

ZIDELL WATERFRONT PROPERTY, PORTLAND, OREGON  
SEDIMENT CAP BOUNDARY REPORT

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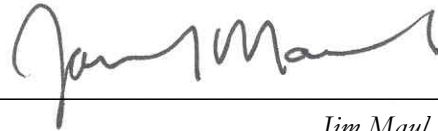
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# SEDIMENT CAP BOUNDARY REPORT

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## ACRONYMS AND ABBREVIATIONS

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|         |                                                |
|---------|------------------------------------------------|
| CEC     | chemical of ecological concern                 |
| COC     | chemical of concern                            |
| COE     | U.S. Army Corps of Engineers                   |
| DEQ     | Oregon Department of Environmental Quality     |
| DEQ-SMA | the maximum 17.3-acre SMA described in the ROD |
| H:V     | horizontal:vertical                            |
| LWG     | Lower Willamette Group                         |
| MFA     | Maul Foster & Alongi, Inc.                     |
| MPECQ   | mean probable effects concentration quotient   |
| mg/kg   | milligrams per kilogram                        |
| µg/kg   | micrograms per kilogram                        |
| PAH     | polycyclic aromatic hydrocarbon                |
| PCB     | polychlorinated biphenyl                       |
| PEC     | probable effects concentration                 |
| PECQ    | probable effects concentration quotient        |
| RAO     | remedial action objective                      |
| RI      | remedial investigation                         |
| ROD     | Record of Decision                             |
| SMA     | sediment management area                       |
| TBT     | tributyltin                                    |
| TEC     | threshold effect concentration                 |
| Zidell  | ZRZ Realty Company                             |

# 1 INTRODUCTION

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On behalf of ZRZ Realty Company (Zidell), Maul Foster & Alongi, Inc. (MFA) has prepared this report describing the spatial configuration of the sediment cap for the Zidell Waterfront Property located at 3121 SW Moody Avenue in Portland, Oregon (see Figure 1-1). This report focuses on the lateral extent of the boundary of the in-water sediment cap (not the remedy for the riverbank) and describes the process used to select the spatial configuration of the sediment cap. The process to determine the sediment cap boundary and the boundary itself were determined by the Oregon Department of Environmental Quality (DEQ) during a series of technical meetings held in October 2008 with Zidell representatives. This report also provides responses to comments the DEQ submitted on May 15, 2008, concerning the sediment cap boundary (see Appendix).

## 1.1 SEDIMENT REMEDIAL ACTION OBJECTIVES

In the Record of Decision (ROD), the DEQ identified the following remedial action objectives (RAOs) for sediment (DEQ, 2005):

- Protect humans against exposure to site-related chemicals of concern (COCs) above protective levels.
- Minimize transport of sediment containing COCs and chemicals of ecological concern (CECs) above cleanup levels to downstream areas of the river.
- Ensure that sediments contaminated with CECs above protective levels do not become accessible to benthic organisms, or to aquatic and terrestrial organisms through food chain exposure.
- Remediate hot spots of contamination in sediment by reducing their concentration, volume, or mobility to the extent feasible and practical.

## 1.2 SEDIMENT REMEDY

To achieve the RAOs, the ROD outlined a multifaceted sediment remedy (DEQ, 2005). The primary risk management actions described in the ROD included the following:

- Capping
- Focused dredging
- Institutional controls
- Natural recovery

The ROD tailored each of the above risk management actions to optimize sediment cleanup, given different conditions in the sediment management area (SMA). For example, to accommodate future barge launching from the on-site Zidell Marine Company barge-building facility, dredging and construction of a low-profile sediment cap were proposed for the area near the slipway.

Capping in the SMA was proposed as the primary risk management action for sediment. The purpose of the cap is to physically isolate sediment from aquatic organisms and surface water to prevent unacceptable exposures to chemicals in sediment. Risk management actions such as institutional controls and natural recovery were proposed for areas with low-level sediment impacts outside the cap. Upland source control has been initiated and is described in detail in Section 2.

