PROPOSED EXPLANATION OF SIGNIFICANT DIFFERENCES

Portland Harbor Superfund Site

Portland, Oregon

U.S. Environmental Protection Agency Region 10

Seattle, Washington

October 2018

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ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirement
BaP	benzo(a)pyrene
BaPeq	benzo(a)pyrene equivalent
BEHP	bis(2-ethylhexyl)phthalate
bml	below mud line
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
COC	contaminant of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CRD	Columbia River datum
CSF	cancer slope factor
CUL	cleanup level
CWA	Clean Water Act
cy	cubic yard
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DDx	DDT+DDD+DDE
DEQ	Oregon Department of Environmental Quality
dioxins	polychlorinated dibenzo-p-dioxins
DMM	disposed material management
ENR	enhanced natural recovery
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FMD	future maintenance dredge
FS	feasibility study
ft	feet
mg/kg	milligram per kilogram
mg/kg-day	milligram per kilogram per day
MGP	manufactured gas production
MNR	monitored natural recovery
MOU	memorandum of understanding
NAPL	non-aqueous-phase liquid
NCP	National Contingency Plan
NPL	National Priorities List
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
PTW	principal threat waste
RAL	remedial action level

RAO	remedial action objective
RM	river mile
ROD	Record of Decision
SDU	sediment decision unit
Site	Portland Harbor Superfund Site
SMA	sediment management area
SWAC	surface area weighted average concentration
TBT	tributyltin
tribes	Native American tribes
USC	United States Code
μg/kg	microgram per kilogram
%	percent

PROPOSED EXPLANATION OF SIGNIFICANT DIFFERENCES
PORTLAND HARBOR SUPERFUND SITE

October 2018

1.0 INTRODUCTION

1.1 Site Name and Location

The Portland Harbor Superfund Site (the Site), as listed on the National Priorities List (NPL) (Superfund Site ID#: ORSFN1002155), includes an in-river and an upland portion. The Site was listed on the NPL in December 2000 mainly due to concerns about contamination in the sediments and the potential risks to human health and the environment from consuming the fish. The Site is in Multnomah County, Oregon, and is an urban and industrial section of the City of Portland that runs along the river north of, and downstream of, the central downtown area. The in-river portion of the Site covers approximately 2,190 acres and extends from river mile (RM) 1.9 (upriver end of the Port of Portland's Terminal 5) to RM 11.8 (near the Broadway Bridge) and is shown on the proposed Explanation of Significant Differences (proposed ESD) Figure 1.

1.2 Lead and Support Agencies

The lead agency for the in-river portion of the Site is the United States Environmental Protection Agency (EPA), in consultation with the support agency, the Oregon Department of Environmental Quality (DEQ). After listing the Site on the NPL, EPA entered into a 2001 Memorandum of Understanding (MOU) with DEQ, six federally recognized Native American tribes (tribes), two other federal agencies, and one other state agency.[1] Under the MOU, DEQ is the lead agency for addressing contamination in the upland portions of the Superfund site, and EPA is the support agency.

1.3 Statement of Purpose

The Record of Decision (ROD), which documents the selected in-river remedy, was signed on January 3, 2017 (EPA 2017a). The Selected Remedy is summarized in Section 2.3 below. This proposed ESD includes changes to the Selected Remedy and the reasons for such changes that are significant but not fundamental changes. This proposed ESD is issued in accordance with Section117(c) of the Comprehensive Environmental Response, Compensation, and Liability Act

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[1] Government parties that signed the MOU include DEQ, the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Grand Ronde Community of Oregon, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Nez Perce Tribe, the National Oceanic and Atmospheric Administration, the U.S. Department of the Interior (National Marine Fisheries Service and U.S. Fish and Wildlife Service), and the Oregon Department of Fish and Wildlife.

(CERCLA), 42 United States Code (USC) § 9617(c), and the National Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) § 300.435(c)(2)(i).

The purpose of the proposed ESD is to document changes to the sediment cleanup levels (CULs) and target tissue level for shellfish for carcinogenic polycyclic aromatic hydrocarbons (cPAHs) measured as benzo(a)pyrene equivalents (BaPeq). This proposed ESD also documents a change to the remedial action level (RAL) for total polycyclic aromatic hydrocarbons (PAHs) for areas of the Site outside of the Navigation Channel. In addition, this proposed ESD documents a correction to the cPAH Shellfish consumption sediment cleanup level.

On January 19, 2017, after the ROD was issued, EPA released an updated *Toxicological Review of Benzo(a)pyrene* (EPA, 2017b). The toxicological review was prepared under the auspices of EPA's Integrated Risk Information System (IRIS) program and developed a revised oral cancer slope factor based on a review of publicly available studies. IRIS is an EPA database containing human health risk information. Consistent with EPA guidance (EPA,1989), information in IRIS supersedes all other sources of toxicity information for conducting human health risk assessments under CERCLA. The toxicological review modified the oral cancer slope factor (CSF) for benzo(a)pyrene (BaP) from 7.3 to 1 milligram per kilogram per day (mg/kg-day). The CSF change means that BaP is less toxic for people who come into contact with or ingest BaP than previously analyzed. In addition, EPA identified an error in the application of the equation that describes the relationship between BaP in sediments and clam tissue that affects risk-based sediment cleanup levels based on acceptable clam tissue concentrations. This error results in a 100-fold reduction in the cPAH Shellfish consumption sediment cleanup level based on the human health clam consumption exposure scenario.

After correcting the mathematical error for the cPAH Shellfish consumption sediment CUL and evaluating the new BaP toxicity information, EPA has determined that modifying the cPAH (BaPeq) CULs and total PAH RAL for contaminated sediments outside the Navigation Channel will maintain the protectiveness of the Selected Remedy while reducing the estimated cost of the Selected Remedy by approximately $35 million. Supporting information and analysis for this proposed ESD are contained in figures and tables included in Appendix A.

For completeness and expediency, this ESD also includes an Errata Memorandum dated April 3, 2018 as Appendix B. The Errata Memorandum documents minor corrections to various tables, figures and text items in the Portland Harbor ROD and are not considered significant differences.

1.4 Administrative Record

This proposed ESD and supporting documents will become part of the Site Administrative Record file, in accordance with the NCP, 40 CFR § 300.825. The EPA Portland Harbor website is the main repository for all administrative records for the Site: https://www.epa.gov/superfund/portland-harbor. The proposed ESD and supporting documents will be available at the following locations:

Multnomah County Central Library
801 SW 10th Avenue
Portland, OR 97205
(503) 988-5123
Monday 10 am–8 pm
Tuesday, Wednesday 12 pm–8 pm
Thursday, Friday, Saturday 10 am–6 pm
Sunday 10 am–5 pm

St. Johns Library
7510 N. Charleston Avenue
Portland, OR 97203
(503) 988-5123
Monday, Tuesday 12 pm–8 pm
Wednesday through Saturday 10 am–6 pm
Sunday 12 pm–5 pm

Kenton Library
8226 N. Denver Avenue
Portland, OR 97217
(503) 988-5123
Monday, Tuesday 12 pm–8 pm
Wednesday through Saturday 10 am–6 pm
Sunday 12 pm–5 pm

EPA Region 10 Oregon Operations Office
805 SW Broadway
Suite 500
Portland, OR 97205
(503) 326-3250
Monday through Friday 9 am–4 pm

EPA Region 10 Superfund Records Center
1200 Sixth Avenue
Seattle, WA 98101
(206) 553-4494 or (800) 424-4372
Monday through Friday 9 am–4 pm

2.0 SITE HISTORY, CONTAMINATION, AND SELECTED REMEDY

2.1 Site History

The Willamette River is the 19th largest river in the United States and one of 14 American Heritage Rivers in the country. It flows into the larger Columbia River, which eventually flows into the Pacific Ocean. Even though the Willamette River is nearly 100 river miles from the Pacific Ocean, there are tidal influences within the Site, and it is a large and dynamic river.

Since the late 1800s, the Portland Harbor section of the lower Willamette River has been extensively modified to accommodate a vigorous shipping industry. Modifications include redirection and channelization of the main river, draining seasonal and permanent wetlands in the lower floodplain, and dredging to maintain the navigation channel, access to docks, and wharf facilities. Constructed structures, such as wharfs, piers, floating docks, and pilings, are common in Portland Harbor where urbanization and industrialization are most prevalent.

The federal navigation channel, with an authorized depth of -40 feet (ft) Columbia River datum (CRD), extends from the confluence of the lower Willamette River with the Columbia River to RM 11.6. In 1999, Congress authorized the Willamette River to be deepened to -43 ft; however, this has not yet occurred. Swan Island Lagoon was created in the 1930s when dredge spoils were used to fill in part of the channel and connect Swan Island to the mainland.

While the harbor area is heavily industrialized, it is located within a region characterized by commercial, residential, recreational, and agricultural uses. Land use along the lower Willamette River includes marine terminals, manufacturing and other commercial operations, public facilities, parks, and open spaces. In addition to industrial activities, the Willamette River and surrounding watershed historically offered access to abundant natural resources in the river and on land. Many of these resources are still present such as fish, marine mammals, waterfowl, land mammals, and native plants.

The Willamette River is also important to many tribes. Fish are among the resources most frequently utilized by the tribes in the Portland Basin and the Willamette Valley. Culturally significant species include salmonids, lamprey (eels), eulachon (smelt), and sturgeon. Native people also fished for a variety of other resident species, including mountain whitefish, chiselmouth, northern pikeminnow, peamouth, and suckers. Tribes have reserved hunting, fishing (particularly salmon and sturgeon species), and certain gathering rights through Treaties with the United States.

2.2 Summary of Contamination

Sources of Contamination

Historically, contaminants from many facilities entered the river system from different activities, including but not limited to ship building and repair; ship dismantling; wood treatment and lumber milling; storage of bulk fuels; manufactured gas production (MGP); chemical manufacturing and storage; metal recycling, production, and fabrication; steel mills, smelters, and foundries; and electrical production and distribution. These activities resulted in direct discharges from upland areas through stormwater and wastewater outfalls; releases and spills from commercial operations occurring over the water; municipal combined sewer overflows; and indirect discharges through overland flow, bank erosion, groundwater, and other nonpoint sources. In addition, contaminants from offsite sources have reached the Site through surface water and sediment transport from upstream and through atmospheric deposition. Operations that continue today along the river banks include bulk fuel storage, barge building, ship repair, automobile scrapping, recycling, steel manufacturing, cement manufacturing, operation and repair of electrical transformers (including electrical substations), and many smaller industrial operations.

Contaminants of Concern

The human health and ecological risk assessments identified 64 contaminants of concern (COCs) that contribute a significant amount of risk to the human and ecological receptors. COCs by media are listed in Tables 1 through 5 in Appendix II of the ROD. A subset of all COCs, called focused COCs, was developed to simplify analysis and evaluation of remedial alternatives. The focused COCs include polychlorinated biphenyls (PCBs), PAHs, dioxins and furans, and DDx, which represents collectively dichlorodiphenyltrichloroethane (DDT) and its primary breakdown products dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethene (DDE).

Principal Threat Waste

Principal threat waste (PTW) is defined as source material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air or that acts as a source for direct exposure. Further, PTWs are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

PTW was identified based on cancer risk (highly toxic) or non-aqueous phase liquid (NAPL) within the sediment bed (source material) and on an evaluation of mobility of contaminants in the sediment. A capping model was used to determine whether there were concentrations of PTW that could not be reliably contained.

Contaminated Media

The environmental media contaminated by COCs include surface sediment (0 to 30 centimeters [cm] below mud line [bml]), subsurface sediment (below 30 cm bml), suspended sediment, surface water, groundwater, biota, and river banks. The surface sediment sample interval (0 to 30 cm bml) is designed to capture that portion of the sediment column that has the potential to be disturbed or transported under typical annual conditions. River banks are defined as areas from top of bank down to the river that may be contaminated along the shoreline next to contaminated in-river shallow areas. The following nature and extent of contamination discussion focuses on sediments, surface water, and river banks. A full description of site contamination is included in Section 6 of the ROD.

Nature and Extent of Contamination

Surface and Subsurface Sediment

Contamination in subsurface sediment was identified as deep as 17 ft bml in the navigation channel and 19 ft bml in the sediment future maintenance dredge (FMD) areas. FMD areas are those locations in the river that are periodically dredged to allow continued marine activity. In the intermediate region, defined as outside the horizontal limits of the navigation channel and FMD areas to the riverbed elevation of approximately -2 ft CRD, the maximum depth of contamination was estimated to be 34 ft bml, but most contamination was less than 10 ft. In the shallow region, defined as shoreward of the riverbed elevation of approximately -2 ft CRD, the maximum depth of contamination was estimated to be 33.5 ft bml. Based on contaminant distribution trends, some general patterns emerged among subsets of different contaminants that reflect fate and transport processes at the Site as well as the relative importance of regional versus site sources, as described below. Additional details are included in the ROD (EPA, 2017a).

Sediment contaminant concentrations were greatest in nearshore areas. Concentrations of contaminants were generally higher in nearshore and off-channel areas such as slips, embayments, and shallow areas, and near some known or suspected sources, as compared to sediments in the navigation channel, Multnomah Channel, and downstream areas.

Organic contaminant concentrations were greater in subsurface sediments. Concentrations of organic contaminants tended to be higher in subsurface sediments than in surface sediments. Concentrations of total PCBs, total DDx, total PAHs, hexachlorobenzene, total chlordanes, aldrin and dieldrin, gamma-hexachlorocyclohexane (Lindane), lead, and tributyltin (TBT) were higher in subsurface than in surface sediments, indicating that historical inputs were likely greater than current inputs. Subsurface contamination was detected as deep as 34 ft bml. In contrast, arsenic, copper, chromium, mercury, and zinc did not have large concentration ranges and generally showed similar levels in surface and subsurface sediments. Other exceptions included areas where higher surface sediment concentrations appeared to be associated with ongoing Site sources, low rates of sediment deposition, and physical sediment disturbance (e.g., from boat scour).

Regional inputs exhibited uniform concentrations across the area. Contaminants that may have been derived predominantly from regional or upstream inputs showed widespread surface sediment distributions without distinct, isolated areas of higher concentrations. Examples of this were arsenic, chromium, and mercury, which occurred at relatively low concentrations throughout the Site with no apparent strong concentration gradients.

Areas of high concentrations were present throughout the Site and generally were located near likely upland sources. A number of contaminants exhibited relatively high sediment concentrations in distinct areas offshore of known or likely sources. These areas were separated by large areas with relatively lower concentrations lacking obvious concentration gradients. Contaminants that exhibited this trend included total PCBs, dioxins, bis(2-ethylhexyl)phthalate (BEHP), butylbenzyl phthalate, pentachlorophenol, hexachlorobenzene, total chlordanes, Lindane, copper, zinc, and TBT.

Some contaminants had areas of high concentrations that were more common in the lower (downstream) half of the Site. Total DDx and total PAHs exhibited elevated concentrations in some locations of the river. Concentrations of certain metals were correlated to sediment grain size. A comparison of metals concentrations to the distributions of percent fines in the Site showed that where sediments were comprised of less than 40 percent (%) fines, chromium and copper concentrations were relatively low (above RM 10, between RM 5 and 7, and in the Multnomah Channel; RI Map 3.1-3). A similar, but less pronounced, correspondence existed between sandy sediments and zinc concentrations.

Multiple contaminants co-occurred. In most areas of the Site, multiple COCs are comingled. At all of the highest surface sediment concentration areas, more than one contaminant is found. This degree of contaminant co-occurrence reflects the variety of sources to the in-river portion of the Site and the history of upland Site development, including wastewater and stormwater conveyance systems and industrial and commercial activities.

Surface Water

Concentrations of contaminants in surface water vary spatially and with river flow. Surface water concentrations in the Site were generally higher than those entering the upstream boundary of the Site (at RM 16) under all flow conditions. The highest contaminant concentrations in surface water within the Site were found near known sources where concentrations in sediment were also highest, such as the areas adjacent to the Gasco and Arkema facilities (RM 6 through RM 7.5W). Surface water samples collected at the downstream end of the Site (RM 2 and Multnomah Channel) showed higher concentrations of PCBs, dioxin/furans, DDx, BEHP, chlordanes, and aldrin than concentrations of these contaminants entering the Site from upstream. This pattern indicates that contamination from the Site is being transported to the Columbia River.

River Banks

River banks are defined as the area from the top of bank down to the river. Contaminants detected in river bank material at levels that pose a risk to human health, the environment, or for recontamination to any implemented remedy, include the focused COCs and other contaminants. The ROD (EPA, 2017a) provides a detailed summary of river bank contaminants on the east and west sides of the river.

Remedial Action Objectives

The remedial action objectives (RAOs) for the Portland Harbor Superfund Site, listed in Section 9 of the ROD, are media-specific goals for protecting human health and the environment. The CULs for COCs associated with these RAOs are identified in Table 17 in the ROD. CULs are the long-term contaminant concentrations that need to be achieved by the remedial alternatives to meet RAOs. The nine RAOs developed to address the human health and ecological risks posed by the contamination at the Site are presented below.

Human Health RAOs

- RAO 1 – Sediment: Reduce cancer and non-cancer risks to people from incidental ingestion of and dermal contact with COCs in sediment and beaches to exposure levels that are acceptable for fishing, occupational, recreational, and ceremonial uses
- RAO 2 – Biota: Reduce cancer and non-cancer risks to acceptable exposure levels (direct and indirect) for human consumption of COCs in fish and shellfish

- RAO 3 – Surface Water: Reduce cancer and non-cancer risks to people from direct contact (ingestion, inhalation, and dermal contact) with COCs in surface water to exposure levels that are acceptable for fishing, occupational, recreational, and potential drinking water supply
- RAO 4 – Groundwater: Reduce migration of COCs in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for human exposure

Ecological RAOs

- RAO 5 – Sediment: Reduce risk to benthic organisms from ingestion of and direct contact with COCs in sediment to acceptable exposure levels
- RAO 6 – Biota (Predators): Reduce risks to ecological receptors that consume COCs in prey to acceptable exposure levels
- RAO 7 – Surface Water: Reduce risks to ecological receptors from ingestion of and direct contact with COCs in surface water to acceptable exposure levels
- RAO 8 – Groundwater: Reduce migration of COCs in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for ecological exposure

Human Health and Ecological RAO

- RAO 9 – River Banks: Reduce migration of COCs in river banks to sediment and surface water such that levels are acceptable in sediment and surface water for human health and ecological exposures

2.3 Selected Remedy in the ROD

Key components of the Selected Remedy are described below. A full description of the Selected Remedy is provided in the ROD.

EPA's remedial strategy for the in-river portion of the Site is to address all contaminated media and complete exposure pathways that pose unacceptable risk to human health or the environment, including sediment, biota, surface water, groundwater, and river banks. The Selected Remedy utilizes a combination of technologies to address contaminated sediment. The same technologies will be used in adjacent river banks if determined the river banks should be remediated in conjunction with the sediment action. Although the Selected Remedy does not directly address surface water, EPA anticipates that taking action on sediment and river banks, in conjunction with control of upland sources conducted under DEQ authority, will reduce contaminants concentrations in all media to acceptable levels and reduce ongoing source of contaminants to Multnomah Channel and the Columbia River.

The Selected Remedy addresses all areas where contaminant concentrations exceed the CULs through a combination of dredging, capping, enhanced natural recovery (ENR), monitored natural recovery (MNR), and institutional controls. CULs were selected after evaluating concentrations protective of human health or the environment from the risk assessment, applicable or relevant and appropriate requirements (ARARs), and background values. Sixty-four COCs found in sediment, surface water, groundwater, and tissue were identified. For each contaminant and in all media such as sediments and surface water, the lowest number protective of human health or the environment was selected unless the available background value was higher, in which case the background value was selected. Table 17 in the ROD provides the CULs and tissue targets as well as the basis for the selected number. The CULs for the Site are expected to reduce unacceptable risk within the river by setting standards for sediment, biota, surface water, groundwater, and river banks. Remediation of the sediment will reduce loading and resuspension of contamination to surface water, which collectively will reduce fish and shellfish exposure to the contamination.

Areas to be capped or dredged called Sediment Management Areas (SMAs) are defined by remedial action levels (RALs) and PTW for the Selected Remedy (Table 21 in the ROD). SMAs for the Selected Remedy are shown on Figure 30 in the ROD. The SMAs represent areas with contaminant concentrations in surface sediment where natural recovery is not occurring or is not likely to be effective in reducing concentrations of COCs within a reasonable time frame. RALs are contaminant-specific sediment concentrations of focused COCs used to define areas for more active cleanup and will reduce contaminant concentrations and risks more effectively than ENR or MNR from current site wide average concentrations. Technology assignments and the approximate areas that will be remediated through dredging, capping, ENR, and areas where COC concentrations will be reduced through MNR are shown on Figures 31a-e in the ROD.

The COCs used to define the SMA boundaries are PCBs, total PAHs, DDx and selected dioxin/furan congeners. These focused COCs encompass the majority of the spatial extent of contaminants posing the majority of the risks as identified in the baseline risk assessments.
In the Feasibility Study (FS) (EPA, 2016b), RALs were developed by considering the volume or acreage of material that would be addressed to achieve reductions of contaminant concentrations (and therefore risk) throughout the Site. The relationships between RAL concentrations and resulting site-wide spatially-area weighted average concentrations (SWACs) or "RAL curves" were developed by plotting acres remediated against the post remediation surface weighted average surface sediment concentration. A range of RALs consisting of seven different concentrations bracketing the distribution of contamination were selected for each focused COC. The selected RALs are a function of the distribution of surface sediment data at the Site and reflect uncertainties in the distribution of contamination and the interpolation method utilized.

Each remedial alternative evaluated in the FS has a different set of sediment RALs. The lowest RALs are in Alternative H; therefore, the areas that are capped and/or dredged increase in acres from Alternatives B through H. A summary of RALs for the focused COCs used to develop Alternatives B through H are presented in Table 18 in the ROD.

The Selected Remedy applies Alternative F RALs to nearshore sediments[2] and Alternative B RALs to the federally authorized navigation channel. Total PAH RAL contours presented in the Portland Harbor FS (EPA 2016b) are shown on proposed ESD Figure 2. For PAHs, RALs were based on total PAHs rather than cPAHs because total PAHs were selected as a focused COC for the Site. The relationship between total PAHs and cPAHs is presented in Appendix D of the FS. The total PAH RALs for the Selected Remedy are 13,000 µg/kg for nearshore sediments and 170,000 µg/kg for the federally authorized navigation channel.

The Selected Remedy in the ROD includes a total constructed area of 394 acres of sediment and 23,305 lineal feet of river bank and allows 1,774 acres of sediment to naturally recover. The Selected Remedy includes 365.4 acres of capping and dredging contaminated sediment and 28.2 acres of ENR. Of that, approximately 215.2 acres of sediment will be dredged to varying depths. Additionally, 23,305 lineal feet of river bank are assumed to be excavated and covered with either an augmented reactive cap or an engineered cap using beach mix or vegetation after excavating approximately 123,000 cubic yards (cy) of contaminated material from river banks. The dredged material removed from the Site will be managed under disposed material management (DMM) scenario 2, with approximately 3,017,000 cy of contaminated sediment and 123,000 cy of soil sent to offsite disposal facilities. Material testing will be used to determine the appropriate disposal facility, either a Subtitle D or C landfill. Ex-situ treatment is assumed for approximately 191,500 cy of sediment and river bank soil prior to disposal and is based on complying with federal and state regulations and the 2004 dispute decision on MGP waste. The need for, and extent of, ex-situ treatment will be based on the offsite disposal requirements and material testing during design and construction. It is assumed that all other dredged material will not require treatment prior to disposal.

The various river areas and their remedy components are discussed in detail below. The final technology assignment will be identified in the remedial design after collection of additional sampling data. The technology assignment will be identified as indicated in the decision tree on Figure 28 in the ROD.

Navigation Channel

The Selected Remedy in the federally authorized navigation channel includes dredging to avoid constructing a cap or residual layer within the authorized dredge depth. Contaminated sediment will be dredged to the depth of the Alternative B RAL concentrations or PTW concentrations shown in Table 21 in the ROD, whichever is lower. Where RALs are achieved through dredging, placement of a residual layer will occur as soon as is practicable following dredging and include the surrounding area that may have been impacted by dredge residuals. If RALs are not achieved or PTW is present below the feasible depth limit of the excavation technology, as approved by EPA, a cap is assumed to be placed after dredging. Navigation and maintenance dredge depth

[2] Nearshore sediments include all sediments outside the federally authorized navigation channel. This includes beach sediments as well as areas designated in the FS as shallow areas, intermediate areas and future maintenance dredge areas.

requirements will need to be considered during design and implementation of the Selected Remedy such that the final constructed elevation is below the authorized depth of the navigation channel, including an over dredge allowance/buffer zone. Implementing the Selected Remedy in the navigation channel will need to consider, and be coordinated with, cleanup conducted in the rest of the Site to minimize recontamination. This cleanup may occur at the same time or later than the other cleanup actions.

Future Maintenance Dredge Areas

FMD areas are those locations in the river outside of the federally authorized navigation channel that are periodically dredged to allow continued marine activity. Contaminated sediment will be dredged to the depth of the site-wide RAL concentrations shown in Table 21 in the ROD or to a depth required to allow placement of a cap or backfill sufficient to be effective over the long term. Where RALs are achieved through dredging, placement of a residual layer will occur as soon as is practicable following dredging within the prism and surrounding area that may have been impacted by dredge residuals. NAPL or PTW that cannot be reliably contained will be dredged unless it is present below the feasible depth limit of excavation technology, in which case it will be capped. A reactive residual layer (sand plus activated carbon) is assumed after dredging if PTW that can be contained lies below the feasible limits of excavation. Maintenance dredge depth requirements will need to be considered during design and implementation of the Selected Remedy such that the final constructed elevation is below the maintained depth, including an over dredge allowance or buffer zone.

Intermediate Region

The intermediate region is defined as outside the horizontal limits of the FMD areas to the riverbed elevation of approximately -2 ft CRD. In this region, avoiding or minimizing impacts to the aquatic environment and floodway need to be considered and evaluated to meet Clean Water Act (CWA) (Section 404) and federal floodway requirements as well as consider climate change impacts. In the intermediate region, contaminated sediment will be dredged to the depth required to achieve RALs (see Table 21 in the ROD) and remove PTW or to a depth required to allow placement of cap or backfill material sufficient to be effective over the long term. The elevation of the top of the cap will be no higher than the pre-design elevation to avoid impacts to the floodway. EPA estimates the dredging depth required to accommodate a cap will generally be 5 feet. The final depth will be determined in remedial design. Where RAL concentrations are achieved through dredging, placement of a residual layer will occur as soon as is practicable following dredging within the prism and surrounding area that may have been impacted by dredge residuals. In the intermediate regions, residual layers will consist of sand (amended with activated carbon if determined to be appropriate) to prevent the transport and release of contaminants from dredge residuals. NAPL or PTW that cannot be reliably contained will be dredged unless it is present below the feasible depth limit of excavation technology, in which case it will be capped. During design and construction, the final elevation of capped and dredged areas will be considered such that the leave surface of the constructed remedy is appropriate for the post-construction use of each specific area. Under any scenario, the elevation of the top of the cap or residual layer will be no higher than the pre-design elevation to avoid loss of submerged aquatic habitat, preserve slope stability, and negate adverse impacts to the floodway. If appropriate to protect sensitive species, a habitat layer will be incorporated into the constructed remedy.

Shallow Region

The shallow region is defined as shoreward of the riverbed elevation of approximately -2 ft CRD. In this region, avoiding or minimizing impacts to the aquatic environment and floodway need to be considered and evaluated to meet CWA (Section 404) and federal floodway requirements as well as consider climate change impacts. Contaminated sediment in this area will be dredged to the depth required to remove all NAPL or PTW that cannot be reliably contained (see Table 21 in the ROD) unless it is present below the feasible depth limit of excavation technology in which case it will be capped. Where PTW is not present but the depth of excavation to achieve RAL concentrations is greater than 5 feet, the area will be dredged to 5 feet with placement of a cap and backfilled to grade. Under any scenario, the elevation of the top of the cap or residual layer will be no higher than the pre-design elevation to avoid loss of submerged aquatic habitat, preserve slope stability, and negate adverse impacts to the floodway. In the shallow regions, a habitat layer, such as beach mix, will be used for the final layer of clean cover in both residual management areas and capped areas to bring the surface back to the original (pre-dredge) elevation and to maintain the natural habitat.

River Bank Region

River banks are defined as areas from top of bank down to the river that may be contaminated along the shoreline next to contaminated in-river shallow areas. Remediation of contaminated river banks is included in the Selected Remedy where it is determined that it should be conducted in conjunction with the in-river actions and to protect the remedy (Figure 9 and Table 21 in the ROD). Other river banks may be included in the remedial action if contamination contiguous with contaminated river sediment is found during remedial design sampling. Engineered caps or vegetation with beach mix will be placed as the final cover based on area-specific designs, which will account for appropriate slope according to the programmatic or site-specific Biological Opinion, as appropriate. NAPL or PTW that cannot be reliably contained, if present, will be fully excavated and not capped unless it is present below the depth limit of excavation technology, as approved by EPA. In those locations, a significantly augmented cap will be constructed below the habitat layer. The state may also undertake actions at some river banks that are the subject of this ROD to expedite source control of contaminated upland areas, as necessary. Those actions will be consistent with the Selected Remedy and meet CERCLA requirements.

3.0 BASIS FOR THE PROPOSED ESD

On January 19, 2017, EPA released an updated *Toxicological Review of Benzo(a)pyrene* (EPA, 2017b). The updated toxicological review modified the oral CSF for BaP from 7.3 to 1 mg/kg-day resulting in a lower risk estimate associated with exposure to BaP and other cPAHs. Given that humans have less cancer risk from exposure to BaP, the modified oral CSF has potential implications for the risk-based human health CULs, target tissue levels, and highly toxic PTW thresholds for cPAHs measured as BaPeq selected in the January 3, 2017 ROD (EPA, 2017a). CULs for cPAHs were calculated using a CSF to achieve a 1 x 10^{-6} cancer risk level and the PTW thresholds were set at a 1 x 10^{-3} level based on the CUL[3].

Although not directly related to a CSF or a measurement of risk, EPA evaluated potential implications of the BaP slope factor change on the total PAH RALs selected in the ROD to determine whether any areas slated for active cleanup primarily or solely due to cPAH risk from direct contact with contaminated sediments or shellfish consumption no longer presented risk or may no longer require active cleanup. However, while undertaking this review, EPA also considered the effect of these changes on other human health and ecological RAOs. In particular, EPA evaluated impacts to surface water CULs and whether ecological risks presented by PAHs, carcinogenic or not, would be adequately addressed if changes to cPAH CULs and/or the total PAH RALs were implemented.

While undertaking the evaluation of the BaP CSF change, EPA discovered a mathematical error in calculating the cPAH Shellfish Consumption sediment cleanup level. Correcting the error reduced the RAO 2 cPAH sediment cleanup level from 3,950 micrograms per kilogram (µg/kg) to 39.5 micrograms per kilogram (µg/kg) without considering any change due to the BaP CSF change.

3.1 Changes to the Sediment Cleanup Levels, Shellfish Target Tissue Levels, and Highly Toxic PTW Thresholds

Human health sediment CULs and shellfish target tissue levels as well as the highly toxic PTW threshold for PAHs in the ROD are based on cPAHs. As a result, the change in the CSF for BaP has a direct effect on the risk-based sediment CULs and target tissue levels for cPAHs. These changes are summarized below.

cPAH Direct Contact Sediment CULs

[3] Risks are probabilities that usually are expressed in scientific notation (e.g., 1 x 10^{-6}). An excess lifetime cancer risk of 1 x 10^{-6} indicates a probability that the RME individual has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other exposures. The upper-bound excess lifetime cancer risks derived in this assessment are compared to the risk range of 10^{-4} to 10^{-6} established in the NCP. EPA's goal of protection for cancer risk is 10^{-6}, and risks greater than 10^{-4} typically will require remedial action. Highly toxic PTW is generally based a 10^{-3} risk level.

The Portland Harbor baseline human health risk assessment included in the *Final Remedial Investigation Report* (RI Report – EPA 2016a) evaluated a range of direct contact exposure scenarios for beach sediment and in-water sediment. Potentially exposed populations evaluated under the beach exposure scenarios included dockside workers, transients, recreational beach users, high frequency fishers, and tribal fishers. Potentially exposed populations evaluated under the in-water sediment exposure scenarios included in-water workers, high frequency fishers, tribal fishers, diver wet suit, and diver dry suit.

Reducing the BaP CSF from 7.3 to 1 mg/kg-day results in an increase in the direct contact sediment CUL specified in the ROD by a factor of 7.3. The ROD selected a cPAH (BaPeq) sediment CUL of 12 micrograms per kilogram (µg/kg) for nearshore sediments based on the recreational beach sediment exposure scenario. Increasing the beach sediment PRG of 12 µg/kg by a factor of 7.3 results in a revised beach sediment PRG and CUL of 85 µg/kg.

The ROD applied the cPAH recreational beach sediment CUL to all nearshore sediments outside the navigation channel. EPA evaluated whether a sediment CUL based on the tribal fisher exposure scenario should be applied to nearshore sediments outside of the navigation channel where recreational beach exposures are not expected to occur. The in-water sediment preliminary remediation goal (PRG) based on the tribal fisher exposure scenario is 106 µg/kg. Increasing the in-water sediment PRG of 106 µg/kg by a factor of 7.3 results in a revised nearshore sediment PRG and CUL of 774 µg/kg.

cPAH Shellfish Consumption Target Tissue Levels

The ROD included target tissue levels for cPAHs in shellfish tissue of 7.1 µg/kg based on the shellfish consumption exposure scenario, herein after referred to as shellfish target tissue levels. Reducing the BaP CSF from 7.3 to 1 mg/kg-day results in a proportional increase in the target tissue level from 7.1 to 51.6 µg/kg. This target tissue level would apply to shellfish tissue throughout the Site. The ROD did not include target tissue levels for cPAHs in fish tissue.

cPAH Shellfish Consumption Sediment Cleanup Levels

The ROD selected a cPAH shellfish consumption sediment CUL of 3,950 µg/kg based on human consumption of clams. The cPAH shellfish consumption sediment CUL is applicable to the entire Site, whereas the direct contact sediment CUL is only applicable to nearshore sediment areas because direct contact exposure pathways are not considered to be complete within the navigation channel at the Site.

For the shellfish consumption sediment CUL, the target tissue level increases by a factor of 7.3. However, the relationship between cPAH (BaPeq) shellfish (clam) tissue levels and sediment levels is a non-linear relationship represented by the following equation presented in Appendix B of the FS (EPA, 2016b):

$$ln(PRG_{sed}) = \frac{((ln(C_{tissue}) - (\ln(f_{lipid}) - \ln(CF) + 2.47)}{0.6} + ln(f_{oc}) \quad \text{(Equation 1)}$$

Where:

PRG_{sed} = Risk-based sediment preliminary remediation goal, dry weight (µg/kg)
C_{tissue} = Risk-based acceptable tissue concentration, wet weight (µg/kg)
CF = Correction factor of 2.3
F_{oc} = Fraction organic carbon, dry weight (0.0171)
F_{lipid} = Fraction of lipid in shellfish (clam) tissue, wet weight (0.022)

During review of potential changes to the cPAH cleanup level resulting from the change in the BaP CSF, EPA became aware of an error in application of the Equation 1. This error resulted from calculating the sediment cleanup level using the units of µg/kg rather than mg/kg (the equation was developed based on a log-log regression equation developed in units of mg/kg). The error reduces the cPAH shellfish consumption sediment CUL presented in the ROD by a factor of 100 from 3,950 µg/kg to 39.5 µg/kg. Due to the non-linear relationship between bulk sediment BaP concentrations and shellfish (clam) tissue BaP concentrations, revising the acceptable clam tissue concentration from 7.1 to 51.6 µg/kg and solving for PRG_{sed} using Equation 1 increases the shellfish consumption cPAH sediment CUL from 39.5 to 1,076 µg/kg.

cPAH Principal Threat Waste Thresholds

The ROD (EPA, 2017a) identified the presence of PTW at the Site. PTW types identified include source material in the form of NAPL, highly toxic material based on a 1 x 10^{-3} risk level, and material that is not reliably contained. The presence of NAPL and not reliably contained PTW associated with PAH contamination is unaffected by the BaP slope factor change. However, the highly toxic PTW threshold for cPAHs of 106,000 µg/kg increases by a factor of 7.3 to 774,000 µg/kg due to the BaP slope factor change. Highly toxic PTW thresholds were presented in Table 21 of the ROD based on the lowest concentration from each of the applicable RAOs. Evaluation by EPA suggests that the corrected 1 x 10^{-3} acceptable cPAH sediment concentration based on the RAO 2 clam consumption scenario may be lower than the RAO 1 direct contact scenario value. However, due to the limited clam tissue data at the 1 x 10^{-3} risk range and the potential for over extrapolation of the non-linear clam tissue/sediment relationship, the cPAH PTW value of 774,000 µg/kg as updated from the BaP slope factor change remains based on RAO 1 (tribal direct contact).

As noted above, PTW types identified at the Site include source material in the form of NAPL, highly toxic material based on a 1 x 10^{-3} risk level, and material that is not reliably contained. Increasing the highly toxic PTW threshold from 106,000 to 774,000 µg/kg will limit the presence of highly toxic PTW at the Site. Areas of PTW identified in the Portland Harbor ROD (EPA, 2017a) are shown on proposed ESD Figure 3.

Application of Sediment Cleanup Levels

The ROD established a cPAH CUL of 12 µg/kg for nearshore sediments based on a recreational beach exposure scenario that included both child and adult exposures. The ROD also established a cPAH shellfish consumption sediment CUL of 3,950 µg/kg applicable to the navigation channel based on the clam consumption exposure scenario.

EPA has re-evaluated application of the nearshore sediment CUL based on the recreational beach exposure scenario and determined that two cPAH direct contact CULs should apply to nearshore sediments. The updated cPAH direct contact beach CUL of 85 µg/kg will apply to recreational beaches based on existing or reasonably anticipated future use. EPA also developed a cPAH direct contact CUL of 774 µg/kg based on the tribal fisher exposure scenario. The cPAH direct contact tribal fisher CUL for in-water sediment of 774 µg/kg will apply to the remainder of nearshore sediments (including non-recreational beach areas). The updated cPAH shellfish consumption sediment CUL of 1,076 µg/kg will apply to the federally authorized navigation channel. This change does not affect the sediment CUL for any other COC at the Site.

Changes to the direct contact sediment CULs, the shellfish consumption target tissue level, the shellfish consumption sediment CUL, and highly toxic PTW threshold for cPAHs (BaPeq) are summarized in proposed ESD Table 1.

3.2 Changes to Total PAH Remedial Action Level

EPA evaluated whether a change to the total PAH RALs for the Selected Remedy was appropriate based on the change to the BaP CSF. This evaluation considered both the total PAH nearshore sediment RAL of 13,000 µg/kg and the total PAH navigation channel RAL of 170,000 µg/kg. The navigation channel RAL is applicable to all contaminated sediments within the federally authorized navigation channel while the nearshore RAL is applicable to all sediments outside the navigation channel.

The evaluation considered whether the Selected Remedy RALs would result in the remediation of PAH contaminated sediment that no longer poses unacceptable risk to human health due to the BaP CSF change based on an evaluation of post construction risk and whether application of the corrected cPAH CUL of 1,076 µg/kg would significantly increase post construction risk associated with the human health fish and shellfish consumption exposure pathway. The evaluation also considered whether a change in the total PAH RAL would affect the ability of the remedy to attain all other RAOs specified in the ROD. The evaluation considered both the tribal fisher and recreational beach exposure scenarios (RAO 1) and other RAOs where PAHs are identified as a COC (RAOs 2, 3, 5 and 7). The evaluation did not consider groundwater RAOs (RAOs 4 and 8) since these will be dependent on engineered caps applied along with the adequacy of source control actions.

Nearshore Total PAH RAL

cPAH Direct Contact In-water Sediment Risk (RAO 1): Updating the direct contact cPAH sediment CUL from 106 µg/kg to 774 µg/kg without adjustment of the nearshore total PAH RAL will result in the remediation of some sediments that do not exceed 774 µg/kg as measured on a one-half rolling river mile SWAC basis. As shown on proposed ESD Figures 4a and 4b, one-half rolling river mile SWACs, if the Alternative F total PAH RAL is used, would exceed 774 µg/kg between approximately RM 4.8 and 6.6 in nearshore sediments along the west shore of the Willamette River (West Shoal) and between approximately RM 3.9 and 4.9 along the east shore of the Willamette River (East Shoal).

EPA conducted an evaluation to determine the percentage of nearshore half-river miles protected based on a range of total PAH RALs. This evaluation is consistent with the direct contact residual risk evaluation presented in Appendix IV of the Portland Harbor ROD. EPA evaluated increasing the total PAH RAL for the Selected Remedy of 13,000 µg/kg by a factor of 7.3 to 95,000 µg/kg (the factor of 7.3 represents the magnitude of the change to the BaP CSF). As is shown in proposed ESD Figure 5, a total PAH RAL of 95,000 µg/kg will protect 22% of nearshore half-river miles. Figure 5 also shows that a total PAH RAL of 30,000 µg/kg will protect 100% of the nearshore half-river mile by achieving the updated direct contact cPAH CUL of 774 µg/kg as measured on one-half rolling river mile SWACs throughout the Site. Based on the results of this evaluation, EPA determined that revising the nearshore total PAH RAL from 13,000 µg/kg to 30,000 µg/kg was appropriate.

cPAH Direct Contact Beach Exposure (RAO 1): In general, the remedial footprint for the Selected Remedy as presented in the ROD does not include beach areas. The exception to this is a beach area near Linnton at approximately RM 4.8 along the east bank of the Willamette River (Beach 04B024) and a beach area near Cathedral Park at approximately RM 5.9 along the west bank of the Willamette River (Beach 05B018). The baseline human health risk assessment (EPA 2016a) determined that the risk associated with these beaches was 5×10^{-5} and 1×10^{-5}, respectively. Updated risk estimates based on the BaP CSF change are 1×10^{-5} and 4×10^{-6}, respectively. These risk estimates are within EPA's risk range and do not need to be addressed through active remediation. In addition, it is expected that risks to human health in beach areas will be further reduced through natural recovery processes. As a result, revising the total PAH RAL from 13,000 µg/kg to 30,000 µg/kg based on the tribal fisher in-water sediment exposure scenario will not significantly affect the ability of the remedy to protect recreational beach users. Long-term monitoring will be performed to verify that the Selected Remedy is protective of recreation beach exposures.

cPAH Shellfish Consumption Risk (RAO 2): As noted above, the BaP CSF change along with the correct application of Equation 1 will increase the corrected cPAH shellfish consumption sediment CUL from 39.5 to 1,076 µg/kg. However, the proposed nearshore total PAH RAL of 30,000 µg/kg was established to achieve the updated direct contract cPAH CUL of 774 µg/kg, as measured on one-half rolling river mile SWACs throughout the site. Because corrected cPAH shellfish consumption sediment CUL of 1,076 µg/kg is above the direct contract cPAH CUL of 774 µg/kg, post-construction risk to human health based on the shellfish consumption exposure pathway does not exceed 1 x 10^{-6} on a rolling river mile basis in nearshore sediments at the Site and no further adjustment of the RAL is needed to address human health risks associated with this exposure pathway.

<u>cPAH Human Health Surface Water Risk (RAO 3)</u>: The BaP CSF change is not expected to result in a change to Oregon water quality standards in the foreseeable future. As a result, the ARAR based surface water CULs specified in Table 17 of the ROD have not been modified. Revising the total PAH nearshore RAL from 13,000 µg/kg to 30,000 µg/kg will reduce the remedial footprint and may result in a slight reduction in the ability of the selected remedy to attain RAO 3.

<u>Total PAH Benthic Risk (RAO 5):</u> The total PAH sediment CUL for benthic risk as presented in Table 17 of the ROD is 23,000 µg/kg. The Selected Remedy is estimated to address 72% of benthic risk areas based on 10 times unacceptable benthic risks at the end of construction with the remainder to be addressed through MNR. Although the change in BaP CSF does not affect the benthic risk total PAH CUL, PAHs in sediment present unacceptable risk to the benthic community. Therefore, changes in total PAH RALs must be evaluated to determine the effect on the attainment of RAO 5 and the CUL. Because the revised total PAH RAL of 30,000 µg/kg is only slightly above the total PAH CUL for protection of the benthic community of 23,000 µg/kg, increasing the total PAH RAL from 13,000 µg/kg to 30,000 µg/kg will have a minimal effect on attainment of RAO 5 or the post-construction metric of 10 times the benthic risk CUL.

<u>PAH Ecological Surface Water Risk (RAO 7):</u> Risk to aquatic life is unaffected by the change in the BaP CSF. Revising the total PAH nearshore RAL from 13,000 µg/kg to 30,000 µg/kg will reduce the remedial footprint and may result in a slight reduction in the ability of the Selected Remedy to attain RAO 7.

Based on its evaluation, EPA determined that the nearshore RAL should be revised from 13,000 to 30,000 µg/kg to avoid remediation of PAH-contaminated sediments that no longer pose a risk to human health for direct contact based on the changes to the nearshore sediment cPAH CUL. EPA has also determined that increasing the total PAH RAL from 13,000 to 30,000 µg/kg will not have a significant effect on the ability of the remedy to protect recreational beach users or to attain RAOs 2, 3, 5, or 7. The total PAH RAL curve utilizing the revised total PAH RAL is shown on proposed ESD Figure 6. The change in the remedial footprint associated with this change is estimated to be 17 acres.

Navigation Channel RAL

EPA evaluated whether the change in BaP CSF necessitated revising the total PAH RAL of 170,000 µg/kg applicable to the navigation channel. This evaluation considered the effect of the RAL change on post-construction risk estimates and whether the change would affect attainment of the RAOs established for the Site. The evaluation focused on RAOs 2, 3, 5, and 7. The evaluation did not consider RAO 1 because the human health direct contact exposure pathway is considered incomplete within the navigation channel.

cPAH Shellfish Consumption Risk (RAO 2): As noted above, the BaP CSF change along with the correct application of Equation 1 will result in a revised cPAH shellfish consumption sediment CUL of 1,076 µg/kg. This change will result in a maximum post construction risk to human health based on the shellfish consumption exposure pathway of 3×10^{-6} as measured on a rolling river mile basis. Based on this post-construction risk level, EPA has determined that the total PAH RAL of 170,000 µg/kg applicable to the navigation channel should not be revised.

cPAH Human Health Surface Water Risk (RAO 3): The BaP CSF is not expected to result in a change to the ARAR based surface water CULs specified in Table 17 of the ROD. Based on an observed increase in total PAH load between river mile 6.3 and 3.9, increasing the total PAH navigation channel RAL above 170,000 µg/kg will reduce the remedial footprint and may result in a reduction in the ability of the Selected Remedy to attain RAO 3.

Total PAH Benthic Risk (RAO 5): As noted above, the total PAH sediment CUL, as presented in the ROD, is 23,000 µg/kg. Although the change in BaP CSF does not affect the benthic risk total PAH CUL, changes in total PAH RALs must be evaluated to determine the effect on attainment of RAO 5. The total PAH RAL applicable to the navigation channel of 170,000 µg/kg is well above the total PAH CUL for protection of the benthic community of 23,000 µg/kg. As a result, any evaluation in changes to the navigation channel RAL must consider the effectiveness of MNR to achieve the total PAH CUL.

As shown on proposed ESD Figure 2, the total PAH navigation channel RAL is exceeded within the navigation channel only between approximately RM 5.1 and RM 6.6. An evaluation of natural recovery processes at the Site determined that the navigation channel between RM 5 and RM 7 is generally not conducive to natural recovery. A multiple line of evidence natural recovery framework considered changes in sediment bed elevation based on two bathymetric surveys conducted in May 2003 and January 2009, the consistency in changes in sediment bed elevation based on five bathymetric surveys conducted between January 2002 and January 2009, sediment grain size, the potential for propeller wash induced erosion, the ratio of subsurface to surface sediment concentrations, and the erosion potential associated with wind and vessel wake generated waves. The results of this multiple line of evidence natural recovery framework are shown on proposed ESD Figure 7. Areas that are conducive to natural recovery are scored as +1, whereas areas where natural recovery is unlikely to be effective are scored as -1. Areas where natural recover is neither favorable nor unfavorable are scored as 0. As shown on proposed ESD Figure 7, natural recovery processes are generally unfavorable within the navigation channel between RM 5.1 and RM 6.6. As a result, increasing the navigation channel RAL above 170,000 µg/kg may limit the ability of the remedy to achieve the total PAH CUL of 23,000 µg/kg over time.

Based on its evaluation, EPA determined that the total PAH RAL of 170,000 µg/kg applicable to the navigation channel should not be revised because it may affect the ability of the Selected Remedy to achieve the total PAH CUL of 23,000 µg/kg for protection of the benthic community (RAO 5). This is because the selected total PAH RAL of 170,000 µg/kg is well above the total PAH CUL and the lack of natural recovery processes within the navigation channel between RM 5 and RM 7 where the total PAH RAL is exceeded.

PAH Ecological Surface Water Risk (RAO 7): Risk to aquatic life is unaffected by the change in the BaP CSF. Based on an observed increase in total PAH load between river mile 6.3 and 3.9, increasing the total PAH navigation channel RAL above 170,000 µg/kg would reduce the remedial footprint which may result in a reduction in the ability of the Selected Remedy to attain RAO 7.

4.0 DESCRIPTION OF SIGNIFICANT DIFFERENCES

This section describes the significant differences between the Selected Remedy presented in the Portland Harbor ROD and the proposed changes to the Selected Remedy resulting from proposed change in sediment CULs, shellfish target tissue levels, and highly toxic PTW thresholds for carcinogenic PAHs and remedial action levels for total PAHs.

Summary of Significant Changes

EPA has considered the effect of the change in the CSF for BaP on the Selected Remedy for the Site and evaluated the effect of the changes on the ability of the remedy to attain the RAOs established in the ROD and the cost of the remedy. The following changes to the remedy are being made to the Selected Remedy and other expected outcomes from the changes are summarized below:

- Update the beach sediment CUL for cPAHs from 12 to 85 µg/kg. This sediment cleanup level is based on the recreational beach exposure scenario as described in Sections 8.1.2.3 and 8.1.4.1 of the ROD and applicable to recreational beach sediments only based upon existing or reasonably anticipated future use.
- Include a direct contact sediment CUL for cPAHs of 774 µg/kg applicable to nearshore sediments (see ROD Table 17 in Appendix A). This sediment CUL is based on the tribal fisher direct contact exposure scenario and applicable to all near nearshore sediments, except for recreational beach areas.
- Correct the mathematical error made in calculating the shellfish consumption sediment CUL thus changing it from 3,950 to 39.5 µg/kg and update the shellfish consumption sediment CUL for cPAHs given the BaP CSF from 39.5 to 1,076 µg/kg. This sediment CUL is based on a subsistence fisher exposure scenario and applicable to the entire Site.
- Update the target tissue level for cPAHs in shellfish tissue from 7.1 to 51.6 µg/kg. This target tissue level for shellfish is based on a subsistence fisher exposure scenario and

applicable to the entire Site. Target fish tissue levels were not developed for cPAHs and are unaffected by this ESD.

- Update the highly toxic PTW threshold for cPAHs from 106,000 to 774,000 µg/kg. This PTW threshold is applicable to the entire Site.
- Update the total PAH RAL applicable to sediments outside the navigation channel from 13,000 to 30,000 µg/kg.
- For beaches where recreational use is possible based on existing and reasonably anticipated land use and any sediment CULs are significantly exceeded, signage or other educational institutional controls may be used until CULs are achieved.

All other elements of the Selected Remedy remain unchanged, including the surface water and groundwater CULs, total PAH sediment CULs, and total PAH RALs applicable to navigation channel sediments. EPA has determined that these changes will maintain the protectiveness of the Selected Remedy while reducing the estimated cost of the Selected Remedy by approximately $35 million. A discussion of changes in scope, performance, and cost is summarized below.

SMA Footprint Changes

Revising the remedial action level for total PAHs from 13,000 to 30,000 µg/kg results in a change to the remedial footprint for the Selected Remedy as depicted on proposed ESD Figure 8. Although this change is based solely on PAHs, post-construction concentrations and risk estimates for other COCs at the Site are also affected. Changes are limited to areas where cleanup is driven solely by PAHs and includes Terminal 4, the west side of the Willamette River between RM 4 and RM 7, the upper portion of Swan Island Lagoon, and the east side of the Willamette River between RM 2.5 and RM 3. The amount of PTW addressed by the remedy is unchanged.

RAO Evaluation

Sediment RAOs

<u>RAO 1 (Human Health Direct Contact)</u>: The changes in post-construction risk estimates resulting from this change are presented in proposed ESD Table 2 and on proposed ESD Figures 9a through 9c. RAO 1 post-construction risk estimates are presented on a ½ rolling river mile basis. For RAO 1, direct contact risk, the greatest change in the post-construction risk, occurred at RM 6.5 West and RM 4.5 East. At RM 6.5 West, post-construction risks are estimated to increase from 6×10^{-7} to 1×10^{-6}, whereas at RM 4.5 East, post-construction risks are estimated to increase from 2×10^{-6} to 3×10^{-6}. Because direct contact non-cancer risk is acceptable, changes in non-cancer hazard indices were not calculated.

<u>RAO 2 (Human Health Shellfish Ingestion)</u>: The changes in post-construction risk estimates are presented in proposed ESD Table 3 and on proposed ESD Figures 10a through 10l. RAO 2 post-

construction risk estimates are presented on a rolling river mile basis. For RAO 2, shellfish consumption risk, the greatest change in the post-construction risk occurred at RM 6.5 West and RM 4.5 East. At RM 6.5 West, post-construction risks are estimated to increase from 2×10^{-5} to 4×10^{-5}, whereas at RM 4.5 East, post-construction risks are estimated to increase from 8×10^{-5} to 1×10^{-4}. Post-construction non-cancer hazard indices quotients also increase. The largest estimated hazard index increases are from 0.8 to 1.7 for a child and from 25 to 48 for an infant at RM 6.5.

RAO 5 (Benthic Organisms): The changes in post-construction benthic risk estimates are presented in proposed ESD Table 4. For RAO 5, revising the total PAH RAL will reduce the percentage of the Site achieving 10 times the benthic risk CULs from 72% to 69% of the Site following construction.

RAO 6 (Fish and Wildlife Prey Consumption): The changes in post-construction fish and wildlife prey consumption are presented on a sediment decision unit (SDU) basis in proposed ESD Table 5 and on proposed ESD Figure 11. The maximum changes were observed in SDU 4.5 East and SDU 6 West. The total hazard index increased from 1.2 to 1.5 for both SDU 4.5 East and SDU 6 West.

Surface Water and Groundwater RAOs

RAOs 3 and 7 (Human Health and Aquatic Life Surface Water): The changes in post-construction reductions in surface water concentration are summarized in proposed ESD Table 6. Reductions in surface water concentrations associated with the Selected Remedy were estimated in the ROD to range between 26% and 91%, depending on the chemical following construction. Revised reductions are expected to range between 25% and 91%, depending on the chemical following construction. In all cases, changes in the reduction in surface water concentrations are 1% or less. For example, reductions in cPAH surface water concentrations were estimated as 78% for the Selected Remedy. Based on the changes to the Selected Remedy, the reduction in cPAH surface water concentrations is estimated as 77%. It is estimated that all surface water COC concentrations will be reduced to 10 times the CULs. Consistent with the ROD, it is expected that CULs (both risk-based and ARAR-based surface water levels) will be achieved over time through a combination of in-river cleanup with source control actions within the Site and actions taken to address toxic media within the watershed.

RAOs 4 and 8 (Human Health and Aquatic Life Groundwater): The area of groundwater plumes addressed by the in-water portion of the updated remedy following construction is estimated to be reduced from 39% to 32% as shown in proposed ESD Table 7. Consistent with the ROD, the remainder of the contaminated groundwater will be dependent on the adequacy of source control actions.

River Banks and Principal Threat Waste

ROD riverbanks with adjacent offshore active remediation areas that have been reduced or removed by the proposed ESD changes have been identified and removed from the selected remedy cost estimate for the purpose of capturing potential cost changes. Actual costs will be determined based on remedial design. The lineal feet of river bank addressed by the updated remedy is estimated to be reduced from 23,305 to 22,592 lineal feet as shown on proposed ESD Table 8 and Figure 12. This represents a reduction from 78% to 75% of contaminated river banks. It is important to note that ROD river banks with no active remediation offshore must still undergo characterization of riverbank CULs and potential active remediation for focused COC's exceeding RALs and/or presence of PTW. Also, consistent with the ROD, the remaining river bank areas are expected to be addressed through other cleanup actions (i.e., upland source control measures).

No change to the amount of PTW addressed by the updated remedy is expected.

Human Health Beach Exposure

In addition to changes in post construction risk, changes in the results of the human risk assessment associated with the change in the CSF for BaP were also evaluated for the human health direct contact beach exposure scenario. Beach areas at the Portland Harbor site were evaluated for dockworkers, transients, recreational beach users and tribal, high frequency and low frequency fishers. The evaluation focused on the exposure scenario that presents the maximum risk for each beach area (tribal fisher or dockworker). The evaluation shows that human health beach exposure risk estimates decline between 0 and 86% depending on the contribution of cPAHs to the total risk at each beach area. The results of this evaluation are shown in proposed ESD Table 9 and Figure 13.

Remedial Quantities and Cost

EPA evaluated the changes in remedial quantities and cost associated with changing the total PAH RAL applicable to nearshore sediments outside the navigation channel. The revised remedial footprint including technology assignments is presented in Figure 14a – f. EPA determined that this change would reduce the total nearshore remedial footprint by 17 acres, reduce the capping area by 8 acres, and reduce the dredging volume by 43,800 cy. This results in a decrease in the present value cost for the Selected Remedy of approximately $35 million. This represents a 3.4% decrease in the overall present value cost of the Selected Remedy. Cost assumptions are included in Appendix A.

5.0 SUPPORT AGENCY COMMENTS

DEQ has reviewed and agrees to the modifications to the CULs for cPAH (BaPeq) and RALs for total PAHs for the Selected Remedy. The support agency letter of concurrence will be provided after consideration of comments received during the public review and comment period.

The Five Tribes support EPA's approach regarding updating CULs for cPAH (BaPeq) and RALs for total PAHs in response to the BaP revision in a proposed ESD. The Five Tribes are the Confederated Tribes of the Grand Ronde Community of Oregon, the Nez Perce Tribe, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes of the Warm Springs Reservation of Oregon. The letter of concurrence is included in Appendix D of this proposed ESD.

6.0 STATUTORY DETERMINATIONS

The Selected Remedy for the Portland Harbor Superfund Site, as modified by this proposed ESD, continues to satisfy the statutory requirements of Section 121 of CERCLA, 42 USC § 9621, to protect human health and the environment, comply with federal and state requirements that are applicable or relevant and appropriate to the remedial action, are cost-effective, and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

7.0 PUBLIC PARTICIPATION COMPLIANCE

The public participation requirements set out in the NCP, 40 CFR § 300.435(c)(2), have been met by adding the ESD and supporting information to the administrative record established under Section 300.815. EPA will publish a notice that briefly summarizes the final ESD, including the reasons for such differences in a major local newspaper of general circulation. EPA also recognized that there is strong community interest in the Portland Harbor Superfund Site and that there was a need for additional public participation opportunities regarding the proposed ESD. As a result, the proposed ESD and supporting administrative record were made available to the public through a 30-day public comment period. In addition, EPA held a public meeting to discuss the changes to the Selected Remedy in the proposed ESD.

8.0 REFERENCES

Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). EPA/540/1-89/002. December.

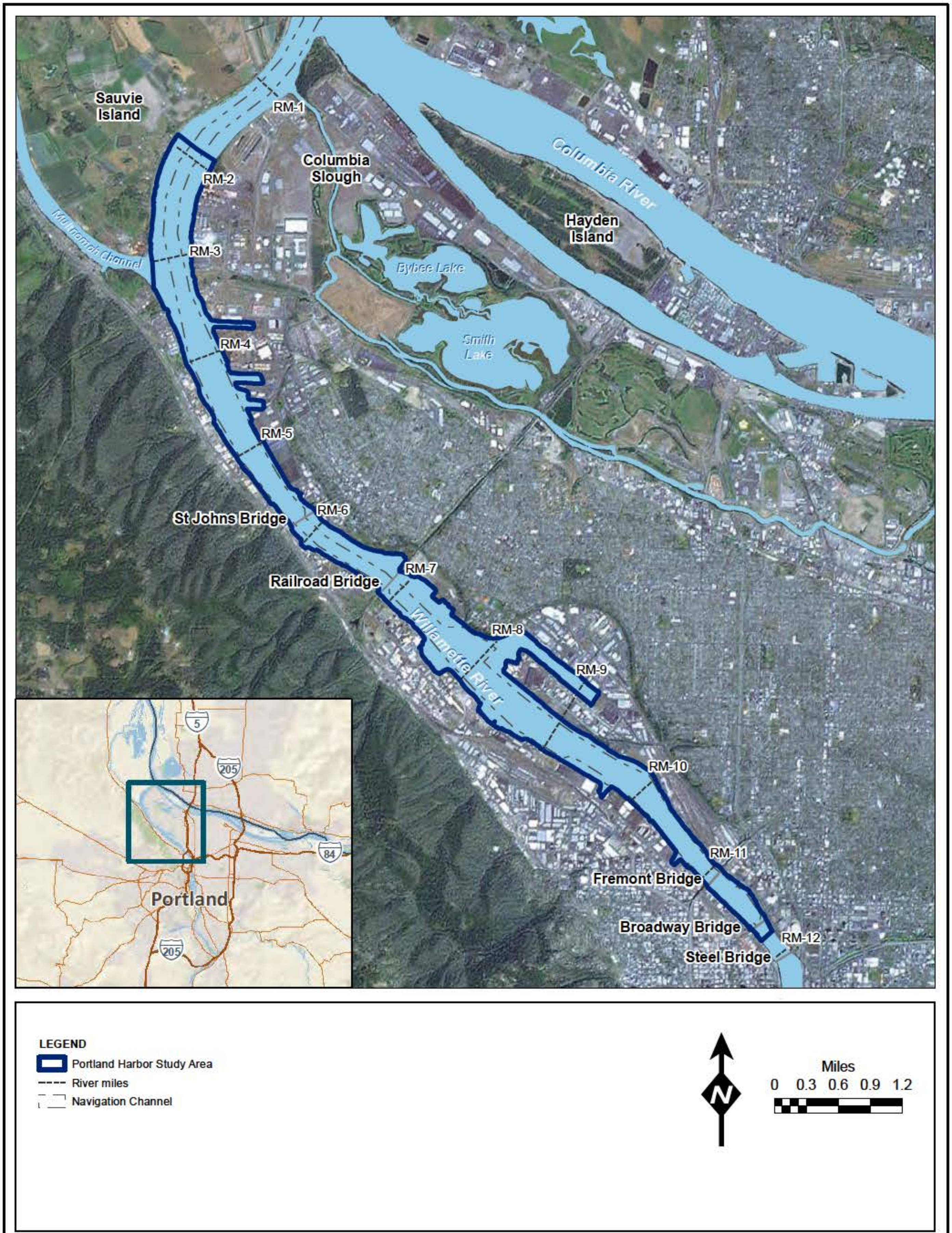
EPA. 2016a. *Final Remedial Investigation Report, Portland Harbor Remedial Investigation/Feasibility Study*. Environmental Protection Agency Region 10, Seattle, WA. February 8.

EPA. 2016b. *Draft Final Portland Harbor Feasibility Study*. Environmental Protection Agency Region 10, Seattle, WA. June.

EPA. 2017a. *Record of Decision for the Portland Harbor Superfund Site*, Portland, Oregon. January 3.

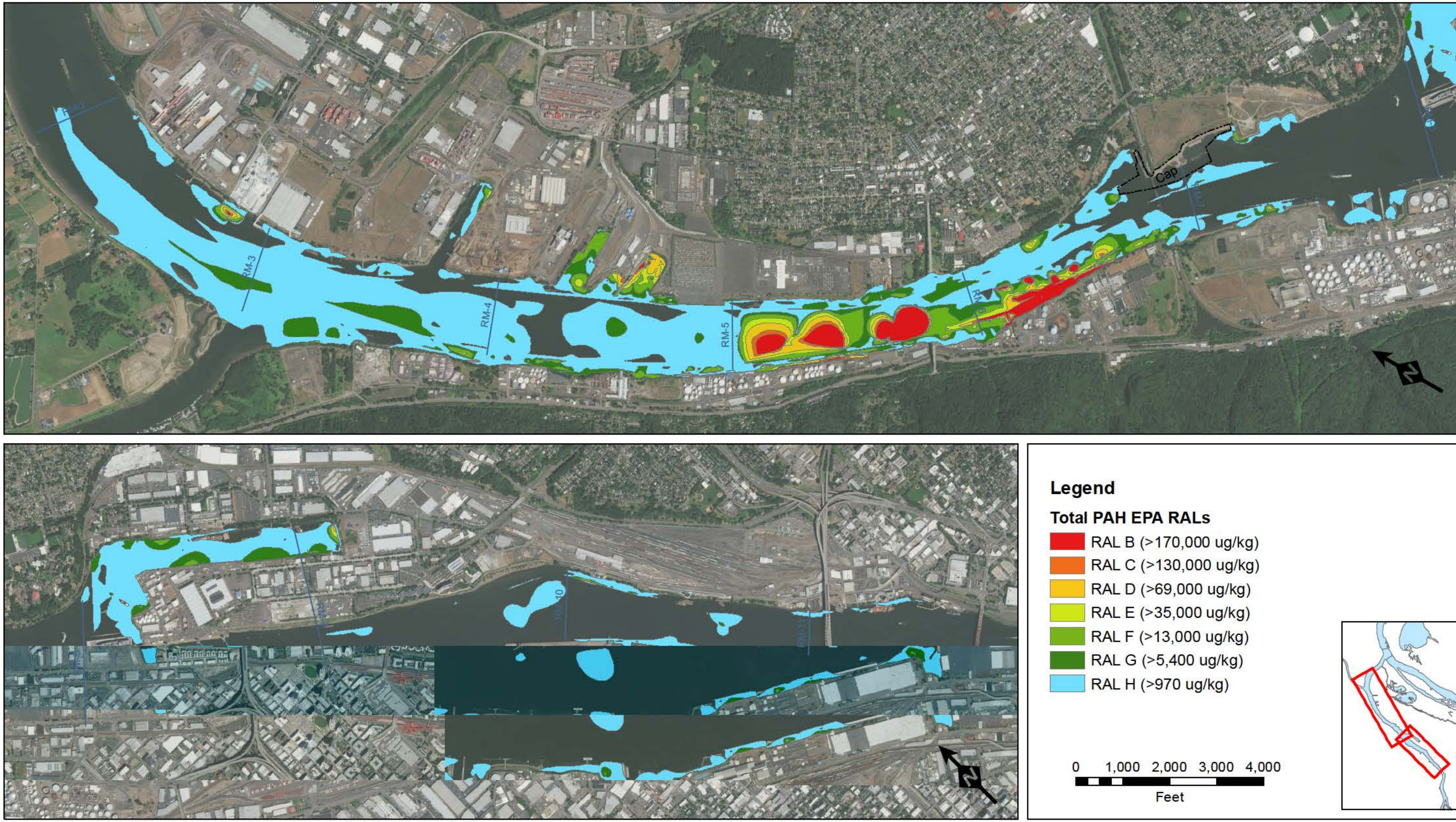
EPA. 2017b. *Toxicological Review of Benzo[a]pyrene*. Integrated Risk Information System, National Center for Environmental Assessment, Office of Research and Development. Washington, DC. January 19.

