

### **3.3.3 Environmental Controls**

Environmental controls during removal of tar body materials will include the use of multiple containment barriers that are designed to limit the movement of various types of materials that are or may be present in the removal area and deter fish movement into the area. Design detail regarding the containment barriers is discussed in the RAPP (Figures 6a and 6b below) and has been updated with more detail on silt curtain design for the EE/CA (Appendix B). The primary standard controls that will be used for in-water removal include:

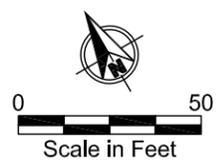
- Inner floating oil absorbent boom to capture buoyant substances
- Silt curtain system to contain suspended sediments and dissolved contaminants
- Bedload baffle to contain any potential residuals along the river bottom
- Bubble curtain to act as a barrier to fish entering the area and to provide secondary containment of water column contaminants and buoyant substances on the water surface
- Outer oil containment boom with an absorbent pad at the surface and a skirt extending 2 feet below the water surface to contain buoyant substances.

These environmental controls will be arranged slightly differently for removal in the inner shoreline area versus the outer channel area. The removal in the inner area will be conducted within a full length silt curtain that is anchored approximately flush with the mudline along with all the other controls and barriers noted above. For removal in the outer area, silt curtains will extend to the bottom except in the channel portion of the containment, where silt curtains would extend within 2 feet of the channel bottom. The bedload baffle will be installed on the bottom and adjacent to the silt curtain, and extend 6 feet upwards. This system provides an approximate 4-foot vertical overlap between the bedload baffle and the silt curtain in the channel area.



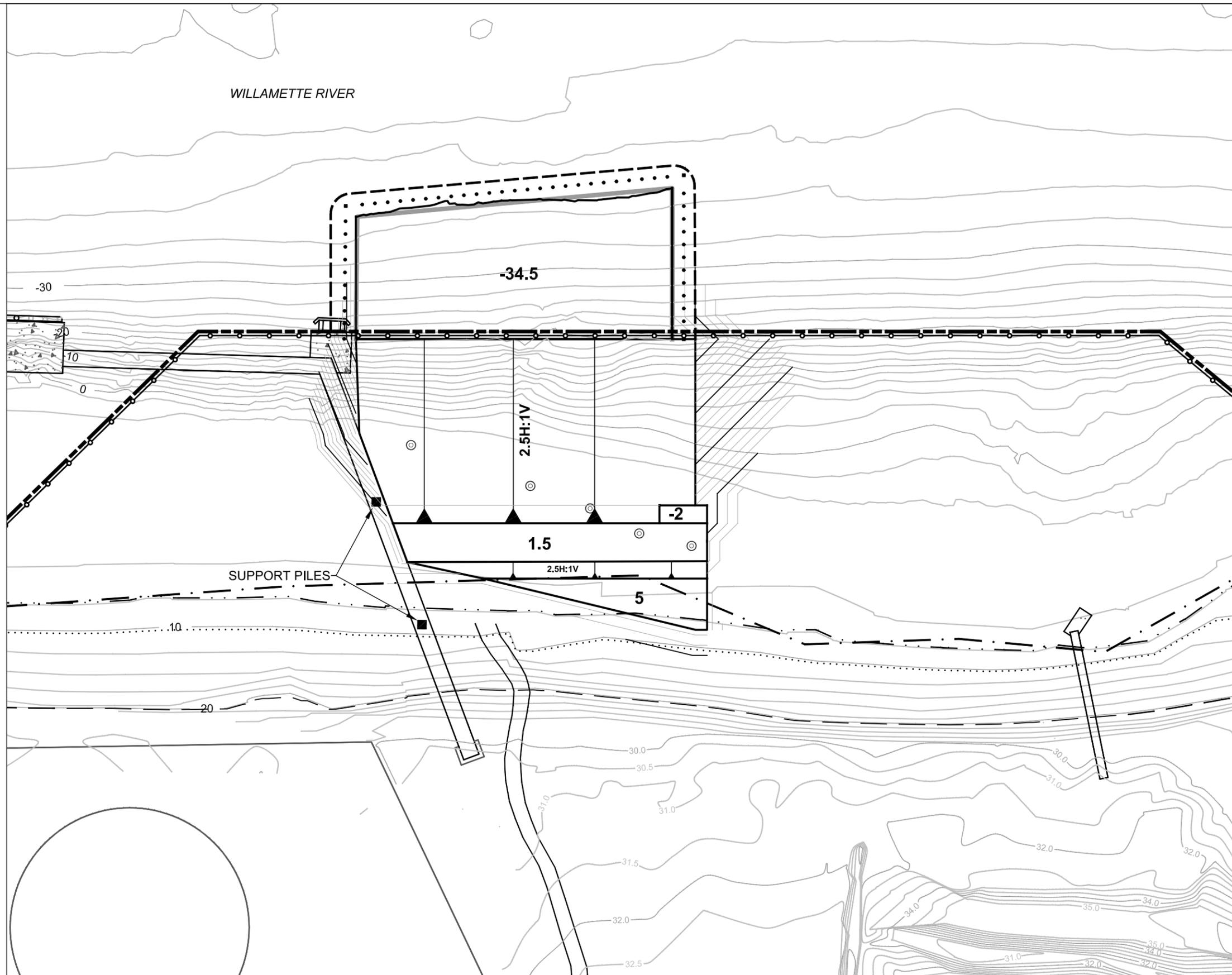
Legend:

- 1.5 Dredge Prism and Dredge Elevation
- · — Property Line
- — — — — OHW = 20.41 ft NAVD 88
- · - · - · - OLW = 7.91 ft NAVD 88
- · · · · 50% River Stage Elevation = 10.23 ft NAVD 88
- — ○ Oil Absorbent Boom (Mobile)
- — — — — Full Length Silt Curtain (Anchored)
- - - - - Oil Containment Boom with Skirt (2 Ft) (Mobile)
- — — — — Bed Load Baffle
- · · · · ■ Bubble Curtain
- ⊙ Pile Location (To be removed before dredging)
- Support Pile Locations (to be protected during dredging)



Notes:

1. Bathymetric contours provided by the Lower Willamette Group as part of the Portland Harbor Superfund Site study (2003).
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002)
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD88 (feet).
5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report, Hahn & Associates, 1998.



May 11, 2005 12:28pm cdaavidson K:\Jobs\000029-GASCO\00002902\00002902-558.dwg FIG 6a (2)

**Figure 6a**  
Containment Configuration for Inner Removal Area  
NW Natural "Gasco" Site

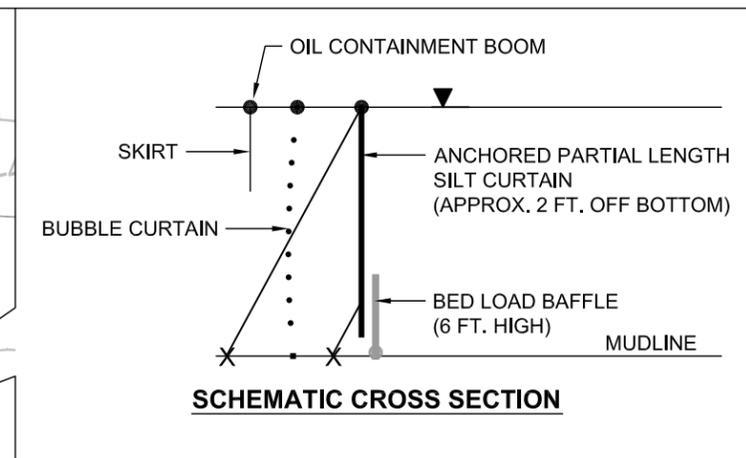
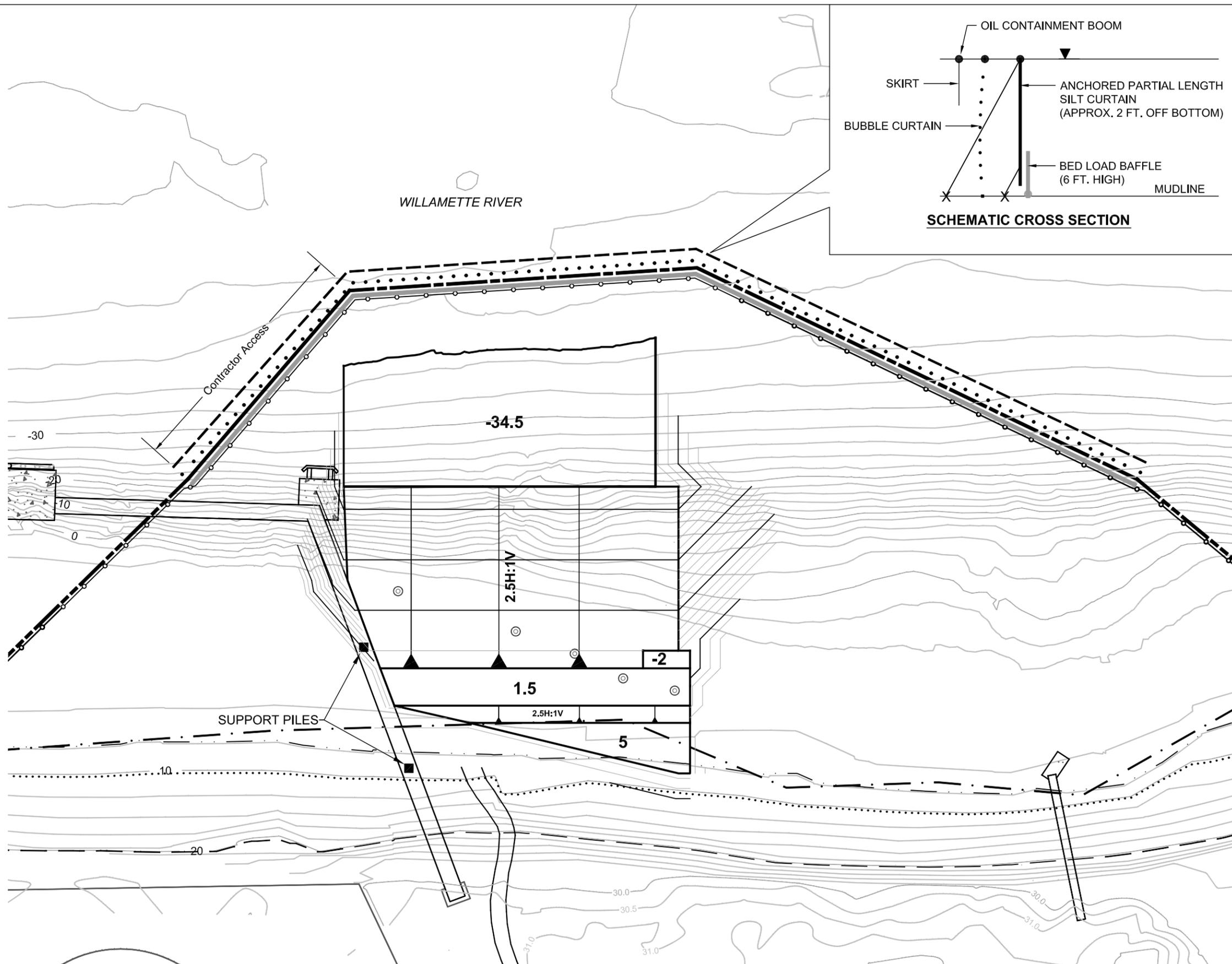
Legend:

- 1.5** Dredge Prism and Dredge Elevation
- · — Property Line
- — — — — OHW = 20.41 ft NAVD 88
- · - · - · - OLW = 7.91 ft NAVD 88
- 50% River Stage Elevation = 10.23 ft NAVD 88
- — ○ Oil Absorbent Boom (Mobile)
- — — — — Full Length Silt Curtain (Anchored)
- - - - - Oil Containment Boom with Skirt (2 Ft) (Mobile)
- — — — — Partial Length Silt Curtain (Mobile "Door")
- - - - - Partial Length Silt Curtain (Anchored)
- — — — — Bed Load Baffle
- · · · · Bubble Curtain
- ⊙ Pile Location (To be removed before dredging)
- Support Pile Locations (to be protected during dredging)



Notes:

1. Bathymetric contours provided by the Lower Willamette Group as part of the Portland Harbor Superfund Site study (2003).
2. Upland topography directed by Anchor Environmental as part of upland investigation (2002)
3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
4. Vertical Datum: NAVD88 (feet).
5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report, Hahn & Associates, 1998.



**DRAFT**

**Figure 6b**  
Containment Configuration for Outer Removal Area  
NW Natural "Gasco" Site

May 11, 2005 12:29pm cdauidson K:\Jobs\000029-GASCO\00002902\00002902-67.dwg FIG 6b (2)

The removal would be staged such that the inner shoreward area removal is conducted first, followed by removal in the outer channel area. In both areas, the non-rigid containment barriers would function to isolate the vicinity of the removal area in order to exclude fish from entering the removal area, and minimize migration of suspended particulates, floating material (e.g. sheens), and bedload outside of the removal area vicinity. Following installation of the non-rigid containment system and prior to any dredging activities, fish within the containment will be removed by seining. Non-rigid containment would be regularly inspected from the surface for proper placement and operation (e.g., checking for anchor dragging, rips, or other wear). River velocity measurements will be collected during all in-water removal activities to ensure velocities do not exceed the threshold for use of the containment barriers. In addition, if water quality monitoring (see below) indicates plumes that could not be clearly associated with other operational issues, divers would be deployed to inspect the silt curtains for potential tears, clogging, or other problems.

Dredging in the inner removal area may be conducted either by loading material across the silt curtain barrier, or alternately, haul barges may be moved through a “door” in the silt curtain that can be temporarily opened. At this time it is anticipated that the inner containment barriers will not have a door. Therefore, an extra dredge and haul barge will offload the material from the inner haul barge to a transport haul barge outside of the inner primary containment. A separate silt curtain, bedload baffle curtain, oil boom, and air bubble curtain will contain the off-loading equipment. Additional discussion on the specific environmental controls to be used while loading and transporting the barges in both scenarios is provided in the EE/CA (Anchor 2005) and in the Removal Action Environmental Project Plan (RAEPP), which is Appendix E of the Draft Final RAPP (Anchor 2004b), and is attached to this document as Appendix C. Both the removal material haul barges and the fuel barges that periodically moor at the Gasco dock will be carefully put in place using tug boats. The purpose of this procedure will be to prevent propwash or wakes from affecting the anchoring and/or performance of the silt curtains and other containment features.

Dredging in the outer removal area will involve one barge and crane, and the outer containment barrier will have a door (unlike the inner containment barrier). When haul



barges are at 85 percent capacity and ready to leave, dredging will stop and a door in the outer containment area will be opened briefly to allow haul barge passage. Prior to opening the door, construction activities within the containment area would be halted for a short period until visual signs of suspended material in the water column subside. To minimize the exchange of water from within the containment area and to exclude fish from entering the area, the door would be opened for a minimal time period and a bubble curtain would be placed across the door. The door is expected to be on the downstream side of the removal area because this location is protected from currents that might enter the contained area and circulate suspended sediments out of the contained area.

For water column impacts, water quality modeling indicated that without containment, there is an approximate 10 percent chance that one chemical (benzo(a)pyrene) would exceed acute water quality criteria at 200 feet from the dredge operation (Anchor 2005, Table F-2, Appendix D of this document), which is approximately equivalent to the monitoring distance required by EPA for this project of 150 feet from the outer containment barrier. With the estimated reduction of impact with proposed BMPs, this probability would be reduced to approximately 5 percent (Anchor 2005). It is expected that further improvements in water quality would be provided by these other BMPs, but these improvements are difficult to quantify. These improvements apply to both particulate and dissolved phase chemicals, which have been shown to be reduced both by impermeable and permeable silt curtains (Landau and Hartman 1999).

The bedload analysis provided a higher range estimate that approximately 3,165 kg of total polycyclic aromatic hydrocarbons (TPAH) could be lost due to bedload movement during the removal action (Anchor 2005). The bedload baffle BMP is estimated to reduce this loss by approximately 75 percent. To understand the potential for impact to downstream areas from this bedload loss, it was conservatively assumed that the full 3,165 kg of TPAH would be lost downstream, and that this material settled and was incorporated into the top 10 cm of sediment over a 0.25 acre (1,000 square meter) area. For comparison, the downstream side of the fringe cap would cover approximately 0.12 acres. The resulting sediment TPAH concentration over this 0.25 acres would be 12.7 mg/kg, well below the sediment guideline Probable Effects Concentration (PEC) of 22.6



mg/kg (see Anchor 2005). Consequently, even if the above conservative estimates are substantially in error, it appears that the mass of TPAH available for bedload loss from this removal would be minimal and likely represents a very small potential for risks to downstream sediments. Further, this analysis indicates that variations on silt curtain “door” placement locations would cause little if any change in the likelihood of any downstream impact due to bedload movement.

The potential for floating material (e.g., sheen) impacts was qualitatively estimated. Given the proposed multi-layered approach to floatable BMPs proposed for this alternative, the overall impact from sheens or similar issues is expected to be either small and/or unlikely, although possible.

It is not necessary to have one apparatus, such as a “full length” silt curtain in place to provide a barrier to each mechanism of transport, nor is that necessarily more effective. The overall function of silt curtains is to deflect and reduce the movement of water within the water column of a given area. They cannot, and are not intended to, completely stop the movement of all water around a site. The overall effect of silt curtains is to greatly diminish (but not eliminate) water flow, thus containing the vast majority of the turbidity and dissolved chemicals typically associated with dredging. Consequently, silt curtains that extend to the bottom do not prevent all water movement or any associated bedload movement at the bottom, because some gap at the bottom, however small, would still exist. The further result of this is that full length silt curtains are not the ideal apparatus for preventing bedload movement or movement of materials suspended very close to the bottom.

For the outer removal area silt curtain configuration, the approximate 10 foot horizontal separation between the partial length (i.e., 2 feet from the bottom) silt curtain and bedload baffle (i.e., extends 6 feet upwards from the bottom) results in a potential pathway for suspended sediment and dissolved constituents to flow underneath the 2 foot gap in the silt curtain and above the bedload baffle. However, this potential transport mechanism will likely be negligible given the low water velocity currents within the silt curtains (i.e., summer low flow river currents will be deflected and further reduced by the curtains) and relatively small gap height. For the fraction of constituents

that is potentially released, the environmental impacts are expected to be minor. For example, the water quality analysis indicates that, even without any containment whatsoever, there is only approximately a 10 percent chance that one chemical (benzo(a)pyrene) would exceed acute water quality criteria at 200 feet from the dredge operation (Anchor 2005, Table F-2, Appendix D of this document). In any case, the silt curtain containment was conservatively assumed in modeling to reduce dispersion of suspended concentrations by 50 percent.

There is also a potential for additional resuspension and loss of bedload material when non-rigid containment is removed at the end of the project (although this is relatively minor when compared to the removal of a rigid containment structure). In addition, the resuspension of sediments due to silt curtain anchor removal would likely be very minor in comparison to the removal itself. As noted above, even if all the material accreted near a bedload baffle were lost once that baffle was removed, the downstream impacts from such material are expected to be very minimal.

The removal and capping would be confined to the construction work windows, so impacts to key fish resources would not be expected. The BMPs used to exclude fish from the construction area also reduce the likelihood of these impacts. For the removal activities conducted within the inner area, the entire area will be fully contained by a full length silt curtain, and fish will be removed from the area prior to construction activities. For the removal activities conducted within the outer area, fish will also be removed from the removal area but there exists some potential for fish to enter the removal area during construction via the gap under the silt curtain on the channelward portion of the area. The proposed bubble curtains, which create a bubble barrier from bottom to surface, are expected to further deter the entry of any fish through this gap.

#### **3.3.4 Barge Transportation, Dewatering, and Off-loading**

When the sealed haul barge is filled to approximately 85 percent capacity, the barge will be pushed down the Willamette and then up the Columbia River navigation channel to the Port of Morrow transloading facility located near Boardman, Oregon for off-loading. No in-water construction or releases of any kind are proposed anywhere outside the immediate removal action area on the Gasco Site. No water or solid materials will be

released to any waters that the sealed haul barges are traversing or at the off-loading facility.

Once the barge is properly secured at the Port of Morrow, a sufficient volume of drying reagent (i.e., quicklime, cement, or paper byproduct) would be placed directly into the barge by a crane. The drying reagent would be worked into the dredged sediments while on the haul barge with the off-loading crane. A clamshell bucket would then be used to mix the drying reagent into the dredge material. A bobcat or similar small piece of equipment would be used to move sediment in the barge and assist in mixing and unloading. The material would be tested after mixing using the Paint Filter Test to ensure the material is consistently and sufficiently dried throughout the barge. Once the consistency of the material is sufficiently solid, the material would be transferred from the barge to trucks using a clamshell bucket lifted by a crane located on the dock and placed into lined trucks using a hopper to avoid spillage. Spillage of material will be prevented using the BMPs including spill aprons over the water and spill control structures on land that prevent any material from spilling directly into the water or running off the dock and into the water (see Anchor 2005). No water will be released from sealed barges while they are docked at the transfer facility. No water or material will be released from the upland transfer facility to the river. BMPs are described in the draft Final RAPP Appendix E (Anchor 2004b) (Appendix C of this document) and further detailed in the EE/CA (Anchor 2005). They are also consistent with EPA's subsequent transport-related disposal standards (USEPA 2005).

### **3.3.5 Truck Loading, Transportation, and Disposal**

After loading, trucks would be inspected and covered to avoid loss of material between the transfer facility and the landfill. Once a truck is cleared to leave the facility, the load would be documented on a trip ticket that would be carried by the driver, with the information recorded by the construction contractor at the transloading facility. Material will be trucked and disposed at the ChemWaste Subtitle C, hazardous waste landfill in Arlington, Oregon. The ChemWaste Landfill has a double liner, incorporating leak detection and leachate collection, as required for hazardous waste (Subtitle C) disposal facilities. BMPs would be implemented to prevent accidental tracking or spilling of contaminated material during overland transport to the disposal facility.

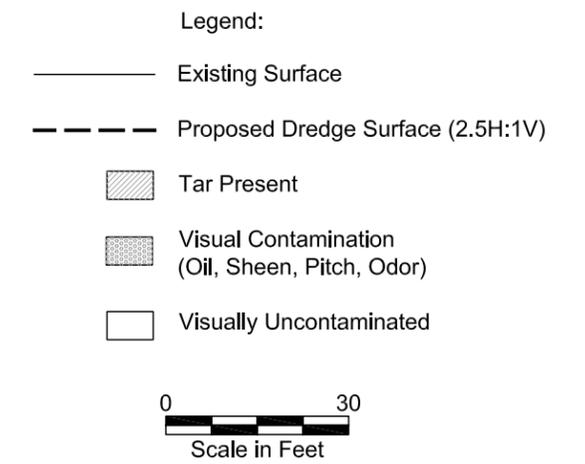
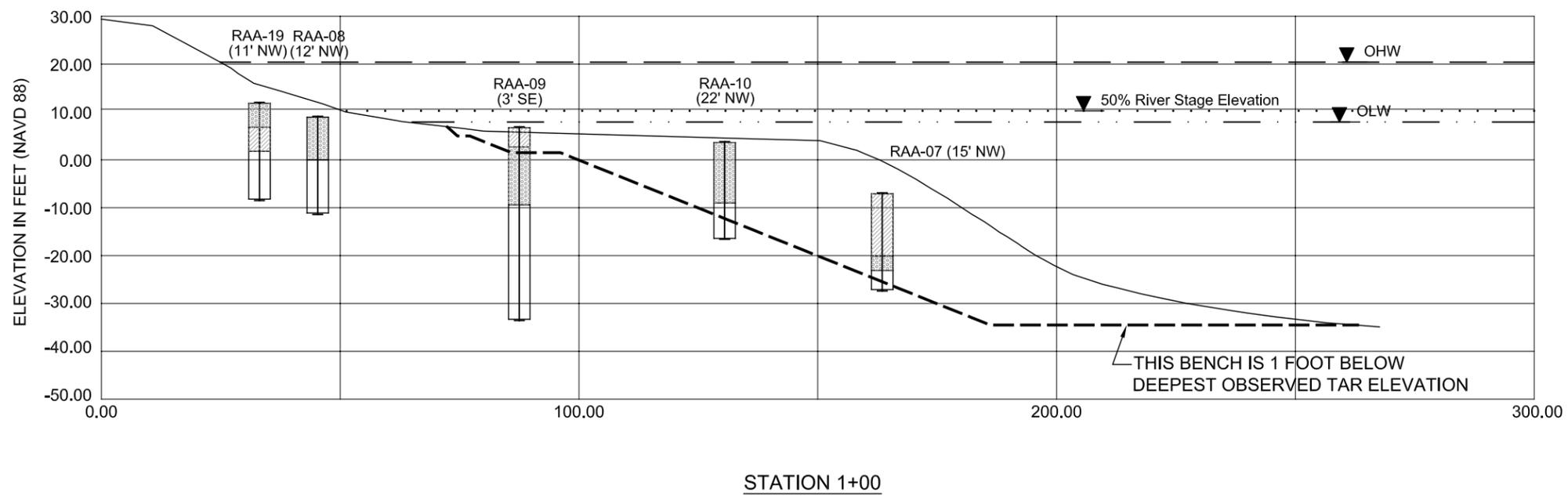
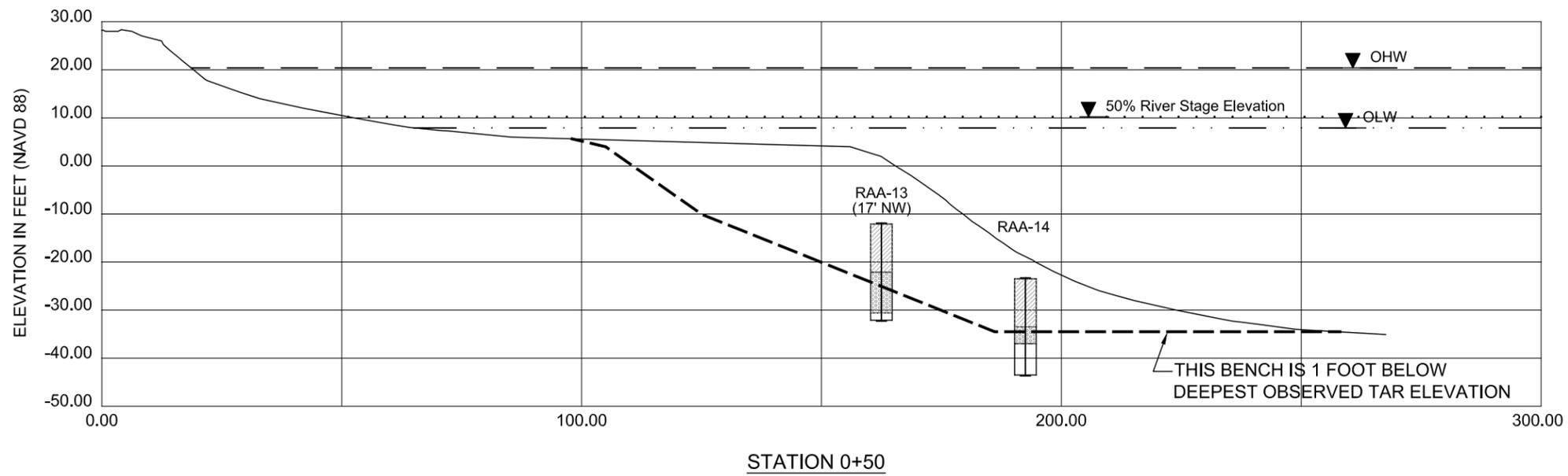
Additional BMPs, such as curbing, would be implemented to prevent surface runoff from the upland portion of the transfer facility to elsewhere at the facility or into the river as noted in the previous section.

### **3.4 Environmental Contour of Dredging Area**

The change in bathymetry as a result of the removal is shown in Figure 4. Based on the Ordinary Low Water (OLW) (4.5 feet mean sea level, 7.9 feet NAVD 88) and Ordinary High Water (OHW) (17.0 feet mean sea level, 20.4 feet NAVD 88) elevations provided by the Oregon Department of State Lands as well as the river mile adjusted 50<sup>th</sup> percentile flow elevation based on the Morrison Street Bridge USGS gage (station 14211720), the surface elevations of the tar body during the removal action will be submerged beneath approximately 0 to 45 feet of water during the removal (Figures 7a and 7b). Daily tides at the Morrison Street Bridge are usually in the 2 to 3 foot range and would not greatly affect water levels in the project area.

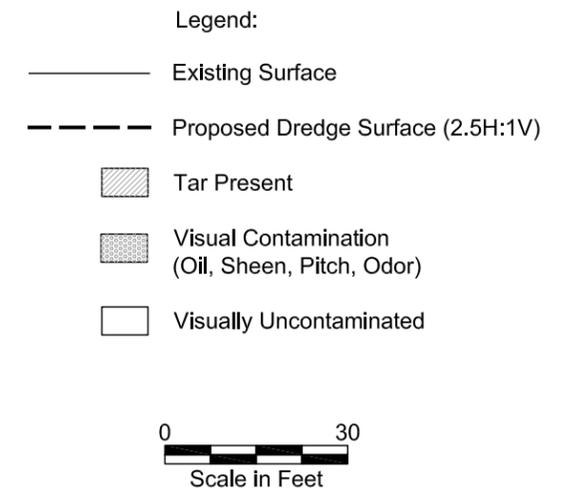
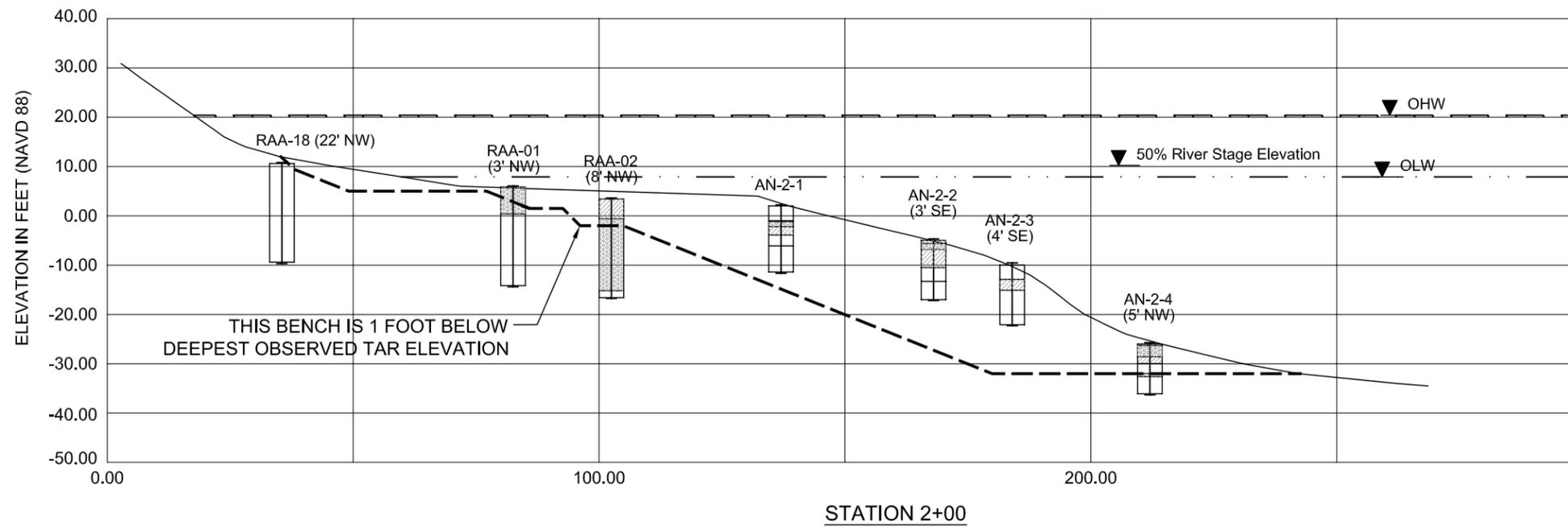
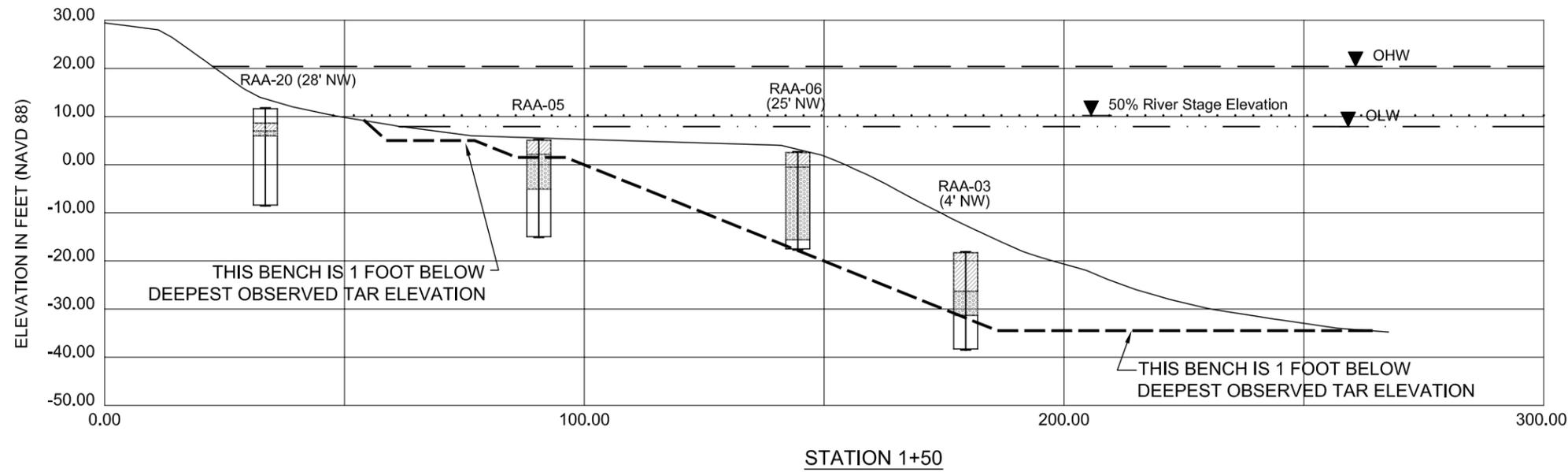
### **3.5 Water Quality**

Conservation measures will be employed as noted in Section 3.3.3. Water quality monitoring will be conducted during all parts of the removal and any exceedances will trigger the implementation of additional controls. Methods (including parameters, locations/depths, frequency/schedule, background surveys, visual monitoring, and equipment) are consistent with the substantive requirements of a Section 401 Water Quality Certification in the State of Oregon, and are further described in Appendix D of the RAPP (Anchor 2004 b) and refined in the EE/CA (Anchor 2005).



Apr 27, 2005 3:48pm cdavidson K:\Jobs\000029-GASCO\00002902\00002902-16.dwg FIG 7a

Apr 27, 2005 3:50pm cdavidson K:\Jobs\000029-GASCO\00002902\00002902-46.dwg FIG 7b



For all operations, field and laboratory water quality parameters will be monitored in the river no more than 150 feet directly upstream (for background conditions) and no more than 150 feet directly downstream of the edge of the primary containment barrier. Three downstream stations will be monitored in an arc as shown in Figure 8. Although the river is tidally influenced at this location, it infrequently undergoes flow reversals due to tidal changes. If flow reversal is observed during construction, then the sampling will be conducted downcurrent and upcurrent (for background conditions) as appropriate. Field parameters for monitoring include: turbidity, temperature, dissolved oxygen, pH, and visual monitoring for sheens. Laboratory parameters include: PAHs (anthracene, benzo(b)anthracene, benzo(a)pyrene, fluoranthene, fluorene, naphthalene, and phenanthrene) and cyanide. For the first sampling event (see Water Quality Monitoring Plan Section 2.2.2, Appendix D of RAPP), an upstream grab sample for these chemicals at the same distance will also be taken to establish background conditions. Visual monitoring will take place for high turbidity, sheens or other visible contamination, and distressed or dying fish whenever construction is actively underway. River velocity measurements will be collected during all in-water removal activities to ensure velocities do not exceed the threshold for use of the containment barriers.