### 1.3 SEDIMENT CAP

In the ROD (DEQ, 2005), the DEQ selected a sediment remedy that satisfied the statutory requirements of ORS 465.315. A primary component of the remedy is a cap that is to be no smaller than the 7.8-acre SMA described in the feasibility study report (MFA, 2004), and no larger than the maximum 17.3-acre SMA described in the ROD. Unless otherwise stated, the abbreviation SMA will refer to the ROD maximum 17.3-acre SMA in the remainder of this report. The DEQ stated that additional sediment characterization was needed to determine the final cap configuration between the minimum and maximum boundaries. MFA collected additional sediment data in 2007 (MFA, 2007), and these data were used with other available sediment data to determine the spatial configuration of the sediment cap.

This report focuses on defining the boundaries of the proposed cap, and does not include a discussion of cap thickness or composition. The design of the cap will be determined through contaminant transport modeling with consideration of protectiveness, cap stability, and habitat features of the design.

In general, two types of capping are considered for sediment at Zidell. For most of the in-water sediment, the cap will include two components: a chemical isolation layer and a physical isolation layer. Several areas of “thin cap” are also included in the final cap configuration. The thin cap will provide a clean layer of sediment that may be colonized. The depth of the clean layer will be sufficient to minimize the probability that the benthic invertebrates will contact or disturb the underlying contaminated sediment. Additional discussion of each capping method is included in Section 4.

### 1.4 SEDIMENT CAP BOUNDARY DETERMINATION

Three technical meetings were held during October 2008 with the DEQ staff and representatives of the Zidell consultant team to select the final cap boundary. Zidell and the DEQ agreed at the first meeting that reduction of the risks that polychlorinated biphenyls (PCBs) in sediment may pose to human health and the

environment was a primary objective of the cap. It was also agreed that the cap should adequately address risk from other COCs.

During the meetings, Zidell and the DEQ reviewed data and evaluations of ambient PCB concentrations, mean probable effects concentration quotients (MPECQs), sediment cleanup levels, sediment toxicity test results, habitat quality, and cap engineering constraints. For each of the meetings, MFA prepared evaluations of how different capping scenarios would reduce site-wide PCB concentrations in sediment.

After an extensive and careful evaluation of the information, the capping scenario presented in Section 4 was selected as the optimal cap configuration.

## 2 BACKGROUND

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A number of factors were considered by Zidell and the DEQ to determine the boundary of the sediment cap. In order to provide context for the sediment cap layout, brief background information about the site is provided below. A more complete description of this background information is presented in the remedial investigation (RI) report (MFA, 2003), the feasibility study report (MFA, 2004), and the ROD (DEQ, 2005).

### 2.1 SITE DESCRIPTION

The Zidell waterfront property consists of 32.17 acres located in section 10, township 1 south, range 1 east of the Willamette Meridian. The site is located at 3121 SW Moody Avenue in Portland, Oregon (Multnomah County) (see Figure 1-1). The south part of the site is currently used for barge construction and office space, and the north part is vacant or is used to store salvage materials.

The property is bordered by SW Moody Avenue and property owned by GHS, LLC on the west, by vacant property owned by Oregon Health Sciences University (and formerly by the Schnitzer Investment Corporation) and zoned for commercial use on the north, and by River Campus Investors (formerly the Pacific Metals facility) on the south (see Figure 2-1). The Willamette River borders the east side of the site, which is approximately between river miles 13 and 15.

### 2.2 SITE HISTORY

Historically, the site was used for industrial activities related primarily to scrap metal recycling and barge building and dismantling. A detailed history of site ownership and operations is available in the RI report (MFA, 2003).

A number of private and public stormwater outfalls have discharged or continue to discharge into the Willamette River along the Zidell reach. Stormwater on the Zidell site discharges to the river through one of three outfalls (two private outfalls and one City of Portland outfall). Two City of Portland combined sewer overflow outfalls that historically drained the 1,152 acre Marquam-Woods drainage basins run through the Zidell property. One of these outfalls was abandoned in 2007 and was replaced with a new outfall, located north of the site and within the proposed cap boundary. In addition, the Oregon Department of Transportation outfall that drained the Marquam Bridge until 2007 runs through the Zidell property.

