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Technical Memorandum

To: Nancy Munn, National Marine Fisheries Service

From: Ali Wick, Ben Hung, and Tom Schadt, Anchor Environmental, L.L.C.

Cc: Nicole LaFranchise, Marcel Hermans, and Krista Koehl, Port of Portland

Sean Sheldrake, EPA

Date: March 4, 2008

Re: Supplemental Information for Biological Assessment for Phase I of the Terminal 4 Removal Action

This brief memorandum provides supplemental information regarding the Biological Assessment (BA) for Phase I of the Terminal 4 Removal Action submitted to National Marine Fisheries Service (NMFS) in December 2007. Pursuant to discussion we have had on the project and the BA, this document provides additional information on the following topics:

1. Literature regarding the use of bubble curtains for fish guidance and/or deterrent
2. Expected contaminant concentrations in the vicinity of the dredging activity
3. Habitat description and clarification for work to be performed at Wheeler Bay

LITERATURE ON USE OF BUBBLE CURTAINS FOR FISH GUIDANCE PURPOSES

Initially, a bubble curtain was proposed as an additional measure to deter fish from entering the Slip 3 vicinity as they are migrating downstream in the Willamette River. The primary deterrent is a net lead that is intended to prevent fish in shallow waters from following the shoreline as it turns east into Slip 3 and keep them out of the construction zone. Since the net has limitations associated with its size (the net is long and wide, difficult to sustain in position), and it also potentially creates navigation impediments if it is too long, the initial intent was for the bubble curtain to serve as a backup to provide additional deterrent to fish potentially entering the slip once they reached the end of the net lead. As we have progressed further into design, we have determined that the bubble curtain has a significant fuel consumption associated with it to operate it continuously (24 hours per day, 7 days per week) during the period corresponding with the dredging. Initial estimates are that about 900 gallons per day of diesel fuel would be used. Given the environmental impacts of such fuel consumption, we completed a more in-depth review of how effective the bubble curtain is expected to be in terms of deterring fish.

Based on a review of the literature regarding studies on fish response to bubble curtains for directional guidance[1], deployment of a bubble curtain for the proposed project would be unlikely to prevent a significant number of fish from potentially entering Slip 3 during construction beyond those that will be deterred through the use of the net. Therefore, our recommendation is to focus the fish deterrent approach on the net upstream of Slip 3. Pertinent literature discusses how behavioral guidance technologies, such as bubble curtains, aim to use fish senses to elicit behaviors that result in fish avoiding or swimming away from areas where injury or mortality can occur. The literature indicates that bubble curtain technologies can repeatedly elicit startle responses in fish, but these technologies have not consistently resulted in consistent movement in a desired direction. Noted fisheries engineer Milo Bell noted in his 1991 fisheries engineering handbook, "Although the literature shows that fish have an immediate response to bubbles (which may be a fright response), experiments with salmonid fish indicate that bubble screens are not effective in either stopping or guiding" (Bell 1991). Also, researchers in Chesapeake Bay have examined the possible use of bubble curtain and strobe light combinations as behavioral guidance systems for estuarine fish. Results of their studies showed that all species studied (perch, spot, and menhaden) showed little avoidance of bubble curtains (Sager et al. 1986).

The hydroelectric and power plant generating industries have also studied the use of bubble curtains for fish guidance/avoidance, and have found similar results as those concluded in Bell's work. Hocutt (1980), in a book regarding power plants, cited an author (Kuznetsov 1971) who suggested that his success with air bubbles may have been associated with the sound that they produce and not with the bubbles per se. Working to keep fish from hydroelectric turbines, Ruggles (1991) pointed out that air bubbles are effective for some (unnamed) saltwater species and possibly for some other (unnamed) species in streams, but not in rivers. More recently, in their efforts to address research and development efforts to facilitate fish movement up and downstream past hydroelectric facilities, the California Energy Commission (CEC) notes that "air bubble curtains have met with limited success in guiding or blocking and diverting fish in

[1] The literature also contains some discussion of bubble curtains for attenuation of sound due to underwater noise from activities such as pile driving.

the laboratory or field" (CEC 2005; cites Kuznetsov 1971; Hocutt 1980; Patrick et al. 1985; EPRI 1999).

For the most part, behavioral barriers for use in fish passage have not been approved of and accepted for use by the resource agencies (OTA 1995). This leads us to conclude that the uncertainty of the current state of technology is such that the use of bubble curtains would not be a prudent measure as a fish deterrent for the Terminal 4 project, and that the use of a bubble curtain would not result in a significant decrease in the number of fish potentially migrating into the construction area at Slip 3.