Figures



ESD Figure 1. Site Area

Portland Harbor Superfund Site



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ESD Figure 2. Total PAH Remedial Action Level Contours

Portland Harbor Superfund Site

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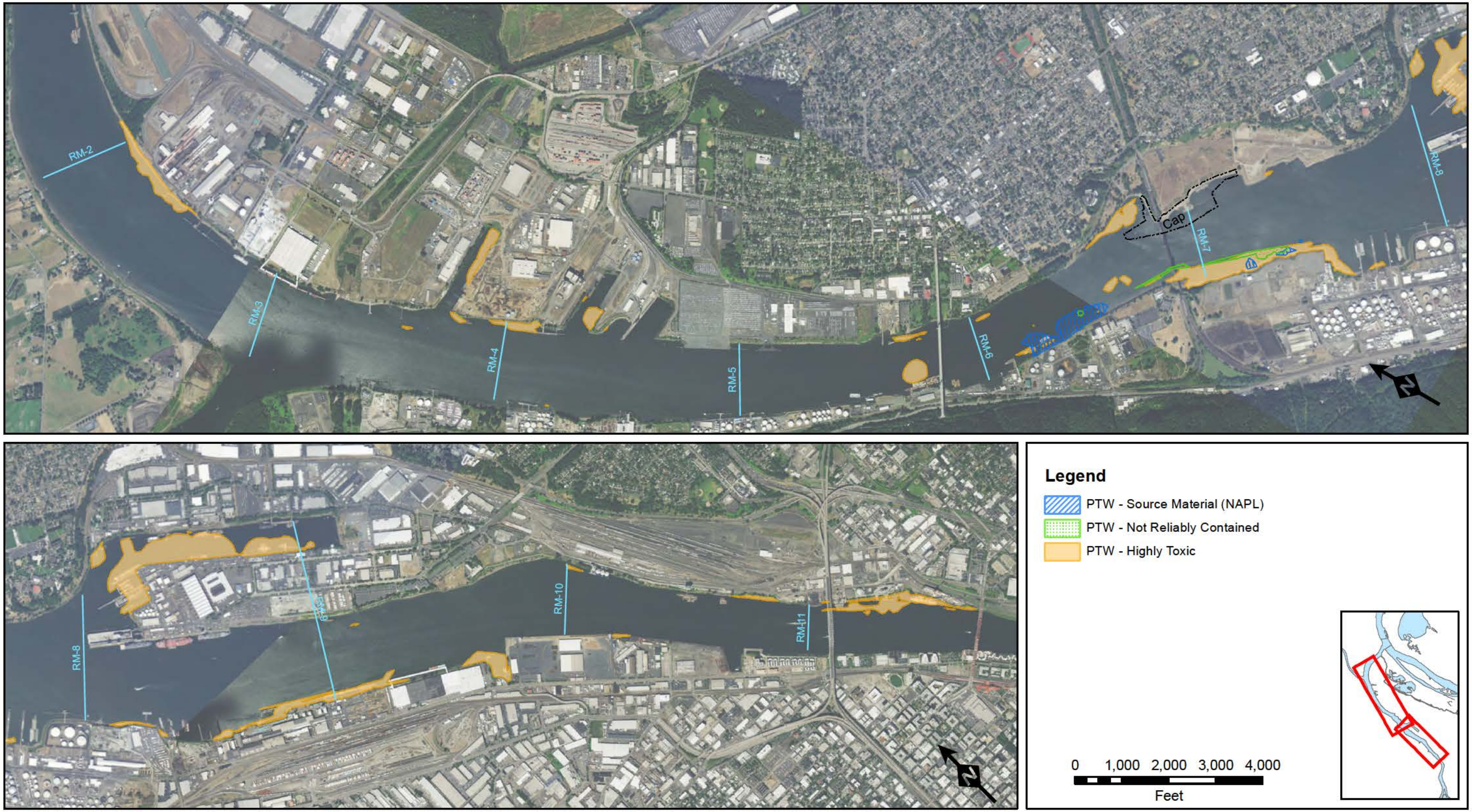

Source Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

ESD Figure 3. Principal Threat Waste

Portland Harbor Superfund Site

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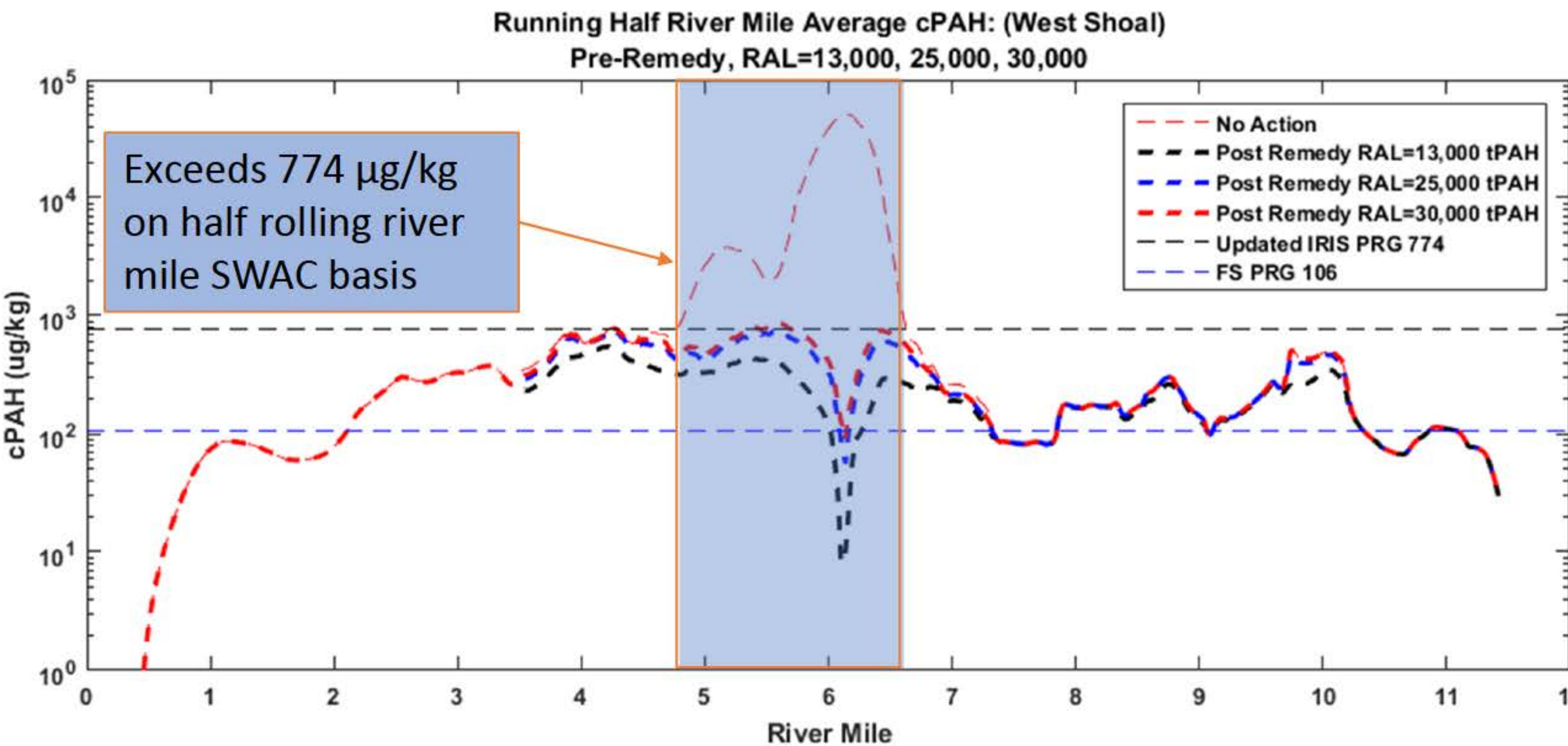
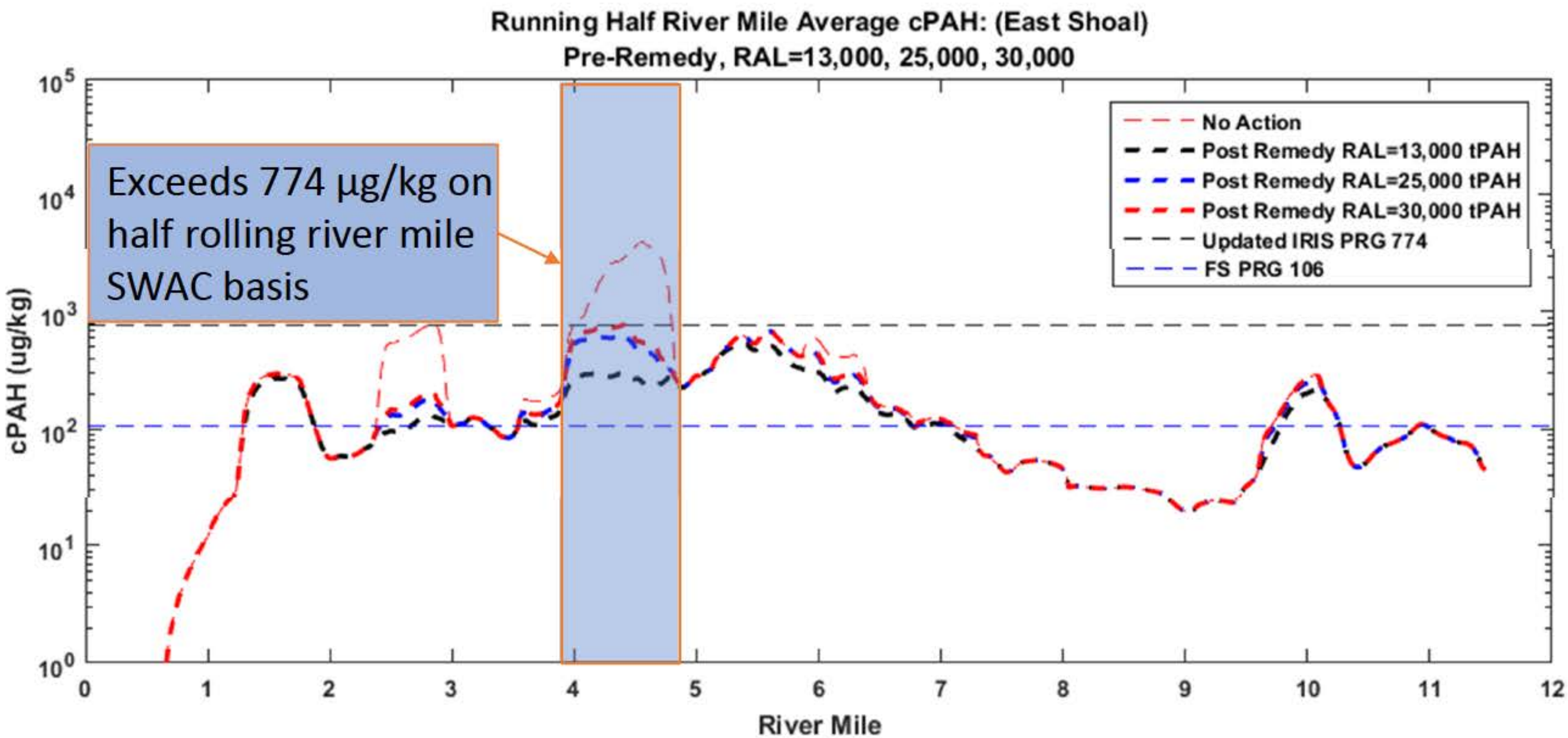


Note: cPAH half rolling river mile SWAC was estimated assuming cleanup above tPAH RAL for each scenario

ESD Figure 4a. Running Half Mile Average cPAH (West)

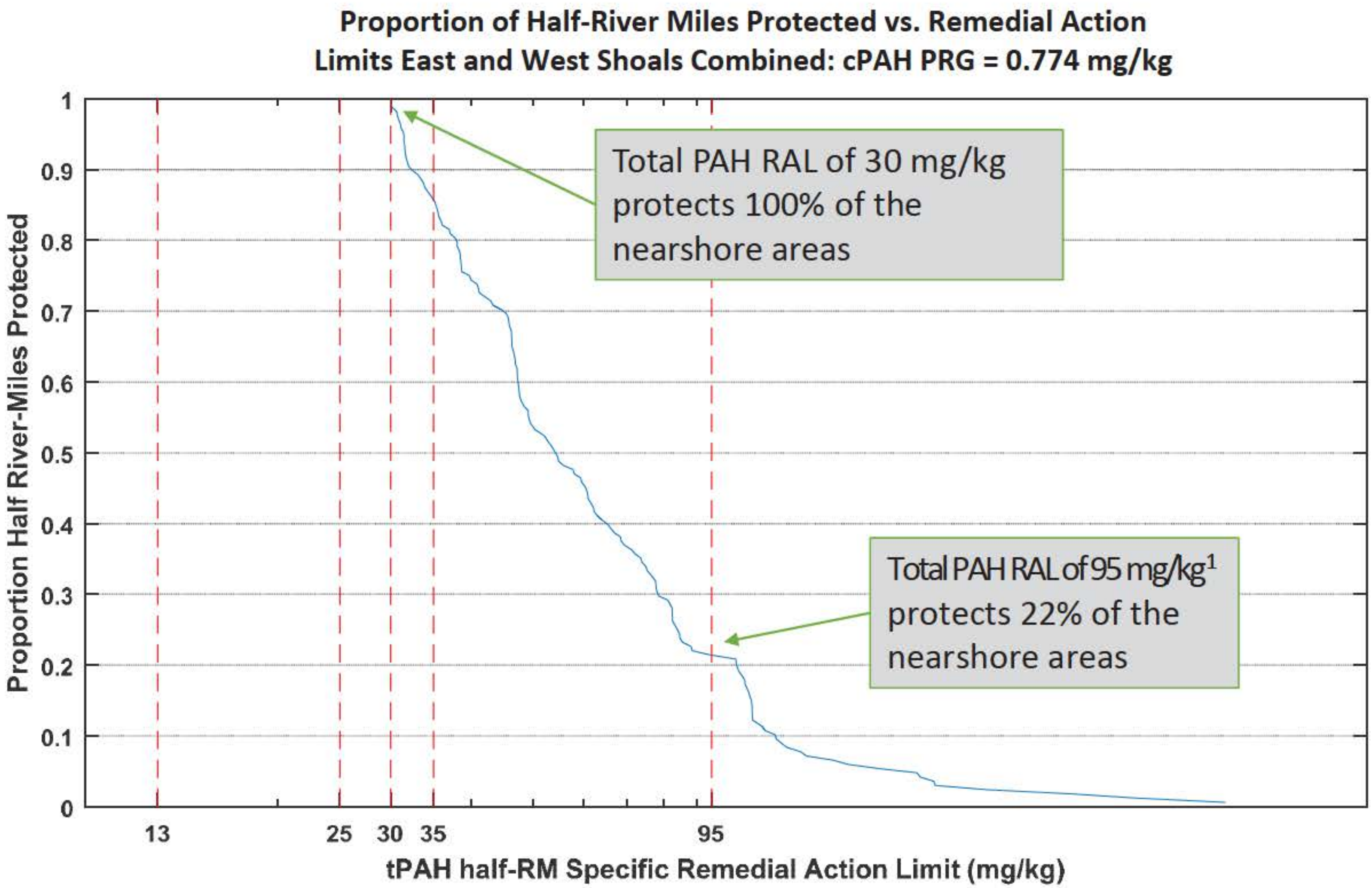
Portland Harbor Superfund Site



Note: cPAH half rolling river mile SWAC was estimated assuming cleanup above tPAH RAL for each scenario

ESD Figure 4b. Running Half Mile Average cPAH (East)

Portland Harbor Superfund Site

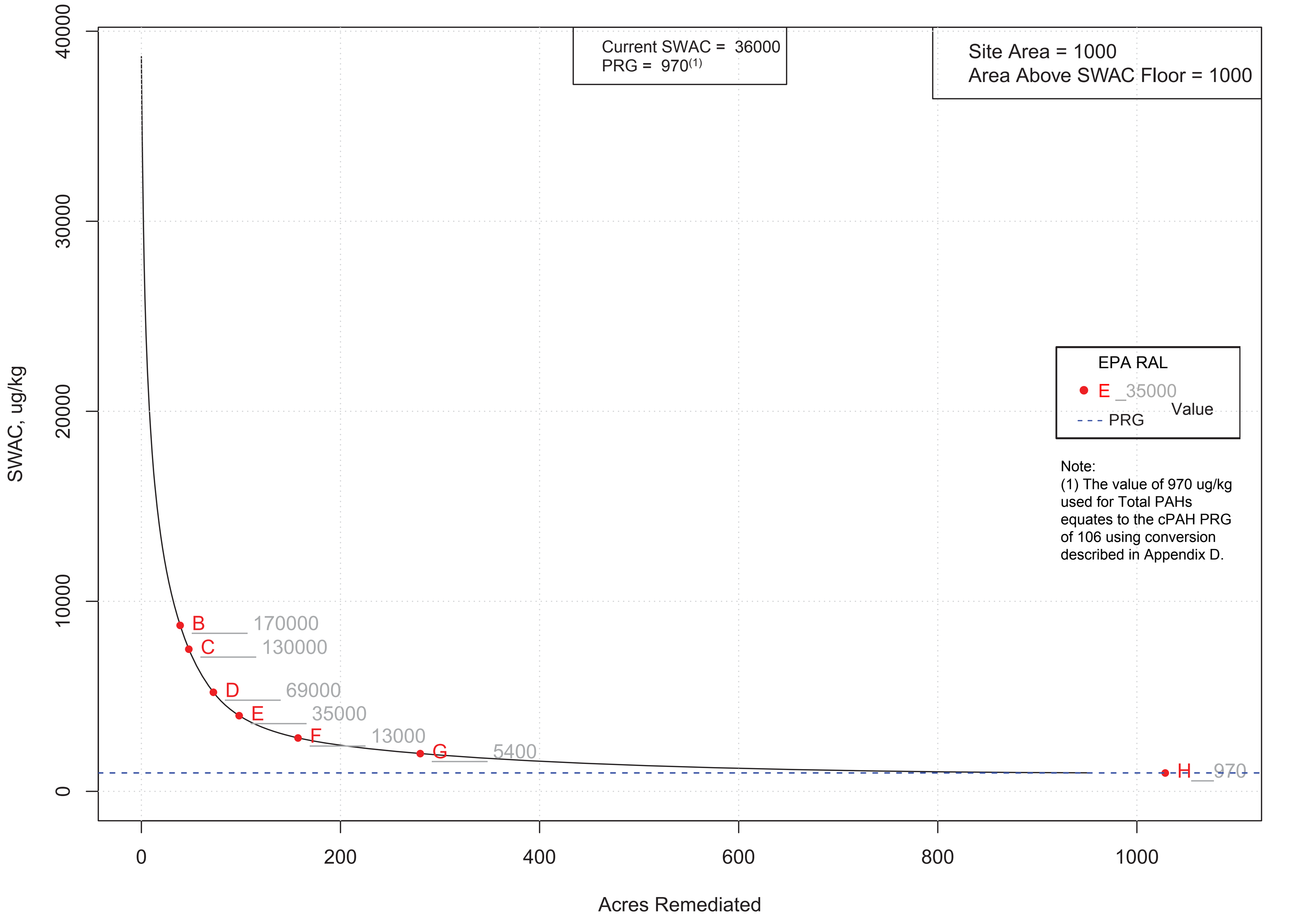


Note:

1 - Total PAH RAL of 95 mg/kg represents an increase in the Alternative F RAL of 13 mg/kg by a factor of 7.3 consistent with the BaP cancer slope factor change

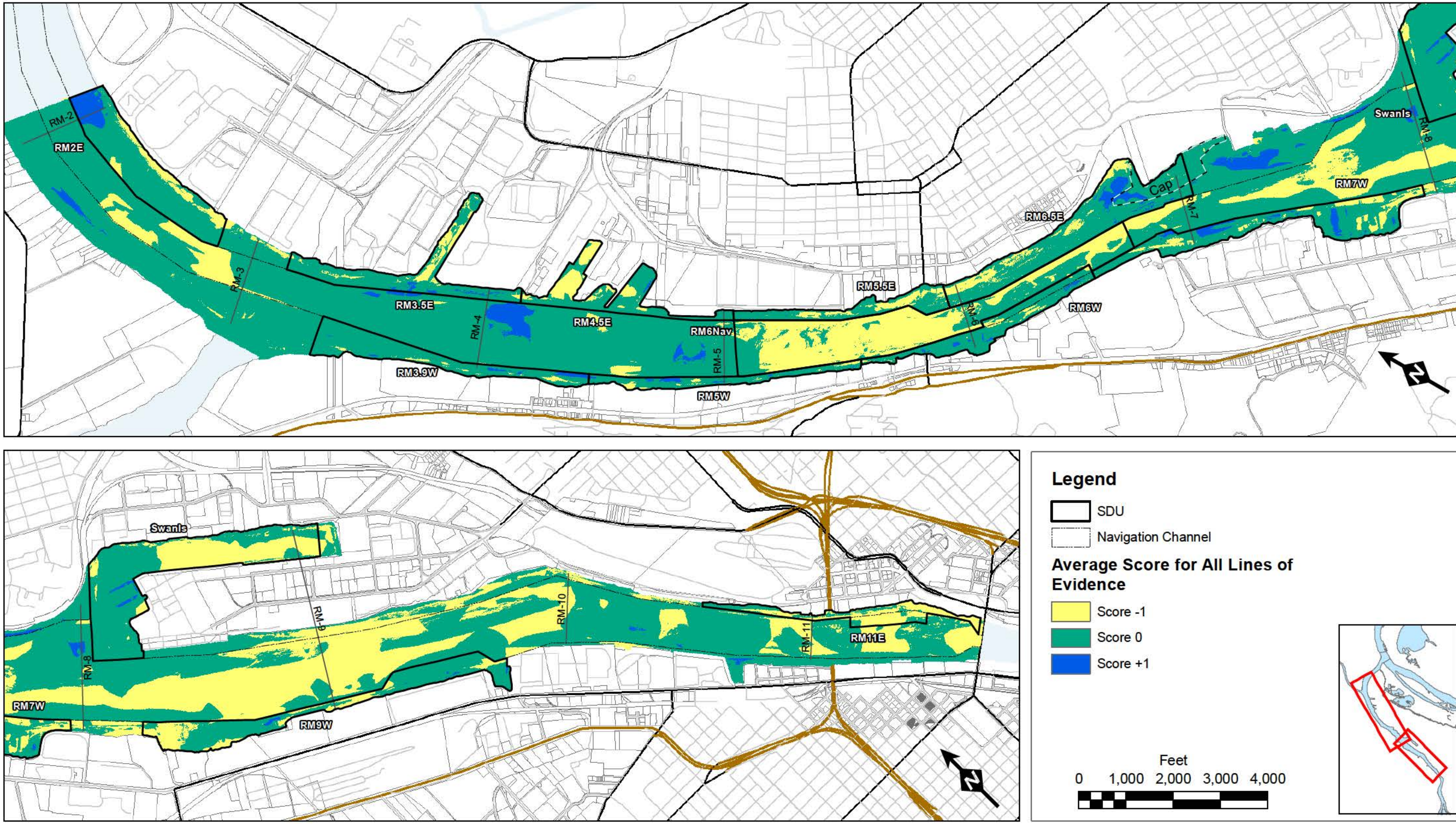
ESD Figure 5. Proportion of Half-River Miles Protected vs. Remedial Action Levels

Portland Harbor Superfund Site



ESD Figure 6. Total PAH RAL Curve

Portland Harbor Superfund Site



ESD Figure 7. Natural Recovery Summary Score

Portland Harbor Superfund Site

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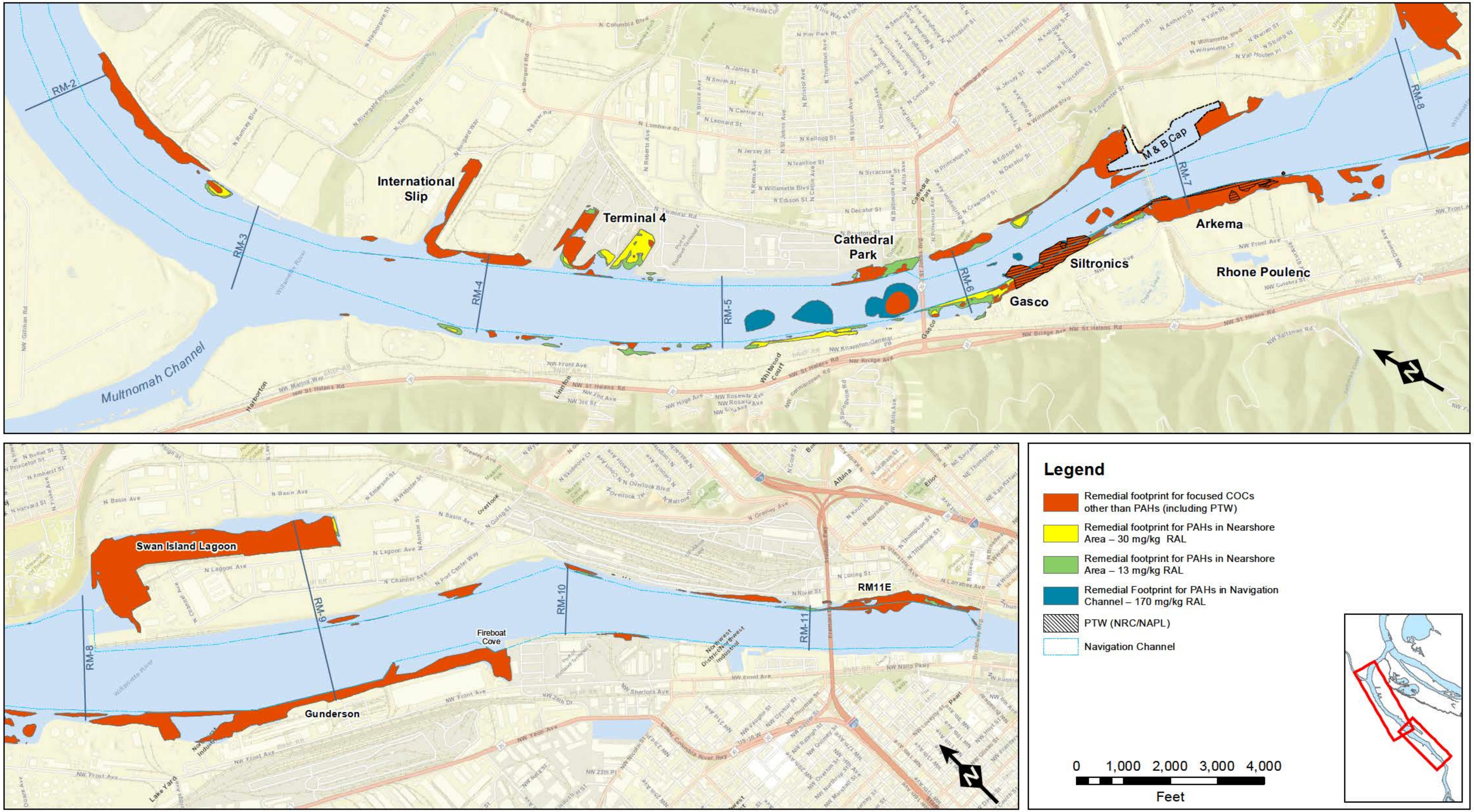

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ESD Figure 8. Revised Remedial Footprint Summary

Portland Harbor Superfund Site

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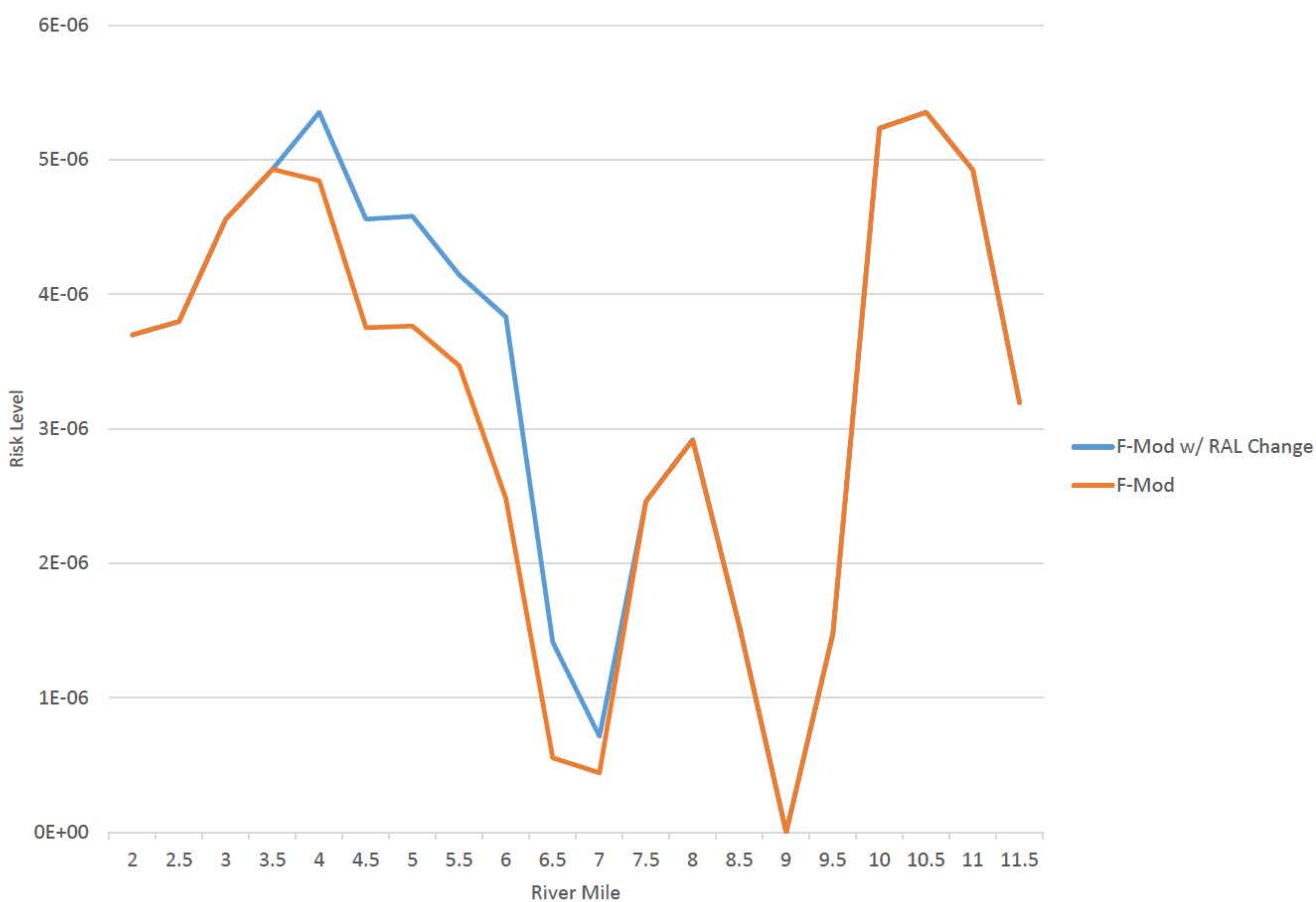
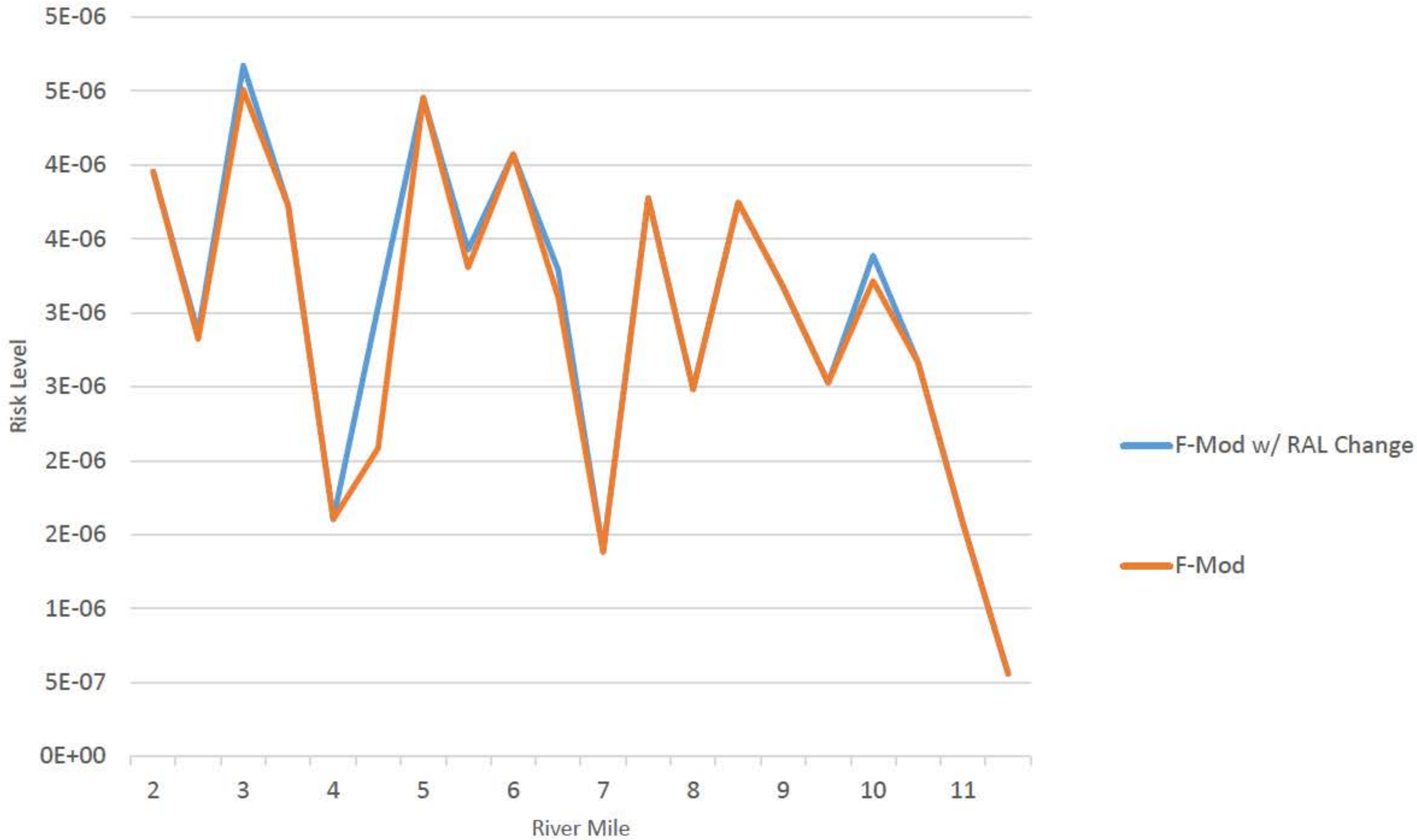


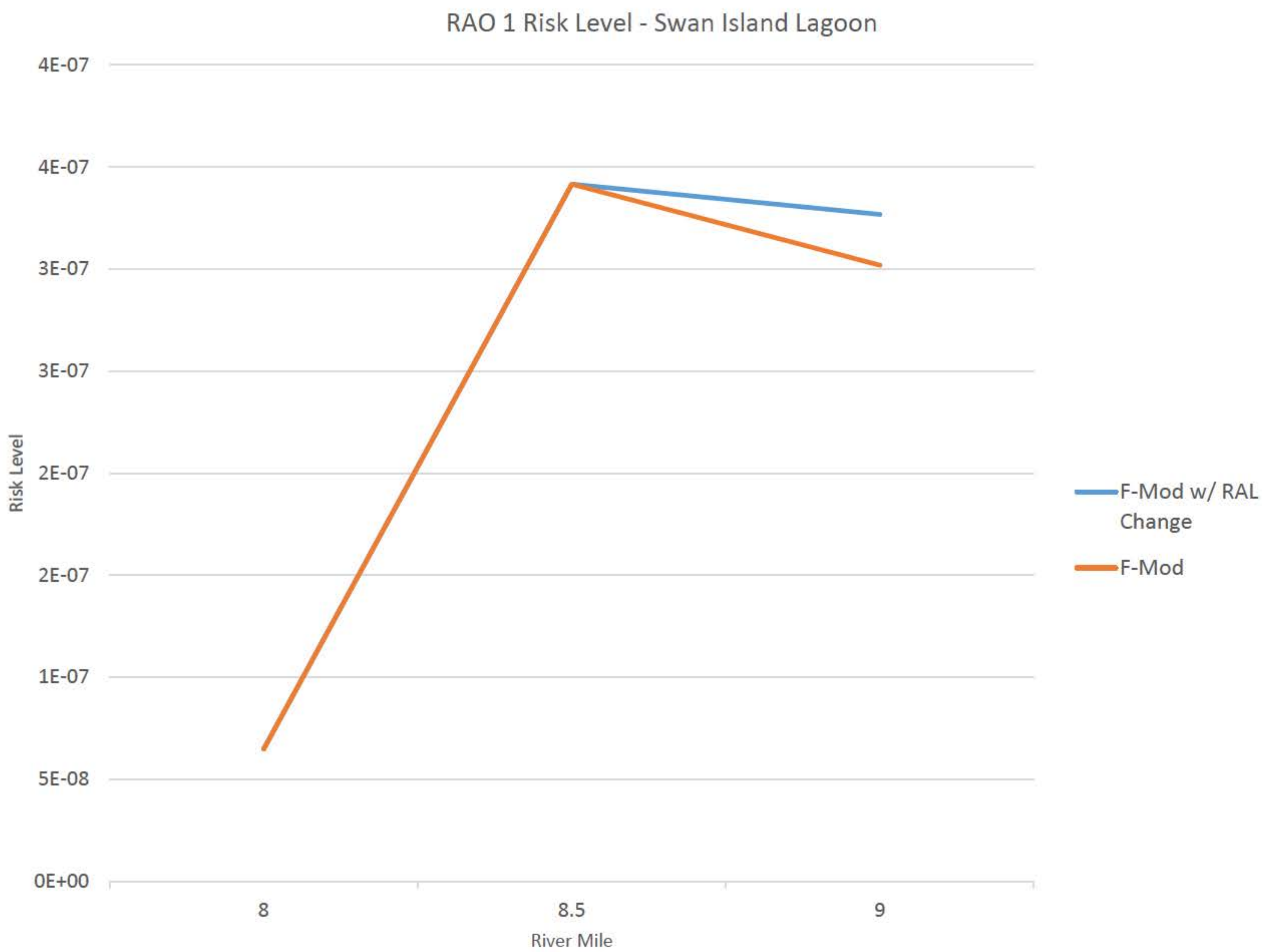
ESD Figure 9a. RAO 1 Risk Level - RM Basis (West)

Portland Harbor Superfund Site



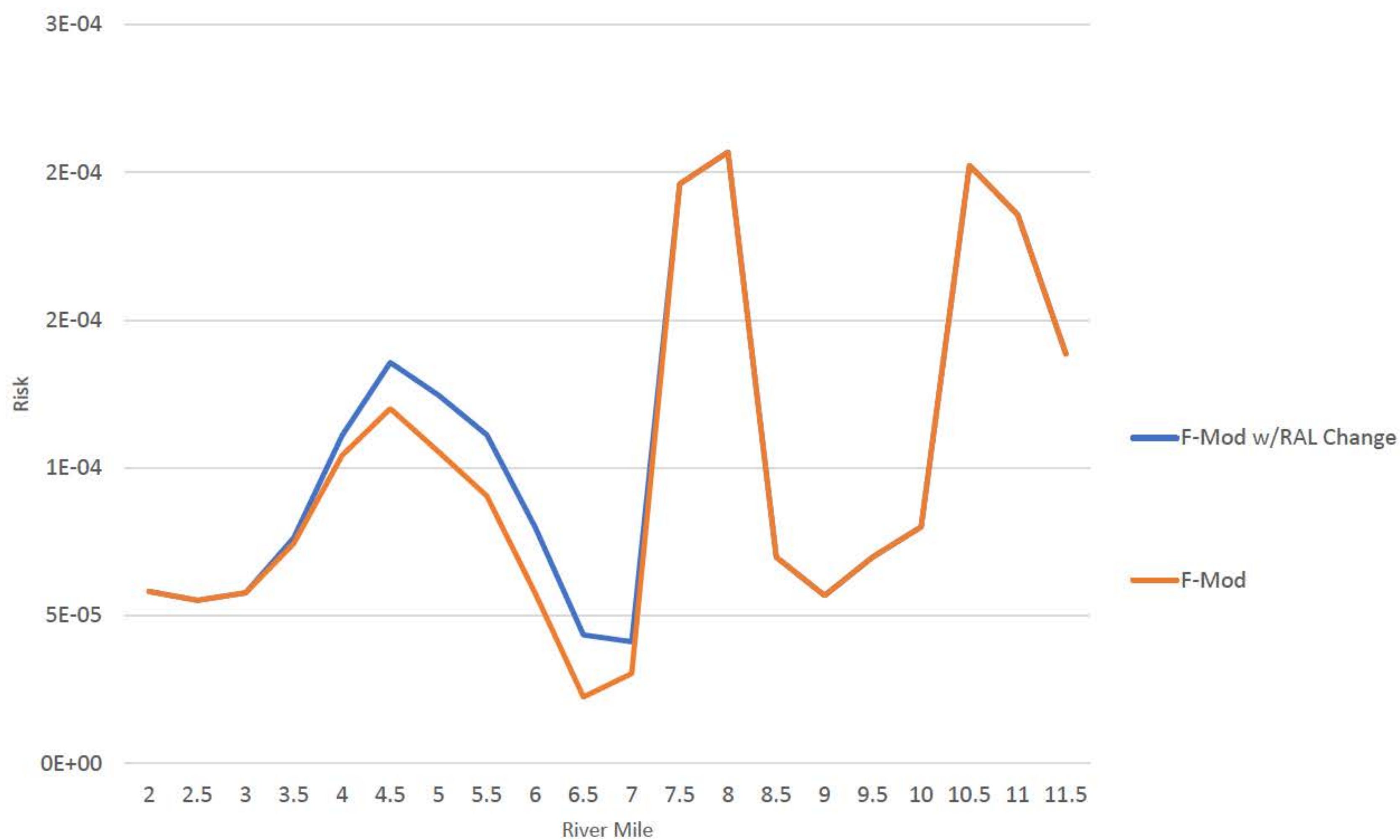
ESD Figure 9b. RAO 1 Risk Level - RM Basis (East)

Portland Harbor Superfund Site



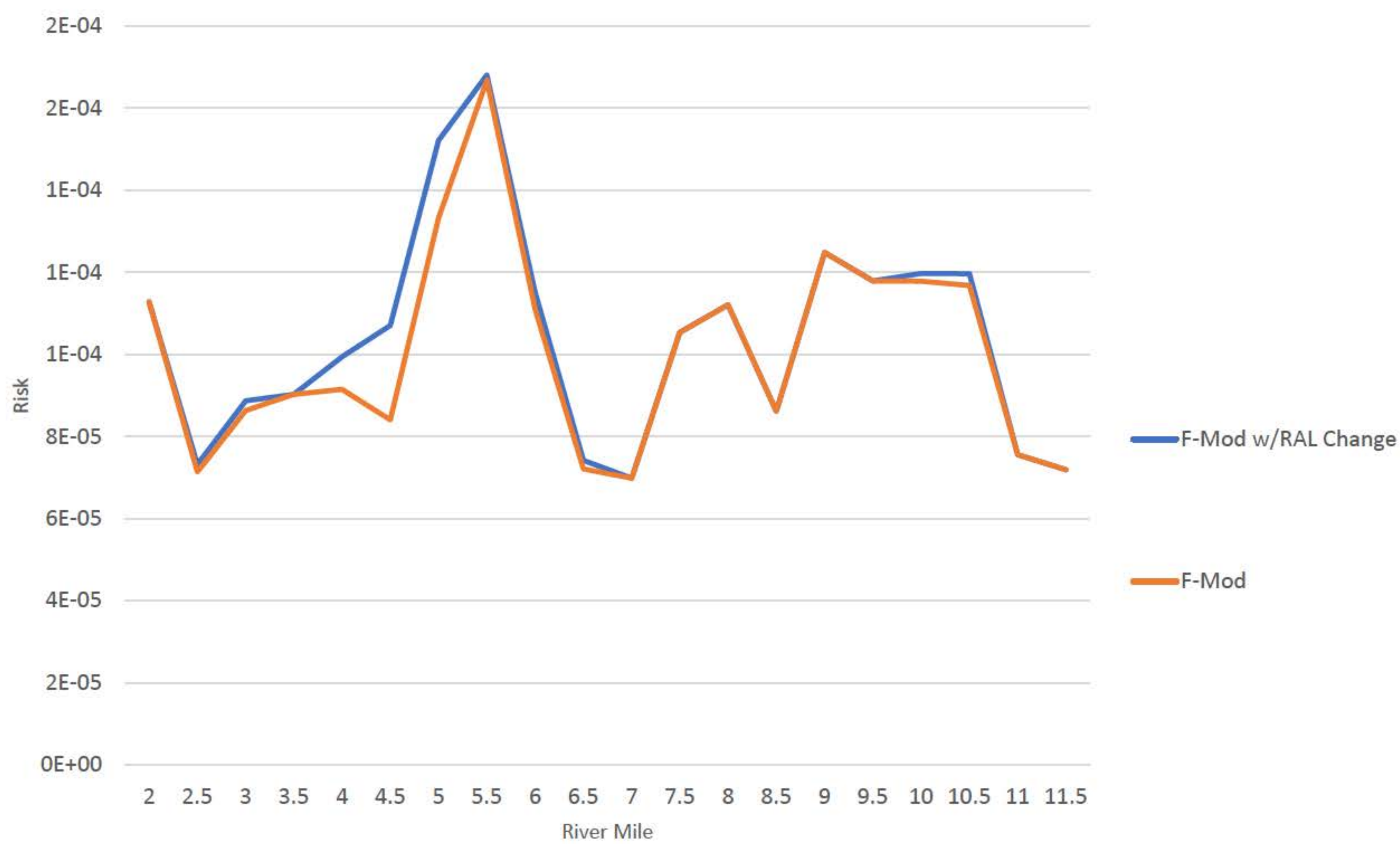
ESD Figure 9c. RAO 1 Risk Level - RM Basis (Swan Island Lagoon)

Portland Harbor Superfund Site



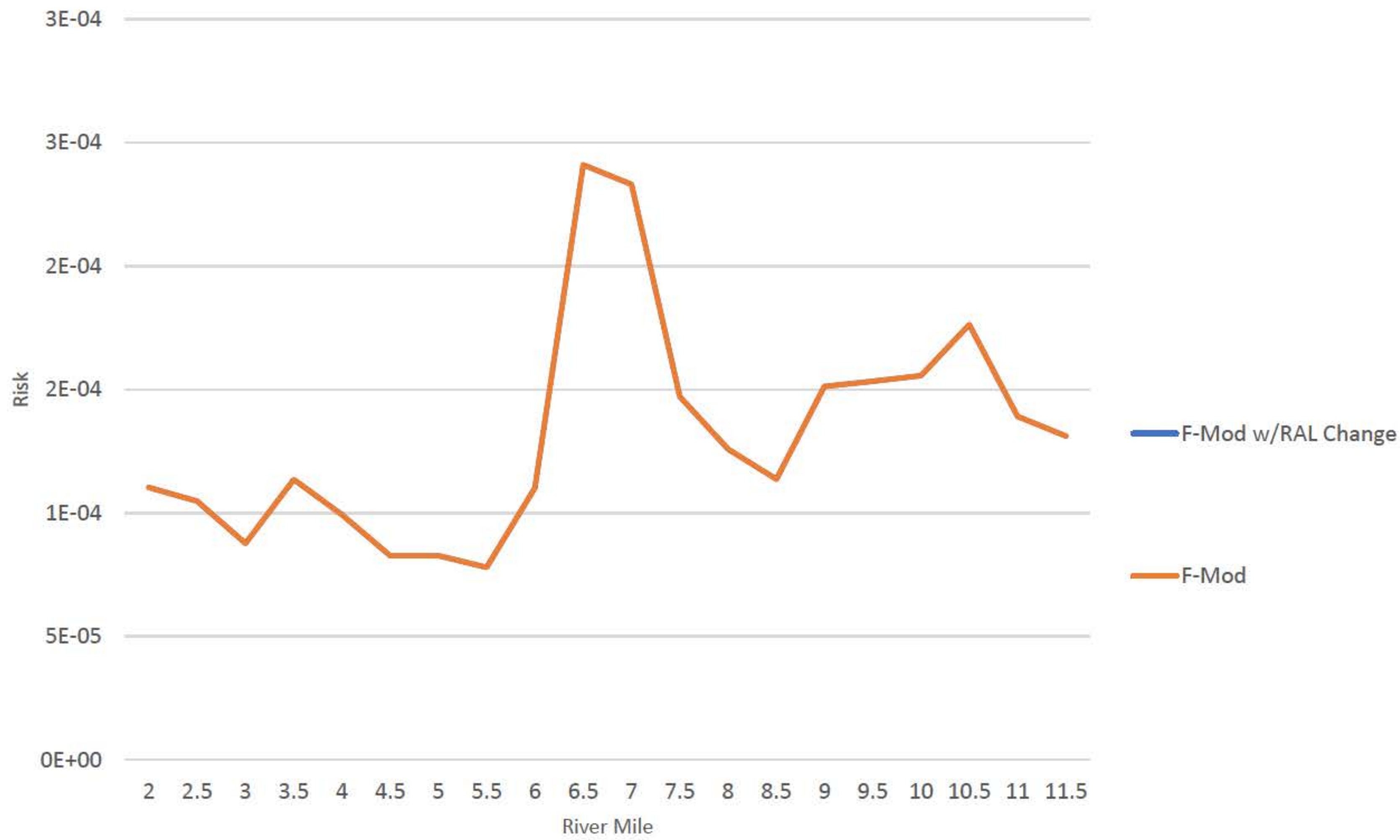
ESD Figure 10a. RAO 2 Risk Level - RM Basis (West)

Portland Harbor Superfund Site



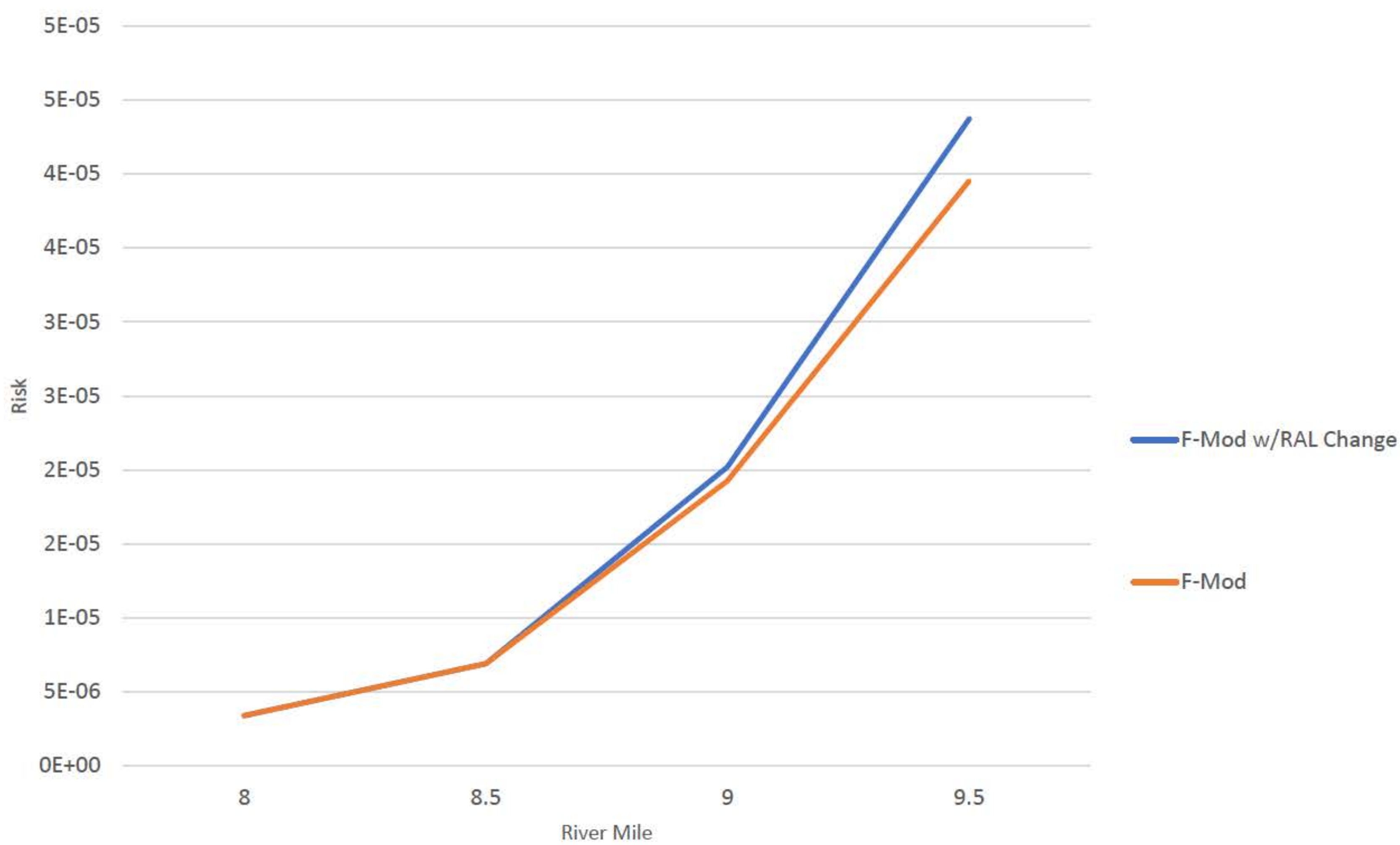
ESD Figure 10b. RAO 2 Risk Level - RM Basis (East)

Portland Harbor Superfund Site



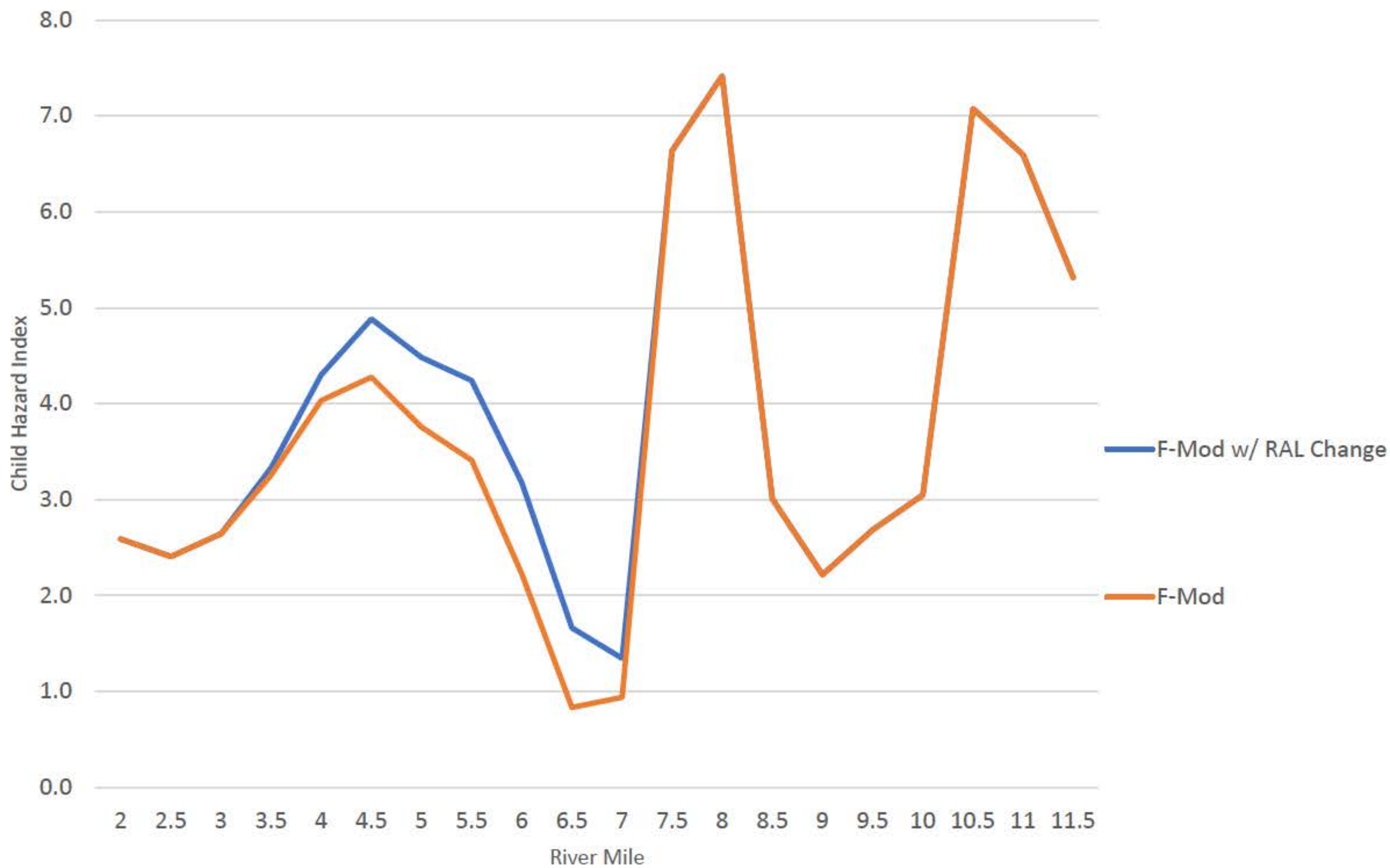
ESD Figure 10c. RAO 2 Risk Level - RM Basis (Navigation Channel)

Portland Harbor Superfund Site



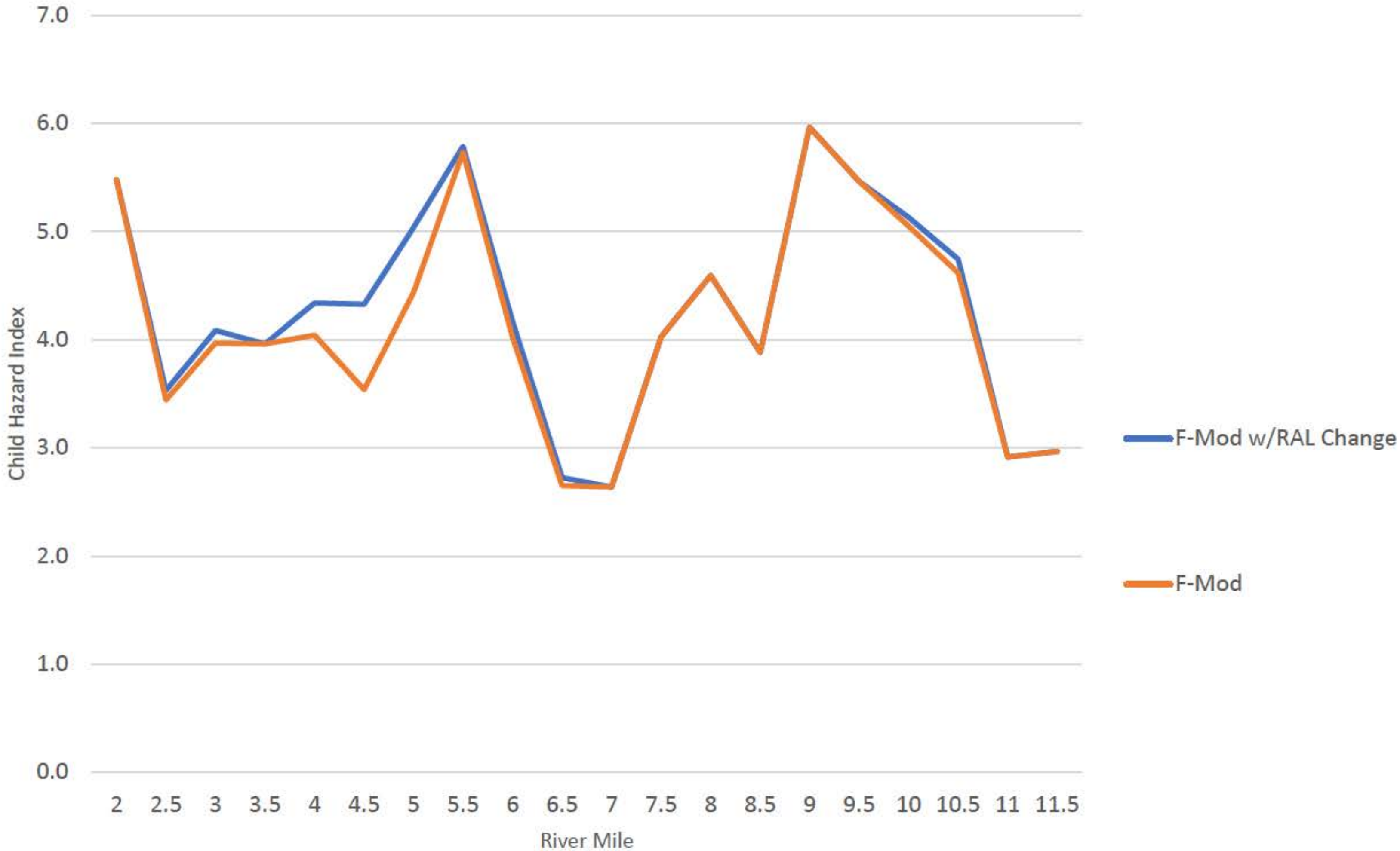
ESD Figure 10d. RAO 2 Risk Level - RM Basis (Swan Island Lagoon)

Portland Harbor Superfund Site



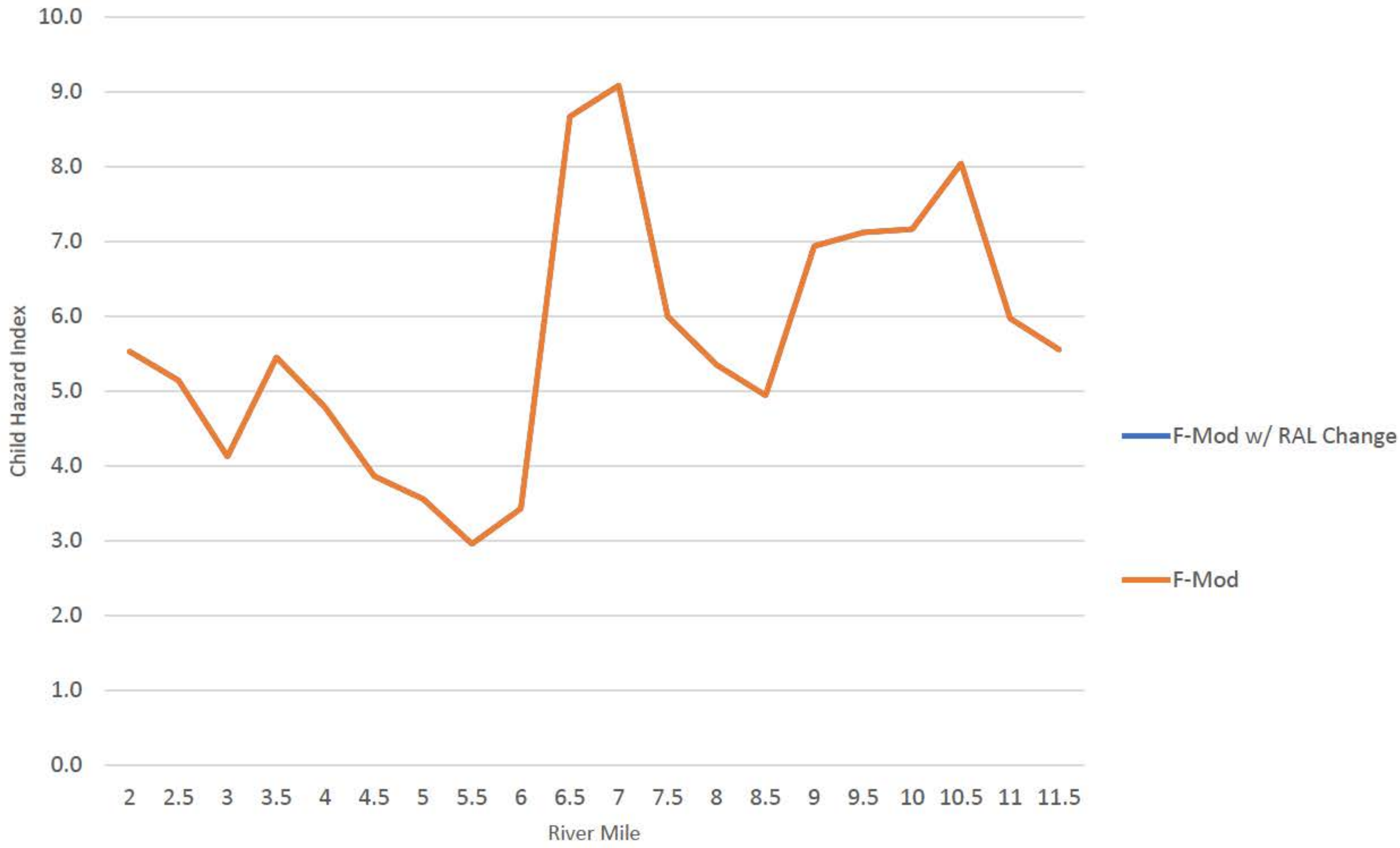
ESD Figure 10e. RAO 2 Hazard Index Child - RM Basis (West)

Portland Harbor Superfund Site



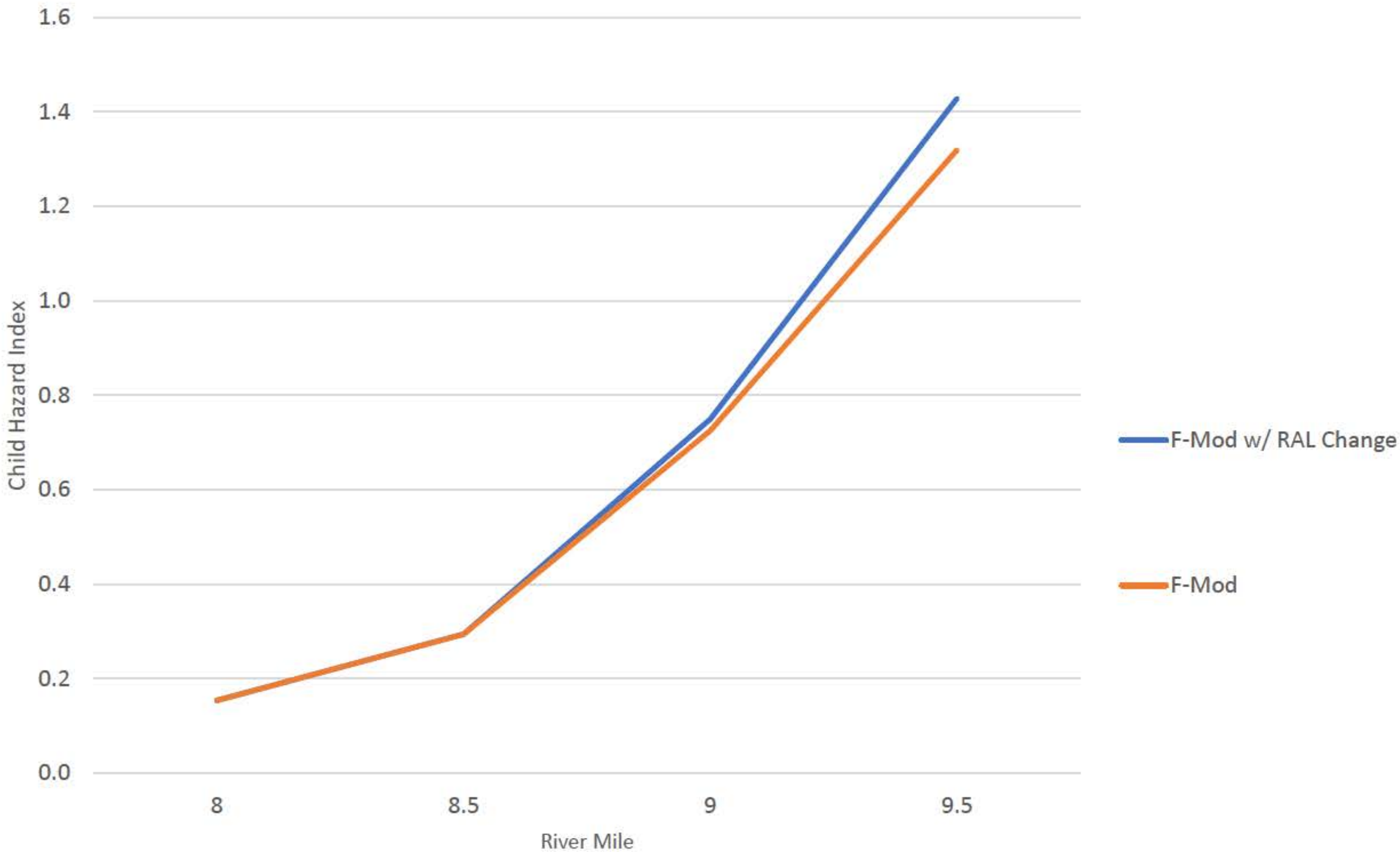
ESD Figure 10f. RAO 2 Hazard Index Child - RM Basis (East)

Portland Harbor Superfund Site



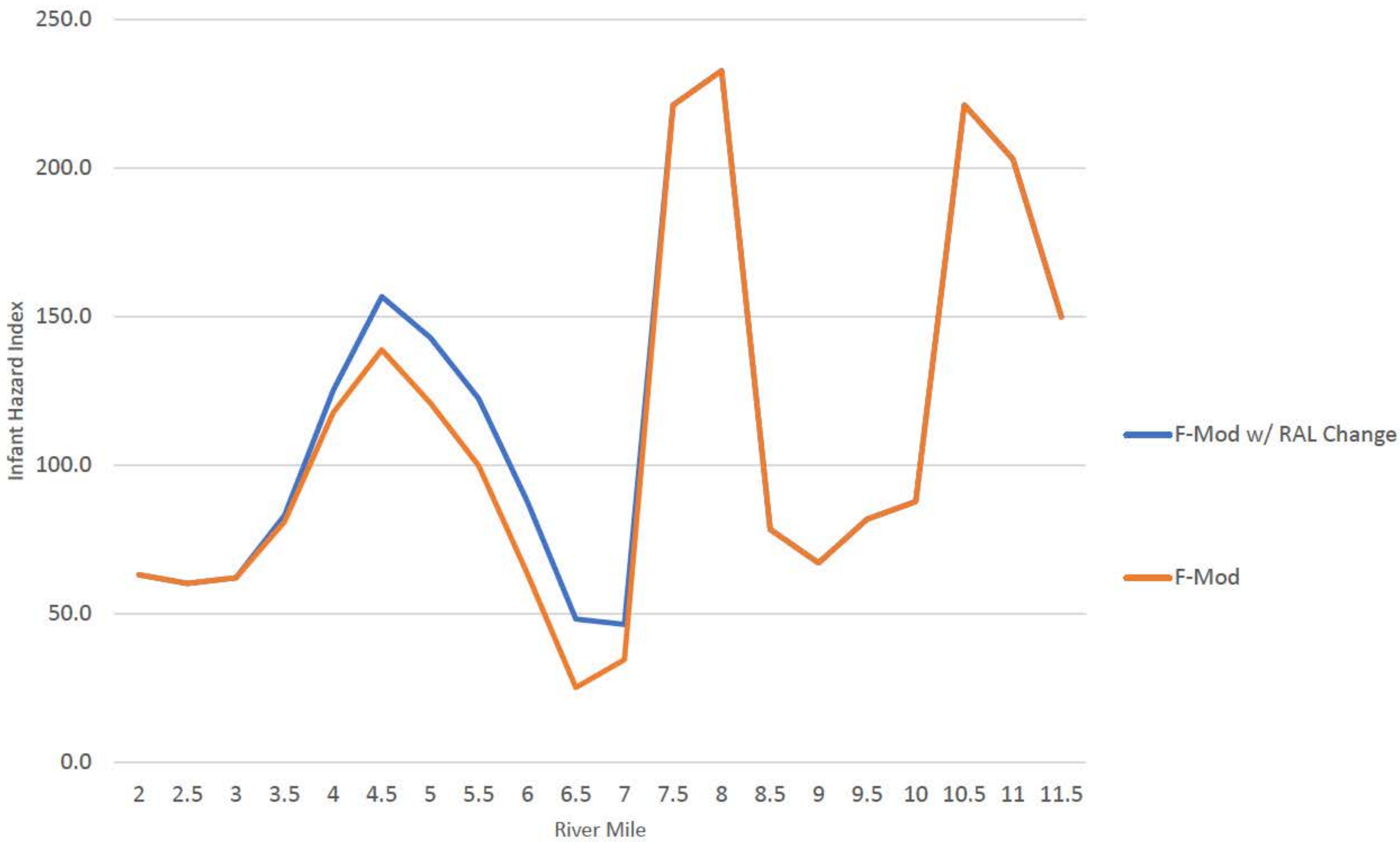
ESD Figure 10g. RAO 2 Hazard Index Child - RM Basis (Navigation Channel)