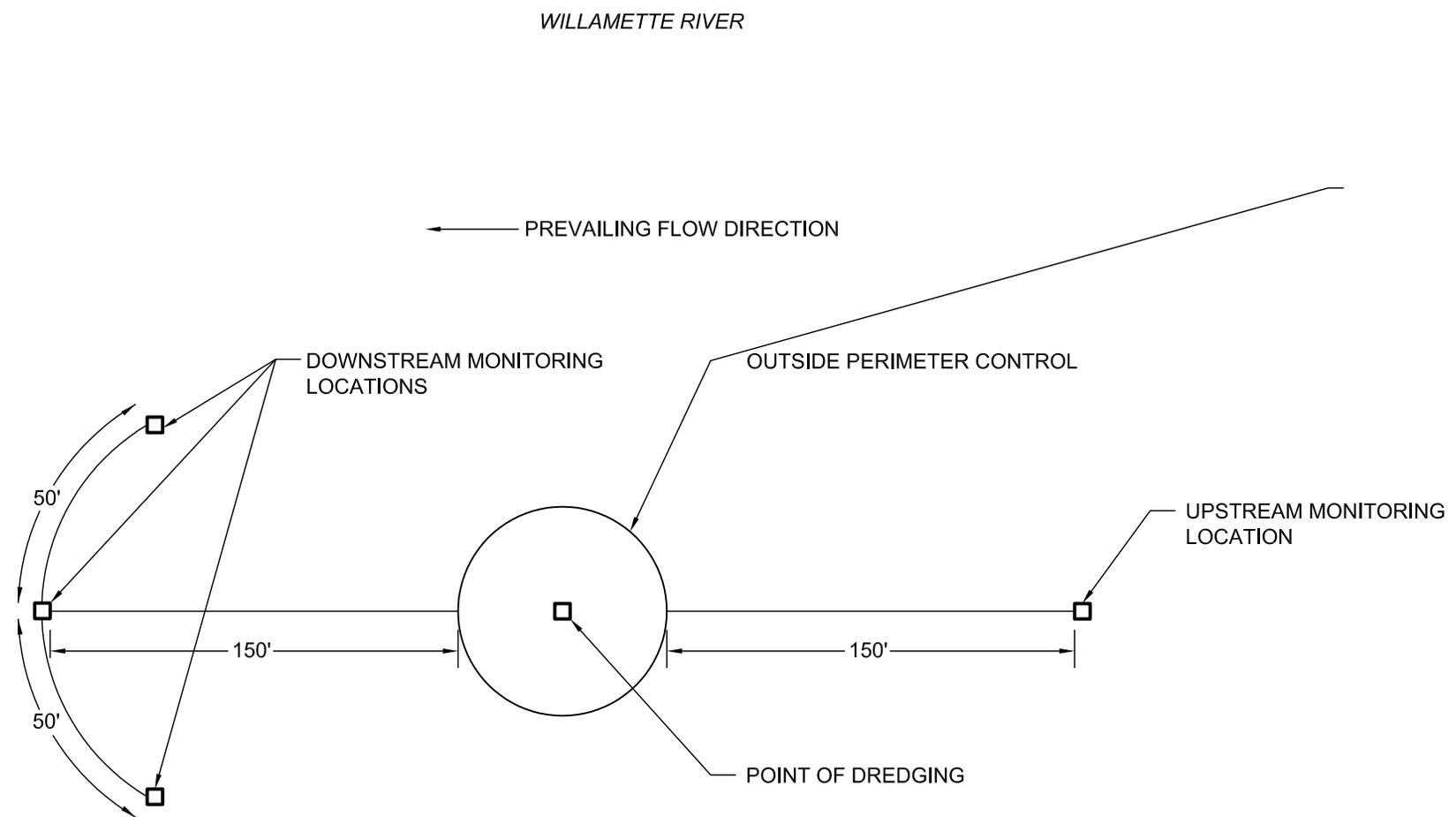
### 3.6 Timing

Federal and state agencies have established work windows to be protective of potential effects to salmonids due to construction activity. In the Lower Willamette River, work windows are in the late summer and fall, from July 1 through October 31, and in the winter, from December 1 through January 31. The draft BA reflected the RAPP draft preliminary design proposal to undertake removal during the winter window. However, EPA has agreed that construction in the July 1 through October 31 work window is more protective of fish, and this draft final BA evaluates the impacts of the removal action on listed species during this period of time.

Most of the construction work will be conducted in September and October 2005. Schedule delays could potentially occur due to maintenance issues associated with the silt curtains and/or successive water quality monitoring exceedences. However, such schedule delays are expected to be unlikely and would be on the order of a few days.



K:\Jobs\000029-GASCO\00002902\00002902-49.dwg FIG 8  
Apr. 27, 2005 3:52pm cdavidson



**Figure 8**  
Schematic Showing Water Quality Monitoring Locations for Field Measurements  
NW Natural "Gasco" Site

### 3.7 Conservation Measures

Conservation measures will be employed to control potential releases to the environment and protect potential receptors. Many of these measures are discussed in Section 3.3.3. The RAEPP (Appendix C of this document) identifies further detail regarding the environmental controls and BMPs that will be implemented to minimize adverse short-term impacts arising from the removal action.

The following conservation measures and BMPs will be implemented during dredging and capping activities:

- The dredge area will be contained within a multiple barrier system during pile removal, dredging, and capping activities (see Section 3.3.3 for detail).
- If currents exceed 1 foot per second (fps; the design speed for the barrier system), operations will stop until currents are below this velocity. The anticipated range of water velocities in the removal action area from July 1 to September 1 is about 0.1 to 0.3 fps, and from September 1 to October 31 is approximately 0.1 to 0.6 fps.
- At all times, the containment barriers will be observed for proper deployment, effectiveness, signs of unacceptable sailing or dragging. In these cases, operations will stop until the curtains can be deployed in a manner that prevents these issues (e.g., additional or different anchoring methods).
- Seining will be implemented to remove as many fish as possible from within the containment barrier before dredging activities are initiated.
- Unless otherwise authorized, the contractor will adhere to timing restrictions specifying allowable in-water work periods. Dredging and capping are expected to be completed by closure of the summer/fall in-water work window (July 1 to October 31).
- The project will adhere to water quality protections and other conditions consistent with the substantive requirements of a 401 Water Quality Certification for this action.
- Turbidity and sheens will be settled/removed before silt curtain doors are opened.
- If a sizeable or substantial sheen is observed, existing protective measures will be reevaluated for efficacy and additional controls deployed per the project RAEPP (Appendix C). Additional sorbent pads, booms, and other sorbent material will be



- on site at all times to be deployed to remove and isolate visible contamination beyond routine sheens.
- A spill response team and an oil skimming response boat will be on call at all times during construction to remove large sheens in the event that any such sheens occur.
  - Existing shoreline characteristics will be maintained to the maximum extent practicable during construction.
  - Standard dredge operation controls will be practiced including taking no multiple bites, no bottom or beach stockpiling of dredge material, minimal swing distance to receiving barge, no over-water swinging to the haul barge outside silt curtain, and pausing the dredge before opening/moving the silt curtain.
  - Additional dredge operation controls, if needed, will include longer dredge cycle times to reduce loss of material, potentially limiting dredging during peak currents, and the use of specialty dredging equipment.
  - The appropriate size and type of bucket to minimize resuspension has been determined per the RAPP.
  - GPS will be used to determine correct bucket location during dredging.
  - Standard barge loading controls will be observed including no barge overfilling (85 percent capacity) to minimize sediment loss when placing excavated material on the receiving barge and use of only sealed barges that allow no water loss from the barge while outside containment barriers.
  - Barges will be sealed. Water releases will only be allowed within containment barriers and will be filtered before release.
  - Metal spill aprons, upland spill control curbing and collection systems, and other spill control measures will be used when transferring material from the haul barges to the transloading facility.
  - Equipment such as fuel hoses, oil drums, oil or fuel transfer valves and fittings will be checked regularly for drips or leaks, and shall be maintained in order to prevent spills into river water.
  - Cover/cap materials will be placed in a controlled and accurate manner, “sprinkling” the material rather than dropping it in larger amounts, and working from lower to higher elevations.
  - Sediment cap/cover material will comply with the standards specified in the December 2003 Technical Plans and Specifications for the McCormick and Baxter



- sediment cap (Environment and Ecology 2003 Section 2.2), and will be an imported, clean, granular material free of roots, organic material, contaminants, and all other deleterious material.
- Wood piling will be pulled, rather than dug, whole from within the silt curtain. Floating debris generated during pile removal and construction will be retrieved and disposed of at an appropriate facility.
  - Operations will be stopped temporarily if injured, sick, or dead listed species are observed in the project area to determine if additional fish are present and to ensure that operations may continue without further impact. NOAA Fisheries Law Enforcement will be notified, and fish will be handled with care to ensure effective treatment or analysis of cause of death. Measures described in the RAEPP will be taken to revise any activities that may have led to the observed problems and exclude fish from the immediate area before work is reinitiated.

The following conservation measures and BMPs will be implemented during transportation and disposal activities:

- No dewater will be created or discharged. Any free liquid remaining in the haul barge after drying reagents are added will be removed and contained for appropriate disposal (either at an appropriate waste water treatment facility or by placing free liquid into the dried material along with additional drying reagent as necessary to remove the free water).
- Dock curbing will be used to prevent any potential spill material and rain water from entering the river.
- Water quality monitoring will be conducted around the barge at the removal and upland transfer facility to confirm that material has not been released.
- Spill response and contingency plans will be included in the final RAPP consistent with EPA's performance standard for transport (USEPA 2005).
- Once over land, the bucket will be emptied into a hopper to funnel material directly into lined trucks.
- Trucks will be water tight and covered during transport to the disposal facility.
- Trucks will be loaded on disposable pads/tarps and underloaded to minimize loss during transport.



- Routine visual inspections of the truck loading area and access routes will be performed.
- The transfer area and all equipment used in transfer activities will be cleaned and decontaminated.
- The effectiveness of these BMPs to control off-site tracking will be assessed through pre- and post-construction soil sampling at the transfer facility and access road, as required by EPA.
- Access to the transfer facility and disposal site will be restricted to authorized personnel.
- Heavy equipment will be decontaminated according to the established facility procedures following contact with Gasco material before moving to an area where hazardous wastes are not actively managed.

## 4 ENVIRONMENTAL BASELINE

The project area lies in the area of Portland designated as an industrial sanctuary within Section 12, Township 1 North, Range 1 West. This chapter describes background information on the area and discusses the environmental baseline of the existing habitat.

### 4.1 Site Background

The Willamette River watershed covers approximately 11,500 square miles in northwest Oregon between the Coast and Cascade mountain ranges. The river travels 187 miles from its headwaters to its mouth at the Columbia River. Most of the rainfall occurs in the fall, winter, and spring, with little rainfall during June, July, and August. The lowest river flow occurs during late summer. Thirteen U.S. Army Corps of Engineers (USACE) dams on tributary systems largely regulate flows in the mainstem Willamette River.

The Gasco Site is located at approximately RM 6 on the west bank of the Lower Willamette River in the Portland Harbor. The City of Portland has zoned the area “heavy industrial,” and the Site is bounded by St. Helens Road to the southwest, the Willamette River to the northeast, and industrial properties to the southeast and northwest (Hahn and Associates, Inc. [HAI] 1998).

The Portland Gas and Coke Company (Gasco) conducted oil gasification operations at the Site from approximately 1913 until 1956, and also engaged in by-products refining during that time. Historically, Gasco also leased portions of the property to other companies for coal-tar distillation and bulk transfer of creosote oil and coal tar pitch. Prior to construction of on-site settling ponds in 1941, oil gasification operations at the Site resulted in direct discharge of oil and tar to a low area on the property that drained via a former channel to the Willamette River sediments (Anchor 2004b).

The oil gasification plant at the Site shut down in 1956. NW Natural currently owns and utilizes the Site for liquefied natural gas storage and distribution, and leases portions of the Site for bulk petroleum storage and distribution, and for coal tar pitch distribution (Anchor 2004b).

Currently, the Site ranges from mostly paved or gravel-covered in the southwestern, western, and central portions of the property, to mixed grass and trees in the northern and southeastern portion of the property. The southeastern portion of the Site (former tar pond area) occupies approximately 10 undeveloped acres of grasses, trees, and a small pond.

## 4.2 Action Area

The action area is the defined geographic area directly and indirectly affected by the proposed project. Physical, chemical, and biological factors were examined and evaluated to indicate baseline conditions from which to evaluate potential effects of the project on the action area. The dredging and capping involved in this project may result in the entrainment or temporary resuspension of sediments or contaminants in the water column, which could pose potential direct and indirect impacts to endangered or threatened species and their habitats. Therefore, the action area includes all aquatic habitat within the containment barriers including the approximately 175-foot by 200-foot dredge footprint, an area extending to approximately 100 feet downriver of the footprint, the barge loading and off-loading vicinities, and the federally authorized navigation channel between the dredging location in the Portland Harbor (approximately RM 6) on the Willamette River and the off-loading facility at the Port of Morrow (approximately RM 270) on the Columbia River. The tar body, and therefore the dredge footprint, is located on the west side of the Lower Willamette River, immediately upstream of the primary Site dock, and extends from an elevation of approximately -35 feet NAVD 88 up to the riverbank. The water depths in the summer over this area are expected to range from 0 to 45 feet deep.

## 4.3 Physical Indicators of Baseline

### 4.3.1 Shoreline, Slope and Sediment Trends

The majority of the shoreline along the Gasco Site is vegetated or riprapped, with some areas of exposed soil. A shoreline stabilization plan has been submitted to Oregon Department of Environmental Quality (ODEQ) for review. The shoreline in the vicinity of the tar body is relatively flat with some herbaceous vegetation at the toe of a steep bank, which separates the shoreline from the uplands (Photo 1).

The ground surface at the Gasco Site slopes gradually northeastward towards the Willamette River. Surface elevations range from approximately 38 feet above mean sea

level (msl; City of Portland datum) at the southwestern portion of the property, to approximately 23 to 30 feet msl at the top of the riverbank. The bank slopes steeply to an elevation of approximately 5 to 8 feet msl, below which exists the shoreline with a more gradual slope (HAI 1998).



**Photo 1**  
**Site Shoreline**

The sediment trend analysis performed by GeoSea Consulting Ltd., (2001) indicates that the depositional environment near the Gasco Site is in dynamic equilibrium, with some specific locations undefined. Adjacent to the Gasco Site, sediments are deposited and scoured in sequence depending on river conditions, with no appreciable net gain or loss of sediment volume. The bathymetry adjacent to the Site has been fairly stable, reflecting human intervention (construction) more than significant erosion or deposition. The bathymetric surveys performed in January 2002 and May 2003 support the conclusion that the shoreline adjacent to the Site is in dynamic equilibrium. The comparison of the two surveys shows small amounts (as much as 1 to 2 feet) of

deposition along much of the shoreline adjacent to the Gasco Site and some smaller areas of similar degrees (up to 1 to 2 feet) of erosion adjacent to the Site.

There are no ongoing discharges of tar or oils from the upland portions of the Site to the river, and seeps of oils or related product-type materials have not been observed along the shoreline of the Site either above or below the water line. Investigations are currently underway to understand whether there is a physical connection between tar and oil in the upland soils and the tar body and whether dissolved chemicals from upland product deposits may be transported via groundwater to the river (HAI 2005).

Substrate in the Columbia River navigation channel consists mainly of clean sand. Silt and clay make up less than 5 percent of the riverbed in the main channel. The river valley is underlain by deep sand deposits (USACE 1999). The channel bottom in the federally authorized navigation channel is dredged to -40 feet Columbia River Datum (CRD), with side slopes up to the natural river bottom depth. These side slopes are prone to slumping and drifting as the loose bottom sand responds to river currents.

#### **4.3.2 Physical Characteristics of Tar Body**

Field observations and laboratory results indicate that in 75 percent of the core locations, the tar and related material were relatively stiff at least within some layers at that location. At 25 percent of the stations, the surficial material was relatively soft and was difficult to recover. Observations of material adhered to sampling devices indicated it was likely deposited alluvial sediment and/or other soft tar-like materials. The physical characteristics of the tar material were spatially heterogeneous and varied in consistency from soft, sticky, plastic, stiff, firm, and brittle. The brittle material is generally gravel-size lumps of tarry sand that appears to have weathered. Much of the brittle tar is found on the sediment surface and was generally found at stations closer into the shoreline in areas that have been exposed to air during low flow conditions. Small pieces of this material were also found at depth in some cores.

During field work the low flow conditions exposed some areas of weathered tar above the water line. This material was stiff enough to walk on and support the weight of a track-mounted Geoprobe rig. Most of the tar present below this weathered layer was a

softer consistency. Although it smears on surfaces it touches, it is too viscous to flow noticeably and the intermixed sands and non-plastic silt/sands prohibited it from acting viscid when sheared in place. No pockets or deposits of liquid or semi-liquid oil were observed in any of the cores. None of the tar layers identified exhibited a noticeable sheen.

The visually contaminated zone varied in consistency from sediments with a slight hydrocarbon odor, slight sheen, slight sticky oil staining, and minor blebs of sticky oil and/or tar to sediments with more extreme hydrocarbon odor, heavy sheen, and sediments more heavily saturated in sticky oil and/or tar blebs. No free hydrocarbon product beyond small scattered oily blebs was identified in any of the cores either in tar or in visually contaminated sediments. All oily sediments encountered felt very sticky and viscous to the touch, were intermixed in a sand/silt matrix and did not flow noticeably during the core cutting and sampling procedure.

#### **4.4 Chemical Indicators of Baseline**

##### **4.4.1 Water Quality**

The Willamette River, from the mouth of the river to Willamette Falls, is currently listed on the 2002 ODEQ 303(d) list as limited in water quality for temperature, bacteria, biological criteria, and toxics for the time period 2001 and 2002. The closest ODEQ monitoring station to the action area is located at the SP&S Railroad Bridge (RM 5), approximately one mile upstream of the proposed project. According to ODEQ's ambient monitoring program, 16 percent of the temperature measurements collected at this station between January 2001 and February 2004 exceeded the ODEQ temperature standard of 20° C (ODEQ 2004). Turbidity levels in the Lower Willamette River tend to be highest in the fall and winter; measured turbidities at the SP&S Bridge monitoring station from January 2001 to February 2004 ranged from 3 NTU to 53 NTU, with the latter measurement recorded in December (ODEQ 2004).

There appears to be limited groundwater/surface water interconnectivity between the surficial fill water bearing zone (WBZ) and the river. Furthermore, contaminant concentrations within the surficial fill WBZ show marked decline between upland source areas and downgradient monitoring points located adjacent to the river. The

greatest groundwater quality impacts in the uplands at the Site have been identified in the upper alluvial WBZ near the southeastern corner of the property (i.e., former tar pond area and away from the riverbank). Studies are currently underway to resolve ODEQ's concern that groundwater may pose a risk to sediment and river water. These studies are being directed by ODEQ under the State Voluntary Cleanup Program.

To provide water quality information for the removal, samples were collected during the design characterization sampling and analyzed using the USACE Dredging Elutriate Test (DRET) method (DiGiano et. al 1995). This analysis is presented in detail in the RAPP, Section 3.5.1 and is summarized below in Section 4.2.1.4. A summary table is presented in Appendix D of this document.

Nutrient loading and contaminants enter the Columbia River through urban and agricultural runoff (USACE 1999). The Oregon 303(d) list also shows exceedances in the Columbia River for polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), DDE (DDT metabolite), and arsenic.

#### **4.4.2 Sediment Quality**

In 1997, ODEQ and EPA sampled sediment in certain areas within Portland Harbor. Results showed that sediments throughout the harbor contain concentrations of various contaminants above EPA preliminary screening levels used for that project. Investigation of these sediments is currently being addressed under CERCLA authority as part of the Federal Superfund process.

USACE (1996), Battelle (1997), HAI (1998), Weston (1998), Anchor (2001), and the Lower Willamette Group (2002) have collected surface sediment samples and cores between the Site shoreline and the edge of the navigation channel. In all, 44 sediment samples were collected from 21 locations. NW Natural also performed an investigation in 2001 to generally define the physical location of the tar deposit on the sediment; however, delineation was based on direct observations by divers, and did not include collecting additional samples. Surface sediment data have also been recently collected by the Lower Willamette Group for the Harbor Superfund Remedial Investigation/Feasibility Study (RI/FS), but those data have not yet been made available in data reports.

Field sampling for the design characterization was performed in July 2004 and is described in detail in the Draft Final RAPP (Anchor 2004b). At each sampling location, a subsample was collected from the tar body, visually contaminated zone, and visually uncontaminated zone for chemical analysis. The objectives of this characterization were to evaluate potential water quality impacts at the point of dredging, the disposal suitability of any removed materials, and the chemical concentrations within and below the visually contaminated zone. All samples were collected and analyzed in accordance with the EPA-approved Quality Assurance Project Plan (QAPP), which is an appendix to the RAWP (Anchor 2004a).

Select samples of the visually contaminated and visually uncontaminated sediments underneath the tar body were analyzed for bulk sediment chemistry. The purpose of collecting these data was to understand the concentrations of chemicals in sediments that might be incidentally removed with the tar, as well as in sediments that might remain after the tar is removed. The chemistry results are presented in detail in the RAPP, and summary tables are attached to this document as Appendix D.

The visually contaminated sediments have relatively high organic carbon content (likely associated with the presence of oil and tar blebs), total petroleum hydrocarbon (TPH) and PAH concentrations, whereas the visually uncontaminated sediments contain relatively normal levels of organic carbon for river sediments and substantially less TPH and PAH. Neither sediment zone has elevated levels of metals. Cyanide was detected in visually contaminated sediments. Cyanide was undetected in seven out of 11 visually uncontaminated sediment samples and was detected at low levels below the detection limit only in the remaining four of these samples. Most volatile chemicals were undetected in both sediment layers, except benzene, toluene, ethylene, and xylene (BTEX) compounds, which were often detected in the visually contaminated sediments. It is notable that BTEX compounds were undetected in the deeper visually uncontaminated sediment layer with only a few low level exceptions.

A streamlined risk evaluation was performed as per EE/CA guidance to evaluate baseline risk to ecological receptors from PAHs and other chemicals of interest for the

Site. The results of this evaluation can be found in Section 2.5.2 of the EE/CA. They indicate that the tar body and nearby sediments may pose risks in their present condition, as stations in and near the tar body have ecological hazard index values above one (hazard index values greater than one indicate a potential risk for direct toxicity to aquatic organisms) based upon conservatives screening levels. A risk assessment for both human health and ecological receptors is being conducted under the Portland Harbor RI/FS, but this document is still under development and discussion.

The substrate in the Columbia River navigation channel is generally clean sand and contains very little organic matter. Sediment quality in this area has been evaluated under the Dredged Material Evaluation Framework (DMEF) Lower Columbia River Management Area, developed cooperatively by the USACE, Region 10 EPA, Washington Department of Ecology (Ecology), Washington Department of National Resources (DNR), and ODEQ (USACE et al. 1998).

## 4.5 Biological Indicators of Baseline

### 4.5.1 Prey Species

Benthic invertebrates in shallow water habitats are key food sources for juvenile salmonids and steelhead as they are found predominantly in the margins of larger rivers (Healy 1991; McCabe et al. 1986). Studies of benthic infauna in the Lower Willamette River indicate that the communities in this area are dominated by oligochaetes and chironomids, which feed on organic matter, algae, and bacteria in the sediments (Integral et al. 2004).

However, analysis of the stomach contents of juvenile Chinook collected from the Lower Willamette River in 2002 indicates that they ate water column filter feeders. A subsequent draft Oregon Department of Fish and Wildlife (ODFW) study funded by the City of Portland supported this finding. The ODFW study revealed that juvenile Chinook and coho stomachs contained predominantly daphnia, an abundant water column species (Vile, Friesen, and Reesman 2004). This information suggests that Lower Willamette River juvenile Chinook may be tied to a pelagic food web rather than a benthic food web.



In addition to salmonid prey, bald eagle prey may be found in the action area. The bald eagles' diet may vary locally and seasonally. Carrion, waterfowl, non-anadromous fish and anadromous fish, particularly spawned salmon serve as important food items in fall and winter (USFWS 1986). Anadromous and warm-water fish, small mammals, carrion, and seabirds are consumed during the breeding season (Rodrick and Milner 1991).



## 5 SPECIES INFORMATION, ANALYSIS OF EFFECTS, AND EFFECTS DETERMINATION

ESA-listed species under USFWS and NOAA Fisheries jurisdiction that could occur in the vicinity of the proposed project are the listed bald eagle, Chinook salmon, chum salmon, coho salmon, sockeye salmon, bull trout, and steelhead trout. Potential direct and indirect effects of the action on these species are discussed below in detail. As discussed above, listed species have been added to this document that may be affected during material off-loading at the Port of Morrow in the Columbia River. Although these species are discussed, it should be emphasized that no in-water work is occurring in the Columbia River and that these additional species will only be affected in the unlikely event of an accidental spill during off-loading. BMPs and conservation measures to prevent such spills and for off-loading and handling in general are discussed previously in this BA and in Appendix C.

### 5.1 Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle is listed as a threatened species under the ESA. Since its listing, population goals in eight of 10 recovery zones in Oregon have been met or exceeded.

#### 5.1.1 Direct and Indirect Effects

Potential direct and indirect effects to the bald eagle from this project include short-term impacts to behaviors such as nesting, foraging, perching, and wintering.

##### 5.1.1.1 Nesting

The majority of nesting bald eagles in Oregon occur in the following areas: the Columbia River downstream of Portland, the Oregon coast and Coast Range, the High Cascades, Klamath Basin, and the upper Willamette River Basin. The majority of nest sites are within 1/2 mile of a body of water such as coastal shorelines, bays, rivers, lakes, farm ponds, and dammed rivers (i.e., beaver dams and log jams), and have an unobstructed view of the water. Bald eagle habitat typically occurs in undeveloped areas with little human activity. Nesting occurs from January 1 to August 15 (USFWS 1986).

The Pacific States Bald Eagle Recovery Plan recommends limiting construction activities near bald eagle nests during critical wintering and nesting periods. The

plan recommends construction and disturbance setbacks of 400 meters (1,313 feet) if the nest does not have a line of sight to the proposed construction activity, or 800 meters (2,625 feet) if the nest is within line of sight of construction. The nearest nest site to the dredging area occurs on the south side of Smith Lake, approximately two miles northeast of the dredge area on the Willamette River (J. Dillon, USFWS, personal communication, 2004). Other nest sites include Burlington Bottoms, along the Multnomah Channel, approximately four miles northwest of the dredge area and Ross Island, approximately nine miles south of the dredge area. The nearest nest to the offloading area at approximately RM 270 on the Columbia River occurs 19 miles away from the site (F. Isaacs, USFWS, personal communication, 2005).

At approximately two miles away, the nearest nest is significantly further away from the project vicinity than the protective 800 meters; therefore, the effects of project activities on nesting based upon location are minimal. Effects of project activities on nesting based upon timing are minimal after August 15, as the birds do not nest at this time. Nesting activities may overlap with the summer/fall construction window from July 1 to August 15; however, the distance to the closest nest from the project vicinity should minimize potential effects.

#### *5.1.1.2 Foraging*

Foraging habitat for bald eagles is typically associated with water features such as rivers, lakes, and coastal shorelines where fish, waterfowl, and seabirds are preyed upon. Bald eagle foraging is opportunistic and they feed on dead or weakened prey. They prefer high structures for perching, such as trees along the shoreline, but will also use other structures such as cliffs, piling, and open ground. They are usually seen foraging in open areas with wide views (Stalmaster and Newman 1979). Foraging could occur in the Lower Willamette River area when eagles are present at nest sites; however, there are many alternative opportunities for this behavior in the vicinity and along the Lower Willamette River, so adverse effects on foraging are not likely to be significant.

There is a potential for indirect effects to foraging eagles if they are exposed to potential bioaccumulative compounds on the project Site. The most significant

compounds found in the action area are PAHs, which do not bioaccumulate in vertebrates. Also, in general, bioaccumulation effects are most important for long-term exposures. The project will reduce the overall levels and extent of chemicals associated with the tar body over the long term.

Although not bioaccumulative, the metabolized intermediates of PAHs can be harmful and potentially carcinogenic. Animal studies indicate that exposure to PAH's with distinct chemical structure can lead to progressive anemia as well as agranulocytosis. The lymphoid system can also be affected, resulting in lymphopenia. Toxic effects have been observed in the intestinal epithelium, spermatogonia and resting spermatocytes in the testis and primary oocytes of the ovary. Epithelial proliferation and cell hyperplasia in the respiratory tract have been reported following subchronic inhalation exposure. There is adequate evidence of the carcinogenic properties of PAHs in animals (RAIS).

Although impacts to individual organisms could occur, the long-term implications of leaving these chemicals in place outweigh the short-term impacts of removal. The use of BMPs as described above is also expected to reduce the ability of any resuspended sediments or associated chemicals to disperse beyond the boundaries of containment measures. Further, many of these chemicals are found throughout Portland Harbor in sediments and water. Consequently, it is unlikely that the overall bioaccumulation of these chemicals in the food chain would be appreciably altered by the short-term resuspension of sediments in this relatively small area. The removal action may have an impact on individual organisms, but is expected to provide a net long-term benefit to populations by improving sediment quality in the river as well as the food chains potentially impacted by those chemicals currently present in sediments.

#### *5.1.1.3 Perching*

Perch sites may be used for activities that include hunting, prey consumption, signaling territory occupation, and resting. Perches are most often associated with food sources near water and will have visual access to adjacent habitats (Stalmaster and Newman 1979). Suitable perch trees exist along sections of the Lower

Willamette River corridor and likely in the adjacent Forest Park. However, as with foraging areas, opportunities exist for selecting alternate perching trees in the vicinity; therefore, adverse effects on perching are not likely to be significant.

#### 5.1.1.4 *Wintering and Winter Roosting*

Wintering bald eagles are found throughout Oregon, but concentrations occur in areas with dependable food supplies such as Klamath and Harney Basins and along the Snake and Columbia Rivers. Wintering activities for bald eagles occur from November 1 through March 1 (J. Dillon, USFWS, personal communication, 2004), and will not overlap with construction during the summer/fall work window. During the winter months, bald eagles forage, construct nests, and engage in courtship activities. The closest winter roosting area is in Burlington Bottoms, approximately four miles to the northwest. At this distance, the nearest winter roosting area is significantly further away from the project vicinity than the protective 800 meters; therefore, effects of project activities on winter roosting based upon timing and location are not expected. It is unlikely that there are any winter roosting areas above the Dalles Dam in the off-loading area vicinity at RM 270.

### 5.1.2 **Effects Determination Recommendation**

Based on the analysis above, the effects determination recommendation is that the *project may affect, but is not likely to adversely affect, bald eagles*. Minimal direct effects on bald eagle nesting are expected because the closest eagle nest occurs approximately two miles from the dredge area and 19 miles from the offloading area. Minimal direct effects on foraging or perching are expected because bald eagles generally have wide foraging and perching areas and, in addition, eagles in the Lower Willamette River are acclimated to consistent human and vessel traffic. Direct effects on winter roosting are not expected based upon timing and location of roosting areas. Because the project will remove a substantial mass of chemicals in sediments, the project is expected to provide a net benefit to eagles in terms of reduced exposure to chemicals in river sediments either directly or through food chain effects. There is a potential for indirect exposure to some chemicals during dredging immediately around the area of the dredge. However, these short-term and spatially small exposures are likely minor as compared to the overall presence of similar chemicals and chemical concentrations in

sediments and water throughout the Portland Harbor, which provide a much greater source of potential long-term chemical risks.

*This project is not likely to adversely affect the bald eagle because:*

- The closest bald eagle nests are two miles from the dredge area and 19 miles from the offloading area.
- There is no construction window overlap with the timing of winter roosting, and the closest eagle winter roosting area is four miles from the dredge area.
- Alternative opportunities exist to the Site vicinity for perching and foraging.
- The project is expected to provide a net benefit in terms of potential chemical exposures by permanently removing a substantial chemical mass from the river.
- There will be no post-construction change in use or increase in human disturbance in the area as a result of the project.
- Disturbance and noise from dredging equipment is not expected to significantly exceed current ambient noise levels generated by existing vessel traffic, and birds are accustomed to background noise levels associated with a working harbor.

## **5.2 Chinook Salmon (*Oncorhynchus tshawytscha*)**

The Lower Columbia River (LCR) and the Upper Willamette River (UWR) ESUs of Chinook may be found in the Willamette and Columbia rivers. The Snake River Fall (SRF), Snake River Spring/Summer (SRSS), and Upper Columbia River (UCR) Chinook may be found in the Columbia River portion of the action area during off-loading, but are unlikely to be found in the Willamette River. The UCR ESU of Chinook is listed as endangered, and all other ESUs of Chinook salmon in the action area are classified as threatened under the ESA.

The LCR ESU of Chinook salmon includes both the fall-run and spring-run stocks. Adults migrating to the Clackamas River experience peak migration in September and October, and continuing through November (NOAA Fisheries 2002b). Juveniles in this ESU migrate past the action area starting in March, continuing through July, with peak occurrence in April, May, and June (NOAA Fisheries 2002b). Based upon migration timing of this ESU, adults and some juveniles will likely be near the Site during the July – October proposed action. Peak outmigration of juveniles should be virtually complete before the July 1 start of this construction window.



Chinook from the UWR ESU are likely to be near the Site during the proposed action construction window. Adults from this ESU migrate through the Lower Willamette River beginning in March, and complete their migration by the end of July. Peak migration should be complete before July 1 construction begins, as this occurs between late April and early June. However, it is also possible that some adults hold for periods of time within the Portland Harbor (NOAA Fisheries 2002b). Chinook subyearlings typically pass through the action area from January through June, and from August through December. Yearlings may migrate through the Lower Willamette River anytime from March through mid-December. Subyearling Chinook have been found in the harbor area over a longer period than other species of salmonids, probably because they actively feed during migration. Some juveniles may over-winter in the Lower Willamette River (NOAA Fisheries 2002b).

Juvenile and adult SRF, SRSS, and UCR Chinook are not likely to be present in the Willamette River, but may be present in the Columbia River during off-loading. Adults are more likely to occur in the deeper water of the main channel. These ESUs migrate through and rear in the Columbia and Snake Rivers, and adults of some ESUs spawn in a few mainstem reaches between RM 113 and 142 (NMFS 2005). In the Columbia River Basin, SRSS adult Chinook salmon migrate upstream past Bonneville Dam from March – July, and SRF adults migrate past Bonneville in August – October (Burner 1951). Based on what is known of UCR fall Chinook salmon, juveniles in the Snake River presumably emerge from the gravel in March and April, and downstream migration usually begins within several weeks of emergence (Chapman et al. 1991). Rich (1922) studied the downstream migration of Chinook salmon in the lower Columbia River and concluded that fry were present from June to October. Juvenile UCR ESU spring Chinook salmon typically pass the upriver dams in early April and migration generally peaks in mid-May.

### **5.2.1 Direct and Indirect Effects**

Potential direct and indirect effects to Chinook salmon from this project include impacts resulting from disturbance to food source, entrainment, water quality effects, exposure to contaminants, and disturbance of existing aquatic habitat.

### 5.2.1.1 Food Source and Benthic Habitat

Dredging and capping typically result in the short-term loss of benthic organisms and their habitat, but in this case there is no benthic community on or in the tar body that will be removed. Therefore, there will be no loss or impact to benthic communities, and there may be improvement as benthic communities recolonize the dredge area once the tar body is removed.

If juvenile Chinook are tied to the pelagic food web, as recent site-specific studies suggest, impacts to the benthic community will likely have an even more limited direct effect on salmonids. However, impacts to pelagic species could result from short-term increases in turbidity, decreases in dissolved oxygen (DO), and resuspension of contaminants that may occur as a result of the project. Studies on *Daphnia spp.* reveal that there is evidence for photo-induced toxicity of PAHs, but the significance of this evidence in natural aquatic systems is not understood.

Southworth et al. (1978) showed that the time for *Daphnia pulex* to biotransform 50 percent of some accumulated PAHs ranged between 0.4 and 0.5 hours; however, Leversee et al (1981) recorded a 21 percent loss of benzo(a)pyrene in 18 hours in daphnids. Whitman and Miller (1982) found that naphthalene completely inhibited the phototactic response of *D. magna* at 2.0 mg/l and depressed the response at 1.0 mg/l. "In general, toxicity increases as molecular weight increases (although high molecular weight PAHs have low acute toxicity) and with increasing alkyl substitution on the aromatic ring" (Eisler 1987). However, *Daphnia spp.* exist throughout the water column, and impacts resulting from exposure to contaminants are not expected to be at a level that would affect the abundance of such ubiquitous prey items.

Ultimately, the removal of tar from the sediment at the Gasco Site will reduce exposure to existing contaminants and will provide long-term benefits to those species and their salmonid and steelhead predators by improving conditions for benthic habitat. NOAA Fisheries stated that for the 10 acre Middle Waterway contaminated sediment removal, the "benthic community in the project area [was] already seriously depressed. Therefore, the normal short-term reduction in the

benthic habitat and prey from this type of [clamshell] dredging will probably not be measurable in the action area.” (NOAA 2003b)

There is no dredging or capping outside of the contained removal area on the Willamette; therefore, potential effects to benthic organisms or benthic habitat is not expected as a result of these activities within the Columbia River.

#### 5.2.1.2 *Entrainment*

The clamshell dredging operation planned within the contained removal area is not expected to entrain juvenile salmonids. In general, pressure waves created as the bucket descends through the water column forewarn salmonids present within the area, and allow individuals time to avoid the bucket. In addition, the clamshell jaws are open during descent, which should reduce likelihood of entrapping or containing fish (NOAA 2003b). The Corps conducted extensive sampling within the Columbia River in 1985 – 1988 (Larson and Moehl 1990) and again in 1997 – 1998. In the 1985 – 1988 study, no juvenile salmon were entrained, and the 1997 – 1998 study resulted in entrainment of two juvenile salmon. McGraw and Armstrong (1990) examined fish entrainment rates outside of peak migration times in Grays Harbor from 1978 – 1989 and found that one juvenile salmon was entrained.