EXPECTED CONTAMINANT CONCENTRATIONS IN VICINITY OF DREDGING ACTIVITY

In response to the request by NMFS for better information on risk of exposure to fish, additional contaminant plume analysis was performed. For those fish that would enter the construction vicinity, the results from contaminant plume analysis show that little or no short-term water quality effects are predicted for toxic constituents of concern. Two separate analyses were performed in order to address both the dissolved and particulate fractions of the plume generated by the dredge. The scenario that was modeled in both cases was based on dredging at the head of Slip 3, which is considered the worst case with respect to the concentration of contaminants in the sediments.

Dissolved Fraction Analysis

The analysis of the dissolved fraction of the plume used elutriate concentration results from the pre-construction Modified Elutriate Testing (MET). These results were used as initial concentrations in a "far-field" dilution model (EPA PLUMES model; EPA/600/R-94/086; Baumgartner et al. 1994). Far-field dilution models are used to model dispersion of contaminant plumes that are beyond the range of an outfall or diffuser that might influence the velocity and trajectory of the plume.

In addition to the initial concentrations, the model inputs included the width of the initial plume and the horizontal current speed. The width of the initial plume corresponds to the size of the dredging bucket that is used. Based on contractor feedback, a conservative worst-case assumption is that the dredging bucket will be approximately 4 feet wide. A horizontal current speed of 0.01 meters/second (the typical velocity at the head of Slip 3) was used based on the hydrodynamic modeling performed during the Engineering Evaluation/Cost Analysis (EE/CA) (BBL 2005; Figure G-1).

Estimated concentrations at 30 meters, the 50-meter early warning boundary, and the 100-meter mixing zone boundary were calculated for chemicals of concern and compared to acute and chronic water quality standards, as well as acute and chronic guidance values. The only parameter with an initial concentration in excess of the regulatory values was lead. The results of the modeling effort are provided in Table 1 (Estimated Water Column Concentrations – Dissolved Basis). Based on the most conservative model algorithm (three computational methods are run simultaneously), a dilution of 3.3 is observed at 30 meters, a dilution of 4.1 is observed at 50 meters, and a dilution of 5.8 is observed at 100 meters (along the plume trajectory). Therefore, the estimated concentration of lead declines to below the chronic water quality criteria before the 50-meter early warning boundary is reached.

Particulate Fraction Analysis

The analysis of the particulate fraction of the plume was based on the DREDGE (USACE) modeling results as reported in the Phase I DAR. The DREDGE model estimates the total suspended solids (TSS) generated by the dredge based on the mechanical dredging parameters and the Site characteristics (See Phase I DAR Figure 10; Anchor 2008). As the concentration of TSS declines with distance away from the dredge, the chemical concentrations decline as well. The 90th percentile sediment concentrations for parameters of interest used in this analysis were calculated based on the results of cores collected from within the Phase I dredge prism.

Estimated concentrations at 30 meters, the 50-meter early warning boundary, and the 100-meter mixing zone boundary were calculated for chemicals of concern. Polycyclic aromatic hydrocarbons (PAHs) were compared to acute and chronic guidance values. Although metal parameters are regulated on a dissolved basis, the particulate-based metals results are nevertheless presented and compared to acute and chronic dissolved water quality standards for informational purposes. The parameters with initial concentrations in the immediate vicinity of the dredge in excess of the guidance values include lead and a number of PAHs. The results of the modeling effort are provided in Table 2 (Estimated Water Column Concentrations – Particulate Basis). Based on this analysis, the concentrations of all parameters will decline to below guidance values before reaching the 50-meter early warning boundary.

CLARIFICATION ON WORK TO BE COMPLETED AT WHEELER BAY

General shoreline habitat conditions in Wheeler Bay, especially at elevation +10 feet and higher, which is the area where Phase I bank stabilization and regrading will occur, are degraded due to oversteepened slopes, bank slumping and contamination, and armored/debris conditions. However, in a small area referred to as Construction Area B in the revised Figure 7a (provided in Attachment A), between the elevations of +10 to +15 feet (NGVD 1929), there is a portion of the shoreline that contains relatively good habitat characterized by gently sloped, finer-grained substrate with large woody debris (LWD) and fewer of the conditions that characterize the rest of shoreline (see Photos 1, 2, and 3 below). Most of the relatively good existing habitat along the Wheeler Bay shoreline is at elevations below +10 feet and is not targeted for modification by the Phase I remediation activities.