## 2.3 SITE SETTING

The site is located near the upriver end of a highly urbanized and industrialized reach of the Willamette River. In addition to Zidell's extensive sediment characterization activities, sediment investigations have been performed by the Lower Willamette Group (LWG) (Integral et al., 2007) and the DEQ (GSI, 2008). Data from these investigations have documented contamination in sediment related to the long history of industrial activities in and upstream of the downtown reach (approximately river miles 12 to 30) of the Zidell property and in proximity to the City of Portland's stormwater outfalls.

## 2.4 FLUVIAL SETTING AND BATHYMETRY

The site is located between the Marquam Bridge and Ross Island. Along this reach, the river flows northwest and is 1,400 to 1,500 feet wide. The main channel is divided by Ross Island. During periods of low and medium flows, tidal effects are evident to river mile 26.5 (Willamette Falls); reverse flow has been measured as far upstream as the site and Ross Island (river mile 15) during low-flow periods.

Figures 2-2 and 2-3 show the bathymetry and slopes offshore of the site, as surveyed in 2007. The resolution of this survey is 1 foot. The bathymetry shows that in the southern portion of the Zidell site, elevation quickly drops to the bottom of the main channel (minus 25 to 30 feet, City of Portland datum). Just to the north of the Ross Island Bridge, the main channel begins to deflect from the west side of the river to the east, and from this point downstream a depositional feature overlaid by shallow water is evident along the Zidell shore. This northern area generally has a steep bank slope leading to the shallow depositional area, or sediment bench, at an elevation of about minus 10 feet. The eastern edge of the sediment bench then drops off to match the bottom of the main channel at a distance of 200 to 400 feet from shore.

Based on the bathymetry, shallow water habitat, represented by river bottom elevations of approximately -20 ft and higher, extends up to 350 feet riverward from the riverbank in the north part of the site, and to less than 60 feet from the riverbank in the south part of the site. Deep water habitat is found below -20 feet City of Portland datum.

The in-water slope in the southern portion of the site is about 2:1 (horizontal:vertical [H:V]) within 60 to 80 feet from shore, and then rapidly decreases to less than 25:1 as it approaches the depth of the main channel (see Figure 2-3). The slopes in the northern portion of the site are somewhat more gradual. Slopes generally vary between 2:1 and 5:1 from within 70 feet of the shorelines to the sediment bench. The bench width is about 100 feet and slopes vary between 5:1 and 25:1. On the eastern side of the bench, the river bottom falls away at a slope between 3:1 and 5:1. At the far north end of the SMA, the in-water slope varies between 5:1 and 25:1, gradually meeting with the main river channel bottom.

Historical fluvial analyses near the site evaluated change in bathymetry over time, grain size distribution, and model-generated river velocities in order to delineate estimated potential depositional and erosional areas offshore of the Zidell site (MFA, 2008a). Depositional areas offshore of Zidell appear to be in the central part of the SMA, within 150 feet from shore, and in the northern nearshore area extending out to the SMA boundary (MFA, 2008a). Erosional areas offshore of Zidell appear to be in the southern portion of the SMA, within 150 feet from shore (MFA, 2008a).

## 2.5 NATURE AND EXTENT OF SEDIMENT IMPACTS

For discussion purposes, the COCs and CECs described in the ROD are collectively referred to as COCs in this report. The COCs identified in the ROD for sediment (DEQ, 2005) are as follows:

- Metals (antimony, cadmium, copper, lead, mercury, nickel, and zinc)
- Tributyltin (TBT)
- Polycyclic aromatic hydrocarbons (PAHs)
- PCBs

Tables 2-1 through 2-4 summarize concentrations of COCs in surface sediment. The highest concentrations of COCs are in sediment located near the shore, where most of the historical ship-dismantling activities took place. Concentrations decrease substantially with distance from shore. With the exception of cadmium, all COCs share this same spatial pattern.

Surface sediment analytical results from samples collected by Zidell are shown on Figures 2-4 and 2-5. Figure 2-4 shows concentrations of PCBs. Figure 2-5 shows concentrations of PAHs, TBT, and metals that exceed the sediment cleanup levels in the ROD.

Concentrations of COCs are generally highest at two nearshore locations: the WRS-75, WRS-10, and WRS-11 area near the northern site boundary, and the WRS-18, WRS-19, and WRS-20 area south of the Ross Island Bridge near stormwater outfalls (see Figures 2-4 and 2-5). Also, concentrations of PAHs are elevated in WRS-15 and WRS-16 near the former ship-dismantling dock and the former oil/water separator associated with this dock (see Figure 2-5).