Portland Harbor Superfund Site



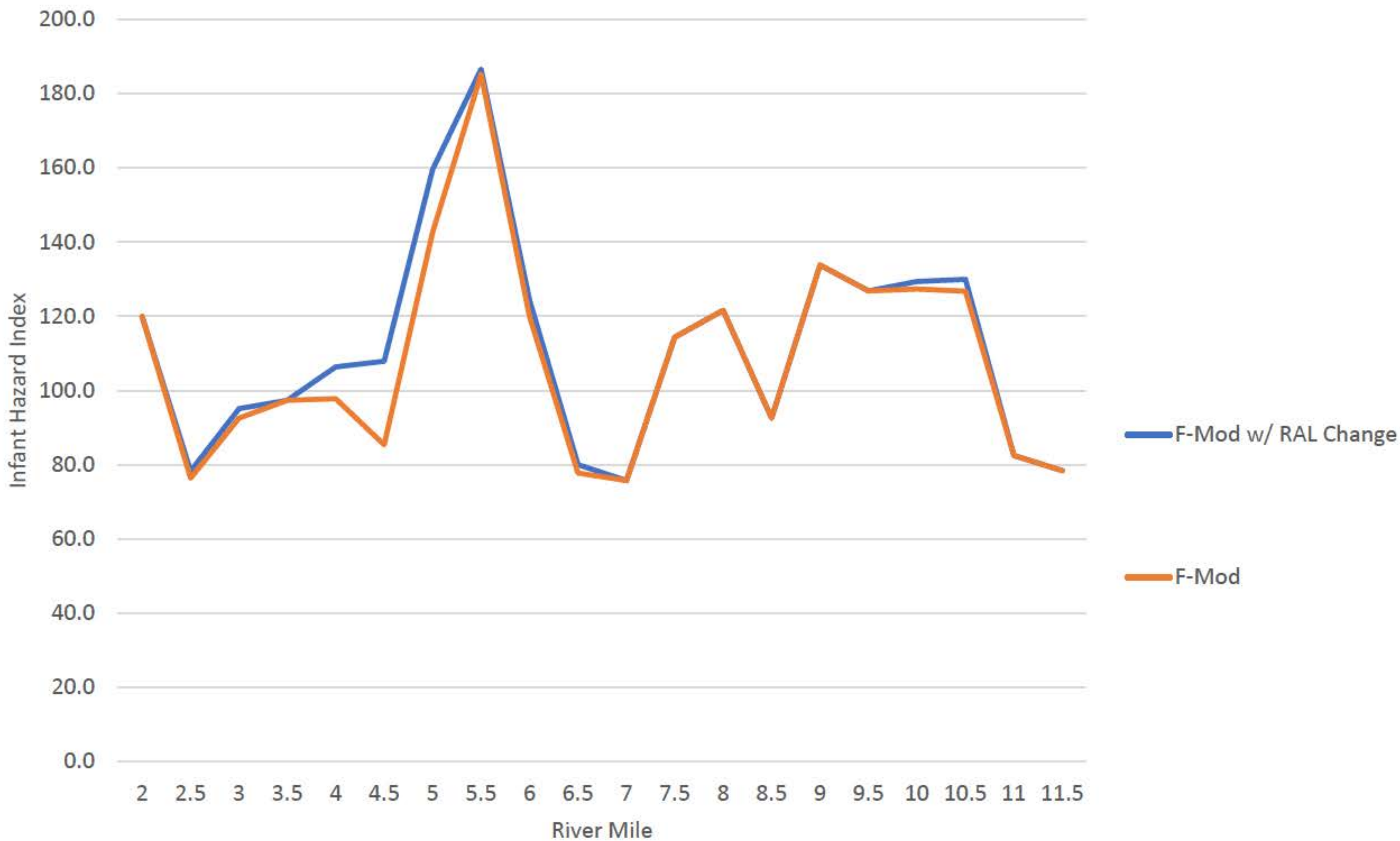
ESD Figure 10h. RAO 2 Hazard Index Child - RM Basis (Swan Island Lagoon)

Portland Harbor Superfund Site



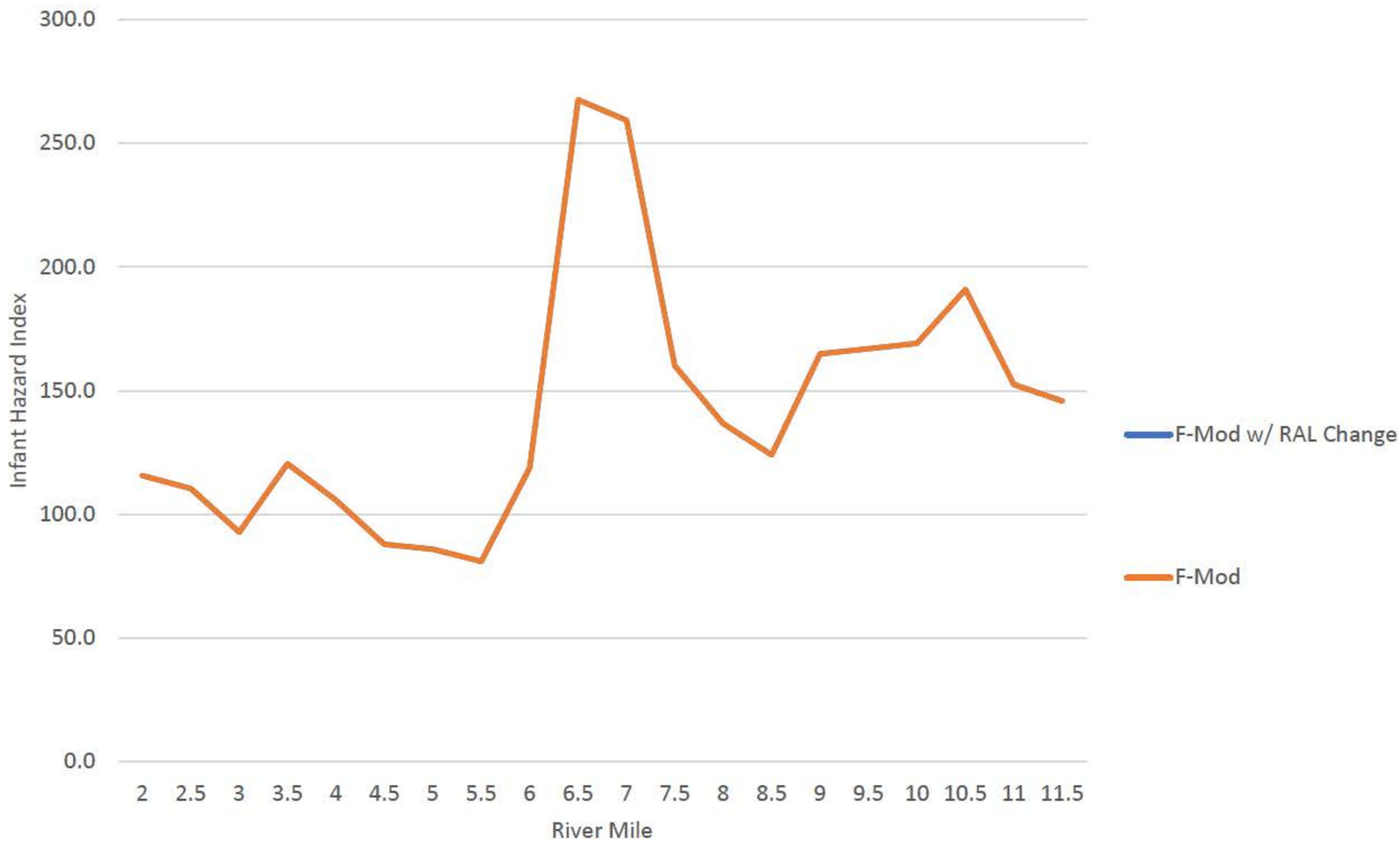
ESD Figure 10i. RAO 2 Hazard Index Infant- RM Basis (West)

Portland Harbor Superfund Site



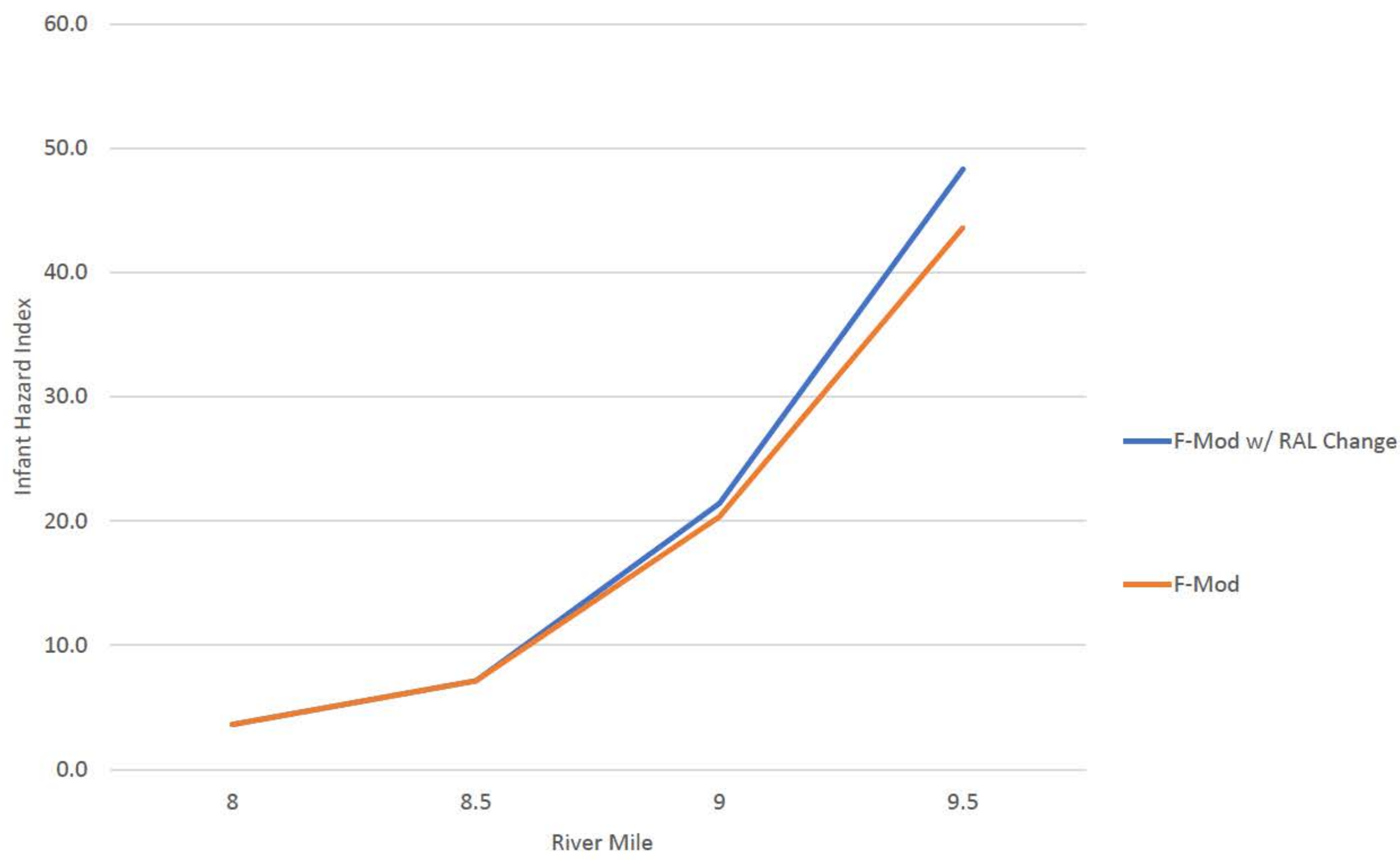
ESD Figure 10j. RAO 2 Hazard Index Infant - RM Basis (East)

Portland Harbor Superfund Site



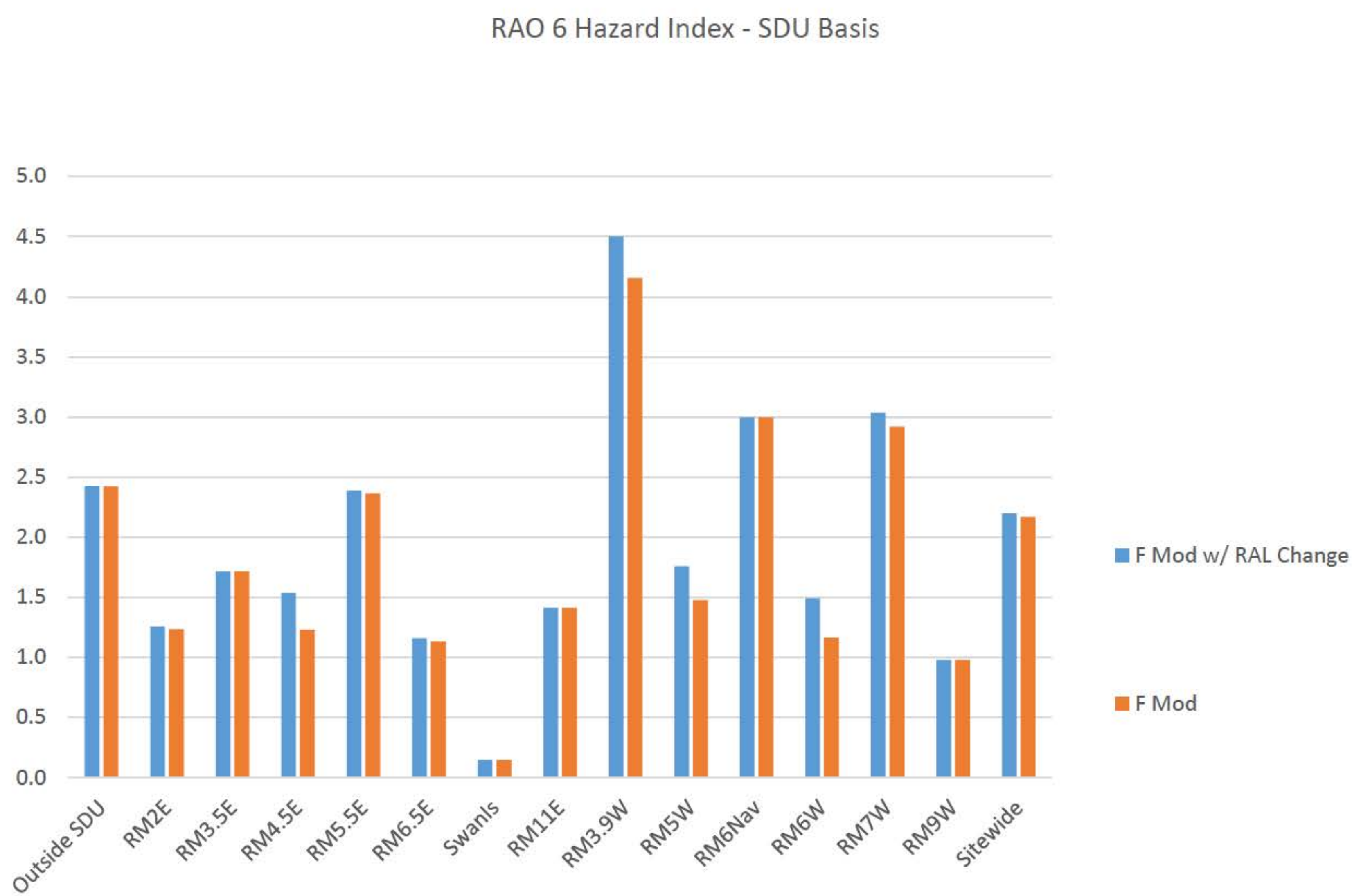
ESD Figure 10k. RAO 2 Hazard Index Infant - RM Basis (Navigation Channel)

Portland Harbor Superfund Site



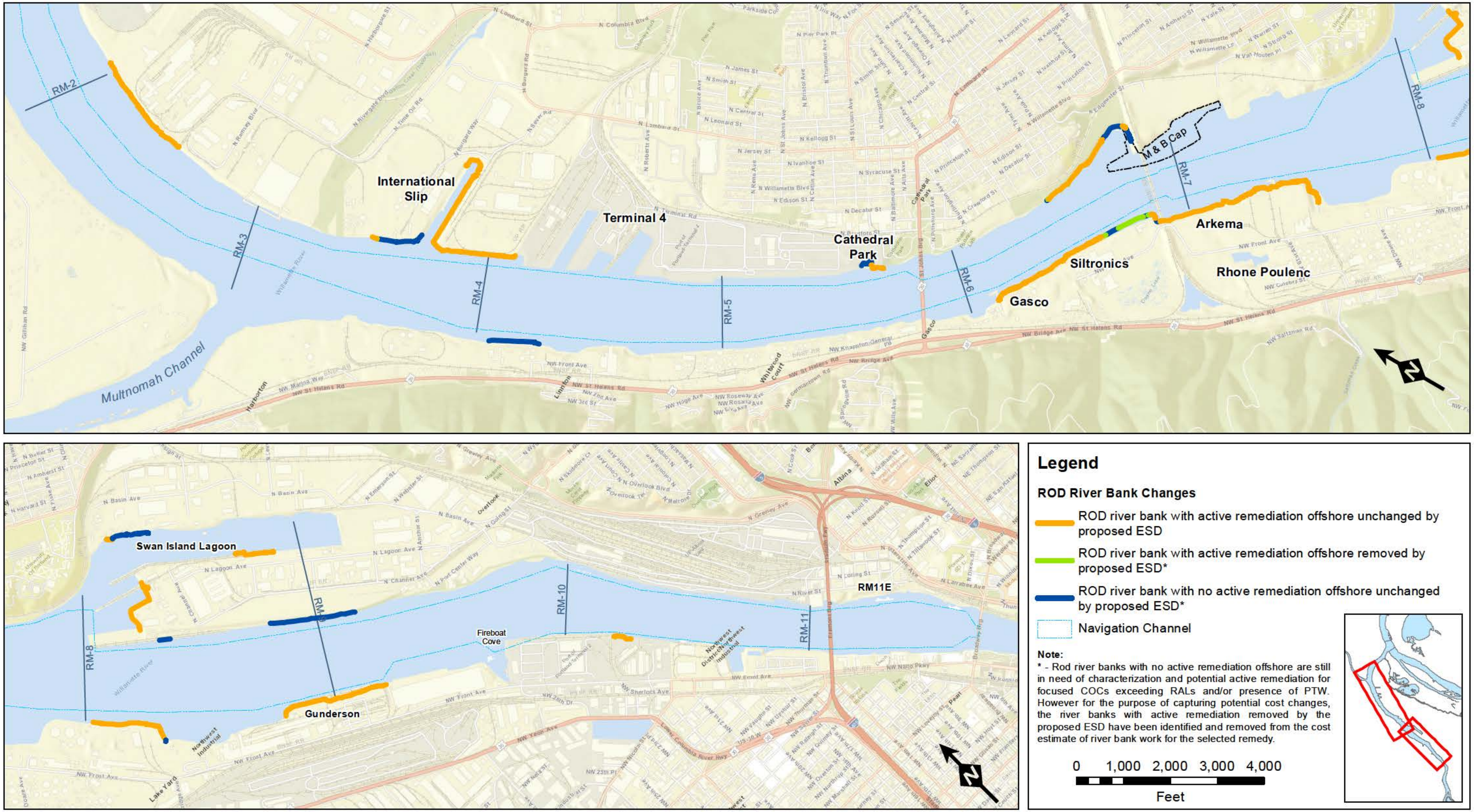
ESD Figure 10l. RAO 2 Hazard Index Infant - RM Basis (Swan Island Lagoon)

Portland Harbor Superfund Site



ESD Figure 11. RAO 6 Hazard Index - SDU Basis

Portland Harbor Superfund Site



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ESD Figure 12. River Bank Change Summary

Portland Harbor Superfund Site

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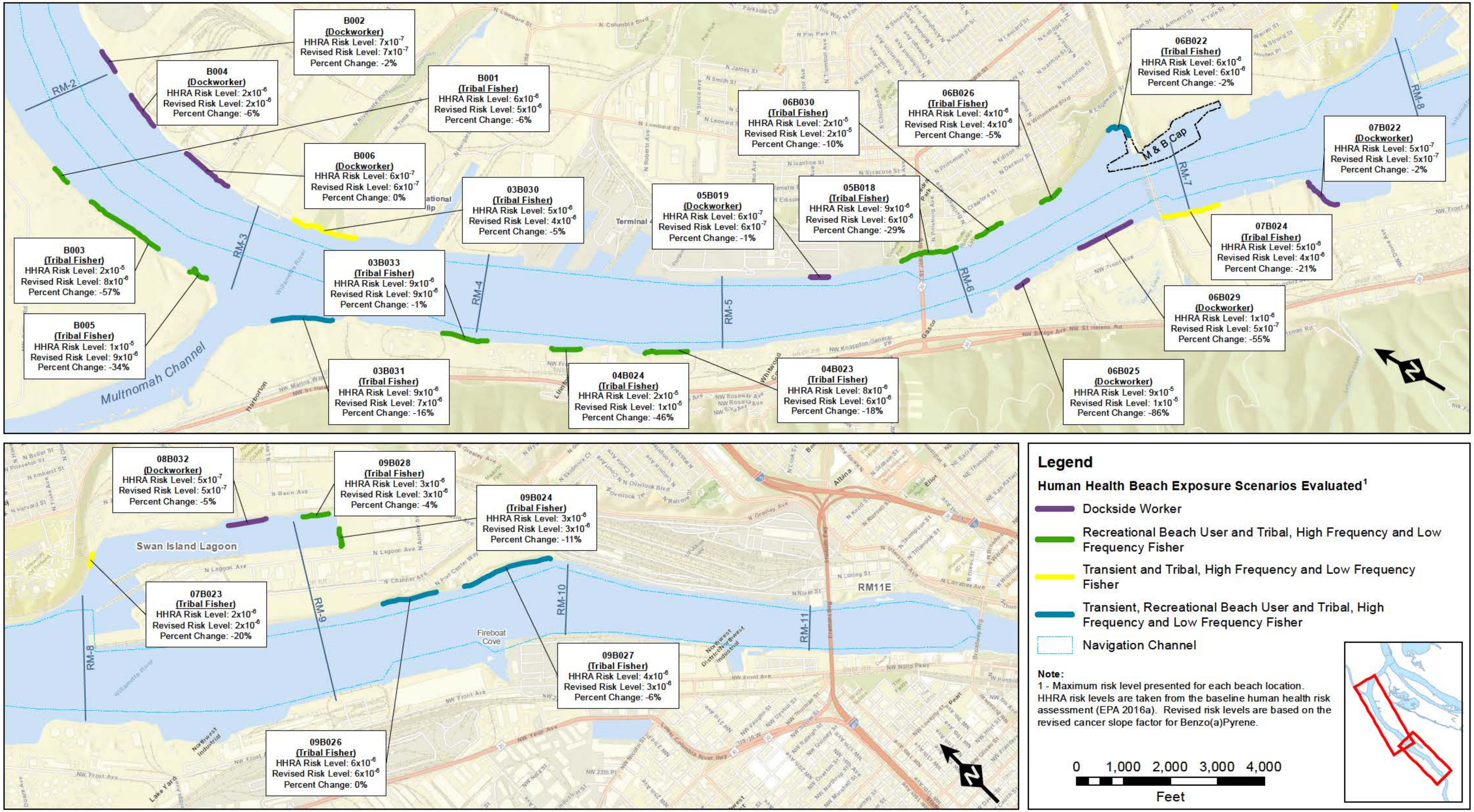

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ESD Figure 13. Human Health Beach Exposure Risk Summary

Portland Harbor Superfund Site

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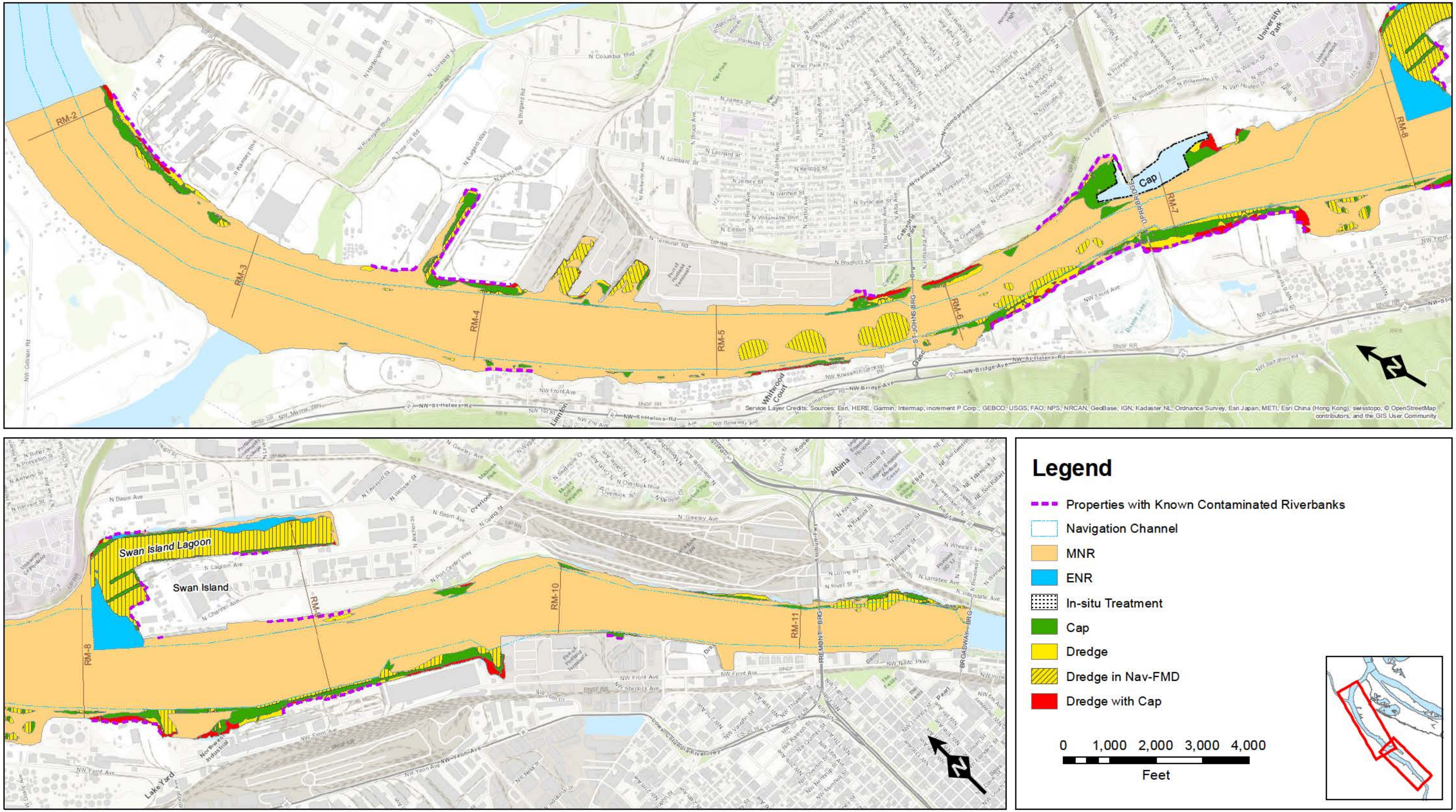

ESD Figure 14a. Remedial Footprint and Technology Assignments, Revised Remedy

Portland Harbor Superfund Site

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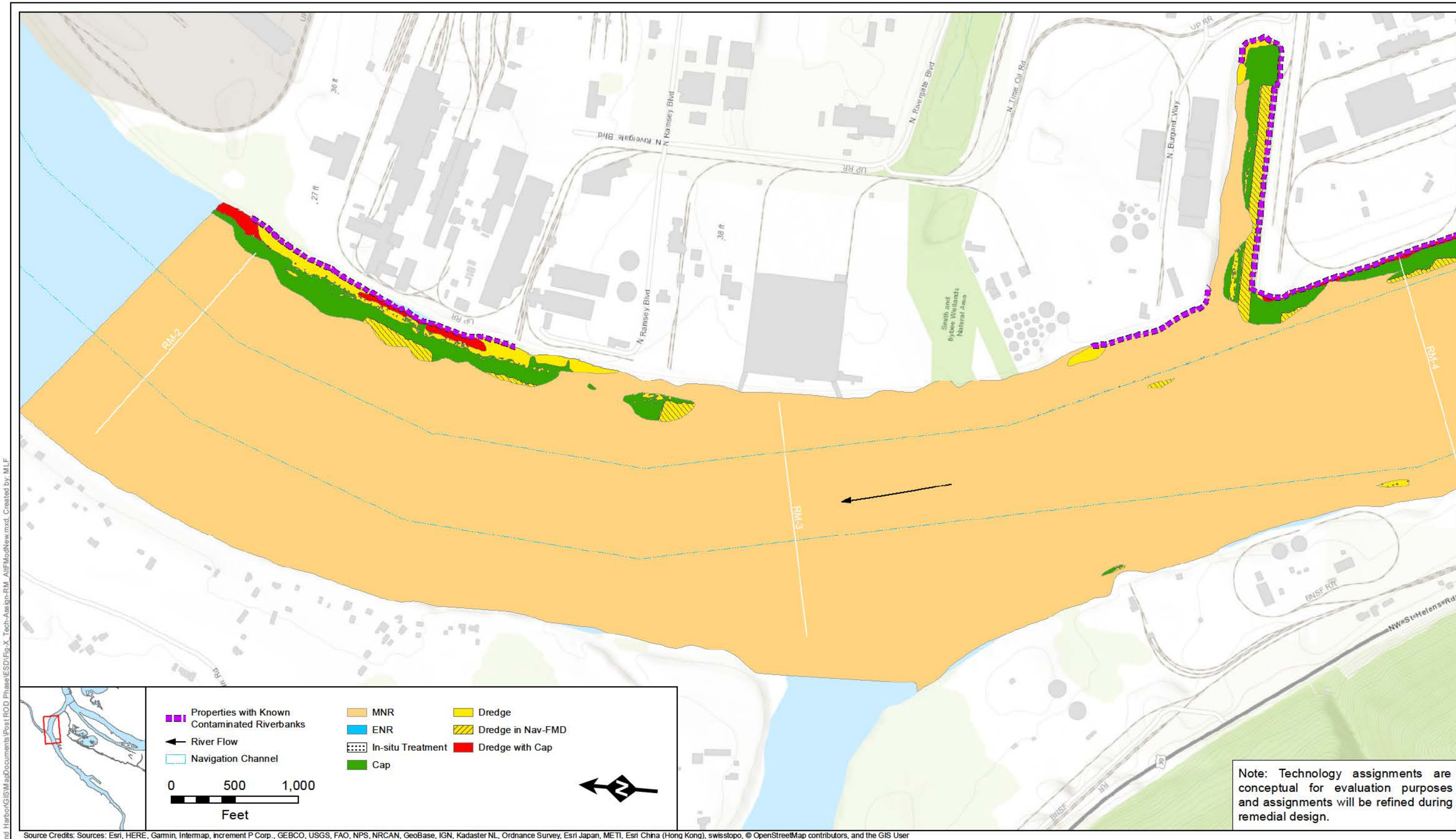

ESD Figure 14b. Remedial Footprint and Technology Assignments, Revised Remedy
River Mile 1.9 to 4
Portland Harbor Superfund Site

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ESD Figure 14c. Remedial Footprint and Technology Assignments, Revised Remedy

River Mile 4 to 6

Portland Harbor Superfund Site

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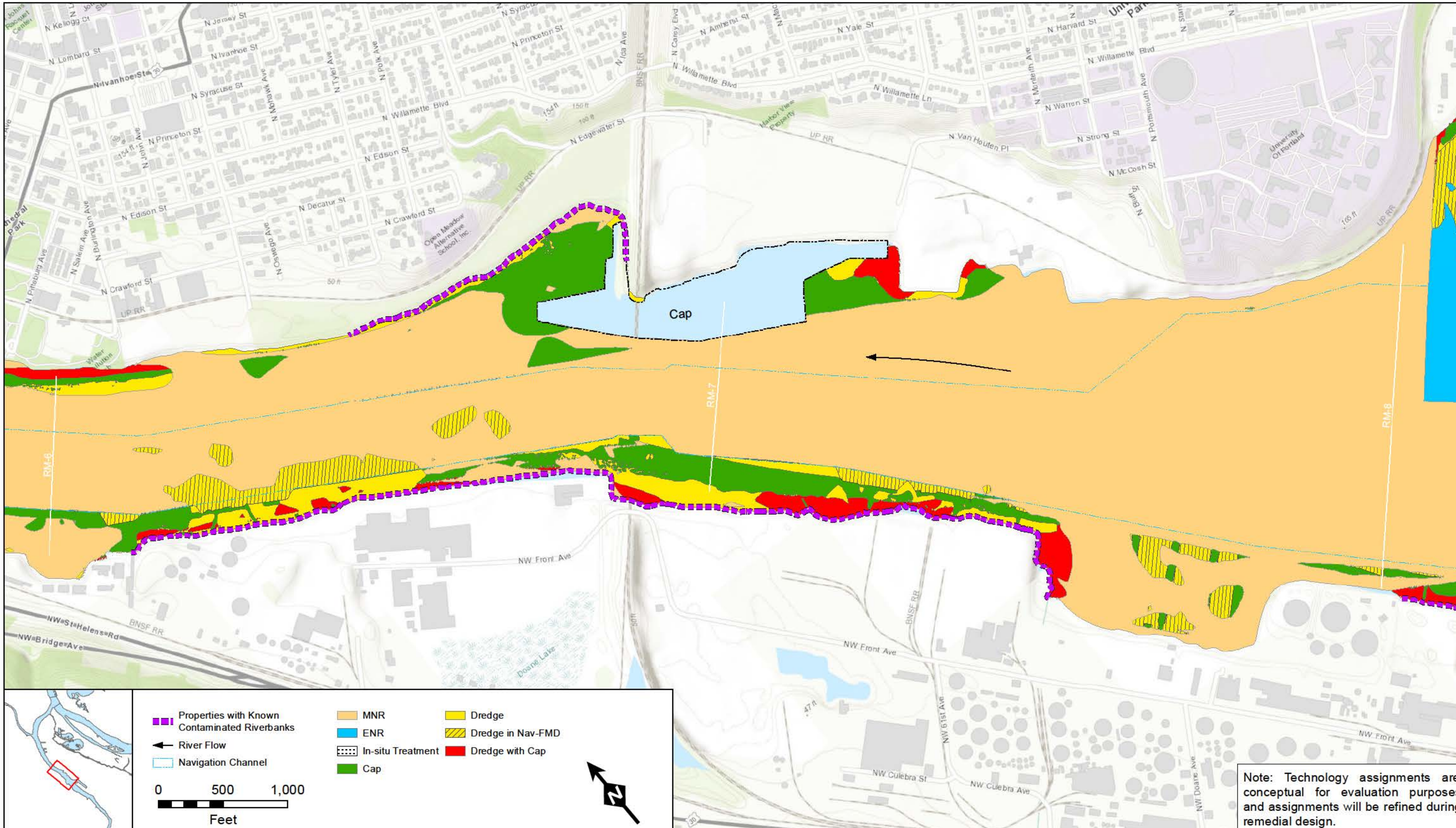

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ESD Figure 14d. Remedial Footprint and Technology Assignments, Revised Remedy
River Mile 6 to 8

Portland Harbor Superfund Site

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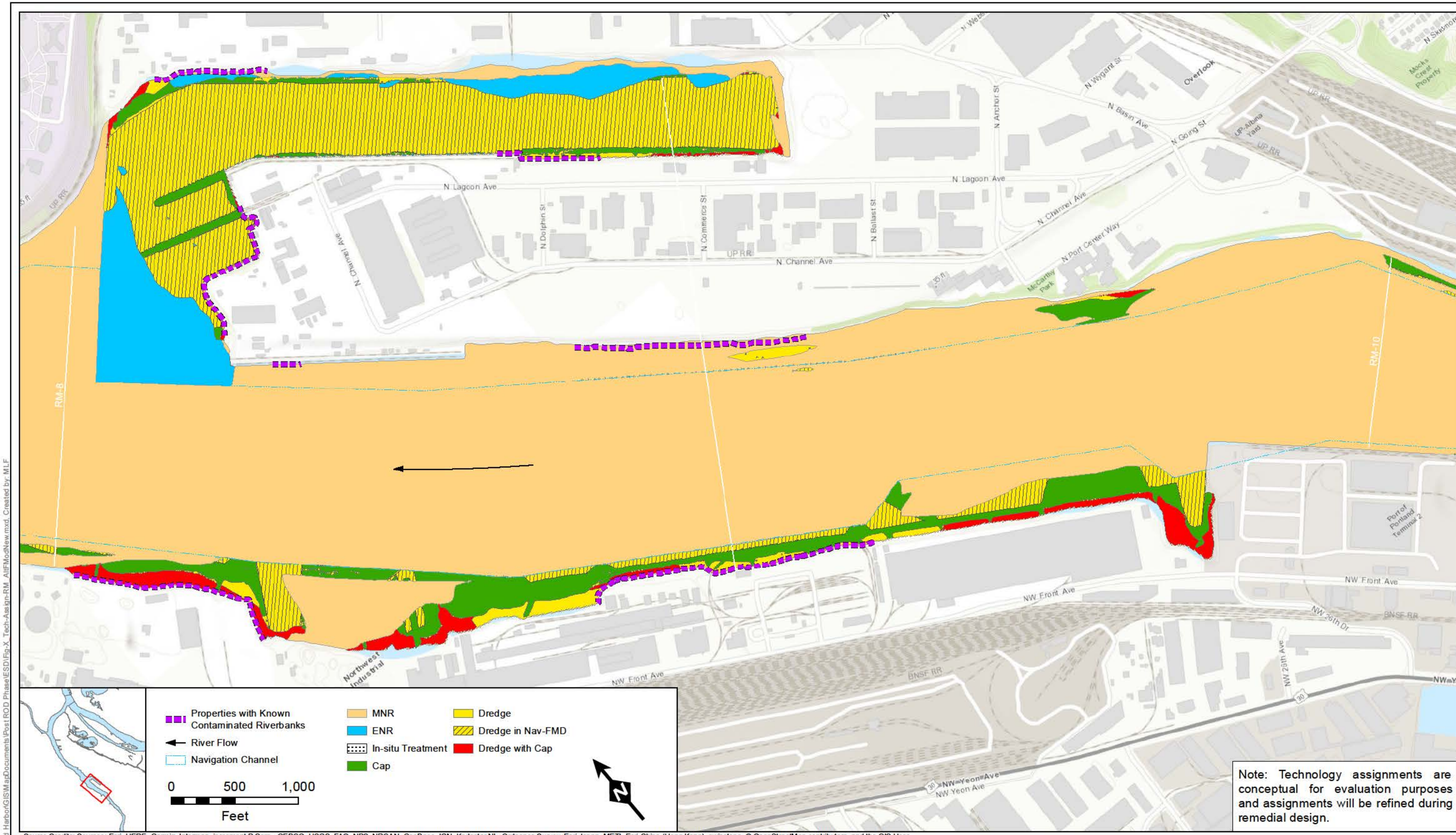

ESD Figure 14e. Remedial Footprint and Technology Assignments, Revised Remedy
River Mile 8 to 10
Portland Harbor Superfund Site

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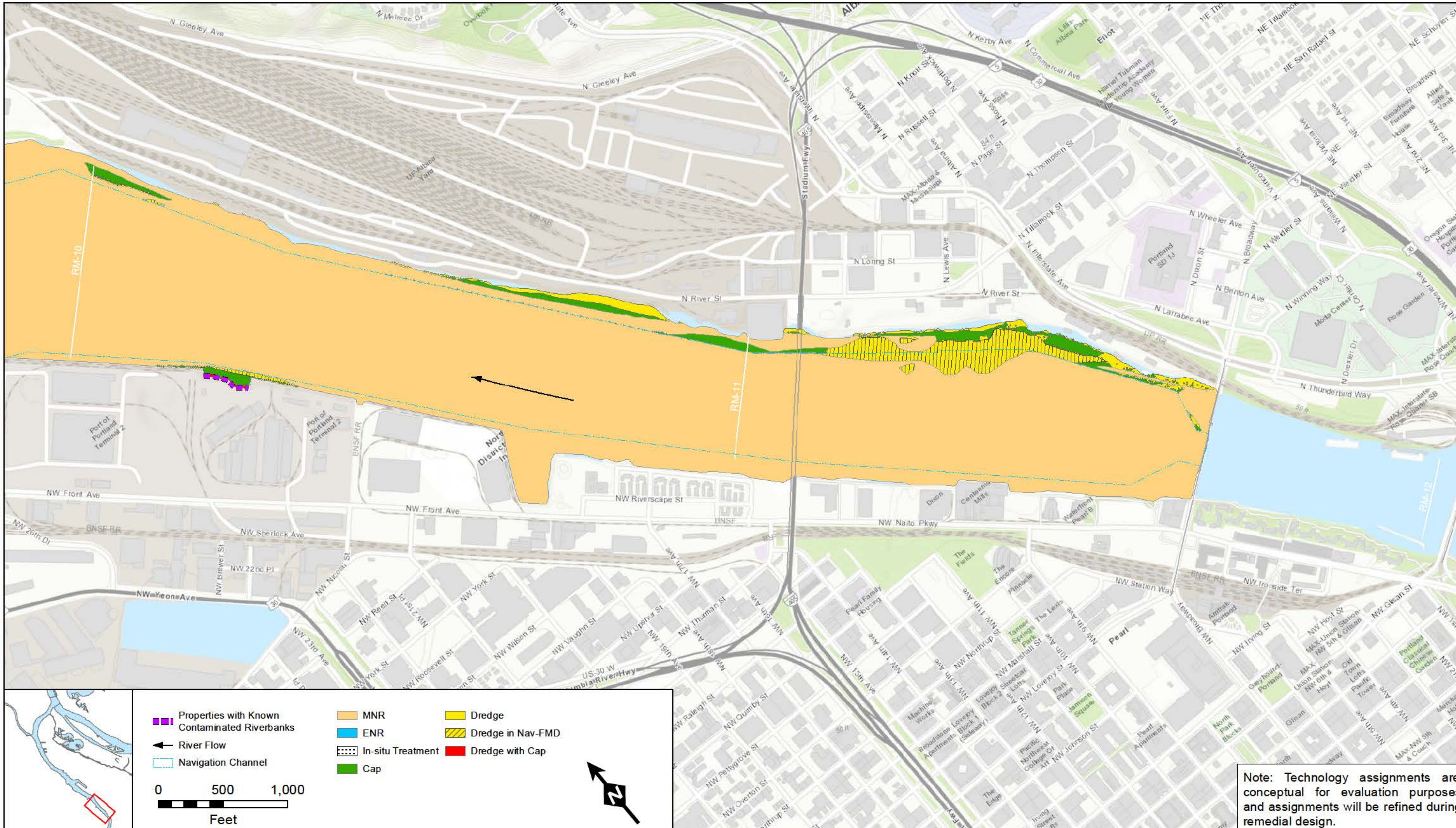

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ESD Figure 14f. Remedial Footprint and Technology Assignments, Revised Remedy
River Mile 10 to 11.8
Portland Harbor Superfund Site

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Tables

ESD Table 1. cPAH (BaPeq) CUL and Highly Toxic PTW Thresholds
Portland Harbor Superfund Site
Portland, OR

Scenario	Application Area	ROD Value	Updated Value [1]
Direct Contact Sediment CUL	Beach Areas	12 µg/kg	85 µg/kg
Direct Contact Sediment CUL	Nearshore sediment (excluding beach areas)	Not provided	774 µg/kg
Clam Consumption Tissue Target Level	Navigation Channel Sediment	7.1 µg/kg	51.6 µg/kg
Shellfish Consumption Sediment CUL	Navigation Channel Sediment	39.5 µg/kg [2]	1,076 µg/kg
Highly Toxic PTW Threshold	Site-Wide	106,000 µg/kg	774,000 µg/kg

[1] Updated Value is based on change in BaP CSF from 7.3 mg/kg-day to 1 mg/kg-day.
[2] Corrected Value

ESD Table 2. RAO 1 Risk Summary - RM Basis
Portland Harbor Superfund Site
Portland, OR

COC	River Mile	Alternative								
		East			West			Swan Island		
		F-Mod w/ RAL Change	F-Mod	Change	F-Mod w/ RAL Change	F-Mod	Change	F-Mod w/ RAL Change	F-Mod	Change
Total	2	4×10^{-6}	4×10^{-6}	0%	4×10^{-6}	4×10^{-6}	0%			
	2.5	3×10^{-6}	3×10^{-6}	1%	4×10^{-6}	4×10^{-6}	0%			
	3	5×10^{-6}	5×10^{-6}	4%	5×10^{-6}	5×10^{-6}	0%			
	3.5	4×10^{-6}	4×10^{-6}	0%	5×10^{-6}	5×10^{-6}	0%			
	4	2×10^{-6}	2×10^{-6}	0%	5×10^{-6}	5×10^{-6}	11%			
	4.5	3×10^{-6}	2×10^{-6}	46%	5×10^{-6}	4×10^{-6}	22%			
	5	4×10^{-6}	4×10^{-6}	0%	5×10^{-6}	4×10^{-6}	22%			
	5.5	3×10^{-6}	3×10^{-6}	4%	4×10^{-6}	3×10^{-6}	20%			
	6	4×10^{-6}	4×10^{-6}	0%	4×10^{-6}	2×10^{-6}	54%			
	6.5	3×10^{-6}	3×10^{-6}	6%	1×10^{-6}	6×10^{-7}	156%			
	7	1×10^{-6}	1×10^{-6}	0%	7×10^{-7}	4×10^{-7}	61%			
	7.5	4×10^{-6}	4×10^{-6}	0%	2×10^{-6}	2×10^{-6}	0%			
	8	2×10^{-6}	2×10^{-6}	0%	3×10^{-6}	3×10^{-6}	0%	6×10^{-8}	6×10^{-8}	0%
	8.5	4×10^{-6}	4×10^{-6}	0%	2×10^{-6}	2×10^{-6}	0%	3×10^{-7}	3×10^{-7}	0%
	9	3×10^{-6}	3×10^{-6}	0%	0	0	n/a	3×10^{-7}	3×10^{-7}	8%
	9.5	3×10^{-6}	3×10^{-6}	0%	1×10^{-6}	1×10^{-6}	0%			
	10	3×10^{-6}	3×10^{-6}	5%	5×10^{-6}	5×10^{-6}	0%			
	10.5	3×10^{-6}	3×10^{-6}	0%	5×10^{-6}	5×10^{-6}	0%			
	11	2×10^{-6}	2×10^{-6}	0%	5×10^{-6}	5×10^{-6}	0%			
	11.5	6×10^{-7}	6×10^{-7}	0%	3×10^{-6}	3×10^{-6}	0%			

ESD Table 3. RAO 2 Risk and Hazard Index Summary - RM
Basis Portland Harbor Superfund Site
Portland, OR

COC	River Mile	Alternative											
		East			Nav Channel			West			Swan Island		
		F-Mod w/ RAL Change	F-Mod	Change	F-Mod w/ RAL Change	F-Mod	Change	F-Mod w/ RAL Change	F-Mod	Change	F-Mod w/ RAL Change	F-Mod	Change
Total Cancer Risk	2	1×10^{-4}	1×10^{-4}	0%	1×10^{-4}	1×10^{-4}	0%	6×10^{-5}	6×10^{-5}	0%			
	2.5	7×10^{-5}	7×10^{-5}	2%	1×10^{-4}	1×10^{-4}	0%	6×10^{-5}	6×10^{-5}	0%			
	3	9×10^{-5}	9×10^{-5}	3%	9×10^{-5}	9×10^{-5}	0%	6×10^{-5}	6×10^{-5}	0%			
	3.5	9×10^{-5}	9×10^{-5}	0%	1×10^{-4}	1×10^{-4}	0%	8×10^{-5}	7×10^{-5}	2%			
	4	1×10^{-4}	9×10^{-5}	9%	1×10^{-4}	1×10^{-4}	0%	1×10^{-4}	1×10^{-4}	6%			
	4.5	1×10^{-4}	8×10^{-5}	27%	8×10^{-5}	8×10^{-5}	0%	1×10^{-4}	1×10^{-4}	13%			
	5	2×10^{-4}	1×10^{-4}	14%	8×10^{-5}	8×10^{-5}	0%	1×10^{-4}	1×10^{-4}	18%			
	5.5	2×10^{-4}	2×10^{-4}	1%	7×10^{-5}	7×10^{-5}	0%	1×10^{-4}	9×10^{-5}	23%			
	6	1×10^{-4}	1×10^{-4}	4%	1×10^{-4}	1×10^{-4}	0%	8×10^{-5}	6×10^{-5}	39%			
	6.5	7×10^{-5}	7×10^{-5}	3%	2×10^{-4}	2×10^{-4}	0%	4×10^{-5}	2×10^{-5}	93%			
	7	7×10^{-5}	7×10^{-5}	0%	2×10^{-4}	2×10^{-4}	0%	4×10^{-5}	3×10^{-5}	35%			
	7.5	1×10^{-4}	1×10^{-4}	0%	1×10^{-4}	1×10^{-4}	0%	2×10^{-4}	2×10^{-4}	0%			
	8	1×10^{-4}	1×10^{-4}	0%	1×10^{-4}	1×10^{-4}	0%	2×10^{-4}	2×10^{-4}	0%	3×10^{-6}	3×10^{-6}	0%
	8.5	9×10^{-5}	9×10^{-5}	0%	1×10^{-4}	1×10^{-4}	0%	7×10^{-5}	7×10^{-5}	0%	7×10^{-6}	7×10^{-6}	0%
	9	1×10^{-4}	1×10^{-4}	0%	2×10^{-4}	2×10^{-4}	0%	6×10^{-5}	6×10^{-5}	0%	2×10^{-5}	2×10^{-5}	5%
	9.5	1×10^{-4}	1×10^{-4}	0%	2×10^{-4}	2×10^{-4}	0%	7×10^{-5}	7×10^{-5}	0%	4×10^{-5}	4×10^{-5}	11%
	10	1×10^{-4}	1×10^{-4}	2%	2×10^{-4}	2×10^{-4}	0%	8×10^{-5}	8×10^{-5}	0%			
	10.5	1×10^{-4}	1×10^{-4}	2%	2×10^{-4}	2×10^{-4}	0%	2×10^{-4}	2×10^{-4}	0%			
	11	8×10^{-5}	8×10^{-5}	0%	1×10^{-4}	1×10^{-4}	0%	2×10^{-4}	2×10^{-4}	0%			
	11.5	7×10^{-5}	7×10^{-5}	0%	1×10^{-4}	1×10^{-4}	0%	1×10^{-4}	1×10^{-4}	0%			
Total Non-Cancer Risk (Child)	2.5	4	3	3%	5	5	0%	2	2	0%			
	3	4	4	3%	4	4	0%	3	3	0%			
	3.5	4	4	0%	5	5	0%	3	3	2%			
	4	4	4	7%	5	5	0%	4	4	7%			
	4.5	4	4	22%	4	4	0%	5	4	14%			
	5	5	4	14%	4	4	0%	4	4	19%			
	5.5	6	6	1%	3	3	0%	4	3	24%			
	6	4	4	4%	3	3	0%	3	2	43%			
	6.5	3	3	3%	9	9	0%	2	1	100%			
	7	3	3	0%	9	9	0%	1	1	43%			
	7.5	4	4	0%	6	6	0%	7	7	0%			
	8	5	5	0%	5	5	0%	7	7	0%	0	0	0%
	8.5	4	4	0%	5	5	0%	3	3	0%	0	0	0%
	9	6	6	0%	7	7	0%	2	2	0%	1	1	3%
	9.5	5	5	0%	7	7	0%	3	3	0%	1	1	8%
	10	5	5	2%	7	7	0%	3	3	0%			
	10.5	5	5	3%	8	8	0%	7	7	0%			
	11	3	3	0%	6	6	0%	7	7	0%			
	11.5	3	3	0%	6	6	0%	5	5	0%			
Total Non-Cancer Risk (Infant)	2	120	120	0%	116	116	0%	63	63	0%			
	2.5	78	76	2%	110	110	0%	60	60	0%			
	3	95	93	3%	93	93	0%	62	62	0%			
	3.5	97	97	0%	121	121	0%	83	81	3%			
	4	106	98	9%	106	106	0%	125	118	6%			
	4.5	108	85	26%	88	88	0%	157	139	13%			
	5	160	143	12%	86	86	0%	143	121	18%			
	5.5	187	185	1%	81	81	0%	122	100	23%			
	6	124	120	4%	119	119	0%	88	64	38%			
	6.5	80	78	3%	268	268	0%	48	25	91%			
	7	76	76	0%	259	259	0%	46	35	34%			
	7.5	114	114	0%	160	160	0%	221	221	0%			
	8	122	122	0%	137	137	0%	233	233	0%	4	4	0%
	8.5	93	93	0%	124	124	0%	78	78	0%	7	7	0%
	9	134	134	0%	165	165	0%	67	67	0%	21	20	5%
	9.5	127	127	0%	167	167	0%	82	82	0%	48	44	11%
	10	129	127	2%	169	169	0%	88	88	0%			
	10.5	130	127	2%	191	191	0%	221	221	0%			
	11	82	82	0%	153	153	0%	203	203	0%			
	11.5	78	78	0%	146	146	0%	150	150	0%			

ESD Table 4. RAO 5 Benthic Risk Summary
Portland Harbor Superfund Site
Portland, OR

Alternative	Benthic Risk*	10x Benthic Risk	100x Benthic Risk
F Mod w/ RAL Change	25%	69%	90%
F Mod	27%	72%	90%
Change	-1%	-3%	0%

*Benthic risk area within Site = 1,289 acres

ESD Table 5. RAO 6 Fish and Wildlife Risk Summary
Portland Harbor Superfund Site
Portland, OR

SDU	Alternative		
	F Mod w/ RAL Change	F Mod	Difference
Outside SDU	2.4	2.4	0%
RM2E	1.3	1.2	2%
RM3.5E	1.7	1.7	0%
RM4.5E	1.5	1.2	25%
RM5.5E	2.4	2.4	1%
RM6.5E	1.2	1.1	2%
SwanIs	0.1	0.1	0%
RM11E	1.4	1.4	0%
RM3.9W	4.5	4.2	8%
RM5W	1.8	1.5	19%
RM6Nav	3.0	3.0	0%
RM6W	1.5	1.2	28%
RM7W	3.0	2.9	4%
RM9W	1.0	1.0	0%
Sitewide	2.2	2.2	1%

ESD Table 6. RAO 3 and 7 Surface Water Reduction Summary
Portland Harbor Superfund Site
Portland, OR

Contaminant of Concern	Surface Water Reduction		
	F-Mod w/RAL change	F-Mod	Change
PCB	72%	72%	0%
cPAH	77%	78%	-1%
DDD	67%	68%	-1%
DDE	58%	59%	-1%
DDT	85%	85%	0%
TCDD TEQ	91%	91%	0%
Arsenic	25%	26%	-1%
BEHP	55%	55%	-1%
Chlordanes	50%	51%	-1%

ESD Table 7. RAO 4 and 8 Percent Groundwater Plume Area Adressed
Portland Harbor Superfund Site
Portland, OR

	Alternative		
	F Mod w/ RAL Change	F Mod	Change
% Reactive Cap within SMA	15%	21%	-7%
% Reactive residual layer within SMA	17%	17%	0%
Total % groundwater plume Area Adressed	32%	39%	-7%

*Groundwater plume area within Site = 243 acres
*Groundwater plume area within Site = 243 acres

ESD Table 8. Percentage Contaminated River Bank Addressed by Each Alternative
Portland Harbor Superfund Site
Portland, OR

Alternative	Feet Contaminated River Bank Addressed	Total Feet Contaminated River Bank	Contaminated River Bank Addressed
F Mod w/RAL change	22,592	30,048	75%
F Mod	23,305	30,048	78%
Change	713	0	-2%

ESD Table 9. Human Health Beach Exposure Risk Summary
Portland Harbor Superfund Site
Portland, OR

Beach Sample	Exposure Scenarios Evaluated	Exposure Scenario with Maximum Risk	Maximum HHRA Risk *	Maximum Revised Risk **	Percent Change in Risk Level
B001	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	6.E-06	5.E-06	-6%
B002	Dockworker	Dockworker	7.E-07	7.E-07	-2%
B003	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	2.E-05	8.E-06	-57%
B004	Dockworker	Dockworker	2.E-06	2.E-06	-6%
B005	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	1.E-05	9.E-06	-34%
B006	Dockworker	Dockworker	6.E-07	6.E-07	0%
03B030	Transient and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	5.E-06	4.E-06	-5%
03B031	Transient, Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	9.E-06	7.E-06	-16%
03B033	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	9.E-06	9.E-06	-1%
04B023	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	8.E-06	6.E-06	-18%
04B024	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	2.E-05	1.E-05	-46%
05B018	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	9.E-06	6.E-06	-29%
05B019	Dockworker	Dockworker	6.E-07	6.E-07	-1%
06B022	Transient, Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	6.E-06	6.E-06	-2%
06B025	Dockworker	Dockworker	9.E-05	1.E-05	-86%
06B026	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	4.E-06	4.E-06	-5%
06B029	Dockworker	Dockworker	1.E-06	5.E-07	-55%
06B030	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	2.E-05	2.E-05	-10%
07B022	Dockworker	Dockworker	5.E-07	5.E-07	-2%
07B023	Transient and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	2.E-06	2.E-06	-20%
07B024	Transient and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	5.E-06	4.E-06	-21%
08B032	Dockworker	Dockworker	5.E-07	5.E-07	-5%
09B024	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	3.E-06	3.E-06	-11%
09B026	Transient, Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	6.E-06	6.E-06	0%
09B027	Transient, Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	4.E-06	3.E-06	-6%
09B028	Recreational Beach User and Tribal, High Frequency and Low Frequency Fisher	Tribal Fisher	3.E-06	3.E-06	-4%

Notes:
* As presented in the Portland Harbor Baseline Human Health Risk Assessment
** Revised risk estimates take into account the updated cancer slope factor for Benzo(a)Pyrene

Appendix A

Technical Information and Supporting Analysis EPA Considered

Appendix A1

Updated Record of Decision Tables 17 and 21

ROD Table 17. Summary of Cleanup Levels or Targets by Media - Updated for ESD

	Surface Water (1)			Groundwater (2)			River Bank Soil/Sediment (3)			Fish Tissue (4)		
Contaminant	**Unit**	**Conc.**	**Basis**	**Unit**	**Conc.**	**Basis**	**Unit**	**Conc.**	**Basis**	**Unit**	**Conc.**	**Basis**
Aldrin	µg/L	0.00000077	A				µg/kg	2	R	µg/kg	0.06	R
Arsenic	µg/L	0.018	A	µg/L	0.018	A	mg/kg	3	B	mg/kg	0.001	R
Benzene				µg/L	0.44	A						
BEHP	µg/L	0.2	A				µg/kg	135	R	µg/kg	72	R
Cadmium				µg/L	0.091	A/R(5)	mg/kg	0.51	R			
Chlordanes	µg/L	0.000081	A				µg/kg	1.4	R	µg/kg	3	R
Chlorobenzene				µg/L	64	R						
Chromium	µg/L	100	A	µg/L	11	A						
Copper	µg/L	2.74	A	µg/L	2.74	A/R	mg/kg	359	R			
Cyanide				µg/L	4	A						
DDx	µg/L	0.01	R	µg/L	0.001	A	µg/kg	6.1	R	µg/kg	3	R
DDD	µg/L	0.000031	A	µg/L	0.000031	A	µg/kg	114	R			
DDE	µg/L	0.000018	A	µg/L	0.000018	A	µg/kg	226	R			
DDT	µg/L	0.000022	A	µg/L	0.000022	A	µg/kg	246	R			
1,1-Dichloroethene				µg/L	7	A						
cis-1,2-Dichloroethene				µg/L	70	A						
Dieldrin							µg/kg	0.07	R	µg/kg	0.06	R
2,4-Dichlorophenoxyacetic acid				µg/L	70	A						
Ethylbenzene	µg/L	7.3	R	µg/L	7.3	R						
Hexachlorobenzene	µg/L	0.000029	A							µg/kg	0.6	R
Lindane							µg/kg	5	R			
Lead				µg/L	0.54	A/R	mg/kg	196	R			
Manganese				µg/L	430	R						
MCPP	µg/L	16	R									
Mercury							mg/kg	0.085	R	mg/kg	0.03	A
Pentachlorophenol	µg/L	0.03	A	µg/L	0.03	A				µg/kg	2.5	R
Perchlorate				µg/L	15	A						
PBDEs										µg/kg	26	R
PCBs	µg/L	0.0000064	A	µg/L	0.014	A/R	µg/kg	9	B	µg/kg	0.25 (6)	R
PAHs							µg/kg	23000	R			
cPAHs (BaP eq)	µg/L	0.00012	A	µg/L	0.00012	A	µg/kg	774 (7)	B	µg/kg	51.6	R
Acenaphthene				µg/L	23	R						
Acenaphthylene												
Anthracene				µg/L	0.73	R						
Benzo(a)anthracene	µg/L	0.0012	A	µg/L	0.0012	A						
Benzo(a)pyrene	µg/L	0.00012	A	µg/L	0.00012	A						
Benzo(b)fluoranthene	µg/L	0.0012	A	µg/L	0.0012	A						
Benzo(g,h,i)perylene												
Benzo(k)fluoranthene	µg/L	0.0013	A	µg/L	0.0013	A						
Chrysene	µg/L	0.0013	A	µg/L	0.0013	A						
Dibenz(a,h)anthracene	µg/L	0.00012	A	µg/L	0.00012	A						
Fluoranthene												
Fluorene												
Indeno(1,2,3-c,d)pyrene	µg/L	0.0012	A	µg/L	0.0012	A						
2-Methylnaphthalene												
Naphthalene	µg/L	12	R									
Phenanthrene												
Pyrene												
Dioxins/Furans (2,3,7,8-TCDD eq)	µg/L	0.0000000005	A									
1,2,3,4,7,8-HxCDF							µg/kg	0.0004	B	µg/kg	0.00008	R
1,2,3,7,8-PeCDD							µg/kg	0.0002	B	µg/kg	0.000008	R
2,3,4,7,8-PeCDF							µg/kg	0.0003	B	µg/kg	0.00003	R
2,3,7,8-TCDF							µg/kg	0.00040658	R	µg/kg	0.00008	R
2,3,7,8-TCDD							µg/kg	0.0002	B	µg/kg	0.000008	R
Tetrachloroethene				µg/L	0.24	A						
Toluene				µg/L	9.8	R						
TPH-Diesel							mg/kg	91	R			
Aliphatic Hydrocarbons C10-C12				µg/L	2.6	R						
Tributyltin	µg/L	0.063	A				µg/kg	3080	R			
Trichloroethene				µg/L	0.6	A						
2,4,5-TP (Silvex)				µg/L	50	A						
Vanadium				µg/L	20	R						
Vinyl Chloride				µg/L	0.022	A						
Xylenes				µg/L	13	R						
Zinc	µg/L	36.5	R	µg/L	36.5	R	mg/kg	459	R			

Notes:

(1) Surface Water Cleanup Levels - RAOs 3 and 7

(2) Groundwater Cleanup Levels - RAOs 4 and 8

(3) Sediment Cleanup Levels - RAOs 1 and 5

(4) Fish Tissue Targets - RAOs 2 and 6

(5) A/R indicates that the ARARs-based number and the risk-based number are the same.

(6) The tissue target is a risk-based number and does not represent background levels. Additional data will be collected to determine background fish tissue concentrations for PCBs during design and construction of the Selected Remedy.

(7) The cleanup level for cPAHs of 774 µg/kg is based on direct contact with sediment and is applicable to nearshore sediment exclusive of beaches and navigation channel sediments. The cleanup level applicable to beach sediments is 85 µg/kg and the cleanup level applicable to the navigation channel is 1076 µg/kg and is based on human consumption of clams.

Abbreviations:

2,4,5-TP (Silvex) - 2-(2,4,5-Trichlorophenoxy)propionic acid, also known as Silvex

ARAR - applicable or relevant and appropriate requirement

B - Background-based number

BEHP - bis(2-ethylhexyl)phthalate

BaP eq - benzo(a)pyrene equivalent

C - carbon

Table 17. Summary of Cleanup Levels or Targets by Media

Abbreviations (continued):
Conc - concentration
cPAH - carcinogenic polycyclic aromatic hydrocarbon
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethene
DDT - dichlorodiphenyltrichloroethane
DDx - DDD + DDE + DDT
HxCDF - hexachlorodibenzofuran
MCPP - 2-(4-chloro-2-methylphenoxy)propanoic acid
mg/kg - milligram per kilogram
PAH - polycyclic aromatic hydrocarbon
PBDE - polybrominated diphenyl ether
PCB - polychlorinated biphenyl
PeCDD - pentachlorodibenzo-p-dioxin
PeCDF - pentachlorodibenzofuran
R - risk-based number
RAO - remedial action objective
TCDD - tetrachlorodibenzo-p-dioxin
TCDF - tetrachlorodibenzofurans
TPH - total petroleum hydrocarbons
µg/kg - microgram per kilogram
µg/L - microgram per liter

ROD Table 21. Sediment RALs and PTW Thresholds for Selected Remedy - Updated for ESD

Contaminants	Site Wide RALs(1) (µg/kg)	PTW Thresholds (2) (µg/kg)	Navigation Channel RALs (µg/kg)
Focused COCs			
PCBs	75	200	1,000
Total PAHs	30,000	NA	170,000
2,3,7,8-TCDD	0.0006	0.01	0.002
1,2,3,7,8-PeCDD	0.0008	0.01	0.003
2,3,4,7,8-PeCDF	0.2	0.2	1
DDx	160	7,050	650
Additional Contaminants			
2,3,7,8-TCDF	NA	0.6	NA
1,2,3,4,7,8-HxCDF	NA	0.04	NA
cPAHs (BaP Eq)	NA	774,000	NA
Chlorobenzene	NA	>320	NA
Naphthalene	NA	>140,000	NA

Notes:
1 – Site wide includes all areas of the Site except the navigation channel. FMD areas are subject to these RALs.
2 – PTW thresholds are based on highly toxic PTW values (10^{-3} risk) except chlorobenzene and naphthalene, which are threshold values for not reliably contained PTW.

Abbreviations:
BaP Eq – benzo(a)pyrene equivalent
cPAH –carcinogenic polycyclic aromatic hydrocarbon
COC – Contaminant of concern
DDx – dichlorodiphenyldichloroethane + dichlorodiphenyldichloroethene + dichlorodiphenyltrichloroethane
FMD – future maintenance dredge
HxCDF - hexachlorodibenzofuran
NA – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PeCDD – pentachlorodibenzo-p-dioxin
PeCDF – pentachlorodibenzofuran
PTW – principal threat waste
RAL – remedial action level
TCDD – tetrachlorodibenzo-p-dioxin
TCDF – tetrachlorodibenzofuran
µg/kg – microgram per kilogram
> – greater than

Appendix A2

Memorandum of Evaluation of Cost Impacts to Alternative F Modified, February 23, 2018

CDM Smith

Memorandum

To: *Sean Sheldrake, U.S. Environmental Protection Agency (EPA) Region 10*

From: *Scott Coffey and Gary Hazen, CDM Federal Programs Corporation*

Date: *February 23, 2018*

Subject: *Evaluation of Cost Impacts to Alternative F Modified from Changes Documented in the Explanation of Significant Difference, Portland Harbor Superfund Site*

Introduction

CDM Federal Programs Corporation (CDM Smith) has been tasked to provide an evaluation of the cost impacts from changes to Alternative F Modified from the January 2017 Portland Harbor Superfund Site Record of Decision (ROD) (EPA 2017) as documented in the accompanying Explanation of Significant Difference (ESD). The changes include modifying the total polycyclic aromatic hydrocarbon (TPAH) remedial action level (RAL) for nearshore sediments (RAL F) from 13,000 µg/kg to 30,000 µg/kg. This effort is hereafter referred to as the "ESD cost evaluation".

Purpose and Intended Uses

The intended use of the ESD cost evaluation is to provide a ROD-level cost estimate revision of Alternative F Modified using the modifications as documented in the ESD. The results of these changes in terms of cost to the revised Alternative F Modified, hereafter referred to as "Alternative F Modified with RAL Change", are compared to the original Alternative F Modified costs presented as part of the ROD. This ESD cost evaluation is intended to provide EPA with an evaluation of the cost impacts from the proposed modifications to support the development of the ESD.

Methodology and Cost Guidance

The ESD cost evaluation was developed based on the same methodology and guidance as described in Appendix IV, Appendix G *(Methodology and Organization of Selected Remedy Cost Estimate)* of the ROD. As detailed in that appendix, these costs are expected to have an accuracy between -30% to +50% of actual cost, based on the scope presented in the ROD. They are prepared solely to facilitate relative comparisons between alternatives for remedy selection purposes, not for establishing project budgets or negotiating Superfund enforcement settlements.

The ESD cost evaluation focuses on changes as documented in ESD. These changes include the modification of the TPAH RALs for only the nearshore areas. The nearshore areas include shallow, intermediate, and future maintenance dredge (FMD) areas. The RALs for the navigation channel were not modified; therefore, quantities and costs for navigation channel areas remained the same as Alternative F Modified from the ROD.

New quantities were developed for Alternative F Modified with RAL Change based on the changes described in the ESD. These quantities were independently derived for this evaluation and were not previously presented in the ROD.

Key Assumptions for the Cost Evaluation

Key assumptions for the ESD cost evaluation include:

1. This evaluation assesses changes as documented in the ESD, including modifications to the TPAH RAL for nearshore sediments (RAL F).
2. The modifications presented in the ESD resulted in small reductions in the quantities of sand, AquaGate, armor, beach mix, and dredging volumes as well as structures impacted (i.e. docks and piles).
3. The estimated construction duration for Alternative F Modified with RAL Change was kept consistent with the construction duration for Alternative F Modified in the ROD cost estimate. As noted in the previous bullet, quantity reductions were relatively small; therefore, the quantity reductions would not likely change the number of years required for construction.
4. Costs for the Alternative F Modified with RAL Change are based on 2016 cost sources with no escalation included, which is consistent with the ROD cost estimate
5. All other costs estimate assumptions unrelated to the quantity modifications were kept consistent with what was presented in the ROD cost estimate.