It is useful to consider the area of existing good habitat within the context of all of the habitat within the larger Phase I remediation project area at Wheeler Bay. The habitat within Construction Area B (between elevations +10 and +15 feet) that is currently in relatively good condition is about 8,400 square feet (sf). This represents about 20 percent of the total existing habitat between +10 and +30 feet that will be affected by the remediation (approximately 40,700 sf). The remaining approximately 80 percent of the habitat that will be affected by the remediation is currently degraded or at an elevation above ordinary high water (OHW) and, through the remediation process, will receive significant habitat improvements. These habitat improvements include hydroseeding with jute matting, willow live stakes, and LWD area (see Attachment A, revised Figure 7b). A total of approximately 32,300 sf of new higher quality habitat will replace existing degraded habitat as a result of the bank stabilization and remediation.

Thus, no net loss of salmonid habitat is expected to occur in Wheeler Bay, as the Phase I stabilization work and habitat work is expected to provide an overall improvement to existing nearshore habitat. Although armor material will be placed along the steepest portion of the shoreline, the net effect will be an improvement over existing conditions, and overall, it is expected that the armor material will be inundated for only approximately 3 days on average throughout the year, and those limited days are not typically at a time when the highest concentration of juvenile downstream migrant salmonids are present.

Photo 1. Looking west and riverward, oversteepened slumping banks, sparse vegetation, and concrete debris at Wheeler Bay (Construction Area A).

Photo 2. Looking east, currently existing quality habitat in part of Construction Area B that will receive additional plantings and LWD habitat.

Photo 3. Looking west and riverward, currently existing degraded habitat in part of construction area B that will receive plantings and LWD habitat.

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TABLES

Table 1
Estimated Water Column Concentrations - Dissolved Basis
(For Parameters Identified for Monitoring During Phase I Dredging Activities)

Parameter	Estimated Dissolved Concentration at Dredge	Estimated Concentration at 30 Meters	Estimated Concentration at 50-meter Early Warning Boundary	Estimated Concentration at 100-meter Mixing Zone Boundary	Acute WQC	Chronic WQC	Acute Guidance Value[1]	Chronic Guidance Value[1]
	From Pre-construction MET	From Far-Field Model[3]	From Far-Field Model[3]	From Far-Field Model[3]				
Metals[2]	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
Cadmium	0.2 U	0.04 U	0.04 U	0.04 U	0.5	0.09	--	--
Lead	**2**	**0.62**	**0.15**	**0.03**	14	0.54	--	--
Zinc	**5**	**1.54**	**0.37**	**0.06**	36	36	--	--
PAHs	µg/L	µg/L	µg/L	µg/L	--	--	µg/L	µg/L
Naphthalene	0.1 UJ	0.1 U	0.1 U	0.1 U	--	--	807	194
Acenaphthylene	0.1 UJ	0.1 U	0.1 U	0.1 U	--	--	1277	307
Acenaphthene	**0.71 J**	**0.22**	**0.17**	**0.12**	--	--	233	56
Fluorene	**0.25 J**	**0.08**	**0.06**	**0.04**	--	--	162	39
Phenanthrene	**0.48 J**	**0.15**	**0.12**	**0.08**	--	--	79	19
Anthracene	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--	--	87	21
Fluoranthene	**0.56 J**	**0.17**	**0.13**	**0.10**	--	--	30	7.1
Pyrene	**0.59 J**	**0.18**	**0.14**	**0.10**	--	--	42	10
Benzo(a)anthracene	**0.11 J**	**0.03**	**0.03**	**0.02**	--	--	9.2	2.2
Chrysene	**0.16 J**	**0.05**	**0.04**	**0.03**	--	--	8.3	2.0
Benzo(b)fluoranthene	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--	--	2.8	0.68
Benzo(k)fluoranthene	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--	--	2.7	0.64
Benzo(a)pyrene	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--	--	4.0	0.96
Indeno(1,2,3-cd)pyrene	0.1 U	0.1 U	0.1 U	0.1 U	--	--	1.2	0.28
Dibenzo(a,h)anthracene	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--	--	1.2	0.28
Benzo(g,h,i)perylene	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--	--	1.8	0.44

Notes:

1. Final Acute Values and Final Chronic Values from USEPA 2003
2. WQCs Based on Willamette River Hardness of 25 mg/L
3. Far-Field plume mixing modeling results using most conservative estimate- Constant Eddy Diffusivity (Plumes Equation 66)