It appears that COCs, regardless of type (e.g., metals, PAHs, PCBs), have remained relatively close to the points of release (e.g., former docks along the shoreline). The vast majority of the contamination is in sediment located within approximately 50 feet of the shore.

## 2.6 UPLAND SOURCE CONTROL

Zidell has initiated upland source control at the site, including:

- Ongoing best management practices, many of which are described in the stormwater pollution control plan for the site.
- An assessment of site operations that was submitted to the DEQ on June 25, 2007.
- Removal of asbestos-containing material from accessible areas of the bank and upland areas, which was completed on June 2 through 5 and August 28 and 29, 2008. A brief report summarizing these activities will be submitted to the DEQ.
- Temporary measures to control bank soil erosion, which were implemented on October 23, 2008. A brief report summarizing these activities will be submitted to the DEQ.
- Stormwater system cleanout and delineation and stormwater system upgrades, as described and proposed in a stormwater evaluation report dated February 7, 2008, and in an addendum dated July 17, 2008. Work is ongoing and will be further described in a future report.
- An evaluation of bank toe erosion and scouring, which was completed with the DEQ in a site visit on September 13 and documented in the Bank Line Toe Erosion and Scouring Evaluation Report (October 12, 2007).

Some upland source control measures are ongoing:

- Source control for the City of Portland Outfall 6 and discussions with the City of Portland about its new outfall just north of the Zidell site but in the area of the proposed sediment cap.
- Investigation of possible outfalls associated with the GHS, LLC property.
- Stormwater system upgrades in progress.
- Ongoing evaluation of stormwater from Zidell's private outfalls.
- The remedy for the bank will provide additional source control to prevent erosion of contaminated sediments along the bank and will be integrated with the in-river sediment cap.

# 3 CAP BOUNDARY EVALUATION

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Representatives of Zidell and DEQ staff attended three technical meetings to develop an approach for determining the cap boundary and to reach agreement on a final boundary, which would move the project forward into design and permitting phases. As part of the decision making, Zidell and the DEQ agreed to optimize the effectiveness of the cap as a tool to reduce risk. The reduction in the area-wide average PCB concentration was used to evaluate the effectiveness of various capping scenarios, while ways to reduce risk from other COCs were also considered.

A number of cap alternatives had been discussed before the technical meetings between the DEQ and Zidell. In April 2008, Zidell proposed a capping scenario that included a cap in the areas of highest COC concentration, and additional areas of thin capping to address isolated areas where cleanup levels are exceeded (see Figure 3-1) (MFA, 2008b). The April 2008 cap boundary was considered the point of departure for the October evaluation of different capping alternatives.

Multiple factors were considered by the DEQ and Zidell during the technical meetings to define the area where the sediment cap will be placed, with the overall objective of protecting human health and the environment. Important considerations included the following:

- Comparisons of COC concentrations with sediment cleanup levels
- MPECQs
- Sediment toxicity test results
- Engineering constraints
- Ambient levels of PCBs in sediment
- Habitat quality

The manner in which each of these factors was considered in cap boundary selection is discussed below.

## 3.1 COMPARISONS WITH SEDIMENT CLEANUP LEVELS

Based on the factors listed above, the cap was configured to include sample locations in the SMA where COC concentrations were above the cleanup levels presented in the ROD (DEQ, 2005). As described in Section 3.5, ambient levels of PCBs (10 to 20 micrograms per kilogram [ $\mu\text{g}/\text{kg}$ ] as specified in the ROD) in this stretch of the Willamette River are above the recreational fisher cleanup level. It is not practical to cap all sediment where PCBs are above the cleanup level.

The ROD included two types of sediment cleanup levels. For chemicals that may bioaccumulate in aquatic food chains, cleanup levels protective of recreational fishers were established. These bioaccumulation cleanup levels are also protective of fish-eating wildlife. Cleanup levels protective of sediment-dwelling organisms that may directly contact COCs in sediment were also presented in the ROD.