Because juvenile and adult Chinook salmon may be present in the Lower Willamette River during the summer/fall in-water work window, entrainment could occur but is unlikely. Multiple containment barriers will be installed, and seining methods will be employed to exclude salmonids from within the containment barrier and prevent potential contact with the clamshell bucket. Several beach seine sets will be deployed to remove fish from the shallow water, and a research-size purse seine will be deployed from the dock to remove fish from deeper water. Additional sets can be deployed periodically if the silt curtain is opened to ensure that fish have not entered the contained area. Captured fish will be contained in a cool, aerated tank and released outside of the action area. This action should minimize the likelihood of any entrainment within the clamshell bucket.

There is no dredging outside of the contained removal area on the Willamette; therefore, entrainment of aquatic species is not expected within the Columbia River.

#### 5.2.1.3 *Dissolved Oxygen (DO)*

Suspension of anoxic sediment compounds during dredging can result in reduced DO in the water column as the sediments oxidize. Any reduction in DO beyond background will be limited in extent and temporary in nature. Based on a review of six studies on the effects of dredging on DO levels, LaSalle (1988) concluded that, considering the relatively low levels of suspended material generated by dredging operations and counterbalancing factors such as flushing, DO depletion around dredging activities should be minimal. In addition, when DO depletion is observed near dredging activities, it usually occurs in the lower water column. A number of other studies reviewed by LaSalle (1988) showed little or no measurable reduction in DO around dredging operations. Simenstad (1988) concluded that because high sediment biological oxygen demand is not common, significant depletion of DO is usually not an impact. A model created by LaSalle (1988) demonstrated that even in a situation where the upper limit of expected suspended sediment is reached during dredging operations, DO depletion of no more than 0.1 mg/l would occur at depth.

The clean sand placed for capping is expected to be oxygenated and will not result in a change in sediment oxygen demand (and resulting DO reduction) during transport through the water column. There may be some resuspension at the point of impact of the cap materials; however, this condition is expected to be temporary and localized and will be monitored. Based on the results of these studies, DO is not expected to drop to a concentration that will adversely affect salmonids.

There is no dredging or capping outside of the contained removal area on the Willamette; therefore, reduced DO is not expected as a result of these activities within the Columbia River, and may only occur in the unlikely event of an accident during transportation or off-loading.

#### 5.2.1.4 Exposure to Contaminants

Contaminants associated with dredge plumes of resuspended material (or loss of sediment porewater) may dissolve in the water column and result in impacts to water quality. Additionally, contaminants could be resuspended when capping material is placed, because dredging may not remove all existing contaminated sediments. There is also a small risk of accidental spills from construction equipment for the duration of the project, and during off-loading at the Port of Morrow.

##### 5.2.1.4.1 PAHs

The primary chemicals associated with tar at the Site are PAHs and benzene. PAHs in water tend to adsorb to sediments either in the water column or in bottom sediments. This adsorption generally makes them less bioavailable via direct contact with organisms. However, in most circumstances, a portion of these PAHs are likely bioavailable to benthic fish and invertebrates through direct contact and diet (Johnson 2000). These PAHs are bioaccumulated in benthic invertebrates to some extent (Varanasi et al. 1989, 1992; Meador et al. 1995), and can result in salmonid exposure through the food chain. Fish feeding in the immediate area may ingest contaminated benthic and/or pelagic invertebrates, or they may incidentally ingest elevated levels of PAHs or other contaminants that have adsorbed to particles in the water column while feeding on pelagic organisms. PAHs are metabolized and detoxified in vertebrates such as fish, and therefore, not bioaccumulated (Varanasi et al. 1989, Johnson 2000). However, some of the intermediate metabolites of PAHs possess carcinogenic and other adverse effects in mammals, and studies have shown that they exhibit many of the same effects in fish (Johnson 2000). Arkoosh et al. (1994) found that exposure to both PAHs and PCBs impaired immunity in juvenile fall Chinook. Impaired immunity has been linked to increased susceptibility to disease and increased predation in the marine environment.

A quantitative water quality analysis was conducted for the RAPP, updated for the EE/CA, and is summarized here. As a first step, the water quality analysis included direct comparison of DRET test results (which are intended to mimic

conditions within a few feet of the dredge operation) to appropriate acute water quality guidelines (National 2002 Recommended Water Quality Criteria and Oak Ridge National Laboratory 1996 Tier II values). Direct comparison of DRET test results to water quality guidelines can provide a method to screen out any chemicals that would not be expected to be present in substantial concentrations close to the dredge.

This screening indicated that the PAHs anthracene, benzo(a)anthracene, benzo(a)pyrene, fluorene, naphthalene, and phenanthrene exceeded acute guidelines in one or more DRET tests. Other chemicals above acute guidelines in the DRET test included copper, ethylbenzene, and toluene.

The second step in the quantitative water quality analysis was to better understand the distribution of chemicals in the water column around dredging operations during this project. A simple analytical model developed by Kuo and Hayes (1991) was employed for this purpose. This model assumes no silt curtains or similar controls are present. In addition, for the chemicals exceeding acute guidelines as noted above, EPA requested additional analyses of cyanide, benzene, fluoranthene, and phenanthrene (which were all detected in at least one of the DRET tests) for this step in the water quality analysis.

The modeling results are detailed in the EE/CA and indicate that all evaluated chemicals are expected to be at or below their acute guidelines at 200 feet from the dredging operation with the exception of benzo(a)pyrene, which has an approximately 10 percent chance of exceeding its acute guideline 200 feet from the dredge. The EPA directed point of compliance for chemical water quality monitoring for this project is 150 feet from the edge of the primary containment barrier, which is approximately equivalent to 200 feet from the dredge. In the EE/CA it was estimated that proposed containment barriers would reduce this potential impact to approximately 5 percent chance of exceeding the water quality guideline at 200 feet. Consequently, it appears unlikely that water quality impacts outside the water quality monitoring distance would affect salmonids that are listed or proposed for listing.



The above evaluation compares chemical levels to acute guidelines, which is a common approach for dredging operations. An alternate approach would be to use chronic guidelines that are based on at least continuous 96-hour exposures. This dredging operation (and most dredging operations) will not occur on a continuous basis because work will stop each night, during equipment movement and maintenance, and when barges are hauled offsite and replaced with new barges. Further, chronic criteria for food chain effects assume that exposures occur over many years, whereas this dredging operation will be completed in approximately one month. Thus, use of chronic criteria (particularly those based on food chain effects) for such comparisons appears inappropriate. However, at NOAA's request the chemicals required for detailed evaluation by EPA (as discussed above) have also been compared to chronic aquatic organism direct toxicity guidelines (as opposed to food chain effect values) from the same information sources as noted above.

This evaluation indicates that benzo(a)anthracene, benzo(a)pyrene, and fluoranthene have a greater than 50 percent chance of exceeding chronic water quality guidelines at 400 feet from the dredge, while naphthalene has a approximate 5 percent chance of exceeding its guideline at 200 feet from the dredge. However, as noted above, this evaluation assumes that no silt curtain or other containment barriers are present and it was estimated in the EE/CA that these controls would reduce the estimated probabilities of exceedance by half.

Regarding bioaccumulative compounds, as mentioned above, many of these chemicals are found throughout the harbor in sediments and water. Consequently, it is unlikely that the overall bioaccumulation of these chemicals in the food chain would be appreciably altered by the short-term resuspension of sediments in this relatively small area.

#### 5.2.1.4.2 Total Petroleum Hydrocarbons (TPH)

In support of the BA, NOAA requested that the water quality information collected for the removal action design be evaluated for potential impacts to

aquatic biota from TPH. Semivolatile organic compounds as well as total petroleum hydrocarbons in the diesel (TPH-D) range and residual (TPH-R) range were also evaluated using DRET test results.

TPH-D and TPH-R do not report concentrations of specific chemicals. Instead, they are measures of the hydrocarbons with similar molecular structures across a range of molecular sizes based on the numbers of carbon molecules. Overall, there is a paucity of aquatic toxicity data for TPHs compared to the dataset that is available for specific PAHs discussed above. Neither Federal nor State aquatic life criteria for TPH ranges have been promulgated in the United States.

Since aquatic life criteria were not available for TPHs, an alternative approach was used to ensure that the available PAH aquatic toxicity data will adequately address potential impacts from the aliphatic and aromatic compounds represented by TPH-D and TPH-R. The details of this approach are presented in Appendix E. Based on this approach, the following conclusions support the use of the PAH acute aquatic criteria for evaluating potential impacts to aquatic species in the Willamette River during the tar body removal action:

1. Due to the similar toxic mechanism of hydrocarbons across all animals (i.e., narcosis) it is reasonable to compare the mammalian RfD data of aliphatic and aromatic hydrocarbons to ascertain their relative toxicity to aquatic species.
2. Based on mammalian RfD data, aromatic compounds, like PAHs, have equal or greater narcotic toxicity relative to aliphatic compounds.
3. Given that PAHs are likely to be more toxic than aliphatic compounds measured in TPH-D or TPH-R, it is reasonable to apply the PAH acute toxicity data where the PAH and TPH-D and TPH-R concentrations are correlated.
4. The concentrations of TPH-D, TPH-R, acenaphthene, anthracene, fluorene, naphthalene, and phenanthrene in the four DRET samples are strongly correlated, with an average greater than 84 percent.

Based on these conclusions, the results of the dredging water quality analyses in the EE/CA for these PAHs were reviewed. It was found that acenaphthene and phenanthrene did not exceed available acute criteria in the DRET test, indicating impacts from these PAHs are unlikely. For the other PAHs (anthracene, fluorene, and naphthalene), the dredging water quality analysis presented in the EE/CA indicates that there is a much less than 5 percent chance of any of these PAHs exceeding their acute criteria at 200 feet from the dredge or even at a distance of 50 feet from the dredge. Thus, based on the correlation between PAH and TPH discussed above, the expected impacts from TPHs is also expected to be unlikely for this project. It should be noted that the model used in this analysis assumes no silt curtain or other containment barrier is present, and thus, does not allow for any further improvements in water quality that would likely be provided by the silt curtain system proposed for this removal action.

The survival and protection of individual organisms from exposure to contaminants is an important focus; however, the beneficial effects of this action to populations will be observed over the long term. Adverse impacts arising from exposure to contaminants in water will be localized and temporary, and will reduce the potential for recontamination of the water column over the long term. Fish will be excluded from the primary work zone by the silt curtains and other barriers and will be able to reduce releases beyond the containment equipment. All removed sediments will be disposed of in an approved disposal facility and any new cover or capping materials will be clean, which will sustain a healthier benthic community and improve foraging opportunities for salmonids. Water quality in the action area outside silt curtains or similar control measures will be monitored as part of the RAEPP. Additional actions will be taken to reduce water quality impacts outside the silt curtains if unacceptable water quality is observed. Ultimately, the long-term effects of exposure to contaminants will be greatly reduced by the dredging.

There is no dredging or capping outside of the contained removal area on the Willamette; therefore, potential effects to organisms as a result of exposure to contaminants is not expected as a result of these activities within the Columbia

River, and may only occur in the unlikely event of an accident during transportation or off-loading.

#### 5.2.1.5 *Turbidity*

Turbidity occurs when suspended organic and inorganic particles in the water column scatter light wavelengths and reduce the light available to underwater environments (Nightingale and Simenstad 2001). Natural processes such as high spring run-off increase sedimentation, and many juvenile salmonids have evolved in response to these conditions (Levy and Northcote 1982). For example, Nightingale and Simenstad report that, as salmonids migrate to estuarine waters, “the spectral sensitivity of their vision physiology changes from the yellow and red wavelengths of freshwater systems to the green wavelengths of turbid estuarine systems” (2001, p. 55).

It is likely that there will be temporary increases in turbidity in the water surrounding the project Site resulting from dredging and capping activities. Sediments can be resuspended during the action of dredging, as well as when capping material is placed, increasing turbidity at varying levels. Mechanical (e.g clamshell) dredging causes increased suspended sediment concentrations due to the impact and withdrawal of the bucket from the substrate, the washing of material out of the bucket as it moves through the water column, and the loss of water as the sediment is loaded onto the barge (Hayes et al. 2004, Nightingale and Simenstad 2001). However, clamshell dredging causes very limited, short-term, and localized turbidity, and should not result in any long-term effects (NOAA 2003b). Suspended sediment concentrations vary throughout the water column, with larger plumes typically occurring at the bottom closer to the actual dredging action. Even without silt curtains or similar controls, plume size decreases exponentially with movement away from the dredging Site both vertically and horizontally. Increases in turbidity that result from dredging activities are short-term, localized (particularly when silt curtains or similar controls are used), and of much less magnitude than increases caused by natural events (Nightingale and Simenstad 2001). Turbidity increases occur naturally through erosion and elevated river flows caused by storms.

The potential effects of increased turbidity on salmonids have been investigated in a number of dredging studies (Servizi and Martens 1987 and 1992, Emmet et al. 1988, Simenstad 1988, Redding et al. 1987, Berg and Northcote 1985, Noggle 1978, Mortensen et al. 1976). There are several mechanisms by which suspended sediment can affect juvenile salmonids including direct mortality, gill tissue damage, physiological stress, and behavioral changes. Each of these potential effects is discussed below.

#### 5.2.1.5.1 Direct Mortality

Direct mortality from extremely high levels of suspended sediment has been documented at concentrations far exceeding those caused by typical dredging operations. Laboratory studies have consistently found that the 96-hour median lethal concentration (LC50) for juvenile salmonids occurs at levels above 6,000 mg/L (Stober et al. 1981, Salo et al. 1980, LeGore and DesVoigne 1973). However, typical samples collected adjacent to dredge sites (within approximately 150 feet) contain suspended sediment concentrations between 50 and 150 mg/L (Palermo et al. 1990, Havis 1988, Salo et al. 1979). Based on an evaluation of seven clamshell dredge operations, LaSalle (1988) determined that suspended sediment levels of 700 mg/L and 1,100 mg/L at the surface and bottom, respectively, would represent the upper limit concentration expected adjacent to the dredge source (within approximately 300 feet). Concentrations of this magnitude could occur at sites with fine silt or clay substrates. Much lower concentrations (50 to 150 mg/L at 150 feet) are expected at sites with coarser sediment. Because direct mortality occurs at turbidity levels that far exceed typical dredging operations, direct mortality from suspended sediment is not expected to occur during this project.

In addition to modeling contaminant concentrations, the Kuo-Hayes model (1991) was used to simulate possible total suspended sediment (TSS) concentrations associated with dredging. Again, the model assumes no silt curtains are in place. At 100 feet from the dredge, a distance closer than the water quality monitoring point of compliance of 150 feet from the dredge, the 50<sup>th</sup> percentile modeling result is 177 mg/L without containment. At 200 feet from the dredge, a distance slightly greater than the water quality monitoring



point of compliance, the 50<sup>th</sup> percentile modeling result is 114 mg/L without containment. At 200 feet, the 95<sup>th</sup> percentile result, which is unlikely to occur with the proposed rigorous BMPs in place, is 375 mg/L without a silt curtain. The EE/CA (Anchor 2005) estimates that the presence of a silt curtain will reduce the probabilities of these concentrations by approximately 50 percent.

All of these estimated TSS concentrations are well below the 96-hour median LC50 of 6000 mg/L for juvenile salmonids discussed above as well as below those levels related to gill damage (3,143 mg/L), physiological stress (500 to 2000 mg/L), and behavioral effects (650 to 3,000 mg/L) discussed in the following sections. In addition, seining will be conducted to exclude fish from within the containment area prior to initiating dredge activities, further reducing salmonid exposure to suspended sediments.

#### 5.2.1.5.2 Gill Tissue Damage

Studies indicate that suspended sediment concentrations occurring near dredging activity are generally not high enough to cause gill damage in salmonids. Servizi and Martens (1992) found that gill damage was absent in underyearling coho salmon exposed to concentrations of suspended sediments lower than 3,143 mg/L. Redding et al. (1987) also found that the appearance of gill tissue was similar for control fish and those exposed to high, medium, and low concentrations of suspended topsoil, ash, and clay. Based on the results of these studies, juvenile and subadult salmonids, if any are present, are not expected to experience gill tissue damage even if exposed to the upper limit of suspended sediment concentrations expected during dredging (see discussion in previous section). Further, given the ability of adult salmonids to avoid areas with less than favorable conditions, adult salmonids are not expected to experience gill tissue damage as a result of this project.

#### 5.2.1.5.3 Physiological Stress

Suspended sediments have been shown to cause stress in salmonids, but at concentrations higher than those typically caused by dredging. Underyearling coho salmon exposed to suspended sediment concentrations above 2,000 mg/L

were physiologically stressed as indicated by elevated blood plasma cortisol levels (Redding et al. 1987). Exposure to approximately 500 mg/L of suspended sediment for two to eight consecutive days also caused stress, but to a much lesser degree (Redding et al. 1987, Servizi and Martens 1987). At 150 to 200 mg/L of glacial till, no significant difference in blood plasma glucose (a stress indicator) concentrations were observed. These results indicate that upper limit suspended sediment conditions near dredging activity (700 to 1,100 mg/L) can cause stress in juveniles if exposure continues for an extended period of time. The TSS estimates for this project (discussed) above are expected to be much lower than these values. Also, continued exposure is unlikely due to the tendency for unconfined salmonids to avoid areas with elevated suspended sediment concentrations (Salo et al. 1980). Others have also reported that typical sediment plumes caused by dredging do not create suspended sediment concentrations high enough to cause stress in juvenile salmonids (Contaminated Sediments Task Force 2003).

#### 5.2.1.5.4 Behavioral Effects

Behavioral responses to elevated levels of suspended sediment include feeding disruption and changes in migratory behavior (Servizi 1988, Martin et al. 1977). Several studies indicate that salmonid foraging behavior is impaired by high levels of suspended sediment (Bisson and Bilby 1982; Berg and Northcote 1985). Redding et al. (1987) demonstrated that yearling coho and steelhead exposed to high levels (2,000 to 3,000 mg/L) of suspended sediment did not rise to the surface to feed. Yearling coho and steelhead exposed to lower levels (400 to 600 mg/L), however, actively fed at the surface throughout the experiment. In these instances, the thresholds at which feeding effectiveness was impaired greatly exceeded the upper limit of expected suspended solids during dredging, and exceeds the estimated TSS concentrations for this project as discussed above.

Adult migration may also be subject to disruption from suspended sediment. Adult salmonids are not necessarily closely associated with the shoreline and are less vulnerable to adverse impacts if they encounter turbid conditions. Whitman et al. (1982) used volcanic ash from the eruption of Mt. St. Helens to recreate

highly turbid conditions faced by returning adult salmon. This study showed that, despite very high levels of ash, adult male Chinook were still able to detect natal waters through olfaction even when subjected to seven days of total suspended sediment levels of 650 mg/L. Therefore, migratory or feeding disruptions are not expected to occur from dredging activities.

#### 5.2.1.6 *Alteration of Nearshore Habitat*

The Lower Willamette River is a migratory corridor for juvenile and adult salmonids discussed in this BA, with the exception of chum salmon. It may also serve as a feeding and rearing area for juvenile steelhead and Chinook salmon (NOAA Fisheries 2002b). During outmigration, salmonid species often prefer shallow margins in the river due to slower water velocities and greater habitat complexity for refugia from predators and for feeding and resting. Salmonid movement in nearshore areas varies. Mains and Smith (1964) found that, in the Columbia and Snake Rivers, Chinook fry and fingerlings outmigrated along the entire width of the rivers, but 50 to 60 percent of the catch occurred within 300 feet of each bank. In the Snake River, shorelines were favored during medium and low water, although the center of the river was preferred at high water. In the Columbia, migrant Chinook preferred the surface zone—43.6 percent were caught within 30 inches of the surface. Everest and Chapman (1972) found that underyearling Chinook in summer occurred over all substrate types, at all depths, and in water of all velocities (up to 1.2 meters per second [m/s]), but abundance decreased with increasing substrate particle size, increasing depth, and increasing water velocity. Lister and Genoe (1970) studied juvenile fall Chinook and coho in the Big Qualicum River in British Columbia. Smaller fry of both species inhabited marginal areas of the river, particularly those with complex structure. As they grew larger, both species moved away from shore into midstream and higher velocity areas. Dawley et al. (1986) also found that juvenile fall Chinook preferred the shallow nearshore of the Columbia River estuary, while yearling Chinook and coho were most abundant in the offshore channel. However, Healey and Jordan (1982) found that in the Fraser and Nanaimo rivers, Chinook fingerlings migrated in the fastest water near the center of the river. Lister and Genoe (1970) summarized that migrating Chinook and coho progress through a series of preferred habitats—initial hiding (possibly in gravel), association with bank



cover, appearance along open shorelines, and finally movement into higher velocity locations.

The length of time spent in shallow water habitat at any location is species-specific. Chum migrate rapidly to the ocean over a few hours to a few days; however, Chinook move gradually over several weeks to several months (Spence et al. 1996).

Adult salmonids may also use river margins when returning to their natal streams, moving rapidly through shallow water, and resting in deep pools and areas with habitat structure (Spence et al. 1996). Bjornn and Reiser (1991) noted that spring Chinook adults may hold in mainstem rivers for several weeks to months if they arrive at spawning sites early. Habitat structure in shallow water habitat, large woody debris and pools, are used as resting areas; however, the Site currently does not have either of these features.

Cross sections of the proposed dredge surface in relation to the OHW and OLW elevations are presented in Figures 7a and 7b and bathymetry is shown in Figure 4 to illustrate potential effects of the removal on shallow water habitat. NOAA quantifies shallow water habitat in the Willamette River as being less than 20 feet deep (NOAA Fisheries 2002b). Using Site bathymetry, and an elevation of -12.1 NAVD 88 as the lower limit of shallow water habitat below OLW, a band of approximately 50 feet, or approximately 0.5 acres, of shallow water habitat will be deepened as a result of this action.

Removal of this habitat may reduce foraging opportunities and cause salmonids to migrate in deeper water where they are more vulnerable to predation. However, conservation measures will be taken to avoid unnecessary impacts and minimize negative effects of the action. In addition, the habitat being removed is contaminated and is located adjacent to and upstream of a working dock with ship traffic, which may limit its function as shallow water habitat. The placement of a 1.5-foot-thick clean sand and gravel pilot cap and cover will isolate any remaining contamination, and it is not anticipated that the remaining depression will collect free product on the cap. However, as a precautionary measure, the possibility for

product collecting will be monitored and contingency actions, including additional removal or other actions, are described in the RAPP. The clean cap surface will provide improved habitat benefits for benthic and fish species. Finally, this is an interim removal action and other long-term sediment remedial actions may take place in and around this location that could also change water depths and other habitat features.

There is no dredging or capping outside of the contained removal area on the Willamette; therefore, potential effects to organisms as a result of exposure to suspended sediment is not expected as a result of these activities within the Columbia River, and may only occur in the unlikely event of an accident during transportation or off-loading.

### **5.2.2 Effects Determination Recommendation**

Potential effects to Chinook salmon include physical and behavioral impacts from water quality impacts, entrainment, and loss of habitat as a result of operations. However, impacts will be minimized by the following:

- The project will adhere to the identified summer/fall construction work window to minimize the number of Chinook salmon potentially affected by the action.
- Impacts to the benthic communities (which do not appear to exist on the tar) and pelagic prey will be short term and not likely to be measurable in the action area. The tar removal action and clean cover or cap will have a long-term beneficial effect on the recolonizing benthic community and salmonid diet.
- Risk of injury by entrainment will be reduced, but perhaps not eliminated by using the clamshell dredge and containment barriers.
- DO and turbidity impacts due to sediment disturbance will be limited by BMPs such as silt curtains, and will be localized, small scale, and temporary. Effects associated with turbidity, such as direct mortality, gill damage, stress, and behavior changes, are not generally seen with levels generated due to dredging. Such impacts will be monitored as described in the RAEPP.
- Exposure to contaminants will be temporary, and fish will be excluded from the primary work area by containment equipment. The removal action is directed at removing the tar body and will also remove associated chemicals. Levels of

many contaminants (other than PAHs) are not significantly higher in the action area than in adjacent RM 5 through 8. The area will be monitored for possible complications, and additional BMPs may be implemented to protect salmonids. Short-term exposure will be offset by the long-term benefits of the removal. Although unlikely, some short-term impacts due to chemical or product releases could occur.

- Changes to shallow water habitat will be temporary and will only affect approximately 0.5 acres.
- Operations will be stopped temporarily if injured, sick, or dead listed species are located in the project area, to determine if additional fish are present and to ensure that operations may continue without further impact. NOAA Fisheries Law Enforcement will be notified, and fish will be handled with care to ensure effective treatment or analysis of cause of death.
- Water quality impacts as a result of transportation, off-loading and disposal will be reduced by using sealed barges filled to no more than 85% capacity, metal spill aprons so that material will not be suspended over open water, not discharging any dewater, dock curbing to prevent spill material and rain water from entering the river, and implementing water quality monitoring around the barge to confirm that material has not been released to the river. No in-water work will occur at the transfer facility.

Based on the analysis above, the effects determination recommendation is that the *project may affect, and is likely to adversely affect UWR and LCR ESUs of Chinook salmon* because migrating adults and juveniles or subadults could be present and affected by the project during construction from construction disturbance and water quality impacts. It is further recommended that the *project may affect, but is not likely to adversely affect SRF, SRSS and UCR ESUs of Chinook salmon* because potential adverse effects to species in the Columbia River would only occur in the unlikely event of an accidental spill at the off-loading facility. If, as described in Section 2 above, the Services continue to support the LTAA recommendation (particularly in light of the work being moved to the summer/fall work window), NW Natural would not implement an action without a Biological Opinion (BO).



### **5.2.3 Critical Habitat for Chinook Salmon**

Based on research by ODFW, adults use the Willamette River primarily as a migratory corridor, while subyearling and yearling Chinook migrate and rear to some extent in the lower river (Friesen et al. 2003).

Critical habitat for Snake River Fall Chinook and Snake River Spring/Summer Chinook salmon is designated as all river reaches accessible to listed Chinook salmon in Columbia River tributaries and adjacent riparian zones between and including the Grays and White Salmon Rivers in Washington and the Willamette and Hood Rivers in Oregon. It includes all river reaches and estuarine areas in the Columbia River from the west end of North Jetty (Washington side) to the west end of Clatsop Jetty (Oregon side) upstream to The Dalles Dam.

Critical habitat for Upper Willamette River, Lower Columbia River, and Upper Columbia River ESUs of Chinook was vacated on April 30, 2002, but is currently proposed for redesignation by August 15, 2005. Critical habitat is proposed for areas containing Primary Constituent Elements (PCEs) essential for the conservation of the species or those that require special management considerations. PCEs include sites that are essential to supporting one or more life stages of the ESU and that contain physical or biological features essential to the conservation of the ESU. Specific sites and features designated for Columbia River salmonids include the following (69 Fed Reg 74582):

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning incubation and larval development.
2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth, and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes supporting growth and maturation.

Critical habitat includes the stream channels within the proposed stream reaches, and includes a lateral extent as defined by the ordinary high water line (33 CFR 319.11).

Proposed critical habitat for the LCR Chinook includes 1,250 miles of streams and 33 square miles (sq mi) of lakes in Washington and Oregon. Critical habitat in the action area is within Unit 10, the Lower Willamette subbasin, and Unit 11, the Lower Columbia River corridor, which extends from the mouth of the Columbia River to the confluence with the Sandy River.

Proposed critical habitat for the UWR Chinook includes 1,571 miles of streams and 18 sq mi of lakes in Washington and Oregon. Critical habitat in the action area is within Unit 10, the Lower Willamette/Columbia River corridor, which extends from the mouth of the Columbia upstream to the confluence of the Willamette and Clackamas rivers. There is no proposed critical habitat for UWR Chinook salmon in the transloading area.

Proposed critical habitat for the UCR Chinook includes 926 miles of streams, and 4 sq mi of lakes in Washington and Oregon. Critical habitat in the action area is within Unit 5, the Columbia River corridor, which extends from the mouth of the Columbia River upstream to Rock Island Dam.

The above information is provided in case critical habitat is redesignated for the Willamette and Columbia River ESUs before the activities described in this BA are complete.

#### **5.2.4 Critical Habitat Effects Determination Recommendation**

The principal PCE in the action area is the freshwater migration corridor, and removal of the tar body will improve this function. Dredging and capping will temporarily disturb approximately 0.5 acres of benthic habitat within the containment barriers. Short-term impacts to habitat include resuspension of sediments and contaminants from construction activities, as well as interim conversion to deeper habitat that is less valuable for juvenile salmonids. Depending upon the results of the harbor-wide Superfund process, this interim habitat conversion could be offset or improved above existing conditions by the eventual completion of the entire sediment remedial action for the harbor. The habitat that will be deepened is currently of poor quality due to the presence of tar and located adjacent to and upstream of a working dock with ship traffic, which may limit its function as shallow water habitat.

Conservation measures to protect listed species and essential fish habitat (EFH) for salmon will also serve to protect designated and proposed critical habitat. It is recommended that this project *may affect, but is not likely to adversely affect designated critical habitat*. It is further recommended that this project *will not adversely modify proposed critical habitat, and if listed, may affect, but is not likely to adversely affect designated critical habitat for Chinook salmon*.

### **5.3 Coho Salmon (*Oncorhynchus kisutch*)**

On June 16, 2004, LCR coho salmon were proposed for listing as threatened under the ESA, and there is no critical habitat designated at this time. This ESU may be found in both the Willamette and Columbia River portions of the action area.

The Willamette River and its tributaries historically provided important spawning grounds for Columbia River basin coho salmon (Fulton 1970); however, most coho habitat in this area has been blocked by numerous tributary dams. While the majority of coho return to the LCR to spawn between early December and March (NOAA 1991), in the Clackamas

River, a tributary to the Willamette River, adult LCR coho pass the North Fork Dam in two peaks September (early run) and in January/February (late/native run) (Weitkamp et al. 1995). Therefore, adult coho could be present in deep water areas in the vicinity of the action area during their upstream spawning migration. Cramer and Cramer (1994) noted that Clackamas River juveniles outmigrated between February and July, and peaked (before the July to October construction window) in May and June.

### **5.3.1 Direct and Indirect Effects**

See discussion under Chinook salmon (Section 5.2.1).

### **5.3.2 Effects Determination Recommendation**

Potential effects to coho salmon include physical and behavioral impacts from water quality impacts, entrainment, and loss of habitat as a result of operations. However, impacts will be minimized by the following:

- The project will adhere to the identified summer/fall construction work window to minimize the number of coho potentially affected by the action.
- Impacts to the benthic communities (which do not appear to exist on the tar) and pelagic prey will be short-term and not likely to be measurable in the action area. The tar removal action and clean cover or cap will have a long-term beneficial effect on the recolonizing benthic community and salmonid diet.
- Risk of injury by entrainment will be reduced, but possibly not eliminated, by using the clamshell dredge and containment barriers.
- DO and turbidity impacts due to sediment disturbance will be limited by BMPs such as silt curtains, and will be localized, small-scale, and temporary. Effects associated with turbidity, such as direct mortality, gill damage, stress, and behavior changes, are not generally seen with levels generated due to dredging. Such impacts will be monitored as described in the RAEPP.
- Exposure to contaminants will be temporary, and fish will be excluded from the primary work area by containment equipment. The removal action is directed at removing the tar body and will also remove associated chemicals. Levels of many contaminants (other than PAHs) are not significantly higher in the action area than in adjacent RM 5 through 8. The area will be monitored for possible complications, and additional BMPs may be implemented to protect salmonids.



Short-term exposure will be offset by the long-term benefits of the removal.

Although unlikely, some short-term impacts due to chemical or product releases could occur.

- Changes to shallow water habitat will be temporary and will only affect approximately 0.5 acres.
- Operations will be stopped temporarily if injured, sick, or dead listed species are located in the project area, to determine if additional fish are present and to ensure that operations may continue without further impact. NOAA Fisheries Law Enforcement will be notified, and fish will be handled with care to ensure effective treatment or analysis of cause of death.
- Water quality impacts as a result of transportation, off-loading and disposal will be reduced by using sealed barges filled to no more than 85% capacity, metal spill aprons so that material will not be suspended over open water, not discharging any dewater, dock curbing to prevent spill material and rain water from entering the river, and implementing water quality monitoring around the barge to confirm that material has not been released to the river.

Based on the analysis above, the effects determination recommendation is that the *project may jeopardize the continued existence of LCR ESU coho salmon and if listed, the project may affect, and is likely to adversely affect coho salmon* because migrating adults and juveniles or subadults could be present and affected by the project during construction from construction disturbance and water quality impacts. If, as described in Section 2 above, the Services continue to support this recommendation (particularly in light of the work being moved to the summer/fall work window), NW Natural would not implement an action without a Biological Opinion (BO).

### **5.3.3 Critical Habitat for Coho Salmon**

Critical habitat has not been designated or proposed for the LCR ESU of coho salmon at this time.

## **5.4 Steelhead (*Oncorhynchus mykiss*)**

Both the LCR and UWR ESUs of steelhead may be found in the Willamette and Columbia River portions of the action area affected by dredging, capping, and off-loading. The UCR,

Snake River (SR) Basin, and Middle Columbia River (MCR) ESUs may be found in the Columbia River off-loading portion of the action area, but are unlikely to be found in the Willamette River portion of the action area. The UCR ESU of steelhead is listed as endangered, and all other ESUs of steelhead are listed as threatened under the ESA. Critical habitat is proposed for all steelhead ESUs.

Based on the updated information provided in NOAA Fisheries' Biological Review Team (BRT) report, most of the LCR and UWR steelhead populations are in decline (NOAA Fisheries 2003a). Summer steelhead of both ESUs are not native to the Willamette Basin; they were introduced into several subbasins in the late 1960s (ODFW 2000).

Steelhead spawn in cool, clear, and well-oxygenated streams with small to large gravel and suitable flow in conditions typical of upper tributaries of rivers (USFWS 1983). LCR steelhead may be found in the Lower Willamette River throughout the year, but peak juvenile outmigration occurs from late April through May (Busby et al. 1995; 1996; NOAA Fisheries 2002b). UWR steelhead adults migrate through the action area prior to the summer/fall construction window, from January through mid-May, and UWR steelhead smolts are present near the Site from March to mid-July (NOAA Fisheries 2002b). Use of the Site by smolts is limited as they are generally expected to pass through the action area in less than one day (NOAA Fisheries 2002b).

Adult UCR, SR, and MCR steelhead may be found in the Lower Columbia River portion of the action area year-round, but the peak of upstream migration generally occurs between mid-January and mid-March, and again between the beginning of May and middle of September (Ellis 1999). Adult steelhead primarily use deeper water for migration.

UCR ESU juveniles migrate downstream past Bonneville Dam between mid-May and late June, and would pass the off-loading area prior to passing the dam. SR Basin ESU juveniles move downstream in a similar timing pattern. Downstream migration typically peaks in late April/early May and declines through late June. MCR ESU juvenile steelhead migrate downstream from late March through June, peaking from late April through mid-May.

#### **5.4.1 Direct and Indirect Effects**

See discussion under Chinook salmon (Section 5.2.1). Only those portions of the project pertaining to off-loading at the Columbia River transfer facility are expected to be relevant potential impacts to UCR, SR, and MCR ESUs of steelhead trout.

#### **5.4.2 Effects Determination Recommendation**

Potential effects to steelhead include physical and behavioral impacts from water quality impacts, entrainment, and loss of habitat as a result of operations. However, impacts will be minimized by the following:

- The project will adhere to the identified summer/fall construction work window to minimize the number of steelhead potentially affected by the action.
- Impacts to the benthic communities (which do not appear to exist on the tar) and pelagic prey will be short-term and not likely to be measurable in the action area. The tar removal action and clean cover or cap will have a long-term beneficial effect on the recolonizing benthic community and salmonid diet.
- Risk of injury by entrainment will be reduced, but possibly not eliminated, by using the clamshell dredge and containment barriers.
- DO and turbidity impacts due to sediment disturbance will be limited by BMPs such as silt curtains, and will be localized, small-scale, and temporary. Effects associated with turbidity, such as direct mortality, gill damage, stress, and behavior changes, are not generally seen with levels generated due to dredging. Such impacts will be monitored as described in the RAEPP.
- Exposure to contaminants is temporary, and fish will be excluded from the primary work area by containment equipment. The removal action is directed at removing the tar body and will also remove associated chemicals. Levels of many contaminants (other than PAHs) are not significantly higher in the action area than in adjacent RM 5 through 8. The area will be monitored for possible complications, and additional BMPs may be implemented to protect salmonids. Short-term exposure will be offset by the long-term benefits of the removal. Although unlikely, some short-term impacts due to chemical or product releases could occur.
- Changes to shallow water habitat will be temporary and will only affect approximately 0.5 acres.