Conclusions

As shown in Table 1, the modifications to quantities based on the changes documented in the ESD would decrease the present value cost from Alternative F Modified as presented in the ROD by approximately $35 million (3.4 percent decrease) when modifications are applied across the entire site.

Organization

The ESD cost evaluation is organized into the following components:

a. Overview – Evaluation of Cost Impacts to Alternative F Modified from Changes Documented in the Explanation of Significant Difference, Portland Harbor Superfund Site

   This is the memorandum you are currently reading that summarizes the approach to developing the ESD cost evaluation.

b. Cost Comparison of Alternative F Modified from the ROD to Revised Alternative F Modified with RAL Change (Table A1)

c. Detailed Cost Estimate Summary – Alternative F Modified with RAL Change (Table A2)

References

EPA. 2017. Record of Decision, Portland Harbor Superfund Site. January 3.

Table A1 - Cost Comparison of Alternative F Modified from the ROD to Revised Alternative F Modified with RAL Change

EXPLANATION OF SIGNIFICANT DIFFERENCES COST SUMMARY

Site: Portland Harbor Superfund Site
Location: Portland, Oregon
Phase: Explanation of Significant Differences (-30% to +50%)
Base Year: 2016

Alternative	Total Capital Cost	Total Periodic Cost	Total Non-Discounted Cost	Present Value Cost
F Modified[1] (2017 ROD)	$1,184,607,000	$524,028,000	$1,708,635,000	$1,054,200,000
F Modified w/RAL Change[2]	$1,145,793,000	$504,654,000	$1,650,447,000	$1,018,830,000
Cost Difference [3]	***-$38,814,000***	***-$19,374,000***	***-$58,188,000***	***-$35,370,000***
Percent Difference [4]	***-3.3%***	***-3.7%***	***-3.4%***	***-3.4%***

Notes:

1 - Costs for Alternative F Modified (2017 ROD) represent the costs presented for Alternative F Modified in the Portland Harbor Superfund Site ROD (EPA 2017).

2 - Costs for Alternative F Modified w/RAL Change represent Alternative F Modified with adjustments made as documented in the accompanying Explanation of Significant Differences (EPA 2018).

3 - Represents the cost difference between Alternative F Modified w/RAL Change and the Alternative F Modified from the ROD.

4 - Represents the percent difference between Alternative F Modified w/RAL Change and the Alternative F Modified from the ROD.

Costs for Alternative F Modified w/RAL Change are based on 2016 cost sources with no escalation included, which is consistent with the ROD cost estimate.

Table A2 - Detailed Cost Estimate Summary

Alternative **F Modified w/RAL Change**

INSTITUTIONAL CONTROLS CAPITAL COSTS: (Assumed to be Incurred During Years 0 through 12)

DESCRIPTION	QTY	UNIT(S)	UNIT COST	TOTAL
Ins itutional Controls	1	LS	$3,623,355	$3,623,355
SUBTOTAL				$3,623,355
Contingency (Scope and Bid)	15%			$543,503
SUBTOTAL				$4,166,858
Project Management	2%			$83,337
Remedial Design	2%			$83,337
Construc ion Management	3%			$125,006
TOTAL				$4,458,538
TOTAL CAPITAL COST				**$4,459,000**

MONITORED NATURAL RECOVERY CAPITAL COSTS: (Assumed to be Incurred During Year 0)

DESCRIPTION	QTY	UNIT(S)	UNIT COST	TOTAL
Monitored Natural Recovery (MNR) for MNR/Enhanced Natural Recovery (ENR) and Broadcast GAC Areas	1,819	AC	$3,686	$6,703,954
SUBTOTAL				$6,703,954
Contingency (Scope and Bid)	20%			$1,340,791
SUBTOTAL				$8,044,745
Project Management	5%			$402,237
Remedial Design	8%			$643,580
Construc ion Management	6%			$482,685
TOTAL				$9,573,247
TOTAL CAPITAL COST				**$9,573,000**

TECHNOLOGY ASSIGNMENTS MEASURES CAPITAL CONSTRUCTION COSTS: (Assumed to be Incurred During Years 0 through 12)

DESCRIPTION	QTY	UNIT(S)	UNIT COST	TOTAL
Mobilization / Demobilization	1	LS	$13,881,000	$13,881,000
Transload Facility Development	1	LS	$15,651,213	$15,651,213
Debris Removal and Disposal	377	AC	$13,107	$4,941,343
Obstruction Removal and Relocation	1	LS	$20,308,861	$20,308,861
Erosion/Residual Control Measures	1	LS	$27,166,335	$27,166,335
Dredging of Contaminated Sediments (Open Water)	2,694,951	CY	$24.53	$66,107,148
Dredging of Contaminated Sediments (Confined)	122,831	CY	$31.10	$3,820,044
Excavation of Riverbanks	119,071	CY	$5.19	$617,978
Dewatering and Water Treatment for Dredging Operations	1	LS	$12,450,462	$12,450,462
Subtitle C/TSCA Disposal (Handling, Transportation, Treatment of Select PTW Materials, and Disposal)	358,891	TON	$191	$68,536,125
Subtitle D Disposal (Handling, Transportation, and Disposal)	4,465,403	TON	$111	$494,570,473
Mitigation	53	AC	$1,070,827	$56,753,831
Sand Placement for Technology Assignments	874,434	CY	$33.80	$29,555,683
Beach Mix Placement for Technology Assignments	66,031	CY	$73.04	$4,822,649
Armor Placement for Technology Assignments	139,983	CY	$72.06	$10,087,157
Reactive/GAC Placement for Technology Assignments	1	LS	$50,696,074	$50,696,074
Geofabric for Riverbanks	24.7	AC	$14,311	$353,488
Organoclay Mat Placement for Technology Assignments	174,300	SF	$6.39	$1,113,777
SUBTOTAL				$881,433,641
Contingency (Scope and Bid)	20%			$176,286,728
SUBTOTAL				$1,057,720,369
Project Management	2%			$21,154,407
Remedial Design	2%			$21,154,407
Construc ion Management	3%			$31,731,611
TOTAL				$1,131,760,794
TOTAL CAPITAL COST				**$1,131,761,000**

Table A2 - Detailed Cost Estimate Summary

Alternative **F Modified w/RAL Change**

SITE-WIDE MONITORING AND MONITORED NATURAL RECOVERY PERIODIC COSTS: (Assumed to be Incurred at Years 2, 4, 6, 8, 10, 14, 18, 22, 26, & 30)

DESCRIPTION	QTY	UNIT(S)	UNIT COST	TOTAL
Monitored Natural Recovery (MNR) for MNR/Enhanced Natural Recovery (ENR) and Broadcast GAC Areas	1,819	AC	$3,686	$6,703,954
Site-Wide Monitoring	1	LS	$957,659	$957,659
Cap Area Monitoring and Reactive Layer Monitoring	1	LS	$27,961,876	$27,961,876
SUBTOTAL				$35,623,489
Contingency (Scope and Bid)	20%			$7,124,698
SUBTOTAL				$42,748,187
Project Management	2%			$854,964
Technical Support	5%			$2,137,409
TOTAL				$45,740,560
TOTAL PERIODIC COST				**$45,741,000**

LONG TERM OPERATIONS AND MAINTENANCE PERIODIC COSTS: (Assumed to be Incurred at Years 5, 10, 15, 20, 25, & 30)

DESCRIPTION	QTY	UNIT(S)	UNIT COST	TOTAL
Long-Term Maintenance for Capping, ENR, and In Situ Treatment	1	LS	$4,908,126	$4,908,126
SUBTOTAL				$4,908,126
Contingency (Scope and Bid)	20%			$981,625
SUBTOTAL				$5,889,751
Project Management	5%			$294,488
Technical Support	10%			$588,975
TOTAL				$6,773,214
TOTAL PERIODIC COST				**$6,773,000**

INSTITUTIONAL CONTROLS PERIODIC COSTS: (Assumed to be Incurred at Years 5, 10, 15, 20, 25, & 30)

DESCRIPTION	QTY	UNIT(S)	UNIT COST	TOTAL
Evaluating and Updating Institutional Controls	1	LS	$626,873	$626,873
SUBTOTAL				$626,873
Contingency (Scope and Bid)	10%			$62,687
SUBTOTAL				$689,560
Project Management	5%			$34,478
Technical Support	10%			$68,956
TOTAL				$792,994
TOTAL PERIODIC COST				**$793,000**

5-YEAR SITE REVIEW PERIODIC COSTS: (Assumed to be Incurred at Years 5, 10, 15, 20, 25, & 30)

DESCRIPTION	QTY	UNIT(S)	UNIT COST	TOTAL
5-Year Site Review	1	LS	$243,687	$243,687
SUBTOTAL				$243,687
Contingency (Scope and Bid)	10%			$24,369
SUBTOTAL				$268,056
Project Management	5%			$13,403
Technical Support	10%			$26,806
TOTAL				$308,265
TOTAL PERIODIC COST				**$308,000**

Table A2 - Detailed Cost Estimate Summary

Alternative **F Modified w/RAL Change**

Summary of Present Value Analysis - Alternative F Modified w/ RAL Change

Year[1]	Capital Costs	Periodic Costs	Total Annual Expenditure[2]	Discount Factor (7.0%)	Present Value[3]
0	$96,974,538	$0	$96,974,538	1.0000	$96,974,538
1	$87,401,538	$0	$87,401,538	0.9346	$81,685,477
2	$87,401,538	$45,741,000	$133,142,538	0.8734	$116,286,693
3	$87,401,538	$0	$87,401,538	0.8163	$71,345,875
4	$87,401,538	$45,741,000	$133,142,538	0.7629	$101,574,442
5	$87,401,538	$7,874,000	$95,275,538	0.7130	$67,931,459
6	$87,401,538	$45,741,000	$133,142,538	0.6663	$88,712,873
7	$87,401,538	$0	$87,401,538	0.6227	$54,424,938
8	$87,401,538	$45,741,000	$133,142,538	0.5820	$77,488,957
9	$87,401,538	$0	$87,401,538	0.5439	$47,537,697
10	$87,401,538	$53,615,000	$141,016,538	0.5083	$71,678,706
11	$87,401,538	$0	$87,401,538	0.4751	$41,524,471
12	$87,401,538	$0	$87,401,538	0.4440	$38,806,283
13	$0	$0	$0	0.4150	$0
14	$0	$45,741,000	$45,741,000	0.3878	$17,738,360
15	$0	$7,874,000	$7,874,000	0.3624	$2,853,538
16	$0	$0	$0	0.3387	$0
17	$0	$0	$0	0.3166	$0
18	$0	$45,741,000	$45,741,000	0.2959	$13,534,762
19	$0	$0	$0	0.2765	$0
20	$0	$7,874,000	$7,874,000	0.2584	$2,034,642
21	$0	$0	$0	0.2415	$0
22	$0	$45,741,000	$45,741,000	0.2257	$10,323,744
23	$0	$0	$0	0.2109	$0
24	$0	$0	$0	0.1971	$0
25	$0	$7,874,000	$7,874,000	0.1842	$1,450,391
26	$0	$45,741,000	$45,741,000	0.1722	$7,876,600
27	$0	$0	$0	0.1609	$0
28	$0	$0	$0	0.1504	$0
29	$0	$0	$0	0.1406	$0
30	$0	$53,615,000	$53,615,000	0.1314	$7,045,011
TOTALS:	$1,145,793,000	$504,654,000	$1,650,447,000		$1,018,829,457

TOTAL PRESENT VALUE OF ALTERNATIVE F MODIFIED WITH RAL CHANGE [4] **$1,018,830,000**

Notes

[1] Alternative F Modified with RAL Change is expected to require cost expenditures for perpetuity since some contamination addressed by the remedy within the sediment bed and associated riverbank soils would remain in-place that do not allow for unrestricted use or unlimited exposure to human or ecological receptors. However, the period of analysis was assumed to be 30 yrs beyond the start of construction in Year 0.

[2] Total annual expenditure is the total cost per year with no discounting.

[3] Present value cost by year is the total annual expenditure discounted by a factor for that year representing the 7 0% real discount rate recommended by "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.

[4] Total present value is rounded to the nearest $10,000. Inflation and depreciation are excluded from the present value cost.

Costs for Alternative F Modified w/RAL Change were developed based on the same methodology and guidance as described in Appendix IV, Appendix G (Methodology and Organization of Selected Remedy Cost Estimate) of the ROD.

Costs presented for the selected remedy are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented.

Percentages used for contingency and professional/technical services costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000. Modifications to the percentages applied for contingency and professional/technical services are documented in Appendix IV, Appendix G of the ROD.

The estimated construction duration for the Alternative F Modified w/RAL Change was kept consistent with the construction duration for Alternative F Modified in the ROD cost estimate.

Costs for Alternative F Modified w/RAL Change are based on 2016 cost sources with no escalation included, which is consistent with the ROD cost estimate.

Abbreviations

AC	Acre
CY	Cubic Yard
LS	Lump Sum
QTY	Quantity
SF	Square Foot
TON	Ton

Appendix A3

Discussion and Response to August 2, 2017 NW Natural Memo, June 13, 2018

Discussion and Response to August 2, 2017 NW Natural Memo titled "*USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels and Remedial Action Levels in Portland Harbor*"

June 13, 2018

Introduction and Purpose

On January 19, 2017, the U.S. Environmental Protection Agency (EPA) released an updated Toxicological Review of Benzo(a)pyrene (USEPA 2017a). The updated toxicological review modified the oral cancer slope factor for benzo(a)pyrene (BaP) from 7.3 per milligram per kilogram-day $(mg/kg\text{-}day)^{-1}$ to 1 $(mg/kg\text{-}day)^{-1}$. The change in the cancer slope factor has potential implications for the risk-based human health cleanup levels (CULs), target tissue levels, and risk-based highly toxic principal threat waste (PTW) thresholds for carcinogenic polycyclic aromatic hydrocarbons (cPAHs) measured as BaP equivalents (BaP Eq) selected in the January 3, 2017 Record of Decision (ROD) for the Portland Harbor Superfund Site (ROD) (USEPA 2017b)[1]. Although not directly related to a cancer slope factor or a measurement of risk, the change in the BAP slope also has implications for the total PAH remedial action levels (RALs) used to establish the remedial footprint of the Selected Remedy presented in the ROD.

This memorandum discusses EPA's evaluation of information presented in document provided by NW Natural titled: "USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels and Remedial Action Levels in Portland Harbor" dated August 2, 2017 (NWN BaP Memo) (Anchor QEA 2017) and summarizes EPA's evaluation and conclusions regarding the effect of the cancer slope factor (CSF) change on the Selected Remedy.

The change in the cancer slope factor for BaP does not impact the Portland Harbor ROD's human health PRGs for surface water because they are based on water quality criteria promulgated by the State of Oregon and these criteria have not been changed. Similarly, risks to ecological receptors are also unaffected by this change. As a result, EPA's evaluation only considered potential changes to the risk-based cPAH CULs based on the direct contact and clam consumption exposure scenarios, the risk based cPAH highly toxic PTW threshold and potential changes in RALs resulting from these changes.

Specifically, this memorandum discusses the following:

- Potential change in direct contact beach and nearshore sediment CUL based on changes to the BaP CSF
- Potential change in fish consumption sediment CUL based on changes to the BaP CSF
- Potential change in highly toxic PTW threshold based on changes to the BaP CSF

[1] cPAH CULs were calculated using a cancer slope factor to achieve a 1×10^{-6} cancer risk level and the principle threat waste (PTW) thresholds are set at a 1×10^{-3} risk level based on the CUL. The Toxicological Review of Benzo(a)pyrene (USEPA 2017a) also included an updated non-cancer oral reference dose of 0.0003 mg/kg-day. However, this updated value was already utilized in the human health baseline risk assessment and development of preliminary remedial goals (PRGs) for the Portland Harbor Site.

- Potential change in nearshore and navigation channel RALs for total PAHs
- Potential application of the cPAH in-water sediment PRG as cPAH CUL for in-water sediments (exclusive of beach and navigation channel sediments).

Carcinogenic PAH Cleanup Levels and Principal Threat Waste Thresholds

Reducing the BaP CSF from 7.3 to 1 $(mg/kg\text{-}day)^{-1}$ results in an increase in the direct contact sediment CUL and highly toxic PTW thresholds specified in the PH ROD by a factor of 7.3. Target tissue thresholds for cPAHs and clam tissue are similarly adjusted. Due to the non-linear relationship between cPAHs in clam tissue and sediment, the clam consumption CUL is adjusted by a factor of approximately 25. Changes to cPAH CULs, target tissue levels and PTW thresholds are summarized in Table 1. The basis for these changes is described in greater detail below.

Table 1 – cPAH (BaP Eq) CUL and Highly Toxic PTW Thresholds

Scenario	Application Area	ROD cPAH CUL	Updated cPAH CUL [1]
Direct Contact Sediment CUL	Nearshore Sediment	12 µg/kg	85 µg/kg
Direct Contact Sediment CUL	Nearshore sediment (excluding beach areas)	Not provided	774 µg/kg
Clam Consumption Tissue Target Level	Navigation Channel Sediment	7.1 µg/kg	51.6 µg/kg
Clam Consumption Sediment CUL	Navigation Channel Sediment	39.5 µg/kg[2]	1,076 µg/kg
Highly Toxic PTW Threshold	Site-Wide	106,000 µg/kg	774,000 µg/kg

[1] Updated Value is based on change in BaP CSF from 7.3 to 1 $(mg/kg\text{-}day)^{-1}$

Human Health Direct Contact In-Water Sediment Cleanup Level

The Portland Harbor Human Health Risk Assessment presented in the Portland Harbor Remedial Investigation Report (USEPA 2016a) evaluated a range of direct contact exposure scenarios for beach sediment and in-water sediment. Potentially exposed populations evaluated under the beach exposure scenarios included dockside workers, transients, recreational beach users, high frequency fishers, and tribal fishers. Potentially exposed populations evaluated under the in-water sediment exposure scenarios included in-water workers, high frequency fishers, tribal fishers, diver wet suit, and diver dry suit.

The human health direct contact sediment CUL for cPAHs established in ROD of 12 µg/kg established in the Portland Harbor ROD was based on a recreational beach exposure scenario. Adjusting the human health direct contact sediment CUL by a factor of 7.3 results in a revised CUL of 85 µg/kg.

The Portland Harbor ROD did not develop cleanup levels based on the in-water exposure scenarios evaluated in the baseline human health risk assessment. In-water sediment PRGs ranged from 106

[2] Due to an error in the application of Equation 1, the cPAH cleanup level presented in the ROD has been revised from 3,950 µg/kg to 39.5 µg/kg. This results in cPAH CUL based on the shellfish consumption exposure scenario of 1,076 µg/kg.

µg/kg for the tribal fisher exposure scenario to 8,572 µg/kg for the in-water worker exposure scenario. Adjusting the in-water nearshore sediment PRG of 106 µg/kg by a factor of 7.3 results in a revised PRG of 774 µg/kg.

EPA has re-evaluated application of the nearshore sediment CUL based on the recreational beach exposure scenario and determined that two cPAH direct contact CULs should apply to nearshore sediments. The updated cPAH direct contact beach CUL of 85 µg/kg will apply to recreational beaches identified in the baseline human health risk assessment and RI Report (EPA 2016a) (EPA 2016a). EPA also developed a cPAH direct contact CUL of 774 µg/kg based on the tribal fisher exposure scenario. The cPAH direct contact tribal fisher CUL for tribal in-water sediment of 774 µg/kg will apply to the remainder of nearshore sediments (non-recreational beach areas).

Human Health Clam Consumption Cleanup Level

For the clam consumption exposure scenario, the target tissue level also increases by a factor of 7.3. However, the relationship between cPAH (BaP Eq) clam tissue levels and sediment levels is a non-linear relationship represented by the following equation presented in Appendix B of the Portland Harbor FS (USEPA 2016b):

$$ln(PRG_{sed}) = \frac{((ln(C_{tissue}) - (\ln(f_{lipid}) - \ln(CF) + 2.47)}{0.6} + ln(f_{oc}) \quad \text{(Equation 1)}$$

Where:

PRG_{sed} = Risk-Based Sediment Preliminary Remediation Goal, dry weight (µg/kg)
C_{tissue} = Risk-Based Acceptable Tissue Concentration, wet weight (µg/kg)
CF = Correction Factor of 2.31
f_{oc} = Fraction Organic Carbon, dry weight (0.0171)
f_{lipid} = Fraction of lipid in clam tissue, wet weight (0.22)

During review of potential changes to the cPAH cleanup level resulting from the change in the BaP CSF, EPA became aware of an error in application of the Equation 1. This error resulted from calculating the sediment cleanup level in the units of µg/kg rather than mg/kg (the equation was developed based on mg/kg). The error reduces the cPAH CUL presented in the ROD by a factor of 100 from 3,950 µg/kg to 39.5 µg/kgAs a result of the non-linear relationship between bulk sediment BaP concentrations and clam tissue BaP concentrations, the cPAH sediment CUL bases on the clam consumption scenario increases from 39.5 to 1,076 µg/kg.

Benthic Risk Direct Contact Cleanup Level

The total PAH cleanup level for protection of the benthic community was established in the Portland Harbor ROD at 23,000 µg/kg. This concentration is above the nearshore total PAH RAL of 13,000 µg/kg established in the Portland Harbor ROD but below both the navigation channel total PAH RAL of 170,000 µg/kg and the highly toxic PTW threshold of 106,000 µg/kg. Although the benthic risk direct contact total PAH sediment CUL is unaffected by the change in BaP CSF, any changes to the remedial action levels for the Selected Remedy will have to consider the impact on benthic risk.

Principal Threat Waste Thresholds

The Portland Harbor ROD established a highly toxic principal threat waste (PTW) threshold for cPAHs of 106,000 µg/kg based on a 1 x 10^{-3} risk level. Because the cPAH highly toxic PTW threshold is based on cancer risk, it is also affected by the BaP CSF change. Adjusting the highly toxic PTW threshold by a factor of 7.3 results in a revised PTW threshold of 774,000 µg/kg.

Remedial Action Levels

Remedial action levels (RALs) are a range of contaminant concentrations that fall between the site-wide spatially area weighted average concentrations (SWACs) prior to initiation of remedial action and cleanup levels for the focused COCs. The Portland Harbor FS developed RALs for six focused chemicals of concern (COCs), including total PAHs[3], by plotting site-acres remediated against the estimated post-remediation SWAC.

Thus, six sets of RALs bracketing the distribution of contamination for seven remedial alternatives (Alternatives B through H) were evaluated in the FS based on this relationship for each focused COC. The RAL curve for total PAHs is presented in Figure 1. For total PAHs, RALs ranged from 170,000 to 970 µg/kg. As noted in Figure 1, the most conservative RAL of 970 µg/kg equates to a cPAH (BaP Eq) concentration of 106 µg/kg based on a regression analysis between total PAH and total cPAH (BaP Eq) sediment concentrations at the Portland Harbor Site developed in the FS. This relationship is represented by the following equation:

$$Total\ PAHs = (BaP\ Eq)(BaP\ EQ)^{m} \times 10^{b} \quad \text{(Equation 2)}$$

Where: m = 0.984 and b = 0.996

The remedial footprint for the Selected Remedy established in the Portland Harbor ROD are defined by exceedances of RALs and the presence of PTW. RALs are contaminant-specific sediment concentrations of focused COCs used to identify areas where capping and/or dredging will be conducted. The Selected Remedy for the Site identified remedial footprints based on two sets of RALs—one applicable to nearshore sediments (the Alternative F RAL) and one applicable to the federally authorized navigation channel (the Alternative B RAL). The total PAH RALs for the Selected Remedy are 13,000 µg/kg for nearshore sediments and 170,000 µg/kg for the federally authorized navigation channel.

EPA evaluated whether changes to the total PAH RALs were necessary due to the BaP CSF change. The evaluation considered both the nearshore RAL and the navigation channel RAL. The evaluation assessed the effect of the RAL change on post-construction risk estimates and if the change would affect attainment of the RAOs established for the Site.

Based on its evaluation, EPA determined that the nearshore RAL should be revised from 13,000 to 30,000 µg/kg to avoid remediation of PAH-contaminated sediments that no longer pose a risk to human health based on the changes to the nearshore sediment cPAH CUL. EPA determined that this change would result in a negligible change to the protectiveness of the remedy, including human health risks

[3] It should be noted that although RALs were developed for both total PAHs, CULs were established for both total PAHs and cPAHs.

associated with shellfish consumption, and would not appreciably change the ability of the remedy to attain the RAOs established for the Portland Harbor Site.

Based on its evaluation, EPA determined that the total PAH RAL of 170,000 µg/kg applicable to the navigation channel should not be revised because it may affect the ability of the Selected Remedy to protect humans who consume shellfish collected from the navigation channel (RAO 2) and achieve the total PAH CUL of 23,000 µg/kg for protection of the benthic community (RAO 5). This is because the selected total PAH RAL of 170,000 µg/kg is well above the total PAH CUL and the lack of natural recovery processes within the navigation channel between RM 5 and RM 7 where the total PAH RAL is exceeded. A summary of the total PAH RALs is presented in Table 2 below.

Table 2 – Total PAH RAL Summary

Application Area	ROD Total PAH RAL	Updated Total PAH RAL
Nearshore Sediment (RAL F)	13,000 µg/kg	30,000 µg/kg
Navigation Channel (RAL B)	170,000 µg/kg	No Change

Remedial Quantity and Cost Implications Quantities

EPA evaluated the changes in remedial quantities and cost associated with changing the total PAH RAL applicable to nearshore sediments outside the navigation channel. EPA determined that this change would reduce the total nearshore remedial footprint by 17 acres, reduce the capping area by 8 acres, and reduce the dredging volume by 43,800 cy. This results in a decrease in the present value cost for the Selected Remedy of approximately $35 million. This represents a 3.4% decrease in the overall present value cost of the Selected Remedy.

Summary

EPA evaluated the effect of changes to the BaP CSF will result on risk-based CULs, target tissue levels and risk-based highly toxic PTW thresholds for cPAHs selected in the Portland Harbor ROD. This evaluation considered the information and analysis included in the document provided by NW Natural titled: "USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels and Remedial Action Levels in Portland Harbor" dated August 2, 2017 (NWN BaP Memo) (Anchor QEA 2017). The evaluation also considered an error in the application of Equation 1 that describes the relationship between BaP in sediment and clam tissue.

Based on its analysis, EPA determined that changes to the cPAH CULs and PTW thresholds were warranted. EPA also determined that including a human health direct contact cPAH CUL based on the tribal fisher exposure scenario was appropriate. Finally, EPA determined that a change to the total PAH nearshore sediment RAL was appropriated but that a change to the total PAH navigation channel RAL was not appropriate because it may affect the ability of the remedy to attain the RAOs established in the Portland Harbor.

References:

Anchor QEA. 2017. Memorandum: USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels and Remedial Action Levels in Portland Harbor. August 2.

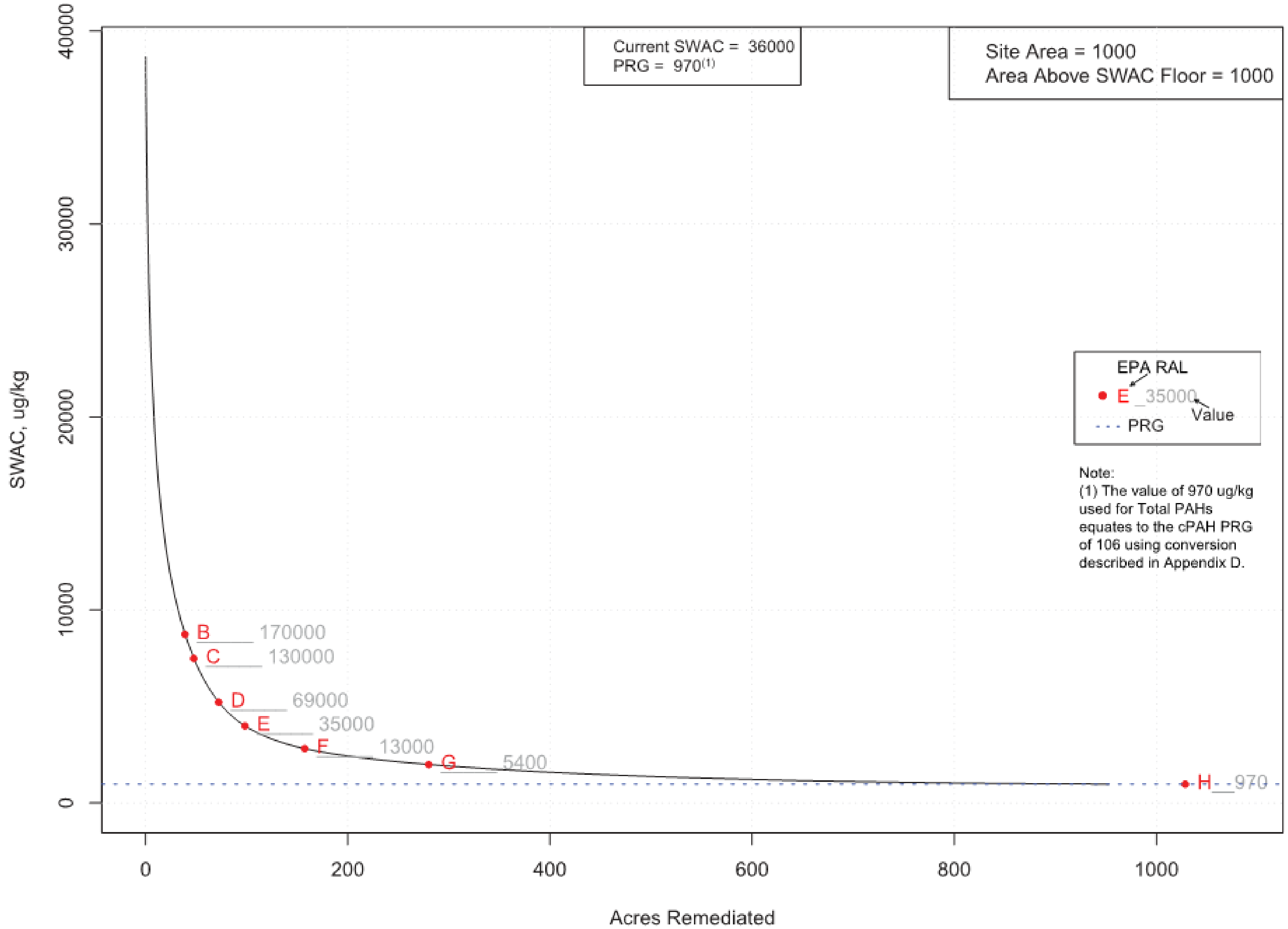
USEPA. 2016a. *Final Remedial Investigation Report, Portland Harbor Remedial Investigation/Feasibility Study*. Environmental Protection Agency Region 10, Seattle, WA. February 8.

USEPA. 2016b. *Draft Final Portland Harbor Feasibility Study*. Environmental Protection Agency Region 10, Seattle, WA. June.

USEPA. 2017a. Toxicological Review of Benzo(a)pyrene. EPA/635/R-17/003Fa. January.

USEPA. 2017b. Record of Decision, Portland Harbor Superfund Site. January 3.

Figure 1 – Total PAH RAL Curve



Appendix A4

Memorandum from Patty Dost, Pearl Legal Group PC, Subject: Portland Harbor cPAH Cleanup Levels, November 28, 2017

P L G

PEARL LEGAL GROUP PC

MEMORANDUM

TO: Elliott Laws

FROM: Patty Dost

DATE: November 28, 2017

RE: Portland Harbor cPAH Cleanup Levels

When you, Tom and Margaret met with Jim Woolford and others on November 15, you requested three changes to the cleanup levels in the ROD. First, EPA's current Portland Harbor cleanup level for direct contact with underwater sediments impacted by carcinogenic polycyclic aromatic hydrocarbons (cPAHs) appears to be a mistake – instead of 12 µg/kg, it should be 106 µg/kg to be consistent with the risk assessment.

Second, EPA's cPAH cleanup level of 3,950 µg/kg for the navigation channel is based on consumption of clams, an exposure scenario EPA had determined in the risk assessment to be incomplete. Accordingly, it should be removed.

Third, all Portland Harbor cPAH cleanup levels should be updated using EPA's current toxicity values so that remedial actions can be designed using the best scientific information to efficiently and cost-effectively reduce risk.

I understand that you promised to send EPA legal and other support for making the requested changes. That support is set forth below.

I. EPA's cPAH cleanup levels are inconsistent with the Baseline Risk Assessment and therefore legally indefensible.

EPA completed the Portland Harbor Baseline Human Health Risk Assessment (BHHRA) in March 2013. The BHHRA identified potential risks to human health from cPAHs in sediment through several different exposure scenarios, including direct contact with soil or sediment on upland beaches, direct contact with in-water sediment during fishing or occupational activities, and consumption of clams and fish. Based upon the BHHRA, EPA developed preliminary remediation goals (PRGs) it believed would be protective of humans exposed to cPAHs in Portland Harbor sediments: 12 µg/kg for direct contact exposure to beach sediment, 106 µg/kg for direct contact with in-water sediment, and 3,950 µg/kg for consumption of clams.[1] EPA was unable to develop a technically sound cPAH sediment PRG for fish consumption.[2]

The Portland Harbor Record of Decision (ROD) adopts two of these three PRGs as cleanup levels, but applies them to areas of the site in which the BHHRA concluded that the exposure pathways for which the PRGs were developed are not complete. First, the ROD applies the 12 µg/kg beach sediment PRG to nearshore in-water sediments. Second, the ROD applies the 3,950 µg/kg clam consumption PRG to sediments in the navigation channel. In both cases, this results in the ROD requiring large areas of cleanup where the BHHRA identified no unacceptable human health risk from cPAHs in sediment.

[1] Portland Harbor Feasibility Study (June 2016), Table 2.2-1a.

[2] EPA memorandum, *Evaluation of Analyses Used to Calculate Bioaccumulation Calculation Results Portland Harbor Superfund Site RAC Contract Number EP-W-05-049* (May 2016), attached at Tab 1.

EPA has no legal basis for requiring remediation in the absence of unacceptable risk.[3] EPA's remedial investigation must include a site-specific baseline risk assessment.[4] The baseline risk assessment provides "the basis for determining whether remedial action is necessary as well as the framework for developing risk-based remediation goals."[5] "As a general policy and in order to operate a unified Superfund program, EPA generally uses the results of the baseline risk assessment to establish the basis for taking a remedial action using either Section 104 or 106 authority."[6]

EPA's selection of in-water cleanup levels that are inconsistent with the BHHRA would likely not survive a judicial challenge. EPA's remedy decisions must be based in reason and science, and EPA must articulate a rational connection between the facts it has found and the choices it has made.[7] EPA has a legal obligation to "explain the key assumptions that underpin its remedy"[8] and must explain decisions that run counter to evidence before it.[9] Although EPA's technical decisions are entitled to deference, courts will review EPA's analysis to "ensure that it is 'rational' and 'makes sense'" and will not absolve EPA of "obvious mistakes."[10]

A. *EPA's ROD applies an upland beach cleanup level to in-water sediments that the baseline risk assessment found posed no direct contact risk*.

EPA's BHHRA identified potential risk from direct contact with cPAHs in nearshore in-water sediment to in-water workers, fishers, and divers. Based upon the BHHRA, EPA developed a direct contact PRG of 106 µg/kg for in-water sediment to be protective of tribal fishers.[11] In the ROD, however, EPA selected a cPAH in-water sediment cleanup level of 12 µg/kg, based upon a child recreational beach exposure scenario.[12] EPA provided no explanation for its application of a beach exposure PRG to in-water sediments other than the statement that its selected cleanup levels "represent the lowest value in each medium (beach or in-river sediment) to be protective of all receptors."[13] EPA did not explain why it abandoned the finding of the BHHRA that the tribal fisher was

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[3] 42 U.S.C §9606(a).
[4] 40 CFR §300.430(d)(4).
[5] *Contaminated Sediment Remediation Guidance or Hazardous Waste* Site (EPA-540-R-05-012, December 2005) ("Sediment Guidance"), p. 2-9.
[6] *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (OSWER Directive 9355.0-30) (April 22, 1991), p. 3.
[7] *United States v. NCR Corp*., 911 F. Supp. 2d 767, 773 (E.D. Wis. 2012) *aff'd sub nom*. United States v. P.H. Glatfelter Co., 768 F.3d 662 (7th Cir. 2014); *United States v. Newmont USA Ltd.*, 504 F. Supp. 2d 1077, 1082 (E.D. Wash. 2007).
[8] *Emhart Industries, Inc. v. New England Container Company, Inc.*, 2017 WL 3535003, *11-12 (D.R.I. 2017) (citations omitted) (finding EPA assumptions concerning use of groundwater and risks from fish consumption on which remedy selection was based arbitrary and capricious).
[9] *Motor Vehicle Mfrs. Ass'n of the U.S., Inc. v. State Farm Mut. Auto. Ins. Co.,* 463 U.S. 29, 43, 103 S. Ct. 2856, 2867 (1983).
[10] *Emhart Industries* at *11.
[11] Portland Harbor Feasibility Study, Appendix B, Table B3-4.
[12] *Id.* The 12 µg/kg cPAH sediment cleanup level actually represents a background value, because the acceptable risk value for children on recreational beaches was below EPA's calculated background value for cPAHs. See Portland Harbor Feasibility Study Table 2.2-4. This cleanup level is applicable to nearshore in-water sediments. *See*, ROD, Table 17, n.7.
[13] ROD, § 9.1.1

the most sensitive receptor for in-water sediment and assumed instead that children would be playing in underwater sediments offshore of industrial facilities.

Although EPA's cPAH in-water sediment cleanup level is based upon a child recreational beach exposure assumption, virtually all of EPA's evaluations supporting its remedy selection for nearshore sediments are based upon the 106 µg/kg PRG for tribal fishers. For example, the Remedial Action Levels (RALs) for cPAHs developed in the Feasibility Study and used to define action areas in the ROD were based on the 106 µg/kg PRG for in-water sediment exposure.[14] "Highly toxic" principal threat waste concentrations in the Feasibility Study and ROD are based on the 106 µg/kg PRG.[15] Most importantly, the Feasibility Study evaluated the performance of all alternatives (including the selected alternative) for EPA's Remedial Action Objective (RAO 1) (reduce risks to people from direct contact with chemicals in sediment and beaches) against the 106 µg/kg tribal fisher PRG.[16] EPA's residual risk evaluations led it to conclude that its selected remedy would be protective of direct contact with sediments "immediately after construction."[17] However, even a cursory review of EPA's residual risk tables in the final Feasibility Study (as well as a set of EPA figures prepared for an earlier draft of the Feasibility Study) reveals that the 12 µg/kg cPAH sediment cleanup level would not be met in almost every segment of the river at the rolling half-mile scale evaluated for RAO1 immediately following construction.[18]

EPA's selection of the 12 µg/kg cPAH cleanup level for in-water sediments looks like an "obvious mistake."[19] EPA should correct the ROD to identify the nearshore in-water cPAH sediment cleanup level as 106 µg/kg.

B. *EPA's ROD applies a clam consumption cleanup level to areas of the river in which the baseline risk assessment correctly assumed that clams would not be harvested*.

The ROD applies a cPAH sediment cleanup level for clam consumption in areas of the river in which the BHHRA found no clam consumption risk: "The cleanup level applicable to sediments in the navigation channel is 3,950 µg/kg and is based on human consumption of clams."[20] This is a change from EPA's Feasibility Study and the Proposed Plan, which identified a PRG of 3,950 µg/kg cPAH as protective of humans consuming fish and shellfish.[21]

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[14] Portland Harbor Feasibility Study, Figure 3.4-2.
[15] ROD, Table 6.
[16] ROD, Appendix J – Update, Calculation of Residual Risk and Post Construction Risk Estimates, Table J2.2-2c. *See also*, ROD Responsiveness Summary at p. 2-126 ("the evaluation of direct contact human health presented in Appendix J (of the FS) only considered direct contact with sediment and did not consider beach exposures").
[17] ROD, p. 121.
[18] ROD, Appendix J, Table J2.2-1c, attached at Tab 2; EPA draft August 2015 draft Feasibility Study, Figure 4.2-7a-h, attached at Tab 3. Indeed, cPAH concentrations alone would exceed 1×10^{-5} levels in many segments of the river. Note also that the ROD states that "at the end of construction … people will be protected from risks associated with playing on beaches and swimming in the river," even though the detailed comparative analysis of remedial alternatives states that, "[r]esidual risk estimates are based on direct contact exposure to shallow sediments. There is insufficient data to estimate post construction risks based on exposure to beach sediments." ROD, p. 121*;* ROD, Table 22 n. 1.
[19] *Emhart Industries* at *11.
[20] ROD, Table 17, note 7.
[21] EPA FS (June 2016), Table 2.2-1a.

During the RI/FS, EPA was unable to develop a technically sound cPAH sediment PRG for fish consumption, because there is no observable relationship between sediment sources and PAH concentrations in fish tissue.[22] Because it was unable to link cPAHs in sediment to fish consumption risk, and despite marginal cPAH fish consumption risk, EPA originally assigned a shellfish consumption PRG to the navigation channel as a surrogate for fish consumption.[23] After several potentially responsible parties, including NW Natural, commented on the lack of technical basis for the fish consumption PRG, EPA dropped the PRG for fish consumption from the ROD but established a 3,950 µg/kg cleanup level for the navigation channel based on clam consumption.

EPA's BHHRA found no risk to humans from clams harvested in the navigation channel.[24] EPA explicitly assumed in the BHHRA that clam harvesting occurred only in nearshore areas: "EPA acknowledges that an appropriate exposure area should be determined in consideration of water depth (i.e., nearshore areas) and the area over which a sustainable shellfish harvest consistent with the clam consumption is possible."[25] Nonetheless, EPA's responsiveness summary states that "EPA … disagrees that the shellfish consumption pathway is not complete for the navigation channel. The commenter has not provided any information to support this statement."[26] On this basis, EPA has determined that approximately 25 acres of the navigation channel must be dredged at an estimated cost in the tens of millions of dollars.

EPA must "explain the key assumptions that underpin its remedy"[27] and must explain decisions that run counter to evidence before it and its own prior findings.[28] EPA itself determined that the clam consumption exposure pathway was complete only in nearshore areas of the site; it cannot put the burden on responsible parties or members of the public to provide "information" supporting the assumptions in EPA's own risk assessment. EPA's requirement for cleanup of large areas not shown by

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[22] *See,* Lower Willamette Group Comments on Portland Harbor Proposed Plan (September 6, 2017), attached at Tab 4, p. 26. EPA's own internal reviews indicate its inability to establish this relationship. *See supra*, note 2. Further, the science is extensive that PAHs do not readily accumulate in vertebrate fish tissue. See Meador et al. 1995, *Reviews of Environmental Contamination and Toxicology* 143:79-164; September 2014 *Toxicological Review of* Benzo(a)pyrene, ORD EPA/635/R-14/312a; Varanasi, et al. 1989, Biotransformation and Disposition of Polycyclic Aromatic Hydrocarbons (PAHs) in Fish: In Varanasi U (ed); Metabolism of Polycyclic Aromatic Hydrocarbons (PAHs) in the Aquatic Environment, CRC Press; and Metabolism of PAHs in Teleost Fish-Scientific Findings, Memorandum from the Northwest Fisheries Science Center of NMFS, available at http://sero.nmfs.noaa.gov/deepwater_horizon/previous_reopening/index.html, October 22, 2010.

[23] 2016 draft Final FS Appendix B, p. B-35.

[24] See Map 5-4.1 (Portland Harbor RI/FS Appendix F, March 28, 2013 – Risks from Clam Consumption, RME), attached at Tab 5.

[25] EPA Comments on Comprehensive Round 2 Site Summary and Data Gaps Analysis Report (January 15, 2008), p. 26.

[26] ROD, Responsiveness Summary, p. 2-35. The extent to which the freshwater clams found in Portland Harbor (which are an invasive species illegal to possess in Oregon) are actually consumed is unknown. BHHRA, p. 29. EPA's decision to include the clam consumption exposure scenario in the risk assessment was based on a single round of interviews of 23 transient individuals. Wagner, letter to DHS (June 6, 2004), attached at Tab 6. The interviews were conducted by an individual with "a severe problem with alcohol" while drinking and fishing with the interviewees; four interviewees reported harvesting clams. *Id*. None of the interviewees reported harvesting clams from the navigation channel.

[27] *Emhart Industries* at *11-12 (D. R.I. 2017) (citations omitted) (finding EPA assumptions concerning use of groundwater and risks from fish consumption on which remedy selection was based arbitrary and capricious).

[28] *Motor Vehicle Mfrs. Ass'n of the U.S., Inc. v. State Farm Mut. Auto. Ins. Co.,* 463 U.S. 29 at 43.

the BHHRA to present unacceptable risk based on the unexplained, last minute abandonment of prior decisions is the very definition of arbitrary and capricious.[29]

II. EPA should recalculate cPAH cleanup levels based upon current IRIS toxicity values before requiring PRPs to design remedies for areas of the river that present no unacceptable risk.

On January 19, 2017, approximately two weeks after EPA issued the Portland Harbor ROD, EPA updated its Integrated Risk Information System (IRIS) toxicity values for benzo(a)pyrene. It is appropriate for EPA to update the cPAH cleanup levels (which are calculated as benzo(a)pyrene equivalent values) with the new IRIS toxicity values now, before requiring potentially responsible parties to incur the substantial expense of designing remedies for areas of the site that EPA could no longer consider to present unacceptable risk based on EPA's own current scientific information.

EPA guidance is clear that risk estimates and the cleanup levels that follow from those estimates should be based upon the most current IRIS values available. EPA "generally recommends IRIS as the principal source for toxicological data in preparing superfund risk assessments."[30]

> In general, if health assessment information is available in the Integrated Risk Information System for the contaminant under evaluation, risk assessors normally need not search further for additional sources of information. Since EPA's development and use of peer review in toxicity assessments, IRIS assessments have undergone external peer review in accordance with Agency peer review guidance at the time of the assessment. IRIS health assessments contain Agency consensus toxicity values.[31]

IRIS "represents the official Agency scientific position regarding the toxicity of the chemicals based on the data available at the time of the review."[32] When selecting remedial goals, EPA site managers should "[u]se the most current toxicity values provided by the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Tables (HEAST)."[33] Indeed, if the new IRIS values had been announced two weeks before the Portland Harbor ROD issued, rather than two weeks after, EPA would have been required to take a step back and update the FS to consider the updated cleanup levels.[34]

Even after a remedy is selected, EPA guidance directs site managers to review existing cleanup levels against updated IRIS values. "It is EPA's policy to encourage appropriate remedy changes in response to advances in remediation science and technology."[35] EPA "recognizes that some remedy decisions made at Superfund sites in the past should be modified to bring those decisions up to date

[29] *United States v. NCR Corp*., 911 F. Supp. 2d at 773 (agency must not rush through the process, "throw darts," "flip a coin," or make a "sudden, knee-jerk decision.").
[30] *Use of IRIS Values in Superfund Risk Assessment,* OSWER directive 9285.7-16 (December 21, 1993), p. 1
[31] *Human Health Toxicity Values in Superfund Risk Assessments*, OSWER directive 9285.7-53 (December 5, 2003), p. 2.
[32] *Id*.
[33] *Rules of Thumb for Superfund Remedy Selection*, OSWER 9355.0-69 (August 1997), p. 6.
[34] *Emhart Industries* at *13 ("Soon after its publication, EPA released a nationwide change to its non-cancer toxicity value for dioxin. Since dioxin is present at the Site, EPA was forced to issue a "Technical Memorandum" updating the BHHRA, cleanup levels, and FS for the Site.").
[35] *A Guide to Preparing Superfund Proposed Plans, Records of Decision and Other Remedy Selection Decision Documents,* EPA 540-R-98-031 (July 1991) ("ROD Guidance), p. 7-1.

with the current state of the science."[36] EPA's *Comprehensive Five-Year Review Guidance* instructs site managers to check for updated toxicity values:

> Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid? In conducting your five-year review, you should evaluate the effects of significant changes in standards and assumptions that were used at the time of remedy selection. *** Similarly, you should investigate the effect of significant changes in the risk parameters that were used to support the remedy selection, such as reference doses, cancer potency factors and exposure pathways of concern.[37]

At other sites, EPA has recalculated cleanup levels based on updated IRIS values by issuing Explanation of Significant Difference (ESD) documents. Here are some examples:

- Salem Acres (Salem, MA) January 1998 ESD (revising cPAH cleanup levels based upon updated B(a)P IRIS values ("benzo(a)pyrene less potent than it was believed when the ROD was written").[38]

- Burlington Northern Somers Plant (Somers, Montana) July 1998 ESD (revising soil remediation level for cPAHs from 36 to 57 ppm B(a)Peq based upon revised B(a)P cancer slope factor).[39]

- Petrochem Recycling Corp (Salt Lake City, Utah) March 1999 ESD (updating soil performance standard for PCBs from 0.15 ppm to 2.7 ppm based upon updated IRIS slope factors).[40]

- Commencement Bay November 1997 ESD (updating PCB cleanup levels for multiple reasons, including new toxicity information and updated exposure assumptions).[41]

We hope that EPA will consider our request to update the cPAH cleanup levels to incorporate the new IRIS toxicity values now.[42] As we have demonstrated in our prior technical submittals to EPA,[43] updating the cPAH cleanup values and the RALs based on those values would, alone, resolve the question of the clam consumption cleanup level, because all areas of the site would already meet protectiveness criteria at the appropriate exposure scale.[44] Updating the RALs and cleanup levels now would provide greater assurance to the public that direct contact with sediments will be protective

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[36] *Superfund Reforms: Updating Remedy Decisions*, EPA 540-F-96-026 (September 1996), p. 2.
[37] *Comprehensive Five-Year Review Guidance*, OSWER 9355.7-03B-P (June 2001), p. 4-4. *See also, Id.* p. 4-5 ("Have toxicity factors for contaminants of concern at the site changed (e.g. Integrated Risk Information System (IRIS) evaluations)?
[38] Attached at Tab 7.
[39] Attached at Tab 8.
[40] Attached at Tab 9.
[41] https://nepis.epa.gov/Exe/ZyPDF.cgi/9100NGII.PDF?Dockey=9100NGII.PDF
[42] "The lead agency is required to consider comments submitted by interested persons after the close of the public comment period only to the extent that the comments contain significant information not contained elsewhere in the administrative record file which could not have been submitted during the public comment period and which substantially support the need to significantly alter the response action. All such comments and any responses thereto shall be placed in the administrative record file." 40 C.F.R. §300.825(c).
[43] *USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels and Remedial Action Levels in Portland Harbor* (AnchorQEA, August 2, 2017), Attached at Tab 10.
[44] *Id.* at p. 8.

immediately after cleanup. Because updated cleanup values would significantly reduce the amount of unnecessary cleanup, they should also reduce disputes among potentially responsible parties and accelerate remedy implementation.[45]

As we understand it, EPA has just agreed to a baseline sampling program that will require approximately 2 years to complete. The extent to which site-specific pre-remedial design investigations, let alone remedial design, will commence at sites other than Gasco remains unclear, but there is certainly no compelling policy reason based upon the status of implementation of the ROD to delay recalculation of the cleanup values to reflect the most current EPA science on cPAH risk.[46]

CONCLUSION

EPA should recalculate its Portland Harbor cPAH sediment cleanup levels and RALs to incorporate the January 19, 2017 updated IRIS toxicity values for benzo(a)pyrene. Doing so now will reduce unnecessary costs for remedial design work based upon outdated values and will promote the harbor-wide settlement process by better defining the costs associated with cPAH cleanups. Updating the cleanup values in conjunction with correcting the nearshore direct contact cleanup level to be consistent with the risk assessment would provide greater assurance to the public that the site will be protective of direct contact with sediments immediately after construction of the remedy, and the update itself could prevent disagreements between EPA and potentially responsible parties over the legality of the clam consumption PRG.

cc: Tom Imeson
Mardilyn Saathoff
Bob Wyatt
Margaret Kirkpatrick

[45] *Id.*

[46] NW Natural acknowledges that the IRIS update to the benzo(a)pyrene value would not affect EPA's RAO 5 TPAH cleanup level. We understand the ROD to support additional data collection to refine areas of benthic toxicity in areas that are not driven by risk via another RAO. ROD, Responsiveness Summary, p. 2-218.

TAB 1

MEMORANDUM

To: EPA Region 10 Portland Harbor RI/FS File

From: Portland Harbor RI/FS Team

Date: May 2016

Subject: Evaluation of analyses used to calculate bioaccumulation calculation results
Portland Harbor Superfund Site
RAC Contract Number EP-W-05-049

PURPOSE

The purpose of this memo is to confirm the analyses used to calculate biota-sediment accumulation factors (BSAFs) and biota-sediment accumulation regressions (BSARs) presented in the Portland Harbor Bioaccumulation Modeling Report (Winward Environmental, 2015) and Appendix Da of the draft Portland Harbor Feasibility Study (Anchor QEA, 2012). The primary steps in this evaluation are:

- Review Section 4 of the Bioaccumulation Modeling Report and the current set of PRGs to identify chemicals for which confirmatory analysis is required.

- Use the results presented in Appendix A of the bioaccumulation Report, the Portland Harbor RI data base and supplemental information provided by the Lower Willamette Group (LWG) to confirm the relationship (or lack thereof) between OC normalized sediment and lipid normalized tissue.

- Determine the potential impact on the current sediment PRGs for the human health fish consumption exposure pathway (RAO 2) and ecological receptor biota (predator) exposure pathway (RAO 6).

IDENTIFICATION OF CHEMICALS

This analysis is limited to chemicals for which BSAFs or BSARs were used to develop PRGs that were used to evaluate remedial action alternatives in the Portland Harbor FS. Based on a review of Tables 2.2-5 (RAO 2 PRG Derivation) and 2.2-9 (RAO 6 PRG Derivation), the following PRGs were selected for evaluation:

- Arsenic

- Mercury

- Carcinogenic PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, dibenz(a,h)anthracene and chrysene
- Bis(2-ethylhexyl) phthalate
- Hexachlorobenzene
- Total PCBs

Human health sediment PRGs for carcinogenic PAHs, were based on consumption of shellfish. As a result, the analysis focused on benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene and chrysene in field collected clams. However, the analysis also looked at the development of BSARs for benzo(a)pyrene in smallmouth bass and the development of BSAFs for benzo(a)anthracene, benzo(a)pyrene and dibenz(a,h)anthracene in large home range fish.

In addition to the above chemicals, total PCBs were included in the smallmouth bass evaluation even though PRGs were developed using the mechanistic model to determine whether a BSAR relationship could be established for total PCBs.

Because the all of the RAO 6 sediment PRGs were developed using the Arnot and Gobas mechanistic food web model, the analysis focused specifically on RAO 2 and the BSARs developed for smallmouth bass and clams and the site-wide BSAFs developed for black crappie, brown bullhead and carp. The process for identifying chemicals for evaluation is presented in Tables 1 and 2.

BSAR AND BSAF RELATIONSHIP CONFIRMATION:

BSARs were developed for those species with exposure areas smaller than the site. These species include benthic invertebrates (laboratory worms, field clams, and crayfish), sculpin, and smallmouth bass. Because PRGs were not established based on tissue-sediment relationships for benthic invertebrates and sculpin, this analysis focused on field collected clam tissue and smallmouth bass.

According to the Bioaccumulation Modeling Report, BSARs were attempted using untransformed and log-transformed sediment and tissue data as follows:

1. Untransformed tissue concentrations vs. sediment concentrations
2. Untransformed tissue concentrations vs. log-transformed sediment concentrations
3. Log-transformed tissue concentrations vs. log-transformed sediment concentrations

BSAFs were developed for large home range fish species including brown bullhead, black crappie and carp.

For organic chemicals, sediment concentrations were normalized based on OC content, and tissue chemical concentrations were normalized based on lipid content to account for the partitioning of these chemicals. No adjustments were made to sediment and tissue chemical concentrations for metals.

Field Clam BSARs:

Selected BSARs for field clams are presented in Table 4-1 of the Bioaccumulation Modeling Report. Of the 15 chemicals evaluated, relationships were established only for benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene and chrysene. BSAR equations for these chemicals are presented in Table 3.

To confirm the field clam BSARs, collocated clam tissue and sediment sample data were extracted from the July 2011 version of the Portland Harbor RI data base (RI_BERA20110727+RA-SummedParams.mdb). Table 1 of Appendix A of the Bioaccumulation Modeling Report presents the collocated sediment and field collected clam tissue sample identification numbers. Sediment and tissue results were normalized to total organic carbon and total lipids respectively consistent with the procedures described in the Bioaccumulation Modeling Report. In addition, any co-located data pair with non-detected tissue or sediment concentrations was removed from the BSAR analysis, so that only pairs of detected sediment and detected tissue concentrations were used in BSAR development.

As noted in Table 4-1, all field clam BSARs were developed based on log-log relationships. According to the Bioaccumulation Modeling Report and supplemental information provided to EPA by the LWG on February 12, 2016, a correction factor was utilized when the BSARs were derived using log-transformed data. Correction factors were applied using the the “smearing estimator” of Duan (1983), as described in Helsel and Hirsh (2002). According to Helsel and Hirsh, transforming estimates from a log regression equation back into the original units imparts a bias into the BSAF estimate. Specifically, the arithmetic mean of log-data provides an estimate of the geometric mean or median rather than the arithmetic mean. The correction factor or “smearing estimator” for a linear model requires re-expressing the residuals (difference between predicted and measured or observed value) from the log-log equation into the original units, and computing their mean. This mean is the correction factor. Correction factors presented in the Bioaccumulation Modeling Report were calculated using the equation presented in Duan (1983) and the R software package. R is a software package that allows a wide range of statistical tests and analyses to be performed. The text of the R code is included as attachment A.

The results of the regression analysis confirmation as obtained from Excel (and without application of the correction factor) are presented in Figure 1. A comparison of the regression equations and r^2 values presented in Figure 1 shows that it was possible to confirm the slope of the line and the r-squared values but not the intercept due to application of the correction factor. This is significant because according to information presented in Burkard (2009), unlike untransformed data where the slope of the line is the

BSAF, for log-log transformations, the log of the BSAF is the intercept of the regression line and not the slope:

$$\ln(C(tissue)) = slope\ x \ln\big(C(sediment)\big) + \ln BSAF$$

Although calculation of the correction factor used to developed field clam BSARs has not been confirmed, application of the correction factor is consistent with the statistical procedures presented in Helsel and Hirsh. In addition, because the R software code has been provided by the LWG, sufficient documentation is available to justify the use of the field clam BSARs developed for benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluroanthene and chrysene.

Smallmouth Bass BSARs:

BSARs for smallmouth bass were not established for RAO 2 PRG contaminants not included in the Food Web Model. In order to confirm the lack of a relationship, BASR relationships were attempted for arsenic, mercury, benzo(a)pyrene, bis(2-ethylhexyl) phthalate, and hexachlorobenzene. A BSAR relationship was also attempted for total PCBs to determine whether a BSAR could be developed for a chemical for which a relationship would be expected based on its physiochemical and bioaccumlative properties. Sediment SWAC data corresponding to each fish tissue sample were obtained from Appendix A of the Bioaccumulation Report. Smallmouth bass fish tissue data were taken from the July 2011 version of the Portland Harbor RI data base (RI_BERA20110727+RA-SummedParams.mdb). Whole body fish tissue (or combined fillet and body w/o fillet fractions) were lipid normalized on a sample by sample basis. Unlike the collocated clam tissue results, it does not appear that the non-detected results were eliminated from the data set prior to developing the BSARs. However, evaluation of the data with the non-detected results removed, did not improve the relationships. The results of the regression analysis are presented in Figure 2. With the exception of total PCBs, the results of the analysis confirmed the lack of a relationship between tissue and sediment. Values of r^2 for arsenic, mercury benzo(a)pyrene, bis(2-ethylhexyl)phthalate and hexachlorobenzene ranged between 0.0009 to 0.2564 depending on the transformation applied. For total PCBs, the r^2 values ranged between 0.44 and 0.50 with the untransformed data providing the best relationship. This confirms that a BSAR relationship could be developed for total PCBs.

Large Home Range Fish Tissue BSAFS:

BSAFs were calculated for large home range species. The tissue concentration was the average of available composite samples for each species, and the sediment concentration was the Study Area SWAC based on a natural neighbor interpolation. However, neither the average tissue concentrations nor the sediment SWAC results are presented in the Bioaccumulation Modeling Report.

As presented in Table 4-6, BSAFs for large home range fish species were developed for antimony, lead, benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene, tributyltin and hexachlorobenzene. However, the only chemical for which large home range fish tissue BSAFs were used to develop RAO 2 sediment PRGs is hexachlorobenzene. A summary of the BSAFs developed is presented in Table 4.

An evaluation of the detection frequency for hexachlorobenzene in large home range fish species indicates that there were infrequent detections of hexachlorobenzene in large home range fish tissue (Table 5). Similarly, although BSAFs were developed for brown bullhead and carp for benzo(a)anthracene, benzo(a)pyrene, and dibenz(a,h)anthracene, there were no detections in 6 brown bullhead tissue samples and only 1 or 2 detections in carp samples. Although no model was developed for bis(2-ethylhexyl) phthalate, there was only one detection of this chemical in large home range fish species (brown bullhead).

Neither the Bioaccumulation Modeling Report nor the supplemental data provided by the LWG included organic carbon normalized SWACs for the chemicals of interest. As a result it is not possible to verify the BSAFs for large home range species presented in Table 4-6. However, there are limited detection of hexachlorobenzene in black crappie and brown bullhead and black crappie. The detection frequency of hexachlorobenzene in carp (9 out of 15 samples) is sufficient that this is only species for which hexachlorobenze BSAFs can reasonably be developed. The lack of detections of benzo(a)anthracene, benzo(a)pyrene, and dibenz(a,h)anthracene in large home range fish species indicates that BSAFs should not be used to develop fish consumption based PRGs for these chemicals.

SUMMARY

The results of this analysis show that a BSAR with an r^2 value of greater than 0.3 can be developed for clam tissue and the four carcinogenic PAHs evaluated, and that the slope of the line of the log-log regression can be verified. Although calculation of the correction factor has not been confirmed, the application of the correction factor is consistent with the procedures presented in Helsel and Hirsh.

The analysis also confirms the lack of a tissue sediment relationship for smallmouth bass for all chemicals that were evaluated (arsenic, benzo(a)pyrene, bis(2-ethylhexyl) phthalate, hexachlorobenzene and mercury). However, the bioaccumulation report does not present the results of the regression analysis so it is not possible to verify the BSAR equations presented in Figure 2.

The analysis also shows that with the possible exception of hexachlorobenzene in carp, there are not sufficient detections of benzo(a)anthracene, benzo(a)pyrene, and dibenzo(a,h)anthracene in large home range fish species and hexachlorobenzene in black crappie and brown bullhead to warrant the use of BSAFs to develop PRGs for these chemicals and species. However, neither the Bioaccumulation Modeling Report or the supplemental data provided by the LWG included organic carbon normalized SWACs for the chemicals of interest for which BSAFs were developed (benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene, and hexachlorobenzene).

Further, the underlying assumption BSAR in the analyses – that the BSAF should change in a linear or ln-linear fashion across all sediment concentrations – may be incorrect for some analytes and ranges of sediment and tissue concentrations. A BSAF may be applicable even when r^2 is zero (BSAF doesn't change with sediment concentration). One might still use a BSAF in this case to help guide monitoring during and after remediation.