Two types of benthic biota cleanup levels are presented in the ROD. When available, reliable consensus-based probable effects concentrations (PECs) were selected as cleanup levels (MacDonald et al., 2000). Reliable PECs were not available for antimony, TBT, and mercury. A threshold effect concentration (TEC) or a value conceptually similar was used as the cleanup level for antimony and mercury.

The benthic biota cleanup level for TBT presented in the ROD was incorrect. The DEQ and Zidell agreed to a revised benthic biota cleanup level for TBT, calculated using a method outlined by Meador (2000) that estimated an organic carbon normalized TBT threshold concentration protective of invertebrates of 6,000 µg/kg of organic carbon. Table 2-2 presents organic carbon normalized TBT concentrations in sediment.

In addition to the organic carbon normalized benthic biota cleanup level, the DEQ and Zidell agreed to a dry weight TBT cleanup level protective of fish. This bioaccumulation cleanup level is 2.3 µg/kg (DEQ, 2007).

## 3.2 MPECQS

MPECQs were used to evaluate how mixtures of chemicals in sediment may adversely impact sediment-dwelling organisms (Ingersoll et al., 2000). The sediment cap included locations in the SMA where MPECQs indicated that sediment may cause toxicity to benthic invertebrates.

A probable effects concentration quotient (PECQ) is the ratio of the concentration of a COC in sediment over the applicable PEC. Two types of MPECQs were calculated. First, PECQs were estimated for eight COCs with reliable consensus-based PECs (six metals, total PAHs, and total PCBs), and the mean of these eight PECQs was calculated. The mean PECQ of the six metals also was calculated. These two types of MPECQs were compared with site-specific threshold effects estimates.

As discussed in Section 3.3, bioassays using the freshwater amphipod *Hyalella azteca* and the freshwater midge *Chironomus tentans* were performed on sediment samples. The results of these bioassays were used to determine threshold MPECQ values. The lowest MPECQ of any sediment sample categorized as a “hit,” based on adverse effects to test organisms, was used as the threshold value to indicate sediment that may be toxic to benthic invertebrates. The MPECQ threshold for the method based on the mean of eight COCs was 0.26 (Table 3-1). The MPECQ threshold for the method based on six metals was 0.29. To the extent practical, the sediment cap included locations in the SMA where MPECQs were above these threshold values.

### 3.3 SEDIMENT TOXICITY

Bioassay analyses were performed on 11 sediment samples distributed throughout the site and upriver. Bioassays included acute 10-day amphipod (*Hyalella azteca*) survival tests, and acute/chronic 10-day midge (*Chironomus tentans*) survival and growth tests. Bioassay results were evaluated using the interpretive criteria outlined in the Northwest Regional Sediment Evaluation Framework (COE et al., 2006). Results of sediment toxicity tests are summarized in Table 3-1.

### 3.4 ENGINEERING CONSTRAINTS

Constructability (implementability) is a consideration in the preparation of the cap boundary. Zidell's geotechnical engineer has advised the team that dredge sand, the material to be used for the cap, that is placed in water naturally runs out to a 5:1 H:V slope. A stable slope can be constructed at a 3:1 H:V by removing excess material after the fill has begun to consolidate. The existing slopes at Zidell vary to as steep as 2:1 H:V. Construction of a sediment cap over areas with an existing slope that is equal to or steeper than 5:1 H:V would require that additional fill be placed adjacent to the cap in order to maintain stability of the cap material. In some areas this would require extending material placement beyond the SMA boundary.

### 3.5 AMBIENT PCB LEVELS

Studies have shown that PCBs are ubiquitous in sediment of the Willamette River both upstream and downstream of the site. The ROD estimated that ambient levels of total PCBs in sediment upriver of the site ranged between approximately 10 and 20 µg/kg (DEQ, 2005). Subsequent sampling by the LWG and the DEQ appears to generally support this estimate.

Ambient concentrations of PCBs in sediment near the site are above the recreational fisher cleanup level. Therefore, the ROD determined that it was not practical to cap all sediment with PCB concentrations above the recreational fisher cleanup level (DEQ, 2005).

The cap boundary was configured such that, following completion of the cap, average concentrations of PCBs in sediment in the immediate area of the site would be within the range of ambient levels.