- Operations will be stopped temporarily if injured, sick, or dead listed species are located in the project area, to determine if additional fish are present and to ensure that operations may continue without further impact. NOAA Fisheries Law Enforcement will be notified, and fish will be handled with care to ensure effective treatment or analysis of cause of death.
- Water quality impacts as a result of transportation, off-loading, and disposal will be reduced by using sealed barges filled to no more than 85% capacity, metal spill aprons so that material will not be suspended over open water, not discharging any dewater, dock curbing to prevent spill material and rain water from entering the river, and implementing water quality monitoring around the barge to confirm that material has not been released to the river.

Based on the analysis above, the effects determination recommendation is that the *project may affect, and is likely to adversely affect LCR and UWR ESUs of steelhead trout* because migrating adults and juveniles or subadults could be present and affected by the project during construction from construction disturbance and water quality impacts. It is further recommended that the *project may affect, but is not likely to adversely affect UCR, SR, and MCR ESUs of steelhead trout* because adverse effects to species in the Columbia River would only occur in the unlikely event of an accidental spill at the off-loading facility. If, as described in Section 2 above, the Services continue to support this LTAA recommendation (particularly in light of the work being moved to the summer/fall work window), NW Natural would not implement an action without a Biological Opinion (BO).

#### **5.4.3 Critical Habitat for Steelhead Trout**

Critical habitat was designated for the LCR, MCR, UCR, SR and the UWR ESUs of steelhead. This designation was vacated on April 30, 2002, but is currently proposed for redesignation by August 15, 2005. PCEs will be listed with the critical habitat designation. PCEs include sites essential to support one or more life stages of the ESU (i.e., spawning, rearing, migration, foraging). Critical habitat includes the stream channels within the proposed stream reaches, and includes a lateral extent as defined by the OHW line (33 CFR 319.11).

Proposed critical habitat for the LCR steelhead includes 2,428 miles of streams, and 27 sq mi of lakes in Washington and Oregon. Critical habitat in the Willamette River action area is within Unit 9, the Lower Willamette River subbasin. There is no proposed critical habitat in the Columbia River portion of the action area.

Proposed critical habitat for the UWR steelhead includes 1,312 miles of streams, and 2 sq mi of lakes in Washington and Oregon. Critical habitat in the Willamette River action area is within Unit 8, the Lower Willamette/Columbia River corridor, which extends from the mouth of the Columbia River upstream to the confluence of the Clackamas and Willamette Rivers. There is no proposed critical habitat for UWR steelhead in the Columbia River action area.

Proposed critical habitat for the MCR steelhead includes 5,376 miles of streams in Washington and Oregon. Critical habitat in the action area is within Unit 4, the Middle Columbia/Lake Wallula Subbasin.

Proposed critical habitat for the SR steelhead includes 7,622 miles of streams, and 4 sq mi of lakes in Washington, Idaho, and Oregon. Critical habitat in the action area is within Unit 26, the Lower Snake/Columbia River corridor, which extends from the mouth of the Columbia River upstream to the confluence with the Palouse River in Washington.

Proposed critical habitat for the UCR steelhead includes 1,247 miles of streams, and 7 sq mi of lakes in Washington and Oregon. Critical habitat in the action area is within Unit 11, the Columbia River corridor, which extends from the mouth of the Columbia River upstream to the confluence with the Yakama River in Washington.

The above information is provided in case critical habitat is redesignated for the Willamette and Columbia River ESUs before the activities described in this BA are complete.

#### **5.4.4 Critical Habitat Effects Determination Recommendation**

The principal PCE in the action area is the freshwater migration corridor, and removal of the tar body will improve this function. Dredging and possible capping will temporarily disturb approximately 0.5 acres of benthic habitat within the containment barriers.

Short-term impacts to habitat include resuspension of sediments and contaminants from construction activities, as well as interim conversion to deeper habitat that is less valuable for juvenile salmonids. Depending upon the results of the harbor-wide Superfund process, this interim habitat conversion could be offset or improved above existing conditions by the eventual completion of the entire sediment remedial action for the harbor. The habitat that will be deepened is currently of poor quality due to the presence of tar and located adjacent to and upstream of a working dock with ship traffic, which may limit its function as shallow water habitat.

Conservation measures to protect listed species and EFH for salmon will also serve to protect proposed critical habitat. It is recommended that this project *will not adversely modify proposed critical habitat, and if listed, may affect, but is not likely to adversely affect* critical habitat for steelhead.

#### **5.5 Chum Salmon (*Oncorhynchus keta*)**

The Columbia River (CR) ESU of chum salmon is listed as threatened under the ESA. Critical habitat is proposed for this ESU. This ESU may be found in the Willamette River portion of the action area, but is unlikely to be found in the Columbia River portion of the action area.

Chum salmon in the Columbia River are limited to areas downstream of Bonneville Dam. Adult chum salmon may occur near the mouth of the Willamette River during their upstream migration from late September through December. They do not spawn in the Willamette River or its tributaries. Chum salmon fry may move into the Lower Willamette River during incoming tides and could feed on organisms within the action area for short periods during their downstream migration (Johnson et al. 1997).

Adults enter the Columbia River to return to spawning grounds during the fall months. Juvenile chum salmon begin their outmigration immediately upon emergence, and likely move past the Columbia River action area between early March and late April.

### **5.5.1 Direct and Indirect Effects**

See discussion under Chinook salmon (Section 5.2.1).

### **5.5.2 Effects Determination Recommendation**

Potential effects to chum salmon include physical and behavioral impacts from water quality impacts, entrainment, and loss of habitat as a result of operations. However, impacts will be minimized by the following:

- The project will adhere to the identified summer/fall construction work window to minimize the number of chum potentially affected by the action.
- Impacts to the benthic communities (which do not appear to exist on the tar) and pelagic prey will be short-term and are not likely to be measurable in the action area. The tar removal action and clean cover or cap will have a long-term beneficial effect on the recolonizing benthic community and salmonid diet.
- Risk of injury by entrainment will be reduced, but not eliminated, by using the clamshell dredge and containment barriers.
- DO and turbidity impacts due to sediment disturbance are limited by BMPs such as silt curtains, and are localized, small scale, and temporary. Effects associated with turbidity, such as direct mortality, gill damage, stress, and behavior changes, are not generally seen with levels generated due to dredging. Such impacts will be monitored as described in the RAEPP.
- Exposure to contaminants is temporary, and fish will be excluded from the primary work area by containment equipment. The removal action is directed at removing the tar body and will also remove associated chemicals. Levels of many contaminants (except PAHs) are not significantly higher in the action area than in adjacent RM 5 through 8. The area will be monitored for possible complications, and additional BMPs may be implemented to protect salmonids. Short-term exposure will be offset by the long-term benefits of the removal. Although unlikely, some short-term impacts due to chemical or product releases could occur.

- Changes to shallow water habitat will be temporary and will only affect approximately 0.5 acres.
- Operations will be stopped temporarily if injured, sick, or dead listed species are located in the project area, to determine if additional fish are present and to ensure that operations may continue without further impact. NOAA Fisheries Law Enforcement will be notified, and fish will be handled with care to ensure effective treatment or analysis of cause of death.
- Water quality impacts as a result of transportation, off-loading, and disposal will be reduced by using sealed barges filled to no more than 85% capacity, metal spill aprons so that material will not be suspended over open water, not discharging any dewater, dock curbing to prevent spill material and rain water from entering the river, and implementing water quality monitoring around the barge to confirm that material has not been released to the river.

Based on the analysis above, the effects determination recommendation is that the *project may affect, and is likely to adversely affect, the CR ESU of chum salmon* because migrating adults and juveniles or subadults could be present and affected by the project during construction from construction disturbance and water quality impacts. If, as described in Section 2 above, the Services continue to support this recommendation (particularly in light of the work being moved to the summer/fall work window), NW Natural would not implement an action without a Biological Opinion (BO).

### **5.5.3 Critical Habitat for Chum Salmon**

Critical habitat was designated for the CR ESU of chum salmon. This designation was vacated on April 30, 2002, but is currently proposed for redesignation on August 15, 2005. PCEs will be listed with the critical habitat designation. PCEs include sites and habitat components essential to support one or more life stages of the ESU (i.e., spawning, rearing, migration, foraging). Critical habitat includes the stream channels within the proposed stream reaches, and includes a lateral extent as defined by the ordinary high water line (33 CFR 319.11).

Proposed critical habitat for the CR ESU of chum salmon includes 656 miles of streams in Washington and Oregon. Critical habitat has not been proposed within either the Willamette or Columbia River portions of the action area.

The above information is provided in case critical habitat is redesignated for the Willamette and Columbia River before the activities described in this BA are complete.

#### **5.5.4 Critical Habitat Effects Determination Recommendation**

Conservation measures to protect listed species and EFH for salmon will also serve to protect proposed critical habitat. However, since critical habitat has not been proposed in the action area, it is recommended that this project *will not adversely modify proposed critical habitat* for the CR ESU of chum salmon.

### **5.6 Sockeye Salmon (*Oncorhynchus nerka*)**

The SR ESU of sockeye salmon was listed as endangered on November 20, 1991. Critical habitat was designated on December 28, 1993. This species may be found in the Columbia River portion of the action area, but is unlikely to be found in the Willamette River portion of the action area.

Adult Snake River sockeye enter the Columbia River in June and July. Spawning typically peaks in mid-October. The majority of sockeye salmon spawn either in inlet or outlet streams of lakes or in lakes themselves. After emerging, juveniles may rear within lakes for 1 year before migrating to sea. Some sockeye salmon populations spawn in rivers, and use low-velocity sections of rivers for juvenile rearing. Juvenile sockeye generally rear in lakes or backwaters of rivers. The action area serves as a migration corridor, but not as rearing habitat for sockeye salmon.

#### **5.6.1 Direct and Indirect Effects**

See discussion under Chinook salmon (Section 5.2.1). Only those portions of the project pertaining to off-loading at the Columbia River transfer facility are expected to be relevant to potential impacts to SR ESU of sockeye salmon.

### 5.6.2 *Effects Determination Recommendation*

Potential effects to sockeye salmon include physical and behavioral impacts from water quality impacts or impacts to habitat in the event of an accidental spill at the off-loading facility. However, any impacts would be minimized by the following:

- A series of spill control BMPs will be used to prevent any discharge of materials to the Columbia River at the transfer site. Such discharges would only be possible in the event of a large scale accident at the transfer site.
- Water quality impacts as a result of off-loading and disposal will be prevented by using sealed barges filled to no more than 85% capacity, metal spill aprons so that material will not be suspended over open water, no discharging of dewater, dock curbing to prevent spill material and rain water from entering the river, and implementing water quality monitoring around the barge to confirm that material has not been released to the river.
- In the event of a small spill, DO and turbidity impacts would be localized, small scale, and temporary. Effects associated with turbidity, such as direct mortality, gill damage, stress, and behavior changes, would not be expected. Such impacts will be monitored following methods described in the RAEPP.
- Exposure to contaminants in the unlikely event of accidental spill would be temporary. The area will be monitored for possible any accidental spills and additional BMPs would be implemented to protect salmonids in the event of a spill. Although very unlikely, some short-term impacts due to chemical or product releases could occur at the transfer facility.
- Operations will be stopped temporarily if injured, sick, or dead listed species are located near the transfer facility, to determine if additional fish are present and to ensure that operations may continue without further impact. NOAA Fisheries Law Enforcement will be notified, and fish will be handled with care to ensure effective treatment or analysis of cause of death.

Based on the analysis above, the effects determination recommendation is that the *project may affect, but is not likely to adversely affect, the SR ESU of sockeye salmon* because adverse effects in the Columbia River will only occur in the unlikely event of an accidental spill at the off-loading facility.

### **5.6.3 Critical Habitat for Sockeye Salmon**

Critical habitat was designated for sockeye salmon on December 28, 1993. Designated critical habitat includes Columbia estuarine and river reaches presently or historically accessible from a straight line connecting the ends of the South and North Jetties at the mouth of the Columbia River, upstream to the confluence with the Snake River.

### **5.6.4 Critical Habitat Effects Determination Recommendation**

Dredging and possible capping will temporarily disturb approximately 0.5 acres of benthic habitat within the containment barriers. Short-term impacts to habitat include resuspension of sediments and contaminants from construction activities, as well as interim conversion to deeper habitat that is less valuable for juvenile salmonids.

Depending upon the results of the harbor-wide Superfund process, this interim habitat conversion could be offset or improved above existing conditions by the eventual completion of the entire sediment remedial action for the harbor. The habitat that will be deepened is currently of poor quality due to the presence of tar and located adjacent to and upstream of a working dock with ship traffic, which may limit its function as shallow water habitat.

Conservation measures to protect listed species and EFH for salmon will also serve to protect proposed critical habitat. It is recommended that this project *may affect, but is not likely to adversely affect* designated critical habitat for sockeye.

## **5.7 Bull Trout (*Salvelinus confluentus*)**

The USFWS listed the bull trout as threatened within the contiguous United States. This includes the CR ESU, which may be found within the proposed action area. Bull trout prefer the upper reaches of cold, clear running streams with clean gravel and cobble substrate for spawning. Bull trout are not known to spawn within the action area. Juvenile and adult bull trout could be present in the action area at any time, but are more likely to be larger in size in the project area than juvenile salmon because few bull trout spawning areas occur near the project Site. Bull trout in the area would have migrated over long distances before reaching the project area. Adult bull trout, similar to adult salmon, are expected to pass through the project area quickly during upstream mitigation.

### **5.7.1 Direct and Indirect Effects**

See discussion under Chinook salmon (Section 5.2.1). Only those portions of the project pertaining to off-loading at the Columbia River transfer facility are expected to be relevant to potential impacts to CR ESU of bull trout.

### **5.7.2 Effects Determination Recommendation**

Potential effects to bull trout include physical and behavioral impacts from water quality impacts or impacts to habitat in the event of an accidental spill at the off-loading facility. However, any impacts would be minimized by the following:

- A series of spill control BMPs will be used to prevent any discharge of materials to the Columbia River at the transfer site. Such discharges would only be possible in the event of a large scale accident at the transfer site.
- Water quality impacts as a result of off-loading and disposal will be prevented by using sealed barges filled to no more than 85% capacity, metal spill aprons so that material will not be suspended over open water, no discharging of dewater, dock curbing to prevent spill material and rain water from entering the river, and implementing water quality monitoring around the barge to confirm that material has not been released to the river.
- In the event of a small spill, DO and turbidity impacts would be localized, small scale, and temporary. Effects associated with turbidity, such as direct mortality, gill damage, stress, and behavior changes, would not be expected. Such impacts will be monitored following methods described in the RAEPP.
- Exposure to contaminants in the unlikely event of accidental spill would be temporary. The area will be monitored for any possible accidental spills, and additional BMPs would be implemented to protect salmonids in the event of a spill. Although very unlikely, some short-term impacts due to chemical or product releases could occur at the transfer facility.
- Operations will be stopped temporarily if injured, sick, or dead listed species are located near the transfer facility, to determine if additional fish are present and to ensure that operations may continue without further impact. NOAA Fisheries Law Enforcement will be notified, and fish will be handled with care to ensure effective treatment or analysis of cause of death.



Based on the analysis above, the effects determination recommendation is that the *project may affect, but is not likely to adversely affect, bull trout* because adverse effects in the Columbia River will only occur in the unlikely event of an accidental spill at the off-loading facility.

### **5.7.3 Critical Habitat for Bull Trout**

Critical habitat was designated for the Klamath River and Columbia River populations of bull trout on September 21, 2004. Final critical habitat for the Columbia River bull trout includes 1,748 miles of streams and 61,235 sq mi of lakes and marshes in Washington, Oregon, and Idaho. The mainstem Columbia River has been excluded from critical habitat under Section 4(b)(2) in support of multiple management actions being undertaken in these reaches through the Federal Columbia Power System (Fed Reg 69, 59999).

### **5.7.4 Critical Habitat Effects Determination Recommendation**

Critical habitat does not exist within the Willamette or Columbia River action areas.

## **5.8 Interrelated/Interdependent and Cumulative Effects**

This removal action is an interim action to remove a tar body within the river. A final remedy (Record of Decision) will also be established by EPA for the entire Portland Harbor Superfund site, which includes the area of this removal action. This harbor-wide remedial action may result in additional remedial action to the Gasco shoreline. The overall purpose of both the interim removal and any final remedial actions is to reduce the risks to human health and the ecosystem from chemicals that may be present in the sediments. A similar capping action pursuant to CERCLA is currently underway at McCormick and Baxter Creosoting Company at RM 7. EPA's Sediment Cap Biological Assessment Addendum for the action (EPA and ODEQ 2003) indicated that "the long term benefits of the remedial actions (a cleaner and more productive environment) will aid in the recovery of federally listed threatened and endangered species." All of these actions and potential future actions taken together are expected to greatly reduce the potential for adverse impacts to listed species. There may be short-term impacts to individuals associated with construction of these removal and potential future remedial actions; however, they are expected to be small in comparison to the long-term overall benefits of these actions.



## 5.9 Incidental Take Analysis

Potential for incidental take of ESA-listed species will be reduced by adherence to work windows in the project area at the time of construction, the implementation of the RAEPP, and the use of specific contingency plans and conservation measures during construction activities. Potential impacts to listed species from contaminants re-mobilized in the water column are not expected to be significant, as the quantitative water quality analysis indicates effects are unlikely at distances of 200 feet from the dredge area without containment measures. The presence of a silt curtain and implementation of other BMPs will further reduce the likelihood of potential effects. Finally, this project will remove a substantial mass of chemicals in the form of the tar body to provide long-term habitat benefits. As a result, incidental take due to significant disruption of normal behavior patterns or death is not expected, and, while the survival and protection of individual organisms is an important goal, the overall impact on listed species is expected to be a net benefit.

## 6 ESSENTIAL FISH HABITAT ASSESSMENT

### 6.1 Essential Fish Habitat Background

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and the 1996 Sustainable Fisheries Act (SFA), an EFH evaluation of impacts is necessary for activities that may adversely affect EFH. EFH is defined by the MSFCMA in 50 CFR 600.905-930 as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” and is designated for groundfish, coastal pelagic, and Pacific salmon composites. The action area for the proposed project includes habitats that have been designated as EFH for various life-history stages of starry flounder (Groundfish EFH composite – *Platichthys stellatus*) and Chinook and coho salmon (Pacific Salmon EFH composite). There are no coastal pelagic fish found in the vicinity of the proposed project.

Designated EFH for groundfish species encompasses all waters from the mean high water line and upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon, and California, seaward to the boundary of the U.S. exclusive economic zone (370.4 km) (PFMC 1998a, 1998b). Groundfish EFH is discussed in the Final Environmental Assessment/Regulatory Impact Review for Amendment 11 to The Pacific Coast Groundfish Management Plan (PFMC 1998a) and NOAA Fisheries’ Essential Fish Habitat for West Coast Groundfish Appendix (NMFS 1998).

Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other waterbodies currently, or historically, accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable manmade barriers (as identified by the Pacific Fisheries Management Council [PFMC]), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years; PFMC 1999). Salmonid EFH is discussed in detail in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999).

The objective of this assessment is to describe potential adverse effects to designated EFH for federally managed fisheries species within the action area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the project. EFH and life history stages for species that may occur in the project vicinity are listed in Table 2.



**Table 2**  
**MSFCMA Managed Species and Life-History Stages**  
**with Designated EFH that May Occur in the Project Vicinity**

Species	Adult	Spawning/ Mating	Juvenile	Larvae	Eggs/ Parturition
Starry flounder	X	X	X	X	X
Chinook salmon	X		X		
Coho salmon	X		X		

## 6.2 Analysis of Effects on EFH

The assessment of potential impacts from the proposed project to the species' EFH is based on information in the above-referenced documents. The potential impacts of dredging and capping on groundfish and Pacific salmon EFH and the conservation measures that avoid and minimize impacts are identified in Table 3.

**Table 3**  
**Affected EFH by Project Element and Proposed Conservation Measures**

Affected EFH	Impact	Conservation Measures
A total of approximately 0.5 acres of benthic habitat would be altered.	<p>The benthic prey community could be removed; however, there is no benthic community on the tar body and removal is expected to provide a net benefit to benthic organisms. Also, salmonids found in the Willamette River may be tied to pelagic food webs rather than benthic food webs. Therefore, potential impacts to the benthic community may not be linked to EFH for these species.</p> <p>Further, groundfish and salmonids are mobile and generally able to distinguish and avoid areas where prey are less abundant. If available, groundfish species could selectively use undisturbed or recolonized areas in the project vicinity.</p> <p>The 0.5 acre action area will be deepened, affecting existing contaminated shallow water habitat.</p>	<p>The project will comply with the timing restrictions specified in the summer/fall in-water work window, when salmonids are absent or present in very low numbers.</p> <p>The proposed removal and any cover or capping action will significantly reduce exposure to existing contamination in sediments, which will improve overall aquatic ecosystem health.</p>

Affected EFH	Impact	Conservation Measures
<p>Suspended sediment concentrations in water column EFH could be temporarily elevated.</p>	<p>Dredging and any cover or capping could cause increases in turbidity at the project Site.</p> <p>In a focused study analyzing the effects of suspended Duwamish River (Seattle, Washington) sediments on salmonids, LeGore and Des Voigne (1973) conducted 96-hour bioassays on juvenile coho salmon using re-suspended sediments from five locations from Kellogg Island to the head of the navigation channel. This analysis found that suspended sediment concentrations of 28,800 mg/L (with sediment doses as high as 5 percent wet weight), well above levels expected during dredging, had no acute effects on coho salmon. Kuo Hayes modeling results for this project estimated TSS concentrations to be lower than 375 mg/L (assuming no containment barriers are present) at distances within 200 ft of the dredge, which is much lower than the above levels of impact. Containment barriers are expected to reduce this concentration by approximately 50 percent.</p> <p>In addition, because groundfish and salmonid species in the Willamette River are mobile, they would be expected to avoid areas where unsuitable conditions exist. For this reason, the adverse effects of turbidity on water column EFH are expected to be minimal.</p>	<p>A silt curtain will encircle the dredge site, enhanced with a bedload baffle on the channel ward side, to contain resuspended and bedload sediments released during the action.</p> <p>Mitigation measures and BMPs in the RAEPF will be implemented.</p> <p>The project will comply with the timing restrictions specified in the summer/fall in-water work window, when salmonids are absent or present in very low numbers.</p> <p>Field parameters for water quality will be monitored 150 ft upriver and downriver, and grab samples for chemicals will be collected 150 ft downriver from the edge of the primary containment barrier.</p> <p>Only sealed barges will be used in transport so that no material will be discharged in transport or at the off-loading facility.</p>
<p>Suspension of sediment has the potential to adversely affect water column EFH by reducing DO.</p>	<p>High concentrations of suspended sediments have the potential to reduce DO levels by exposing nutrients to bacterial breakdown (Mortensen et al. 1976). A model created by LaSalle (1988) demonstrated that even in a situation where the upper limit of expected suspended sediment is reached during dredging operations, DO depletion of no more than 0.1 mg/L would occur at depth. LaSalle (1998) concluded that based on the relatively low levels of suspended material generated by dredging operations and considering factors such as flushing, DO depletion around these activities should be minimal.</p>	<p>Mitigation measures and BMPs in the RAEPF will be implemented.</p> <p>A silt curtain will encircle the dredge site, enhanced with a bedload baffle on the channel ward side, to contain resuspended and bedload sediments released during the action.</p> <p>The project will comply with the timing restrictions specified in the summer/fall in-water work window,</p> <p>Field parameters for water quality will be monitored 150 ft upriver and downriver, and grab samples for chemicals will be collected 150 ft downcurrent from the edge of the primary containment barrier.</p>



Affected EFH	Impact	Conservation Measures
<p>Water column EFH could be adversely affected by resuspended tar and oil or by spills from construction equipment.</p>	<p>It is not expected that dredge and capping actions will resuspend tar and oil from the tar body outside of the containment area, affecting salmonid and groundfish EFH.</p> <p>There is a nominal chance that an unintentional release of fuel, lubricants, or hydraulic fluid from the construction equipment could lead to adverse impacts to groundfish or salmonid EFH.</p> <p>In addition, because groundfish and salmonid species in the Willamette River are mobile, they would be expected to avoid areas where unsuitable conditions exist. For this reason, the adverse effects of toxics on water column EFH are expected to be minimal.</p>	<p>Two layers of floating oil absorbent booms and a oil containment skirt (extending 2 ft below water surface) will encircle the dredge site to contain floating oil released during the action.</p> <p>Field parameters for water quality will be monitored 150 ft upriver and downriver, and grab samples for chemicals will be collected 150 ft downcurrent from the edge of the primary containment barrier.</p> <p>Oil-absorbant pads and similar materials will be on Site in the event they are needed in addition to above BMPs and can also be used for construction equipment spills.</p> <p>Construction equipment will be serviced, stored, and fueled at least 100 feet away from the shoreline and routinely checked for leaks and other potential hazards.</p> <p>The project will comply with the timing restrictions specified in the summer/fall in-water work window, when salmonids are absent or present in very low numbers.</p>

**6.3 EFH Conclusion**

Pursuant to the MSFCMA and the SFA, an EFH Assessment has been completed and concludes that the proposed action may affect EFH. Consultation on EFH is requested in conjunction with the ESA consultation. A breakdown of the effect determinations is listed below.

**6.3.1 EFH Determination of Effects**

The impacts of the project on salmon and groundfish EFH are discussed in Table 3.

Approximately 0.5 acres of contaminated shallow habitat in an industrial area will be dredged and capped with clean sand to reduce exposure from sediments, and improve overall aquatic ecosystem health. Mechanical actions may temporarily resuspend sediments and/or tar and oil, temporarily reduce DO, and alter benthic habitat in the action area. These potential adverse impacts are expected to be offset by the improvement obtained in removing the tar body, which currently impacts the Site both in terms of physical substrate (which appears to contain no benthic communities) as well as representing a chemical mass in the river. Adverse impacts to salmonid and groundfish EFH by sediment resuspension should be minimized by the use of silt



curtains, bedload baffles, two layers of floating oil containment booms, an oil containment skirt (extending 2 feet below the water surface) and other BMPs, as well as by the implementation of water quality monitoring. Salmonids may not be substantially affected by the benthic community disturbance, as they may not entirely rely upon the benthic food web. In addition, the timing of the action is critical for salmonids, and will occur during the specified summer in-water work window, from July 1 to October 31. However, even with the improvement of aquatic shallow water substrate and the implementation the above-mentioned conservation measures, the overall project may adversely affect salmonid and groundfish EFH.



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**APPENDIX A**

**USFWS SPECIES LIST FOR WILLAMETTE RIVER**

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## United States Department of the Interior



**FISH AND WILDLIFE SERVICE**  
**Oregon Fish and Wildlife Office**  
**2600 SE 98th Avenue, Suite 100**  
**Portland, Oregon 97266**  
**Phone: (503) 231-6179 FAX: (503) 231-6195**

Reply To: 8330.04171 (04)  
File Name: Sp0417.wpd  
TS Number: 04-3106

**Libby Smith**  
Anchor Environmental, LLC  
6650 SW Redwood Lane, Suite 110  
Portland, OR 97224

**Subject: NW Natural Gasco Tar Removal Project**  
**USFWS Reference # 1-7-04-SP-0417**

Dear Ms. Smith:

This is in response to your Species List Request Form, dated June 11, 2004, requesting information on listed and proposed endangered and threatened species that may be present within the area of the NW Natural Gasco Tar Removal Project in Multnomah County. The Fish and Wildlife Service (Service) received your correspondence on June 11, 2004.

We have attached a list (Enclosure A) of threatened and endangered species that may occur within the area of the NW Natural Gasco Tar Removal Project. The list fulfills the requirement of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). U.S. Army Corps of Engineers (COE) requirements under the Act are outlined in Enclosure B.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems on which they depend may be conserved. Under section 7(a)(1) and 7(a)(2) of the Act and pursuant to 50 CFR 402 *et seq.*, COE is required to utilize their authorities to carry out programs which further species conservation and to determine whether projects may affect threatened and endangered species, and/or critical habitat. A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) which are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (NEPA) (42 U.S.C. 4332 (2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to the Biological Assessment be prepared to determine whether they may affect listed and proposed species. Recommended contents of a Biological Assessment are described in Enclosure B, as well as 50 CFR 402.12.

If COE determines, based on the Biological Assessment or evaluation, that threatened and endangered species and/or critical habitat may be affected by the project, COE is required to consult with the Service following the requirements of 50 CFR 402 which implement the Act.

Enclosure A includes a list of candidate species under review for listing. The list reflects changes to the candidate species list published May 4, 2004, in the Federal Register (Vol. 69, No. 86, 24876) and the addition of "species of concern." Candidate species have no protection under the Act but are included for consideration as it is possible candidates could be listed prior to project completion. Species of concern are those taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

If a proposed project may affect only candidate species or species of concern, COE is not required to perform a Biological Assessment or evaluation or consult with the Service. However, the Service recommends addressing potential impacts to these species in order to prevent future conflicts. Therefore, if early evaluation of the project indicates that it is likely to adversely impact a candidate species or species of concern, COE may wish to request technical assistance from this office.

Your interest in endangered species is appreciated. The Service encourages COE to investigate opportunities for incorporating conservation of threatened and endangered species into project planning processes as a means of complying with the Act. If you have questions regarding your responsibilities under the Act, please contact Kevin Maurice at (503) 231-6179. All correspondence should include the above referenced file number. For questions regarding salmon and steelhead trout, please contact NOAA Fisheries Service, 525 NE Oregon Street, Suite 500, Portland, Oregon 97232, (503) 230-5400.

Sincerely,

Kemper M. McMaster  
State Supervisor

Enclosures  
1-7-04-SP-0417

cc:  
Nongame, Oregon Department of Fish and Wildlife, Salem, Oregon.

## Enclosure A

FEDERALLY LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES,  
 CANDIDATE SPECIES AND SPECIES OF CONCERN THAT MAY OCCUR WITHIN THE  
 AREA OF THE NW NATURAL GASCO TAR REMOVAL PROJECT  
 1-7-04-SP-0417

LISTED SPECIES<sup>1/</sup>BirdsBald eagle<sup>2/</sup>*Haliaeetus leucocephalus*

T

FishChum salmon (Lower Columbia River)<sup>4/</sup>*Oncorhynchus keta*

\*\*T

Steelhead (Upper Willamette River)<sup>5/</sup>*Oncorhynchus mykiss*

\*\*T

Steelhead (Lower Columbia River)<sup>6/</sup>*Oncorhynchus mykiss*

\*\*T

Chinook salmon (Lower Columbia River)<sup>8/</sup>*Oncorhynchus tshawytscha*

\*\*T

Chinook salmon (Upper Willamette River)<sup>8/</sup>*Oncorhynchus tshawytscha*

\*\*T

PlantsGolden paintbrush<sup>10/</sup>*Castilleja levisecta*

T

Willamette daisy<sup>11/</sup>*Erigeron decumbens* var. *decumbens*

E

Howellia

*Howellia aquatilis*

T

Bradshaw's lomatium

*Lomatium bradshawii*

E

Kincaid's lupine<sup>11/</sup>*Lupinus sulphureus* var. *kincaidii*

T

Nelson's checker-mallow

*Sidalcea nelsoniana*

T

PROPOSED SPECIES

None

CANDIDATE SPECIES<sup>12/</sup>BirdsYellow-billed cuckoo<sup>13/</sup>*Coccyzus americanus*

Streaked horned lark

*Eremophila alpestris strigata*FishCoho salmon (Lower Columbia River)<sup>14/</sup>*Oncorhynchus kisutch*

\*\*CF

SPECIES OF CONCERNMammals

Pacific western big-eared bat

*Corynorhinus townsendii townsendii*

Silver-haired bat

*Lasionycteris noctivagans*

Long-eared myotis (bat)

*Myotis evotis*

Fringed myotis (bat)

*Myotis thysanodes*

Long-legged myotis (bat)

*Myotis volans*

Yuma myotis (bat)

*Myotis yumanensis*

Camas pocket gopher

*Thomomys bulbivorus*

Birds

Tricolored blackbird  
 Band-tailed pigeon  
 Olive-sided flycatcher  
 Yellow-breasted chat  
 Oregon vesper sparrow  
 Purple martin

*Agelaius tricolor*  
*Columba fasciata*  
*Contopus cooperi borealis*  
*Icteria virens*  
*Pooecetes gramineus affinis*  
*Progne subis*

Fish

Green sturgeon  
 Pacific lamprey  
 Coastal cutthroat trout (Upper Willamette)

*Acipenser medirostris*  
*Lampetra tridentata*  
*Oncorhynchus clarki clarki*

Invertebrates

California floater (mussel)  
 Columbia pebblesnail

*Anodonta californiensis*  
*Fluminicola fuscus*

Plants

White top aster  
 Pale larkspur  
 Willamette Valley larkspur  
 Peacock larkspur

*Aster curtus*  
*Delphinium leucophaeum*  
*Delphinium oregonum*  
*Delphinium pavonaceum*

(E) - Listed Endangered

(T) - Listed Threatened

(CH) - Critical Habitat has been designated for this species

(PE) - Proposed Endangered

(PT) - Proposed Threatened

(PCH) - Critical Habitat has been proposed for this species

(S) - Suspected

(D) - Documented

Species of Concern - Taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

(CF) - Candidate: National Marine Fisheries Service designation for any species being considered by the Secretary for listing for endangered or threatened species, but not yet the subject of a proposed rule.

\*\* Consultation with National Marine Fisheries Service may be required.