Detected/Modeled parameters are presented in BOLD

WQC = Water Quality Criteria

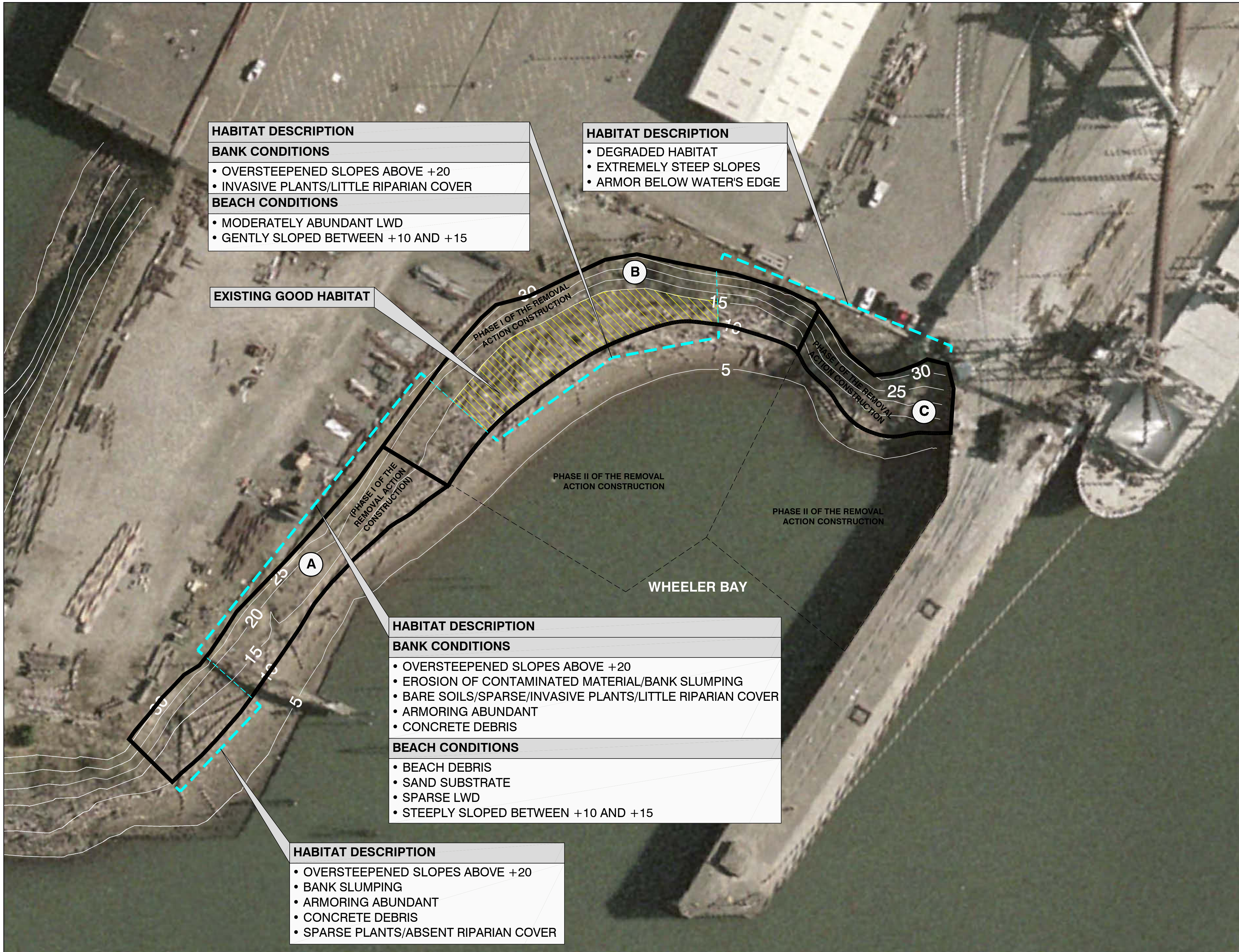
Estimated value exceeds regulatory values

Table 2
Estimated Water Column Concentrations - Particulate Basis
(For Parameters Identified for Monitoring During Phase I Dredging Activities)