### 3.6 HABITAT QUALITY

In general, shallow water habitats can have greater ecological value than deeper water habitats for a variety of reasons, such as: greater primary productivity, more diverse invertebrate communities, foraging accessibility for aquatic wildlife, and preferential use by some fish species and life stages (e.g., juvenile Chinook salmon). To block potential exposure pathways and enhance natural recovery processes, the cap

included a large proportion of the shallow water habitat where the river bottom appeared stable (i.e., not scouring environments or steep slopes).

### 3.7 PCB CONCENTRATION REDUCTION

To determine the cap configuration that optimizes site-wide reduction in sediment contamination, a number of capping scenarios were evaluated. PCBs were the primary risk drivers in sediment, and PCB concentrations were used primarily to evaluate contaminant risk reduction. Additional consideration was given to other contaminants as well.

As an initial point of discussion, MFA estimated the arithmetic mean concentration of PCBs for all data points (with the exception of non-detects with elevated method reporting limits [i.e., greater than 100 µg/kg]) located in sediment outside the cap for a variety of capping scenarios. As shown in Figure 3-2, caps extending only 50 feet from shore resulted in substantial reductions in mean PCB concentrations in residual sediment, and average PCB concentrations declined very little with caps that extended farther from the shore. The cap boundary proposed by Zidell in April 2008 (MFA, 2008b) (herein referred to as the April cap boundary) lies well beyond the point of inflection, where large increases in cap area result in much smaller reductions in remaining average PCB concentration.

The next step was to estimate the area-weighted average PCB concentration for several cap scenarios. Data collected offshore of the site by Zidell and subsequently by the DEQ's Downtown Portland Sediment Characterization effort (2008) were included in the evaluation. The RI offshore of Zidell evaluated the extent of contamination from Zidell-related sources. As indicated in the ROD (DEQ, 2005), the locality of the facility was not determined because of the presence of contamination from other sources. In the evaluation of site-wide PCB concentration reduction, Zidell and DEQ agreed to use all available data collected within close proximity to the site, including data collected outside the SMA.

Area-weighted averages were calculated by first defining Thiessen polygons surrounding each PCB sample result in the study area. Thiessen polygons define the area around each sample point, using an algorithm to calculate the location of a boundary midway between available points. The resulting polygons include all the space that lies less than halfway between the polygon center point and any other Thiessen polygon center point. The area within each polygon was assigned the PCB concentration of the Thiessen polygon center point.

After Thiessen polygons were created, a cap area was superimposed on the polygons. The cap area represented a polygon and was assigned a concentration value of 1 µg/kg. This value is a conservative estimate of the average PCB concentration in cap materials that would be expected if the cap were comprised of clean sand. The area-weighted average PCB concentration was then calculated for the entire study area. This concentration represents a site-wide average PCB concentration that would be expected immediately after the completion of the cap and before possible changes in

concentrations due to the natural deposition of new sediment in the study area. An evaluation of the potential long-term condition of the site (assuming a moderate amount of PCB recontamination) was performed by assigning the cap a PCB concentration of 10 µg/kg. The cap scenarios evaluated (Scenarios A through D and a scenario that involves capping the entire SMA) are shown in Figures 3-3 through 3-7. Results of the area-weighted averaging are presented in Table 3-2.

### 3.8 SUMMARY OF EVALUATION

The area-weighted average PCB concentration analysis looked at six scenarios, including the April cap boundary, cap boundaries that MFA identified as Scenarios A through D, and the DEQ SMA, which was specified in the ROD as the maximum size of the cap. Scenarios A through D progressively enlarged the cap (moving the boundary farther from shore) from the April cap boundary to the DEQ-SMA. Scenario A expanded the April cap boundary in a few locations in order to include elevated concentrations of TBT and metals. Scenarios B, C, and D incrementally added more capping to address concentrations of PCBs above the ROD cleanup level.

The area-weighted average post-capping PCB concentration was tabulated for each of the scenarios along with the resulting cap size; see Table 3-2. The proposed April cap results in a 90.9 percent decrease in exposed PCBs within the study area. By comparison, capping the entire SMA reduces the PCB risk by only an additional 2.3 percent compared to an increase in cap area of 8.3 acres (a 2.5 percent reduction in risk compared to a 93 percent increase in acreage). So for a very large increase in acreage, there is relatively little additional decrease in PCB concentration.