<sup>1/</sup> U. S. Department of Interior, Fish and Wildlife Service, October 31, 2000, Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 and 17.12

<sup>2/</sup> Federal Register Vol. 60, No. 133, July 12, 1995 - Final Rule - Bald Eagle

<sup>4/</sup> Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Columbia River Chum Salmon

<sup>5/</sup> Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Middle Columbia and Upper Willamette River Steelhead

<sup>6/</sup> Federal Register Vol. 63, No. 53, March 19, 1998, Final Rule - West Coast Steelhead

<sup>8/</sup> Federal Register Vol. 64, No. 56, March 24, 1999, Final Rule - West Coast Chinook Salmon

<sup>10/</sup> Federal Register Vol. 62, No. 112, June 11, 1997, Final Rule - *Castilleja levisecta*

<sup>11/</sup> Federal Register Vol. 65, No. 16, January 25, 2000, Final Rule - *Erigeron decumbens* var. *decumbens*, *Lupinus sulphureus* ssp. *kincaidii* and Fender's blue butterfly

<sup>12/</sup> Federal Register Vol. 69, No. 86, May 4, 2004, Notice of Review - Candidate or Proposed Animals and Plants

<sup>13/</sup> Federal Register Vol. 66, No. 143, July 25, 2001, 12-Month Finding for a Petition To List the Yellow-billed Cuckoo

<sup>14/</sup> Federal Register Vol. 62, No. 87, May 6, 1997, Final Rule - Coho Salmon

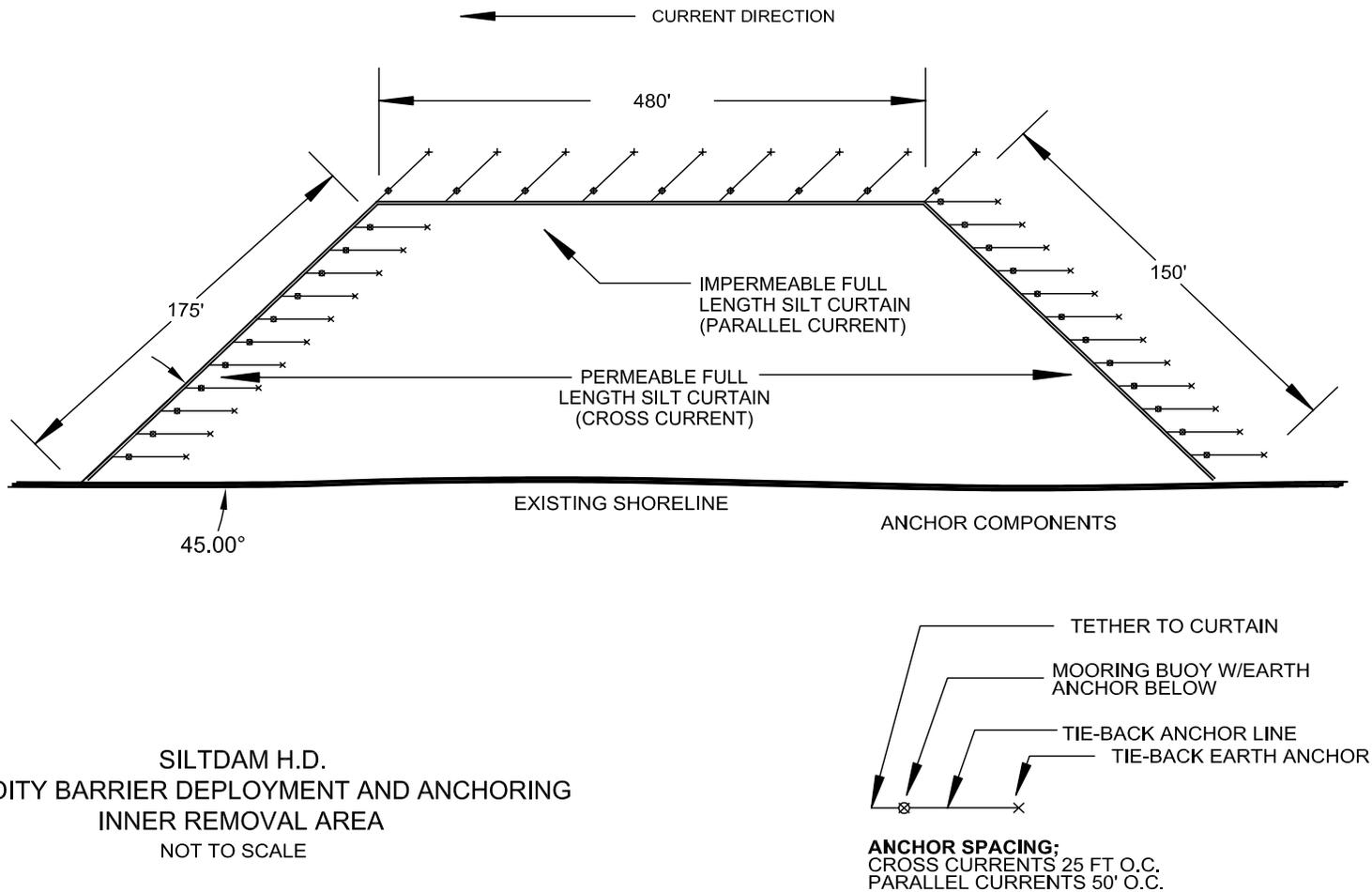
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**APPENDIX B**

**SILT CURTAIN DETAIL**

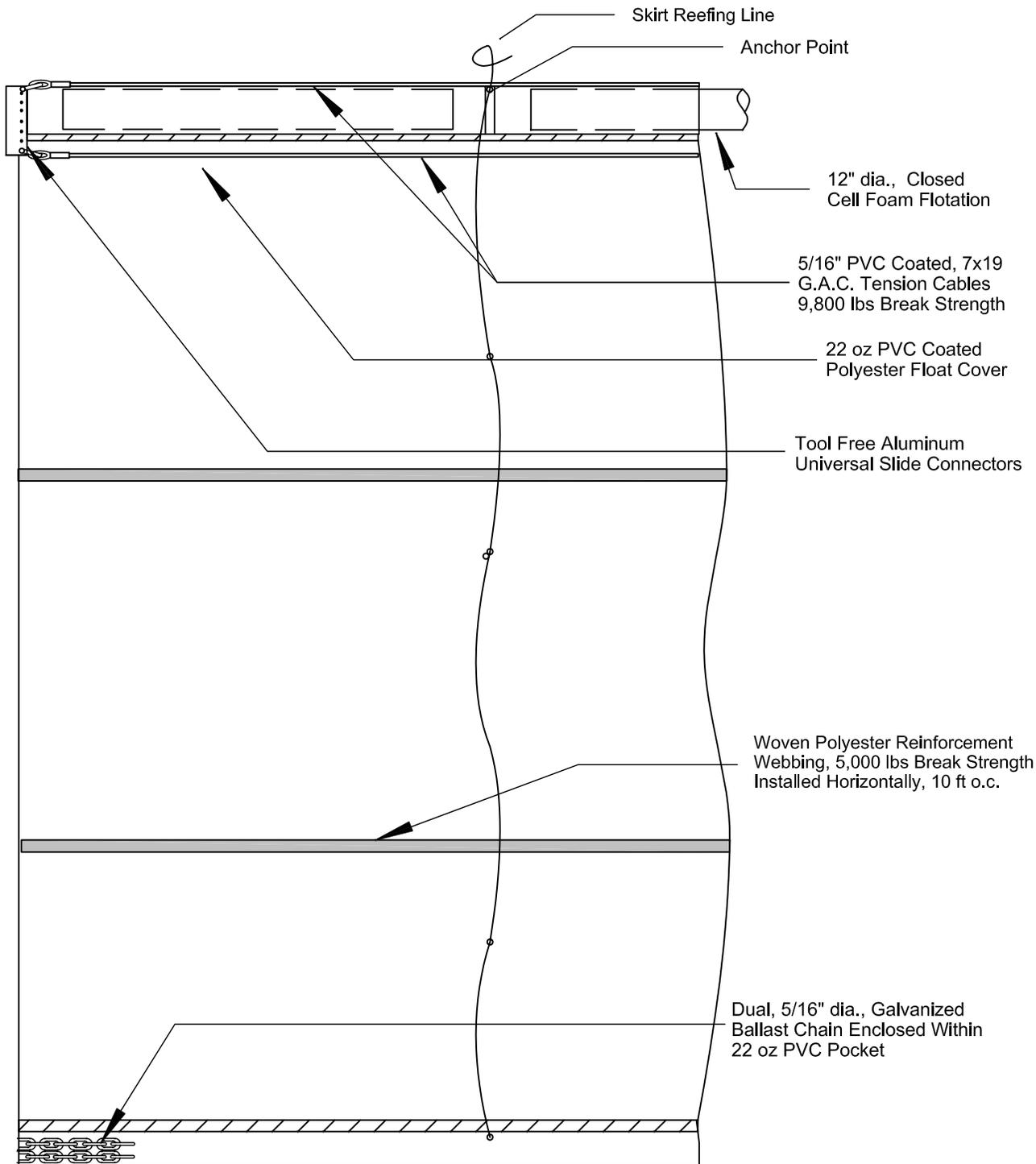
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Mar 21, 2005 1:23pm cdavidson K:\jobs\000029-GASCO\00002902\00002902-69.dwg D-1



**Figure D-1**  
Inner Removal Area Anchoring Schematic  
NW Natural "Gasco" Site

SILTDAM H.D., TURBIDITY BARRIER WITH SKIRT  
REEFING LINES AND WEBBING REINFORCEMENT  
NOT TO SCALE

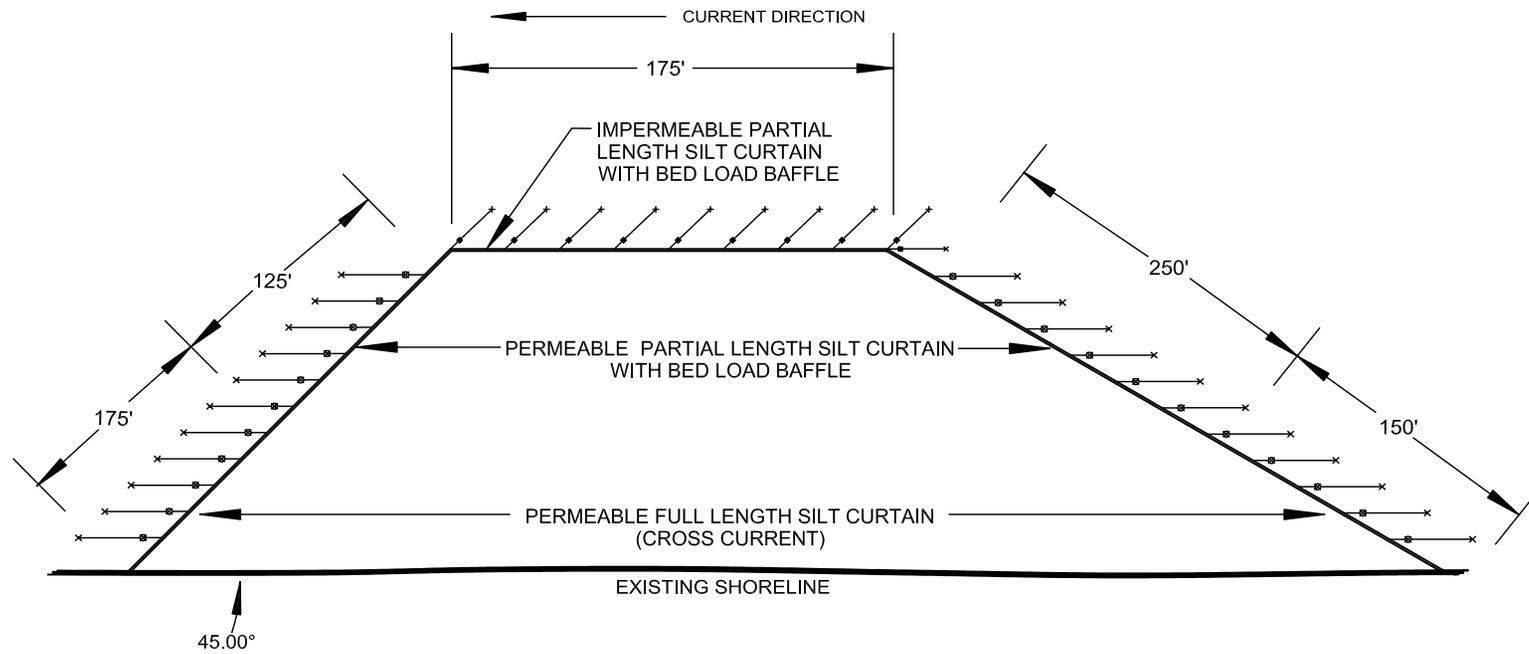


Mar 16, 2005 4:01pm cdavris\66\Jobs\000029-GASCO\00002902\00002902-69.dwg D-2

Figure D-2

Turbidity Barrier with Skirt Reefing Lines and Webbing Reinforcement  
NW Natural "Gasco" Site

Mar 16, 2005 4:00pm cdavidson K:\Jobs\000029-GASCO\00002902100002902-69.dwg D-3



SILTDAM H.D.  
TURBIDITY BARRIER DEPLOYMENT AND ANCHORING  
OUTER REMOVAL AREA  
NOT TO SCALE

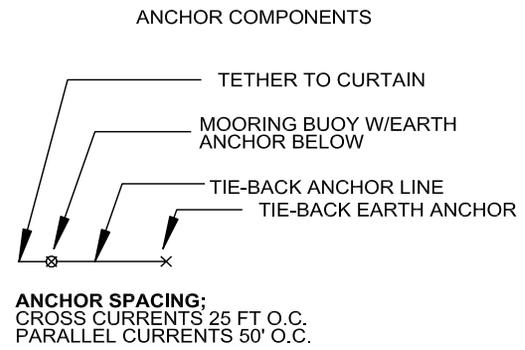
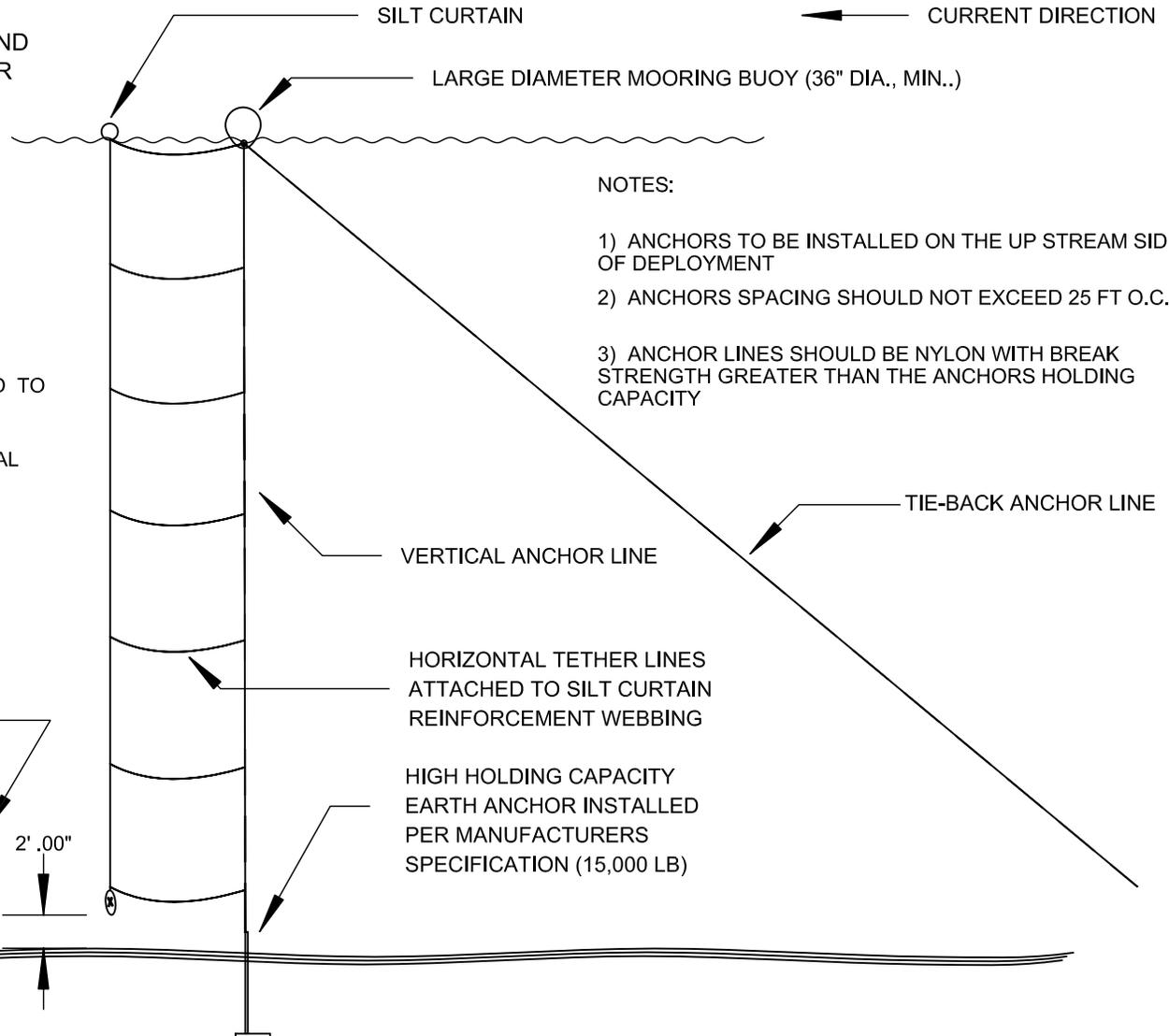


Figure D-3  
Outer Removal Area Anchoring Schematic  
NW Natural "Gasco" Site

SILTDAM H.D.  
TURBIDITY BARRIER DEPLOYMENT AND  
ANCHORING PROFILE VIEW - OUTER  
REMOVAL AREA  
NOT TO SCALE

← CURRENT DIRECTION

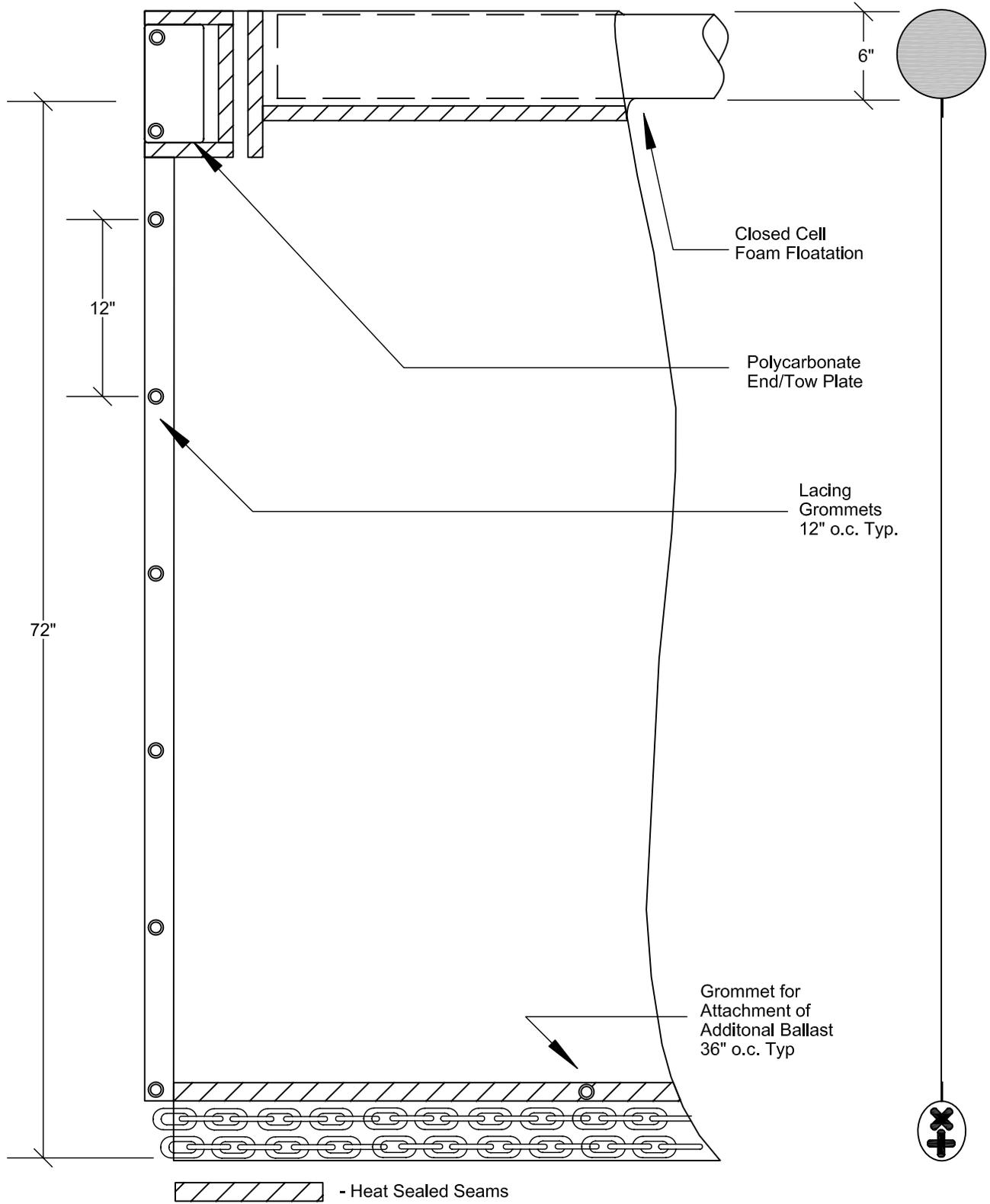


Mar 16, 2005 1:14pm cdavidson

**Figure D-4**  
Outer Removal Area - Partial Depth Curtain with Bed Load Baffle Curtain  
NW Natural "Gasco" Site

SILTDAM H.D., BED LOAD BAFFLE CURTAIN DETAIL

NOT TO SCALE



NOTE: ADDITIONAL BALLAST MUST BE ATTACHED TO THE BOTTOM OF THE CURTAIN IN ORDER TO OVER-COME THE BUOYANCY OF FLOATATION. ADDITIONAL BALLAST WEIGHT SHOULD BE THE EQUIVALENT OF 20 LBS/FT

Mar 15, 2005 4:45pm cdavids\66\Jobs\000029-GASCO\00002902\00002902-69.dwg D-5



Figure D-5

Bed Load Baffle Curtain Detail  
NW Natural "Gasco" Site

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**APPENDIX C**

**REMOVAL ACTION ENVIRONMENTAL PROJECT PLAN (RAEPP)**

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## **APPENDIX E**

### **REMOVAL ACTION ENVIRONMENTAL PROTECTION PLAN DRAFT FINAL DESIGN SUBMITTAL**

#### **REMOVAL ACTION NW NATURAL "GASCO" SITE**

##### **Prepared for Submittal to**

U.S. Environmental Protection Agency, Region 10  
1200 Sixth Avenue  
Seattle, Washington 98101

##### **Prepared by**

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

##### **On behalf of**

NW Natural  
220 NW Second Avenue  
Portland, Oregon 97209

**November 2004**

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Attachment E-1 – Quantitative Water Quality Analysis



## 1 INTRODUCTION

This document presents the Draft Final Removal Action Environmental Protection Plan (RAEPP) for the “Gasco” Site (Site) Removal Action (Project) being conducted by NW Natural. It is one part of the Draft Final Design Submittal for the Project. The objective of this RAEPP is to minimize potential short-term impacts to the environment during construction. The RAEPP identifies the environmental controls and Best Management Practices (BMPs) that will be implemented (as well as contingency measures and additional controls that may be implemented should specific circumstances arise) to minimize adverse short-term impacts of the removal action. The RAEPP also defines the water quality measurements and levels that will be used to assess water quality impacts and trigger additional contingency measures, if necessary. The Water Sediment Monitoring Plan (WSMP)—Appendix D of the Draft Final Design Submittal will be used in conjunction with the RAEPP. The WSMP describes the water quality measurements, monitoring methods, and data collected that will be used in the assessment process described in this RAEPP.

Construction operations covered by this RAEPP include dredging (and related activities such as piling removal or placement), barge loading, transfer of dredged materials to upland transport, and placement of fringe cover and pilot cap at the Site after dredging is complete. Henceforth, these construction phases will be referred to as dredging, barging, transferring, upland processing, and cover/cap placement. These construction operations are described in detail in the Removal Action Project Plan (RAPP) and Transportation and Disposal Plan (TDP).

## **2 ACTION TRIGGERS AND ENVIRONMENTAL CONTROLS REFINEMENT PROCESS**

Section 3 of this RAEPP describes environmental controls and BMPs (hereafter referred to together as controls) that will be employed during construction to minimize short-term environmental impacts. There are two general types of environmental controls considered, which are defined as:

- Standard – controls that are typically employed during contaminated sediment removal projects and will be employed at all times during the applicable operation regardless of any water quality measurements or other observations regarding environmental impacts. These controls are intended to minimize those potential impacts that might otherwise be expected without such controls.
- Project Specific – controls that have been selected specifically for the conditions of this project based on EPA and partner agency comments regarding concerns about potential water quality and other impacts. These controls will be employed at all times during the applicable operation regardless of any water quality measurements or other observations regarding environmental impacts.
- Additional – controls that will be employed as contingency measures if and when certain specific conditions are measured (e.g., water quality results per the WSMP) or observed. These additional controls are intended to minimize any potential impacts if they occur despite the use of standard controls. Generally, additional controls are implemented in a step-wise and issue-specific fashion as may be needed to reduce any potential impacts that may be measured or observed.

The primary method of determining the need for additional controls is through results evaluation of the water quality measurements and observations described in the WSMP. The determination of the need for additional controls as described in this section is consistent with the substantive requirements of Clean Water Act, Section 401 Water Quality Certification in the State of Oregon. The evaluation methods and triggers for additional controls have been developed through review of recent water quality certificates issued for dredging and contaminated sediment remediation projects in the Columbia and Lower Willamette Rivers (see Section 5 for details) as well as specific comments from EPA and partner agencies.



## 2.1 Action Triggers

The water quality results that will trigger the implementation of additional environmental controls and other contingency actions are shown in Table E-1. Should the results of the monitoring indicate an exceedance of any of the water quality triggers, the WSMP describes the additional monitoring, notification, and reporting requirements. The additional controls and other contingency actions that are summarized in Table E-1 and discussed in Section 3 will be implemented in a stepwise and issue-specific fashion until the exceedance is no longer observed.

In addition, when an exceedance is observed and additional controls are applied, monitoring will be conducted (field or laboratory parameters, whichever were exceeded) after the full resumption of the operation with the new additional controls in place. If exceedances continue to occur, the same process will be repeated after the implementation of another round of additional controls. This monitoring will be in addition to the standard monitoring frequency described in the WSMP.

Section 3 describes the additional controls that can be implemented to reduce potential water quality impacts that may be indicated by trigger exceedances.

In addition, the WSMP calls for visual monitoring of the project area during all operations. If any of the following are observed, this will also constitute a trigger for additional controls:

- Observations of high turbidity that might reasonably result in exceedance of triggers in Table E-1. (In this case, these visual observations will be first verified through additional monitoring and compared to the quantitative levels in Table E-1.)
- Distressed or dying fish outside containment barriers (see Section 3.2.5 for additional controls specific to this situation).

Use of these action triggers allows, on a temporary basis (during construction), exceedances of the water quality levels described above within containment barriers and/or 100 feet outside barriers for field parameters, and/or 150 feet outside barriers (or 328 feet or 100 meters from the point of dredging, whichever is greater) for laboratory chemistry parameters. In addition, as noted in Table E-1, additional controls will be implemented if a second exceedance of field parameter is observed 30 minutes after the first exceedance. This

procedure allows temporary exceedances of field parameters more than 100 feet from barriers or operations, but only for durations of 30 minutes or less.

A water velocity trigger of 2.5 feet per second (fps) will be used to determine the need for ceasing operations at the removal area due to potential loss of silt curtain effectiveness. Exceedance of the water velocity trigger does not indicate a potential water quality impacts, which are instead measured through the other parameters noted above. Rather, water velocity of 2.5 fps is a trigger to ensure that silt curtains are operating effectively while removal actions are taking place and should ensure that water quality impacts are avoided.

Laboratory chemistry parameters have triggers for both chronic and acute guidelines. The procedures for exceeding these two values differ. If chronic guidelines are exceeded, then the proper implementation of standard controls will be checked, confirmed, and/or reestablished, as necessary. In addition, the monitoring frequency for chemistry parameters will increase to once per day until the exceedances are no longer observed. If exceedances of the chronic guidelines persist for more than four days, then additional controls will be implemented. If acute guidelines are exceeded, then additional controls will be implemented where the activities associated with the exceedance (as sampled three days prior) are still being conducted in a similar manner.

As noted in the WSMP, Total Petroleum Hydrocarbons (TPH) will also be analyzed in samples sent to a laboratory. There are no specific risk-based values associated with TPH in surface waters that are valid for use with this project. However, if substantial concentrations of TPH (greater than 100 mg/L) are found in any samples, the site will be inspected for the presence of substantial sheens per Table E-1. If substantial sheens are present, then actions noted in Table E-1 will be triggered.

The WSMP includes monitoring at the base of the silt curtains to determine whether materials are escaping beneath the silt curtain and moving along the mudline. If substantial presence of tar particles or dense oils is found through visual observations or monitoring, then additional controls noted in Section 3 will be implemented.

## **2.2 Notification Requirements**

EPA will be notified in the event of any water quality exceedances as specified in the WSMP. This includes both immediate verbal notifications where the EPA field representative is on-site and daily as well as weekly written notifications to EPA. Also, the Construction Quality Assurance Officer (CQAO) will notify EPA of any additional controls and monitoring that were triggered and employed to minimize potential for water quality impacts. Notification will take place on the same day that such additional controls or monitoring were conducted as a part of the daily report.



### 3 ENVIRONMENTAL CONTROLS AND BEST MANAGEMENT PRACTICES

All operations will be conducted employing standard environmental controls and best management practices (controls) that minimize the potential for water quality impacts. Additional controls (contingency measures) will be implemented where the water quality triggers defined in Section 2 have been exceeded. The standard, project specific, and additional controls for each of the major operations for this removal action construction are discussed below. Under each operation, each potential control is identified as either a standard, project specific, or additional control.

As noted in Section 2, the approach to employing additional controls is a stepwise procedure. Where a water quality exceedance occurs, every potential additional control is not employed simultaneously. Rather, the approach is to examine the current operations and identify the most likely causes of the water quality exceedances measured. Thus, it may be possible to link exceedances to specific practices or issues associated with one aspect of the operation. In this case, a single additional control targeted to address the specific issue may eliminate the water quality problem. Where the implemented additional controls fail to improve water quality (as measured by additional monitoring events as noted in Section 2), then more broad scale or active control measures may be indicated.

#### 3.1 Sheen and Spill Prevention and Response

For all operations, a spill response team will be notified and on standby over the course of the operations. The spill response team will have available for use at the site an oil skimming boat, additional absorbent booms, and absorbent pads.

*Curtain Opening Procedures (Project Specific Control)* – Several levels of containment barriers will be present during the removal operations and are described in the next section. For most of the operation these barriers will provide complete containment of the removal area. Occasionally, it will be necessary to open the containment barriers to allow the passage of equipment. In these cases, the area inside the containment barrier(s) will be observed. If sheen is present inside the outer skirt and boom, oil absorbent booms and pads will be used to remove the sheen before this outer barrier is opened to prevent release of that sheen or floating material. Similarly, if substantial turbidity exists within the silt curtain, operations will stop to allow larger solids to settle before opening the silt curtain.

The goal in this case is not to achieve water clarity, but rather allow a brief period of time for some decrease in turbidity.

***Spill Prevention Inspection (Standard Control)***—Fuel hoses, oil drums, oil or fuel transfer valves and fittings, etc., shall be checked regularly for drips or leaks, and shall be maintained in order to prevent spills into river water.

***Sheen Contingency Response (Additional Control)*** – Deployment of additional booms and absorbent materials will be triggered whenever substantial sheen is observed outside the outer standard perimeter controls (per the triggers in Section 2). In addition, operations will cease until sheen outside containment barriers can be removed and any further loss of material beyond the containment barriers can be stopped.

***Spill Response (Additional Control)*** – If substantial oily releases or free product is observed, the spill response boat will be deployed and standby in the event that this material cannot be contained and removed inside the perimeter controls. The Oregon Department of Environmental Quality (DEQ) Spill Response Team (Northwest Region/Portland: (503) 229-5614) will also be notified.

Operations will cease until such time as the spill response team can limit, contain, or remove spilled or discharged materials from the Project area. In addition, extra absorbent pads will be present on site for all operations and will immediately be deployed under the above circumstances.

### **3.2 Dredging**

A clamshell dredge will be used to remove the tar body using a water-based derrick. Dredged material will be placed in a barge for subsequent transport. Dredging methods are described in detail in the RAPP.

Dredging controls are separated into three main categories: containment barriers, operational controls, and types of dredging equipment. The efficacy of each of these controls is related to site-specific variables (e.g., sediment physical properties and water currents). Each of the types of controls is discussed more in the following sections. In

addition, some removal and potential placement of temporary pilings may be necessary before and/or after dredging operations. Controls for piling operations are discussed in Section 3.2.4.

### **3.2.1 Containment Barriers**

*Triple Barrier System (Project Specific Control)* – As described in the RAPP, the area of removal has been subdivided into two areas (the outer channel area and the inner shoreward area) based on the feasibility of installing the containment barriers (see Figures E-1 and E-2). Containment barriers for the inner area will include a full length silt curtain (project specific control). Containment barriers for the outer area will include partial length silt curtains for the portion of the silt curtain that is in the navigation channel (standard control). The installation and maintenance of full length silt curtains in the navigation channel is technically impracticable because the maximum water depth at the outside of the removal area is expected to be approximately 40 feet during the work. As currents increase, deep silt curtains become more infeasible, thus the summer work window with substantially lower currents is preferable for deployment of full length silt curtains.

To address EPA's concerns about a partial length silt curtain, a triple barrier is proposed for both the inner and outer dredge areas. The triple barrier includes:

- Oil absorbent boom (innermost barrier)
- Full-length impermeable silt curtain (inner area) anchored to the bottom and a partial length silt curtain (outer area)
- Oil containment skirt with oil absorbent boom (outer barrier)

The silt curtains will be permeable fabric on the upstream side to minimize the direct impact of currents, and impermeable fabric on the downstream side. The full length silt curtains will be designed as shown in Figure E-3. If work were to be conducted in the winter, the anchoring system would instead include heavy anchors that dig into the sediment surface every 25 to 50 feet along the bottom edge. This additional anchoring will be needed to withstand the currents. Consequently, work in the summer is preferable from this logistical standpoint.



The partial length silt curtains will have a similar design, but would be approximately 20 feet long (extending from the water surface to 20 feet below the surface) and would be weighted rather than fixed to the river bottom with anchors.

Placement of containment barriers around the outer area will limit the access of fuel barges to the dock. The dredging under this second scenario will be targeted for a time when barges are not scheduled to arrive at the dock. As the exact day of removal start becomes known, the dredging of the inner and outer areas will be staged such that barge docking during outer area removal can be avoided. This will be much easier in the 4-month-long summer work window as opposed to the 2-month-long winter work window. For the inner area dredging, barge docking will be controlled with additional tugs as needed to avoid propwash affecting the full length silt curtain. In addition, the outer floating skirt, which is easily moved as compared to the silt curtain, will be moved aside at docking times.

Based on experience with silt curtains in similar river environments and consultation with silt curtain suppliers, river velocities in excess of 1 fps require very aggressive anchoring systems that decrease the ability to move and position the silt curtains to different areas. Currents in excess of approximately 2.5 to 3.0 fps would make silt curtains infeasible in these water depths. Consequently, working in the summer is preferable both from a logistical standpoint, but also from the standpoint of minimizing the potential for impacts to water quality and environment. As noted in Appendix H, Attachment B, the expected range for current velocities at the Gasco Site is 0.7 to 3 fps in the winter and 0.1 to 0.3 fps in the summer. Consequently, working in low current conditions of summer provides a substantial factor safety for the effective use of these silt curtains.

***Cease/Modify Operations in High Currents/Waves (Additional Control)*** – If currents exceed 2.5 fps, operations will stop until currents are again below this velocity. At all times the curtains will be observed for proper deployment, effectiveness, signs of unacceptable sailing or dragging. In these cases, operations will stop until the curtains can be deployed in a manner (e.g., additional or different anchoring methods) that prevents these issues. Wave action that visibly compromises floating skirts and/or



booms will also trigger limiting or stopping operations until either wave conditions calm or controls can be deployed in an effective manner under those conditions. Because at this time of year, flow reversals are extremely unusual, the use of permeable silt curtains on the upstream side is not expected to result in any loss of materials. In the event a flow reversal is observed, work would be suspended until the currents have returned to their normal direction.

### **3.2.2 Operational Controls**

Operational controls are methods of using and deploying dredging equipment that can minimize the resuspension and loss of materials to the water column. Types of dredging operational controls are discussed below.

***No Multiple Bites (Standard Control)*** – When the clamshell bucket takes multiple bites, the bucket loses sediment as it is reopened for subsequent bites. Sediment is also released higher in the water column, as the bucket is raised, opened, and lowered. Multiple bite techniques will not be allowed on the project.

***No Bottom Stockpiling (Standard Control)*** – Bottom stockpiling is when material is dredged and then temporarily placed on the bottom prior to final removal to the barge. This increases the handling of the sediment with each step potentially causing more material loss to the water column. Bottom stockpiling will not be allowed on the project.

***Pausing before Opening Silt Curtains (Project Specific Control)*** – The dredge will be moved between the containment areas at least once during the removal action. The silt curtain and associated containment barriers must be opened to allow the equipment to enter or exit the containment area. Before silt curtains are opened or moved, dredging operations will cease to allow some resettling of suspended sediments within the silt curtain area. The appropriate settling period will vary depending on the silt content and other properties of the sediment and will be judged through visual observations or turbidity measurements, if necessary. The intention of this control is not to achieve pristine or clear water within the silt curtain area, which may take hours or even days. Rather, it is intended to simply allow some gross settling of larger grain size materials.

***Spill Apron (Project Specific Control)*** – When the dredge bucket must swing over water between the containment area and the haul barge, a spill apron will be used below the path of the bucket to avoid dropping dredged material into the water. The spill apron will drain into the haul barge or into the containment area. The haul barges are water tight and scuppers will be sealed when the barge is in transit between the removal site and the offloading facility. While dredged material is being loaded into the haul barge, return water will be directed only into the fully contained removal area and solids will be retained in the barge by filter fabric or hay bales as described in Section 3.3.

***Increased Cycle Time (Additional Control)*** – Cycle time refers to the time it takes for the bucket to be deployed, recovered, moved to and from the haul barge, and returned to the sediment bed. Longer cycle time is achieved by reducing the velocity of either the ascending loaded bucket or descending empty bucket through the water column. Limiting ascension velocity can reduce the potential for washing of sediment from the bucket. In addition, pausing at the surface of the water before movement through the air and to the barge can also reduce the amount of water laden sediment that washes from the bucket. Limiting the descending velocity reduces the impact of the bucket on the bottom, which can cause resuspension. However, limiting the velocity of the descending bucket reduces the volume of sediment that is picked up with each bite and requires more total bites to remove the same material, which can cause more overall resuspension. Consequently, if needed, descending velocity should only be limited to the extent that relatively full buckets can be obtained for each bite. Sediment resuspension can also be reduced by pausing the bucket at bottom after impact and before digging.

***Reduce or Stop Dredging during Peak Currents (Additional Control)*** – Because of the short construction window, dredging will initially proceed at all times of the day. However, high flows or tidal exchange periods can result in higher currents that carry any resuspended material further downstream. If it is found that water quality exceedances occur during periods of higher currents, an additional control may be to reduce the amount or rate of dredging or completely stop dredging until current velocities decrease.