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TAB 2

Table J2.2-1c

Rolling River Mile Average Concentrations - cPAHs (µg/kg) - 0.5 Mile Increments

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
1.8	East	285.27	285.27	285.22	283.78	282.50	282.50	281.82	283.78
1.9	East	186.86	183.32	182.29	179.84	176.96	176.96	175.82	179.84
2	East	109.20	96.92	94.10	91.09	87.40	87.40	85.85	91.09
2.1	East	70.52	53.34	48.21	43.79	39.56	39.56	37.86	43.79
2.2	East	68.53	46.11	40.46	35.65	30.23	30.23	27.86	35.65
2.3	East	68.30	47.58	42.36	38.13	31.09	31.09	28.41	38.13
2.4	East	72.13	53.50	48.88	45.39	37.72	37.72	34.39	45.39
2.5	East	100.32	90.32	83.48	69.85	51.04	51.04	39.92	69.85
2.6	East	260.05	230.35	127.55	89.82	58.76	58.76	42.40	89.82
2.7	East	291.09	265.35	155.32	106.32	67.62	67.62	49.07	118.83
2.8	East	330.61	302.02	178.48	123.59	83.63	83.63	63.97	137.65
2.9	East	366.76	335.38	199.80	139.56	98.14	98.14	77.89	154.99
3	East	378.99	342.93	193.30	140.72	111.59	111.59	100.92	158.45
3.1	East	147.28	147.28	144.53	129.07	117.79	117.79	114.39	147.28
3.2	East	123.17	123.17	122.85	122.85	122.69	122.69	122.47	122.85
3.3	East	136.32	136.32	133.30	133.30	132.93	132.93	128.12	133.30
3.4	East	127.61	127.61	124.55	124.55	124.09	124.09	118.04	124.55
3.5	East	103.45	103.45	100.97	100.52	91.46	91.46	80.28	100.52
3.6	East	172.84	97.27	84.23	78.46	61.95	61.95	50.44	78.46
3.7	East	179.17	100.32	86.96	79.70	61.10	61.10	45.42	79.70
3.8	East	178.68	93.22	80.33	70.51	47.73	47.73	31.63	70.51
3.9	East	195.24	106.54	91.25	69.90	40.86	40.86	19.42	69.90
4	East	248.27	129.99	109.63	81.01	46.48	46.48	19.35	81.01
4.1	East	728.16	726.84	721.31	477.94	159.25	159.25	56.39	477.94
4.2	East	1246.57	1245.78	1198.34	929.37	181.08	181.08	43.96	929.37
4.3	East	1782.86	1773.03	1345.04	975.23	235.15	235.15	60.41	975.23
4.4	East	3074.92	2823.89	1741.18	1095.22	257.00	257.00	65.42	1095.22
4.5	East	3710.28	3478.82	1862.81	1093.30	281.79	281.79	61.57	1093.30
4.6	East	4185.69	3902.69	1927.87	1114.36	293.82	293.82	61.92	1114.36
4.7	East	4957.91	4571.35	1919.87	905.11	337.01	337.01	91.48	905.11
4.8	East	4953.33	4494.46	1855.23	841.19	324.02	324.02	100.17	841.19
4.9	East	3027.23	3027.23	1047.80	489.04	353.49	353.49	151.99	489.04
5	East	327.32	327.32	327.32	327.32	326.85	326.85	258.05	327.32
5.1	East	396.32	396.32	396.32	396.32	396.32	396.32	261.20	396.32
5.2	East	472.15	472.15	472.15	472.15	472.15	472.15	253.14	472.15
5.3	East	487.34	487.34	487.34	487.34	470.21	470.21	257.25	470.21
5.4	East	648.39	648.39	648.39	648.39	473.76	473.76	201.41	473.76
5.5	East	791.48	791.48	791.48	705.73	425.67	425.67	146.70	425.67
5.6	East	756.13	754.13	754.13	662.10	327.38	327.38	96.74	327.38
5.7	East	753.01	751.51	751.51	682.34	400.16	400.16	101.62	400.16
5.8	East	783.51	782.16	782.16	719.82	444.98	444.98	122.94	475.43

Table J2.2-1c

Rolling River Mile Average Concentrations - cPAHs (µg/kg) - 0.5 Mile Increments

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
5.9	East	708.01	706.78	706.78	646.17	462.45	462.45	210.21	511.54
6	East	619.79	618.74	618.64	607.09	486.73	486.73	267.41	542.06
6.1	East	767.76	767.76	716.22	622.10	489.94	489.94	294.15	744.48
6.2	East	746.34	746.34	685.98	575.15	425.84	425.84	315.52	742.84
6.3	East	622.76	622.76	565.35	461.89	343.59	343.59	285.64	619.62
6.4	East	514.43	513.47	457.38	362.84	266.85	266.85	215.13	512.61
6.5	East	411.54	401.88	341.10	255.14	177.55	177.55	134.57	400.61
6.6	East	175.43	159.12	140.00	130.70	105.92	105.92	78.44	157.40
6.7	East	85.51	70.14	56.22	55.99	53.65	53.65	45.73	68.53
6.8	East	63.97	49.64	37.28	37.07	34.93	34.93	30.21	48.14
6.9	East	58.10	44.76	34.06	33.86	31.91	31.91	28.18	44.38
7	East	63.19	44.64	35.46	35.27	33.73	33.73	31.64	56.05
7.1	East	83.64	60.65	42.47	42.46	41.88	41.88	40.58	83.25
7.2	East	95.25	72.49	50.52	50.52	47.62	47.62	45.94	93.68
7.3	East	97.98	74.98	52.76	52.76	49.83	49.83	48.32	96.40
7.4	East	98.34	73.13	48.63	48.63	45.35	45.35	44.13	96.57
7.5	East	88.78	74.07	50.80	50.80	46.58	46.58	44.95	86.51
7.6	East	60.06	58.83	50.07	50.07	45.79	45.79	42.16	57.54
7.7	East	47.33	47.33	47.33	47.33	47.29	47.29	42.92	47.33
7.8	East	53.59	51.37	51.37	50.95	50.59	50.59	32.93	50.95
7.9	East	60.86	41.71	41.71	41.29	40.91	40.91	22.79	41.29
8	East	64.55	32.80	32.80	32.44	31.19	31.19	15.85	32.44
8.1	East	61.58	30.57	30.57	30.22	29.04	29.04	17.10	30.22
8.2	East	58.26	27.88	27.88	27.54	26.38	26.38	15.42	27.54
8.3	East	50.11	13.97	13.97	13.97	12.84	12.84	12.45	13.97
8.4	East	45.83	24.04	24.04	24.04	22.74	22.74	22.30	24.04
8.5	East	34.24	34.24	34.24	34.24	34.24	34.24	34.20	34.24
8.6	East	36.89	36.89	36.89	36.89	36.79	36.79	36.69	36.89
8.7	East	38.29	38.29	38.29	38.29	38.00	38.00	37.70	38.29
8.8	East	38.44	38.44	38.44	38.44	37.77	37.77	33.74	38.44
8.9	East	36.13	36.13	36.13	36.13	33.72	33.72	26.51	36.13
9	East	34.04	34.04	34.04	34.04	31.13	31.13	22.15	34.04
9.1	East	28.84	28.84	28.84	28.84	26.01	26.01	17.38	28.84
9.2	East	23.29	23.29	23.29	23.29	20.75	20.75	12.61	23.29
9.3	East	22.38	22.38	22.38	22.38	19.02	19.02	13.09	22.38
9.4	East	25.39	25.39	25.39	25.39	17.81	17.81	12.92	25.39
9.5	East	24.85	24.85	24.85	24.85	17.40	17.40	11.87	24.85
9.6	East	27.04	27.04	27.04	27.04	19.92	19.92	14.41	27.04
9.7	East	33.15	33.15	33.15	33.15	26.13	26.13	20.71	33.15
9.8	East	50.35	50.25	50.16	48.52	39.91	39.91	28.13	48.52
9.9	East	157.81	157.70	157.60	149.77	67.36	67.36	38.05	154.95

Table J2.2-1c

Rolling River Mile Average Concentrations - cPAHs (µg/kg) - 0.5 Mile Increments

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
10	East	218.90	218.78	218.67	210.07	118.10	118.10	78.51	215.75
10.1	East	303.54	303.39	303.26	292.62	178.88	178.88	121.87	299.65
10.2	East	378.63	378.44	378.28	364.85	221.32	221.32	148.55	373.72
10.3	East	435.76	435.76	435.76	422.58	247.08	247.08	171.42	433.75
10.4	East	216.49	216.49	216.49	216.49	206.99	206.99	167.83	216.49
10.5	East	127.54	127.54	127.54	125.13	113.66	113.66	92.83	125.13
10.6	East	58.37	58.37	58.37	49.33	35.81	35.81	29.97	49.33
10.7	East	55.75	55.75	55.75	46.54	27.37	27.37	17.73	46.54
10.8	East	66.50	66.50	66.50	57.49	29.84	29.84	13.99	57.49
10.9	East	71.11	70.31	69.04	58.82	34.29	34.29	15.51	58.82
11	East	74.55	71.13	65.00	54.79	33.29	33.29	12.65	54.79
11.1	East	86.31	71.05	60.46	52.10	31.40	31.40	10.07	52.10
11.2	East	88.58	59.17	46.90	37.41	22.56	22.56	7.26	37.41
11.3	East	72.01	42.92	30.43	20.47	13.20	13.20	5.28	20.47
11.4	East	63.35	34.72	23.18	13.76	7.00	7.00	1.38	13.76
11.5	East	59.21	29.21	20.91	12.40	6.58	6.58	1.78	12.40
11.6	East	47.93	23.63	18.33	12.13	6.79	6.79	1.90	12.13
11.7	East	26.65	23.05	20.74	16.24	10.33	10.33	2.89	16.24
1.8	West	62.11	62.11	62.11	62.11	62.11	62.11	62.11	62.11
1.9	West	62.46	62.46	62.46	62.46	62.46	62.46	62.46	62.46
2	West	69.50	69.50	69.50	69.50	69.50	69.50	69.50	69.50
2.1	West	86.86	86.86	86.86	86.86	86.86	86.86	86.86	86.86
2.2	West	109.69	109.69	109.69	109.69	109.69	109.69	109.69	109.69
2.3	West	160.70	160.70	160.70	160.70	160.70	160.70	160.70	160.70
2.4	West	216.19	216.19	216.19	216.19	216.19	216.19	215.28	216.19
2.5	West	256.95	256.95	256.95	256.95	256.95	256.95	246.87	256.95
2.6	West	320.09	320.09	320.09	320.09	320.09	320.09	285.84	320.09
2.7	West	427.95	427.95	427.95	427.95	427.95	427.95	321.95	427.95
2.8	West	513.27	513.27	513.27	513.27	513.27	513.27	352.94	513.27
2.9	West	526.51	526.51	526.51	526.51	526.51	526.51	371.27	526.51
3	West	586.96	586.96	586.96	586.96	586.96	586.96	394.01	586.96
3.1	West	647.53	647.53	647.53	647.53	647.53	647.53	407.71	647.53
3.2	West	617.29	617.29	617.29	617.29	617.29	617.29	404.33	617.29
3.3	West	546.32	546.32	546.32	546.32	545.47	545.47	365.34	546.32
3.4	West	516.01	516.01	516.01	516.01	515.01	515.01	319.22	516.01
3.5	West	431.10	431.10	431.10	431.10	429.87	429.87	282.44	431.10
3.6	West	320.54	320.54	320.54	320.54	318.90	318.90	251.50	320.54
3.7	West	373.99	373.99	373.99	352.46	258.36	258.36	194.92	352.46
3.8	West	426.48	426.48	426.48	400.88	287.29	287.29	192.64	400.88
3.9	West	503.13	503.13	503.13	472.48	330.22	330.22	212.62	472.48
4	West	644.46	644.46	644.46	605.28	390.05	390.05	176.66	605.28

Table J2.2-1c

Rolling River Mile Average Concentrations - cPAHs (µg/kg) - 0.5 Mile Increments

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
4.1	West	821.69	821.69	821.69	782.88	489.17	489.17	144.37	782.88
4.2	West	682.16	682.16	682.16	677.65	533.94	533.94	145.20	677.65
4.3	West	732.10	732.10	732.10	727.05	571.97	571.97	135.33	727.05
4.4	West	840.73	840.73	840.73	835.63	557.96	557.96	94.96	835.63
4.5	West	772.50	772.50	772.50	772.50	499.14	499.14	119.79	772.50
4.6	West	593.79	593.79	593.79	592.04	376.81	376.81	136.58	592.04
4.7	West	718.99	718.99	711.00	652.47	325.64	325.64	160.79	652.47
4.8	West	696.78	696.78	688.77	630.08	296.69	296.69	182.46	630.08
4.9	West	756.67	756.67	706.02	604.99	298.34	298.34	201.23	604.99
5	West	904.84	904.84	845.85	597.11	283.58	283.58	187.08	597.11
5.1	West	1352.60	1352.60	980.81	638.54	300.18	300.18	167.35	638.54
5.2	West	2277.41	1934.17	906.25	545.19	286.52	286.52	127.53	545.19
5.3	West	3143.22	2757.01	1149.48	648.54	279.96	279.96	65.85	648.54
5.4	West	3233.89	2819.33	1154.25	673.79	396.69	396.69	59.08	673.79
5.5	West	3059.56	2650.05	1008.27	707.00	475.85	475.85	75.97	707.00
5.6	West	2640.67	2264.25	1070.46	836.59	518.55	518.55	127.89	859.25
5.7	West	1869.14	1836.29	1266.85	917.04	504.08	504.08	171.97	1158.39
5.8	West	2391.43	1841.79	1354.01	1098.30	510.74	510.74	165.33	1354.01
5.9	West	6066.89	2386.42	1320.10	1019.74	404.12	404.12	140.70	1320.10
6	West	14260.55	2215.14	1193.81	906.11	328.49	328.49	116.58	1193.81
6.1	West	21991.86	2044.06	1034.16	760.87	249.80	249.80	81.87	1034.16
6.2	West	29236.75	1824.08	779.40	627.65	183.65	183.65	41.57	779.40
6.3	West	40104.32	1213.09	285.27	177.98	22.86	22.86	0.00	285.27
6.4	West	38796.86	294.52	214.70	165.60	46.48	46.48	10.64	47.78
6.5	West	25684.49	586.63	504.02	402.75	89.43	89.43	13.56	90.77
6.6	West	11444.97	950.62	843.35	662.72	130.46	130.46	15.80	131.76
6.7	West	2747.09	819.26	678.48	511.10	100.81	100.81	12.81	101.80
6.8	West	955.57	730.89	601.93	447.69	88.31	88.31	11.43	88.31
6.9	West	573.49	476.19	403.08	296.09	51.95	51.95	4.36	51.95
7	West	431.07	288.39	222.10	150.91	26.41	26.41	2.66	26.41
7.1	West	388.34	93.24	39.15	7.75	1.09	1.09	1.19	1.09
7.2	West	337.05	32.98	18.15	6.13	1.25	1.25	0.00	1.25
7.3	West	301.70	27.00	18.52	12.86	8.11	8.11	4.10	8.11
7.4	West	242.36	38.97	36.32	33.02	28.44	28.44	18.99	28.44
7.5	West	174.70	51.50	49.49	45.92	36.50	36.50	22.23	36.50
7.6	West	72.27	65.47	64.07	61.45	49.58	49.58	27.75	49.58
7.7	West	67.72	65.88	64.55	62.32	51.23	51.23	28.44	51.23
7.8	West	65.82	65.80	65.73	64.95	53.14	53.14	28.90	54.27
7.9	West	69.93	69.92	69.83	66.98	47.04	47.04	21.18	55.04
8	West	81.38	81.38	81.38	71.75	44.11	44.11	18.32	64.36
8.1	West	154.22	154.22	152.78	127.27	13.66	13.66	2.77	126.62

Table J2.2-1c

Rolling River Mile Average Concentrations - cPAHs (µg/kg) - 0.5 Mile Increments

Portland Harbor Superfund Site

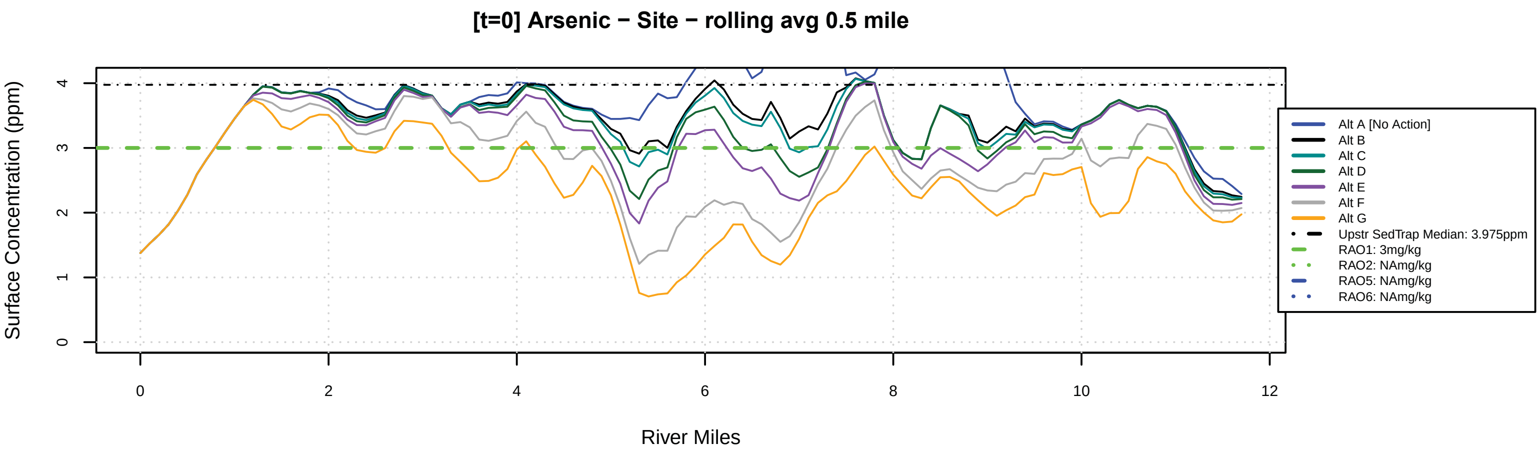
Portland, Oregon

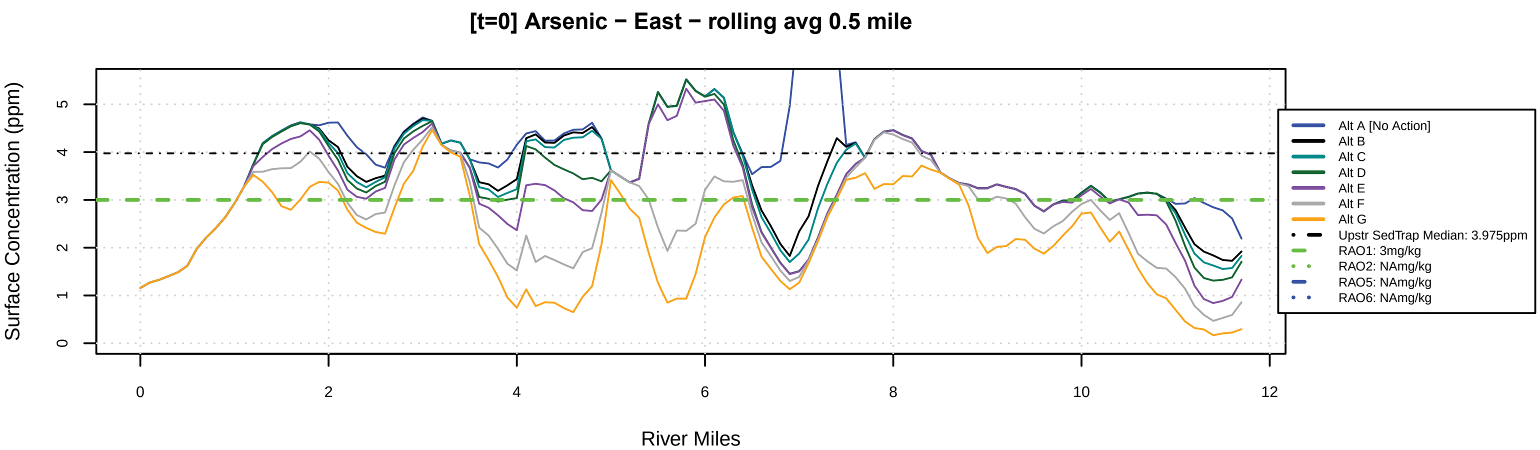
		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
8.2	West	182.11	182.11	180.96	158.76	37.60	37.60	8.66	158.76
8.3	West	166.50	165.99	165.12	142.72	43.08	43.08	20.70	142.72
8.4	West	164.84	163.87	163.05	131.35	39.75	39.75	19.52	131.35
8.5	West	157.94	156.98	156.07	122.94	38.06	38.06	19.12	122.94
8.6	West	127.83	119.42	110.27	78.72	40.20	40.20	20.23	78.72
8.7	West	126.22	90.14	77.50	40.06	21.28	21.28	17.73	40.06
8.8	West	157.77	85.13	59.05	15.14	2.29	2.29	0.58	15.14
8.9	West	199.49	73.54	34.76	5.52	0.00	0.00	0.00	5.52
9	West	244.30	88.99	22.98	3.73	0.00	0.00	0.00	3.73
9.1	West	177.20	61.01	24.76	13.06	4.58	4.58	2.95	13.06
9.2	West	117.12	60.71	33.93	24.75	10.68	10.68	6.83	24.75
9.3	West	88.48	58.85	42.66	34.62	11.69	11.69	7.59	34.62
9.4	West	102.36	77.62	61.19	36.99	12.35	12.35	8.13	36.99
9.5	West	148.22	125.81	81.07	34.07	10.73	10.73	7.05	34.07
9.6	West	173.60	145.67	90.06	34.97	10.55	10.55	7.00	34.97
9.7	West	212.97	176.37	103.49	31.20	7.10	7.10	5.20	31.20
9.8	West	277.97	226.84	125.00	23.84	8.75	8.75	7.45	23.84
9.9	West	300.06	277.99	132.37	28.88	19.25	19.25	12.56	28.88
10	West	122.87	122.87	121.18	110.42	90.67	90.67	38.14	112.11
10.1	West	156.51	156.51	155.27	144.59	87.73	87.73	31.04	145.83
10.2	West	282.49	282.49	281.38	272.30	222.85	222.85	121.80	273.41
10.3	West	354.58	354.58	353.49	344.85	297.10	297.10	199.55	345.93
10.4	West	352.57	352.57	351.48	342.73	295.04	295.04	208.29	343.81
10.5	West	186.72	186.72	186.72	185.45	167.31	167.31	106.71	185.45
10.6	West	146.85	146.85	146.85	146.85	146.85	146.85	100.48	146.85
10.7	West	92.15	92.15	92.15	92.15	92.15	92.15	70.90	92.15
10.8	West	70.85	70.85	70.85	70.85	70.85	70.85	52.63	70.85
10.9	West	66.88	66.88	66.88	66.88	66.88	66.88	50.18	66.88
11	West	65.35	65.35	65.35	65.35	65.35	65.35	65.33	65.35
11.1	West	77.48	77.48	77.48	77.48	77.48	77.48	77.48	77.48
11.2	West	91.43	91.43	91.43	91.43	91.43	91.43	90.27	91.43
11.3	West	89.88	89.88	89.88	89.88	89.88	89.88	88.54	89.88
11.4	West	79.16	79.16	79.16	79.16	79.16	79.16	77.95	79.16
11.5	West	84.56	84.56	84.56	84.56	84.56	84.56	83.18	84.56
11.6	West	77.70	77.70	77.70	77.70	77.70	77.70	75.99	77.70
11.7	West	49.64	49.64	49.64	49.64	49.64	49.64	49.64	49.64
7.8	Swan Isl	274.24	34.87	34.82	3.82	1.90	1.90	0.28	3.82
7.9	Swan Isl	180.11	14.06	13.93	7.22	1.90	1.90	0.72	7.22
8	Swan Isl	230.60	19.33	18.31	9.87	4.01	4.01	0.98	9.87
8.1	Swan Isl	270.08	21.30	19.69	11.76	5.88	5.88	1.26	11.76
8.2	Swan Isl	306.92	20.23	18.69	11.55	6.23	6.23	2.12	11.55

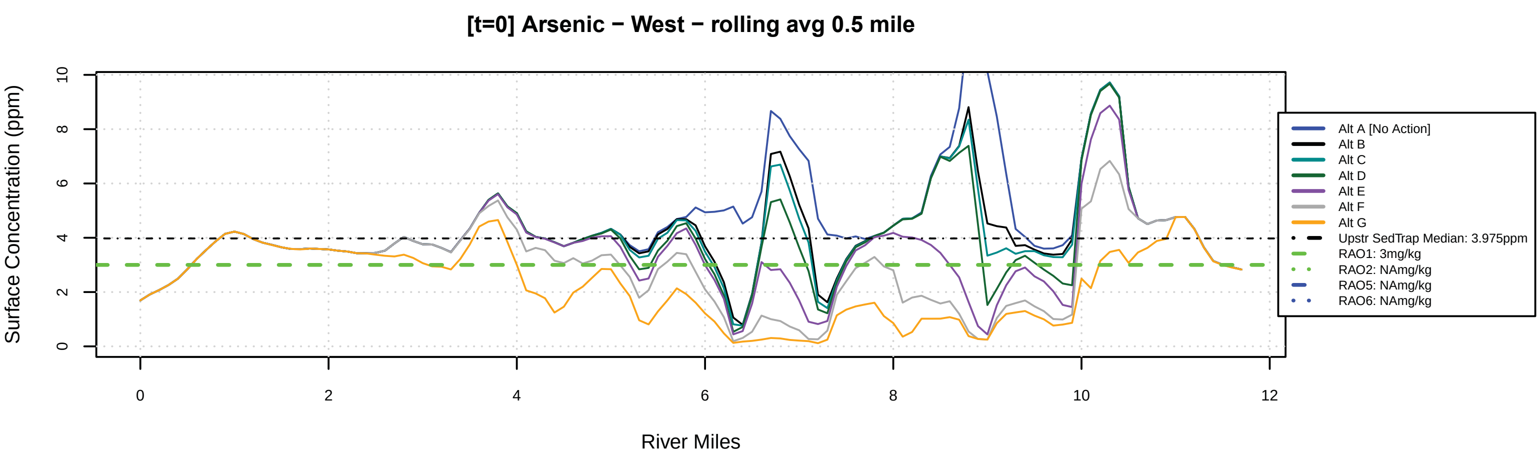
Table J2.2-1c
Rolling River Mile Average Concentrations - cPAHs (µg/kg) - 0.5 Mile Increments
Portland Harbor Superfund Site
Portland, Oregon

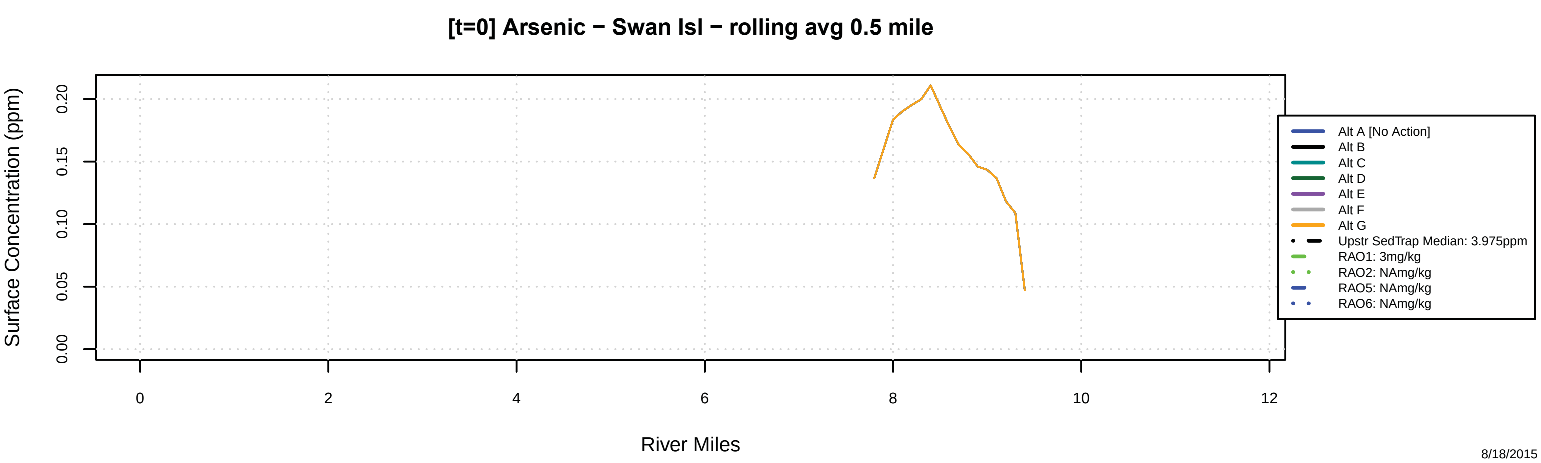
		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
8.3	Swan Isl	324.18	18.63	17.03	11.80	6.47	6.47	2.34	11.80
8.4	Swan Isl	385.51	21.35	19.09	13.03	8.70	8.70	3.54	13.03
8.5	Swan Isl	388.14	18.20	15.29	11.45	9.16	9.16	5.45	11.45
8.6	Swan Isl	359.27	21.05	10.30	7.14	6.12	6.12	5.51	7.14
8.7	Swan Isl	288.09	25.06	8.82	5.66	4.49	4.49	3.91	5.66
8.8	Swan Isl	258.99	26.91	8.34	5.28	3.96	3.96	3.54	5.28
8.9	Swan Isl	309.88	108.46	63.12	40.65	6.27	6.27	4.28	87.76
9	Swan Isl	339.31	131.60	76.02	49.89	7.15	7.15	4.69	109.02
9.1	Swan Isl	325.88	167.56	104.18	68.44	8.88	8.88	5.55	151.36
9.2	Swan Isl	379.46	258.88	169.67	111.36	13.46	13.46	8.08	249.40
9.3	Swan Isl	431.88	369.29	248.47	162.50	19.22	19.22	11.44	366.47
9.4	Swan Isl	63.59	63.59	63.59	63.59	63.59	63.59	63.59	63.59

TAB 3


[t=0] Arsenic − Site − rolling avg 0.5 mile
Surface Concentration (ppm)
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 3.975ppm
RAO1: 3mg/kg
RAO2: NAmg/kg
RAO5: NAmg/kg
RAO6: NAmg/kg


[t=0] Arsenic − East − rolling avg 0.5 mile
Surface Concentration (ppm)
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 3.975ppm
RAO1: 3mg/kg
RAO2: NAmg/kg
RAO5: NAmg/kg
RAO6: NAmg/kg


[t=0] Arsenic − West − rolling avg 0.5 mile
Surface Concentration (ppm)
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 3.975ppm
RAO1: 3mg/kg
RAO2: NAmg/kg
RAO5: NAmg/kg
RAO6: NAmg/kg


[t=0] Arsenic − Swan Isl − rolling avg 0.5 mile
Surface Concentration (ppm)
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 3.975ppm
RAO1: 3mg/kg
RAO2: NAmg/kg
RAO5: NAmg/kg
RAO6: NAmg/kg

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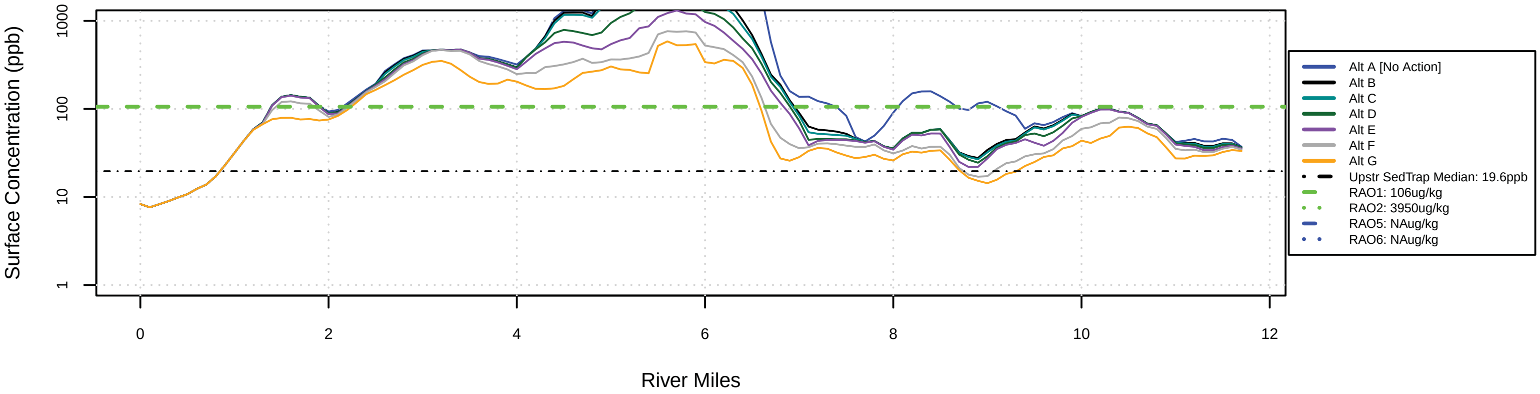
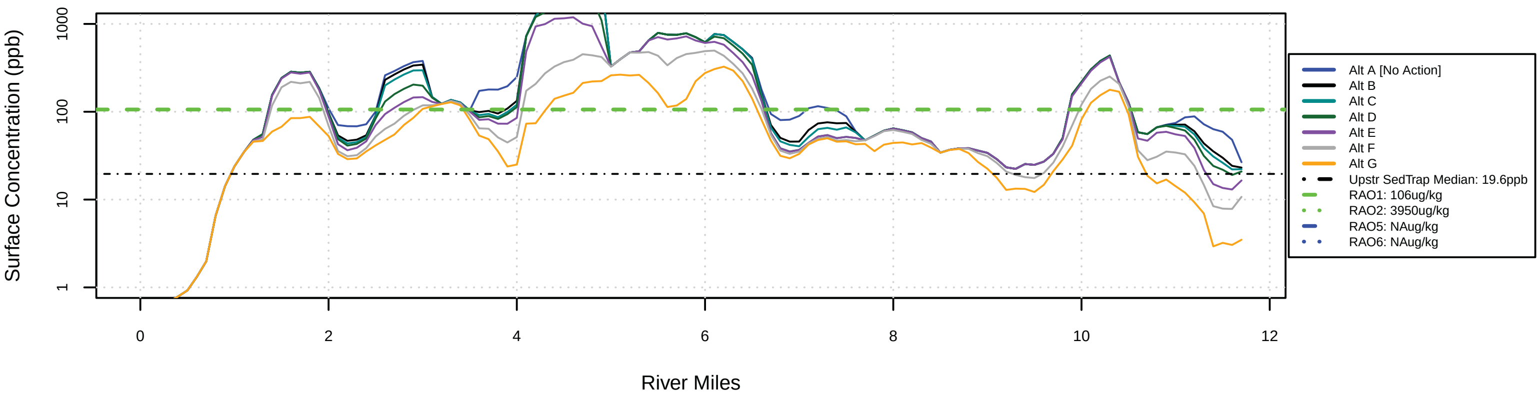
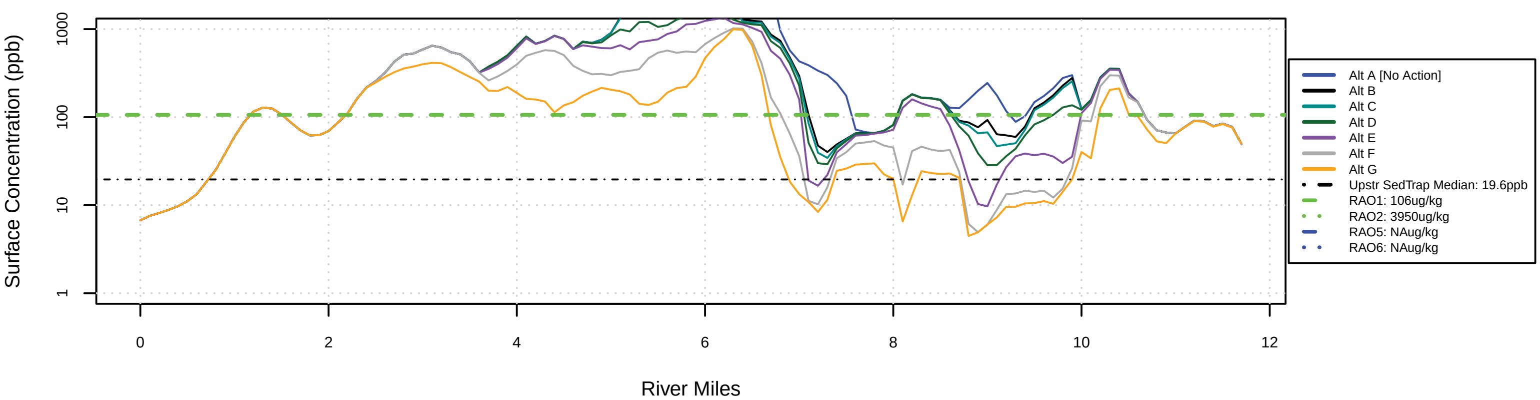
[t=0] cPAHs − Site − rolling avg 0.5 mile



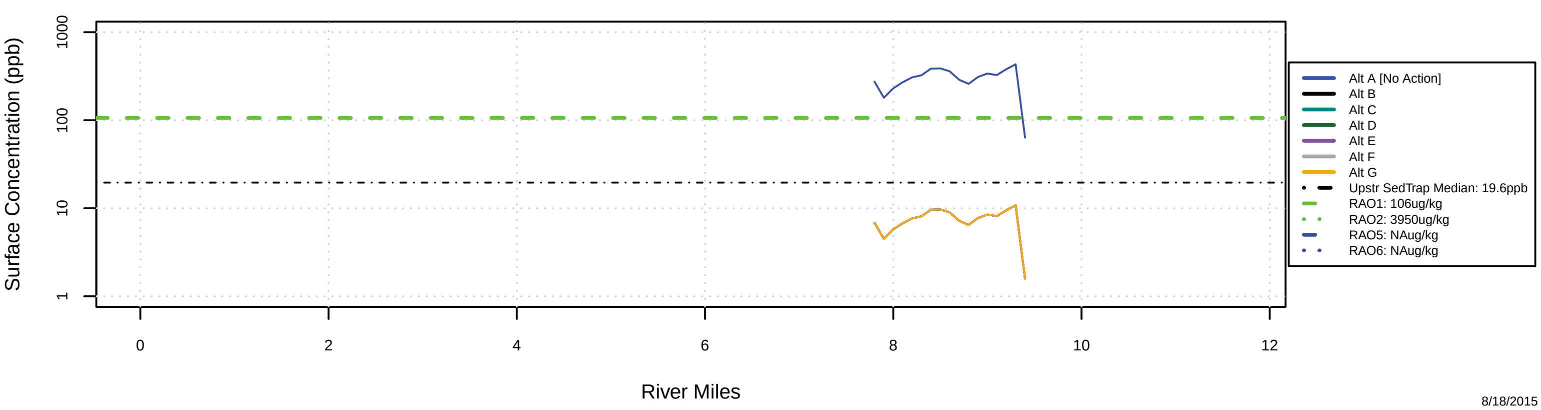
[t=0] cPAHs − East − rolling avg 0.5 mile



[t=0] cPAHs − West − rolling avg 0.5 mile



[t=0] cPAHs − Swan Isl − rolling avg 0.5 mile



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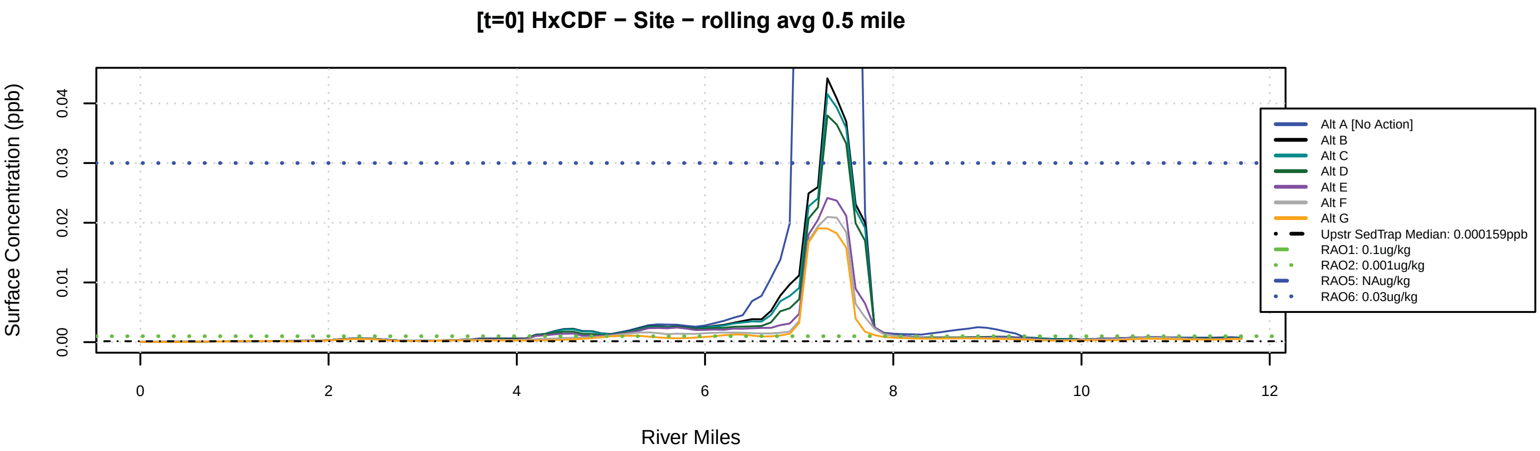
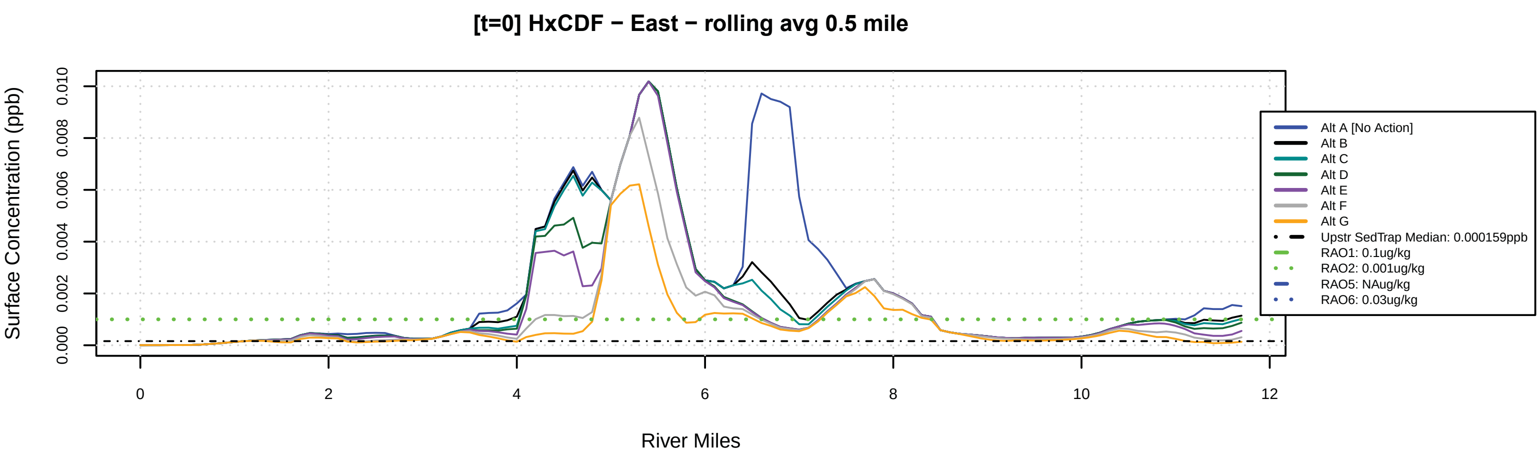
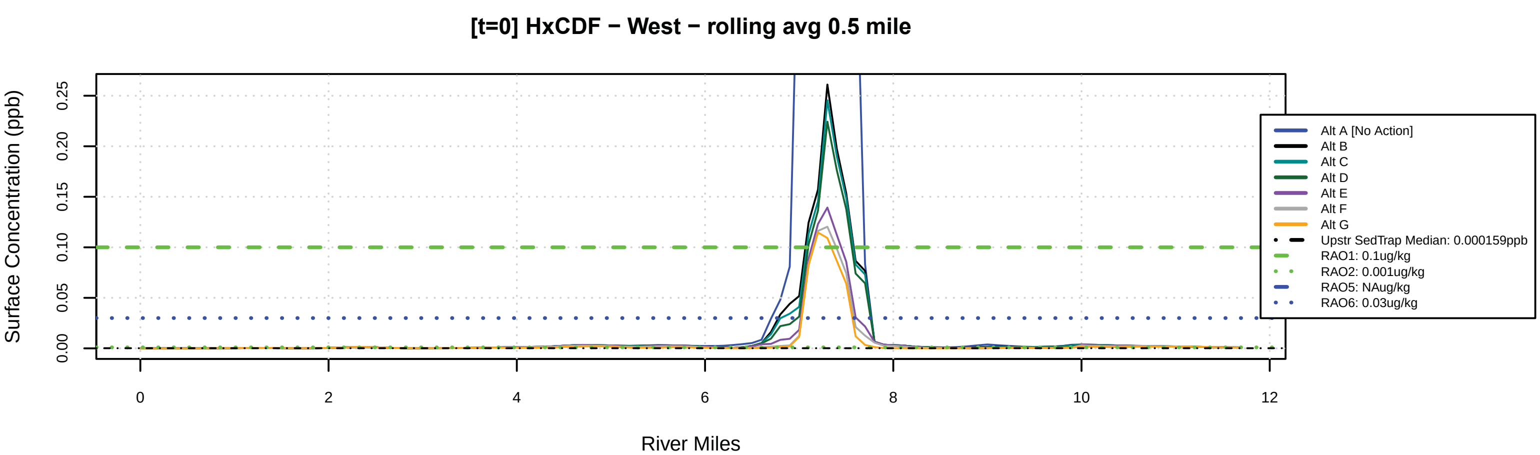
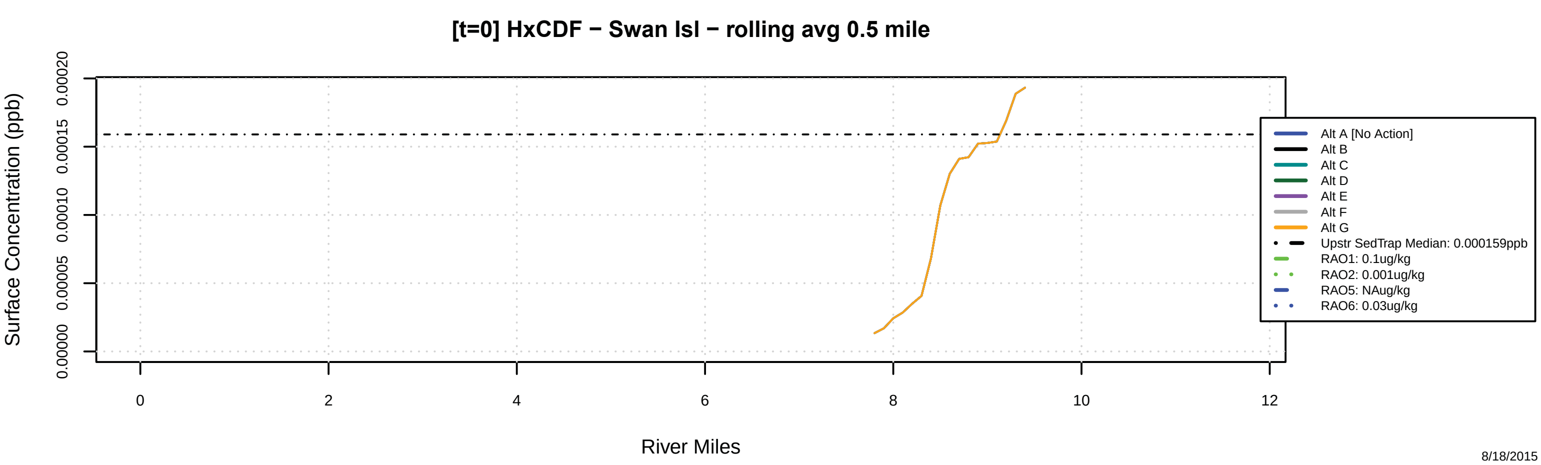

[t=0] HxCDF − Site − rolling avg 0.5 mile
Surface Concentration (ppb)
0.00
0.01
0.02
0.03
0.04
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.000159ppb
RAO1: 0.1ug/kg
RAO2: 0.001ug/kg
RAO5: NAug/kg
RAO6: 0.03ug/kg


[t=0] HxCDF − East − rolling avg 0.5 mile
Surface Concentration (ppb)
0.000
0.002
0.004
0.006
0.008
0.010
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.000159ppb
RAO1: 0.1ug/kg
RAO2: 0.001ug/kg
RAO5: NAug/kg
RAO6: 0.03ug/kg


[t=0] HxCDF − West − rolling avg 0.5 mile
Surface Concentration (ppb)
0.00
0.05
0.10
0.15
0.20
0.25
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.000159ppb
RAO1: 0.1ug/kg
RAO2: 0.001ug/kg
RAO5: NAug/kg
RAO6: 0.03ug/kg


[t=0] HxCDF − Swan Isl − rolling avg 0.5 mile
Surface Concentration (ppb)
0.00000
0.00005
0.00010
0.00015
0.00020
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.000159ppb
RAO1: 0.1ug/kg
RAO2: 0.001ug/kg
RAO5: NAug/kg
RAO6: 0.03ug/kg

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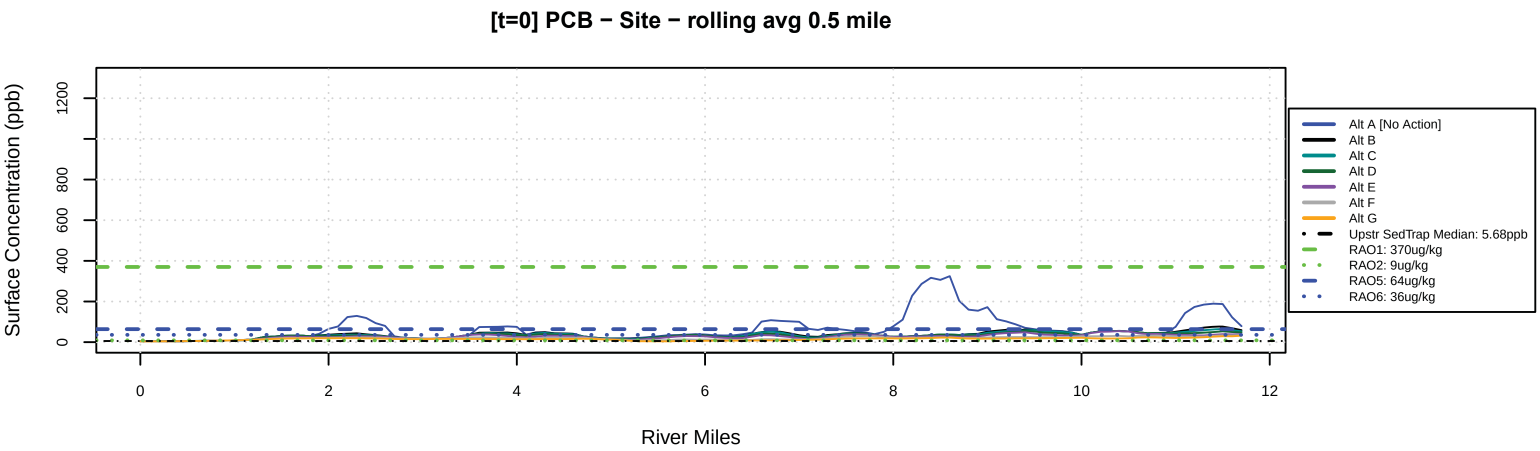
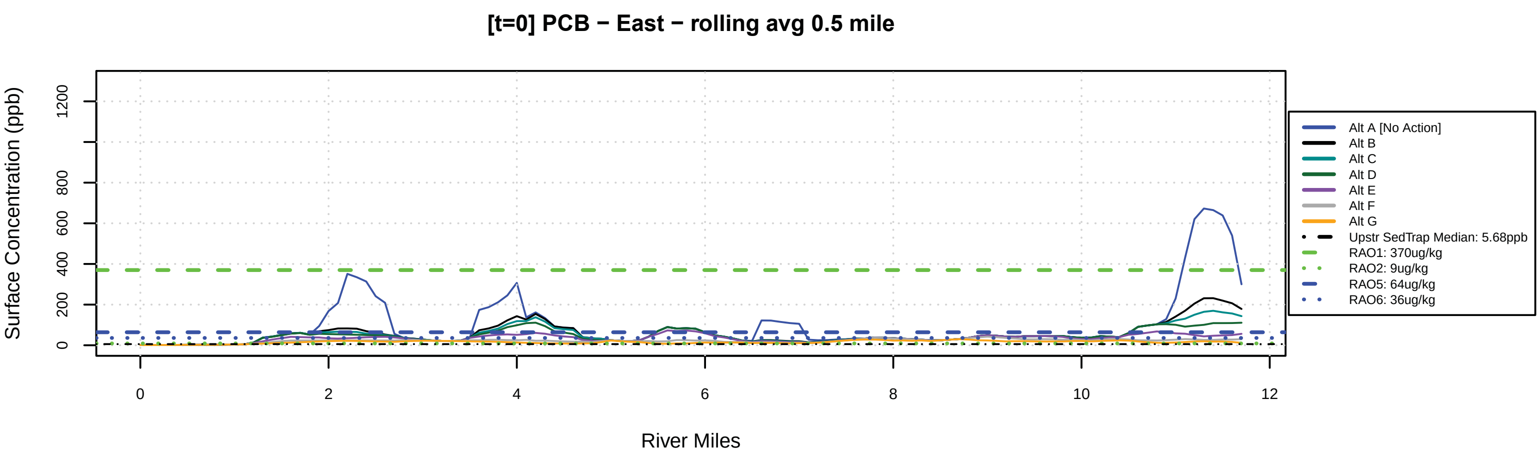
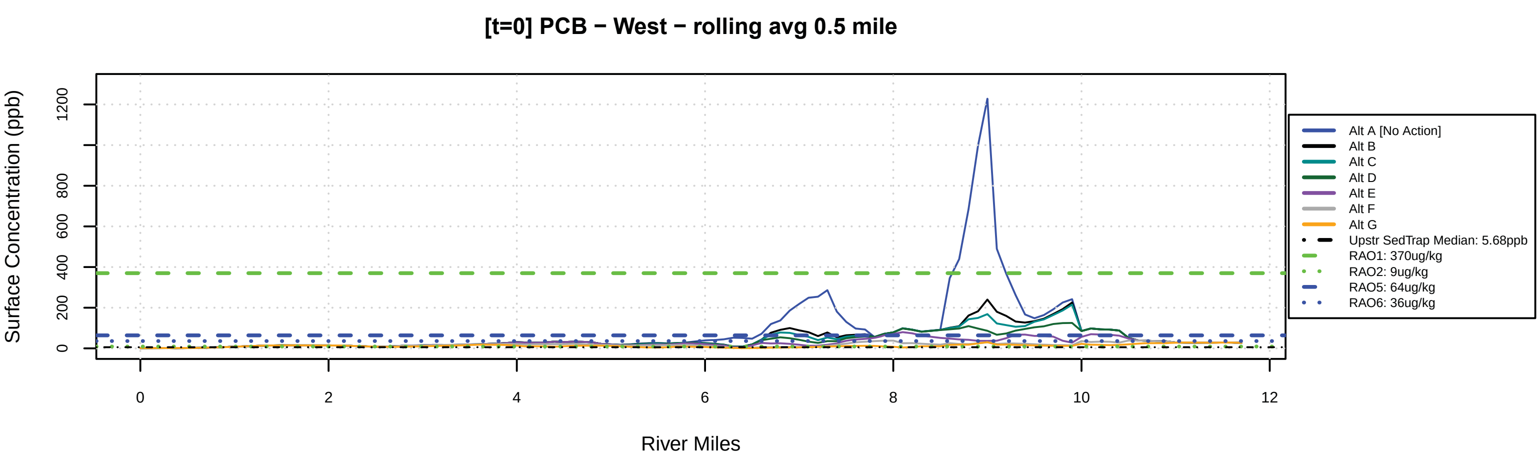
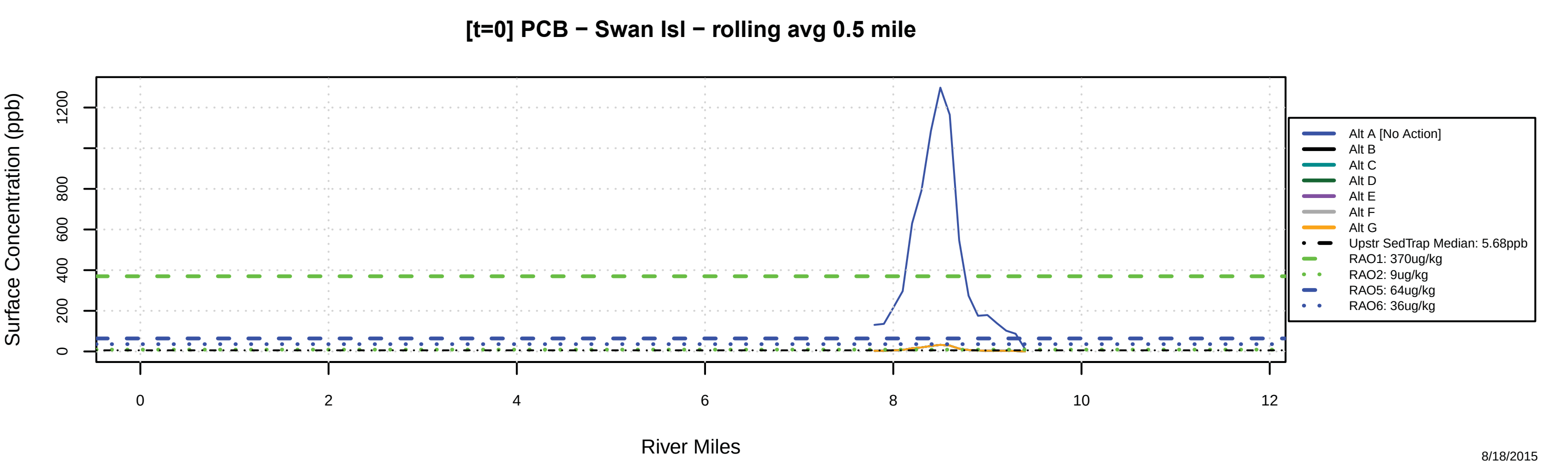

[t=0] PCB − Site − rolling avg 0.5 mile
Surface Concentration (ppb)
0
200
400
600
800
1200
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 5.68ppb
RAO1: 370ug/kg
RAO2: 9ug/kg
RAO5: 64ug/kg
RAO6: 36ug/kg


[t=0] PCB − East − rolling avg 0.5 mile
Surface Concentration (ppb)
0
200
400
600
800
1200
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 5.68ppb
RAO1: 370ug/kg
RAO2: 9ug/kg
RAO5: 64ug/kg
RAO6: 36ug/kg


[t=0] PCB − West − rolling avg 0.5 mile
Surface Concentration (ppb)
0
200
400
600
800
1200
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 5.68ppb
RAO1: 370ug/kg
RAO2: 9ug/kg
RAO5: 64ug/kg
RAO6: 36ug/kg


[t=0] PCB − Swan Isl − rolling avg 0.5 mile
Surface Concentration (ppb)
0
200
400
600
800
1200
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 5.68ppb
RAO1: 370ug/kg
RAO2: 9ug/kg
RAO5: 64ug/kg
RAO6: 36ug/kg

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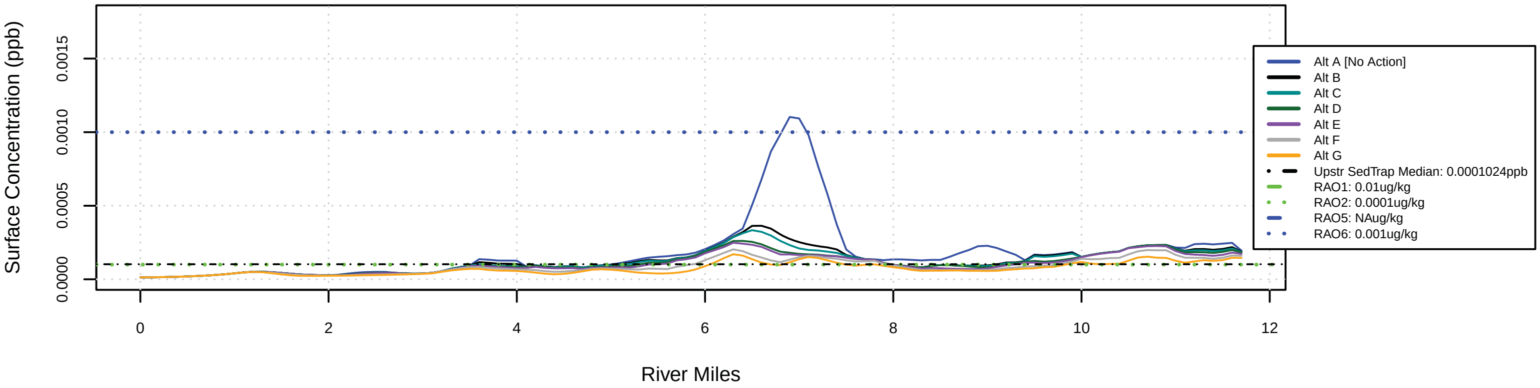
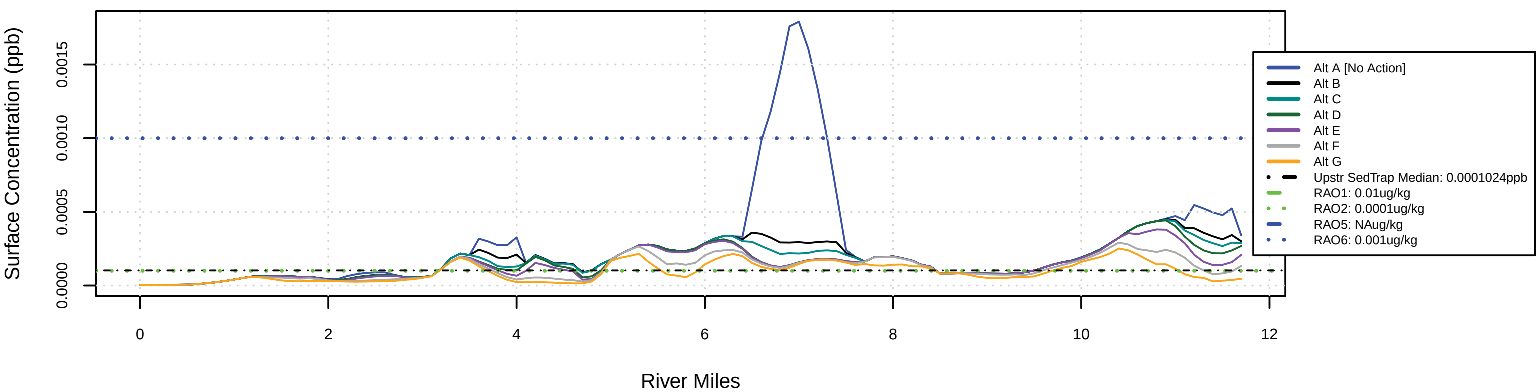
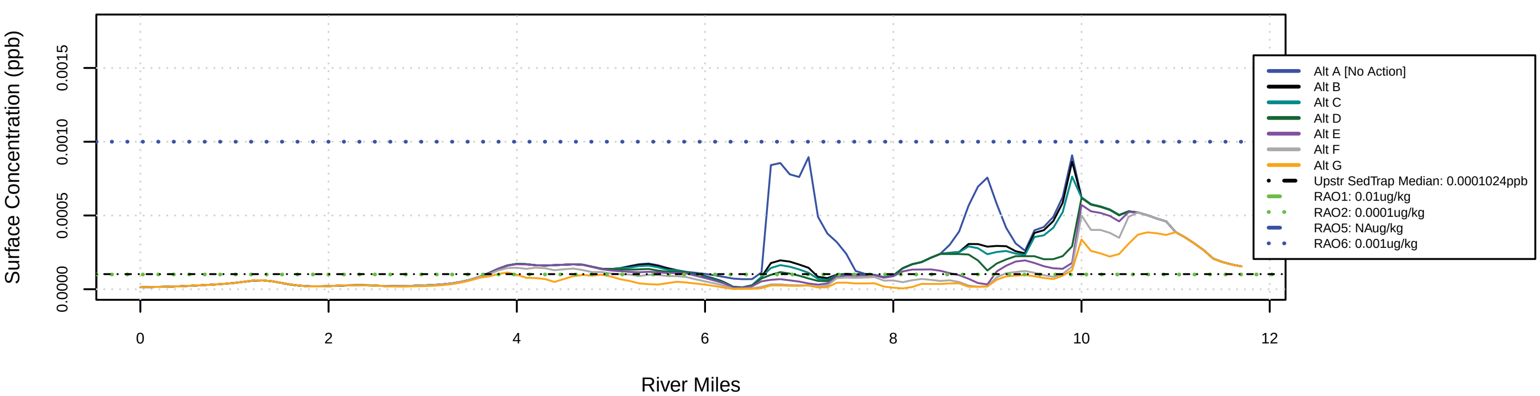
[t=0] PeCDD − Site − rolling avg 0.5 mile



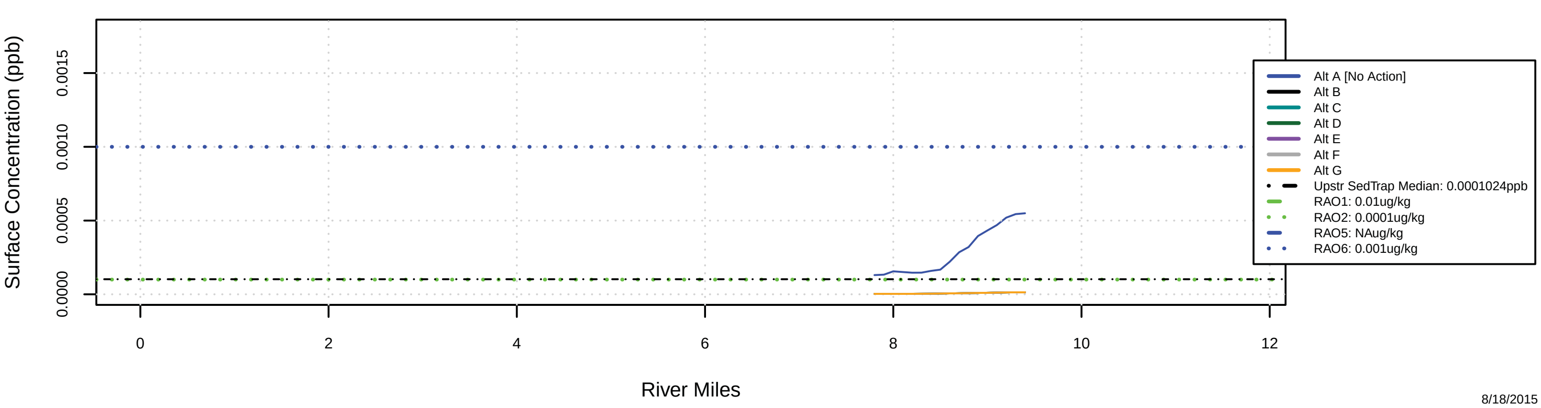
[t=0] PeCDD − East − rolling avg 0.5 mile



[t=0] PeCDD − West − rolling avg 0.5 mile



[t=0] PeCDD − Swan Isl − rolling avg 0.5 mile



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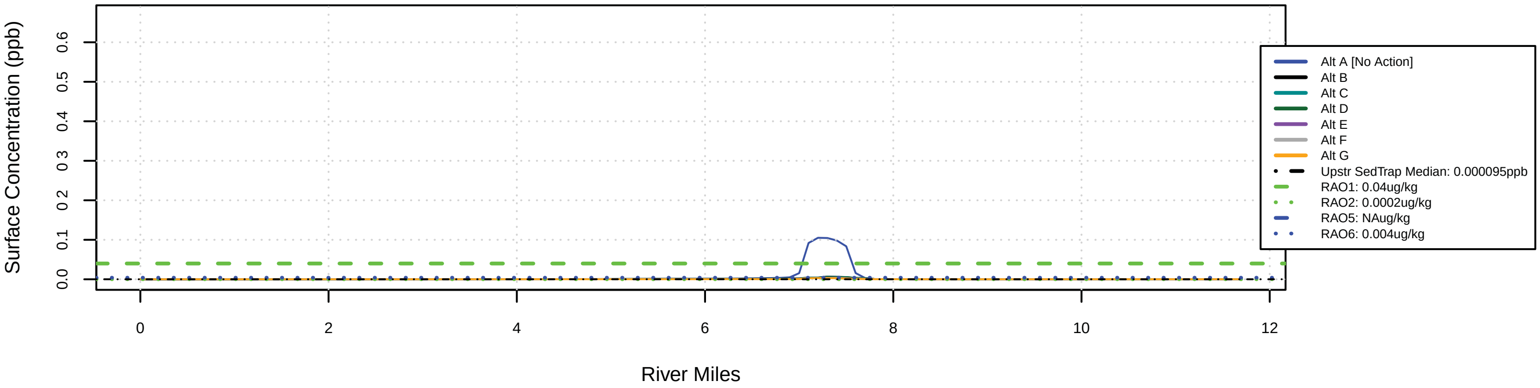
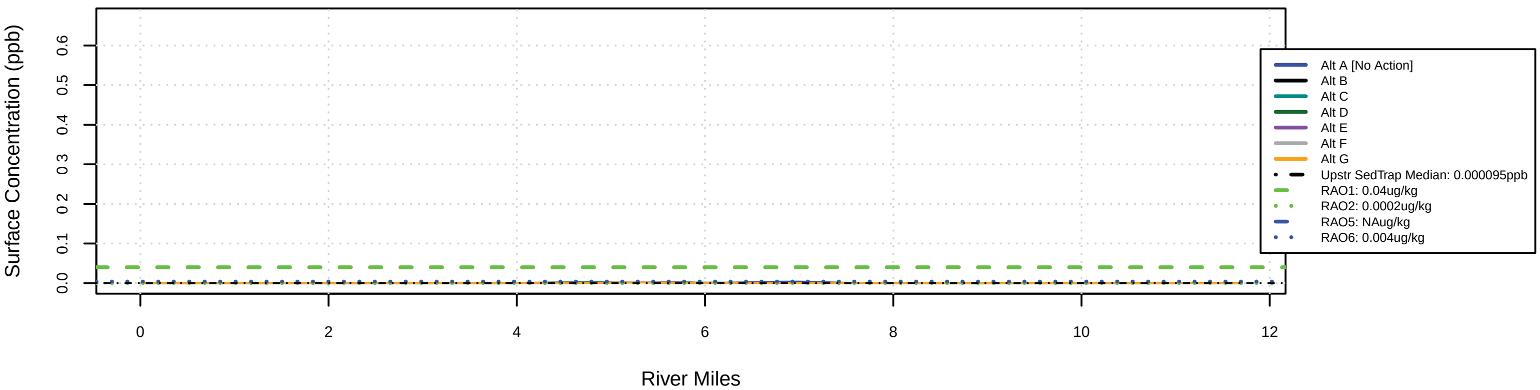
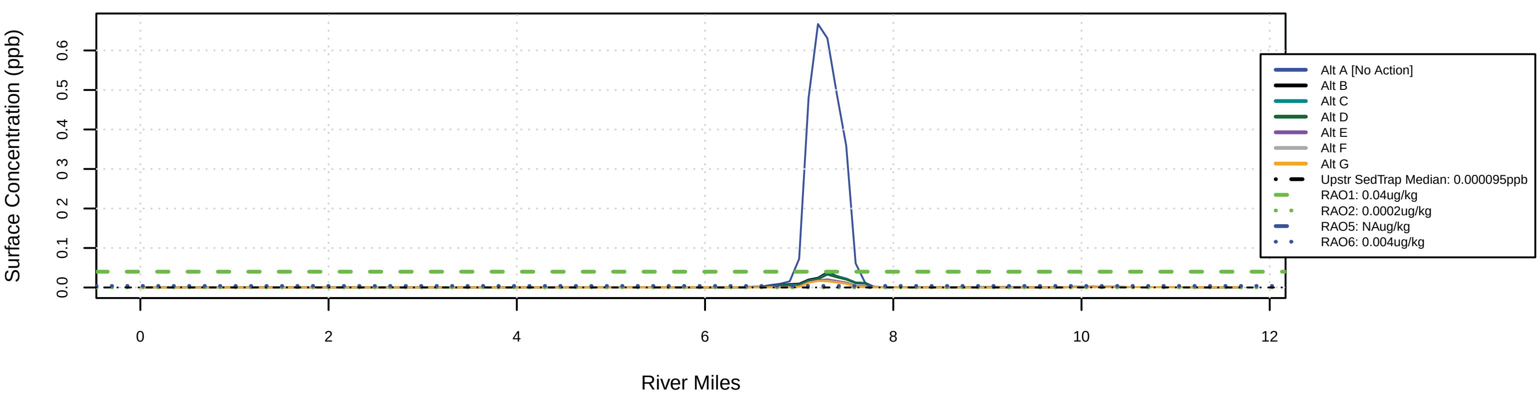
[t=0] PeCDF − Site − rolling avg 0.5 mile



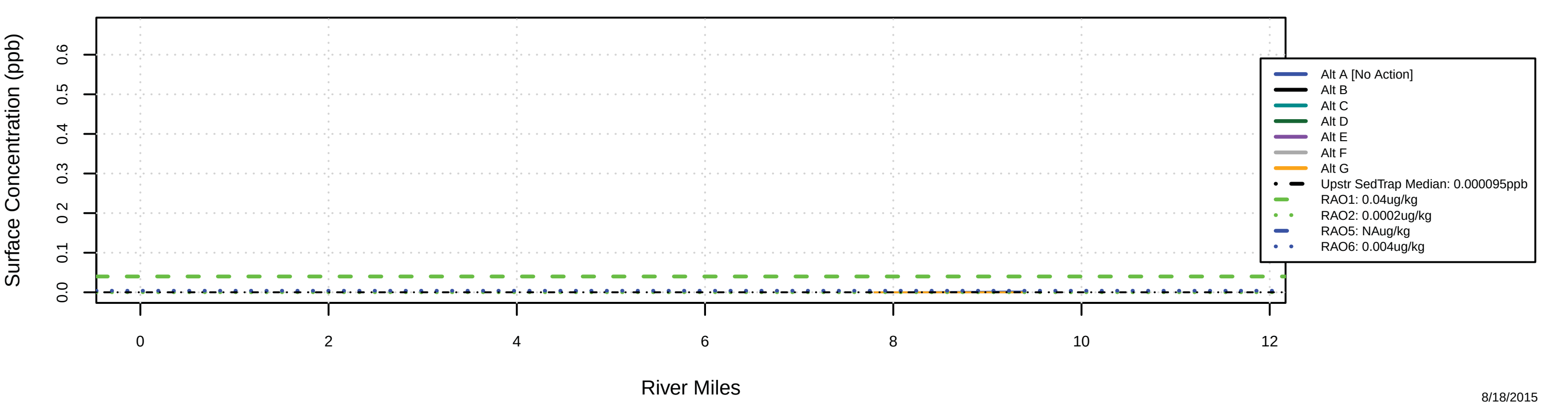
[t=0] PeCDF − East − rolling avg 0.5 mile



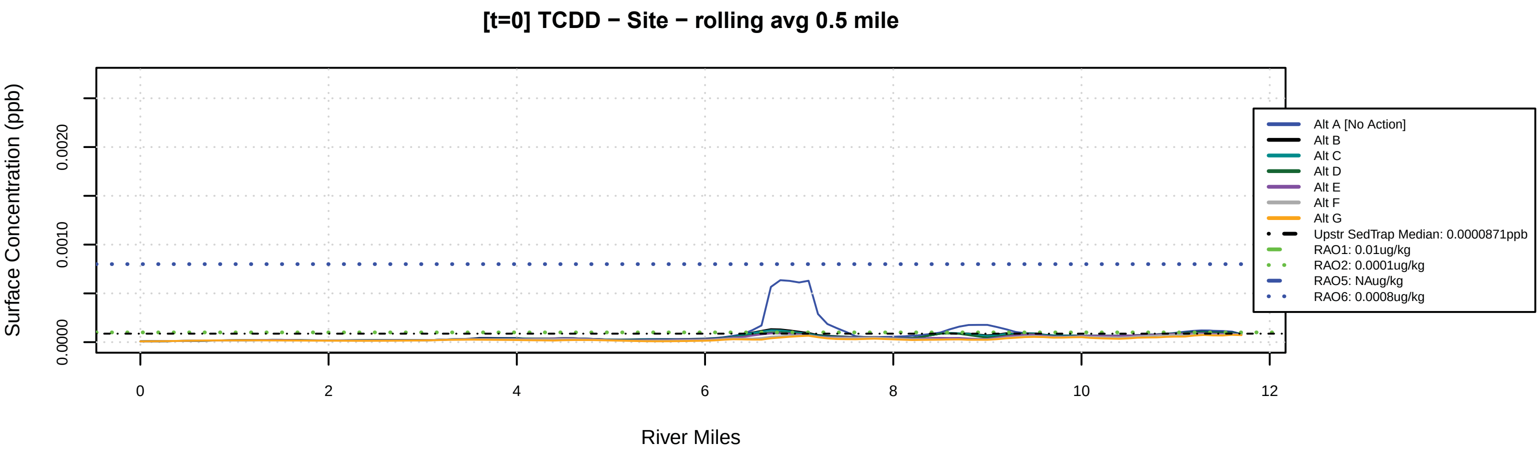
[t=0] PeCDF − West − rolling avg 0.5 mile