The meetings also addressed cap constructability (implementability), specifically the inability to end a cap in areas of steep in-water slopes. In some of the far-shore locations, it would be necessary to extend the cap construction beyond the SMA in order to achieve a stable slope.

After an extensive and careful evaluation of the information with the DEQ, MFA recommended Scenario A as the optimal cap configuration to reduce site-wide PCB concentrations and to address areas of elevated metal and TBT concentrations. DEQ requested modifications to the Scenario A boundary to include three additional areas of thin sand cap (see Section 4).

# 4 ATTRIBUTES OF SELECTED CAP

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The selected cap is shown in Figure 4-1. Spatial dimensions of the cap were selected to achieve RAOs and optimize risk reduction. The selected cap boundary is based on a modification of Scenario A (Figure 3-3). The boundary consists of approximately 9.8 acres of cap and 1.9 acres of thin sand cap (6- to 10-inch thickness). As mentioned previously, three areas of thin sand cap were added to Scenario A to address specific areas of contamination. From north to south, the additions to Scenario A are as follows:

**Area 1:** Capping this area provides additional coverage of elevated PAH and PCB concentrations. This area is in the relatively shallow, level, stable sediment area that potentially has good habitat value. Capping within this boundary is implementable because slopes are less than 5:1 (H:V).

**Area 2:** Extend the cap to provide coverage of elevated TBT and metals detections along with increased coverage of PCB concentrations. This area is a relatively shallow, level, stable sediment area that potentially has good habitat value. Capping within this boundary is implementable because slopes are less than 5:1 (H:V).

**Area 3:** This addition addresses PCB exceedance of ambient concentrations in an area that is subjected periodically to barge-launch activities. The fluvial analysis has shown the area to be otherwise stable. Coverage of the location also provides better additional coverage of sediment near elevated metals detections. Capping in this area would minimize the potential transport of contaminated sediments downstream. Capping within this boundary is implementable because slopes are less than 5:1 (H:V); however, river velocities and fluvial evaluation suggest that an alluvial gravel layer may be necessary.

The selected cap has the following attributes:

- With the exception of PCBs, the cap will cover almost all sediment in the SMA where concentrations of COCs are above ROD cleanup levels. A few exceptions are described in Section 4.1.
- The cap will cover almost all sediment in the SMA where MPECQs are above threshold effect levels. One exception is described in Section 4.2.
- The cap will cover all sediment in the SMA where bioassay results were classified as toxic to benthic organisms.
- Following completion of the cap, average PCB concentrations, inside and outside of the SMA (i.e., within the subject study area), will be within the range of ambient levels (10 to 20 µg/kg).

- In areas of low erosion potential, the cap will provide areas of shallow water habitat that have uncontaminated sediment.
- Site-wide PCB concentration reductions were optimized. As discussed below, the cap is larger than the optimal size for PCB risk reduction in order to meet other RAOs.

The 11.7-acre cap boundary lies between the maximum and minimum boundaries described in the ROD and therefore meets the standards specified in ORS 465.315.

## 4.1 CLEANUP LEVELS

With the following four exceptions, the cap covers all sediment where COCs other than PCBs had concentrations above a ROD cleanup level (see Tables 2-1 through 2-4 and Figure 2-5):

- At WRS-84, mercury was detected at 0.27 milligrams per kilogram (mg/kg); the benthic biota cleanup level is 0.2 mg/kg.
- At WRS-85, TBT was detected at 5.5 µg/kg; the bioaccumulation cleanup level for fish is 2.3 µg/kg.
- At WRS-83, benzo(a)pyrene was detected at 36.8 µg/kg; the recreational fisher cleanup level is 21 µg/kg.
- At WRS-67, benzo(a)pyrene was detected at 23.2 µg/kg; the recreational fisher cleanup level is 21 µg/kg.

Given the location of the four samples above, it was not practical to extend the cap to these areas. Furthermore, as described below, these four areas with uncapped sediment will not pose unacceptable risks to human health or the environment.