### **3.2.3 Dredging Equipment (Additional Controls)**

Removal will be accomplished primarily using an 8 cubic yard (cy) dredge bucket. However, several other bucket types and sizes will be available and may be used depending on site conditions encountered, including a 15 cy cable arm bucket and a 9 cy “flat lip” bucket. In some circumstances a large bucket may cause less resuspension of material. If bucket efficiency appears to be the source of any water quality exceedances, a larger capacity bucket may be employed. In addition, other types of buckets that will be present on site may dig better in the consistency of material encountered in some areas. A bucket that digs the most effectively usually causes less resuspension. Consequently, the most effective bucket will be selected for the particular materials encountered throughout the dredge prism.

### **3.2.4 Piling Related Controls (Standard Controls)**

Standard controls for piling removal will include:

- Pulling rather than digging out pilings
- All piling removal inside triple containment barrier noted above.

Digging for piling stubs will be avoided, if possible. Any woody debris that is lost to the water will be captured and removed from the water.

### **3.2.5 Fish Protection Measures**

Fish protection measures apply to threatened and endangered fish species, non-listed fish species, and other species of interest to particular parties such as lamprey and sturgeon.

***Measures to Protect Fish from Entrapment (Project Specific Control)*** – When the silt curtain is closed, entrapment of fish could occur within the curtain, but is not expected to be likely. Seining methods will be employed to exclude fish from within the containment barrier and prevent potential contact with the clamshell bucket. Several beach seine sets will be deployed to remove fish from the shallow water, and a research-size purse seine will be deployed from the dock to remove fish from deeper water. Additional sets may be deployed periodically when the silt curtain is opened to allow occasional passage of any equipment during the project. This should ensure that fish

have not entered the contained area during these temporary opening events. Captured fish will be contained in an aerated tank and released outside of the action area. A preliminary design used bubble curtains to exclude fish during times that the silt curtains were opened. Additional investigation in the use of bubble curtains and similar devices is that they have been shown to be effective primarily for use in suppressing sound associated with pile driving. It is very unclear whether a bubble curtain would substantially deter fish from entering the containment area. Conversely, seining (described above) is a proven technology for safely capturing and removing fish from specific areas of construction.

***Cease Operations If Distressed or Dying Fish Observed and Methods for Recommencing Work (Additional Control)*** – In the event that distressed or dying fish are observed, all work will stop and the fish will be collected and examined. If such species are endangered or threatened initial notification will be made to the NOAA Fisheries Law Enforcement Office located at Vancouver Field Office, 600 Maritime, Suite 130, Vancouver, Washington 98661; telephone: 360/418-4246.

Care will be taken in handling sick or injured specimens to ensure effective treatment. Handling of dead specimens will take care to preserve biological material in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered and threatened species or preservation of biological materials from a dead animal, the CQAO will carry out instructions provided by NOAA Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

Work will not recommence until informal discussions with the Services can be held to determine appropriate actions. If non-listed species are found, then sonar and/or diver surveys may be conducted of the area to determine whether fish are present, and if so where. Seining as described above will be employed to remove any living fish from the area before work recommences.

### 3.3 Barge Loading

***No Release of Water Outside Silt Curtains (Project Specific Control)*** – The haul barges are water tight and barge ports will be sealed when the barge is in transit between the removal site and the offloading facility. While dredged material is being loaded into the haul barge, return water will be directed only into the fully contained removal area. Solids will be retained within the barge by placing geofabric or hay bales over the water returns. Before the haul barge leaves the removal site, the return water devices will be removed or sealed so there is no release from the barge in transit.

***Barge Spill Control (Project Specific Control)*** – Spill controls will be employed to prevent material dripping from the swinging bucket from entering water outside the silt curtain. The specific control employed will depend on the orientation of the haul barge and dredge derrick at any particular moment in the dredge operation. In some cases, the haul barge will be set flush up against the silt curtain to prevent any outside spillage. In other cases a spill apron will be used that will extend out away from the barge. In other cases, the haul barge may be inside the silt curtains during loading. This apron will either be deployed so that material drains into the barge or back into the contained area behind the silt curtain.

***Fill Barge to Only 85-90 percent Capacity (Project Specific Control)*** – In some types of dredging operations, the barge is overfilled with sediment so that additional water (and some associated sediments) are lost. This increases the sediment load in the barge. This practice will not be allowed for this project. To prevent any possible spillage, barges will be filled to only 85 to 90 percent capacity.

### 3.4 Transferring

Once the barge is loaded, it will be transported to a dock for transfer of the sediment to trucks for transport to the disposal facility. The following controls can be employed during the unloading of barges to trucks.

***Sediment Spill Protection (Standard Control)*** – A protective “capture barge,” temporary structure, and/or spill apron will be placed along the swing pathway of the bucket to prevent material from entering the water. The upland area within the vicinity of the swing pathway will also be lined with plastic liner to capture material that falls onto the ground.



The plastic liner will be visually inspected following transfer of material to each truck. If material is identified on the liner it will either be cleaned from the liner surface or the liner will be removed and disposed (at the disposal facility) and replaced with a new liner.

***Prevent Return Material/Water (Standard Control)*** – A metal spill apron will be used for off-loading the dredged material from barge to truck. The apron and upland area will include structures (e.g., curbs) necessary to prevent sediment and water from running off the dock and shoreline area and back into the water. In addition, adequate curbing will be installed to contain water and sediments from discharging to the river or any other surface water feature such as drains or ditches. Any retained wet materials will be collected and incorporated back into the materials being loaded onto trucks.

***Dewater Control (Standard Control)*** – No dewater will be created or discharged as a part of the transfer and disposal process. If free water is accepted by the disposal facility, the sediments will be loaded directly to lined and sealed trucks for transport to the facility. If free water is not accepted by the facility, then drying agents will be added (either Portland Cement, quicklime, or paper-based product) until the material is of acceptable consistency. These agents will be added to the barge and mixed in with the loading bucket. Through these methods no free dewater will be created or discharged to surface waters.

***Upland Transport Lined/Watertight Containers (Standard Control)*** – Containers or trucks that are loaded with sediment containing free liquid for transport to upland disposal facilities will be either lined with impermeable liners or water tight containers. Trucks carrying material that has no free liquid will not need to be lined or watertight. The truck bed and cargo will be covered to keep rainwater from contacting the material and loss of material in transport.

***Upland Transport Loading Capacity (Standard Control)*** – The transfer bucket used to load trucks with material from the haul barge will be opened the minimum amount required to empty the desired quantity of material into the trucks. Trucks will not be overfilled to the point that sudden stops may cause “sloshing” overflow or other spillage.

***Upland Area Sweeping (Standard Control)*** – The transloading facility will be continuously visually monitored and be swept regularly to prevent potential spreading of materials.

***Loadout Pad Lining (Project Specific Control)*** – Prior to loading dredged material into trucks, the trucks will be driven onto a disposable liner on the loadout pad. Before the truck is cleared to drive off the loadout pad, the truck and the liner will be inspected for spilled material. Any spilled material will be removed from the truck or the liner. If contamination cannot be thoroughly removed from the liner, the contaminated area will be covered to avoid tracking contaminants onto truck tires and out of the loadout area. After the truck is cleared to leave the loadout area, the liner will be inspected for spillage or damage. Contaminated or damaged liners will be discarded (sent to the disposal facility) and replaced before the next truck enters the loadout pad.

***Access Area Inspection (Standard Control)*** – After the truck is cleared to leave the loadout pad and before it is cleared to leave the transfer facility, the paved area just traversed by the truck will be visually inspected for tracking of contaminated material. If contamination is found, the truck will be routed to a decontamination area to be cleaned and re-inspected before it is cleared to leave the transfer facility and travel on public roads. The paved area will be cleaned and absorbents will be used if appropriate to avoid spreading contamination.

***Area and Equipment Cleaning (Standard Control)*** – All contaminated sediment and materials will be removed from the outside of barges, aprons, trucks, bulldozers, and railcars using dry decontamination methods (brushing or sweeping), prior to leaving the project site. Wheels of trucks may be washed as necessary.

***Containment of Additives (Standard Control)*** – One of three additives may be used to eliminate free liquids in the dredged material: paper manufacturing byproduct, Portland cement, and quicklime. The paper manufacturing byproduct has no associated health hazards although it must be contained to prevent it from littering the facility or surroundings or entering the water. Portland cement and quicklime are respiratory irritants and have high pH. Drying agents will be delivered to the site via truck and unloaded to temporary covered holding containers to prevent contact with rain water and escape of

these materials to wider areas. These agents will be transferred to the barge for mixing in the barge with the transfer bucket.

***Mixing of Additives and Dredged Material (Standard Control)*** – Prior to mixing any of the reagents with the dredged material, the operator will dig a mixing depression in the dredged material on the barge. The transfer bucket will be detached from the cable on the truck loadout pad to limit the area potentially affected by contaminated material on the transfer bucket. A bin for moving reagent will be connected to the cable near the reagent holding container, and the reagent will be dispensed from the holding container to the bin. The bin will be positioned over the mixing depression and lowered as close as possible to the dredged material in the barge without contacting the contaminated material, and the reagent will be dumped into the mixing depression. After the desired quantity of reagent is added to the barge, the bin will be detached from the cable and the bucket will be reattached, moved to the barge, and the dredged material and reagent will be mixed by successively scooping wet dredged material into the reagent and dragging partially mixed material out of the depression. Mixing will continue until there is no apparent free liquid in the barge and the material appears homogenous. Smaller quantities of reagent will be added for each mix if dust is raised during mixing. Neither dredged material nor reagent will be allowed to spill or drift (as dust) out of the barge and into the water.

***Limit Operations to Appropriate Weather (Additional Control)*** – If very high river flows or storm events occur, operations should be limited to the extent necessary to prevent loss of materials. This may include ceasing operations where rain events might cause overflow of onshore containment devices such as curbs noted above. Upgrading runoff controls from equipment and transloading facilities will be considered, if appropriate, as an option to limiting operations during rainfall.

### **3.5 Fringe Cover and Pilot Cap Placement**

As described in the RAPP, a fringe cover and pilot cap will be placed over the newly created sediment surface after dredging. The placement method will be via clamshell placement of material from a barge to the bottom. The following controls can be employed during this operation:

***Quality of Cover/Cap Material (Standard Control)*** – Clean materials used for the cover/cap will be suitable for in-water disposal and will meet the chemical analytical criteria of the Dredge Material Evaluation Framework (USACE et al. 1998). They will be essentially free of organic or other types of waste debris.

***Placement Methods (Standard Control)*** – The cover/cap material will be placed on the newly created sediment surface via clamshell bucket. The following operational controls will be used to limit the potential for resuspension and loss of contaminated sediments that may remain in the area:

- The clamshell will be cracked open while swinging over the desired area of placement. This results in “sprinkling” of material over the bottom and avoids impact of a large amount of material with the bottom in one location.
- The entire area will be covered with a 6 inch lift of cover/cap material working from lower to higher elevations. This approach will result in immediate coverage of all potentially contaminated areas and avoids the potential for cross contamination of cover/cap material.
- The entire area will then be covered with additional 6 inch lifts as necessary to achieve the final required cover/cap thickness in the same manner.

***Containment Barriers (Project Specific Control)*** – As described in Section 3.2.1, silt curtains and associated containment barriers will surround the removal area during cover/cap placement.

## 4 OTHER PROTECTIVE MEASURES

### 4.1 Protection of Land Resources

The land resources within the project boundaries and outside the limits of work shall be preserved in their present condition or be restored to a condition after construction that will appear to be consistent with previous site uses, and not detract from the appearance of the area. Areas of bare soil exposed at any time shall be held to a minimum. Surface drainage from cuts and fill, whether or not completed shall be held in sedimentation ponds or the areas shall be graded to control erosion within acceptable limits. Temporary erosion and sediment control measures such as partial backfilling, mulching, ditches, dikes, drains, sedimentation basins, or silt fences or curtains shall be provided as needed, and maintained.

### 4.2 Disposal

Except as described in this RAEPP, disposal of any wastes, effluents, trash, grease, chemicals, or other contaminants in surface waters will not be allowed. If any waste material is accidentally released in unauthorized areas, the material shall be removed and the area restored to a condition approximating the adjacent undisturbed area.

Petroleum products, chemicals, fresh cement, riprap, grout, or other deleterious waste materials will not be allowed to enter waters of the State. All foreign materials, construction debris, refuse, waste, used absorbent materials, and similar items must be removed from the site and placed in an appropriate upland disposal facility.

### 4.3 Protection of Fish and Wildlife

All work shall be performed and all steps taken to prevent interference or disturbance to fish and wildlife. This includes threatened and endangered species, non-listed species, and other species of interest to particular parties such as lamprey and sturgeon. Unless otherwise authorized, all work shall be performed within in-water work periods established for fish by Oregon Department of Fish & Wildlife, and all work shall comply with a Biological Assessment for the project approved by EPA. EPA will consult with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). Water flows or habitat outside the project boundaries that are critical to fish or wildlife shall not be altered or disturbed. Protective measures as noted in Section 3 will be employed if dead or distressed fish are observed. If a listed species is found to be distressed or dead, EPA may

require additional control measures beyond those discussed in the final design and BA. This situation constitutes an action trigger as noted in Section 2, and will result in the appropriate measures and notifications as described there. A biological assessment has been prepared and submitted to the USFWS and NMFS for review and issuance of a biological opinion, which has not yet been completed by these agencies. If the Biological Opinion requires additional reasonable and prudent measures, the removal work will comply with such measures. Other protective measures may be required by the final Biological Opinion, and these will be reflected as appropriate in the final design RAEPP.

#### **4.4 Dust Control**

Dust control shall be performed as the work proceeds, whenever a dust nuisance or hazard occurs.

## 5 WATER QUALITY ANALYSIS

The process for determining water quality exceedances, trigger levels, and triggering additional controls as described in this RAEPP is consistent with the substantive requirements of a Section 401 Water Quality Certification in the State of Oregon and Section 404(b)(1) of the Clean Water Act. This RAEPP was developed through review of recent water quality certificates issued for dredging and contaminated sediment remediation projects in the Columbia and Lower Willamette Rivers including the Columbia River Deepening Project (DEQ 2003a) and the McCormick and Baxter Superfund Site Remediation (DEQ 2003b).

The water quality monitoring requirements and exceedance levels are consistent with these recent water quality certifications. The environmental controls (both standard and additional) meet, and in most cases exceed, the requirements of these recent water quality certificates. Because these recent water quality certificates were issued for compliance with Section 401 and 404(b)(1) in these same waters for similar projects, the removal alternative described in the RAPP complies with the substantive requirements of these regulations.

The 404(b)(1) guidelines require consideration of potential impacts on the following:

- Physical and chemical characteristics of aquatic ecosystem
- Biological characteristics of the aquatic ecosystem
- Special aquatic sites
- Human use characteristics

Each of these items and potential alternatives are discussed below. Based on the evaluation below, short-term adverse impacts are being minimized to the extent practicable while still attaining the goal of removing the tar body from the site. Additional mitigation is not needed beyond the standard and potential additional controls proposed here and the placement of a temporary cover or pilot cap until full scale remediation of all contaminated sediments within the Portland Harbor Superfund Site can take place.

### 5.1 Physical and Chemical Characteristics

The chemical characteristics of the removal action area will be substantially improved due to the removal action. Because the removal action is a time critical action to prevent potential ongoing impacts to aquatic ecosystems, other alternatives to this removal were not

considered. Cover/cap material applied to the area will be cleaner than any sediments currently existing in the area, and will meet open water disposal requirements (USACE et al. 1998).

The physical characteristics of the removal action area will also be improved over existing conditions. Tar body waste material substrate will be replaced with clean sand or similar material that should pose less substrate impact to aquatic ecosystems. The dredge cut will cause a slight depression in the bank of the river. However, the created elevations are similar to the water depths currently present throughout the adjacent river channel as well as the varied shoreline bathymetry throughout this portion of the river.

## **5.2 Biological Characteristics**

There are likely little if any current benthic or similar biological communities in the area due to the presence of tar. Thus, there will be little if any impact to resident communities during the removal. There may be some unavoidable water quality impacts within containment barriers. Proposed standard and additional controls should be sufficient to limit water quality impacts that might impact fish or water column communities outside the containment barriers in the area. Water quality monitoring will provide a means to verify this and upgrade controls as needed. Also, containment barriers will prevent fish from swimming into the removal area. Overall, the short-term adverse biological impacts associated with the removal are likely outweighed by the long-term benefits to area biological communities by removing this material from the river.

## **5.3 Special Aquatic Sites**

No special aquatic sites will be affected by this removal action.

## **5.4 Human Use Characteristics**

Human uses of this industrial shoreline site are limited to dock unloading activities associated with the upland industries. The removal action will have no substantial impact on these activities. In addition, any potential chemical risks to human health posed by the tar body will be reduced by this removal action.

## 6 REFERENCES

DEQ 2003a. Letter dated June 23, 2003. To: Colonel Richard W. Hobernicht U.S. Army Corps of Engineers. From: Michael T. Llewelyn Administrator Water Quality Division, DEQ. Regarding: U.S. Army Corps of Engineers' (Corps) requests for water quality certification dated September 4, 2002, November 26, 2002 and March 28, 2003 for The Corps Portland District proposal to deepen the Columbia River Navigation Channel between River Mile (RM) 3.0 and RM 106.5, including the area adjacent to Port of Portland Terminal 6 in the Oregon Slough.

DEQ 2003b. Memorandum dated December 9, 2003. To: Susan Gardner, Project Engineer, Ecology & Environment, Inc. From: Kevin Parrett, Project Manager, Oregon Department of Environmental Quality. Subject: Clean Water Act 401 Water Quality Certification and 404 Evaluation McCormick & Baxter Superfund Site.

USACE, USEPA, Washington Department of Ecology, and DEQ. 1998. Dredge Material Evaluation Framework Lower Columbia River Management Area. Public Review Draft. Portland, Oregon.



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## Tables

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**Table E-1  
Water Quality Triggers for Additional Environmental Controls**

Parameter	Unit	Location	Trigger <sup>a</sup>	Action Triggered
Turbidity	Nephelometric Turbidity Units (NTU)	100 feet downstream of operations <sup>b</sup>	> 3 NTU over background (where background <50 NTU)  >10% over background (where background >50 NTU) <sup>c</sup>	Inspect construction and select an additional control(s) that focus on cause of exceedance
Dissolved Oxygen (DO)	mg/L	100 feet downstream of operations <sup>b</sup>	<6.5 modify operations <6.0 cease operations <sup>d</sup>	Inspect construction and select an additional control(s) that focus on cause of exceedance
pH	Standard units	100 feet downstream of operations <sup>b</sup>	<6.5 or >8.5	Inspect construction and select an additional control(s) that focus on cause of exceedance
Oil/Sheen	Visual Observation	Outside of outer containment barrier	Large contiguous, thick, heavy, or persistent oil/sheen present outside the outer containment barrier	Inspect construction and select targeted additional sheen controls from Section 3.1
Benzo(a)pyrene	µg/L	150 feet downstream of containment barriers or 328 feet downstream from point of dredging (whichever is greater) <sup>b</sup>	Chronic – 0.014 <sup>e</sup> Acute – 0.24	For chronic, confirm standard controls and increase monitoring to once per day (see text for exceedances of more than four consecutive days). For acute, inspect construction and select an additional control(s) that focus on cause of exceedance.
Benzo(a)anthracene	µg/L	150 feet downstream of containment barriers or 328 feet downstream from point of dredging (whichever is greater) <sup>b</sup>	Chronic – 0.027 <sup>e</sup> Acute – 0.49	
Water Velocity	fps	Upstream and immediately in line with operation	2.5 fps	Stop operations and secure silt curtains and other containment barriers
Distressed or Dead Fish	Visual Observation	Anywhere in proximity to site.	Any distressed, dying, or dead fish.	Stop all operations, collect fish, determine species, notify Services if listed species present, apply controls required by Biological Opinion and/or additional controls for non-listed species (see Section 3.2.5 for handling of distressed or dead fish)

- a If field parameter monitoring results exceed trigger, then the same field parameter will be measured within 30 minutes of the determination of the exceedance. If the exceedance continues, the additional controls discussed in Section 3 will be implemented.
- b Sampling will occur at the specified distance from the edge of the outer containment barrier. Although flow reversals due to tidal fluctuations are rare in winter months on this part of the river, if such reversals are observed, sampling will be conducted up current (background) and down current for field parameters, as appropriate.
- c Trigger is exceeded where downstream conditions exceed the specified amounts relative to both the event-specific background and the preconstruction background survey.
- d If DO levels fall below 6.5 mg/L, additional controls discussed in Section 3 will be implemented. If DO levels fall below 6.0 mg/L, operations will cease until DO levels rise above 6.0 mg/L and additional controls discussed in Section 3 will be implemented before resumption of work.
- e If chronic levels are exceeded, see text for description of activities. If acute levels are exceeded, additional controls will be applied where activities are still consistent with activities at the time the sampling occurred.

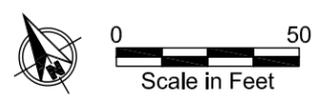
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## Figures

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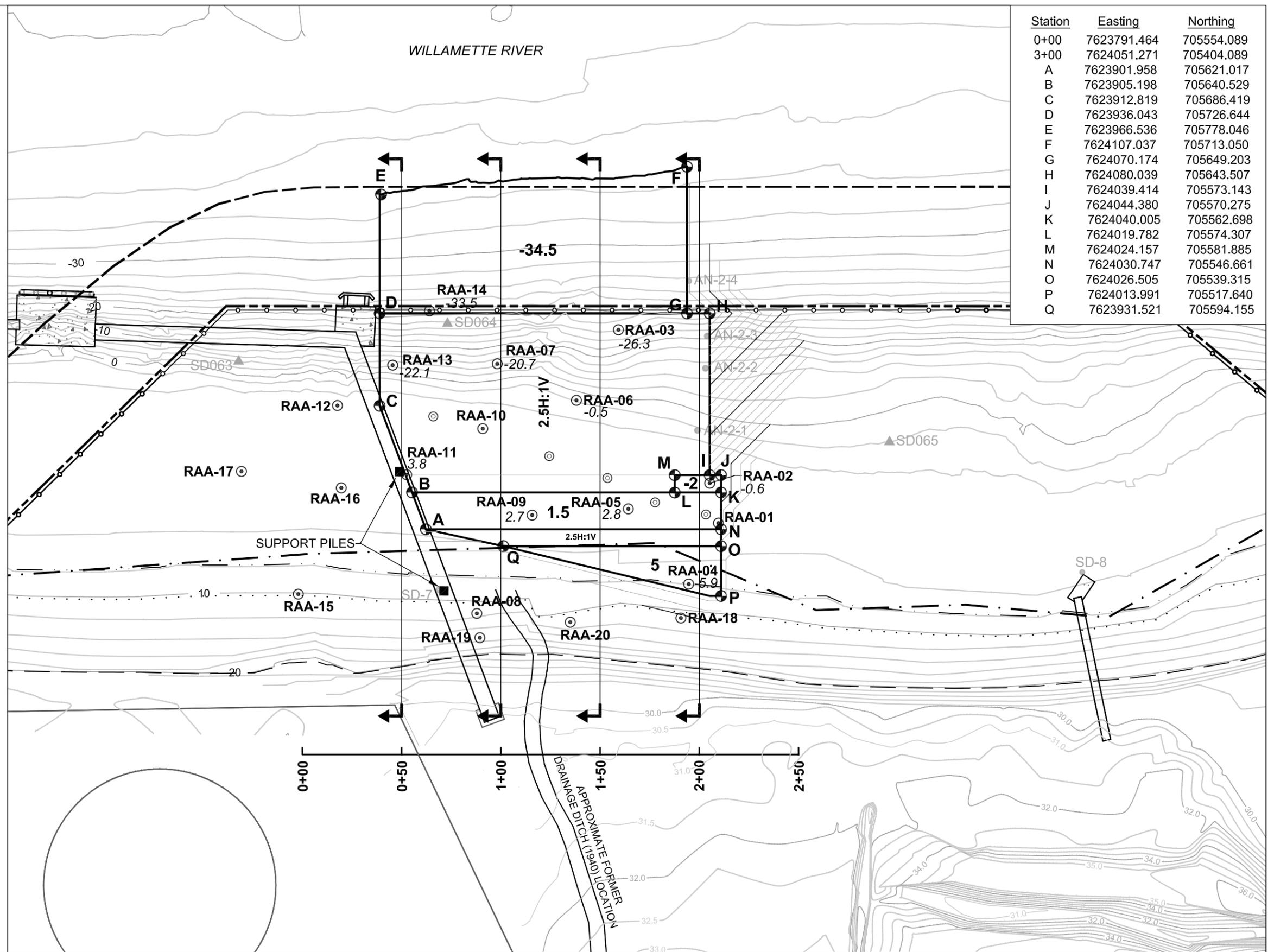
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- Legend:**
- 1.5 Dredge Prism and Dredge Elevation
  - ⊙ RAA-01 Sample Location and Number (July 2004, Anchor)
  - 33.5 Bottom Elevation of Surface Tar Body in Removal Action Area (ft NAVD88)
  - AN-2-1 ● Previous Sediment Core Location (Anchor 2001)
  - SD063 ▲ Previous Sediment Core Location (Weston 1998)
  - SD-7 ● Previous Sediment Core Location (HAI 1996)
  - ⊙ Pile Location (To be removed before dredging)
  - Support Pile Locations (to be protected during dredging)
  - · — Property Line
  - OHW = 20.41 ft NAVD 88
  - · — OLW = 7.91 ft NAVD 88
  - · · · · 50% River Stage Elevation = 10.23 ft NAVD 88
  - ○ ○ Oil Absorbent Boom (Mobile)
  - — — Full Length Silt Curtain (Anchored)
  - — — Oil Absorbent Boom with Skirt (2 Ft) (Mobile)

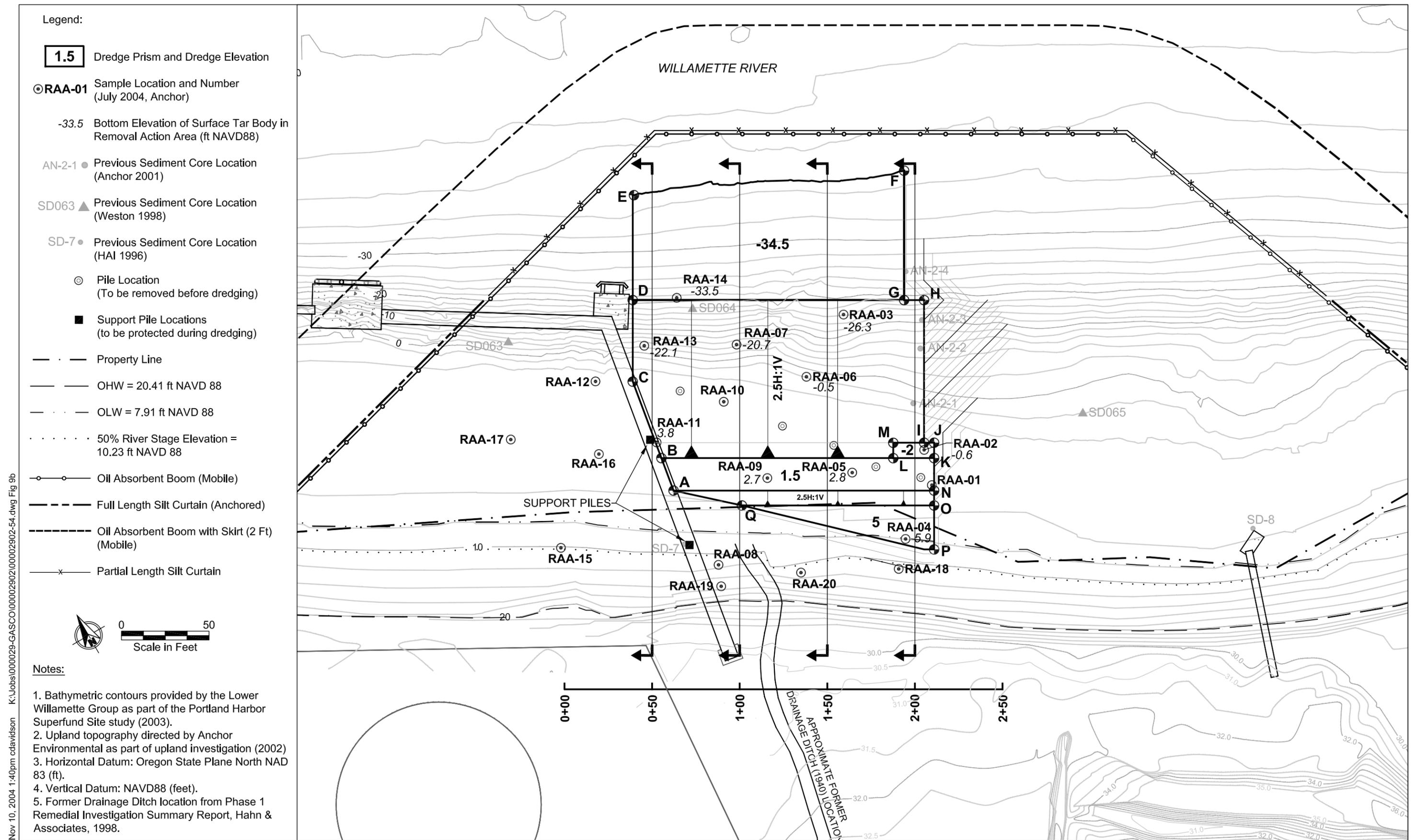


- Notes:**
1. Bathymetric contours provided by the Lower Willamette Group as part of the Portland Harbor Superfund Site study (2003).
  2. Upland topography directed by Anchor Environmental as part of upland investigation (2002)
  3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
  4. Vertical Datum: NAVD88 (feet).
  5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report, Hahn & Associates, 1998.

Station	Easting	Northing
0+00	7623791.464	705554.089
3+00	7624051.271	705404.089
A	7623901.958	705621.017
B	7623905.198	705640.529
C	7623912.819	705686.419
D	7623936.043	705726.644
E	7623966.536	705778.046
F	7624107.037	705713.050
G	7624070.174	705649.203
H	7624080.039	705643.507
I	7624039.414	705573.143
J	7624044.380	705570.275
K	7624040.005	705562.698
L	7624019.782	705574.307
M	7624024.157	705581.885
N	7624030.747	705546.661
O	7624026.505	705539.315
P	7624013.991	705517.640
Q	7623931.521	705594.155



**Figure 9a**  
Schematic of Full Length Silt Curtain and Containment Barriers  
NW Natural "Gasco" Site



- Legend:
- 1.5 Dredge Prism and Dredge Elevation
  - ⊙ RAA-01 Sample Location and Number (July 2004, Anchor)
  - 33.5 Bottom Elevation of Surface Tar Body in Removal Action Area (ft NAVD88)
  - AN-2-1 ● Previous Sediment Core Location (Anchor 2001)
  - SD063 ▲ Previous Sediment Core Location (Weston 1998)
  - SD-7 ● Previous Sediment Core Location (HAI 1996)
  - ⊙ Pile Location (To be removed before dredging)
  - Support Pile Locations (to be protected during dredging)
  - · — Property Line
  - — — — — OHW = 20.41 ft NAVD 88
  - · · · — — OLW = 7.91 ft NAVD 88
  - · · · · 50% River Stage Elevation = 10.23 ft NAVD 88
  - Oil Absorbent Boom (Mobile)
  - — — — — Full Length Silt Curtain (Anchored)
  - · · · — — Oil Absorbent Boom with Skirt (2 Ft) (Mobile)
  - x — Partial Length Silt Curtain

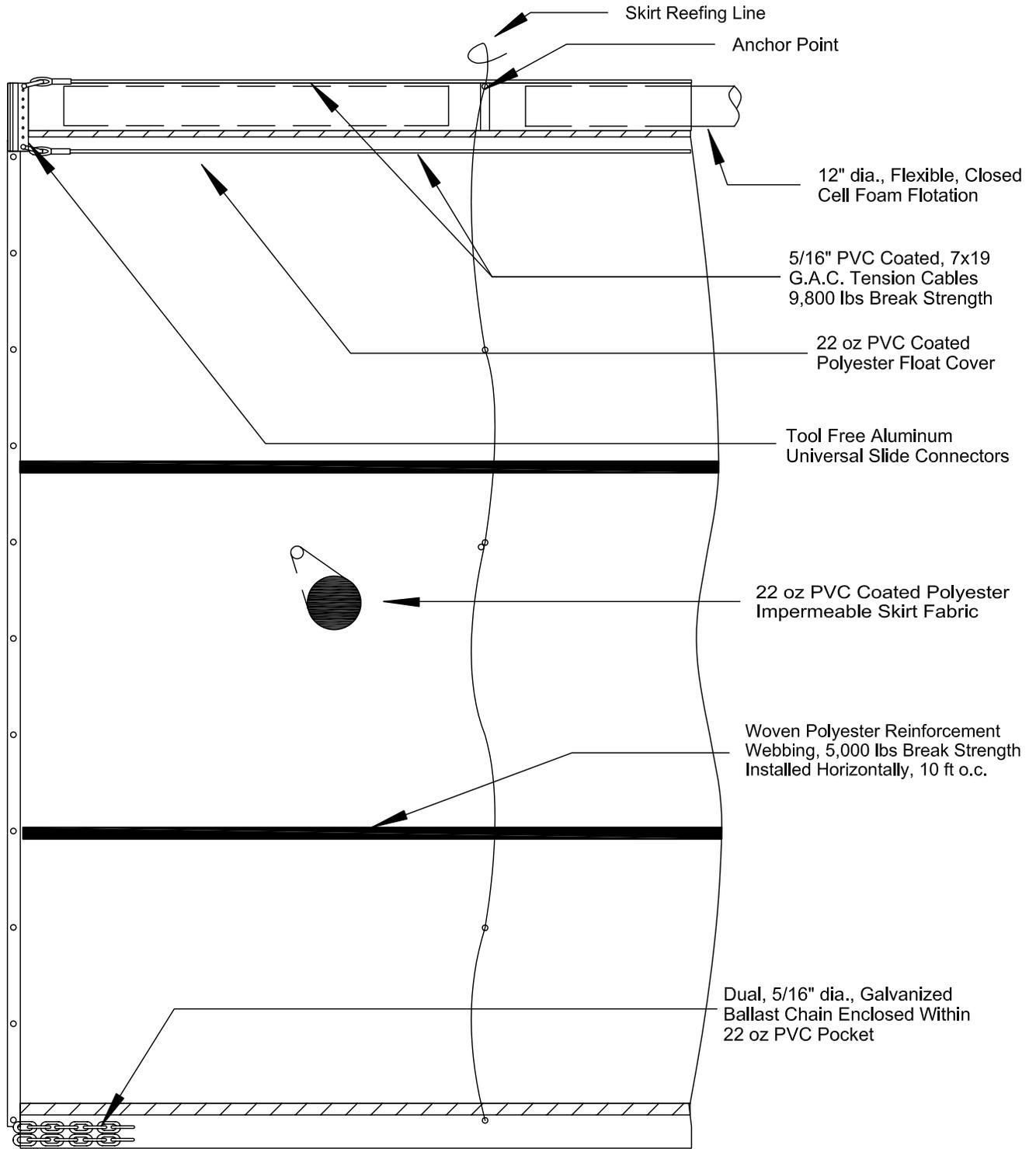
- Notes:
1. Bathymetric contours provided by the Lower Willamette Group as part of the Portland Harbor Superfund Site study (2003).
  2. Upland topography directed by Anchor Environmental as part of upland investigation (2002)
  3. Horizontal Datum: Oregon State Plane North NAD 83 (ft).
  4. Vertical Datum: NAVD88 (feet).
  5. Former Drainage Ditch location from Phase 1 Remedial Investigation Summary Report, Hahn & Associates, 1998.

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**Figure 9b**  
Schematic of Partial Length Silt Curtain and Containment Barriers  
NW Natural "Gasco" Site

Nov 10, 2004 10:43am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-52.dwg FIG 9c



**SILTDAM IMPERMEABLE, H.D., TURBIDITY BARRIER WITH SKIRT REEFING/ADJUSTING LINES AND REINFORMENT WEBBING**

Note: Drawing provided by Brockton Equipment/Spilldam, Inc.



**Figure 9c**  
Silt Curtain Design  
NW Natural "Gasco" Site

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**ATTACHMENT E-1**

**QUANTITATIVE WATER QUALITY ANALYSIS**

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## **Attachment E-1**

### **Quantitative Water Quality Analysis for the Gasco Removal Action**

#### **1 INTRODUCTION**

This attachment describes the quantitative analysis of expected water quality conditions around dredging operations at the Gasco Removal Action. It describes the overall analysis methods and results.

#### **2 DRET SCREENING WITH ACUTE WATER QUALITY GUIDELINES**

The purpose of the Dredging Elutriate Test (DRET) test is to understand what, if any, chemicals could be present in appreciable concentrations in the water column during dredging operations (DiGiano et al. 1995). The DRET test simulates water column conditions immediately around the dredge (within a few feet) and without further data analysis, does not provide a direct indication of wider water quality impacts that would be expected from dredging operations. However, direct comparison of DRET test results to water quality guidelines can provide a conservative method to screen out any chemicals that would not be expected to cause water quality impacts, even very close to a dredging operation.