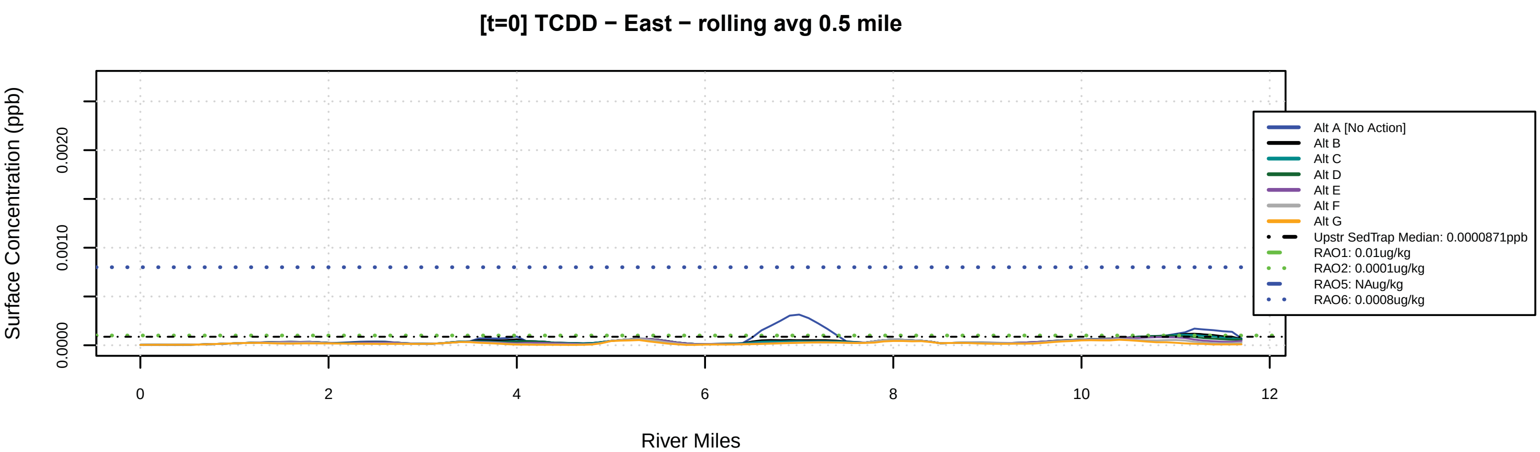


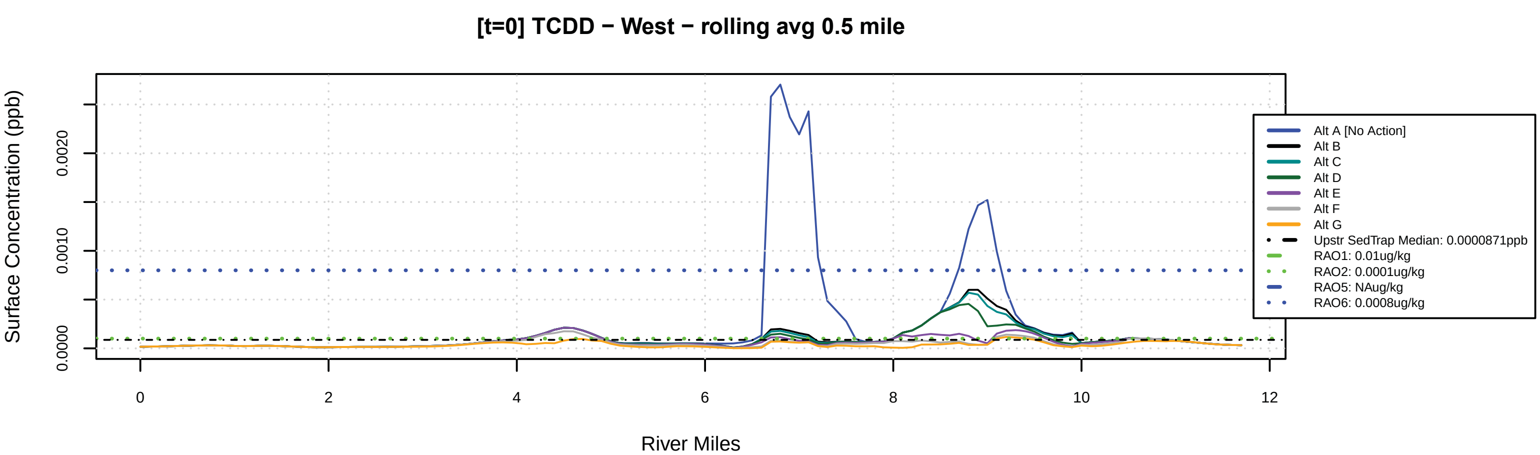
[t=0] PeCDF − Swan Isl − rolling avg 0.5 mile

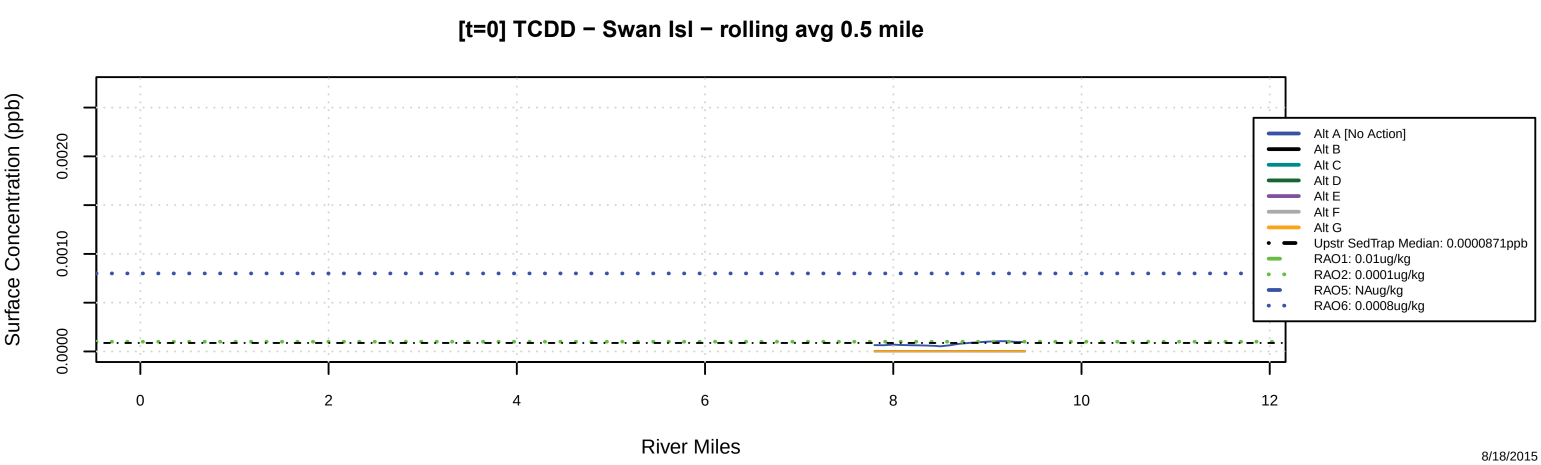


8/18/2015

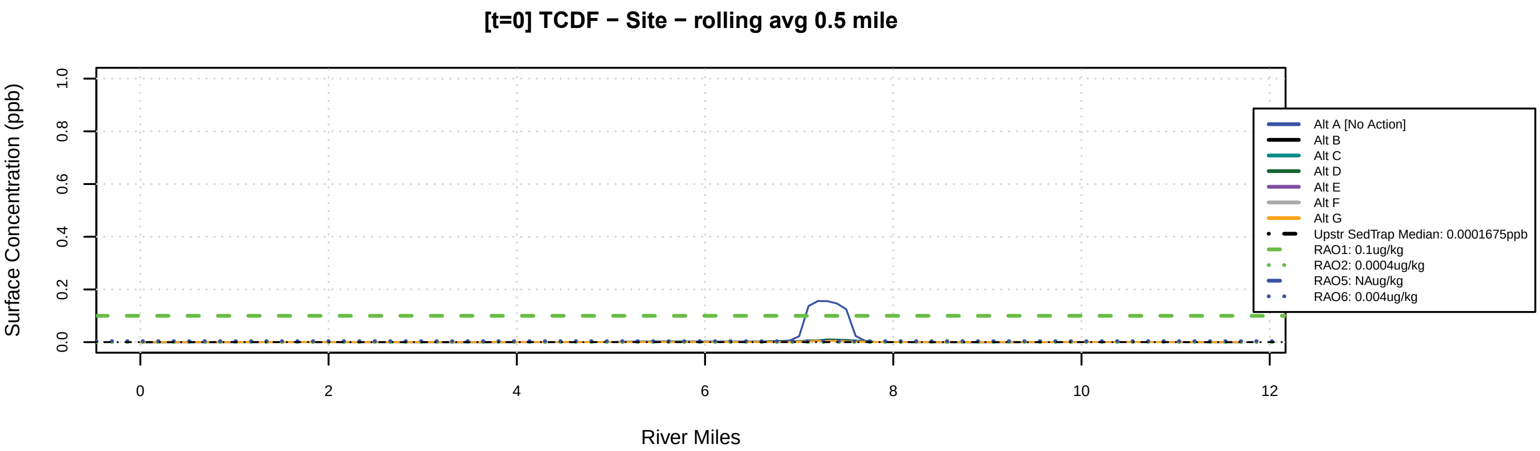

[t=0] TCDD − Site − rolling avg 0.5 mile
Surface Concentration (ppb)
0.0000
0.0010
0.0020
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.0000871ppb
RAO1: 0.01ug/kg
RAO2: 0.0001ug/kg
RAO5: NAug/kg
RAO6: 0.0008ug/kg

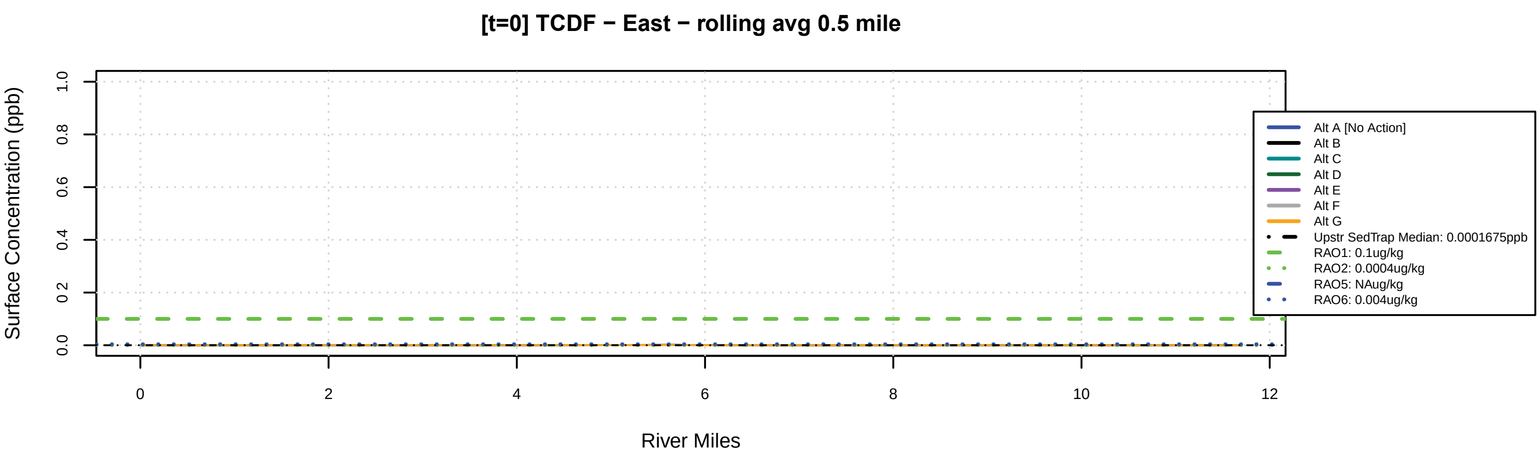

[t=0] TCDD − East − rolling avg 0.5 mile
Surface Concentration (ppb)
0.0000
0.0010
0.0020
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.0000871ppb
RAO1: 0.01ug/kg
RAO2: 0.0001ug/kg
RAO5: NAug/kg
RAO6: 0.0008ug/kg

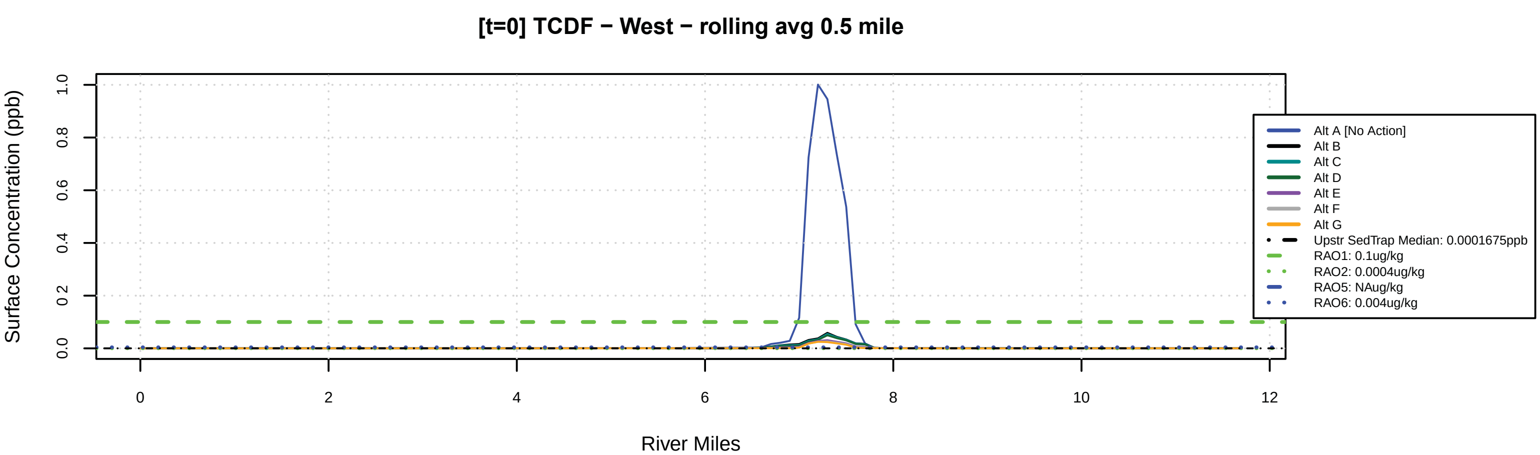

[t=0] TCDD − West − rolling avg 0.5 mile
Surface Concentration (ppb)
0.0000
0.0010
0.0020
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.0000871ppb
RAO1: 0.01ug/kg
RAO2: 0.0001ug/kg
RAO5: NAug/kg
RAO6: 0.0008ug/kg


[t=0] TCDD − Swan Isl − rolling avg 0.5 mile
Surface Concentration (ppb)
0.0000
0.0010
0.0020
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.0000871ppb
RAO1: 0.01ug/kg
RAO2: 0.0001ug/kg
RAO5: NAug/kg
RAO6: 0.0008ug/kg

8/18/2015


[t=0] TCDF − Site − rolling avg 0.5 mile
Surface Concentration (ppb)
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.0001675ppb
RAO1: 0.1ug/kg
RAO2: 0.0004ug/kg
RAO5: NAug/kg
RAO6: 0.004ug/kg


[t=0] TCDF − East − rolling avg 0.5 mile
Surface Concentration (ppb)
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.0001675ppb
RAO1: 0.1ug/kg
RAO2: 0.0004ug/kg
RAO5: NAug/kg
RAO6: 0.004ug/kg


[t=0] TCDF − West − rolling avg 0.5 mile
Surface Concentration (ppb)
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
River Miles
Alt A [No Action]
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Alt E
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RAO1: 0.1ug/kg
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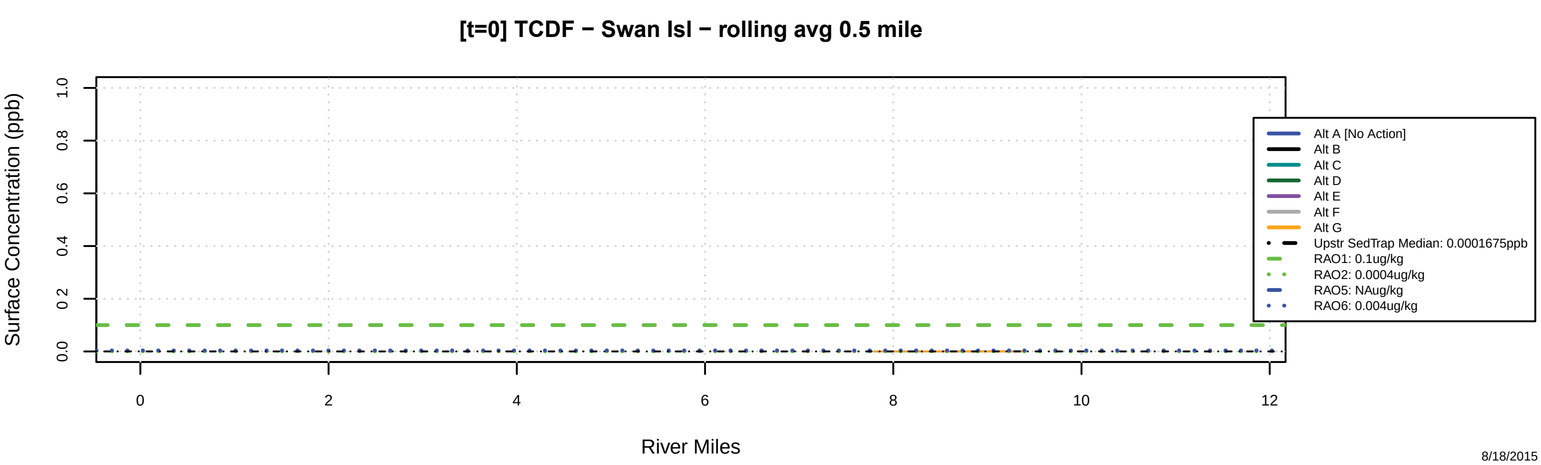
RAO5: NAug/kg
RAO6: 0.004ug/kg


[t=0] TCDF − Swan Isl − rolling avg 0.5 mile
Surface Concentration (ppb)
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
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8
10
12
River Miles
Alt A [No Action]
Alt B
Alt C
Alt D
Alt E
Alt F
Alt G
Upstr SedTrap Median: 0.0001675ppb
RAO1: 0.1ug/kg
RAO2: 0.0004ug/kg
RAO5: NAug/kg
RAO6: 0.004ug/kg

8/18/2015

TAB 4

LWG
LOWER WILLAMETTE GROUP

Chairperson: Bob Wyatt, NW Natural
Treasurer: Frederick Wolf, DBA, Legacy Site Services for Arkema

September 6, 2016

U.S. Environmental Protection Agency, Region 10
ATTN: Harbor Comments
U.S. Environmental Protection Agency
805 SW Broadway, Suite 500
Portland, OR 97205

Re: Lower Willamette Group Comments on Portland Harbor Proposed Plan (Lower Willamette River, Portland Harbor Superfund Site, EPA Docket No: CERCLA-10-2001-0240)

Dear EPA Region 10:

The Lower Willamette Group (LWG) appreciates the opportunity to comment on the U.S. Environmental Protection Agency's (EPA's) June 8, 2016, Proposed Plan and Feasibility Study (FS) for the Portland Harbor Superfund Site (Site).

Introduction

The LWG formed in 2001 as a group of business and government entities who stepped forward to work with EPA to study the risks posed by contamination at the Site and evaluate cleanup alternatives.[1] EPA's common practice at Superfund sites is for the Remedial Investigation (RI) and FS to be developed by potentially responsible parties (PRPs) under EPA oversight.[2] After years of data collection, analysis, and intensive engagement with EPA staff, the LWG presented EPA with a Draft FS in 2012. The LWG continues to stand behind the 2012 LWG Draft FS as a scientifically and legally supported approach to evaluating remediation alternatives for the Site. Over the years that followed, EPA took more active control of the RI/FS and, in the LWG's view, diverged further and further from a scientifically and legally supported approach to cleanup. The LWG expressed significant technical, legal, and policy concerns when EPA produced a Draft FS in 2015. Rather than engage meaningfully with those concerns, EPA formally took over the FS and produced a draft Final FS and Proposed Plan that are even further detached than EPA's 2015 Draft FS from acceptable science and responsible risk characterization and management. In-depth knowledge of the Site and of the technical and legal foundations of its own and EPA's work gives the LWG unique insight and leads the LWG to the conclusion that EPA's selection of Alternative I in the Proposed Plan is incorrect.

[1] Members of the LWG participating in these comments are Arkema Inc., Chevron U.S.A. Inc., Evraz Inc. NA, Gunderson LLC, NW Natural, Phillips 66 Company, Port of Portland, TOC Holdings Co., Union Pacific Railroad Company, Bayer CropScience Inc., BNSF Railway Company and Kinder Morgan.

[2] "The purpose of this memorandum is to reaffirm the EPA's commitment to having potentially responsible parties (PRPs) conduct the remedial investigation/feasibility study (RI/FS) at Superfund sites wherever appropriate." *Promoting Enforcement First for Remedial Investigation/Feasibility Studies at Superfund Sites* (EPA, March 20, 2012).

Executive Summary

The overarching objective of selecting a remedy under the National Contingency Plan (NCP) decision-making process is to identify the cleanup that will be effective and provide "sensible, reliable solutions for identified site problems."[3] Key factors in the decision-making process under the NCP include using a reasonable characterization of risks at the Site (including a consideration of uncertainties) and assessing how well the cleanup will protect people from unacceptable risks and how much it will cost, both in terms of adverse impacts on the community and dollars to be spent. In addition, an important consideration when selecting a remedy is how long it will take before reasonable cleanup goals are achieved.

At this Site, EPA's assessment of risks to human health is based on a series of unrealistic and unsupported assumptions regarding exposure and exposure durations and fails to consider how widely used preparation and cooking methods reduce contaminants in fish tissue. The result is cleanup goals that are not reasonably achievable, because they are based on worst case scenarios, not exposures that are reasonably expected to occur as required by the NCP.

Despite their conservative nature, EPA largely abandoned the Baseline Risk Assessments (BLRAs) in the 2016 draft Final FS by developing preliminary remediation goals (PRGs) inconsistent with the BLRAs, applying remedial action levels (RALs) in areas of the Site where relevant exposures do not occur or where the PRGs are already met, and evaluating the effectiveness of its cleanup alternatives at reducing risk using methodologies that are completely unrelated to the BLRAs. To take but one example of how divorced EPA's remedy selection is from the risk assessments, the EPA approved Baseline Ecological Risk Assessment (BERA) evaluated multiple lines of evidence and concluded that about 4 to 8% of the site presents benthic risk. In 2014 and 2015, EPA and the LWG mapped an approach for applying the BERA in the FS (the Comprehensive Benthic Risk Area [CBRA] approach) that identified approximately 61 acres for the evaluation of active remedies. In the 2016 draft Final FS, however, EPA completely abandoned the BERA and the corresponding EPA/LWG CBRA approach to conclude, without explanation, that benthic risk is present at 1,289 acres, or nearly 60% of the Site. And even with this massive expansion of asserted benthic risk, EPA's preferred remedial alternative fails to address 16% of the 61 acres of benthic risk area identified by the EPA/LWG CBRA approach.

In the face of overwhelming evidence to the contrary, EPA assumed that the complex and dynamic Willamette River is essentially unchanging over time and lacks diversity in its course, assigned prescriptive remediation technologies without accounting for site-specific details, and then incorrectly estimated the probable cost and duration required for implementation of those technologies. As a result, EPA's evaluation of the relative performance of its remedial alternatives is seriously flawed, and its attempt at considering the cost-effectiveness of the alternatives lacks any meaningful foundation.

For example, EPA's evaluation of the protectiveness and "long-term effectiveness" of cleanup alternatives and "cost-effectiveness" is not based on achievement of cleanup goals. Rather, because EPA rejected all methods that might have allowed it to quantify the expected rate of natural recovery of sediments, EPA employs an invented standard—"interim targets" for "risk reduction at construction completion"—to evaluate these criteria and exclude less expensive alternatives from the evaluation for reasons not based on data. EPA rationalizes using these interim targets by stating that protective alternatives would achieve ultimate cleanup goals within a reasonable timeframe (i.e., 30 years) through natural recovery. EPA *assumes* Alternatives E and I will achieve cleanup goals and Applicable or Relevant and Appropriate Requirements (ARARs) in 30 years and *assumes* Alternatives B and D will not. No information in the record supports EPA's assumptions. In the absence of credible information to support its assumptions, EPA has no basis for representing whether alternatives will or will not achieve cleanup goals within a certain time. This critical omission and reliance on assumptions in the long-term effectiveness and cost-effectiveness determinations is arbitrary and capricious. A less expensive alternative that is easier to implement (and therefore quicker to start and finish) may achieve cleanup goals in a comparable or even faster timeframe than a much more complex, disruptive, and expensive alternative.

[3] NCP Preamble, 55 Fed. Reg. 8666, 8700 (March 8, 1990).

The trend shown by the data is decreasing surface sediment and fish tissue concentrations. In 2013, the LWG presented an evaluation of smallmouth bass polychlorinated biphenyl (PCB) tissue measurements made in 2002, 2007, and 2012 that indicate statistically significant declines in tissue concentrations across almost all areas of the Site.[4] Further, 2014 site-wide sediment PCB data[5] show this downward trend in contaminant concentrations in surface sediments due to the effects of natural recovery at the Site. EPA's disregard of recent data in its evaluation of the effectiveness of alternatives undermines the validity of its conclusions.

In addition, EPA's evaluation of cost-effectiveness is superficial and based on inaccurate cost estimates. Cost-effectiveness is not a minor, dispensable factor in the NCP. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that EPA determine that the selected remedy be cost-effective.[6] EPA must compare the cost to effectiveness of each alternative individually and compare the cost and effectiveness of alternatives in relation to one another.[7] Effectiveness means evaluating long-term effectiveness; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness.

In analyzing an individual alternative, the decision-maker should compare, using best professional judgment, the relative magnitude of cost to effectiveness of that alternative. In comparing alternatives to one another, the decision-maker should examine incremental cost differences in relation to incremental differences in effectiveness in order to determine that the effectiveness afforded is proportional to the cost. EPA's inadequate analysis of this important criterion in the Proposed Plan is not sufficient.

Further, EPA substantially underestimated the cost for its Preferred Alternative (Alternative I). EPA estimated Alternative I as $1,173 million compared to LWG's estimate of $2,127 million (non-discounted capital costs and annual expenditures over a 30 year period). In addition to using overly optimistic estimates for dredging and capping production rates, EPA's estimate fails to include reasonable estimates for contingencies, oversight, project management, construction management, water quality control structures, mobilization/demobilization, design, and fees for capping on state lands, as well as several other important categories of cost. The LWG's experienced sediment remediation consultant reviewed EPA's cost estimate and believes the cost is underestimated by about $954 million (non-discounted capital costs and annual expenditures over a 30 year period). A more realistic estimate of the cost to perform EPA's Preferred Alternative is well above EPA's margin of error of +50/-30% accuracy for FS cost estimates, rendering the selection of Alternative I invalid.[8]

Portland Harbor was added to the National Priorities List (NPL) in 2000. Sixteen years later, EPA has identified a preferred cleanup alternative that will not be under construction for at least 5 to 7 years. In the opinion of experienced sediment remediation professionals who have reviewed the Proposed Plan, construction will take 14 years or more to complete, given the constraints on performing intrusive work in designated critical habitat for several endangered species of salmon and steelhead and the physical and logistical complexities presented by an active commercial harbor. Completion of the active phase of the cleanup appears to be decades in the future. This is not an acceptable outcome.

As explained in this letter, because EPA is overly conservative in describing the risks at the Site, has not prioritized which areas of the Site pose the highest risk and should be addressed first, has disregarded recent data, and has evaluated cleanup alternatives in a manner that is arbitrary and capricious, EPA's proposed cleanup will not provide meaningful protection within a reasonable timeframe. Unless EPA addresses the issues raised in these comments when it writes the Record of Decision (ROD), this project, after all of these years and well over $100 million spent to date, will not succeed.

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[4] Lower Willamette River Smallmouth Bass Data Monitored Natural Recovery Analysis, a presentation file from Anchor QEA provided to EPA on March 18, 2013. A copy of this presentation file is Attachment 1.
[5] *Sediment sampling data report, Portland Harbor, Portland, Oregon*, prepared for de maximis Inc., (Kleinfelder, May 11, 2015). (Attachment 2)
[6] 42 U.S.C. § 9621(b).
[7] NCP Preamble, 55 Fed. Reg. 8728.
[8] *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, page 2-10 (EPA October 1988).

EPA can and must do better. In its October 19, 2015, letter to the National Remedy Review Board (NRRB), the LWG provided several recommendations on implementing the cleanup, including focusing on the most significant and pervasive risks, reducing the uncertainty about natural recovery, and maximizing flexibility in remedial design and implementation of the cleanup. Our review of the Proposed Plan has not changed those general recommendations. The risks at the Site do not warrant a cleanup with a completion so far in the future.

Comments

In keeping with the LWG's in-depth and long-term engagement with risk assessment and remedial alternatives evaluation at the Site, the following comments are highly detailed, technical explanations of the key deficiencies in EPA's 2016 draft Final FS and Proposed Plan. The choices and decisions EPA makes in the Portland Harbor ROD must be based in reason and science, and EPA must articulate a rational connection between the facts found and the choices it has made.[9] EPA must consider all important aspects of the problem and explain decisions that run counter to evidence before it.[10] And EPA must not rush through the process, "throw darts," "flip a coin," or make a "sudden, knee-jerk decision."[11] As explained below, EPA's 2016 draft Final FS and Proposed Plan contain major technical errors and draw conclusions that are contrary to the facts and data before EPA and that are, without explanation, inconsistent with the NCP, EPA guidance and even EPA's own prior decisions about the Site.[12]

Our comments identify the incorrect assumptions, inaccurate information and flawed analyses supporting EPA's remedial alternatives evaluation and therefore EPA's Preferred Alternative (Alternative I). EPA's approach diverges from legal requirements for remedy selection, including the nine criteria set out in the NCP, and is inconsistent with EPA guidance and EPA practice at other similar sites. EPA did not consider adequately or ignored completely important information, and the conclusions drawn by EPA are unsupported by, or run counter to, the evidence before EPA. In short, the choices and decisions EPA has made in the Proposed Plan are not supported by reasoned, scientific explanation provided in the FS or elsewhere. As a result, it would be arbitrary and capricious for EPA to select the Preferred Alternative identified in the Proposed Plan as the remedy for Portland Harbor.

The LWG's comments are organized around six categories of deficiencies in EPA's approach:

- **Section I**: EPA departed from the previously approved BLRAs and selected Remedial Action Objectives (RAOs) and PRGs that are not risk-based, risk-managed, or achievable.

- **Section II**: EPA took an unprecedented, inappropriate approach to designating "principal threat waste" (PTW) at the Site, which adds significant costs but does not reduce risk.

- **Section III**: EPA oversimplified the complex, dynamic natural processes occurring within and outside of the Site (the conceptual site model), leading it to inappropriately discount relevant new scientific information and the impact of changes over time to remedy evaluation and selection.

- **Section IV**: EPA did not apply, or misapplied, quantitative analysis to the NCP-required remedy selection criteria of protectiveness, long-term effectiveness, short-term effectiveness, and cost.

- **Section V**: Accurate analysis shows that EPA's remedy is not cost-effective—i.e., it does not meaningfully reduce risks when compared to less time- and resource-intensive remedy alternatives—and that EPA has not conveyed to the public accurate information about risk or risk reduction at the Site.

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[9] *United States v. NCR Corp*., 911 F. Supp. 2d 767, 773 (E.D. Wis. 2012) *aff'd sub nom*. United States v. P.H. Glatfelter Co., 768 F.3d 662 (7th Cir. 2014); *United States v. Newmont USA Ltd.*, 504 F. Supp. 2d 1077, 1082 (E.D. Wash. 2007).
[10] *Motor Vehicle Mfrs. Ass'n of the U.S., Inc. v. State Farm Mut. Auto. Ins. Co.,* 463 U.S. 29, 43, 103 S. Ct. 2856, 2867 (1983).
[11] *United States v. NCR Corp*., 911 F. Supp. 2d at 773.
[12] EPA has acknowledged that certain of its FS evaluations were "arbitrary" and that it needs to provide a rationale for its choices. Koch email to McKenna, June 17, 2014. A copy of this email is Attachment 3. As these comments discuss, in many cases, EPA has not met this standard.

- **Section VI:** EPA'**s** remedy selection should include a plan for how cleanup will be implemented through baseline data collection and remedial design and implementation at operable units.

The LWG's comments also provide additional information for the Administrative Record. This information was exchanged between EPA and the LWG during preparation of the RI/FS, provided by the LWG to EPA in the course of the LWG's work on the RI/FS, or previously generated by EPA. The LWG previously recommended that most of these records be placed within the Administrative Record as appendices to relevant LWG deliverables; in most if not all cases, EPA required the LWG to remove the records from the deliverables. We are therefore incorporating these and similar records into our comments on the Proposed Plan for inclusion in the Administrative Record file pursuant to 40 CFR §300.815(b).

I. EPA's Proposed Remedy is Inconsistent with Approved Risk Assessments, is Not Focused on Actual Risk Reduction, and Lacks Any Meaningful Risk Management

In its August 2015 Draft FS, EPA determined that all of the remedial alternatives it evaluated, Alternatives B through G, were protective of human health and the environment and in compliance with ARARs. Yet, EPA indicated to the National Remedy Review Board (NRRB) and Contaminated Sediment Technical Advisory Group (CSTAG) that it favored an alternative that included a relatively high level of mass removal through dredging and upland disposal with an extremely high cost estimate of about $1.5 billion. The LWG commented to the NRRB and EPA that each component of the remedy should be aligned with addressing risks identified in the BLRAs included in the RI and that a remedy tailored to addressing sediment contamination that is actually causing risk would result in a remedy that is protective, effective, implementable, and cost-effective. The primary basis for the LWG's recommendation to ground the remedy in measurable and meaningful risk reduction was EPA's own guidance.

It appears that the LWG's comments caught EPA's attention by demonstrating that EPA was proposing a remedy that was far more expensive with no material increase in risk reduction. However, rather than selecting a remedy in its Proposed Plan more focused on achieving actual risk reduction in a timely and cost-effective manner, EPA without explanation recalculated baseline risk in a manner inconsistent with the EPA-approved BLRAs in order to artificially inflate risk reduction estimates for larger alternatives and claim that now the very same Alternatives B and D that were declared protective in the 2015 Draft FS are no longer protective of the environment.[13]

A. <u>EPA's Declaration that Alternatives B and D May Not Be Protective of the Environment is Arbitrary and Capricious</u>

EPA's Proposed Plan rejects Alternative B and D as not meeting the threshold criteria of protectiveness.[14] EPA has determined that an alternative is protective if it will achieve EPA's PRGs within 30 years.[15] However, because EPA decided that "a long-term model is not available to predict the time to meet the PRGs," EPA assessed protectiveness by "evaluating achievement of interim targets at the end of construction, as well as any additional benefit provided by [institutional controls]."[16] EPA then concludes, "Alternatives B and D may not be protective of the environment because of the timeframe needed to achieve PRGs through MNR and ICs would not provide protection [*sic*] ecological receptors during this time period."[17] As we understand it, EPA reaches this conclusion (which is inconsistent with its conclusion in the 2015 Draft FS that Alternatives B and D *are* protective), based upon its determination in the FS that "post-construction risks are greater than the interim targets thus MNR is unlikely to achieve PRGs within a reasonable time frame due to the uncertainty regarding the effectiveness of MNR with such high remaining contaminant concentration."[18]

EPA's evaluation of interim targets does not address the guidance recommendation that the long-term outcome of remedial alternatives should be assessed quantitatively.[19] EPA's selection of interim targets, generally at 10 times

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[13] See, e.g. Proposed Plan, p. 50-51.
[14] Proposed Plan, Table 15.
[15] EPA draft Final FS p. 4-6 ("[A] reasonable time frame…was considered to be 30 years").
[16] EPA draft Final FS p. 4-6.
[17] Proposed Plan, p. 50-51.
[18] EPA draft Final FS p. 4-18. See also EPA draft Final FS p. 4-43.
[19] *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA 2005) (hereafter, the "Sediment Guidance," p. 2-23 and 2-25; *Contaminated Sediments Remediation Guidance* (Interstate Technology and Research Council, 2014) (hereafter, "ITRC") ITRC), p. 61.

the PRGs, is arbitrary and unexplained. In the absence of a quantitative long-term assessment, EPA has no way to determine whether 10 times the PRGs are more likely to be met in 30 years as compared to any other multiplier of the PRG, or any other benchmark based upon, for example, physical properties of the river or chemical properties of a specific contaminant. Despite this arbitrary framework, EPA concludes that only Alternatives B and D "may not be protective of the environment because of the time frame needed to achieve PRGs through MNR." EPA does not explain when it expects Alternatives E and I to achieve the PRGs relative to either Alternatives B and D or its 30 year reasonable timeframe. Nothing in the 2016 draft Final FS or Proposed Plan explains why EPA considers some of the alternatives that meet some ecological risk interim targets protective and others not protective.

EPA acknowledges that concerns about potential risks to human health related to the inability of all of the alternatives to achieve interim targets immediately post-construction can be effectively managed by institutional controls while monitored natural recovery works to attain remedial goals.[20] Ecological exposures, however, cannot be managed through institutional controls. The Proposed Plan concludes that Alternative B does not achieve the RAO 5 (ecological direct toxicity) interim target[21] and that Alternatives, B, D, E, and I may not meet the RAO 6 (ecological bioaccumulation RAO) interim target.[22] The Proposed Plan does not claim that those goals will not be met by the 30-year reasonable timeframe. The actual results of EPA's own analyses indicate that all of these alternatives are in fact protective.

With respect to RAO 5, EPA's 2016 draft Final FS and Proposed Plan approach to benthic risk is entirely inconsistent with the multiple lines of evidence approach used to identify benthic risk areas in the approved BERA and should not be used to conclude that Alternative B is not protective of ecological receptors. Although the BERA concludes (as EPA notes in the Proposed Plan) that "[u]nacceptable risks to benthic invertebrates are located in approximately 4-8 percent of the Site,"[23] the draft Final FS presents benthic risk areas that cover 1,289 acres (or about 59% of the Site).[24]

EPA's large benthic risk areas mapped in the 2016 draft Final FS and Proposed Plan extend into areas shown to lack toxicity based on laboratory toxicity tests and other BERA lines of evidence. EPA and the LWG agree that empirical toxicity testing is one of the most important and direct measures of benthic toxicity available. Figure 1 shows the locations of failing and passing bioassay tests in relationship to "benthic risk" areas mapped on Figure 4.1-1 in the 2016 draft Final FS. EPA identifies broad areas of benthic risk (yellow) in locations that passed bioassay tests (blue dots). Thus, the benthic toxicity that EPA's Proposed Plan assumes exists in these areas in fact does not exist.

EPA determined these broad benthic risk areas by mapping any exceedance of individual benthic PRGs, which are derived from various toxicity models, and by ignoring empirical toxicity data from Portland Harbor. Without explanation, EPA's current approach is exactly the opposite of its own prior instructions to the LWG: "EPA and the LWG recognize that the sediment quality guidelines produced by any model (LRM, FPM or generic SQGs such as PECs or PELs) are intended to be used as a set – not individually."[25] EPA further compounds this error by making numerous errors (or at least unexplained decisions that differ from the EPA-approved BERA) regarding its compilation of the individual benthic PRGs for RAO 5 involving at least PCBs, DDx, and DDT.[26] The overall result of this haphazard approach is that EPA's alternatives require large amounts of active remediation on the basis of RAO 5 while failing to even address all of the EPA/LWG CBRAs previously agreed to as shown in Table 1.

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[20] See Proposed Plan p. 50 (All alternatives other than the no action alternative "in conjunction with MNR and institutional controls, are expected to be protective of human health.").
[21] "Alternative B is the only alternative that does not achieve the interim target of addressing 50 percent of the benthic risk area; all other alternatives achieve the interim target."
[22] "Alternatives B, D, E and I do not achieve the ecological HQ interim target of 10."
[23] BERA, p. 774, Proposed Plan, p. 20.
[24] See, e.g., Table 4.2-7. Pages 11-12 of the Proposed Plan describe the site as 2167 acres.
[25] "Resolution of EPA September 27, 2010 Comments on Benthic Risk Evaluation" in EPA-approved BERA Attachment 1.
[26] See, Windward Environmental's Technical Memorandum *Review of EPA's FS relative to the LWG/EPA agreed comprehensive benthic approach (September 6, 2016),* Attachment 4.

Figure 1. Comparison of EPA Mapped Areas Above RAO 5 PRGs and Pooled Bioassay Results from the BERA.

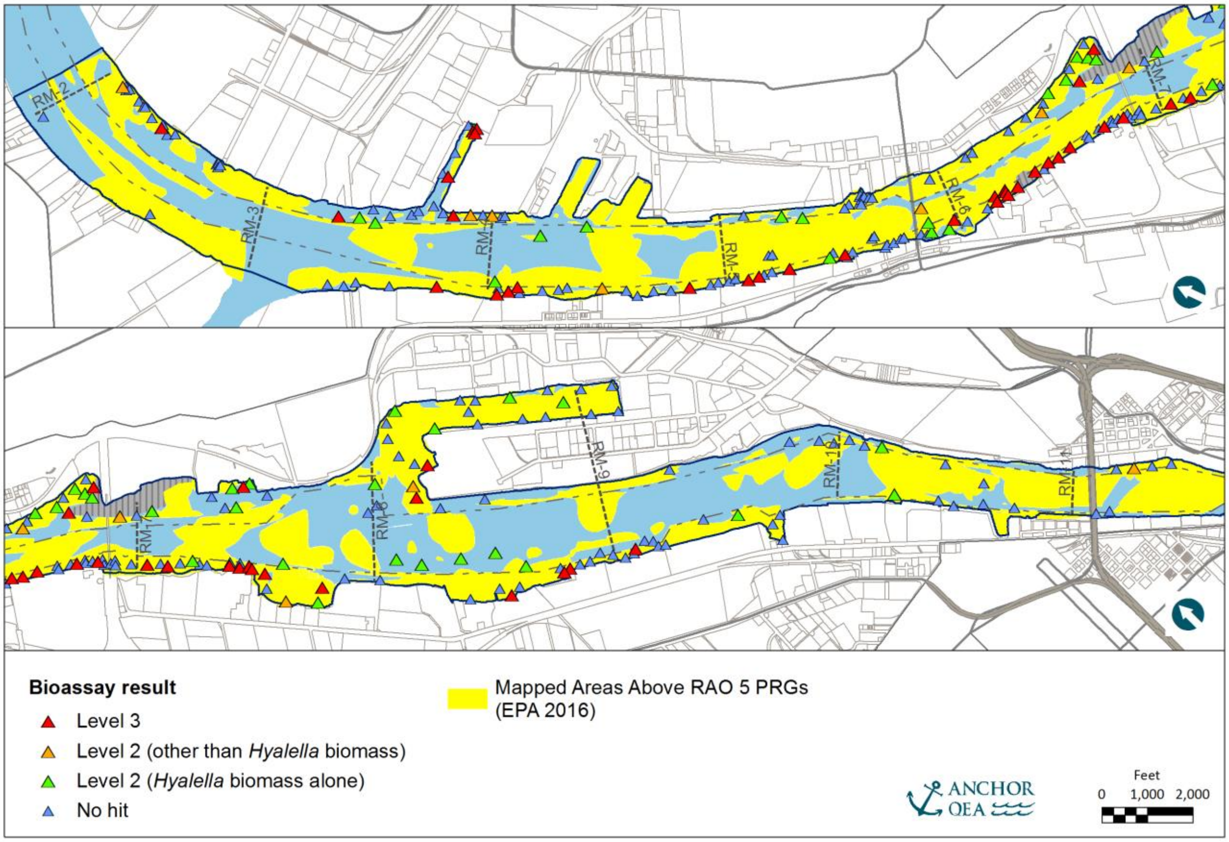

Table 1. Comparison of EPA's 2016 Draft Final FS Alternatives to the CBRAs Directed by EPA in 2014.

EPA Draft Final FS Alternative	Percent of EPA/LWG CBRAs Addressed by EPA Alternative
B	59%
C	66%
D	77%
E	83%
F	89%
G	92%
H	100%
I	84%

The EPA/LWG CBRA approach combines multiple lines of evidence, including bioassay toxicity tests. EPA supported this approach for many years before abruptly abandoning it in the final stages of preparation of the 2015 Draft FS. On April 4, 2014, EPA provided final direction to the LWG on mapping the CBRAs developed for the 2012 LWG Draft FS.[27] On February 2, 2015, EPA advised the Oregon Department of Environmental Quality (DEQ) that it was "not doing something new or different than what was done in the final BERA" and that the revised CBRA layers "are part of the Section 3 development of the alternatives, not Section 2, since they are depiction *[sic]*

[27] Burt Shepard email to John Toll, April 4, 2014, Attachment 5.

remedial action areas and not used for development of PRGs."[28] On February 27, 2015, EPA requested that the LWG submit revised text and maps incorporating its April 4, 2014, direction for the CBRAs; the LWG submitted the requested information on April 3, 2015.[29] The 2015 Draft FS, however, makes no mention of the EPA/LWG CBRAs, and the June 2016 draft Final FS maps benthic risk areas by point-by-point application of PRGs. EPA has never explained its changed approach to benthic risk and the corresponding shift from a remedial approach focused on the most certain areas of benthic risk, which (consistent with the findings of the BERA) encompasses a few percent of the Site to a very large percentage of the Site where significant evidence demonstrates limited or no benthic risk. And yet EPA's alternatives (except Alternative H, which covers the entire Site) do not address even the focused areas of elevated benthic risk.[30] Thus, EPA's distinction that Alternative I is protective of benthic risk, while Alternative B is not protective, is even more arbitrary when readily available and technically appropriate information is considered.

Further, EPA's interim target for RAO 5 is arbitrary based upon EPA's own analyses. EPA very simplistically mapped individual benthic PRG exceedances and used a 10 times exceedance factor to identify interim target benthic risk areas. EPA completed this interim target determination by assuming that an alternative would be protective if it is addressed through active remediation of 50% of the 10 times exceedance area. As discussed above, the 10 times exceedance factor is arbitrary and not supported by any long-term assessment of the alternatives. The 50% requirement is a second arbitrary step that is not tied to any quantitative assessment. EPA provides no explanation of why it picked 50% and not 33 or 67%, or any other value between 1 and 100%. EPA's own 2016 draft Final FS Table 4.2-7 illustrates the arbitrary nature of these decisions. In that table, EPA indicates that Alternative B addresses 48% of the 10 times benthic risk area, while Alternative I addresses 64%. Missing the threshold of 50% by a mere 2% implies a level of certainty to the analysis that is implausible, given the arbitrary nature of the threshold in the first place. Indeed, based on Table 4.2-7, Alternative B would actively remediate about 90 acres based on benthic risk, while the EPA-approved BERA concluded there may be as few as 87 acres of benthic risk.[31] The fact that, as discussed above, none of EPA's final alternatives actually address all benthic risk areas identified by the EPA/LWG CBRA approach just underscores the arbitrariness of EPA's approach in the 2016 draft Final FS.

With respect to RAO 6 (ecological bioaccumulation), as noted above, EPA concluded that "Alternatives B, D, E and I do not achieve the ecological HQ interim target of 10." Putting aside EPA's arbitrary decision to single out only Alternatives B and D as not protective, and ignoring the failure of its Preferred Alternative to meet the same interim target, a cursory review of EPA's own results suggests that all of these alternatives are protective. In the 2016 draft Final FS, EPA refers to Figures 4.2-9 through 4.2-17 and Table 4.2-5 to support its conclusions about RAO 6.[32] Based on this information, there are numerous problems associated with concluding any of these alternatives are not protective:

- As EPA notes on page 4-20 of the 2016 draft Final FS, these figures show that only bis-2-ethyhexyl-phthalate (BEHP) exceeds the 10 times threshold in any river mile or Sediment Decision Unit (SDU) examined and only in Swan Island Lagoon (SIL) or portions of SIL in the case of the rolling river mile analysis.

- On an SDU area basis, Table 4.2-5 shows that the BEHP exceeds the threshold by a factor 11 (slightly above the arbitrary threshold of 10) for Alternative B only.

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[28] Koch email to Jennifer Peterson, February 2, 2015, Attachment 6.
[29] Koch email to Toll, February 27, 2015Attachment 7.
[30] *Appendix P, Comprehensive Benthic Approach, Draft Feasibility Study* (Windward Environmental LLC, March 2015), Attachment 8. The LWG's 2012 draft FS addressed all CBRAs, with the exception of the 3 small additional areas resulting from EPA's April 4, 2014 direction and reflected in these revised text and maps submitted April 3, 2015.
[31] *See*, BERA p. 776. EPA concluded that benthic risk is "projected to extend over between 4 and 8% of the surface sediment area within the Study Area." According to the Proposed Plan, the Site covers approximately 2167 acres; four percent of 2167 acres is just under 87 acres. Proposed Plan, p. 11-12.
[32] See e.g., draft Final FS p. 4-20.

- The BEHP Hazard Quotient (HQ) exceedances highlighted in EPA's 2016 draft Final FS for Alternatives D and I are identical, each with an HQ of 19.[33] EPA cannot legitimately conclude with identical HQs in the same small area that Alternative D is not protective but Alternative I is protective.

- The rolling river mile analysis shows the BEHP exceedances (above threshold of 10) only occur for small fractions of a rolling river mile, around river miles 8 and 9.5 within SIL. This strongly suggests that these "exceedances" are due to one or two individual samples at either end of the SIL area. This reason appears insufficient to declare entire site-wide alternatives as not protective, particularly when any concerns (if real) could be addressed by small modifications to the alternatives in these limited areas either in the FS or in remedial design.

- EPA indicates in the 2016 draft Final FS that "…it is unlikely that ENR in SIL would sufficiently reduce the HQs in the long term due to the remaining concentrations outside the SMA." This appears to be a misstatement of EPA's own approach, because SIL is one of the few places in EPA's alternatives where Enhanced Natural Recovery (ENR) is specifically used outside the Sediment Management Area (SMA) boundaries as defined by the RALs.[34] Under EPA's approach, ENR material would be placed throughout SIL outside the SMAs, which would presumably address the one or two samples with relatively high BEHP concentrations on either end of SIL.[35] There is no quantitative analysis of the long-term outcomes for BEHP concentrations for any of these alternatives. Even a simple calculation of the concentration reduction expected from sand ENR placement in SIL would likely show substantial reductions in the specific BEHP exceedances noted by EPA.

- The HQ exceedances highlighted in EPA's 2016 draft Final FS for Alternative B, D, E, and I range from 34 to 15, with Alternatives D and I both having HQs of 19. EPA does not explain how it decided that an HQ of 34 in a very limited area is not likely to achieve protectiveness in 30 years while an HQ of 19 is protective in one case, but not in the other, over the same period.

Further, all these "exceedances" are based on a BEHP PRG that is questionable. EPA's RAO 6 PRG for BEHP is 135 micrograms per kilogram (ppb) and is based on a bioaccumulation endpoint for smallmouth bass tissue, but the PRG cannot be entirely replicated by the LWG based on the information available in the 2016 draft Final FS. As the LWG previously commented on the EPA 2015 Draft FS, taking into account the low frequency of surface water and tissue Toxicity Reference Value (TRV) exceedances, the conservatism of the fish tissue TRV, the absence of a relationship between site sediment and tissue concentrations, and the absence of evidence of BEHP biomagnification, EPA's selection criteria for contaminants of ecological significance do not support its decision to identify BEHP as a contaminant of ecological significance. It does not warrant an RAO 6 PRG.[36] It is also noteworthy that the BERA did not find widespread risks for BEHP. The BERA found smallmouth bass TRV exceedances in 4 of 31 samples in only 3 river miles.[37] The maximum BEHP exceedance occurred at river mile 3.5, which is many river miles downstream of the SIL area that caused EPA's determination that Alternatives B and D are not protective. Finally, the BERA is clear that the smallmouth bass BEHP TRV is based on one highly uncertain study.[38] Thus, determining a precise but arbitrary threshold of 10 times this highly uncertain PRG, and then rigidly applying that threshold to make a site-wide non-protectiveness determination highlights the absence of any reasonable risk management decision framework for the 2016 draft Final FS and Proposed Plan.

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[33] Draft Final FS, p. 4-42 and 4-80.
[34] Draft Final FS p. 4-20. See also Proposed Plan Figures 10a, b, and c, which indicate application of ENR sand outside SIL RAL boundaries.
[35] As noted elsewhere (in this document) it is problematic that EPA did not include ENR in SIL in the calculations of SWAC reductions. In this case, including ENR in SWAC calculations would likely have changed EPA's determinations in the 2016 FS about BEHP exceedances in SIL. EPA replied on July 20, 2016 to LWG clarification requests that, "The post-construction SWACs in the FS do not reflect the placement of ENR as they also do not include MNR." This reply attempts to equate ENR with MNR, but ENR clearly includes active placement of sand material at the time of construction, which is a form of active remediation as indicated by the word "enhanced" in the term ENR.
[36] *See*, "LWG Comments on Revised FS Section 2 (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240". Letter from LWG to EPA dated June 19, 2014.
[37] BERA Table 7-7.
[38] BERA Table 7-45.

B. If Alternative B Fails to Meet Chemical-specific ARARs, All Alternatives Do, and EPA Should Waive Them Now

EPA's Proposed Plan states that "Alternative B does not achieve chemical-specific ARARs in a reasonable time frame, but will attain the action-specific and location specific ARARs. All other alternatives will attain their respective Federal and State ARARs."[39] The 2016 draft Final FS states, "Alternative B may not comply with all ARARs…. It is unlikely that chemical-specific ARARs would be achieved in a reasonable time frame."[40] As noted above for EPA's long-term protectiveness evaluations, EPA's conclusion about Alternative B not meeting chemical-specific ARARs "in a reasonable timeframe" is entirely arbitrary, because EPA has no quantitative method to assess the long-term outcomes of the alternatives.[41] This ARAR determination for Alternative B is also arbitrary, because it is based on a flawed EPA analysis of surface water data that is inconsistent with Site technical information and any reasonable conceptual site model (CSM).

EPA supports these conclusions with the following statements on page 4-20 of the 2016 draft Final FS: "Exceedances of water quality criteria for protection of human health from contaminated sediment within the Site would continue for PCBs, cPAHs, and 2,3,7,8-TCDD eq at the completion of construction. There is insufficient surface water data to evaluate the effectiveness of this alternative in meeting the aquatic life water quality criteria for BEHP, PAHs and TBT." On page 4-6 of the 2016 draft Final FS, EPA refers to Appendix K as the source of these determinations. The LWG reviewed Appendix K and found it contains numerous flaws that preclude any accurate conclusions regarding surface water concentrations or compliance with surface water ARARs.[42] In summary, EPA's Appendix K analysis errors include the following:

- EPA used flow weights for averaging surface water data that are the opposite of the actual average annual river flow conditions. EPA assumed 240 days of the year were in a high flow condition, when the U.S. Geological Survey Portland river gauge data show that <u>low</u> flows (less than the long-term average of 33,000 cubic feet per second) occur about 250 days out of the year.

- EPA used river mile 11 West and Navigation Channel data to calculate weighted average surface water concentrations (SWACs) for the Site and for concentrations entering the Site. Using these same data to represent both locations on the river results in inaccurate determinations for both locations.

- Although perhaps a typographical error, EPA indicates it subtracted the concentration entering the Site from the average site concentration to obtain concentrations for the "Downtown Reach." As written, such a calculation would produce the contribution from the Site instead.

- EPA assumes that post-construction surface water concentrations will decrease proportional to the percent reduction in sediment surface-weighted average concentrations (SWACs). This simplistic assumption ignores other contributions to surface water, most notably the upstream concentrations entering the Site. As a result, EPA estimates much greater percent reductions for the alternatives than is possible. For example, EPA calculates 92% reduction in Site surface water concentrations for Alternative G, but correctly accounting for upstream inputs would place this estimate at only about a 50% reduction.

- EPA also ignores within-site upland sources such as National Pollutant Discharge Elimination System (NPDES)-permitted stormwater and NPDES-permitted process and cooling water discharges that are beyond the control of sediment remedies.[43] For example, the annual loading summary provided in Table 6.1-11 of the EPA-approved RI shows that nearly 30% of the PCB load to the Site comes from stormwater.

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[39] Proposed Plan, p. 52. See also Proposed Plan Table 15.
[40] EPA draft Final FS, p. 4-20.
[41] EPA rejected the fate and transport model that the LWG developed with EPA encouragement and EPA input over the course of the RI/FS which, if finalized in EPA's draft Final FS, would have provided the means to assess those outcomes.
[42] See the technical memorandum *Further Evaluation of EPA's Flawed Surface Water Analysis in 2016 draft Final FS Appendix K* (Anchor QEA August 8, 2016), Attachment 9.
[43] NPDES-permitted discharges are exempt from CERCLA remedial action requirements under the "federally permitted release" exemption. 42 USC §9607(j).

By ignoring these sources, EPA further and incorrectly inflates the erroneous percent reductions achieved by all alternatives.

These flaws cause EPA to systematically over-estimate the percent reduction in surface water concentrations provided by the alternatives. If EPA applied the same subjective judgments in the 2016 draft Final FS text for Alternative B to corrected (lower) reduction estimates for the other alternatives, EPA would conclude that most of the alternatives (likely including Alternative I) do not meet chemical-specific ARARs. Instead of attempting to correct the Appendix K results, EPA should develop a plausible CSM that recognizes the true role of upstream inputs to the Site and NPDES-permitted discharges.[44] A correct CSM for surface water would demonstrate that it is unreasonable to expect sediment remedies to drive improvements in Site surface water concentrations that are unrelated (e.g., upstream watershed sources) to Site sediment issues.

Such a CSM is fully supported by Site and upstream surface water data. The LWG previously submitted to EPA in the 2012 LWG Draft FS (p. 3-11) analyses demonstrating that "upstream background surface water 95th percentile UPL concentrations of arsenic, total PCBs [polychlorinated biphenyls], total PAHs, dieldrin, 4'4-DDT, sum DDT, and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) entering the Site exceeded the respective fish consumption values for these contaminants." The values being referred to here are various state and federal water quality criteria, which EPA has adopted as PRGs in the 2016 draft Final FS (Tables 2.1-4 and 2.2-1) and Table 11 of the Proposed Plan. EPA subsequently rejected the RI surface water upriver statistics (i.e., the upper confidence limit [UPL]).[45] However, even if EPA had examined just the arithmetic mean of upriver surface water data,[46] EPA would have found the concentrations of aldrin, arsenic, BEHP, DDD, DDE, DDT, hexachlorobenzene, PCBs, several polycyclic aromatic hydrocarbons (PAHs), and 2,3,7,8-TCDD toxic equivalent entering the Site exceed both the state and federal fish consumption water quality ceritifcation (WQC) for these contaminants. It is important to note that this list includes all of the focused RAL chemicals (i.e., PCBs, DDx, dioxin/furans, and PAHs). Therefore, a waiver will be needed for these criteria-based surface water PRGs due to upstream inputs, regardless of the exact statistics used to evaluate those upstream inputs. Consequently, no sediment remedy, even combined with source controls within the Site itself, can technically be expected to attain water concentrations lower than incoming upstream conditions for these chemicals.

Per EPA sediment remediation guidance,[47] "RAOs should reflect objectives that are achievable from the site cleanup." This leads to one of two possible EPA management decisions: 1) EPA should remove surface water RAOs from the 2016 draft Final FS, given that site sediments are not the primary cause of surface water ARAR exceedances and therefore sediment remedies alone cannot achieve all of the most important chemical-specific ARARs in surface water; or 2) EPA should waive water quality ARARs for these same chemicals in the ROD. EPA continues to maintain that, "Currently, EPA does not have a basis for waiving any ARARs. Any ARAR waivers would have to be conducted through the remedy selection process and documented in a ROD amendment."[48] If EPA had correctly estimated alternative surface water concentrations (even using the simplistic approach attempted in Appendix K), or simply compared the upstream concentrations to EPA's proposed surface water PRGs, then it would have an obvious available basis for waiving many of the water quality-related ARARs. Instead EPA maintains that site sediment remedies might somehow achieve site surface water reductions below ARARs despite multiple other sources also contributing to those same ARAR exceedances. EPA supports this ongoing bias by conducting obviously flawed analyses, such as Appendix K, and ignoring upstream data and then contending there is no basis for waiving the surface water ARARs.

Although EPA's guidance contemplates that ARAR waivers can be made either at the time of the ROD or later in a ROD amendment, CERCLA Section 121 strongly suggests that this determination should be made at the time of the ROD ("The President may select a remedial action meeting the requirements of paragraph (1) [protectiveness] that

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[44] See Section III, infra.
[45] EPA's rejection of the calculation of upriver statistics was formally disputed by the LWG. See request for Dispute Resolution of EPA's Notice of Decisions on Background Regarding Section 7 of the Remedial Investigation; Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240.
[46] See 2011 draft RI, Table 7.2-5a. EPA removed reference to upstream concentrations statistics from later versions of the RI.
[47] Sediment Guidance, p. 2-15.
[48] 2016 draft Final FS p. 2-6.

does not attain a level or standard of control at least equivalent to [an ARAR] if the President finds that . . . ."). The LWG calls upon EPA to make these decisions at the time of the ROD. EPA has the information it needs now to make the waiver determinations. If EPA does not do so, tens or hundreds of millions of dollars may be wasted striving to meet unachievable surface water ARARs that no sediment remedy can meet.

Similarly, Safe Drinking Water Maximum Contaminant Levels (MCLs) that EPA uses as surface water and groundwater PRGs[49] are likely not achievable throughout the spatial extent of some groundwater plumes along the shoreline or out under the river, and achievement of such criteria is not necessary to design and implement groundwater and sediment remedies that are protective of all reasonable and likely future uses of groundwater. EPA should either determine that MCLs are not applicable, relevant or appropriate because MCLs do not apply to the groundwater in this context, or it should waive these water quality criteria ARARs now. MCLs are not applicable, relevant, or appropriately applied to groundwater here because the Oregon statute designates the Lower Willamette River as a potential public and private water supply only following adequate pretreatment[50] and because the federal Safe Drinking Water Act under which MCLs are developed designate that drinking water is appropriately sampled at the point of distribution.[51]

C. EPA's Risk Evaluations in the 2016 Draft Final FS and Proposed Plan, Individually and Collectively, Present an Inaccurate and Biased Picture of Risk Reduction Attainable through Sediment Cleanup at Portland Harbor

1. EPA's development and application of PRGs for the 2016 draft Final FS and Proposed Plan are inconsistent with the BLRAs

EPA's methods and results throughout the 2016 draft Final FS and the Proposed Plan are often inconsistent with the BLRAs, culminating in both a baseline (i.e., no action) and a post-construction risk assessment that departs significantly from the methods and findings of the BLRAs. EPA should address only those potential risks for contaminants, media, and pathways that were clearly found to pose unacceptable risks in the BLRAs, and EPA should further focus on the subset of unacceptable risks that are required for selecting an effective and protective remedy using all of the FS criteria (i.e., EPA should conduct reasonable risk management). Instead, EPA has departed from the BLRAs and applied virtually none of EPA's 11 Risk Management Principles for "making scientifically sound and nationally consistent risk management decisions at contaminated sediment sites."[52] In short, EPA should use a "risk-based framework" to "select site-specific, project-specific, and sediment specific risk management approaches that will achieve risk-based goals" and "ensure that sediment cleanup levels are clearly tied to risk management goals."[53]

The LWG has previously commented that EPA's PRG development procedures were substantially flawed and should be corrected prior to finalization of the FS.[54] The vast majority of errors previously identified persist in the 2016 draft Final FS and are carried through to the PRGs summarized in Table 11 of the Proposed Plan. EPA continues to propose chemicals of concern (COCs) and PRGs under circumstances that are technically inappropriate, scientifically invalid, and inconsistent with guidance. As noted in prior comments, EPA should instead include in the FS only those COCs and PRGs:

- For contaminant/exposure scenario pairs (ecological or human health) for which the EPA-approved BLRAs identified potentially unacceptable risk from in-river media.

[49] 2016 FS Tables 2.1-4 and 2.2-1.
[50] OAR 340-041-0340, Table 340A.
[51] 40 CFR Part 141, § 141.23(a).
[52] *Principles for Managing Contaminated Sediment Risk at Hazardous Waste Sites*; February 12 2002. OSWER Directive 9285.6-08. See also Sediment Guidance, Appendix A-1. The relevance of this guidance to risk management steps in the FS is reviewed in detail in Sections 10.1 and 10.2 of the LWG's 2012 draft FS.
[53] Sediment Guidance, page 1-5.
[54] "LWG Comments on Revised FS Section 2 (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240)". Letter from LWG to EPA dated June 19, 2014; "LWG comments on EPA's Feasibility Study Revised Draft Section 2 Text," March 25, 2015.

- That are calculated consistent with EPA-approved BLRA methods.

- Where there is sufficient scientifically valid information to calculate those PRGs.

- That are technically practicable to achieve or, alternatively, for which acceptable risk levels can be reached through sediment remedial action alternatives evaluated in the FS.

- That reflect a reasonable risk management framework including that: 1) the BLRAs indicate a contaminant is significantly contributing to risk' and 2) evaluation of remedial alternatives with respect to a potential COC or PRG is necessary to select a protective remedy.

- That can be attained through sediment remediation, which would exclude any surface water PRGs based on water quality ARARs with substantial contributions from upstream sources or CERCLA-exempt NPDES-permitted discharges. Instead, EPA should waive these ARAR criteria in the ROD, as they are clearly impracticable to meet due to upstream and likely continued upland sources.

- For matrices that can be directly addressed through sediment remediation, which would exclude PRGs for the fish tissue matrix, given that upstream and upland water sources contribute to unacceptable levels in fish tissue. As noted in the past, the LWG agrees with the concept of using fish tissue levels as monitoring tools for a limited number of COCs but not as performance goals or PRGs for sediment remedies.

EPA's designation of large areas in the navigational channel for cleanup based on petroleum contamination is a clear example of the magnitude of errors resulting from EPA's inexplicable severance of the results of the BLRAs from the 2016 draft Final FS and Proposed Plan. The Baseline Human Health Risk Assessment (BHHRA) is clear that fish consumption risks from cPAHs are likely less than 1% of the total cumulative risks for this pathway, with the remainder coming mostly from PCBs and dioxin/furans.[55] EPA has been unable to develop a technically sound cPAH sediment PRG for fish consumption because there is no observable relationship between sediment sources and PAH concentrations in fish tissue.[56] Because it was unable to link cPAHs in sediment to fish consumption risk, and despite the marginal cPAH fish consumption risk, EPA assigned a shellfish consumption PRG to the navigation channel as a surrogate for fish consumption,[57] even though no shellfish harvesting can occur within the navigation channel. EPA cannot simply assume that a PRG based on bioaccumulation in shellfish is representative or appropriate for protection of humans consuming fish.[58] A "rich and comprehensive" body of scientific literature establishes that vertebrate fish and shellfish metabolize PAHs very differently and that there is "very low risk of exposure to PAHs that are a health concern for humans consuming finfish."[59] In the Lower Duwamish Waterway ROD, in fact, EPA concluded that development of a sediment cPAH PRG for the human health seafood

[55] See Figure 7-3 of the EPA-approved BHHRA.
[56] EPA's own internal reviews indicate this. See EPA memorandum, May 2016 "Evaluation of analyses used to calculate bioaccumulation calculation results Portland Harbor Superfund Site RAC Contract Number EP-W-05-049" to EPA Region 10 Portland harbor RI/FS File from Portland Harbor RI/FS Team (May 2016), Attachment 10. Further, the science is extensive that PAHs do not readily accumulate in vertebrate fish tissue. See Meador et al. 1995, *Reviews of Environmental Contamination and Toxicology* 143:79-164; September 2014 *Toxicological Review of* Benzo(a)pyrene, ORD EPA/635/R-14/312a; Varanasi, et al. 1989, Biotransformation and Disposition of Polycyclic Aromatic Hydrocarbons (PAHs) in Fish: In Varanasi U (ed); Metabolism of Polycyclic Aromatic Hydrocarbons (PAHs) in the Aquatic Environment, CRC Press; and Metabolism of PAHs in Teleost Fish-Scientific Findings, Memorandum from the Northwest Fisheries Science Center of NMFS, available at http://sero.nmfs.noaa.gov/deepwater_horizon/previous_reopening/index.html, October 22, 2010.
[57] 2016 draft Final FS Appendix B, p. B-35.
[58] In response to LWG comments noting this fact, EPA's explanation for such an assumption was, "EPA calculated a PRG for cPAHs to address unacceptable risks associated with consumption of shellfish, and we anticipate that this PRG will also address the unacceptable risks identified in the BHHRA associated with consumption of fish." How or why EPA believed this to be a scientifically appropriate decision was never explained. Koch email to McKenna and Wyatt (April 10, 2015).
[59] *Metabolism of PAHs in Teleost Fish-Scientific Findings*, Memorandum from the Northwest Fisheries Science Center of NMFS (vertebrate fish enjoy "highly efficient metabolism of PAHs" whereas bivalves such as oysters and clams have a "low capacity to metabolize PAHs"). See also, *Metabolism of Polycyclic Aromatic Hydrocarbons (PAHs) in the Aquatic Environment*, CRC Press.

consumption pathway was inappropriate, because no observable relationship exists between cPAH sediment and tissue concentrations.[60]

Even if such a PRG were valid, EPA's further decisions to abandon the site use factor used in the BHHRA for the direct contact cPAH PRG,[61] convert that cPAH PRG to a TPAH PRG based upon an irrelevant correlation calculation,[62] and then use this number as a basis for development of TPAH RALs for application in areas of the Site where no direct contact can occur results in a meaningless alternatives analysis. EPA's own immediate post-construction SWAC estimates[63] indicate that Alternative B SWACs in the navigation channel would be below the cPAH shellfish consumption PRG of 3,950 parts per billion (ppb) for every rolling river mile examined (the maximum SWAC at river mile 5.5 was 3,305 ppb within SDU 6Nav). Because Alternative B meets the cPAH shellfish PRG in the navigation channel immediately after construction, even if the shellfish PRG were a valid surrogate for a fish consumption PRG there would be no additional cPAH risk reduction from any of the other larger alternatives (D through I). Alternative RALs much higher than the Alternative B TPAH RAL (170,000 ppb) might provide a more cost-effective balance of active remediation and natural recovery for cPAHs in the navigation channel, but EPA considers no such alternatives. EPA's alternatives evaluation effectively compares only Alternative B against the "no action" Alternative A before selecting an extensive dredging remedy for the navigation channel. The LWG's estimated cost (based upon review of EPA's dredge volumes) of this unnecessary remediation in SDU 6Nav exceeds $62 million, which would classify this SDU, standing alone, as a mega-site. This outcome is manifestly inconsistent with any reasonable risk management approach, especially where fish consumption risks associated with PAHs account for less than 1% of the fish consumption risk identified in the BHHRA, and therefore, no meaningful or measurable human health risk reduction would be attained.[64]

The LWG's prior comments provide many other examples and detail how EPA's deviation from the BLRAs and failure to apply risk management are clearly inconsistent with EPA guidance.[65] Numerous examples of each of these issues are provided in the LWG's prior comments on 2015 Draft FS Section 2. Table 2 provides a summary of COCs and PRGs that EPA should use. Attachment 11 provides additional comments on EPA's COCs and PRGs contained in the 2016 draft Final FS and corrects the numerous issues and EPA errors identified by the LWG in EPA's most recent PRG tables (Proposed Plan Table 11 and 2016 draft Final FS Table 2.2-1).