As mentioned previously, the benthic biota cleanup level for mercury is a TEC. The TEC is a concentration below which sediment toxicity is highly unlikely, and TECs are typically used as conservative screening levels to identify sediment that may require further evaluation. Many samples with concentrations above the TEC are not toxic to benthic organisms (MacDonald et al., 2000). Most of the benthic biota cleanup levels in the ROD are PECs, not TECs. The consensus-based PEC for mercury is 1.1 mg/kg (MacDonald et al., 2000). Because the detected mercury concentration at WRS-84 is only slightly above the TEC and is below the PEC, it is unlikely that mercury would pose unacceptable risks to benthic organisms at this location.

TBT was detected in only one sample located outside the selected cap (WRS-85). The detected concentration of TBT at WRS-85 is below the benthic biota cleanup level (Table 2-2), but above the bioaccumulation cleanup level of 2.3 µg/kg for fish. Using the method reporting limit as the TBT concentration, the average concentration of TBT in uncapped sediment is below the bioaccumulation cleanup

level for fish (Table 2-2). The single isolated TBT detection outside the cap is unlikely to pose unacceptable risks to fish.

A single PAH (benzo(a)pyrene) was detected above the recreational fisher cleanup level at two locations outside the selected cap. However, benzo(a)pyrene in sediment outside the cap is unlikely to pose unacceptable risks to recreational fishers. PAHs are generally rapidly biotransformed by fish, and tend not to accumulate in tissues (Eisler, 1987; Varanasi, 1989). Benzo(a)pyrene was not classified as a significant bioaccumulative COC in sediment bioaccumulation guidance developed by the DEQ after the cleanup levels in the ROD were developed (DEQ, 2007).

## 4.2 MPECQS

One sediment sample outside the selected cap had an MPECQ above the threshold effect level. The metals-only MPECQ at WRS-31 was 0.31 and above the threshold value of 0.29 (see Table 3-1). However, a bioassay was performed on this sample and the bioassay results were not considered a hit. The bioassay results indicate that sediment at WRS-31 is not toxic to benthic organisms.

## 4.3 SEDIMENT TOXICITY

Three sediment samples were categorized as hits, based on the bioassay results: WRS-25, WRS-35, and WRS-46 (see Table 3-1). The WRS-25 sample location is included within the proposed cap boundary. The WRS-46 location was originally intended as a background location and is over 500 feet upriver of the site. Bioassay test results for WRS-46 and subsequent sediment sampling performed by the DEQ indicate that contaminant sources unrelated to the Zidell property are present upriver of the site. The WRS-35 sample location is outside the SMA. Four sediment locations where bioassay results indicated no toxicity lie outside the proposed cap boundary (i.e., WRS-31, WRS-47, WRS-26, and WRS-52).

## 4.4 PCB CONCENTRATION REDUCTION

PCB area-weighted average concentration reduction as a function of capped acreage is shown in Table 3-2 and Figure 4-2. Figures 3-3 through 3-7 show capping Scenarios A through D and the scenario that would involve capping the entire SMA. Figure 4-1 shows the selected cap boundary.

The areal extent of the selected cap is approximately 11.7 acres. The scenario was selected because it optimizes reduction of PCB concentrations and also achieves other RAOs.

## 4.5 CAP TYPES

The selected cap configuration includes two types of cap, which are identified as cap and thin cap.

### Cap

For most of the in-water sediment the cap will include two components: a chemical isolation layer and a physical isolation layer. The chemical isolation will act as a barrier to contaminant release to the surface water. The physical isolation layer will consist of a bioturbation layer (i.e., a layer that may be disturbed by animals that burrow or dig in the sediment) and/or a gravel layer to protect the cap from erosion. The characteristics and materials used within each layer will be determined through modeling during cap design.

### Thin Cap

Several areas of thin cap are included in the final cap configuration. The thin cap will provide a clean layer of sediment that may be colonized. The depth of the clean layer will be sufficient to minimize the probability that the benthic invertebrates will contact or disturb the underlying contaminated sediment. Figure 4-1 identifies three areas of thin sand cap, which were added to Scenario A at the request of DEQ. The thin layer of sand (6 to 10 inches) will function as a physical isolation layer of clean sediment for benthic organisms to inhabit, but is not intended to serve as a chemical isolation layer limiting advection and diffusion of COCs through the cap.

## LIMITATIONS

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The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

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