Parameter	90th Percentile Chemical Concentrations in Dredge Prism	Estimated Concentration at the Dredge 10 Percent Loss; 0.01 m/s Velocity; TSS = 180 mg/L From DREDGE Model	Estimated Concentration at 30 Meters 10 Percent Loss; 0.01 m/s Velocity; TSS = 1.7 mg/L From DREDGE Model	Estimated Concentration at 50-meter Early Warning Boundary 10 Percent Loss; 0.01 m/s Velocity; TSS = 0.44 mg/L From DREDGE Model	Estimated Concentration at 100-meter Mixing Zone Boundary 10 Percent Loss; 0.01 m/s Velocity; TSS = <0.44 mg/L From DREDGE Model	Acute WQC	Chronic WQC	Acute Guidance Value[1]	Chronic Guidance Value[1]
Metals[2]	mg/kg	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
Cadmium	4.84	0.871	0.008	0.002	<0.002	0.5	0.09	--	--
Lead	837	151	1.423	0.368	<0.363	14	0.54	--	--
Zinc	1.99	0.358	0.003	0.001	<0.001	36	36	--	--
PAHs	µg/kg	µg/L	µg/L	µg/L	µg/L	--	--	µg/L	µg/L
Naphthalene	3,040	0.547	0.005	0.001	<0.001	--	--	807	194
Acenaphthylene	119	0.021	0.000	0.0001	<0.0001	--	--	1277	307
Acenaphthene	14,000	2.52	0.024	0.006	<0.006	--	--	233	56
Fluorene	9,020	1.62	0.015	0.004	<0.004	--	--	162	39
Phenanthrene	58,800	10.6	0.100	0.026	<0.026	--	--	79	19
Anthracene	11,700	2.11	0.020	0.005	<0.005	--	--	87	21
Fluoranthene	120,000	21.6	0.204	0.053	<0.053	--	--	30	7.1
Pyrene	99,400	17.9	0.169	0.044	<0.044	--	--	42	10
Benzo(a)anthracene	79,800	14.4	0.136	0.035	<0.035	--	--	9.2	2.2
Chrysene	77,100	13.9	0.131	0.034	<0.034	--	--	8.3	2.0
Benzo(b)fluoranthene	82,400	14.8	0.140	0.036	<0.036	--	--	2.8	0.68
Benzo(k)fluoranthene	62,400	11.2	0.106	0.027	<0.027	--	--	2.7	0.64
Benzo(a)pyrene	86,700	15.6	0.147	0.038	<0.038	--	--	4.0	0.96
Indeno(1,2,3-cd)pyrene	85,400	15.4	0.145	0.038	<0.038	--	--	1.2	0.28
Dibenzo(a,h)anthracene	16,400	2.95	0.028	0.007	<0.007	--	--	1.2	0.28
Benzo(g,h,i)perylene	53,500	9.63	0.091	0.024	<0.024	--	--	1.8	0.44

Notes:
1. Final Acute Values and Final Chronic Values from USEPA 2003
2. Based on Willamette River Hardness of 25 mg/L
WQC= Water Quality Criteria
Estimated value exceeds regulatory values

ATTACHMENT A



HABITAT NOTES:
1. 16.6 NGVD IS ORDINARY HIGH WATER (OHW)
2. WATER REACHES +10 FT NGVD <1% OF THE TIME ANNUALLY IN THE PERIOD FEBRUARY TO MAY/JUNE DURING THE HEAVIEST SHALLOW-WATER JUVENILE SALMON USE PERIOD.

0 40 80
SCALE IN FEET

PLAN NOTES:
1. HORIZONTAL DATUM: PORT OF PORTLAND LOCAL PROJECTION (INTERNATIONAL FEET) VERTICAL DATUM: NGVD 29-47
2. BATHYMETRIC SURVEY BY PORT OF PORTLAND DATED NOVEMBER, 2007

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 7a
Existing Wheeler Bay Habitat Conditions
Phase I of the Removal Action - Biological Assessment
Portland, Oregon

LEGEND:

HYDROSEEDING WITH JUTE MATTING

WILLOW LIVE STAKE PLANTING ZONE

COTTONWOOD POLE PLANTING

HABITAT LOG (ANCHORED) (TYPICAL)

LARGE WOODY DEBRIS (UNANCHORED, SALVAGED) OVER TOE ARMOR (TYPICAL SCHEMATIC)

0 60

Scale in Feet

NOTES:

1. HORIZONTAL DATUM: PORT OF PORTLAND LOCAL PROJECTION (INTERNATIONAL FEET) VERTICAL DATUM: NGVD 29-47
2. FOR NGVD CONTROL POINT, SEE PORT OF PORTLAND DRAWING RG 2006-3024 (NOVEMBER 2006)

Feb 29, 2008 3:18pm tgriga K:\Jobs\050332-PORT_OF_PORTLAND\05033201 TERMINAL 4\60 PERCENT\BA\05033201-BA7b.dwg BA FIG 7b

ANCHOR
ENVIRONMENTAL, L.L.C.

Figure 7b

Proposed Wheeler Bay Post-Phase I Habitat Conditions

Phase I of the Removal Action -Biological Assessment

Portland, Oregon