[60] Lower Duwamish Waterway Superfund Site Record of Decision, November 2014, p.75.
[61] This issue is detailed in "LWG Comments on Revised FS Section 2 (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240)". June 19, 2014. See also, "LWG comments on EPA's Feasibility Study Revised Draft Section 2 Text," March 25, 2015.
[62] The LWG previously commented on this issue on page 11 of "List of significant comments on EPA Feasibility Study Section 3 and 4 (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240)" September 8, 2015.
[63] 2016 FS Appendix J Table J2.3-2i.
[64] TPAHs may be a source of benthic risk, but (for the reasons described above) benthic risk is targeted more precisely through application of the multiple lines of evidence used to evaluate benthic risk in the BERA and as applied in the EPA/LWG CBRA approach.
[65] LWG Comments on Revised FS Section 2 (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240", letter from LWG to EPA dated June 19, 2014. "LWG comments on EPA's Feasibility Study Revised Draft Section 2 Text," March 25, 2015.

Table 2. LWG Proposed Remediation Goals

Contaminant	Sediment - In-Water		Sediment-Beach Human Health Direct Exposure Areas	
	Units	**Conc.**	**Units**	**Conc.**
Arsenic	ppm	4	ppm	3 (or site-specific background)
Cadmium	ppm	Rely on EPA/LWG CBRA instead		
Chlordanes	ppb	Need to derive RAO 2 RG using upstream water values		
DDx	ppb	7.5		
DDD	ppb	Rely on EPA/LWG CBRA instead		
DDE	ppb	Rely on EPA/LWG CBRA instead		
DDT	ppb	Rely on EPA/LWG CBRA instead		
Dieldrin	ppb	Need to derive RAO 2 RG using upstream water values		
Lead	ppm	Rely on EPA/LWG CBRA instead		
Mercury	ppm	Rely on EPA/LWG CBRA instead		
PCBs	ppb	(20 or as determined by additional equilibrium evaluations)		
PAHs	ppb	Rely on EPA/LWG CBRA instead		
cPAHs (BaPEq) - human health direct contact unacceptable risk exposure areas	ppb	424	ppb	12
cPAHs (BaPEq) - areas contributing to clam unacceptable risk consumption exposure based on bioaccumulation	ppb	OC-normalized		
Dioxins/Furans (2,3,7,8-TCDD eq)	ppb	0.04		
1,2,3,4,7,8-HxCDF	ppb	Recalculate based on equilibrium		
1,2,3,7,8-PeCDD	ppb	Recalculate based on equilibrium		
2,3,4,7,8-PeCDF	ppb	Recalculate based on equilibrium		
2,3,7,8-TCDF	ppb	Recalculate based on equilibrium		
2,3,7,8-TCDD	ppb	Recalculate based on equilibrium		
TPH-Diesel	ppb	Rely on EPA/LWG CBRA instead		

As discussed above, the LWG disagrees that there should be any surface water PRGs, because it is not possible to achieve them through sediment remedies (any ARARs related to these PRGs should be waived by EPA in the ROD), and there should be no groundwater and riverbank PRGs. To the extent that EPA chooses to proceed with these types of PRGs, specific ongoing concerns associated with EPA's most recent COCs and PRGs include:

- To the extent that any surface water PRGs are noted as "A" for "ARARs" on Proposed Plan Table 11, these should all be the Oregon water quality standard (WQS) rather than the National Recommended Ambient Water Quality Criteria (NRWQC) (e.g., aldrin, arsenic, copper, DDE, pentachlorophenol, BaP, dibenz(a,h)anthracene).

  > "If a State has promulgated a numerical [water quality standard, or "WQS"] that applies to the contaminant and the designated use of the surface water at a site, the WQS will generally be applicable or relevant and appropriate for determining cleanup levels, rather than [the National Recommended Water Quality Criterion or "NRWQC"]. A WQS represents a determination by the State, based on the [NRWQC], of the level of contaminant which is protective in that surface water body, a determination subject to EPA approval." (Emphasis added.) 53 F.R. 51394, 51442 (Dec. 21, 1988, explanation of revisions to the National Contingency Plan).[66]

  The proposed arsenic surface water PRG is a good example of this. Oregon revised its human health water quality criteria for arsenic to 2.1 micrograms per liter (µg/L) on April 21, 2011. In doing so, Oregon evaluated the NRWQC but set its standard higher than the NRWQC based on state-specific reasons, including its development of state-specific bio-concentration factors. EPA approved these criteria on October 17, 2011, making these revised criteria effective under the Clean Water Act. Thus, any discharge to the Willamette River meets the state water quality standard as long as it does not create a concentration in the river in excess of 2.1 µg/L. However, EPA ignored this Oregon standard in its Proposed Plan and has instead proposed a surface water PRG for arsenic of 0.018 µg/L, based on the NRWQC. This means that EPA will require any discharge to the Portland Harbor (e.g., groundwater or discharges from remedial actions) to be cleaned up as if it had to meet a 0.018 µg/L concentration in the river, even though the State of Oregon has said that a concentration of 2.1 µg/L is fully protective. EPA should not so arbitrarily ignore Oregon's protectiveness determination on this issue—that is, set the stage to require very substantial expenditures so that water discharging to the river is more than 100 times cleaner than the surface water standard itself, a standard that Oregon has determined through its EPA-approved water quality standard process is fully protective.
- To the extent that EPA has set surface water PRGs for a class of chemicals on an ARAR basis where Oregon has chosen not to have a WQS for that class, but instead has WQSs for the individual chemicals in the class, it should be removed. For example, Oregon opted to adopt WQSs for individual PAHs rather than cPAHs as a class. EPA should not set a surface water or groundwater PRGs on an ARAR-basis for cPAHs, because it has already set PRGs for the individual chemicals included in that class consistent with Oregon's WQSs.

- In no case should a groundwater PRG be set on an ARAR-basis using a surface WQS or NRWQC. Instead, EPA should rely on the surface water PRG and indicate that groundwater treatment is required if the groundwater would cause the exceedance of that surface water PRG in the surface water.

- To the extent the WQS or NRWQC that are adopted as PRGs have associated limitations, those need to be carried forward into the final PRGs (e.g., some apply only to a dissolved fraction or to a particular valance state). Similarly, to the extent a PRG is based on a particular exposure scenario (e.g., beach direct contact), it should not be applied to different exposure areas. See Table 2 and Attachment 11.

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[66] *See also* Lori Cora letter of February 2, 2010: "If the State's water quality criteria is promulgated after the most recent NRWQC for that contaminant is published, but adopted a criteria less stringent than the NRWQC due to water body-specific reasons, per Subsection 2(B) (i), EPA may determine that the NRWQC is not relevant and appropriate as long as the remedy will be protective using the State promulgated standard."

- As discussed above, MCLs should not be surface water PRGs or groundwater PRGs; if they are, they should be applied at the theoretical point of distribution after treatment, consistent with Oregon and federal law.[67]

- Tapwater Regional Screening Levels (RSLs) should not be groundwater PRGs, and manganese in particular should not be a PRG for the following reasons:

  – Table 11 of the Proposed Plan proposes a groundwater PRG for manganese of 430 µg/L. The origin of this criterion appears to be an EPA RSL for *tapwater*, based on risk to human health.[68]

  – Table 2.2-2 of the EPA draft Final FS indicates that manganese was not found to pose a risk to human health, so it should not have a PRG set based on a human health criterion.

  – The value is an RSL, not an ARAR.[69]

  – The surface water itself already meets this identified PRG; thus, there is no basis for setting a PRG in groundwater for the purpose of protecting the surface water pursuant to RAO 4.[70] This is because manganese is one of the chemicals subject to changes in concentration based on the geochemistry; specifically, the manganese becomes oxidized as it moves into the surface water, and it precipitates out of solution. Thus, groundwater concentrations are not predictive of surface water concentrations.

  – For RAO 4, which appears to be the basis for the proposed groundwater PRG, human use of surface water from the Willamette River requires pre-treatment as discussed above. Manganese is one of the substances that is most clearly controlled by conventional water pretreatment, which includes hardness adjustment/water softening, filtration, and chlorination. Therefore, manganese levels in groundwater/porewater in no way reflect the manganese concentrations that would be present in water used for potable purposes.

  – The current manganese RSL, which is the basis of the Portland Harbor manganese PRG, is derived from an incorrect and unsubstantiated, un-peer-reviewed evaluation of the manganese EPA IRIS assessment and is not appropriate as a PRG.

- Table 11 of the Proposed Plan lists some substances where there is no PRG (e.g., phenanthrene and pyrene). These should be removed.

The Proposed Plan does not explain how water PRGs will be applied. If EPA chooses not to delete them for reasons discussed above, risk-based surface water PRGs should be applied consistent with the exposure scenario that determined the unacceptable risk. If the PRGs are ARAR-based, they should be applied consistent with state procedures to determine water quality standard exceedances.[71] Further, if EPA keeps groundwater PRGs that are

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[67] OAR 340-041-0340, Table 340A; 40 CFR Part 141, Section 141.23(a).

[68] Note that Table 2.1-1 of EPA draft Final FS incorrectly identifies the source of this PRG as an "EPA Regional Screening Level (RSL) for Groundwater." In fact, the current version of the document that EPA references in that table is called the "Regional Screening Level (RSL) Resident *Tapwater* Table" (May 2016 version). The prior November 2015 version to which EPA cites in FS Table 2.1-1 was called the "Regional Screening Level (RSL) Summary Table," but it clearly indicated that the manganese RSL to which EPA refers of 430 µg/L was for "Tapwater."

[69] Table 2.1-1 of EPA draft Final FS specifically identifies the RSL table from which this was taken as a "To Be Considered" criteria, not an ARAR.

[70] See Attachment 12.

[71] ODEQ rules establish that all aquatic protection water quality standards are applied as a 96-hour average concentration, which may not be exceeded more than once every three years. OAR 340-041-8033, Table 30. Oregon guidance establishes that its human health criteria should be evaluated based on the geometric mean of 24-hour composite samples of high and low flow conditions of the waterbody. ODEQ, *Reasonable Potential Analysis Process for Toxic Pollutants*, Feb 13, 2012, at 34 and 80.

based on surface water ARARs, these need to be as measured in the surface water at the point of groundwater discharge,[72] because that is the beneficial use those ARARs are meant to protect.

Finally, we note that Proposed Plan Table 11 attempts to "summarize" the more detailed PRG tables from the 2016 draft Final FS. Proposed Plan Table 11 combines human health and ecological PRGs by media so that the origin and appropriate application of each PRG is lost. For example, Proposed Plan Table 11 cPAH notes a "riverbank soil/sediment" PRG of 12 ppb; which is an incorrect and misleading summary of that PRG. In fact, this particular PRG only applies to very limited beach areas as more accurately described in 2016 FS Table 2.2-1, and does not apply to the vast majority of the Site. EPA appears to have simply picked the lowest available PRG value from the 2016 draft Final FS PRG tables for each matrix "summarized" in Proposed Plan Table 11 without reference to how or where each particular PRG might be applicable or inapplicable to certain evaluations and decisions in remedy design and implementation. This leaves the reader with the false impression that each of these PRGs applies in all situations, which is clearly not the case and would be inconsistent with both the 2016 draft Final FS and the BLRAs.

In summary, EPA should apply the risk management called for by guidance and, in the ROD, select a refined and narrowed subset of PRGs as Remediation Goals (RGs). As explained above, the LWG believes RGs should be established only for sediments and only for COCs for which the EPA-approved BLRAs found significant unacceptable site-related risk and which can be addressed through a sediment remedy. Those proposed RGs are set forth in Table 2 above. Attachment 11 (specifically Table 11a of that attachment) shows in detailed, red-lined form how and why EPA should narrow its list of sediment PRGs contained in Proposed Plan Table 11 to get to the Table 2 list of proposed RGs. Because concentrations of COCs in fish tissue are highly influenced by upstream and NPDES sources that are not subject to the Portland Harbor remedial action, EPA should not set fish tissue PRGs. The LWG does believe it would be useful, however, to set fish tissue monitoring levels and shows in Attachment 11 (specifically Table 11b to that attachment) how EPA should narrow its list of fish tissue PRGs contained in Proposed Plan Table 11 to a meaningful list of fish tissue monitoring concentrations. For the reasons described above, the LWG does not believe EPA should set either surface water or groundwater RGs in the ROD. If EPA should proceed to use any of these values as RGs or as targets, please note that the LWG has also found errors and inconsistencies with the risk assessments in the PRG values that EPA has proposed. These comments are also provided in Attachment 11. Finally, the LWG reiterates its previous comments on EPA's PRG development.[73] Attachment 11 provides a summary of the LWG's position with respect to each PRG, by matrix and by RAO, narrowed to the list of PRGs set forth in EPA's 2016 draft Final FS.

2. EPA's post-construction risk evaluation is not consistent with the BLRAs

EPA conducts a post-construction risk evaluation in the 2016 draft Final FS for each alternative and uses the resulting post-construction risk estimates to evaluate the effectiveness of the various alternatives immediately after construction. EPA's post-construction risk estimates are inconsistent with the BLRAs in numerous respects. These inconsistencies cause EPA to err regarding the relative effectiveness of the alternatives, which in turn, results in EPA selecting an unnecessarily large and expensive preferred alternative (Alternative I).

a. The post-construction risk evaluation assumes different exposure scenarios and spatial scales than the BLRAs

Just as EPA's PRG selection in the 2016 draft Final and Proposed Plan deviates from the BLRAs in multiple respects to drive potentially unnecessary cleanup, EPA's post-construction risk estimates alter exposure scenarios and spatial scales and use inappropriate PRGs to inflate the perceived benefit of more aggressive actions. We have

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[72] Except for 303(d) listed chemicals, this would have to include provision for assumed mixing in the water column, consistent with Oregon's rules for allowed mixing zones.

[73] LWG Comments on Revised FS Section 2 (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240", letter from LWG to EPA dated June 19, 2014; "LWG comments on EPA's Feasibility Study Revised Draft Section 2 Text", March 25, 2015.

identified the following discrepancies (which are not comprehensive) between the BLRAs and the 2016 draft Final FS post-construction risk evaluation:

- For RAO 1, continued exclusion of the site use factor from the BHHRA for the benzo(a)pyrene equivalent (BaPEq) FS PRG (106 ppb) results in concluding that not even Alternative G will meet this PRG for many half river miles examined (2016 draft Final FS Table J2.2-1c). However, if the BHHRA site use factor is accurately applied (resulting in a PRG of 424 ppb), Alternative B appears to achieve RAO 1 immediately following construction in all but a few half river miles (e.g., around river miles 4, 5, and 6 East and 3, 4, 5, and 6 West).

- For RAO 2 human health fish consumption risks, EPA generated post-construction SWACs on: 1) a 1-river mile basis longitudinally split into the two shoreline areas and the navigation channel for the recreational fisher scenario; 2) a site-wide basis for the subsistence fisher scenario: and 3) an SDU basis (which represents subareas of various inconsistent sizes and shapes) for the recreational fisher scenario.[74] However, in the EPA-approved BHHRA, risks were evaluated by whole river miles with no longitudinal splitting for recreational fish consumption and without reference to SDUs, which did not exist when the BHHRA was completed.

- For RAO 2, the human health post-construction risks for Alternative A (which should be identical to the BHHRA baseline condition) differ from the risks calculated in the BHHRA, which indicates there are inconsistencies. The baseline highest non-cancer risk for a breastfeeding infant in the BHHRA was a Hazard Index (HI) of 10,000 site-wide (for nursing infants of subsistence fishers). The highest 2016 draft Final FS post-construction risk estimates for the same scenario for Alternative A were 3,333 for site-wide, which is substantially less than the BHHRA result. The highest FS HI estimates for Alternative A (254,000 on a river mile scale and 22,589 on an SDU scale) should be equivalent to the BHHRA recreational fisher infant scenario, because EPA calculated them using an ingestion rate of 49 grams per day. However, the maximum recreational fisher infant river mile HI from the BHHRA is 1,000, which is one to two orders of magnitude less that EPA's Alternative A estimates. The reasons for these differences are unclear.

  In addition to questionable assumptions regarding exposure to resident fish, EPA does not take into consideration several key uncertainties in assessing risk, including food preparation and cooking methods (which can reduce PCB concentrations by up to 87%).[75] EPA's assumptions are not merely conservative but are wholly unrealistic, contrary to the "conservative but within a realistic range of exposure scenarios" recommended by the NCP.[76]

- For RAO 2, there is a significant disconnect between the BHHRA and post-construction risks for dioxins/furans (and other inconsistencies with the BHHRA results also likely exist).

  - For a breastfeeding infant, the highest HQs for dioxin/furan TEQ calculated in the BHHRA are 10 on a site-wide basis (tribal fish consumption, whole body diet) and 10 on a river-mile basis (recreational reasonable maximum exposure [RME] consumption, river mile 7). Table J2.3-1a in the 2016 draft Final indicates that the site-wide HQ for the same infant scenario from HxCDF alone (not the entire TEQ) is 785 for Alternative A, almost two orders of magnitude higher.

  - For a child, the highest HQs for dioxin/furan TEQ calculated in the BHHRA are also 10 on a site-wide basis (tribal fish consumption, whole body diet) and 10 on a river-mile basis (recreational RME consumption, river mile 7). Table J2.3-1a in the 2016 draft Final FS shows a site-wide HQ of 23 for just HxCDF.

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[74] 2016 FS, p. 4-10.

[75] BHHRA, p. 89. EPA states that on page 49 of the same document that no adjustments were made to contaminant concentrations in raw fish tissue because of the uncertainties associated with preparation and cooking practices.

[76] NCP Preamble, 55 Fed. Reg. 8710.

  - The dioxin/furan Reference Dose has changed since the BHHRA was completed but that appears unlikely to account for the difference between the BHHRA and Alternative A post-construction risks.

  - In August 2015, EPA acknowledged the inadequacy of HxCDF data in terms of quality and spatial coverage in written correspondence with the DEQ. At that time, EPA was in charge of finalizing its FS and had the authority to require supplemental scientific investigations to address and resolve these concerns. Instead, it chose to develop PRGs and RALs based on data EPA characterized as inadequate. In doing so, EPA abrogated its duty to produce scientifically sound and supportable risk estimates as well as cleanup criteria in the form of supportable PRGs and RALs.[77]

  - Additional issues with EPA's dioxin/furan PRGs and post-construction risk approach are detailed in Attachment 11.[78]

- For RAO 5, ecological direct contact risks, multiple issues with EPA's benthic post-construction risk estimates are discussed above.

- For RAO 6, ecological bioaccumulation risks, 2016 draft Final FS SWACs were generated on a rolling 1-river mile basis with longitudinal splitting and on an SDU scale (p. 4-8). Like other post-construction risk estimates, EPA divides the post-construction SWAC by the PRG for each chemical. Importantly, the PRGs for the various RAO 6 chemicals are based on different ecological receptors evaluated in the BERA. These include smallmouth bass tissue for BEHP, sculpin tissue for DDx, sandpiper dietary assessment for DDE, mink for PCBs, and osprey egg assessment for dioxin/furans. These receptors all have widely divergent exposure parameters (including spatial scales) in the BERA and post-construction risks cannot be estimated by applying a "one size fits all" spatial scale to every PRG. Further, none of the BERA-appropriate spatial scales are consistent with longitudinally split river miles or SDUs. EPA does not recognize in the 2016 draft Final FS that this is even an issue and presents no discussion of why blanket application of split river miles and SDU spatial scales are possibly consistent with the various receptor exposures being evaluated.

  - For example, the DDE PRG is based on the BERA spotted sandpiper dietary assessment that was evaluated on a 2-river mile scale of beach sediment. The BERA evaluation spatial scale differs substantially from EPA's longitudinally split river miles or SDUs. EPA's Dioxin/furan PRG is based on the BERA osprey egg assessment, which was evaluated on a much larger scale than 1 river mile, much less longitudinally split river miles, or SDUs.

  - Also, the LWG has previously commented[79] that almost all of the RAO 6 PRGs, and as a result the post-construction risks calculated, are based on inappropriate or inconsistent determinations as compared to the BERA methods. Attachment 11 contains a summary of the most up-to-date comments from LWG on each of the RAO 6 PRGs.

  - As a result, all of the RAO 6 post-construction risk estimates appear to be unsupported and do not present any accurate accounting of the relative ecological risks or risk reductions achieved by any of the alternatives.

- For RAO 9, EPA considers the number of lineal feet of riverbank soils that are addressed by each alternative as a qualitative measure of human health and ecological risk reductions (EPA draft Final FS p. 4-9). Given that the RI and BLRAs include no riverbank soils (as defined in the RI) data and contain no

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[77] See email message E. Allen USEPA to DEQ dated August 20, 2015.
[78] See Technical Memorandum, *Review of Human Health Risk Analyses in the Portland Harbor Feasibility Study and Proposed Plan*" (S), Section 3 (detailing a comparison of EPA's fish consumption risk estimates to BHHRA and 2012 smallmouth bass estimates). A copy of this memorandum is Attachment 14.
[79] LWG Comments on Revised FS Section 2 (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240," letter from LWG to EPA dated June 19, 2014. "LWG comments on EPA's Feasibility Study Revised Draft Section 2 Text," March 25, 2015.

risk assessment of riverbank soils, EPA should not have evaluated these post-construction risks at all. Any "qualitative" assessment is mere conjecture in the absence of actual evaluation of riverbank soils data or baseline risks earlier in the RI/FS process.[80]

Appendix J of the 2016 draft Final FS glosses over many method details; thus, it is not possible to fully comment on EPA's post-construction risk methodology. However, given that it is clear that all of the above aspects are inconsistent with the BLRAs, it is highly likely that other details of the methods, if they were known, would also be inconsistent with the BLRA methods.

b. Inflated SWAC recalculation skews the apparent performance of EPA's alternatives

As noted above, all of EPA's post-construction risk estimates are based on calculating a ratio of the immediate post-construction exposure concentrations in the numerator (SWACs or related tissue concentrations) to the toxicity level (PRGs) in the denominator. EPA presents these ratio results as HQ (non-cancer) or cancer-risk levels for each alternative.[81] As noted above, there are numerous inconsistencies with the BLRAs in EPA's determination and application of the risk-based PRGs in the denominator. This subsection focuses mainly on the numerator (exposure concentration) errors. EPA's FS conclusions rely mainly on post-construction risk estimates for human health fish consumption (RAO 2) and ecological bioaccumulation risks (RAO 6), so discussions here are confined to those scenarios (human health) and receptors (ecological). (In addition, EPA evaluated benthic risk reduction for ecological (RAO 5), and errors associated with this analysis are discussed previously.)

Regarding human health fish consumption (RAO 2), EPA relies on PCB post-construction non-cancer risk estimates for the child[82] (e.g., 2016 draft Final FS Figures 4.2-2 and 4.2-6) and infant scenarios (e.g., 2016 draft Final FS Figure 4.2-4). To simplify the discussion, we focus here on the child scenario errors, but similar errors exist for the infant scenario. EPA presents two types of results: 1) non-cancer HQs and cancer-risk levels;[83] and 2) allowable fish meals, which are calculated through an algebraic rearrangement of the risk equation to solve for the number of meals producing an acceptable risk level under any given post-construction exposure concentration. EPA uses the same flawed exposure concentrations to support both results.

Specifically, EPA graphics (such as 2016 draft Final FS Figures 4.2-2, 4.2-4, and 4.2-6) present baseline (Alternative A) and immediate post-construction risk levels and allowable fish meals for each alternative that depict a sharp decrease in the risk levels between the baseline condition (Alternative A) and the progressively more aggressive alternatives. This steep decrease is caused by EPA's flawed calculation of baseline PCB SWACs for the Site, which EPA newly assumed to be about 208 ppb site-wide.[84] As recently as EPA's 2015 Draft FS and November 2015 NRRB presentation,[85] EPA had been presenting the site-wide SWAC as about 85 to 87 ppb, which is similar to the site-wide SWAC presented in the 2012 LWG Draft FS, the EPA-approved BHHRA and BERA, and essentially all EPA and LWG prior discussions and documents. The 2016 draft Final FS indicates the same FS database was used as the 2015 Draft FS; however, the new SWAC does not involve any new data and is exclusively a reinterpretation of the same data available for many years. In addition, EPA presents a site-wide SWAC of 92 ppb on Figure 3.4-1 (depicting PCB RAL curves) in the 2016 draft Final FS, which is only slightly higher than the

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[80] EPA acknowledges the RI/FS data are insufficient to make an assessment (p. 4-9), but proceeds nonetheless, "A qualitative assessment of protectiveness for river banks is conducted for each alternative as there are no current means to quantitatively assess the effectiveness of the alternative in achieving PRGs in river banks due to uncertainty in contaminant concentrations and locations."

[81] Note that this is a "short cut" method for a residual risk assessment. Typically, such assessments are conducted by calculating post remediation sediment (and other matrices as appropriate) concentrations and then applying those concentrations to forward risk assessment calculations.

[82] EPA's FS and Proposed Plan fail to mention that these risk estimates are for the child scenario, which is more conservative (higher risks) than the adult scenario (e.g., FS Table 4.2-2, Figure 4.2-2, and similar figure titles do not mention whether the risks presented are for adult or child scenarios). EPA typically mentions that "people would be advised to eat no more than 6 fish meals every 10 years" (Proposed Plan p. 58); this makes it unclear which "people" are being evaluated. EPA's widespread use of the child scenario was only discovered through laborious cross checking between EPA's FS main text and appendices and by conducting independent calculations.

[83] EPA focuses on the adult scenario for discussion of cancer risks in the 2016 FS.

[84] This critical information is buried in Draft Final FS, Appendix J, Table J2.3-1a.

[85] "Portland Harbor Remedial Investigation". Presentation to the CSTAG/NRRB, November 18, 2015. Kristine Koch, U.S. EPA, Region 10. Part 2, p. 27.

historical estimates. This SWAC level implies that EPA developed the RAL curves using a different baseline SWAC than the post-construction risk estimates, which is another unexplained inconsistency in EPA's methods.

EPA's new assumed baseline PCB SWAC of about 208 ppb is not mentioned once in the 2016 draft Final FS and Proposed Plan main text, figures, or tables.[86] EPA also does not explain why an upward shift that more than doubles the previously estimated baseline PCB site-wide SWACs is warranted or why this huge inconsistency with the EPA-approved BLRAs is acceptable. EPA generally cites in the FS main text both Appendix I and Appendix J for further information regarding SWAC uncertainties and methods for the post-construction risk assessment. Appendix I of the 2016 draft Final FS presents site-wide PCB SWAC uncertainty analysis results that range from 79 to 205 ppb (p. I-5), and the five methods used produced an average result of 120 ppb (Table I-1). Thus, the 208 ppb SWAC is even above the extreme maximum value from the analyses in Appendix I. Appendix J indicates (p. J-3) that "[s]ite-wide sediment concentrations were calculated for RAO 2 using the post remedial SWACs developed for each SDU and other areas of the river as described in Appendix I. A site-wide average concentration for each COC – represented by the 95 percent upper confidence limit on the mean – was then calculated for each RAO 2 COC using ProUCL." In response to the LWG's questions, this method was later clarified by EPA in an email response: "The figure below was used to develop site-wide SWACs. A SWAC of each area was computed and then put into Pro-UCL to determine the 95th percent UCL on the mean of those SWACs. The SWACs that are used in the FS are provided in Appendix J and K."[87] Despite the confusing and conflicting scattered statements, our current understanding is that the EPA value of 208 ppb derived in Appendix J may be completely separate from the value of 205 ppb described in Appendix I, and they are only coincidentally similar. This remains unclear.

Assuming that this interpretation is correct, the Appendix J method of calculating site-wide SWACs appears fundamentally flawed. EPA is indicating that the Site was cut into 31 subareas, and a SWAC was "computed" (the SWAC method here is unclear) for each subarea. EPA then made the assumption that the SWAC for each subarea was somehow a potentially representative "sample" of the entire Site SWAC, which is clearly an inaccurate and scientifically unsupportable assumption. Empirical data collected over 15 years irrefutably demonstrate that the Site has areas with relatively high and low PCB (and other chemical) concentrations, and the SWAC in any given subarea may have little relationship to the overall surface-weighted average across the entire Site. By selecting the concentration from one subarea to represent all post-construction risk estimates for the entire Site, EPA is deciding that all human health and ecological exposures represented by any particular RAO or scenario occur in that one subarea. In other words, while a given BHHRA scenario may assume a person is catching fish from the entire Site, EPA's FS method reduces this assumption to a person catching fish from just one select subarea for the entire exposure period. And because EPA is using an UPL, this person is assumed to consume only fish from an area with comparatively high concentrations.

A second unstated assumption is that the 31 subareas defined by EPA are a statistically valid way of dividing the Site. EPA clarified that the subareas are based on SDUs, which EPA states were devised to specifically identify the areas of highest COC concentrations on a rolling river mile basis. Obviously, many other methods could be used to define subareas of the Site, each of which would yield different statistics than the one EPA selected. Further, EPA has created an explicitly bimodal distribution of subareas, with some subareas focused on the highest observed concentrations (the SDUs) and remaining subareas focused on the lowest observed concentrations. This method is biased and inherently inaccurate for subsampling Site SWACs, and consequently it is likely that other less biased and more scientifically supportable subsampling methods would produce a lower overall SWAC estimate.

Regardless, it is inappropriate to use any of these new subsampling methods, because they will all create Site SWACs that are inaccurate and inconsistent with those used in the EPA-approved BLRAs, which in turn causes the remedy selection process to diverge from an appropriate focus on reducing risks actually identified in the BLRAs.

EPA's unscientific and artificially inflated new SWACs apply to other COCs as well, as shown in Table 3. An evaluation of EPA's new site-wide SWAC for 2,3,4,7,8-PeCDF clearly illustrates the problems with EPA's new

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[86] Indeed, the 208 ppb PCB SWAC would effectively designate the entire Site as Principal Threat Waste (PTW). *See* 2016 draft Final FS Table 3.2-1 (highly toxic PTW threshold is 200 ppb). Yet 2016 draft Final FS Table 4.2-9 identifies just 172 (out of 2167) acres of the Site as PTW.
[87] Email response number 8 from Kristine Koch on July 20, 2016 regarding LWG's "Request for Clarification."

SWACs. EPA's new site-wide SWAC for 2,3,4,7,8-PeCDF is 0.04 ppb. Out of 374 surface sediment samples analyzed for 2,3,4,7,8-PeCDF, only 10 samples in the entire Site are equal to or greater than 0.04 ppb, and these samples were all collected between river mile 6.7 and 7.3. The LWG calculated SWAC using EPA's 2015 natural neighbor contour surfaces is 0.00588 ppb, which is an order of magnitude less than EPA's new SWAC for this compound. As an additional example, EPA calculates that risk from a single dioxin/furan congener, 1,2,3,4,7,8-Hx CDF, is higher than the total TEQ. This is physically and logically impossible. It was also known to EPA to have been calculated using a flawed characterization and poor data quality.[88] When EPA's own contractor summarized percent contributions to risk from dioxin/furan congeners from actual fish tissue date, the TEQ risk from 1,2,3,4,7,8-Hx CDF was approximately 3 percent.[89]

Table 3. Comparison of EPA's New Site SWACs to Values Estimated by LWG Using EPA's Natural Neighbor Surfaces.

Chemical	Site-Wide SWAC (ppb)	
	Table J2.3-1a (EPA 2016 Draft Final FS)	SWACs Estimated by LWG Using Natural Neighbor Surfaces Provided by EPA
PCBs	208	86
DDx	138	30
1,2,3,7,8-PeCDD	0.0003	0.0002
2,3,4,7,8-PeCDF	0.04	0.006
2,3,7,8-TCDD	0.0003	0.0001

Another issue with EPA's post-construction SWACs is that EPA assumes a "zero" replacement value for areas where active dredging and capping is assumed to take place.[90] That is, the remediated area is assumed to attain a concentration of zero for any evaluated COC immediately after construction is complete. Although this assumption is convenient and simple, it is clearly incorrect for dredge areas, where dredge residuals are known to occur. These residuals can be managed, but it is nearly impossible to reduce post-dredge residual concentrations to zero.[91] The use of zero as a replacement values for dredge areas makes the larger alternatives with more mass removal appear to have greater immediate risk reduction than will actually occur. For example, EPA presents several post-construction SWACs for PCBs that are below EPA's background value of 9 ppb (and the LWG's calculated equilibrium value of 20 ppb). Even if such immediate post-construction concentrations were temporarily achievable, inputs and deposition of sediments from upstream would be expected to quickly return these areas to an equilibrium concentration. Thus, EPA compounds the appearance of steep SWAC declines by simultaneously artificially inflating the baseline SWAC and then over-estimating the SWAC reductions that will occur due to dredging.

The consequences of substantially diverging from the BLRA SWACs at this late date are not considered or discussed anywhere in the 2016 draft Final FS or Proposed Plan. The consequences, combined with other issues like the zero replacement value, are widespread, impacting every post-construction risk estimate presented by EPA and skewing the overall evaluation of the alternatives' effectiveness. Because EPA increases the baseline Alternative A SWACs by a factor of about 2.4, all of EPA's baseline risk estimates are higher than the BHHRA by a

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[88] See email message E. Allen USEPA to DEQ dated August 20, 2015.

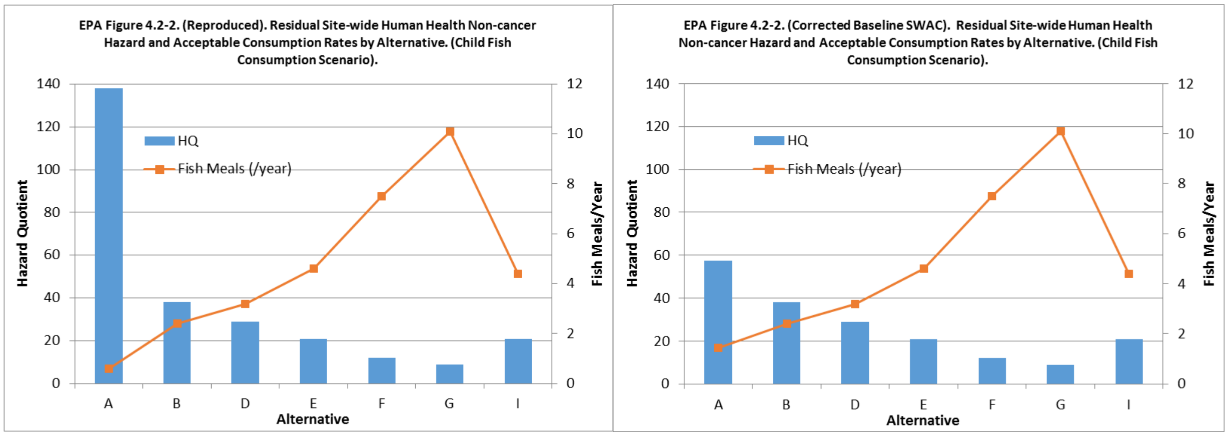
[89] CDM Smith, "Evaluation of Dioxin/Furan Congeners Against Total Dioxin/Furans, Portland Harbor Superfund Site," December 23, 2014, Table 1 (presenting results by river mile, with the contribution to risk attributed to 1,2,3,4,7,8-Hx CDF by river mile segments ranging from 0 to 20 percent and, once corrected for the fact that the wrong TEF was applied (TEF for 1,2,3,4,7,8-Hx CDF is 0.1, not 0.3, according to https://rais.ornl.gov/documents/dioxin_tef.pdf), averaging approximately 3%).

[90] 2016 draft Final FS p. ES-14.

[91] See discussion in the LWG 2012 draft FS in Sections 6.2.7.3 and 8.2.2.4; Bridges, et al. 2010: Dredging Processes and Remedy Effectiveness: Relationship to the 4 Rs of Environmental Dredging. Todd S. Bridges, Karl E. Gustavson, Paul Schroeder, Stephen J. Ells, Donald Hayes, Steven C. Nadeau, Michael R. Palermo, and Clay Patmont. Integrated Environmental Assessment and Management. February 10, 2010. 2010 SETAC; ITRC p. 181; and "Sediment Monitored Natural Recovery Case Studies." Presentation at the Battelle Eighth International Conference on Remediation and Management of Contaminated Sediments. January 12-15, 2015. Carl Stivers and Clay Patmont of Anchor QEA. (Attachment 13)

similar factor.[92] Figure 2 provides an example of how EPA's post-construction risk figures would change if baseline SWACs consistent with BLRAs were used instead. The risk reduction (HQs) from the baseline condition in Alternative A provided by all the alternatives becomes substantially less, and the graph becomes much less compelling visually. Similarly, the number of allowable fish meals provided by Alternative I (for example) goes from 7 times greater than baseline to only 3 times greater than baseline.

Figure 2. Comparison of EPA's FS Risk Estimates to Corrected Values Using a Baseline SWAC Consistent with the BLRAs.

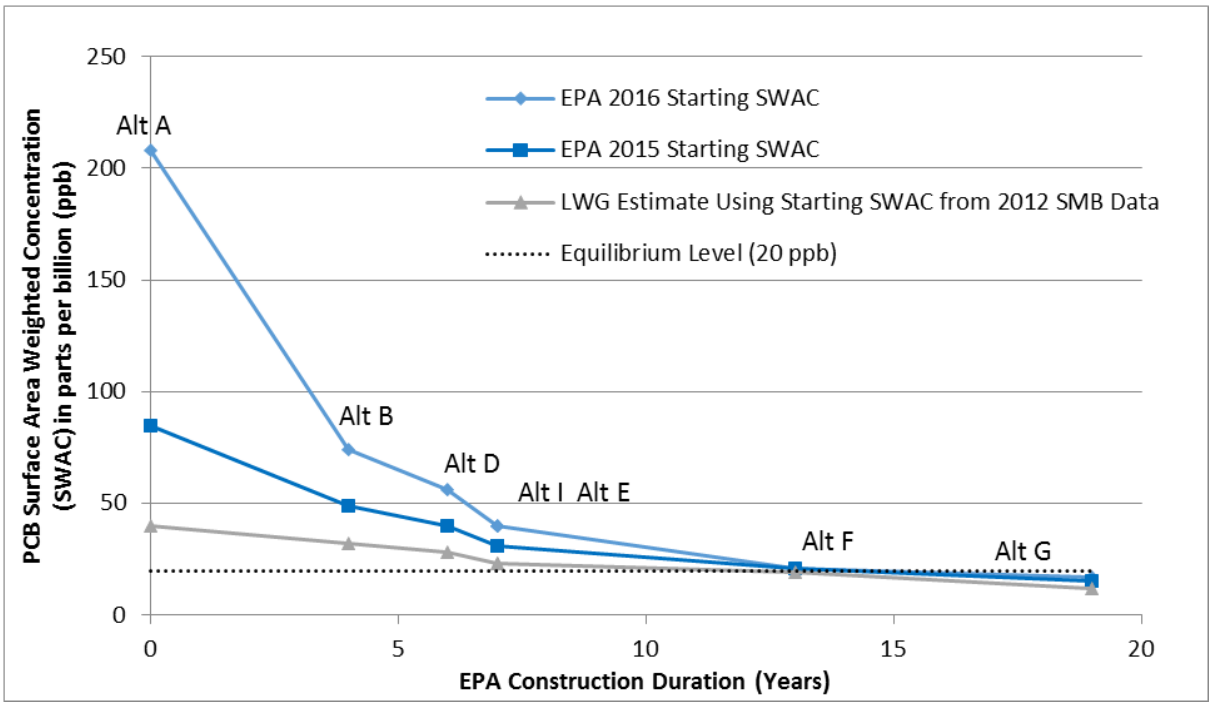


As another example, EPA calculated, using the Food Web Model and the new sediment SWAC of 208 ppb, an average PCB site-wide fish tissue concentration of 521 ppb. The comparable average site-wide fish tissue concentration in the BHHRA, based on actual tissue data collected in 2007 and earlier, is 227 ppb, which equates to a site-wide modeled sediment SWAC of 85 ppb.[93] Using EPA's modeled tissue concentration of 521 ppb, the acceptable consumption rate based on the non-cancer endpoint would be 1.9 fish meals/year for the child scenario; whereas the actual BHHRA tissue concentration of 227 ppb results in an acceptable consumption rate of 4.2 meals/year. The above calculation of 1.9 meals/year for Alternative A (baseline) using EPA's fish tissue concentration is higher than the meals per year shown for Alternative A in EPA's Figure 4.2-2 (reproduced in Figure 2 above), which presents 0.6 fish meal/year for the presumably same scenario. This difference illustrates another error in EPA's calculations that was only discernable through independent calculations. It appears that EPA is using the child scenario but altering the fish meal size from 3.5 ounces to the adult meal size of 8 ounces, which is clearly inconsistent with the BHHRA methods. Putting aside the reasonableness of a child consuming adult meal portions for long periods while still remaining a child, the net result of EPA's poorly explained additional change to the exposure assumptions is to drive allowable fish meals even further down for the baseline condition. Combined with the artificially inflated new SWAC, this meal size change compounds the portrayal of the baseline condition as much worse than the actual BHHRA findings. Again, this further increases the perceived benefit of any SWAC and tissue concentration reductions assumed for the more aggressive alternatives. It should also be noted that even with the change to adult meal size for the child scenario, the LWG could not exactly reproduce EPA's allowable fish meals, which likely indicates other undescribed procedures were employed that create further inconsistencies with the EPA-approved BHHRA.

[92] There may be other differences between some calculations because EPA used additional methods that are also inconsistent with the BLRAs. A factor of 2.4 is accurate to assess the impact of this one variable (i.e., the new SWAC for PCBs).
[93] See Attachment 14. memorandum "Review of Human Health Risk Analyses in the Portland Harbor Feasibility Study and Proposed Plan" detailing a comparison of EPA's fish consumption risk estimates to BHHRA and 2012 smallmouth bass estimates. See also, "Lower Willamette River Smallmouth Bass Data Monitored Natural Recovery Analysis." A presentation file from Anchor QEA provided to EPA on March 18, 2013." (Attachment 1)

Figure 3 illustrates the effect of the choice of the baseline site-wide SWAC on the utility of various alternatives, as represented by construction durations,[94] using a "knee of the curve" analysis. Figure 3 presents the knee of the curve when the baseline PCB SWAC is assumed to be 208, 85, and 40 ppb. These are EPA's artificially inflated 2016 draft Final FS SWAC estimate, the SWAC consistent with the EPA-approved BLRAs that EPA used in the 2015 Draft FS, and the SWAC estimated from the 2012 smallmouth fish tissue sampling, respectively.[95] As the initial SWAC decreases, the incremental benefit in terms of SWAC reduction for each successively longer alternative also decreases. The utility of the alternatives as determined by the knee of the curve shifts away from Alternatives F and G and toward Alternatives B and D. In the case of the lowest initial SWAC (gray line), there is virtually no added benefit in moving from Alternative B to I, while the short-term and other duration associated impacts increase substantially. When a higher value is used for the initial conditions, the most aggressive and resource consuming alternatives erroneously appear to provide more benefit. Also note that due to EPA's zero replacement value assumption, the SWACs for the largest alternatives erroneously appear to achieve levels below equilibrium level (black dotted line in Figure 3).

Figure 3. Immediate Post-construction SWACs and EPA Durations.



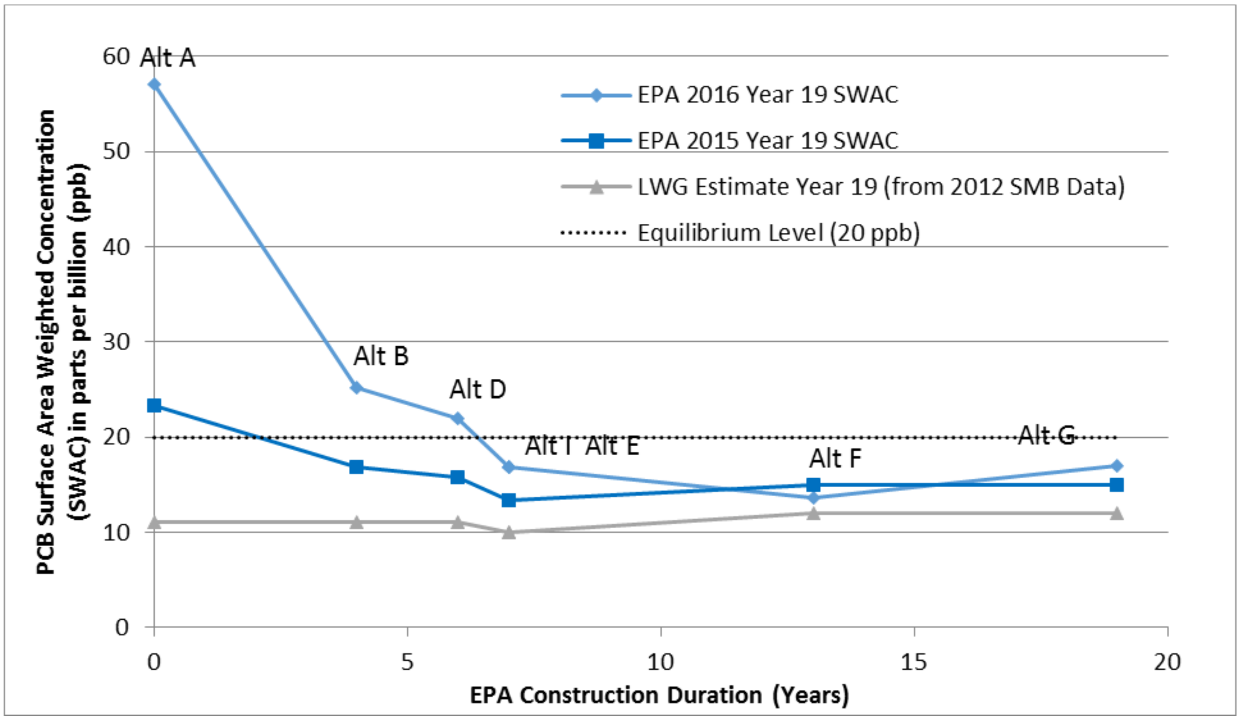
While EPA has increased the perceived benefit of the larger alternatives (such as Alternative I) by artificially increasing the baseline condition by a factor of 2.4 above the approved BLRAs, the 2012 smallmouth bass data strongly suggest the Site has continued to recover below the BLRA SWACs (i.e., the RI and BLRAs use data that were collected mostly between 2002 and 2008). As noted in the LWG's presentations of the 2012 smallmouth bass data to EPA, that data strongly suggest that some parts of the Site that EPA identifies for active remediation are already approaching equilibrium conditions.[96]

[94] As EPA's draft Final FS points out, as the durations of the alternatives rise the short-term impacts to the environment and community, the number of feasibility issues, and costs also rise.
[95] "Lower Willamette River Smallmouth Bass Data Monitored Natural Recovery Analysis." A presentation file from Anchor QEA provided to EPA on March 18, 2013. (Attachment 1)
[96] See also Kennedy/Jenks Consultants Memo dated March 6, 2013, that summarizes the data that shows a decline in concentrations. Kennedy Jenks' March 6 memo acknowledges it is comparing 2012 discrete samples to earlier composite samples and bases its comparison on means, maximum, and minimum detected concentrations. (Attachment 15)

c. EPA ignores upstream and other external contributions that limit the risk reduction available through sediment cleanup to system equilibrium values

EPA has previously acknowledged that equilibrium is a useful concept for the Site.[97] The LWG has provided EPA with detailed evaluations demonstrating that, due to upstream sources, the Site is unlikely to ever achieve site-wide PCB SWACs less than 20 ppb.[98] Figure 3 shows immediate post-construction SWACs using EPA's incorrect zero replacement value assumption, but as the Site continues to recover over time, presumed additional decreases in Site SWACs provided by longer and larger alternatives will not actually occur. Figure 4 presents estimated SWACs for all alternatives at 19 years after construction starts,[99] which is EPA's assumed construction duration for Alternative G. Figure 4 shows that any perceived benefits of longer and larger alternatives are unlikely, because EPA's analysis does not consider that concentrations cannot decrease below Site equilibrium conditions. For example, using EPA's 2016 SWAC values, the additional 14 years of estimated construction from Alternative G, or 3 years of construction from EPA's Preferred Alternative. would result in a difference in PCB SWAC of only about 5 ppb from Alternative B.[100]

Figure 4. Estimated SWACs 19 Years after Construction Starts.



The equilibrium concept is a critical consideration in evaluating the long-term effectiveness of remedial alternatives in the FS. EPA guidance provides that sediment remedies "should reflect objectives that are achievable from the site

[97] As recently as April 2015, EPA endorsed the concept of equilibrium as a measure of the most a sediment remedy can accomplish and committed to perform an equilibrium evaluation in Section 4 of the FS. "EPA will conduct an equilibrium evaluation in Section 4 of the FS. The most appropriate means to evaluate whether RAOs or PRGs are achievable by any of the alternatives being developed in Section 3 of the FS is to conduct the detailed evaluation in Section 4 of the FS using the first seven NCP criteria. This information will be considered in developing the final remediation goals/cleanup levels." EPA Response to LWG's March 25, 2015 Comments on the Portland Harbor FS Section 2 (April 10, 2015), p. 2. A copy of EPA's response is Attachment 16.

[98] *Sediment Equilibrium Estimates for the Revised Feasibility Study*, (LWG, August 7, 2014). This Technical Memorandum is Attachment 17. The discussion herein focuses on the expected Site equilibrium for PCBs. As addressed in the LWG's memorandum, equilibrium concentrations for a number of COCs (including background sensitive risk-drivers DDX and dioxins/furans) can be predicted, and the LWG specifically provided that analysis to EPA for PCBs and DDX.

[99] See Section V.C. for a description of methods to estimate long-term SWACs. These methods avoid using computer models that EPA has expressed uncertainty about.

[100] See Table 6, infra.

cleanup."[101] Concentrations below equilibrium cannot be achieved by any alternatives, and any comparisons assuming otherwise are fundamentally flawed. Unlike Portland Harbor, equilibrium has been fully integrated into Proposed Plan decisions at other sites. In the Lower Duwamish Waterway (LDW) Proposed Plan, several datasets representing COC concentrations in suspended sediments entering that site from the upstream Green/Duwamish River system were evaluated because they represent "future COC concentrations in the LDW after implementation of cleanup alternatives."[102] This included the use of deposited sediments in an upper turning basin, because "these data provide an indicator of suspended sediments settling within the upper reach of the LDW."[103] The Grasse River ROD indicates, "The selected remedy will comply with all of the listed ARARs in Tables 13-1 through 13-3 except two chemical-specific ARARs which are not expected to be met due to Site background PCB loading conditions. Therefore, because of technical impracticability, those two ARARs are being waived."[104]

D. EPA's Selection of Its Preferred Alternative is Not Based Upon Meaningful Risk Reduction and Fails to Apply Appropriate Risk Management Principles

According to the EPA-approved BHHRA, consumption of resident fish, such as carp and smallmouth bass, represents the majority of potential human health risk at the Site. Calculated site-wide subsistence fisher risks are orders of magnitude higher than other scenarios,[105] and 93% of this risk comes from PCBs.[106]

EPA's BHHRA evaluated the risks to a subsistence fisher eating 228 resident fish meals/year.[107] EPA calculated such high potential risk to subsistence fishers that EPA has determined that, under current conditions, children and other vulnerable populations should eat only 0.6 resident fish meal/year.[108] According to EPA, healthy adults can currently eat 4.3 meals/year.[109] The most aggressive cleanup alternatives evaluated by EPA would allow vulnerable populations to eat 7.5 to 10 meals/year after construction is complete.[110] Healthy adults could eat 38 meals/year after construction of Alternative F, but because the estimated post-construction PCB SWAC of 21 ppb is approximately the equilibrium value, Alternative G would be unlikely to push additional fish consumption using EPA's risk assumptions much, if at all, above the 38 meals/year estimated for Alternative F. EPA's Preferred Alternative would allow 4.4 meals/year for children and 22 meals/year for adults after construction.

Extensive evidence from other sites suggest that fish tissue PCB concentrations will temporarily increase for a period of 3 to 5 years after dredging of contaminated sediments takes place.[111] The dynamic Food Web Modeling of alternatives in the 2012 LWG Draft FS (Appendix Hb) also projects this reaction in fish tissue concentrations during and after dredging. This evidence all indicates that fish consumption risks will increase significantly during construction and will persist for several years after construction is completed to allow time for the fish tissue to respond to the new sediment conditions. Therefore, and as discussed more fully in Section V.C. below, because the fish consumption risk reduction achievable through a sediment cleanup is limited by sediment equilibrium, cleanup alternatives involving longer and more aggressive construction activities are likely to significantly increase fish consumption risks in the short term while resulting in no greater long-term increase in fish meals. In other words, as

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[101] Sediment Guidance, p. 2-15.
[102] *Proposed Plan Lower Duwamish Waterway Superfund Site*, EPA, Region 10. Seattle Washington. February 28, 2013, pp. 26-27.
[103] *Id*.
[104] *Record of Decision Grasse River Superfund Site (a.k.a. Alcoa Aggregation Site) Massena, St. Lawrence County*, New York. EPA, Region II. New York, New York. April 2013, p. 54.
[105] BHHRA page 101; Figure 7-1.
[106] BHHRA p. 4; Figure 7-3; Table 5-74.
[107] Proposed Plan p. 18.
[108] Proposed Plan p.32.
[109] EPA focused on the child fisher non-cancer scenario in the 2016 FS. Consequently, to compare to OHA adult advisories, the LWG estimated adult allowable fish meals using EPA's methods. See "Review of Human Health Risk Analyses in the Portland Harbor Feasibility Study and Proposed Plan," Attachment 14.
[110] Proposed Plan p. 58. As noted previously, EPA does not state these values are based on the child recreational scenario, but independent calculations suggest that this is the scenario that EPA is presenting in the Proposed Plan.
[111] See discussion in the LWG 2012 draft FS in Sections 6.2.7.3 and 8.2.2.4; Bridges, et al. 2010: Dredging Processes and Remedy Effectiveness: Relationship to the 4 Rs of Environmental Dredging. Todd S. Bridges, Karl E. Gustavson, Paul Schroeder, Stephen J. Ells, Donald Hayes, Steven C. Nadeau, Michael R. Palermo, and Clay Patmont. Integrated Environmental Assessment and Management. February 10, 2010. 2010 SETAC; IRTC p. 181; and "Sediment Monitored Natural Recovery Case Studies." Presentation at the Battelle Eighth International Conference on Remediation and Management of Contaminated Sediments. January 12-15, 2015. Carl Stivers and Clay Patmont of Anchor QEA.

shown in Table 8 below, Alternative B, which EPA projects would take 4 years to complete, would allow 4.1 meals/year for children 12 years after construction starts, right about the same time that fish tissue levels for Alternative I, which EPA projects would take 7 years to complete, would likely be settling down to EPA's projected post-construction 4.4 meals/year.[112]

The Oregon Health Agency's current fish consumption health advisories are summarized in Table 4. Table 4 compares these advisories to the results of EPA's 2016 draft Final FS allowable fish meal calculations for each alternative. For the adult scenario, Table 4 shows that EPA's Alternative A, representing the existing condition, provides an allowable number of fish meals (4.3 meals/year) that is substantially less than both of the current Oregon Health Agency (OHA) adult advisories. For the vulnerable population or child scenario, Table 4 shows that EPA would allow children to currently eat a little more fish than the OHA advisory, but only because that advisory is already set at zero.

Table 4. Comparison of EPA 2016 Draft Final FS and Oregon Health Agency Allowable Fish Meals (meals/year).

Estimate Source	Healthy Adults[1]	Vulnerable Populations (including children)[2]
OHA Advisories		
PCBs, Portland Harbor	12	0
Mercury, Willamette River[3]	48	12
EPA 2016 Draft Final FS – EPA assumed immediate post-construction consumption per Appendix J		
Alternative A (no action, assumed current condition)	4.3	0.6
EPA recommendation during construction	[4]	0.6
Alternative B	12	2.4
Alternative D	16	3.2
Alternative E	23	4.6
Alternative F	38	7.5
Alternative G	52	10.1
Alternative I	22	4.4

Notes
1 Because the 2016 draft Final FS focuses on child scenario, EPA adult values are estimated by LWG calculations (see attached memorandum "Review of Human Health Risk Analyses in the Portland Harbor Feasibility Study and Proposed Plan.")
2 OHA "vulnerable" populations include children, women of child bearing age, and people with some types of diseases. EPA child values from Figure 4.2-4 in the 2016 draft Final FS.
3 For mainstem Willamette, which includes Portland Harbor.
4 Page 58 of EPA's Proposed Plan states that "people" would be advised no more than 0.6 meals per year during construction. Based upon the calculations in Appendix J, we interpret "people" to mean children and are therefore unable to determine what EPA recommends for adults.

EPA's 2016 draft Final FS concludes that "the existing [OHA] advisories might not be sufficiently effective in protecting human health since the current recommended rate of one meal per month [12 meals/year] for the general population may not be sufficiently protective of consumers."[113] We are not aware that EPA has previously stated that the OHA fish advisory was not protective for adults, even though EPA approved the BHHRA more than 3 years ago. EPA should consider that the conflict between the OHA advisory and EPA's BHHRA indicates EPA's risk estimates may be incorrect. At a minimum, EPA should coordinate with OHA to provide clear, credible, and consistent public health information. EPA should also explain its advisory in light of the U.S. Food and Drug

[112] See Section V.C, *infra*.
[113] 2016 draft Final FS, p. 4-15.

Administration's threshold for PCBs in fish sold in supermarkets of 2 parts per million (ppm), which is more than 1,000 times higher than EPA's cleanup goal of 0.3 ppb in resident fish tissue.[114]

EPA must also recognize that consumption of resident fish in the Willamette River will continue to be limited by mercury fish tissue concentrations that are unrelated to Portland Harbor (e.g., upstream watershed soils, upstream historic gold mining activities, and regional and global combustion sources) and therefore beyond the scope of the Superfund cleanup to address. Mercury, like PCBs, is also a persistent pollutant that will remain in the river after the cleanup is completed. Accordingly, we assume OHA's fish advisory with respect to mercury will remain in place. To a person eating fish from the Site, there is no real world difference between fishing limitations based on PCBs versus mercury. Both chemicals potentially reduce the amount of fish people can consume. The continuing mercury fish advisory is guidance from a credible health agency that provides important context for sediment remediation risk management decisions and determining the most cost-effective sediment remedy.

E. EPA's Establishment of RAO 9 for Source Control Is Arbitrary and Capricious Because There is No Information in the RI or Risk Assessment to Support It

EPA's Proposed Plan includes an RAO 9 for riverbanks. EPA's reason for including this RAO is that, according to vaguely described information it received from DEQ, some contamination remains in some identified riverbank soils at levels that, if erosion were to occur, might result in recontamination of sediments.[115] EPA states in the Proposed Plan that remediation of contaminated river banks is included "if it is determined that it should be conducted in conjunction with the in-river actions." EPA's Proposed Plan provides Figure 6 and Table 5 as the full extent of its evaluation of why and where such remedial action is required. It adds that "[o]ther river banks may be included in the remedial action, if contamination contiguous with the river sediment is found during remedial design sampling."[116]

In February 2001, a Memorandum of Understanding (MOU) related to the Site was executed among EPA, Oregon DEQ, and several state, federal, and Tribal natural resource trustees. That MOU provided that EPA would be the lead agency for investigating and cleaning up contamination in the river sediment and DEQ, using state cleanup authority, was designated as the lead agency for identifying and controlling upland sources adjacent to or near the river. Pursuant to that MOU, the Portland Harbor Joint Source Control Strategy was finalized by EPA and DEQ in December 2005. Since that time, many owners and operators of facilities along the river, including several LWG members, have been actively involved with DEQ, planning and implementing source control measures. DEQ has provided EPA regular updates on its source control efforts. As of March 2016, DEQ reported it is on track to complete its determinations of the need for source control measures at all upland sites within the Portland Harbor and to have needed measures in place prior to implementation of CERCLA in-water remedies, in order to prevent likely future adverse effects on water or sediment quality.[117]

In the 2016 draft Final FS and Proposed Plan, EPA has ignored many of those fully or partially completed actions and identified groundwater and riverbank concerns. Although the FS states that information received from DEQ was the basis of these concerns, that information must not be current or complete. In some instances, the groundwater and riverbank contamination has already been addressed, and in others property owners have agreed with DEQ to implement remedies at or before the time of the adjacent in-water remedy.[118] There is no reason for EPA to now insert RAO 9 into the FS and Proposed Plan, given the ongoing, successful efforts to control upland sources.

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[114] 21 CFR §109.30.
[115] 2016 draft Final FS, page 1-17.
[116] Proposed Plan at 13.
[117] Portland Harbor Upland Source Control Summary Report (DEQ, March 25, 2016 update), at 119.
[118] For example, as of March 2016, DEQ reported that river bank remedial action at the Evraz Rivergate site had been fully implemented and that the pathway was considered controlled. *Id.* at 101. Figure 6 of the Proposed Plan, however, shows this as a river bank requiring remediation.

At no time during the LWG's development of the RI and risk assessments did EPA suggest that riverbank data should be collected sufficient to support the development and evaluation of riverbank remedial alternatives.[119] EPA's last-minute incorporation of riverbanks in the FS, when no upland media were evaluated in the approved RI or risk assessments, is counter to EPA policy and guidance. "The purpose of the remedial investigation (RI) is to collect data necessary to adequately characterize the site for the purpose of developing and evaluating remedial alternatives."[120] Here, EPA provides no data or analysis related to what riverbank-related remedial actions are to be implemented or what specific areas present unacceptable risks. EPA refers to Appendix A as the data source for its riverbank analysis. Appendix A appears to be a random compilation of various data, some of which has nothing to do with riverbanks. A review of the "matrix code" column finds most entries are blank, and many entries are data that are not from riverbank soils. The entries include tissue, water, porewater, groundwater, outfall, stormwater, and surface water. In summary, no care was used to put this database together, and much of the information appears to have little to do with delineating contaminated riverbanks. Appendix A also contains a disclaimer noting that it is taken exactly as-is from third-party sources with no quality assurance or quality control performed by EPA. Section 2.2.2 of the EPA-approved RI states that EPA Order 5360.1 and Office of Solid Waste and Emergency Response (OSWER) Directive 9355.9-01[121] requires that environmental measurements be of known quality, verifiable, and defensible. The Office of the Inspector General concluded in an audit of Region 9 Superfund sites[122] that data used for cleanup decision-making should be validated using EPA functional guidelines.[123]

Despite all of these inadequacies in the data, EPA relies on the data to identify riverbank areas for remediation and then to assess the relative effectiveness of remedial alternatives. This assessment is not grounded in adequate site specific information and therefore is arbitrary and capricious.

EPA should delete RAO 9 and all evaluations of alternatives based on riverbank contamination and rely upon DEQ to adequately address source control as it is required to do under the 2001 MOU and as it is successfully doing.

F. <u>To the Extent the Plan Intends to Prescribe In-river Actions to Address Groundwater Contamination, it is Arbitrary and Capricious Because There is No Information in the RI or Risk Assessment to Support It</u>

EPA's discussion of groundwater in the Proposed Plan is confusing. On the one hand, it appears that the Plan does not prescribe remedies for groundwater and that it is EPA's intent that the ROD will not address it either:

> "It is EPA's expectation that DEQ's upland source control actions will adequately address groundwater contamination. EPA's RAOs above are focused on containing and reducing migration of COCs from groundwater to surface water and biologically active areas of sediment. Should groundwater not be addressed adequately under DEQ's actions, EPA may, at a future time, determine if action is warranted under CERCLA to further address groundwater contamination."[124]

On the other hand, the Proposed Plan states that reactive caps "may" be required when it is predicted that " flow of groundwater or pore water will release contamination through the cap,"[125] and that

> "[i]t is EPA's expectation that the majority of the current identified groundwater plumes will be addressed by DEQ's actions and the alternatives will only need to address the portion of the plumes that extend into the river. Since the extent of these plumes impacting pore water is not currently known, these areas will

[119] For the same reason, EPA has no basis for drawing conclusions about any potential risks to the Columbia River associated with potential transport of chemicals from the Portland Harbor Site. The Columbia River was not investigated or evaluated in any part of the RI, BLRAs, or FS.
[120] 40 CFR §300.430.
[121] *Data quality process for Superfund, Interim final*. EPA-540-G93-071. USEPA, 1993.
[122] Environmental data quality at DOD Superfund sites in Region 9.
http://www.epa.gov/oig/reports/1995/ffqar9rp.htm . Office of Inspector General, USEPA, 1995.
[123] U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA 540/R-99/00801. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, October 1999. And USEPA contract laboratory program national functional guidelines for inorganic data review. EPA 540-R-01-008. Office of Emergency and Remedial Response, USEPA, 2002.
[124] Proposed Plan at 22.
[125] Proposed Plan at 27.

> need to be refined during remedial design and at that point it will be determined which residual groundwater plumes will need to be addressed in the river."[126]

EPA goes so far in the Proposed Plan to identify a single commercial product, "AquaGate+10%PAC," to use in reactive caps where groundwater contamination is present.[127]

If EPA's intent was the former, to leave groundwater remedial actions to DEQ under its source control authority or, at the most, to address groundwater in subsequent ROD amendments, then EPA need not address the remainder of comments in this subsection. For purposes of estimating costs, it may have been reasonable for EPA to include some screening level scoping of groundwater measures to account for the cost of some groundwater-focused actions identified during remedial design as having a potential to recontaminate sediments. However, if this is all EPA intended, in the ROD EPA should: 1) remove the groundwater RAOs; and 2) remove the comparative analysis of alternatives criteria related to groundwater RAOs. Groundwater and the potential for any stranded wedges to affect caps should be considered as part of sediment remedial designs and sediment caps should be appropriately designed to address recontamination or groundwater migration issues.

However, if it is EPA's intent to issue a ROD that prescribes groundwater-focused remedial action as actually described in the Proposed Plan, that would be completely unsupported by the RI and Risk Assessments or by any analysis included in EPA's 2016 draft Final FS and Proposed Plan, and would therefore be arbitrary, capricious, and not in accordance with law, for the following reasons:

- The entire extent of the Proposed Plan's discussion of groundwater remediation consists of three isolated paragraphs, one figure, and one table.[128] As quoted above, EPA admits that it does not know the extent of any groundwater plume, because its RI and risk assessments were not intended to investigate or assess any such plumes. Proposed Plan Table 3 is a summary of contaminants of concern in "porewater and transition zone water" with no explanation of where in the site these samples are or where they present risk.

- Proposed Plan Figure 5 is described only as "multiple areas" that "DEQ has identified...with groundwater contamination," with no data or quantitative assessment. There is nothing in the Proposed Plan that provides data or analysis to support the figure, and it is inconsistent with DEQ documentation, ignoring extensive and successful groundwater source control evaluation and remedial action work by DEQ at many of these sites, including the Arkema, Evraz, Gunderson, NW Natural and Time Oil sites.[129]

- EPA does not have any basis in the Administrative Record before it to conclude as it does in Section 3.4.7.3 of the 2016 draft Final FS and page 27 and Figure 10 of the Proposed Plan (and in its discussions of the various alternatives) with respect to groundwater that reactive caps are necessary at any particular site, or type of site, or to specify a particular type of reactive cap:

  - EPA has not evaluated the risks associated with any particular site or in any way (beyond drawing Proposed Plan Figure 5) defined the technical basis for its assumed extent of groundwater "plumes";

  - Without any analysis of appropriate technologies to treat the COCs driving risk, EPA has no basis to prescribe any particular type of reactive cap;

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[126] Proposed Plan at 60.
[127] Proposed Plan at 65.
[128] Proposed Plan at 13, 27 and 60, Table 3 and Figure 5.
[129] As with the vague references to communications with DEQ regarding riverbanks, this information does not appear to be current or accurate. For example, as of March 2016, DEQ has concluded that no source control measures are needed in groundwater for the Evraz Rivergate site and that the potential for recontamination from groundwater at that site is low. *Portland Harbor Upland Source Control Summary Report* (DEQ, March 25, 2016 update), at 101. Nonetheless, Figure 5 of the Proposed Plan shows a groundwater plume encompassing the entire shoreline of the Evraz site. Similarly, with respect to the Time Oil site, the March 2016 DEQ report states that "a pump and treat system is operating to prevent [the pentachlorophenol plume's] migration to the river." *Id.* at 83. Yet EPA's FS identifies the Time Oil pentachlorophenol plume as one of the "known contaminated groundwater plumes currently or potentially discharging to the river." 2016 draft Final FS pages 1-13 – 1-14.