This conservative screening is shown in the Table 1. The DRET analytical results were compared acute (short-term) water quality guidelines available through references cited by DEQ (2001) in their "Guidance for Ecological Risk Assessment Level II Screening Level Values" (SLVs) for freshwater aquatic receptors. This DEQ guidance document presents only chronic (long-term) water quality guidelines for aquatic organisms from the references cited within the document. Aquatic chronic water quality guidelines are intended for comparison to continuous long-term potential impacts to water bodies. Dredging operations for this project are expected to be discontinuous (e.g., stopping at night and during equipment movement) and of a relatively short duration of approximately two weeks. Consequently, it is most appropriate to compare any expected chemical concentrations near dredging operations to acute values shown in Table 1 rather than the chronic values in DEQ (2001). The two sources of water quality guidelines for aquatic life referenced in DEQ (2001) are Oak Ridge National Laboratory (ORNL) toxicity values contained in "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota" (ORNL 1996) and Oregon regulations OAR 340-41. These sources were examined for each chemical analyzed for appropriate acute water quality values

that would be consistent with the overall approach used to select guideline values by DEQ (2001).

As shown in Table 1, only copper, anthracene, benzo(a)anthracene, benzo(a)pyrene, fluoranthene, fluorene, naphthalene, phenanthrene, ethylbenzene, and toluene exceed one of the acute water quality guidelines. Copper was detected in the visually contaminated samples at levels just above the guidelines. Detections of metals in elutriate tests for even relatively clean sediments are not unusual occurrences, particularly for copper. It is notable that the concentrations of copper in the visually contaminated bulk sediments are quite low, with copper ranging from 14 to 27 mg/kg as compared to Dredge Material Evaluation Framework (DMEF) criteria (USACE et al., 1998) of 390 mg/kg. Consequently, it is unlikely that copper poses any greater short-term risk than that found during dredging of clean sediments that occurs on a regular basis throughout the Columbia/Willamette River system.

### **3 QUANTITATIVE WATER QUALITY ANALYSIS**

The Table 1 results indicate that several chemicals may be present in water very close (within) a few feet of dredging operations. However, this comparison provides no direct information about the concentrations of these chemicals over wider areas around the dredge.

#### **3.1 Analysis Methods**

To better understand the distribution of chemicals in the water column around dredging operations during this project, a simple analytical model developed by Kuo and Hayes (1991) was employed. This model was developed specifically to estimate the plumes of suspended sediment that occur around bucket dredging operations, and was calibrated to measurements from four separate dredging operations throughout the country. The model predicts the amount of suspended sediment present in the water column at a specified distance downstream from a dredging operation. This model assumes no silt curtains or similar controls are present. Consequently, it provides a very conservative estimate of water column concentrations around the Gasco removal action dredging, which will employ several types of environmental controls as detailed in main text Appendix E.

The suspended sediment concentration results of the Kuo Hayes model can be used to predict the concentration of chemicals present in the water column around the dredge as

well, using a few simple mass balance calculations that rely on the chemical concentrations observed in the bulk sediments and the DRET test. These additional steps are very similar to the mass calculations contained in the Army Corps "DREDGE" model (Hayes and Je 2000), also developed by Donald Hayes. However, unlike the DREDGE model, site specific results of the DRET test can be input into the Kuo Hayes analysis conducted here.

The controlling equation for the Kuo Hayes model is presented in their 1991 paper, which predicts suspended sediment concentrations at the specified distances. The modeled suspended sediment result and the DRET test results were used to calculate the chemical concentration at that same distance as follows:

$$C_w = \left( \frac{TSS}{10^6 \frac{mg}{kg}} \right) * C_s * \frac{C_d}{C_t}$$

where:

$C_w$  = concentration of chemical in water ( $\mu\text{g/L}$ )

TSS = concentration of suspended sediments predicted by Kuo Hayes equation ( $\text{mg/L}$ )

$C_s$  = concentration of chemical in dredge sediments ( $\mu\text{g/kg}$ )

$C_d$  = concentration of chemical observed in DRET water at end of test ( $\mu\text{g/L}$ )

$C_t$  = concentration of chemical in DRET vessel at start of test ( $\mu\text{g/L}$ )

The model was run in a probabilistic mode using @RISK software (Palisade 2001), assuming general ranges of various input parameters. This probabilistic approach provides an approximation of the likelihood or percent chance of exceeding water quality guidelines given the reasonable variations that might be expected in river currents, sediment type, chemical concentrations in sediments, etc., based on available data. Because insufficient data are available to determine the statistical distributions of various needed input parameters, high, mid-range, and low values were determined for each input parameter based on the ranges of data available. These values were placed in simple triangular distributions (described in Palisade 2001) with the mid-range value defining the peak of the triangular distribution. Essentially, such an approach assumes that the mid-range value is the most likely one to occur on any trial, while values ranging to the high and low ends of the distribution are increasingly unlikely to occur.

The input parameters for the model (including high, mid-range, and low values for parameters with triangular distributions) along with data sources for these values are shown in Table 2.

### **3.2 Analysis Results**

Modeling results are shown in Table 3 as the ratio of the predicted water column concentration over the applicable acute guideline. Ratios greater than 1 indicate a predicted exceedance of the water quality guideline. Results are presented for each of the chemicals exceeding acute guidelines in the DRET test (Table 1) at distance of 50, 100, 200, 300, and 400 feet downstream of the dredging operation. For each distance, 50th, 90th, and 95th percentile results are also presented. The percentile result can be viewed as a probability of exceedance. For example, given the range of input parameters, there is a 95 percent chance that the predicted results are at or below the value shown in the 95th percentile column.

As shown in Table 3, the 50th and 90th percentile results at all distances from the dredge for all chemicals are below their respective criteria. Only benzo(a)pyrene is predicted to exceed its guideline using the 95th percentile estimate at 50 feet from the dredge. However, benzo(a)pyrene is below its guideline at 100 feet from the dredge.

## **4 CONCLUSION**

This analysis assumes that no environmental controls are present. Even with this assumption, these results indicate that exceedances of appropriate water quality guidelines at distances greater than 50 feet from the dredge are unlikely for this removal action. Consequently, with the use of environmental controls detailed in the main text of Appendix E, water quality impacts to the river system are expected to be very unlikely.

## **5 REFERENCES**

DEQ. 2001. Guidance for Ecological Risk Assessment. Level II Screening Level Values. Oregon Department of Environmental Quality. Portland, Oregon.

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**Table 1**  
**Elutriate Testing Analytical Summary - Comparison to Acute Water Quality Guidelines**

Location ID Sample ID Sample Date Depth Interval Sediment Zone	Units	USEPA AWQC Acute	ORNL 1996 or OAR 340-41 Acute	RAA-03 RAA-03SD- 7/21/2004 5-13 ft Visually Cont.	RAA-11 RAA-11SD- 7/22/2004 2-4 ft Tar Body	RAA-11 RAA-11SD- 7/22/2004 4-13 ft Visually Cont.	RAA-13 RAA-13SD- 7/20/2004 9-11 ft Tar Body
<b>Sheen Visible in Elutriate Test Vessel?</b>				No	Yes	No	Yes
<b>Measurable Non-Aqueous Phase Layer in Test Vessel?</b>				No	No	No	No
<b>Conventionals</b>							
Cyanide	mg/l	0.022	a	0.01 U	<b>0.01</b>	0.01 U	<b>0.01</b>
<b>Metals</b>							
Arsenic (dissolved)	ug/l	340	a	<b>2.3</b>	<b>0.7</b>	<b>0.5</b>	<b>0.8</b>
Arsenic (total)	ug/l	340	a	<b>3.5</b>	<b>0.8</b>	<b>0.8</b>	<b>1</b>
Chromium (dissolved)	ug/l	16	a	<b>0.31 J</b>	<b>0.4</b>	<b>0.32 J</b>	<b>0.35 J</b>
Chromium (total)	ug/l	16	a	<b>5.39</b>	<b>1.08</b>	<b>1.09</b>	<b>1.53</b>
Copper (dissolved)	ug/l	13	a	<b>13.1</b>	<b>1.66</b>	<b>2.27</b>	<b>1.06</b>
Copper (total)	ug/l	13	a	<b>16.5</b>	<b>2.07</b>	<b>2.29</b>	<b>3.77</b>
Lead (dissolved)	ug/l	65	a	<b>0.12</b>	<b>0.06</b>	<b>0.12</b>	<b>0.09</b>
Lead (total)	ug/l	65	a	<b>7.46</b>	<b>0.92</b>	<b>3.11</b>	<b>2.32</b>
Nickel (dissolved)	ug/l	470	a	<b>0.7</b>	<b>1.2</b>	<b>1.4</b>	<b>1.2</b>
Nickel (total)	ug/l	470	a	<b>4.4</b>	<b>1.9</b>	<b>2.1</b>	<b>2.1</b>
Zinc (dissolved)	ug/l	120	a	<b>2.7</b>	<b>1.2</b>	<b>1.5</b>	<b>2.7</b>
Zinc (total)	ug/l	120	a	<b>16.5</b>	<b>3.7</b>	<b>4.1</b>	<b>7.3</b>
<b>Total Petroleum Hydrocarbons (TPH)</b>							
TPH - Diesel Range	ug/l	--	--	<b>430 Z</b>	<b>17000 Z</b>	<b>240 J</b>	<b>13000 Z</b>
TPH - Residual Range	ug/l	--	--	<b>280 J</b>	<b>400 J</b>	<b>99 J</b>	<b>790 Z</b>
<b>Semi-Volatile Organic Compounds (SVOC)</b>							
1,2,4-Trichlorobenzene	ug/l	--	700	0.20 U	3.9 U	0.20 U	20 U
1,2-Dichlorobenzene	ug/l	--	260	0.20 U	3.9 U	0.20 U	3.9 U
1,3-Dichlorobenzene	ug/l	--	630	0.20 U	3.9 U	0.20 U	3.9 U
1,4-Dichlorobenzene	ug/l	--	180	0.20 U	3.9 U	0.20 U	3.9 U
2,4,5-Trichlorophenol	ug/l	--	--	0.48 U	9.6 U	0.48 U	9.6 U
2,4,6-Trichlorophenol	ug/l	--	--	0.48 U	9.6 U	0.48 U	9.6 U
2,4-Dichlorophenol	ug/l	--	2,020	0.48 U	9.6 U	0.48 U	48 U
2,4-Dimethylphenol	ug/l	--	2,120	2.0 U	<b>14 J</b>	2.0 U	200 U
2,4-Dinitrophenol	ug/l	--	--	3.9 U	77 U	3.9 U	77 U
2,4-Dinitrotoluene	ug/l	--	330	0.20 U	3.9 U	0.20 U	3.9 U
2,6-Dinitrotoluene	ug/l	--	330	0.20 U	3.9 U	0.20 U	3.9 U
2-Chloronaphthalene	ug/l	--	1,600	0.20 U	3.9 U	0.20 U	3.9 U
2-Chlorophenol	ug/l	--	4,380	0.48 U	9.6 U	0.48 U	9.6 U
2-Methylnaphthalene	ug/l	--	--	<b>0.030 J</b>	<b>470</b>	<b>0.050 J</b>	<b>710</b>
2-Methylphenol	ug/l	--	230	0.48 U	<b>3.3 J</b>	0.48 U	<b>1.6 J</b>
2-Nitroaniline	ug/l	--	--	0.20 U	3.9 U	0.20 U	3.9 U
2-Nitrophenol	ug/l	--	--	0.48 U	9.6 U	0.48 U	48 U
3,3'-Dichlorobenzidine	ug/l	--	--	2.0 U	39 U	2.0 U	39 U
3-Nitroaniline	ug/l	--	--	0.96 U	20 U	0.96 U	20 U
4,6-Dinitro-2-methylphenol	ug/l	--	--	2.0 U	39 U	2.0 U	39 U
4-Bromophenylphenylether	ug/l	--	--	0.20 U	3.9 U	0.20 U	3.9 U
4-Chloro-3-methylphenol	ug/l	--	--	<b>0.057 J</b>	9.6 U	<b>0.076 J</b>	48 U
4-Chloroaniline	ug/l	--	--	0.20 U	3.9 U	0.20 U	20 U
4-Chlorophenyl-phenylether	ug/l	--	--	0.20 U	3.9 U	0.20 U	3.9 U
4-Methylphenol	ug/l	--	--	0.48 U	<b>15</b>	0.48 U	<b>12</b>
4-Nitroaniline	ug/l	--	--	0.96 U	20 U	0.96 U	20 U
4-Nitrophenol	ug/l	--	230	2.0 U	39 U	2.0 U	39 U
Acenaphthene	ug/l	--	1,700	<b>64</b>	<b>150</b>	<b>6.7</b>	<b>440</b>
Acenaphthylene	ug/l	--	--	<b>1.7</b>	<b>390</b>	<b>0.48</b>	<b>140</b>
Anthracene	ug/l	--	13	<b>0.12 J</b>	<b>41</b>	<b>1.2</b>	<b>58</b>
Benzo(a)anthracene	ug/l	--	0.49	<b>0.78</b>	<b>4.8</b>	<b>0.76</b>	<b>19</b>
Benzo(a)pyrene	ug/l	--	0.24	<b>0.55</b>	<b>4.6</b>	<b>1</b>	<b>24</b>

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Benzo(b)fluoranthene	ug/l	--	--	0.61	4.5	1	22
Benzo(g,h,i)perylene	ug/l	--	--	0.39	3.8 J	1	20
Benzo(k)fluoranthene	ug/l	--	--	0.21	1.4 J	0.39	6.9
Benzoic acid	ug/l	--	740	1.9 J	96 U	2.1 J	480 U
Benzyl alcohol	ug/l	--	150	4.8 U	96 U	4.8 U	96 U
bis(2-Chloroethoxy)methane	ug/l	--	--	0.20 U	3.9 U	0.20 U	20 U
bis(2-Chloroethyl)ether	ug/l	--	--	0.20 U	3.9 U	0.20 U	3.9 U
bis(2-chloroisopropyl)ether	ug/l	--	--	0.20 U	3.9 U	0.20 U	3.9 U
bis(2-Ethylhexyl)phthalate	ug/l	--	27	2.0 U	39 U	2.0 U	39 U
Butylbenzylphthalate	ug/l	--	--	0.028 J	3.9 U	0.027 J	3.9 U
Chrysene	ug/l	--	--	0.81	7.4	2.1	24
Dibenzo(a,h)anthracene	ug/l	--	--	0.037 J	3.9 U	0.086 J	1.8 J
Dibenzofuran	ug/l	--	66	0.044 J	23	0.072 J	28
Diethylphthalate	ug/l	--	1,800	0.27	3.9 U	0.52	3.9 U
Dimethylphthalate	ug/l	--	--	0.20 U	3.9 U	0.20 U	3.9 U
Di-n-butylphthalate	ug/l	--	--	0.091 J	3.9 U	0.15 J	3.9 U
Di-n-octylphthalate	ug/l	--	--	0.39 U	7.7 U	0.39 U	7.7 U
Fluoranthene	ug/l	--	34	19	56	6.3	110
Fluorene	ug/l	--	70	0.078 J	130	0.32	150
Hexachlorobenzene	ug/l	--	--	0.20 U	3.9 U	0.20 U	3.9 U
Hexachlorobutadiene	ug/l	--	90	0.20 U	3.9 U	0.20 U	20 U
Hexachlorocyclopentadiene	ug/l	--	7	0.96 U	20 U	0.96 U	20 U
Hexachloroethane	ug/l	--	980	0.20 U	3.9 U	0.20 U	3.9 U
Indeno(1,2,3-cd)pyrene	ug/l	--	--	0.36	3.2 J	0.83	17
Isophorone	ug/l	--	117,000	0.20 U	3.9 U	0.20 U	20 U
Naphthalene	ug/l	--	2,300	0.078 J	6900	0.27	11000
Nitrobenzene	ug/l	--	27,000	0.20 U	3.9 U	0.20 U	3.9 U
N-Nitroso-di-n-propylamine	ug/l	--	5,850	0.20 U	3.9 U	0.20 U	3.9 U
n-Nitrosodiphenylamine	ug/l	--	3,800	0.20 U	3.9 U	0.20 U	3.9 U
Pentachlorophenol	ug/l	19	--	0.072 J	20 U	0.071 J	2.0 J
Phenanthrene	ug/l	--	30	0.49	280	1	300
Phenol	ug/l	--	3,600	0.10 J	8.9 J	0.17 J	2.5 J
Pyrene	ug/l	--	--	20	58	6	110
<b>Volatile Organic Compounds (VOCs)</b>							
1,1,1-Trichloroethane	ug/l	--	200	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichloroethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	ug/l	--	830	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	ug/l	--	450	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichlorobenzene	ug/l	--	--	2.0 U	2.0 U	2.0 U	2.0 U
1,2,4-Trichlorobenzene	ug/l	--	700	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dibromo-3-chloropropane	ug/l	--	--	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dichlorobenzene	ug/l	--	260	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	ug/l	--	118,000	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloropropane	ug/l	--	23,000	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	ug/l	--	630	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	ug/l	--	180	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	ug/l	--	240,000	20 U	20 U	20 U	20 U
2-Hexanone	ug/l	--	1,800	20 U	20 U	20 U	20 U
4-Methyl-2-pentanone (MIBK)	ug/l	--	2,200	20 U	20 U	20 U	20 U
Acetone	ug/l	--	28,000	24	53	25	8.4 J
Benzene	ug/l	--	2,300	0.50 U	810	0.26 J	220

**Table 1**  
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Bromochloromethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
Bromodichloromethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
Bromoform	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
Bromomethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
Carbon disulfide	ug/l	--	17	0.50 U	<b>0.53</b>	0.50 U	0.50 U
Carbon tetrachloride	ug/l	--	35,200	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	ug/l	--	250	0.50 U	0.50 U	0.50 U	<b>0.35 J</b>
Chloroethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
Chloroform	ug/l	--	28,900	0.50 U	0.50 U	0.50 U	0.50 U
Chloromethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,2-Dichloroethene	ug/l	--	1,100	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,3-Dichloropropene	ug/l	--	6,060	0.50 U	0.50 U	0.50 U	0.50 U
Cyclohexane	ug/l	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
Dichlorodifluoromethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
Dichloromethane	ug/l	--	26,000	<b>0.66 J</b>	<b>0.67 J</b>	<b>0.53 J</b>	<b>0.90 J</b>
Ethylbenzene	ug/l	--	130	0.50 U	<b>62</b>	0.50 U	<b>290</b>
Isopropylbenzene	ug/l	--	--	2.0 U	<b>23</b>	<b>2.0 U</b>	<b>14</b>
m,p-Xylenes	ug/l	--	230	0.50 U	<b>210</b>	0.50 U	<b>210</b>
Methyl acetate	ug/l	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Methyl cyclohexene	ug/l	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Methyltert-butylether	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	ug/l	--	230	0.50 U	<b>100</b>	0.50 U	<b>120</b>
Styrene	ug/l	--	--	0.50 U	<b>38</b>	0.50 U	0.50 U
Tetrachloroethene	ug/l	--	5,280	0.50 U	0.50 U	0.50 U	0.50 U
Toluene	ug/l	--	120	0.50 U	<b>320</b>	0.50 U	<b>160</b>
trans-1,2-Dichloroethene	ug/l	--	1,100	0.50 U	0.50 U	0.50 U	0.50 U
trans-1,3-Dichloropropene	ug/l	--	6,060	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	ug/l	--	45,000	0.50 U	<b>0.15 J</b>	0.50 U	<b>0.17 J</b>
Trichlorofluoromethane	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl chloride	ug/l	--	--	0.50 U	0.50 U	0.50 U	0.50 U

Notes:

 Yellow shading indicates value that exceeds one or more relevant guidelines.

**Detected values shown in bold**

**J** The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

**U** The compound was analyzed for, but was not detected at or above the MRL/MDL..

**Z** The chromatographic fingerprint does not resemble a petroleum product.

AWQC - Ambient Water Quality Criteria

ORNL - Oak Ridge National Laboratory (see text for details)

-- Not Available

a - defer to AWQC for most up to date value

**Table 2**  
**Input Parameters for Kuo Hayes Modeling**

Parameter	Low	Mid-Range	High	Data Source
Bucket size, cy		4		Expected bucket size
Cycle time, sec		30		Minimum expected cycle time
Solids percentage, %	61	68	75	Tarbody and v.c. results
Specific gravity of solids (g/cm <sup>3</sup> )	2.2	2.5	2.7	Range for tar and sediments
Spillage, %	0.5	1.5	2.5	Standard range for dredge operations
Water depth, m	2	3	14	Site bathymetry
Ambient current velocity, m/s	0.14	0.274	0.914	Appendix H, Attachment B
Settling velocity, m/s	0.0000001	0.00001	0.005	Conservative range of grain size distributions
Bulk Sediment Chemical Concentration (ug/kg)				Combined range from tar and v.c. materials
Copper	14100	29650	45200	
Anthracene	28000	564000	1100000	
Benzo(a)anthracene	24000	432000	840000	
Benzo(a)pyrene	35000	517500	1000000	
Fluoranthene	97000	1548500	3000000	
Fluorene	15000	407500	800000	
Naphthalene	26000	3163000	6300000	
Pheneanthrene	150000	2775000	5400000	
Ethylbenzene	53	15527	31000	
Toluene	3	9002	18000	
Fraction Chemical in DRET water (unitless; $D_w/D_t$ )				DRET results range for tar and v.c.
Copper	0.0609	0.0890	0.1170	
Anthracene	0.0037	0.0045	0.0053	
Benzo(a)anthracene	0.0002	0.0017	0.0033	
Benzo(a)pyrene	0.0001	0.0015	0.0029	
Fluoranthene	0.0004	0.0100	0.0196	
Fluorene	0.0163	0.0175	0.0188	
Naphthalene	0.1095	0.1421	0.1746	
Pheneanthrene	0.0052	0.0054	0.0056	
Ethylbenzene	0.2000	0.5677	0.9355	
Toluene	0.8889	0.9444	1.0000	

**Table 3**  
**Dredge Water Quality Kup-Hayes Model Simulation Results - 4 cy Bucket and 30 sec Cycle Time**

Distance from Dredge	50 ft			100 ft			200 ft			300 ft			400 ft			Acute Guideline
	50th	90th	95th													
<b>Total Suspended Sediment Concentration (mg/L)</b>	93	281	362	65	194	244	45	130	165	36	101	128	30	83	107	N/AV
<b>DRET-Based Water Concentration Ratio (unitless) - As Compared to Acute Water Quality Guidelines</b>																
Copper	1.75E-02	5.77E-02	7.68E-02	1.23E-02	4.01E-02	5.29E-02	8.46E-03	2.72E-02	3.52E-02	6.79E-03	2.12E-02	2.79E-02	5.76E-03	1.74E-02	2.29E-02	13
Anthracene	1.71E-02	5.62E-02	7.27E-02	1.20E-02	3.89E-02	4.92E-02	8.27E-03	2.63E-02	3.33E-02	6.54E-03	2.04E-02	2.51E-02	5.52E-03	1.73E-02	2.11E-02	13
Benzo(a)anthracene	1.24E-01	4.37E-01	6.34E-01	8.67E-02	3.04E-01	4.46E-01	5.98E-02	2.07E-01	3.11E-01	4.76E-02	1.65E-01	2.39E-01	3.95E-02	1.36E-01	1.88E-01	0.49
Benzo(a)pyrene	2.57E-01	8.66E-01	1.39E+00	1.81E-01	6.03E-01	9.70E-01	1.25E-01	4.14E-01	6.36E-01	1.01E-01	3.30E-01	4.85E-01	8.56E-02	2.78E-01	4.03E-01	0.24
Fluoranthene	3.79E-02	1.34E-01	1.91E-01	2.66E-02	9.32E-02	1.32E-01	1.83E-02	6.27E-02	8.96E-02	1.46E-02	4.87E-02	6.95E-02	1.23E-02	4.06E-02	5.85E-02	33.6
Fluorene	8.60E-03	3.13E-02	4.00E-02	6.04E-03	2.17E-02	2.77E-02	4.19E-03	1.46E-02	1.85E-02	3.29E-03	1.12E-02	1.43E-02	2.81E-03	9.44E-03	1.18E-02	70
Naphthalene	1.68E-02	5.44E-02	7.33E-02	1.17E-02	3.79E-02	5.10E-02	8.12E-03	2.61E-02	3.53E-02	6.46E-03	2.06E-02	2.78E-02	5.44E-03	1.71E-02	2.27E-02	2300
Pheneanthrene	4.35E-02	1.42E-01	1.92E-01	3.04E-02	9.91E-02	1.33E-01	2.13E-02	6.80E-02	8.91E-02	1.67E-02	5.32E-02	6.82E-02	1.42E-02	4.44E-02	5.52E-02	30
Ethylbenzene	5.65E-03	1.97E-02	2.72E-02	3.94E-03	1.35E-02	1.88E-02	2.71E-03	9.24E-03	1.28E-02	2.15E-03	7.21E-03	9.95E-03	1.84E-03	6.04E-03	8.32E-03	130
Toluene	6.19E-03	1.97E-02	2.95E-02	4.33E-03	1.37E-02	2.05E-02	2.99E-03	9.34E-03	1.37E-02	2.41E-03	7.47E-03	1.10E-02	1.99E-03	6.32E-03	9.14E-03	120

DRET - Dredging Elutriate Test

N/AV - Not Available

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**APPENDIX D**

**SEDIMENT CHEMISTRY TABLES**

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**Table 2**  
**Chemical Analytical Results for Visually Contaminated and Visually Uncontaminated Zones**

Location ID Sample Date Depth Interval Sediment Zone	Unit	RAA-02	RAA-04	RAA-06	RAA-06	RAA-09	RAA-13	RAA-14	RAA-17	RAA-20	RAA-04	RAA-05	RAA-06	RAA-08	RAA-10	RAA-11	RAA-11	RAA-12	RAA-14	RAA-17	RAA-19
		7/20/2004 10-19 ft VC	7/21/2004 5-6 ft VC	7/20/2004 4-15 ft VC	7/20/2004 4-7 ft VC	7/19/2004 5-16 ft VC	7/20/2004 11-15 ft VC	7/20/2004 10-14 ft VC	7/22/2004 0-10 ft VC	7/20/2004 5-6 ft VC	7/21/2004 6-20 ft VU	7/19/2004 10-20 ft VU	7/20/2004 15-20 ft VU	7/21/2004 7-20 ft VU	7/19/2004 10-20 ft VU	7/22/2004 13-20 ft VU	7/22/2004 13-20 ft VU	7/20/2004 18-20 ft VU	7/20/2004 14-20 ft VU	7/22/2004 14-20 ft VU	7/22/2004 9-20 ft VU
<b>Conventionals</b>																					
Total Organic Carbon	%	10.2	8.96 J	3.68	--	6.46	13.2	14.2	5.87	--	--	1.63	1.39	0.84 J	4.87	1.35	1.52	2.76	0.36	1.65	0.83
Total Solids	%	61.6	74.8	68.7	70.8	73.7	69.1	61.5	62	66.9	63.9	66.2	66.6	67.8	65.5	66.4	65.3	62.6	72	62.3	69.3
Cyanide	mg/kg	0.08 J	1.7	0.17 J	--	0.8	0.7	0.8	0.14 J	--	--	0.2 UJ	0.2 U	0.04 J	0.1 J	0.2 UJ	0.2 UJ	0.09 J	0.06 J	0.3 J	0.2 UJ
Percent fines	%	69.7	--	26.67	--	9.89	17.88	52.9	48.64	--	--	57.7	46.3	52.5	71.4	53.7	54.6	79.9	27.14	64.04	49.5
<b>Metals</b>																					
Arsenic	mg/kg	3	--	2.3	--	1.9	1.7	2.8	3	--	--	2.5	2.7	1.9	2.5	2.9	2.9	2.9	2.3	3.2	1.8
Chromium	mg/kg	19.8	--	18.3	--	14.9	11.6	18	18.6	--	--	19.2	17.7	17.7	18.3	18	18.5	20.3	17.3	21.5	18.3
Copper	mg/kg	27.1	--	19.4	--	15.8	14.1	26.9	26.3	--	--	23.7	22.6	21.4	25.9	23.3	23.4	28.6	18.6	26.8	21.8
Lead	mg/kg	26.1	--	20	--	10.2	9.83	18.5	19.8	--	--	10.7	14	4.59	16	12.8	12.8	19	3.47	15	4.68
Nickel	mg/kg	19.6	--	19.6	--	19.5	15.8	20.8	20.4	--	--	19	18.2	18.8	18.4	18	18.7	18.9	20.5	20.6	19.8
Zinc	mg/kg	64.1	--	50.2	--	41.5	43.8	79.9	64.5	--	--	51.3	53.8	43.3	56.5	51.2	52.1	65.1	42.4	57.6	44.6
<b>Total Petroleum Hydrocarbons (TPH)</b>																					
TPH - Diesel Range	mg/kg	8800 Z	26000Z	2800 Z	--	15000 Z	17000 Z	51000Z	3400 Z	--	--	190 Y	130 Y	17 J	2800 Z	190 Y	160 Y	510 Z	24 U	180 Y	23 U
TPH - Residual Range	mg/kg	8100 Z	14000Z	2800 Z	--	9100 Z	11000 Z	24000Z	3600 Z	--	--	420 O	300 O	39 J	2700 Z	340 O	300 O	760 Z	49 J	370 O	31 J
<b>Semivolatile Organic Compounds</b>																					
2,4,5-Trichlorophenol	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
2,4,6-Trichlorophenol	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
2,4-Dichlorophenol	µg/kg	5000 U	--	--	--	2000 U	10000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
2,4-Dimethylphenol	µg/kg	25000 U	--	--	--	10000 U	50000 U	--	4000 U	--	--	--	50 U	--	5100 U	--	--	5000 U	50 U	40 U	--
2,4-Dinitrophenol	µg/kg	100000 U	--	--	--	40000 U	20000 U	--	16000 U	--	--	--	200 U	--	21000 U	--	--	20000 U	200 U	160 U	--
2,4-Dinitrotoluene	µg/kg	5000 U	--	--	--	2000 U	1300 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
2,6-Dinitrotoluene	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
2-Chloronaphthalene	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
2-Chlorophenol	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
2-Methylnaphthalene	µg/kg	65000	510000	7500	--	210000	440000	1600000	11000	--	--	260	7.2 J	140	31000	440	850	2300	39	160	15
2-Methylphenol	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
2-Nitroaniline	µg/kg	10000 U	--	--	--	4000 U	2000 U	--	1600 U	--	--	--	20 U	--	2100 U	--	--	2000 U	20 U	16 U	--
2-Nitrophenol	µg/kg	5000 U	--	--	--	2000 U	10000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
3,3'-Dichlorobenzidine	µg/kg	50000 U	--	--	--	20000 U	10000 U	--	8000 U	--	--	--	100 U	--	11000 U	--	--	10000 U	100 U	80 U	--
3-Nitroaniline	µg/kg	10000 U	--	--	--	4000 U	2000 U	--	1600 U	--	--	--	20 U	--	2100 U	--	--	2000 U	20 U	16 U	--
4,6-Dinitro-2-methylphenol	µg/kg	50000 U	--	--	--	20000 U	10000 U	--	8000 U	--	--	--	100 U	--	11000 U	--	--	10000 U	100 U	80 U	--
4-Bromophenylphenylether	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
4-Chloro-3-methylphenol	µg/kg	5000 U	--	--	--	2000 U	10000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
4-Chloroaniline	µg/kg	5000 U	--	--	--	2000 U	10000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
4-Chlorophenyl-phenylethe	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
4-Methylphenol	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	63	--	1100 U	--	--	1000 U	10 U	51	--
4-Nitroaniline	µg/kg	10000 U	--	--	--	4000 U	2000 U	--	1600 U	--	--	--	20 U	--	2100 U	--	--	2000 U	20 U	16 U	--
4-Nitrophenol	µg/kg	50000 U	--	--	--	20000 U	10000 U	--	8000 U	--	--	--	100 U	--	11000 U	--	--	10000 U	100 U	80 U	--
Acenaphthene	µg/kg	200000	710000	47000	--	230000	830000	1400000	61000	--	--	1000	100	200	120000	1600	1900	14000	150	120000	370
Acenaphthylene	µg/kg	9900	99000	3000	--	170000	140000	190000	3400	--	--	120	36	90	4900	200	290	640 J	12	57	8
Anthracene	µg/kg	95000	400000	28000	--	160000	420000	550000	32000	--	--	780	110	140	63000	960	1000	9600	56	56000	9.4
Benzo(a)anthracene	µg/kg	89000	290000	24000	--	130000	340000	410000	29000	--	--	940	280	140	50000	910	1100	7900	42	78000	16
Benzo(a)pyrene	µg/kg	130000	340000	35000	--	170000	450000	500000	43000	--	--	1800	610	200	67000	1800	2100	11000	60	130000	22
Benzo(b)fluoranthene	µg/kg	110000	200000	20000	--	150000	390000	290000	37000	--	--	1100	540	120	58000	1100	1200	9900	53	110000	16
Benzo(g,h,i)perylene	µg/kg	120000	260000	33000	--	140000	370000	390000	38000	--	--	2000	680	160	63000	2200	2600	11000	56	130000	21
Benzo(k)fluoranthene	µg/kg	36000	210000	21000	--	48000	130000	330000	10000	--	--	980	140	110	17000	900	1100	2900	16	260	13
Benzoic acid	µg/kg	100000 U	--	--	--	40000 U	200000 U	--	16000 UJ	--	--	--	200 U	--	21000 U	--	--	20000 U	200 U	160 UJ	--
Benzyl alcohol	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
bis(2-Chloroethoxy)methan	µg/kg	5000 U	--	--	--	2000 U	10000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
bis(2-Chloroethyl)ether	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
bis(2-chloroisopropyl)ether	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
bis(2-Ethylhexyl)phthalate	µg/kg	100000 U	--	--	--	810 J	20000 U	--	16000 U	--	--	--	8.7 J	--	21000 U	--	--	20000 U	37 J	8.3 J	--
Butylbenzylphthalate	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
Chrysene	µg/kg	110000	380000	30000	--	170000	420000	500000	35000	--	--	1300	380	160	63000	1300	1500	10000	80	93000	23
Dibenzo(a,h)anthracene	µg/kg	12000	22000	2000	--	17000	48000	33000	4100	--	--	110	39 J	17	7100	97	110	860 J	5.4 J	100	1.6 J
Dibenzofuran	µg/kg	5600	56000	1700	--	17000	40000	81000	1800	--	--	36	3.4 J	18	3700	64	97	370 J	5.4 J	25	1.3 J
Diethylphthalate	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
Dimethylphthalate	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
Di-n-butylphthalate	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
Di-n-octylphthalate	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	110						

**Table 2**  
**Chemical Analytical Results for Visually Contaminated and Visually Uncontaminated Zones**

Location ID Sample Date Depth Interval Sediment Zone	Unit	RAA-02	RAA-04	RAA-06	RAA-06	RAA-09	RAA-13	RAA-14	RAA-17	RAA-20	RAA-04	RAA-05	RAA-06	RAA-08	RAA-10	RAA-11	RAA-11	RAA-12	RAA-14	RAA-17	RAA-19
		7/20/2004 10-19 ft VC	7/21/2004 5-6 ft VC	7/20/2004 4-15 ft VC	7/20/2004 4-7 ft VC	7/19/2004 5-16 ft VC	7/20/2004 11-15 ft VC	7/20/2004 10-14 ft VC	7/22/2004 0-10 ft VC	7/22/2004 5-6 ft VC	7/21/2004 6-20 ft VU	7/22/2004 10-20 ft VU	7/19/2004 15-20 ft VU	7/21/2004 7-20 ft VU	7/19/2004 10-20 ft VU	7/22/2004 13-20 ft VU	7/22/2004 13-20 ft VU	7/20/2004 18-20 ft VU	7/20/2004 14-20 ft VU	7/22/2004 14-20 ft VU	7/22/2004 9-20 ft VU
N-Nitroso-di-n-propylamine	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
n-Nitrosodiphenylamine	µg/kg	5000 U	--	--	--	2000 U	1000 U	--	800 U	--	--	--	10 U	--	1100 U	--	--	1000 U	10 U	8.0 U	--
Pentachlorophenol	µg/kg	50000 U	--	--	--	20000 U	10000 U	--	8000 U	--	--	--	100 U	--	11000 U	--	--	10000 U	100 U	80 U	--
Phenanthrene	µg/kg	<b>440000</b>	<b>2200000</b>	<b>150000</b>	--	<b>910000</b>	<b>2200000</b>	<b>3200000</b>	<b>150000</b>	--	--	<b>4000</b>	<b>660</b>	<b>640</b>	<b>280000</b>	<b>4200</b>	<b>5200</b>	<b>44000</b>	<b>260</b>	<b>320000</b>	<b>47</b>
Phenol	µg/kg	15000 U	--	--	--	6000 U	3000 U	--	2400 U	--	--	--	<b>8.4 J</b>	--	3100 U	--	--	3000 U	<b>5.4 J</b>	<b>11 J</b>	--
Pyrene	µg/kg	<b>400000</b>	<b>1500000</b>	<b>150000</b>	--	<b>590000</b>	<b>1400000</b>	<b>2200000</b>	<b>140000</b>	--	--	<b>5700</b>	1600	<b>480</b>	<b>230000</b>	<b>6100</b>	<b>7500</b>	<b>39000</b>	<b>170</b>	<b>380000</b>	<b>64</b>
<b>Volatile Organic Compounds (VOC)</b>																					
1,1,1-Trichloroethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,1,2,2-Tetrachloroethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,1,2-Trichloroethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,1,2-Trichlorotrifluoroethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,1-Dichloroethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,1-Dichloroethene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,2,3-Trichlorobenzene	µg/kg	--	--	--	--	--	--	--	3200 U	--	--	--	--	--	--	--	--	--	--	32 U	--
1,2,4-Trichlorobenzene	µg/kg	33 U	--	--	--	120 U	150 U	--	800 U	--	--	--	10 U	--	31 U	--	--	32 U	10 U	8.0 U	--
1,2-Dibromo-3-chloropropane	µg/kg	33 U	--	--	--	120 U	150 U	--	3200 U	--	--	--	30 U	--	31 U	--	--	32 U	28 U	32 U	--
1,2-Dichlorobenzene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,2-Dichloroethane	µg/kg	<b>6.1 J</b>	--	--	--	<b>140</b>	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,2-Dichloropropane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,3-Dichlorobenzene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
1,4-Dichlorobenzene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
2-Butanone (MEK)	µg/kg	33 U	--	--	--	120 U	150 U	--	3200 U	--	--	--	30 U	--	31 U	--	--	<b>14 J</b>	28 U	32 U	--
2-Hexanone	µg/kg	33 U	--	--	--	120 U	150 U	--	3200 U	--	--	--	30 U	--	31 U	--	--	32 U	28 U	32 U	--
4-Methyl-2-pentanone (MIBK)	µg/kg	33 U	--	--	--	120 U	150 U	--	3200 U	--	--	--	30 U	--	31 U	--	--	32 U	28 U	32 U	--
Acetone	µg/kg	33 UJ	--	--	--	<b>58 J</b>	150 UJ	--	3200 U	--	--	--	<b>61 J</b>	--	<b>24 J</b>	--	--	<b>69 J</b>	<b>24 J</b>	<b>47</b>	--
Benzene	µg/kg	<b>290</b>	<b>17000</b>	<b>190</b>	<b>1200</b>	<b>6700</b>	<b>620</b>	<b>18000</b>	800 U	<b>400</b>	<b>2.2 J</b>	--	7.5 U	<b>2.9 J</b>	<b>23</b>	7.5 U	<b>1.3 J</b>	8.0 U	<b>3.6 J</b>	7.9 U	<b>9.2</b>
Bromochloromethane	µg/kg	--	--	--	--	--	--	--	800 U	--	--	--	--	--	--	--	--	--	--	7.9 U	--
Bromodichloromethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Bromoform	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Bromomethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 UJ	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Carbonsulfide	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Carbon tetrachloride	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Chlorobenzene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Chloroethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Chloroform	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Chloromethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
cis-1,2-Dichloroethene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
cis-1,3-Dichloropropene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Cyclohexane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	1600 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Dibromochloromethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Dichlorodifluoromethane	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Dichloromethane	µg/kg	17 U	--	--	--	<b>7.0 J</b>	<b>12 J</b>	--	3200 U	--	--	--	<b>1.7 J</b>	--	<b>1.8 J</b>	--	--	<b>3.1 J</b>	<b>1.7 J</b>	<b>2.9 J</b>	--
Ethylbenzene	µg/kg	<b>53</b>	<b>7100</b>	<b>120</b>	<b>370</b>	<b>780</b>	<b>130</b>	<b>31000</b>	<b>1600</b>	<b>1300</b>	<b>7.8 U</b>	--	7.5 U	7.4 U	<b>25</b>	7.5 U	7.6 U	8.0 U	<b>1.5 J</b>	7.9 U	7.2 U
Isopropylbenzene	µg/kg	<b>3.5 J</b>	--	--	--	<b>72 J</b>	<b>19 J</b>	--	<b>190 J</b>	--	--	--	30 U	--	<b>4.1 J</b>	--	--	<b>1.8 J</b>	<b>3.4 J</b>	32 U	--
m,p-Xylenes	µg/kg	<b>25</b>	<b>6900</b>	<b>32</b>	<b>120</b>	<b>580</b>	<b>200</b>	21000 U	800 U	<b>570</b>	7.8 U	--	7.5 U	7.4 U	<b>10</b>	7.5 U	7.6 U	<b>2.9 J</b>	7.0 U	7.9 U	7.2 U
Methyl acetate	µg/kg	8.1 UJ	--	--	--	28 UJ	36 UJ	--	1600 U	--	--	--	7.5 UJ	--	7.6 UJ	--	--	8.0 UJ	7.0 UJ	7.9 U	--
Methyl cyclohexane	µg/kg	8.1 U	--	--	--	<b>6.7 J</b>	36 U	--	1600 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Methyltert-butylether	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
o-Xylene	µg/kg	<b>13</b>	<b>4800</b>	<b>49</b>	<b>170</b>	<b>350</b>	<b>100</b>	<b>11000</b>	<b>330 J</b>	<b>700</b>	7.8 U	--	7.5 U	7.4 U	<b>11</b>	7.5 U	7.6 U	<b>1.5 J</b>	7.0 U	7.9 U	<b>1.0 J</b>
Styrene	µg/kg	8.1 U	--	--	--	<b>60</b>	36 U	--	800 UJ	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Tetrachloroethene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Toluene	µg/kg	<b>3.2 J</b>	<b>1300</b>	<b>11</b>	<b>54</b>	<b>1500</b>	<b>56</b>	<b>3800</b>	800 U	<b>100 J</b>	7.8 U	--	7.5 U	<b>1.9 J</b>	<b>2.5 J</b>	7.5 U	7.6 U	8.0 U	7.0 U	7.9 U	7.2 U
trans-1,2-Dichloroethene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
trans-1,3-Dichloropropene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Trichloroethene	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--
Trichlorofluoromethane	µg/kg	8.1 UJ	--	--	--	28 UJ	36 UJ	--	800 U	--	--	--	7.5 UJ	--	7.6 UJ	--	--	8.0 UJ	7.0 UJ	7.9 U	--
Vinyl Acetate	µg/kg	33 U	--	--	--	120 U	150 U	--	--	--	--	--	30 U	--	31 U	--	--	32 U	28 U	--	--
Vinyl chloride	µg/kg	8.1 U	--	--	--	28 U	36 U	--	800 U	--	--	--	7.5 U	--	7.6 U	--	--	8.0 U	7.0 U	7.9 U	--

Notes:

- 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).
- U The compound was analyzed for, but was not detected at or above the MRL/MDL.
- Z The chromatographic fingerprint does not resemble a petroleum product.
- VC Visually Contaminated
- VU Visually Uncontaminated

**Table 3  
Dredging Elutriate Test (DRET) Analytical Summary**

Location ID Sample Date Depth Interval Sediment Zone	Units	Relevant Acute Water Quality Criteria	RAA-03 7/21/2004 5-13 ft Visually Cont.	RAA-11 7/22/2004 2-4 ft Tar Body	RAA-11 7/22/2004 4-13 ft Visually Cont.	RAA-13 7/20/2004 9-11 ft Tar Body
Sheen Visible in Elutriate Test Vessel?			No	Yes	No	Yes
Measurable Non-Aqueous Phase Layer?			No	No	No	No
<b>Conventionals</b>						
Cyanide	mg/l	0.022	0.01 U	<b>0.01</b>	0.01 U	<b>0.01</b>
<b>Metals</b>						
Arsenic (dissolved)	µg/l	340	<b>2.3</b>	<b>0.7</b>	<b>0.5</b>	<b>0.8</b>
Arsenic (total)	µg/l	340	<b>3.5</b>	<b>0.8</b>	<b>0.8</b>	<b>1</b>
Chromium (dissolved)	µg/l	16	<b>0.31 J</b>	<b>0.4</b>	<b>0.32 J</b>	<b>0.35 J</b>
Chromium (total)	µg/l	16	<b>5.39</b>	<b>1.08</b>	<b>1.09</b>	<b>1.53</b>
Copper (dissolved)	µg/l	13	<b>13.1</b>	<b>1.66</b>	<b>2.27</b>	<b>1.06</b>
Copper (total)	µg/l	13	<b>16.5</b>	<b>2.07</b>	<b>2.29</b>	<b>3.77</b>
Lead (dissolved)	µg/l	65	<b>0.12</b>	<b>0.06</b>	<b>0.12</b>	<b>0.09</b>
Lead (total)	µg/l	65	<b>7.46</b>	<b>0.92</b>	<b>3.11</b>	<b>2.32</b>
Nickel (dissolved)	µg/l	470	<b>0.7</b>	<b>1.2</b>	<b>1.4</b>	<b>1.2</b>
Nickel (total)	µg/l	470	<b>4.4</b>	<b>1.9</b>	<b>2.1</b>	<b>2.1</b>
Zinc (dissolved)	µg/l	120	<b>2.7</b>	<b>1.2</b>	<b>1.5</b>	<b>2.7</b>
Zinc (total)	µg/l	120	<b>16.5</b>	<b>3.7</b>	<b>4.1</b>	<b>7.3</b>
<b>Total Petroleum Hydrocarbons (TPH)</b>						
TPH - Diesel Range	µg/l	--	<b>430 Z</b>	<b>17000 Z</b>	<b>240 J</b>	<b>13000 Z</b>
TPH - Residual Range	µg/l	--	<b>280 J</b>	<b>400 J</b>	<b>99 J</b>	<b>790 Z</b>
<b>Semi-Volatile Organic Compounds (SVOC)</b>						
1,2,4-Trichlorobenzene	µg/l	--	0.20 U	3.9 U	0.20 U	20 U
1,2-Dichlorobenzene	µg/l	260	0.20 U	3.9 U	0.20 U	3.9 U
1,3-Dichlorobenzene	µg/l	630	0.20 U	3.9 U	0.20 U	3.9 U
1,4-Dichlorobenzene	µg/l	180	0.20 U	3.9 U	0.20 U	3.9 U
2,4,5-Trichlorophenol	µg/l	--	0.48 U	9.6 U	0.48 U	9.6 U
2,4,6-Trichlorophenol	µg/l	--	0.48 U	9.6 U	0.48 U	9.6 U
2,4-Dichlorophenol	µg/l	2,020	0.48 U	9.6 U	0.48 U	48 U
2,4-Dimethylphenol	µg/l	2,120	2.0 U	<b>14 J</b>	2.0 U	200 U
2,4-Dinitrophenol	µg/l	--	3.9 U	77 U	3.9 U	77 U
2,4-Dinitrotoluene	µg/l	330	0.20 U	3.9 U	0.20 U	3.9 U
2,6-Dinitrotoluene	µg/l	--	0.20 U	3.9 U	0.20 U	3.9 U
2-Chloronaphthalene	µg/l	--	0.20 U	3.9 U	0.20 U	3.9 U
2-Chlorophenol	µg/l	4,380	0.48 U	9.6 U	0.48 U	9.6 U
2-Methylnaphthalene	µg/l	--	<b>0.030 J</b>	<b>470</b>	<b>0.050 J</b>	<b>710</b>
2-Methylphenol	µg/l	230	0.48 U	<b>3.3 J</b>	0.48 U	<b>1.6 J</b>
2-Nitroaniline	µg/l	--	0.20 U	3.9 U	0.20 U	3.9 U
2-Nitrophenol	µg/l	--	0.48 U	9.6 U	0.48 U	48 U
3,3'-Dichlorobenzidine	µg/l	--	2.0 U	39 U	2.0 U	39 U
3-Nitroaniline	µg/l	--	0.96 U	20 U	0.96 U	20 U
4,6-Dinitro-2-methylphenol	µg/l	--	2.0 U	39 U	2.0 U	39 U
4-Bromophenylphenylether	µg/l	--	0.20 U	3.9 U	0.20 U	3.9 U
4-Chloro-3-methylphenol	µg/l	30	<b>0.057 J</b>	9.6 U	<b>0.076 J</b>	48 U
4-Chloroaniline	µg/l	--	0.20 U	3.9 U	0.20 U	20 U
4-Chlorophenyl-phenylether	µg/l	--	0.20 U	3.9 U	0.20 U	3.9 U
4-Methylphenol	µg/l	--	0.48 U	<b>15</b>	0.48 U	<b>12</b>
4-Nitroaniline	µg/l	--	0.96 U	20 U	0.96 U	20 U
4-Nitrophenol	µg/l	230	2.0 U	39 U	2.0 U	39 U
Acenaphthene	µg/l	1,700	<b>64</b>	<b>150</b>	<b>6.7</b>	<b>440</b>
Acenaphthylene	µg/l	--	<b>1.7</b>	<b>390</b>	<b>0.48</b>	<b>140</b>
Anthracene	µg/l	13	<b>0.12 J</b>	<b>41</b>	<b>1.2</b>	<b>58</b>
Benzo(a)anthracene	µg/l	0.49	<b>0.78</b>	<b>4.8</b>	<b>0.76</b>	<b>19</b>
Benzo(a)pyrene	µg/l	0.24	<b>0.55</b>	<b>4.6</b>	<b>1</b>	<b>24</b>
Benzo(b)fluoranthene	µg/l	--	<b>0.61</b>	<b>4.5</b>	<b>1</b>	<b>22</b>
Benzo(g,h,i)perylene	µg/l	--	<b>0.39</b>	<b>3.8 J</b>	<b>1</b>	<b>20</b>
Benzo(k)fluoranthene	µg/l	--	<b>0.21</b>	<b>1.4 J</b>	<b>0.39</b>	<b>6.9</b>
Benzoic acid	µg/l	740	<b>1.9 J</b>	96 U	<b>2.1 J</b>	480 U
Benzyl alcohol	µg/l	150	4.8 U	96 U	4.8 U	96 U
bis(2-Chloroethoxy)methane	µg/l	--	0.20 U	3.9 U	0.20 U	20 U
bis(2-Chloroethyl)ether	µg/l	--	0.20 U	3.9 U	0.20 U	3.9 U
bis(2-chloroisopropyl)ether	µg/l	--	0.20 U	3.9 U	0.20 U	3.9 U
bis(2-Ethylhexyl)phthalate	µg/l	27	2.0 U	39 U	2.0 U	39 U
Butylbenzylphthalate	µg/l	--	<b>0.028 J</b>	3.9 U	<b>0.027 J</b>	3.9 U
Chrysene	µg/l	--	<b>0.81</b>	<b>7.4</b>	<b>2.1</b>	<b>24</b>
Dibenzo(a,h)anthracene	µg/l	--	<b>0.037 J</b>	3.9 U	<b>0.086 J</b>	<b>1.8 J</b>
Dibenzofuran	µg/l	66	<b>0.044 J</b>	<b>23</b>	<b>0.072 J</b>	<b>28</b>
Diethylphthalate	µg/l	1800	<b>0.27</b>	3.9 U	<b>0.52</b>	3.9 U
Dimethylphthalate	µg/l	--	0.20 U	3.9 U	0.20 U	3.9 U
Di-n-butylphthalate	µg/l	190	<b>0.091 J</b>	3.9 U	<b>0.15 J</b>	3.9 U
Di-n-octylphthalate	µg/l	--	0.39 U	7.7 U	0.39 U	7.7 U
Fluoranthene	µg/l	3,980	<b>19</b>	<b>56</b>	<b>6.3</b>	<b>110</b>
Fluorene	µg/l	70	<b>0.078 J</b>	<b>130</b>	<b>0.32</b>	<b>150</b>
Hexachlorobenzene	µg/l	--	0.20 U	3.9 U	0.20 U	3.9 U

**Table 3  
Dredging Elutriate Test (DRET) Analytical Summary**

Location ID Sample Date Depth Interval Sediment Zone	Units	Relevant Acute Water Quality Criteria	RAA-03 7/21/2004 5-13 ft Visually Cont.	RAA-11 7/22/2004 2-4 ft Tar Body	RAA-11 7/22/2004 4-13 ft Visually Cont.	RAA-13 7/20/2004 9-11 ft Tar Body
Hexachlorobutadiene	µg/l	90	0.20 U	3.9 U	0.20 U	20 U
Hexachlorocyclopentadiene	µg/l	7	0.96 U	20 U	0.96 U	20 U
Hexachloroethane	µg/l	210	0.20 U	3.9 U	0.20 U	3.9 U
Indeno(1,2,3-cd)pyrene	µg/l	--	<b>0.36</b>	<b>3.2 J</b>	<b>0.83</b>	<b>17</b>
Isophorone	µg/l	117,000	0.20 U	3.9 U	0.20 U	20 U
Naphthalene	µg/l	190	<b>0.078 J</b>	<b>6900</b>	<b>0.27</b>	<b>11000</b>
Nitrobenzene	µg/l	27,000	0.20 U	3.9 U	0.20 U	3.9 U
N-Nitroso-di-n-propylamine	µg/l	5,850	0.20 U	3.9 U	0.20 U	3.9 U
n-Nitrosodiphenylamine	µg/l	3,800	0.20 U	3.9 U	0.20 U	3.9 U
Pentachlorophenol	µg/l	19	<b>0.072 J</b>	20 U	<b>0.071 J</b>	<b>2.0 J</b>
Phenanthrene	µg/l	--	<b>0.49</b>	<b>280</b>	<b>1</b>	<b>300</b>
Phenol	µg/l	10,200	<b>0.10 J</b>	<b>8.9 J</b>	<b>0.17 J</b>	<b>2.5 J</b>
Pyrene	µg/l	--	<b>20</b>	<b>58</b>	<b>6</b>	<b>110</b>
<b>Volatile Organic Compounds (VOCs)</b>						
1,1,1-Trichloroethane	µg/l	200	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	µg/l	2,100	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichloroethane	µg/l	5,200	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethane	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	µg/l	830	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	µg/l	450	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichlorobenzene	µg/l	--	2.0 U	2.0 U	2.0 U	2.0 U
1,2,4-Trichlorobenzene	µg/l	700	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dibromo-3-chloropropane	µg/l	--	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dichlorobenzene	µg/l	260	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	µg/l	8,800	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloropropane	µg/l	23,000	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	µg/l	630	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	µg/l	180	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	µg/l	240,000	20 U	20 U	20 U	20 U
2-Hexanone	µg/l	1,800	20 U	20 U	20 U	20 U
4-Methyl-2-pentanone (MIBK)	µg/l	2,200	20 U	20 U	20 U	20 U
Acetone	µg/l	--	<b>24</b>	<b>53</b>	<b>25</b>	<b>8.4 J</b>
Benzene	µg/l	2,300	0.50 U	<b>810</b>	<b>0.26 J</b>	<b>220</b>
Bromochloromethane	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
Bromodichloromethane	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
Bromoform	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
Bromomethane	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
Carbon disulfide	µg/l	17	0.50 U	<b>0.53</b>	0.50 U	0.50 U
Carbon tetrachloride	µg/l	180	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	µg/l	1,100	0.50 U	0.50 U	0.50 U	<b>0.35 J</b>
Chloroethane	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
Chloroform	µg/l	490	0.50 U	0.50 U	0.50 U	0.50 U
Chloromethane	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,2-Dichloroethene	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,3-Dichloropropene	µg/l	6,060	0.50 U	0.50 U	0.50 U	0.50 U
Cyclohexane	µg/l	--	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
Dichlorodifluoromethane	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
Dichloromethane	µg/l	26,000	<b>0.66 J</b>	<b>0.67 J</b>	<b>0.53 J</b>	<b>0.90 J</b>
Ethylbenzene	µg/l	130	0.50 U	<b>62</b>	0.50 U	<b>290</b>
Isopropylbenzene	µg/l	--	2.0 U	<b>23</b>	<b>2.0 U</b>	<b>14</b>
m,p-Xylenes	µg/l	--	0.50 U	<b>210</b>	0.50 U	<b>210</b>
Methyl acetate	µg/l	--	1.0 U	1.0 U	1.0 U	1.0 U
Methyl cyclohexene	µg/l	--	1.0 U	1.0 U	1.0 U	1.0 U
Methyltert-butylether	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	µg/l	--	0.50 U	<b>100</b>	0.50 U	<b>120</b>
Styrene	µg/l	--	0.50 U	<b>38</b>	0.50 U	0.50 U
Tetrachloroethene	µg/l	830	0.50 U	0.50 U	0.50 U	0.50 U
Toluene	µg/l	120	0.50 U	<b>320</b>	0.50 U	<b>160</b>
trans-1,2-Dichloroethene	µg/l	1,100	0.50 U	0.50 U	0.50 U	0.50 U
trans-1,3-Dichloropropene	µg/l	0.99	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	µg/l	440	0.50 U	<b>0.15 J</b>	0.50 U	<b>0.17 J</b>
Trichlorofluoromethane	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl chloride	µg/l	--	0.50 U	0.50 U	0.50 U	0.50 U

Notes:

 Yellow shading indicates value that exceeds acute criteria.

**Detected values shown in bold**

**J** The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

**U** The compound was analyzed for, but was not detected at or above the MRL/MDL.

**Z** The chromatographic fingerprint does not resemble a petroleum product.

Water quality criteria from National Ambient Water Quality Criteria, Oregon proposed and existing regulations, and ORNL 1996.

-- Not Available

**Table 4  
TCLP Testing Analytical Summary**

Location ID Sample Date Depth Interval Sediment Zone	Units	TCLP Criteria	RAA-03 7/21/2004 5-13 ft Visually Cont.	RAA-11 7/22/2004 2-4 ft Tar Body	RAA-11 7/22/2004 4-13 ft Visually Cont.	RAA-13 7/20/2004 9-11 ft Tar Body
<b>Metals</b>						
Arsenic	mg/l	5	<b>0.03 J</b>	0.1 U	0.1 U	0.1 U
Barium	mg/l	100	<b>1.5</b>	<b>0.6 J</b>	<b>0.6 J</b>	<b>0.5 J</b>
Cadmium	mg/l	1	0.01 U	0.01 U	0.01 U	0.01 U
Chromium	mg/l	5	0.01 U	<b>0.004 J</b>	<b>0.003 J</b>	<b>0.003 J</b>
Lead	mg/l	5	0.05 U	0.05 U	0.05 U	0.05 U
Selenium	mg/l	1	0.1 U	0.1 U	0.1 U	0.1 U
Silver	mg/l	5	0.02 U	0.02 U	0.02 U	0.02 U
Mercury	mg/l	0.2	0.001 U	0.001 U	0.001 U	0.001 U
<b>Pesticides</b>						
Chlordane	mg/l	0.03	0.0050 U	0.0050 U	0.0050 U	0.0050 U
Endrin	mg/l	0.02	0.00050 U	0.00050 U	0.00050 U	0.00050 U
gamma-BHC (Lindane)	mg/l	0.4	0.00050 U	0.00050 U	0.00050 U	0.00050 U
Heptachlor	mg/l	0.008	0.00050 U	0.00050 U	0.00050 U	0.00050 U
Heptachlor Epoxide	mg/l	--	0.00050 U	0.00050 U	0.00050 U	0.00050 U
Methoxychlor	mg/l	10	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Toxaphene	mg/l	0.5	0.010 U	0.010 U	0.010 U	0.010 U
2,4-D	mg/l	10	0.10 U	0.10 U	0.10 U	0.10 U
Silvex	mg/l	1	0.02 U	0.02 U	0.02 U	0.02 U
<b>Semi-Volatile Organic Compounds (SVOC)</b>						
2,4,5-Trichlorophenol	mg/l	400	0.10 U	0.10 U	0.10 U	0.10 U
2,4,6-Trichlorophenol	mg/l	2	0.10 U	0.10 U	0.10 U	0.10 U
2,4-Dinitrotoluene	mg/l	0.13	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ
2-Methylphenol	mg/l	200	0.10 U	<b>0.022 J</b>	0.10 U	0.10 U
4-Methylphenol	mg/l	200	0.10 U	<b>0.083 J</b>	0.10 U	0.10 U
Hexachlorobenzene	mg/l	0.13	0.10 U	0.10 U	0.10 U	0.10 U
Hexachlorobutadiene	mg/l	0.5	0.10 U	0.10 U	0.10 U	0.10 U
Hexachloroethane	mg/l	3	0.10 U	0.10 U	0.10 U	0.10 U
Nitrobenzene	mg/l	2	0.10 U	0.10 U	0.10 U	0.10 U
Pentachlorophenol	mg/l	100	0.25 U	0.25 U	0.25 U	0.25 U
Pyridine	mg/l	2	0.50 U	0.50 U	0.50 U	0.50 U
<b>Volatile Organic Compounds (VOC)</b>						
1,1-Dichloroethene	mg/l	0.7	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dichloroethane	mg/l	0.5	0.20 U	0.20 U	0.20 U	0.20 U
1,4-Dichlorobenzene	mg/l	7.5	0.20 U	0.20 U	0.20 U	0.20 U
2-Butanone (MEK)	mg/l	200	8.0 U	8.0 U	8.0 U	8.0 U
Benzene	mg/l	0.5	0.20 U	<b>30 *</b>	<b>0.45</b>	<b>3.3 *</b>
Carbon tetrachloride	mg/l	0.5	0.20 U	0.20 U	0.20 U	0.20 U
Chlorobenzene	mg/l	100	0.20 U	0.20 U	0.20 U	0.20 U
Chloroform	mg/l	6	0.20 U	0.20 U	0.20 U	0.20 U
Tetrachloroethene	mg/l	0.7	0.20 U	0.20 U	0.20 U	0.20 U
Trichloroethene	mg/l	0.5	0.20 U	0.20 U	0.20 U	0.20 U
Vinyl chloride	mg/l	0.2	0.080 U	0.080 U	0.080 U	0.080 U

Notes:

J The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

U The compound was analyzed for, but was not detected at or above the MRL/MDL.

\* The result is greater than the criteria value.

**Table F-2  
Dredge Water Quality Kuo-Hayes Model Simulation Results**

Distance from Dredge	50 ft			100 ft			200 ft			300 ft			400 ft			Acute (ug/L)
Percentile Result	50th	90th	95th													
<b>Total Suspended Sediment Concentration (mg/L)</b>	263	757	961	177	491	621	114	283	375	83	209	280	65	163	223	N/AV
<b>DRET-Based Water Concentration Ratio (unitless) - As Compared to Acute Water Quality Criteria</b>																
Copper	3.42E-02	1.07E-01	1.43E-01	2.29E-02	6.93E-02	9.26E-02	1.45E-02	4.25E-02	5.62E-02	1.06E-02	3.11E-02	4.11E-02	8.34E-03	2.40E-02	3.24E-02	13
Cyanide	6.03E-03	6.03E-03	6.03E-03	4.11E-03	4.11E-03	4.11E-03	2.69E-03	2.69E-03	2.69E-03	2.03E-03	2.03E-03	2.03E-03	1.63E-03	1.63E-03	1.63E-03	22
Anthracene	2.64E-02	8.81E-02	1.30E-01	1.78E-02	5.94E-02	8.60E-02	1.14E-02	3.63E-02	5.31E-02	8.11E-03	2.66E-02	3.92E-02	6.26E-03	2.16E-02	3.01E-02	13
Benzo(a)anthracene	3.41E-01	1.24E+00	1.65E+00	2.31E-01	7.82E-01	1.08E+00	1.45E-01	4.79E-01	6.48E-01	1.08E-01	3.51E-01	4.69E-01	8.46E-02	2.81E-01	3.71E-01	0.49
Benzo(a)pyrene	7.12E-01	2.45E+00	3.52E+00	4.86E-01	1.63E+00	2.28E+00	3.14E-01	1.03E+00	1.42E+00	2.32E-01	7.65E-01	1.03E+00	1.81E-01	6.02E-01	8.06E-01	0.24
Benzene	5.60E-04	5.60E-04	5.60E-04	3.81E-04	3.81E-04	3.81E-04	2.49E-04	2.49E-04	2.49E-04	1.89E-04	1.89E-04	1.89E-04	1.51E-04	1.51E-04	1.51E-04	2300
Fluoranthene	8.98E-04	3.32E-03	4.31E-03	5.92E-04	2.08E-03	2.83E-03	3.79E-04	1.29E-03	1.75E-03	2.81E-04	9.29E-04	1.31E-03	2.19E-04	7.43E-04	1.05E-03	3980
Fluorene	1.24E-02	4.34E-02	6.44E-02	8.39E-03	2.78E-02	3.97E-02	5.38E-03	1.70E-02	2.38E-02	3.96E-03	1.25E-02	1.70E-02	3.08E-03	9.76E-03	1.33E-02	70
Naphthalene	3.36E-02	1.21E-01	1.71E-01	2.28E-02	7.92E-02	1.14E-01	1.45E-02	4.79E-02	7.12E-02	1.03E-02	3.36E-02	5.49E-02	7.91E-03	2.60E-02	4.37E-02	2300
Ethylbenzene	1.57E-02	5.65E-02	7.70E-02	1.05E-02	3.69E-02	4.83E-02	6.60E-03	2.21E-02	3.04E-02	4.89E-03	1.58E-02	2.30E-02	3.82E-03	1.24E-02	1.80E-02	130
Toluene	1.77E-02	5.59E-02	7.52E-02	1.18E-02	3.66E-02	4.94E-02	7.57E-03	2.19E-02	3.04E-02	5.58E-03	1.62E-02	2.18E-02	4.27E-03	1.23E-02	1.78E-02	120
Total Hazard Index	1.20E+00	4.17E+00	5.84E+00	8.16E-01	2.73E+00	3.80E+00	5.22E-01	1.70E+00	2.33E+00	3.86E-01	1.25E+00	1.69E+00	3.01E-01	9.92E-01	1.33E+00	

Note:

DRET - Dredging Elutriate Test

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**APPENDIX E**

**PAH ANALYSIS**

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In support of the biological assessment, NOAA requested that the water quality information collected for the removal action design be evaluated for potential impacts to aquatic biota from total petroleum hydrocarbons (TPH). Semi-volatile organic compounds as well as total petroleum hydrocarbons in the diesel (TPH-D) range and residual (TPH-R) range were measured in a dredging elutriate test (DRET) of tar body and visually contaminated sediment samples (Table 6, RAPP, Anchor 2004b, as cited in the BA). As described in Section 2.2.1 of the RAPP (Anchor 2004), the DRET is intended as a bench scale simulation of the chemicals that might be present in the water column within a few feet of the point of dredging.

TPH-D or TPH-R measure classes of chemical compounds (aliphatic and aromatic) that have similar structural characteristics and that can be differentiated using analytical methods. In other words, TPH-D and TPH-R do not report concentrations of specific chemicals. Instead, they are measures of the hydrocarbons with similar molecular structures across a range of molecular sizes based on the numbers of carbon molecules. For example, TPH-D is representative of aromatic and aliphatic compounds with carbon chains containing between 6 and 24 carbon molecules (C6-24). Overall, there is a paucity of aquatic toxicity data for TPHs compared to the dataset that is available for specific polycyclic aromatic hydrocarbon (PAH) compounds. The primary reason for the lack of applicable toxicity data with for TPH measures is because the nature of the chemicals making up these mixtures can vary greatly between samples. Instead, toxicologists have focused studies on individual chemicals for which there is more certainty in the measurements.

Neither Federal nor State aquatic life criteria for TPH ranges have been promulgated in the U.S. However, aquatic life water standards are used in British Columbia ([http://wlapwww.gov.bc.ca/epd/epdpa/contam\\_sites/policy\\_procedure\\_protocol/protocols/petro\\_hydro\\_h20.html](http://wlapwww.gov.bc.ca/epd/epdpa/contam_sites/policy_procedure_protocol/protocols/petro_hydro_h20.html)), but are quantified in terms of volatile petroleum hydrocarbons (C6-10) in water and light extractable petroleum hydrocarbons (C10-19) in water. Therefore, the Canadian values are not comparable to the available TPH-D and TPH-R measures from the DRET test.

Since aquatic life criteria were not available for TPHs, an alternative approach was used to ensure that the available PAH aquatic toxicity data will adequately address potential impacts from the aliphatic and aromatic compounds represented by TPH-D and TPH-R. PAHs are aromatic compounds, some of which are captured in TPH-D and TPH-R analyses. For example,



acenaphthene, anthracene, fluorene, naphthalene, and phenanthrene, aromatic chemicals which were measured individually and have acute aquatic toxicity values, were also measured as part of TPH-D.

Since aquatic toxicity criteria are not available for aliphatic compounds, a comparison of the toxicity between aliphatic and aromatic compounds was not possible. However, mammalian reference dose (RfD) data are available for both aliphatic and aromatic compounds. The mechanism of acute toxicity for aliphatic and aromatic hydrocarbons (PAHs included) is narcosis, the disruption of the lipid bilayer of the cell wall. This is the case for all animals. The relative narcotic toxicity is correlated with the Kow of the compound, a measure of the chemical's affinity for lipids. Due to the similar toxic mechanism across all animals, it is reasonable to compare the mammalian RfD values of aliphatic and aromatic hydrocarbons to ascertain their relative toxicity to aquatic species. Washington Department of Ecology provides recommended reference doses for petroleum fractions and individual hazardous substances that include oral and inhalation RfD values for aliphatic and aromatic petroleum fractions ([http://www.ecy.wa.gov/programs/tcp/tools/CLARC\\_v\\_3.1/CLARC\\_%20PART\\_IV\\_TPH.pdf](http://www.ecy.wa.gov/programs/tcp/tools/CLARC_v_3.1/CLARC_%20PART_IV_TPH.pdf)). Overall, for similar equivalent carbon fractions, the aliphatic RfDs are equal to or greater than the aromatic RfDs. A higher RfD, which is measured in mg/kg-body wt./day) indicates a chemical is less toxic. Therefore, these data indicate that the aromatic compounds have equal or greater narcotic toxicity relative to aliphatic compounds.

PAH acute toxicity data are available as reported in Table 6 of the RAPP (Anchor 2004b). Based on the evaluation above, it is reasonable to apply the PAH acute toxicity data under the assumption that PAH and TPH-D and TPH-R concentrations are correlated. The concentrations of TPH-D, TPH-R, acenaphthene, anthracene, fluorene, naphthalene, and phenanthrene in the four DRET samples are strongly correlated, with an average greater than 84 percent.



**Table E-1**  
**Summary of Correlation Coefficients Between Selected PAHs and TPHs in DRET Samples**

	TPH-D	TPH-R	acenaphthene	anthracene	fluorene	naphthalene	phenanthrene
TPH-D	1						
TPH-R	0.68	1					
acenaphthene	0.65	0.99	1				
anthracene	0.91	0.90	0.90	1			
fluorene	0.96	0.85	0.84	0.99	1		
naphthalene	0.88	0.93	0.93	1.00	0.98	1	
phenanthrene	0.97	0.83	0.81	0.98	1.00	0.97	1
Average	0.84	0.86	0.85	0.95	0.94	0.95	0.93

The following conclusions support the use of the PAH acute aquatic criteria presented in Table 6 of the RAPP (Anchor 2004b) for evaluating potential impacts to aquatic species in the Willamette River during the tar body removal action:

1. TPH-D and TPH-R are measures of mixtures of aromatic and aliphatic compounds and these constituents can vary greatly between samples.
2. Neither Federal nor State aquatic life criteria for TPH have been promulgated in the United States. There is a paucity of TPH toxicity data.
3. Due to the similar toxic mechanism of hydrocarbons across all animals, narcosis, it is reasonable to compare the mammalian RfD data of aliphatic and aromatic hydrocarbons to ascertain their relative toxicity to aquatic species.
4. Based on mammalian RfD data, aromatic compounds, like PAHs, have equal or greater narcotic toxicity relative to aliphatic compounds.
5. Given that PAHs are likely to be more toxic than aliphatic compounds measured in TPH-D or TPH-R, it is reasonable to apply the PAH acute toxicity data under the assumption that PAH and TPH-D and TPH-R concentrations are correlated.
6. The concentrations of TPH-D, TPH-R, acenaphthene, anthracene, fluorene, naphthalene, and phenanthrene in the four DRET samples are strongly correlated, with an average greater than 84 percent.

Based on this conclusion, the results of the dredging water quality analyses in the EE/CA (Anchor 2005) for these PAHs were reviewed. It was found that acenaphthene and phenanthrene did not exceed available acute criteria in the DRET test, indicating impacts from this PAH are very unlikely. For the other PAHs (anthracene, fluorene, and naphthalene), the dredging water quality analysis presented in the EE/CA indicates that there is a much less than



5 percent chance of any of these PAHs exceeding their acute criteria even within 50 feet from the dredge. It should be noted that the model used in this analysis assumes no silt curtain or other containment barrier is present, and thus, does not allow for any further improvements in water quality that would likely be provided by the silt curtain system proposed for this removal action.