- EPA has, nonetheless, gone so far as to prescribe one particular commercial product for a reactive cap, AquaGate+10%PAC, apparently based on one presentation that this for-profit commercial business provided to EPA in April 2015, without any performance assessment to determine whether this reactive cap product or any other alternative reactive cap products would address particular COCs driving risk at any particular location;

- EPA has failed to address the implementability of its prescribed reactive caps. Rather than prescribe the use of AquaGate+10%PAC, EPA's ROD should simply state that the need for reactive caps will be evaluated at the design stage for any areas with "stranded" groundwater plumes and that any particular cap material and deployment mechanism will be chosen based on that assessment.

In summary, groundwater should be addressed in the ROD by stating that EPA continues to rely upon DEQ to adequately address source control, as it is required to do under the 2001 MOU and as it is successfully doing. If EPA selects any groundwater-focused "in-river actions," they should be only in those areas where the BLRAs identified known in-water risks from the residual impacts of contaminated groundwater discharge and the extent of the action should be determined in the sediment remedial design. EPA should not prescribe sediment remedies that ignore completed or committed upland source control measures.

II. EPA's Principal Threat Waste Approach Leads to Arbitrary and Capricious Remedial Technology Selections, Inconsistent with both EPA Guidance and Practice as to the Appropriate Consideration of Principal Threat Waste

EPA's Proposed Plan addresses three categories of principal threat waste (PTW), which it describes as "PTW source material," "PTW that cannot be reliably contained," and "highly toxic PTW."[130]

EPA's Proposed Plan incorporates an unprecedented approach in its consideration of PTW that leads to prescriptive remedial technology assignments that are inconsistent with EPA guidance and practice. Perhaps more importantly, EPA's PTW approach is unnecessary to making Portland Harbor remedial technology assignments, because it duplicates other proper risk-based alternatives evaluation considerations already taken into account. In particular, EPA's designation of PTW leads to two aspects of its proposed remedial alternative that should be eliminated as unnecessary:

1. Designation of a set of RALs based on PTW (Table 13 of the Proposed Plan)

2. Prescriptive technology assignments based on the PTW designation (Figures 10a, 10b, and 10c of the Proposed Plan)

Between these two results, EPA adds very material costs to its remedy. For example, EPA requires activated carbon or aquablock/organoclay amendment in caps and residual covers in all areas where PTW (as defined by EPA) exists, even if the PTW is removed by dredging. This assumption adds approximately $52 million to the remedy cost. Additionally, EPA has specific ex situ treatment and disposal requirements for certain PTW that would increase disposal costs by as much as $43 million. Both of these are required by EPA without any evaluation of implementability or effectiveness, let alone cost-effectiveness.

A. <u>EPA's Application of PTW Concepts is Inconsistent with Guidance and Practice</u>

EPA has designated large geographic areas as PTW based on its evaluation of the "high toxicity" criterion as compared to the human health fish consumption PRGs.[131] Its designations are inconsistent with its risk assessment and inconsistent with EPA guidance.

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[130] Proposed Plan, p. 14.
[131] Proposed Plan, p. 14.

First, EPA does not accurately assess the presence of greater than 10^{-3} cancer risk at the Site consistent with risk assessments or the intent of EPA guidance.[132] For total PCBs, dioxin/furan TEQ and total 2,4′ and 4,4′-DDD, -DDE, -DDT (DDx), EPA simply multiplied certain 10^{-6} cancer risk PRGs by 1,000 based on human health fish consumption (high consumption rate, mixed diet, fillet only) to determine concentrations associated with 10^{-3} cancer risk. For BaPEq, EPA followed the same procedure using a sediment direct contact PRG for high frequency fisher.

However, before applying such concentrations for PTW identification, even assuming this is an appropriate pathway to evaluate in this context, the presence of actual risks greater than 10^{-3} needs to be determined. In fact, greater than 10^{-3} risk was not found in the BHHRA for dioxin/furan TEQ, total DDx, or BaPEq for any scenario evaluated. Therefore, the definition of highly toxic as described in EPA PTW guidance[133] is only potentially applicable to total PCBs.

That leads to the question of what pathways are relevant for purposes of defining principal threats. For total PCBs, greater than 10^{-3} cancer risk was found in the BHHRA for three fish consumption scenarios: subsistence (mixed diet, fillet), recreational (mixed diet, fillet), and tribal (whole body and fillet). The PTW guidance states:

> "'Source material" is defined as material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or acts as a source for direct exposure." [emphasis added].

The fish consumption risks do not represent direct exposures from source materials, but rather integrate contaminant contributions from sediment, surface water, and diet. As a consequence, the sediments by themselves do not directly pose risks greater than 10^{-3}. In addition, contaminants in fish do not represent a reservoir for migration of contamination to other media in any reasonable sense.

Applying the PTW guidance, only contaminants that were actually found to pose greater than 10^{-3} cancer risk in media that potentially represent a source to other media or of direct exposure should be evaluated for the highly toxic aspect of the PTW definition, and only in those areas where that level of risk was found to occur in the BLRAs. No contaminants meet these conditions at the Site. EPA's definition of PTW in this case is particularly inappropriate given 2012 fish tissue data[134] that show PCB concentrations in fish tissue have declined significantly. If these 2012 concentrations are applied to risk estimates using methods consistent with the BHHRA (using the 95% UCL for the site-wide subsistence consumption scenario, fillet tissue), the resulting human health cancer risk for consumption of smallmouth bass is 4×10^{-4}, substantially lower than 10^{-3}. And the end result of EPA defining PTW by these methods is that EPA has designated material containing PCBs at 200 ppb as PTW; a concentration which is 100 ppb below the sediment cleanup objective of 300 ppb applied in the Hylebos Waterway of Commencement Bay. Thus, EPA is adding nearly $100 million to remedial action costs based on its consideration of a risk level that likely no longer exists and concentrations that are below final cleanup levels established at other Region 10 sites.

Regardless of concentration, EPA should not identify materials that can be reliably contained as principal threat waste. EPA's 2016 draft Final FS states, "'[r]eliably contained' was not used in identifying PTW but rather was used to determine what concentrations of PTW could be reliably contained."[135] This clearly contradicts the guidance, which discusses reliably contained as part of PTW identification.[136]

> "Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. *** No 'threshold level' of toxicity/risk has been established to

[132] *A Guide to Principal Threat and Low Level Wastes*. Office of Solid Waste and Emergency Response. Superfund Publication 9380.03-06FS. November 1991.
[133] *Id.*
[134] "Lower Willamette River Smallmouth Bass Data Monitored Natural Recovery Analysis." A presentation file from Anchor QEA provided to EPA on March 18, 2013. (Attachment 1)
[135] 2016 draft Final FS, page 3-3.
[136] NCP Preamble, 55 Fed. Reg. 8666 at 8703 (March 8, 1990); A Guide to Principal Threat and Low Level Wastes, OSWER Superfund Publication 9380.03-06FS (November 1991).

> equate to 'principal threat.' However, where toxicity and mobility of source material combine to pose a potential risk of 10-3 or greater, generally treatment alternatives should be evaluated. *** Determinations as to whether a source material is a principal or low level threat waste should be based on inherent toxicity as well as consideration of *** the potential mobility of the wastes in the particular environmental setting ***."[137]

The guidance is clear that PTW only exists where the factors of highly toxic or highly mobile *combine* with a condition of not reliably containable. EPA acknowledges (in 2016 draft Final FS Table 3.2-2) that all COCs at the concentrations present in the Site, with just two exceptions (chlorobenzene and naphthalene), *can* be reliably contained.[138] Thus, none of the areas where these contaminants are absent should be designated as PTW. Accordingly, if all PCB, PAH (except naphthalene), and DDx concentrations present at the Site can be reliably contained, then EPA is not required to address them as a PTW. And naphthalene concentrations detected in the RI were not found in the BHHRA to pose a greater than 10^{-3} risk for any media or scenario evaluated and therefore do not constitute PTW.

Similarly, the 2016 draft Final FS and the Proposed Plan provide no discussion or explanation of how material with sediment concentrations above the EPA-identified highly toxic thresholds or the presence of "globules or blebs"[139] of non-aqueous phase liquid (NAPL) pose a risk of migration without any knowledge as to what the globules or blebs consisted of or whether such substances are naturally occurring.[140] EPA's interpretation of any trace evidence of NAPL as PTW is devoid of scientific justification and is inconsistent with situations described in the guidance, such as "pools of NAPLs submerged beneath ground water or in fractured bedrock, NAPLs floating on ground water" or where physical processes are likely to mobilize "source materials" as defined in the guidance.[141] EPA had the responsibility and opportunity to require scientific investigation of globules and blebs as part of the RI or as a supplemental RI. Except at the Gasco Sediment Site (where extensive investigations have defined areas of "substantial product" consistent with the consent order for that site), EPA chose not to do so and to rely entirely on unsupported speculation for its decision making instead. The 2016 draft Final FS interpretation is also inconsistent with the final remedy selected by EPA at the McCormick and Baxter site within Portland Harbor, where sediments containing NAPL were reliably contained using conventional and active capping technologies.[142]

Finally, the 2016 draft Final FS and Proposed Plan state that "All PTW treated ex-situ is assumed to be disposed at a RCRA Subtitle C facility." This assumption is inconsistent with the detailed waste disposal decision and treatment framework identified in the Gasco Sediment Site Statement of Work and FS dataset.[143] A total of 22 toxicity characteristic leaching procedure (TCLP) samples were collected as part of the FS and Gasco Sediments Site investigations to support waste disposal determinations (i.e., Subtitle C versus Subtitle D) and only three samples exhibited concentrations exceeding the TCLP Allowable Limits, all for benzene. Bench-scale testing showed that addition of a minimum 5% Portland cement reduced the benzene concentrations below the TCLP Allowable Limits. Both the 2016 draft Final FS and Proposed Plan assume all PTW is treated ex situ (e.g., with Portland cement);

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[137] Id. at 2.
[138] The LWG disagrees this determination is correct. The LWG 2012 draft FS conducted the same analysis (Appendix Hc) using more appropriate technical procedures and determine that all materials and chemicals at the Site are reliably containable through readily available sediment capping technologies. Importantly, these exceptions were based on preliminary cap modeling that used "representative site conditions" for model input parameters. These "representative" model input parameters do not exist at all sites. For example, they have been demonstrated not to exist at the Gasco site based on site-specific data collection performed under oversight by DEQ and in coordination with EPA. Consistent with the Proposed Plan text, it will be important to perform site-specific cap modeling evaluations during remedial design to determine cap protectiveness. Proposed Plan p. 15.
[139] Draft Final FS, page 3-3.
[140] We also note that EPA's PTW-NRC footprint is mapped inconsistently between the FS and Proposed Plan. EPA provided a later clarification (July 20, 2016 email from Kristine Koch) that one map represents "subsurface NRC" and the other "surface NRC," but the FS and Proposed Plan do not ever use these terms, and it is entirely unclear how these different types of NRC are relevant to EPA's PTW evaluations, if at all.
[141] *A Guide to Principal Threat and Low Level Wastes*, OSWER Superfund Publication 9380.03-06FS (November 1991)
[142] *Third Five-Year Review Report for McCormick & Baxter Creosoting Company Superfund Site*. (Oregon Department of Environmental Quality and U.S. Environmental Protection Agency. September 26, 2011).
[143] Administrative Settlement Agreement and Order on Consent for Removal Action for the Gasco Sediment Site, U.S. EPA Region 10 CERCLA Docket Number 10-2009-0255 (September 9, 2009).

therefore, the Proposed Plan should assume that all ex situ treated PTW material may be disposed of at a Subtitle D facility. Otherwise, the need for treatment of sediments destined for an upland landfill should be based on acceptance criteria of that facility.

B. EPA's Designation of PTW is Unnecessary and Legally Inappropriate Given the Balanced Evaluation of the NCP Evaluation Criteria that is Required

Moreover, even if EPA concludes that any areas of the Site contain PTW, which we believe would be inconsistent with guidance, that does not justify EPA's creation of a distinct PTW RAL set or prescriptive technology assignments based on the presumed presence of PTW. According to EPA's PTW guidance, "the principal threat/low level threat waste concept and the NCP expectations were established to help streamline and focus the remedy selection process, not as a mandatory waste classification requirement."[144] The NCP itself notes that even duly designated PTW is appropriately contained, rather than removed or treated, when it "poses a relatively low long-term threat or where treatment is impracticable."[145] EPA's Sediment Guidance confirms that this is most often the appropriate, practicable approach at sediment sites: "Based on available technology, treatment is not considered practicable at most sediment sites," and "[i]t should be recognized that in-site containment can also be effective for principal threat wastes, where that approach represents the best balance of the NCP nine remedy selection criteria."[146]

EPA's alternatives evaluation for Portland Harbor demonstrates that virtually all material at the Site can be reliably contained, and where EPA's analysis indicates it may not be contained, the material does not represent a direct 10^{-3} or greater cancer risk. Accordingly, EPA should eliminate the designation of any PTW areas. This outcome would be consistent with EPA's treatment of the same issue at the Lower Duwamish Waterway Superfund site and other similar sediment cleanup sites.[147]

III. EPA's Conceptual Site Model is Inadequate

The purpose of a CSM in environmental remediation is to aid site managers in understanding and directly accounting for contaminant sources, environmental fate and transport processes, and exposure pathways and receptors. "For sediment sites, perhaps even more so than for other types of sites, the CSM can be an important element for evaluating risk and risk reduction approaches…A good CSM can be a valuable tool in evaluating the potential effectiveness of remedial alternatives... [t]he CSM should capture in one place the pathways remedial actions are designed to interdict to reduce exposure of human and ecological receptors to contaminants."[148] "Because of the inherent complexity of these projects, site characteristics (such as source areas, transport mechanisms, background and upstream areas, and key site features) should be clearly identified in a CSM before evaluating and selecting remedial alternatives."[149] Therefore, to be an effective tool in decision-making, a CSM must provide the framework for establishing testable hypotheses related to the behavior of the system and how it will react to any given alternative.

The CSM should be developed iteratively, as more data and site information become available (for example, during the course of the RI).[150] The CSM should reflect the best and most recent understanding of site conditions and dynamics. A more dynamic site will require a more elaborate and detailed CSM. The Lower Willamette River is a highly complex and dynamic system, and the CSM must account for this complexity.

Given the complex and dynamic nature of the Site and the clear need for a robust CSM as recommended by EPA's Sediment Guidance, EPA's reduction of 15 years of data collection and evaluation to two sentences and a one-page

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[144] *Id.* at 2.
[145] 40 CFR §300.430(a) (1) (iii) (B).
[146] Sediment Guidance at p 7-4.
[147] See, *LWG Response to EPA's Principal Threat Waste Approach* (August 7, 2014).
[148] Sediment Guidance, p. 2-7.
[149] ITRC, p. 6.
[150] "As a site CSM is refined, professional judgment must be used to determine the additional data needed for remedy selection." ITRC, p. 4.

sketch[151] is inexplicable by any scientific or technical measure. EPA's sketch compares poorly to the description in guidance of a CSM. "Project managers may find it useful to develop several CSMs that highlight different aspects of the site. At complex sediment sites, often three CSMs are developed: 1) sources, release and media, 2) human health, and 3) ecological receptors. For sites with more than one contaminant that are driving the risks, especially if they behave differently in the environment (e.g., PCBs vs. metals), it is often useful to develop a separate CSM for different contaminants or groups of contaminants."[152] "The first step in the remedial evaluation framework is to review the CSM to understand the relationship between sources, migration pathways, and receptors and to understand the physical conditions and contaminant properties governing exposure and risk at the site. Information presented in the CSM should support identification of the site-specific characteristics needed in the evaluation of remedial technologies."[153]

EPA's CSM sketches some of the site receptors and processes as though the Site exists in a permanent condition of uniformity and steady state, despite the Willamette River being a very dynamic system. EPA errs by considering site processes through the lens of a closed system in which outside sources and forces are largely irrelevant, thereby defeating the very purpose of a CSM.[154] At best, EPA's Portland Harbor CSM is a static snap shot of the Site that offers no explanation of the complex behaviors of the Site. Site-specific hypotheses cannot be deduced from a sketch. The sketch does not allow its users to coherently understand the effects of changes in surface chemistry of the sediments, surface water quality, or tissue concentrations over time. It also cannot adequately address the effects of source control over time, the effects of human activity, or the relative benefits associated with different remedial alternatives.

To formulate and implement effective remedial alternatives at Superfund sites, site-specific conditions must be well characterized and incorporated into a CSM demonstrating that observed conditions can be accurately extrapolated to the system as it may vary physically, biologically, and temporally. NRC guidance appropriately states the importance of conducting risk management decisions "on a site-specific basis…incorporat[ing] all available scientific information" because "[w]ithout a valid conceptual model of the site, it is not possible to define how a management option can successfully meet the risk-reduction goals and objectives."[155] At contaminated sediment sites in particular, "the development of an accurate conceptual site model, which identifies contaminant sources, transport mechanisms, exposure pathways, and receptors at various levels of the food chain" is "especially important...because the interrelationship of soil, surface and groundwater, sediment, and ecological and human receptors is often complex."[156] EPA's Technical *Resource Document on Monitored Natural Recovery* explains that an evaluation of the feasibility of monitored natural recovery (MNR) (and presumably other proposed remedial alternatives) "is best achieved through the development of a CSM that adequately captures the physical, chemical, and biological processes that control contaminant fate, transport, and bioavailability."[157]

Neither the RI nor EPA's FS contains a coherent, complete and accurate CSM that identifies and addresses site-specific context and conditions in sufficient detail to adequately describe the dynamic complexity present at the Site. The result is an inability to rationally develop and evaluate resource intensive and technically challenging remediation alternatives at the Site.

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[151] 2016 draft Final FS p. 1-21, "The CSM integrates the information gathered to date and provides a coherent hypothesis of the contaminant fate and transport at the Site. Figure 1.2-26 provides a simplified visual summary of this hypothesis, including the complete human and ecological exposure pathways."
[152] Sediment Guidance, p. 2-7.
[153] ITRC, p. 19.
[154] "The CSM and site geomorphology help determine the degree of site characterization required to properly evaluate remedial technologies. Understanding the relationship between contaminant sources, transport mechanisms, exposure media, and factors that control contaminant distribution and potential exposure is critical to developing a focused site characterization approach. For example, sediment transport is often controlled by infrequent, high energy events. " ITRC, p. 21.
[155] *A Risk-Management Strategy for PCB-Contaminated Sediments*. (Committee on Remediation of PCB-Contaminated Sediments, Board on Environmental Studies and Toxicology, Division on Life and Earth Studies, National Research Council, May 2001).
[156] Sediment Guidance, p. ii.
[157] *Resource Document on Monitored Natural Recovery* (EPA 2014), Section 1.3.2, p. 6.

A. Errors that Result from the Use of EPA's CSM

There are numerous examples of important dynamic processes that have been overlooked or poorly evaluated in the development of EPA's CSM. Appropriate evaluation of these processes is critical to understanding source dynamics; rate and extent of physical, chemical, and biological transformations; exposure; and how the system will react to any given remedial alternative.

1. Non-steady State Conditions and Aggregation of Data

Due to EPA's nearly non-existent CSM, for many analyses EPA inappropriately aggregates extensive data collected over the course of a decade, which erroneously portrays a highly dynamic system as unchanging and uniform.

There were multiple rounds of data collected at the Site during sampling events over an approximately 10-year period of time, and some data included in the RI/FS database predate this period by another 5 years (back to 1997). It is potentially appropriate for some RI/FS purposes to aggregate these data and plot them on maps and figures, such as portraying the general nature and extent of contamination in relative terms (i.e., to discern relatively high and low concentration areas). However, such simple aggregation is fatally flawed for any evaluations where an appropriately developed CSM would indicate dynamic changes over time (e.g., evaluating potential natural recovery or long-term outcomes of remedial alternatives).

An appropriate CSM would emphasize that Site river sediments have dynamic characteristics and parameters including chemical concentrations that likely increase or decrease over time. By continually aggregating synoptic data without regard to sampling year, any sense of time dependent variation present in these data was lost in EPA's evaluations. There are numerous examples of 2016 draft Final FS statements and conclusions that are incorrect or misleading due to the insufficient CSM that fails to recognize dynamic and changing site conditions. A few examples include:

- Groundwater and riverbank source descriptions (e.g., FS pp. 1-13 through 1-19) and plume maps do not consider source controls implemented at many upland sites in the last five years or so.

- For unexplained reasons, EPA uses only the 2007 and 2012 fish tissue data (and ignores the 2002 tissue data) in its very limited evaluation of tissue contaminant trends (FS pp. 3-34), which essentially halves the available time period that can be evaluated. EPA's discussion is heavily focused on finding any potential evidence of a "zero" trend, which is a bias caused by EPA's simplistic and static CSM.[158]

- EPA's effectiveness evaluations focus almost exclusively on SWACs immediately post-construction (p.3-65, 4-6, 4-10 and elsewhere), and no quantitative estimates of long-term alternative outcomes are included. As described elsewhere in this document,[159] EPA could have easily devised empirically based estimates of long-term outcomes of the alternatives without resorting to complex computer models.

- EPA states that "Sediment trend data do not exist for this Site; insufficient biota and water trend data exist…" (p. 4-4).[160] If EPA had adopted the CSM formulated early in the RI/FS process, any trend data deficiencies now perceived by EPA would have been addressed. In fact, the LWG provided such

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[158] EPA provides no details in the 2016 FS of its fish tissue statistical analysis, but a memorandum titled "MNR Evaluation – Fish Contaminant Concentrations," May 2016 is within EPA's Administrative Record for the Site. The LWG found EPA's statistical analysis to be flawed in several respects including that EPA's statistical model lacks power for detecting declines in fish tissue concentrations, is overly simplistic for the task, confounds the analysis by normalizing by non-correlated lipid contents, and ignores 2002 data for poorly explained reasons. See LWG memorandum, *Comments on EPA MNR Evaluation Using Fish Contaminant Concentrations*, (September 6, 2016) (Attachment 18) EPA's results disagree with the LWG's findings as previously provided to EPA in "Lower Willamette River Smallmouth Bass Data Monitored Natural Recovery Analysis," a presentation file from Anchor QEA provided to EPA on March 18, 2013 (Attachment 1).
[159] See Section V.C.
[160] Note that the LWG disagrees with this statement, and the LWG 2012 draft FS Section 6.2 provides a good example of using the available data to understand Site trends to the maximum extent practicable. The LWG's conclusion, which was later verified by the 2012 smallmouth bass tissue data, was that Site concentrations are declining measurably in just the last 10 years.

> supporting information as far back as the Programmatic Work Plan stage, and when the LWG requested collecting time series surface sediment data to fill part of this data gap, EPA rejected that request.[161]

Probably the least defensible use of the static Site bias portrayed by EPA's insufficient CSM appears a little later on page 4-4 of the 2016 draft Final FS.

> "EPA has concluded that the HST model predictions are inconsistent with the CSM for this Site, as it shows significant concentration reductions occurring within the first 10 years for the No-Action alternative. However, given that the majority of the contamination was released into the river 30-80 years ago and similar reductions have not been observed, the model results appear inconsistent with the empirical data collected during the RI."

We are unaware of chemistry data from 30 to 80 years ago that EPA has compared to data collected during the RI/FS to reach this "empirical" conclusion, and no such data appears in the Administrative Record for the Proposed Plan. However, a significant amount of information collected during the RI demonstrates that river conditions have changed over time. For example, EPA's RI found that, "Concentrations of total PCBs, DDx, total PAHs, hexachlorobenzene, total chlordanes, aldrin and dieldrin, gamma-HCH, lead, and TBT are higher in subsurface than in surface sediments, indicating that historical inputs were likely greater than current inputs."[162]

The dynamics of sediment surface chemistry also have a direct effect on the calculation of RALs and evaluations of natural recovery. When sediment surface chemistry is dynamic over time, the RAL will also vary depending on the time and rate of natural recovery estimated, because RALs define the dividing line between areas that will be actively remediated versus areas that will undergo natural recovery. In turn, these time-dependent RALs and their linkage to natural recovery estimates are one of the key characteristics of the selected remedy (i.e., they define where active remediation will take place).

Yet, EPA devotes about three pages of its FS (starting at p. 3-32) to a discussion of the processes affecting RAL selection and natural recovery. As described in guidance, "Using MNR as a remedy at a contaminated sediment site requires a thorough understanding of the sources, exposure pathways, and receptors in the CSM. Site managers must be able to predict, with some degree of certainty, that contaminant concentrations will decline or be effectively addressed within a specific time frame." Guidance also states that natural recovery evaluations at contaminated sediment sites should be based on multiple lines of evidence.[163] Many of these lines of evidence were collected as part of the Portland Harbor RI/FS process and provide a strong empirical basis for the occurrence of natural recovery in Portland Harbor. Section 6.2.2 of the LWG 2012 Draft FS provides a detailed evaluation of each of these lines of evidence, which were summarized in past LWG FS comments.[164] These important lines of evidence include:

- Sources are being progressively controlled. DEQ's latest source control report indicates DEQ has completed source control evaluations and implemented (or will implement) controls on one or more potential pathways at approximately 149 of 171 sites examined in detail to date.[165]

- The aggregate information from five multi-beam surveys indicates widespread deposition of sediments across many areas of the Site. Although EPA's FS emphasizes the uncertainties of these data, for reasons

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[161] Letter from EPA to LWG dated January 2, 2008, regarding "Portland Harbor Superfund Site; Administrative Order on Consent for Remedial Investigation and Feasibility Study; Docket No. CERCLA-10-2001-0240. Round 3B Comprehensive Sediment and Bioassay Field Sampling Plan – Addendum 1: Fate and Transport Modeling – Estimation of Temporal Chemistry Changes in Surface Sediments."
[162] RI, page 10-4.
[163] Sediment Guidance; Magar et al. 2009 (Magar, V., D. Chadwick, T. Bridges, P. Fuchsman, J. Conder, T. Dekker, J. Stevens, K. Gustavson, and M. Mills. 2009. Technical Guide: Monitored Natural Recovery at Contaminated Sediment Sites. Environmental Security Technology Certification Program (ESTCP), Project ER-0622.); ITRC 2014.
[164] Letter to EPA, September 8, 2015, Re: List of significant comments on EPA Feasibility Study Section 3 and 4 (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240).
[165] Portland Harbor Upland Source Control Summary Report (DEQ, March 25, 2016 update), at 108.

detailed in past comments, the LWG disagrees that these data present substantial uncertainties about deposition.

- Sediment trap and suspended sediment data clearly show that incoming settling sediment has substantially lower contaminant concentrations than most of the site bedded sediment, which will drive bedded sediment concentrations lower over time.

- Radio-isotope coring data, although limited, indicates deposition rates consistent with other measures such as the bathymetry time series.

- Site surface sediment grain sizes are fine-grained across the majority of the Site, strongly indicating a long-term depositional environment exists in these areas.

- Surface to subsurface sediment concentration ratios in most areas of the Site indicate newer surface strata contain lower concentrations than older subsurface strata, which illustrates that surface sediment concentrations are decreasing over time.

- Surface sediment concentrations measured over time (i.e., time series) indicate surface sediments have decreasing contaminant concentrations. The 2012 Draft FS data are somewhat limited, but new PCB data collected in 2014 by other parties provide additional useful information and suggest that PCB sediment concentrations are continuing to decline. [166]

- Smallmouth bass PCB tissue measurements made in 2002, 2007, and 2012 indicate statistically significant declines in tissue concentrations across almost all areas of the Site.[167] Despite uncertainties expressed in EPA's FS, differences in sampling and compositing schemes across the years can be controlled to determine statistically valid results.

- Comparisons of sediment profile images collected in 2001 (by the LWG) and 2013 (by other parties)[168] indicate that much of the Site now has well established Stage 3 benthic communities indicating stable and recovering substrates.

- Simple modeling (such as EPA's SEDCAM modeling, which was never included in EPA's FS) and complex modeling (such as the 2012 Draft FS QEA FATE model and coupled dynamic Food Web Model) all generally indicate recovery of surface sediments over a reasonable timeframe toward a relatively consistent range of potential equilibrium levels.

One of the most important rules of environmental data analysis is the evaluation of time series data to establish the dynamics of site processes (e.g., the rate and extent of changes in physical, chemical, and biological systems). EPA failed to conduct this evaluation, and the assumption of a steady state and uniform Site was mistakenly accepted as valid for the vast majority of the EPA's FS analyses.

2. Role of Surface Water Chemistry and Variation

EPA's CSM fails to consider the non-steady state dynamics of PCBs and DDx in surface water. This causes EPA to ignore the likely effects of water quality on fish tissue concentrations for hydrophobic COCs. Using DDx as an example, the RI demonstrates that variation in Site sediment concentrations explains about 33% of the variation of DDx in resident fish tissue.[169] Obviously, there are other factors that control the remaining 67% of the observed

[166] *Sediment sampling data report, Portland Harbor, Portland, Oregon*, prepared for de maximis Inc., (Kleinfelder, May 11, 2015) (Attachment 2).
[167] "Lower Willamette River Smallmouth Bass Data Monitored Natural Recovery Analysis." A presentation file from Anchor QEA provided to EPA on March 18, 2013. (Attachment 1)
[168] *Characterization of the Lower Willamette River with sediment profile imaging Changes in space & time,* prepared for de maximis, Inc. (Germano & Associates, Inc. June 2014.). (Attachment 19)
[169] Integral 2016 *Review of EPA's Food Web Model* C167-1504. Prepared for Legacy Site Services LLC, Exton, PA. Integral Consulting Inc., Portland, OR. August 30, 2016. (Attachment 20)

variation, which are not addressed by EPA's sketch CSM. This error leads to the unsupportable premise that sediment remediation alone can result in acceptable levels of DDx in tissue, a premise that ignores eight rounds of surface water data that demonstrate significantly higher concentrations of DDx are entering the Site during times of high winter flow than are present during the summer or fall. A similar relationship exists for PCBs. Further, none of the surface water samples for DDx or PCBs taken during either high or low flow conditions entering the Site from upstream obtained during the RI were below EPA's New/Updated CWA 304(a) Human Health Criteria and Oregon's water quality standards. These errors could have been avoided had EPA followed standard practice that "… all sediment sites should include the development of a CSM that identifies watershed inputs and characterizes background conditions."[170]

The CSM also fails to account for the endogenous risk (or risk arising from factors outside the domain of the CSM), including the contribution of upstream chemical inputs to surface water PRG exceedances and ongoing human health fish consumption risks. For example, as discussed in Section I.D and Table 4, the current OHA mercury fish consumption advisory for vulnerable populations on the Lower Willamette River allows only 12 resident fish meals/year. Because this advisory is due to mercury sources upstream of the Site, the advisory is expected to continue after any Portland Harbor sediment remediation is implemented. EPA's FS focuses on (flawed) post-construction risk estimates for the child fish consumption scenario (a vulnerable population). EPA estimates that under the most aggressive alternative (Alternative G), a child will be able to consume 10 fish meals/year, while Alternative B allows 2.4 meals/year. Thus, none of EPA's alternatives result in actual increase in the amount of fish people can consume above the current OHA fish consumption advisory. Similarly, the difference between the smallest and largest alternatives is just a few fish meals per year. Consequently, any perceived benefit to allowable fish consumption from the more aggressive alternatives does not actually exist.

In fact, even if every grain of sediment was removed from the Site and replaced with the cleanest sand available, resident fish tissue would still be adversely impacted by mercury, PCBs, and other contaminants from upstream sources. Contrary to guidance, the CSM sketch fails to address this key relationship between upstream water quality and marginal risk reductions and, as a consequence, the utility of the alternatives.

3. Importance of Non-steady State Chemical Processes

Some of the COCs associated with site sediments are chlorinated organic compounds (e.g., PCBs, DDx, and dioxin/furans). Current scientific literature demonstrates chlorinated compounds can undergo biotic and abiotic changes when present in sediments, surface water, and groundwater. Such processes include aerobic and anaerobic reactions (i.e., in the presence and absence of oxygen). Potentially important biogeochemical recovery pathways observed at other sites are not identified or operationalized in the CSM sketch or discussed elsewhere in EPA's FS. "At a minimum, the CSM should address the following: source(s), nature and extent of contamination, sediment transport pathways and mechanisms, sediment deposition rate; exposure pathways associated with chemical contamination, and the potential for in situ degradation...."[171] Section 2.6 of the LWG 2012 FS provides a good example of such a CSM.

a. Role of Spatial Complexity

Data obtained during the RI demonstrate the Site is complex and varies substantially over space for many parameters relevant to sediment remediation (sediment concentrations, grain size, organic carbon content, deposition rates, erosive forces, varying sources, water movements and currents, etc.). Given there is no CSM that discusses this complexity, particularly with regards to spatial variations in sediment grain size and organic carbon content, EPA erred when it calculated background concentrations for the Site. This error was the subject of a formal dispute by the LWG,[172] where LWG requested retaining the previously calculated RI background values for multiple

[170] ITRC, p. 59.
[171] ITRC, p. 69. [emphasis added]
[172] Request for Dispute Resolution of EPA's Notice of Decisions on Background Regarding Section 7 of the Remedial Investigation; Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240. The LWG requested that, "the full data set with consideration of organic carbon correction be retained as the selected set of background values and applied in the FS. These values are shown in the "all data" columns of Table 7.3-1b (and the related Appendix H Table H-2b) of the RI Section 7 revision agreed to by EPA and the LWG on December 12, 2013."

chemicals including a value of 16 ppb for PCBs. In addition, the LWG submitted a technical memorandum regarding equilibrium conditions,[173] which represent the lowest likely achievable sediment concentrations at the Site due to ongoing upstream inputs of COCs. This memorandum concludes that the appropriate site-wide equilibrium value for PCBs is 20 ppb. Both these documents address issues of sediment spatial variations, particularly for organic carbon content.

EPA rejected the LWG's position that EPA used background data outlier identification methods that are only appropriate for parameters whose latent distribution is normal. Because river sediment grain size and organic carbon content are highly varied over space due to natural processes and concentrations of organic compounds in sediments co-vary with grain size and carbon content, the concentration of compounds (including PCBs and DDx) cannot be normally distributed at the sampling spatial scales associated with the upstream (reference area) data. Thus, EPA's application of outlier methods associated with assumed normal distributions combined with inappropriate data censoring led EPA to artificially low background values (e.g., 9 ppb for PCBs) that are not likely achievable by any sediment remedy. Both an appropriate background analysis and incorporation of equilibrium concepts indicate that EPA should be using a background value more in the 20 ppb range for PCBs. EPA's error could have been avoided had the CSM properly addressed spatial complexity of sediment and other parameters both at the Site and upstream of the Site.

4. Effect of Inadequate CSM on Alternatives Selection

The absence of a coherent and complete CSM results in the selection of the wrong alternative. EPA assumes that time zero (immediate post-construction) SWACs are a good measure of risk reduction for all alternatives measured against arbitrary interim targets, which ignores any reasonable CSM conclusions regarding the dynamic nature (and overall declining concentrations of chemicals) of the system. Thus, EPA assumes that the Preferred Alternative will achieve faster and more cost-effective risk reduction, when in fact smaller, less resource-intensive alternatives will achieve similar risk reduction in a similar time period (and at much lower cost), if the dynamic nature of MNR (both during remedy construction and after) is properly taken into account. See Section V.C of this document for a more detailed discussion on the appropriate alternative selection taking into account expected system changes over the long term.

IV. EPA's Alternatives Evaluation is Incomplete, Misleading, and Almost Entirely Qualitative

An appropriate alternatives evaluation must fairly and carefully weigh the costs[174] against the benefits[175] of the alternatives both individually and relative to one another. "The evaluation should consider both positive effects, such as long-term effectiveness as measured through risk reduction, and negative effects, such as the adverse effects associated with implementation."[176] This evaluation should also demonstrate how the alternatives' dollar costs are proportional to their effectiveness (benefit) in reducing risk. The NCP states, "Each remedial action selected shall be cost-effective, provided that it first satisfies the threshold criteria set forth in § 300.430(f)(1)(ii)(A) and (B)…A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." The evaluation should also fully and transparently assess each of the FS criterion contained in the NCP (40 CFR Section 300.430(e)(9)). Unfortunately, EPA's alternatives evaluation has almost no comparison of the overall costs and benefits of the alternatives and fails to fully evaluate many of the FS criterion. Further, where costs (including impacts) or benefits (effectiveness) are discussed independent of each other, EPA:

- Develops alternatives that prescribe technology assignments, which precludes any meaningful comparison of the effectiveness of different technologies.

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173 *Sediment Equilibrium Estimates for the Revised Feasibility Study*, an LWG Technical Memorandum submitted to EPA on August 7, 2014.
174 Including the wider sense of the term "costs" such as environmental and community negative impacts due to remedy implementation.
175 Per the NCP, benefits are measured through effectiveness criteria: "Cost-effectiveness is determined by evaluating the following three of the five balancing criteria noted in § 300.430(f) (1)(i)(B) to determine overall effectiveness: long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, and short-term effectiveness.
176 ITRC p. 52.

- Fails to evaluate alternatives consistent with any coherent CSM (as already discussed in Section III).
- Presents flawed post-construction risk estimates to support effectiveness and protectiveness determinations.
- Presents no quantitative or detailed short-term effectiveness evaluation.
- Presents no quantitative or detailed long-term effectiveness evaluation.
- Ignores valuable recent data that would aid in long-term effectiveness evaluations.
- Systematically underestimates the costs and durations of the alternatives.
- Fails to fully consider many implementability challenges.

The result is a defective alternatives evaluation that leads to the ultimate error: selecting the wrong remedial alternative.[177]

A. EPA's Prescriptive Technology Assignments Preclude Meaningful Comparison of the Effectiveness of Different Technologies

EPA's 2016 draft Final FS and Proposed Plan continue to prescriptively assign technologies on the basis of a generic scoring matrix and decision trees without consideration of site-specific factors. EPA's approach prevents meaningful comparison of the performance of various technologies in the FS, because all alternatives employ the same technologies in the same geographic areas.[178] And because the technology assignment is based on FS-level information and screening evaluations, the prescriptive set of evaluation criteria will not appropriately or accurately predict the most appropriate technology assignments or configurations for remedial design based on design-level engineering evaluations and data available at the time of design, including data collected post-ROD. For example, the FS assignments are based on overall general assumptions regarding slopes, presumed erosion and deposition zones, and required depths of removal to reach protective levels. However, real designs implemented throughout the country at other sites (and within Portland Harbor to date) have varied, often substantially, from the FS-assumed criteria and are known to be effective. With respect to riverbank contamination and presumed groundwater contamination, the FS technology assignments are based solely on those general broad designations, without consideration of which COCs are present and conditions of exposure.[179]

EPA's selected remedy should build in the flexibility needed to evaluate the likely performance of technologies against RAOs in the context of the complexities of each particular SDU and within SDUs. EPA should clearly explain the conditions under which changes to major alternative elements (e.g., changes in technologies assignments, methods to address PTW, methods for determining treatment and disposal requirements, and requirements for rigid containment) might be considered or allowed based upon site-specific engineering evaluations and newly developed information.[180]

Attachment 21 provides a decision framework EPA could include in the ROD to specify how technology assignments would be finalized or refined on a site-specific basis. Subject to some general rules (i.e. dredging will typically be required for active remediation in the navigation channel or future maintenance dredge areas and capping will typically be required around permanent structures), dredging or capping at a specific location would be

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[177] Table 15 of the Proposed Plan summarizes EPA's comparison evaluation of alternatives.

[178] 2016 draft Final FS, p. ES-17: "Alternative A is a No Action Alternative, Alternatives B through I that apply the same suite of remedial technologies and process options to varying degrees based on Site-specific characteristics: containment, sediment/soil treatment (in-situ and ex-situ), sediment/soil removal, sediment/soil disposal, MNR/ENR, and institutional controls" (emphasis added).

[179] By contrast, the Corps of Engineers capping guidance document provides design level guidance of modeling and assessment methods to determine the concentration of contaminants of concern that can be safely isolated by capping.

[180] The Lower Duwamish Proposed Plan had an entire subsection that described some of the issues with design implementation and what factors and remedy components would have to be worked out in more detail in design. Proposed Plan, Lower Duwamish Water Superfund Site, https://www3.epa.gov/region10/pdf/sites/ldw/pp/ldw_pp_022513.pdf, §10.1, page 89.

determined by application of demonstration criteria through engineering evaluations during remedial design.[181] Such an approach is consistent with guidance, which clearly indicates both dredging and capping are feasible under a wide range of highly overlapping conditions, and many design options and components exist so that either capping or dredging can be tailored to be highly effective and protective under the same conditions.[182]

B. <u>EPA's FS Presents Flawed Post-construction Risk Estimates</u>

As discussed in Section I.A., EPA fails to maintain consistency with the BERA regarding benthic risk areas, and as a result, all FS estimates of the alternatives' ability to reduce benthic risks are incorrect. As demonstrated in Section I.C.1. EPA uses many PRGs that are inconsistent with the BLRAs and factors in virtually no risk management decisions, resulting in risk estimates that are misaligned with the findings of the BLRAs. As discussed in Section 1.C.2, EPA's incorrect PRGs combined with artificially inflated baseline SWACs create much higher estimates of baseline risks for Alternative A in the FS as compared to the baseline risks in the BLRAs. This approach also creates the appearance of greater risk reductions for the other alternatives than are possible, including unrealistic numbers of increased allowable fish meals as discussed in Section I.D. The overall result of these problems is that EPA repeatedly identifies large areas that are designated for active sediment cleanup where risks are either not present or cannot be meaningfully reduced through a sediment cleanup. A prime example of this is the application of PAH RALs in the navigation channel with no clear benefit as described in Section I.C.1.

Because of EPA's continual and compounding disregard for the methods and findings of the BLRA, all of the risk estimates presented in the 2016 draft Final FS are incorrect and generally portray inflated baseline risks and greater risk reductions than are possible or achievable. EPA cannot use the incorrect risk estimates to determine the relative effectiveness or risk reduction of any of the alternatives. And EPA has no foundation to reasonably decide whether any of its alternatives meet the threshold criteria of protectiveness or compliance with ARARs.

C. <u>No Quantitative or Detailed Short-term Effectiveness Evaluation</u>

As the LWG has previously commented,[183] guidance strongly recommends a comprehensive and quantitative evaluation of dredge release impacts:

- "Generally, the project manager should assess all causes of resuspension and realistically predict likely contaminant releases during a dredging operation."
- "To the extent possible, the project manager should estimate total dredging losses on a site-specific basis and consider them in the comparison of alternatives during the feasibility study."
- "Dredging residuals have been underestimated at some sites, even when obvious complicating factors are not present."
- "Project managers should be aware that most engineering measures implemented to reduce resuspension also reduce dredging efficiency. Estimates of production rates, cost, and project time frame should take these measures into account."

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[181] Attachment 21 builds on a capping demonstration decision tree developed by EPA in late 2015 for the FS but ultimately not included in the final FS.

[182] For example, EPA's Sediment Guidance, page iii states: "When evaluating alternatives with respect to effectiveness and permanence, it is important to remember that each of the three potential remedy approaches may be capable of reaching acceptable levels of effectiveness and permanence…" See also p. 3-2, "However, due to the limited number of approaches that may be available for contaminated sediment, generally project managers should evaluate each approach carefully, including the three major approaches (MNR, in-situ capping, and removal through dredging or excavation) at every sediment site at which they might be appropriate." See also p. 7-5, "Project managers should note that these characteristics are not requirements. It is important to remain flexible when evaluating sediment alternatives and when considering approaches that at first may not appear the most appropriate for a given environment. When an approach is selected for a site that has one or more site characteristics or conditions appearing problematic, additional engineering or ICs may be available to enhance the remedy."

[183] Letter to EPA, September 8, 2015, Re: List of significant comments on EPA Feasibility Study Section 3 and 4 (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240)

- "The strategy for the project manager should be to minimize the resuspension levels generated by any specific dredge type, while also ensuring that the project can be implemented in a reasonable time frame."

EPA provides some discussion of dredge residuals and releases, but no new quantitative evaluations were added since the LWG's comments were submitted on the 2015 Draft FS. The general discussion provided in FS Appendix O and page 3-23 continues to rely on the findings of one project (Hudson River Phase 2) as the basis for its assumption that contaminant releases during dredging in Portland Harbor will be only 1% of the total contaminant mass dredged. This is three times lower than the 3% release rate recommended by the LWG in the 2012 Draft FS based on a review of numerous other recent contaminated sediment dredge projects. EPA further uses this one project to assume that most releases greater than 1% can be eliminated by quickly covering dredge residuals by applying daily clean cover. This assumption will require additional equipment to be available to place these materials or the dredge production rates need to be reduced, which is inconsistent with the 2016 draft Final FS-assumed 24 hours a day, 6 days a week dredging production rate (see Section IV.F). Thus, EPA is establishing a 1% release rate for Portland Harbor based on one project (Hudson River Phase 2) that appears to be one of the lowest release rates documented to date. Further, EPA is applying this optimistic release rate from a site that is entirely different both chemically and physically from Portland Harbor, which includes 10 river miles of highly varying physical and chemical conditions. Regardless of these general discussions, EPA never applies the assumed 1% release rate in any type of quantitative evaluation of dredging releases or the associated increases in fish tissue concentrations as documented on many other projects.[184] These projects document that fish tissue PCB levels typically increase dramatically during contaminated sediment dredging events and stay elevated for 3 to 5 years afterward. None of these likely impacts are quantified or factored into EPA's assumptions about allowable fish meals during and shortly after the construction period.

EPA also states on page 3-24 of the 2016 draft Final FS that residual covers should be applied on a daily basis, a requirement without precedent for a project of this scale. EPA also discusses many other water quality best management practices (BMPs), silt curtains, sheetpile walls, and other dredging water quality controls that are assumed to be employed either all the time or under various conditions. However, contrary to guidance (cited above) the effect of daily covers and this wide array of dredging controls on alternative costs and durations are not quantified or even discussed. The effects of all these controls on alternative cost, duration, and implementability are substantial and are not demonstrated in the 2012 LWG Draft FS to provide additional risk reduction.

For example, EPA assumes sheetpile barrier walls will be used anywhere that trace or greater levels of NAPL is present in water depths up to 50 feet (see 2016 draft Final FS Appendix O). Yet, the 2016 draft Final FS FS fails to incorporate into each alternative's duration the time to install and remove sheetpile walls or factor in the lower dredging production rates that occur in and around the confined space created. The costs of sheetpiles that EPA uses ($2,750 per linear foot) would not be sufficient for water depths approaching 40 to 50 feet; these depths would require a much more expensive cofferdam-type system and require site-specific engineering analyses to determine if they are even feasible. EPA also continues to depict (2016 draft Final FS FS Figure 3.4-33) sheetpiles in greater than 50 feet of actual water depth, which is technically infeasible. Figure 3.4-33 also implies that sheetpiles will be installed in the navigation channel, which would not be permitted by the U.S. Army Corps of Engineers (USACE) or U.S. Coast Guard, because it presents a hazard to navigation in an active vessel traffic lane. Sheetpiles would also impact or prevent ongoing shoreline water dependent operations and nearshore fish migration. EPA also fails to discuss that driving sheetpile walls can transport sediment contamination deeper into clean subsurface sediments or that removal of the sheetpile walls after construction will cause contaminated sediment releases as well. Finally, EPA never quantifies whether the additional cost of sheetpiles (including the impact of slower construction times on costs) is justified by their assumed additional effectiveness.

Other types of construction and short-term impacts could occur with all the alternatives, such as:

[184] See discussion in the LWG 2012 draft FS in Sections 6.2.7.3 and 8.2.2.4; Bridges, et al. 2010: Dredging Processes and Remedy Effectiveness: Relationship to the 4 Rs of Environmental Dredging. Todd S. Bridges, Karl E. Gustavson, Paul Schroeder, Stephen J. Ells, Donald Hayes, Steven C. Nadeau, Michael R. Palermo, and Clay Patmont. Integrated Environmental Assessment and Management. February 10, 2010. 2010 SETAC; ITRC p. 181; and "Sediment Monitored Natural Recovery Case Studies." Presentation at the Battelle Eighth International Conference on Remediation and Management of Contaminated Sediments. January 12-15, 2015. Carl Stivers and Clay Patmont of Anchor QEA.

- Potential risks to both construction workers and the general public from sediment removal, transload, transportation, and treatment

- Community impacts from multi-year dredging, capping, and transload operations on the river (e.g., recreational uses, light, and noise)

- Increased greenhouse gas and air pollution discharges

- Impacts to the community and commerce from increased river vessel traffic, community road truck traffic, and potential increased train traffic

EPA only briefly discusses these issues, and when they are discussed, EPA quickly transitions to biased explanations of how these impacts can be avoided or minimized (e.g., FS pages 4-34 through 4-38). Although EPA mentions that short-term impacts will be greater for larger alternatives, the pervasive explanations of minimization measures misleadingly makes these impacts all appear relatively inconsequential.

EPA does not perform any type of quantitative evaluation of dredge releases or other short-term impacts. Almost all of EPA's alternative comparison conclusions rest on simple comparisons of construction durations and the amount of materials handled. We note that EPA made numerous comments on the 2012 LWG Draft FS indicating that document spent too much time discussing durations of the alternatives,[185] even though that document included quantitative estimates of dredge releases, worker risks, community impacts, and air emissions, all of which are important to remedial alternatives evaluation and selection.

In comparison to the 2012 LWG Draft FS, EPA's short-term impact conclusions rely on little more than conjecture about construction durations. For example, EPA notes that "since Alternative I also involves less construction than Alternative E, Alternative I would have less short-term impact on the community, workers, and the environment." However, EPA's Proposed Plan Table 15 shows that Alternatives E and I receive the same overall short-term effectiveness score of "better," as does Alternative D. Alternative B, which has shorter durations and less material transport, recieves a score of "moderate" for unclear reasons. (No alternative receives the "best" score here, which is inconsistent with the other criteria scoring.) Regardless of the approach to evaluating short-term effectiveness, sound policy demands that risk be evaluated holistically and not in baseline and post-construction silos. If the objective is to prevent environmental morbidity and mortality, then the possible tradeoff related to occupational and implementation related injuries, disease, and deaths caused by the cleanup activities themselves must be explicitly taken into consideration in the cost-benefit analysis of the remedial alternatives.

D. <u>No Quantitative or Detailed Long-term Effectiveness Evaluation</u>

As discussed previously, EPA made the determination that no quantitative long-term modeling of the alternatives or natural recovery was possible for the Site. EPA's Sediment Guidance addresses the role of quantitative estimates in making these critical decisions:

> "The time needed until protection is achieved can be difficult to assess at sediment sites, especially where bioaccumulative contaminants are present. Generally, for sites where risk is due to contaminants in the food chain, time to achieve protection can be estimated using models. These models may have significant uncertainty, but may be useful for predicting whether or not there are significant differences between times to achieve protection using different alternatives. When comparing time to achieve protection from MNR to that for active remedies such as capping and dredging, it is generally important to include the time for design and implementation of the active remedies in the analysis."

[185] "For example, the comparative evaluation of alternatives overemphasizes duration of cleanup in the evaluation of short-term impacts…" and "The FS bases a significant portion of the overall effectiveness evaluation on the duration of the cleanup." Letter from EPA to LWG December 18, 2012 regarding, Portland Harbor Superfund Site, Administrative Order on Consent for Remedial Investigation and Feasibility Study: Docket No. CERCLA-10-2001-0240 EPA Comments on the Portland Harbor Rl/FS Draft Feasibility Study (March 30, 2012).

This guidance is particularly relevant for large and complex sites like Portland Harbor where uncertainties are often greater and quantitative estimates help to understand those site uncertainties and better support appropriate remedy decision-making. For example, EPA Region 10 recently completed decision-making using such quantitative approaches for the similarly complex Lower Duwamish Waterway Superfund site.[186]

The absence of quantitative evaluations is the result of rejecting empirical data collection and modeling studies that the LWG conducted in coordination with EPA and under its interim approvals and for the express purpose of informing the RI/FS.[187] EPA's ultimate rejection of LWG's proposed QEAFATE model only came after years of discussion and refinements to that model based on EPA's detailed comments. EPA made little earnest attempt to replace that model with another form of quantitative long-term estimate. For example, EPA rejected its own SEDCAM modeling results and USACE particle tracking models and then failed to consider simple quantification techniques like the half-life estimates discussed in Section V.C.

As a result, and despite the fact that EPA acknowledges that natural recovery is occurring at the Site,[188] EPA is reduced to assuming that:

- Immediate post-construction sediment SWACs are the only available means to quantify the long-term effectiveness of the alternatives, which EPA acknowledges is not an actual long-term measure of the alternatives.

- These immediate post-construction SWACs will remain constant for all alternatives until construction commences, despite EPA identifying the need for multiple years of post-ROD assessment and pre-design data collection and the fact that alternatives that involve more construction will likely take longer to design than alternatives that require less construction.

- SWACs will remain constant during the time of construction even though some areas will not be actively remediated and will obviously undergo natural recovery to the extent that is expected for any given area.

- Immediate post-construction SWACs are static relative to each other even over long periods of time. For example, EPA assumes the estimated post-construction SWACs for Alternative B, with an estimated 4-year construction period, can somehow be compared directly to Alternative I, with an estimated 7-year construction period, or Alternative H, with an estimated 62-year construction period.

These assumptions greatly simplify the alternatives analyses, but they have no basis in reality and are directly contrary to guidance.

The assumption that SWACs remain constant until construction commences is particularly problematic. EPA describes the construction timeframes for all alternatives to be preceded by a "Year 0" condition.[189] This Year 0 is described as including the following work:

- Establishment of initial conditions: "Monitoring (sampling) of sediment, water, biota, and pore water will need to be the first phase, and it will encompass the entire Site to establish a baseline and delineate the SMAs for construction. It is expected that <u>this phase will take 3 to 5 years</u>."

- Construction of an on-site material handling/treatment facility

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[186] Record of Decision. Lower Duwamish Waterway Superfund Site. EPA, Region 10. November 2014.
[187] During this same period, EPA was only able to express ever increasing uncertainty about every empirical data collection effort it approved and oversaw, including one of the most detailed time series bathymetry data sets (showing widespread deposition) ever collected for a sediment Superfund site, high resolution grain size sampling, sediment trap and suspended sediment data, subsurface sediment concentration profiles, radio-isotope cores, disaggregated surface sediment data, time series fish tissue data (including the 2012 smallmouth data collection EPA itself conceived and attempted to execute), and other data.
[188] 2016 draft Final FS p. 3-33.
[189] 2016 draft Final FS p. 3-41 (emphasis added).

- Start-up activities and mobilization, including pre-design investigations
- And the first year of construction: "Year 0 is the first year of construction."

This conceptual timeline does not include any explicit time for completion of the ROD and Consent Decrees. It also does not include time for remedial design, which usually proceeds in at least three EPA review steps (e.g. 30, 70, 100% design). At the most optimistic, the assumptions lead to construction starting no sooner than 5 to 7 years from the ROD. Given EPA assumes that the PRGs will be achieved in 30 years (and as discussed in Section V.C, this equates to a natural recovery half-life of about 10 years), the Site sediment concentrations will have decreased by at least an additional 25% before construction starts. Thus, once initial conditions are set, it will be time to conduct another round of initial condition sampling. More importantly, EPA does not appear to have given any meaningful consideration to pre- or post-construction time periods when evaluating the relative performance of its alternatives. EPA should provide a realistic vision and timeframe for implementation of its alternatives, including the time prior to construction. EPA should clearly identify in its alternatives development and decision trees that sediment management areas and technology assignments and process options will be refined and adjusted through site-specific remedial design and implementation, because the Site is sure to have changed substantially in the time between the ROD and construction.

EPA converted immediate post-construction SWACs to risk estimates by comparing PRGs, many of which are inconsistent with the risk assessments, using spatial scales that are also inconsistent with the risk assessments. EPA also made analogous estimates for fish tissue and surface water that rely on the same immediate post-construction SWACs, and as a result, these estimates are equally useless to assess long-term effectiveness of the alternatives. Some of the problems associated with the tissue estimates are discussed in Section I.C.2.b, and the additional errors involved in EPA's surface water estimates from Appendix K are discussed in Section I.B and are not repeated here.

Rather than actually quantitatively evaluating long-term effectiveness, EPA's new approach for the 2016 draft Final FS uses interim targets, which are basically 10 times its PRGs. EPA then compared immediate post-construction risks to these interim targets for evaluating the "overall protection of human health and the environment" for each alternative. EPA states that if alternatives meet these interim targets, it is reasonable to assume the PRGs will be met through subsequent natural recovery in 30 years.[190] This assumption is justified only by saying that it is "commensurate with the site-specific contaminants and conditions." Particularly in the absence of a coherent CSM, EPA cannot simultaneously claim that it cannot quantitatively estimate MNR and then decide that MNR will work in 30 years. This global assumption also hides a second and equally important and unsupported assumption that EPA's PRGs can eventually be achieved through a sediment remedy. As the equilibrium analyses discussed above demonstrate, many of EPA's PRGs are not achievable even over the very long term. EPA never explains why these assumptions and flawed associated analyses are technically superior to either the LWG's effectiveness evaluations or its own prior evaluations in the 2015 EPA Draft FS.

Even within EPA's interim targets approach to evaluating effectiveness, there are internal inconsistencies. For example, the Preferred Alternative does not meet the interim targets for RAOs 1, 2, and 6 (Proposed Plan pp. 51-52). Likewise, Figure 4.2-4 of the 2016 draft Final FS shows none of the alternatives meet the interim targets (except Alternative G) ,and Figure 4.2-2 shows a similar result (no alternatives except Alternatives F and G meet the interim target). And for most of the other RAOs, there is either "insufficient information" to determine whether Alternative I meets EPA's interim targets, or only qualitative comparisons between alternatives, such as "[p]ost-construction, the estimated contaminated groundwater area addressed by each alternative increases as the footprint of the SMAs increases."

[190] Draft Final FS p. 4-6: "As a long-term model is not available to predict the time to meet the PRGs, interim targets for risks and HIs were established to evaluate the potential for achievement of PRGs in a reasonable time frame, which was considered to be 30 years, commensurate with the site-specific contaminants and conditions. These interim targets are higher than residual risks once PRGs are achieved, and assume that further reductions will be achieved through MNR."

Ultimately, EPA simply abandons any effort to consider long-term effectiveness beyond its assumed construction durations. EPA notes in the Proposed Plan that Alternatives D, E, and I have roughly the same MNR footprint.[191] However, Alternative D is ranked *low* and Alternatives E and I are ranked *moderate* in Proposed Plan Table 15. To the extent this conclusion is based on EPA's stated goal in the Proposed Plan (page 63) to "maximize permanence through removal of highly contaminated sediment" this conclusion is directly contradictory to guidance, which is clear that mass removal is not an appropriate way to evaluate sediment remediation alternatives; rather the evaluation must address reduction in risk.[192]

Finally, EPA's FS does not quantify or otherwise estimate the performance of enhanced natural recovery (ENR) in SIL SDU either in terms of sediment SWACs or post-construction risks. EPA identified ENR as an applicable technology for SIL in all alternatives considered in the FS, with ENR covering more than 60% of the SDU for Alternative I. ENR is a commonly employed remedial alternative for contaminated sediment sites. It refers to accelerating the natural recovery process by engineering means and includes adding a thin layer of clean sediment and/or additives to enhance contaminant degradation. The 2016 draft Final FS concludes that ENR is expected to meet RAOs in SIL. It provides that the thickness and composition of the ENR layer will be determined during remedial design but that a 12-inch layer is expected to be sufficient.

Despite EPA's conclusions regarding the applicability and effectiveness of ENR in the SIL environment, EPA has arbitrarily ignored the impact of ENR on reducing PCB SWACs and corresponding risks. That is, SWAC and risk calculations reported for the SIL area by EPA in the FS simply do not reflect any benefit expected to be achieved by ENR. EPA's failure to evaluate the impact of ENR on risk results in an incomplete analysis of effectiveness for all alternatives and therefore prevents a meaningful comparison among the alternatives in accordance with the NCP. It is also contrary to EPA's 2015 Draft FS, which explicitly considered the effect of ENR on the SWAC. EPA has failed to provide any reason for its change in position from the 2015 Draft FS. Furthermore, ENR (including the potential for an additive to enhance contaminant degradation or sequestration) contributes significantly to the overall costs of a remedy. Therefore, its effect on risk reduction must be considered when evaluating the cost-effectiveness of remedial alternatives.

E. <u>EPA Ignores Recent Data that Aid in Long-term Effectiveness Evaluations</u>

There is substantial evidence that important chemical characteristics of the Lower Willamette River have changed significantly since the RI.[193] Analyses of the 2012 smallmouth bass data (submitted to EPA) strongly suggest the Site is already approaching equilibrium levels in some areas of the Site. Because that analysis also suggests that the half-life of the process is about 10 years, which is consistent with the recovery rate that EPA must have used as the basis for its assumption that a PCB PRG of 9 ppb can be reached in 30 years,[194] it appears likely that a large proportion of the surface sediments at the Site will be at or near equilibrium levels by the time of remedy implementation, thus eliminating the need for an aggressive cleanup approach such as Alternative I. As noted above, based on a realistic assessment of EPA's timeframe until construction start, Site concentrations are likely to be around 25% lower than the already much lower 2012 estimate. The 2014 PCB sediment data yield similar conclusions.

Because of the relationship between RALs and natural recovery (RALs delineate active construction areas from natural recovery areas), RALs are sensitive to SWAC changes caused by natural recovery. As the Site recovers before construction, the same RALs will delineate ever smaller areas of active construction until equilibrium is reached. Failure to recognize these ongoing processes will cause errors in the selection of the most cost-effective alternative as well as in the assignment of remedial technologies in the absence of flexibility during remedial design to adjust to changing river conditions. Yet, EPA's 2016 draft Final FS and Proposed Plan provide no clear

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[191] Proposed Plan, p. 61.
[192] Sediment Guidance, p.7-1 and p. 7-16.
[193] "Lower Willamette River Smallmouth Bass Data Monitored Natural Recovery Analysis," a presentation file from Anchor QEA provided to EPA on March 18, 2013.
[194] Using Alternative I (the preferred alternative), EPA estimates a post-construction SWAC of 40 ppb at construction completion, which is 7 years after construction started. In order to reach a level of 9 ppb in the 23 years remaining within EPA's 30-year assumption, the site-wide concentration would need to halve every 10 years. This equates to 20 ppb at 17 years after construction started and 10 ppb at 27 years after construction started. Consequently, 9 ppb would be achieved at about 28 years after construction started.

description of how any future design adjustments might impact alternative selection now, what site-specific remedy adjustments will be allowed in the remedial design phase, how those adjustments would be determined, and what procedural steps would be needed (e.g., part of design decisions, Explanation of Significant Difference, or ROD amendments). Instead, the Proposed Plan describes technology assignments based on FS-level screening criteria that apparently will be entirely prescriptive during remedial design regardless of how the Site might evolve over time.

F. EPA Systematically Underestimates Costs and Durations

EPA's estimated costs for performing each of the alternatives continue to omit significant cost elements, including EPA's anticipated "initial conditions" sampling, sufficient pre-remedial engineering design investigations, Oregon Department of State Lands access, lease and easement fees, and agency oversight and participation costs (which alone have amounted to more than 27% of the LWG'S RI/FS costs to date). EPA also dramatically underestimates other cost elements on the basis of unrealistic and, in some cases, impossible assumptions about dredge and cap production rates and volumes, remediation waste processing, engineering design, construction management, BMPs EPA intends to require, and the present value of money (including the cost of financial assurance).

As EPA itself notes, "[c]ost is a central factor in all Superfund remedy selection decisions." Cost estimates are developed at different stages of the Superfund process and are dependent on and have a direct relationship with project definition and design. The cost estimate of the Preferred Alternative is usually transferred from the FS to the Proposed Plan and further included in the ROD, subject to any modifications resulting from the public comment process or the availability of new information.

During the FS phase, cost estimates are developed for the purpose of "comparing remedial alternatives during the remedy selection process...." Cost estimates are prepared during the "development and screening of alternatives" stage, as well as during the "detailed analysis of alternatives" stage. "Screening-level cost estimates are used to screen out disproportionately expensive alternatives in determining what alternatives should be retained for detailed analysis," while estimates generated during the "detailed analysis" stage are "used to compare alternatives and support remedy selection." EPA's *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* describes data sources that should be used to generate cost estimates, which include "cost curves, generic unit costs, vendor information, standard cost estimating guides, historical cost data, and estimates for similar projects, as modified for the specific site."

Overall, properly evaluating the cost and cost-effectiveness of each remedial alternative is crucial to ensuring compliance with CERCLA and NCP directives. Regardless of the relevant FS stage, cost estimates "should clearly present" the "expected accuracy range of the cost estimate." The expected accuracy range of cost estimates generated during the "screening of alternatives" phase is -50 to +100%, while the expected accuracy range of cost estimates generated during the "detailed analysis of alternatives" phase is -30 to +50%.

1. Correcting Significant Errors in EPA's Cost Estimates Results in Cost and Duration Projections more than Double EPA's Estimates

An accurate estimate demonstrates that EPA's proposed remedy is more likely to cost close to $1.8 billion (net present value)—more than double EPA's estimate of $811 million (net present value). Attachment 22 presents a side-by-side comparison of EPA's approach to major cost items with LWG's approach.[195] This comparison is summarized in Table 5. The areas of difference most significant to the overall discrepancy between EPA's and the LWG's cost estimates include production rates, volume estimates for capping, use of sheetpile walls, mobilization and demobilization, and design and contingency cost percentages.

EPA's June 2016 cost estimate reduced the publicly announced cost of the remedy without actually changing many significant elements of the remedy. When EPA presented its Preferred Alternative to the NRRB in November 2015, it estimated a cost of $1.5 billion. When EPA proposed virtually the same alternative on June 8, 2016, the cost was

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[195] The LWG follows EPA's approach of using a certain cost for each line item. In fact, of course, there is variability and uncertainty in each cost projection. Attachment 23, LWG memorandum on EPA Cost Sensitivity Evaluation (September 6, 2016) evaluates the impacts of these uncertainties.

$811 million—nearly a 50% decrease from what EPA had estimated in November. A couple of material, but isolated, changes to the remedy approach contributed to the decrease (such as the assumed method of PTW ex situ treatment). But without any other significant changes to the key drivers of remedy cost—like significant changes in the volume of material to be dredged and disposed of—it was not clear how the remedy cost estimate decreased by hundreds of millions of dollars.

EPA did choose estimates at the low end of EPA-recommended ranges for many cost assumptions. For contingency assumptions, EPA modified contingency percentages to the low end of the recommended range on the grounds of the remedy's high cost and the detailed technology assignment modeling in the FS. In reality, the size, uncertainty and complexity of Portland Harbor warrants contingency percentages at least in the middle of the range. For remedial design, EPA guidance recommends 6% of capital cost, yet EPA selected 2%. Reasonable estimates for these two factors alone contribute an additional $375 million to the remedy cost estimate.

Table 5. Comparison of EPA and LWG Cost Approach.

Capital Costs			
Item	**EPA**	**LWG**	**Difference**
Direct Costs			
Mobilization/Demobilization	$9,045,000	$42,784,000	$33,700,000
Debris Removal and Disposal	$3,827,000	$3,779,000	$0
Obstruction Removal and Relocation	$15,146,000	$14,955,000	-$200,000
Erosion/Residual Control Measures (Dredge Water Quality Controls)	$25,228,000	$136,546,000	$111,300,000
Dredging of Contaminated Sediments (Open Water)	$38,183,000	$28,889,000	-$9,300,000
Dredging of Contaminated Sediments (Confined)	$2,897,000	$63,343,000	$60,400,000
Excavation of Riverbanks	$533,000	$3,337,000	$2,800,000
Dewatering and Water Treatment for Dredging Operations	$7,261,000	$31,465,000	$24,200,000
Subtitle C/TSCA Disposal	$68,536,000	$81,961,000	$13,400,000
Subtitle D Disposal	$280,706,000	$302,648,000	$21,900,000
Mitigation	$36,408,000	$62,900,000	$26,500,000
DSL Costs	-	$8,616,000	$8,616,000
Sand Placement for Technology Assignments	$20,353,000	$38,678,000	$18,300,000
Beach Mix Placement for Technology Assignments	$3,635,000	$11,425,000	$7,800,000
Armor Placement for Technology Assignments	$5,803,000	$16,473,000	$10,700,000
Reactive/GAC Placement for Technology Assignments	$44,759,000	$94,945,000	$50,200,000
Geofabric for Riverbanks	$303,000	$304,000	$0
Organoclay Mat Placement for Technology Assignments	$1,173,000	$1,159,000	$0
Transload Facility Development	$10,529,000	$37,660,000	$27,100,000
Subtotal	**$574,325,000**	**$981,867,000**	**$407,500,000**
Contingency	$114,865,000	$392,747,000	$277,900,000
Direct Cost Subtotal	**$689,190,000**	**$1,374,614,000**	**$685,400,000**
Indirect Costs			
Remedial Design	$13,784,000	$100,000,000	$86,200,000
Project Management	$13,784,000	-	$36,399,000
Responsible Party Oversight and Project Management	-	$29,432,000	
Agency Oversight and Project Management	-	$16,848,000	
Engineering Support During Construction	-	$9,204,000	
Contractor Project Management	-	$15,375,000	
Construction Management	$20,676,000	-	
Special Insurance and Bonding	-	$68,731,000	$68,731,000

Capital Costs			
Item	**EPA**	**LWG**	**Difference**
Indirect Cost Subtotal	**$48,244,000**	**$239,590,000**	**$191,300,000**
TOTAL CAPITAL COST	**$737,434,000**	**$1,614,204,000**	**$876,800,000**
NPV Cost	**$811,299,000**	**$1,772,629,000**	**$961,300,000**

Estimated Removal Volume (cy)	1,752,000	2,080,000	328,000
Estimated Total Cap Volume (cy)	814,000	1,230,000	416,000
Estimated Duration (Seasons)	7	15	8

Other Capital Costs			
Item	**EPA**	**LWG**	**Notes**
Establish Institutional Controls	$3,726,000	$11,020,000	EPA over construction duration; LWG Year 0
Initial MNR Monitoring	$10,197,000	$10,795,000	EPA/LWG Year 0
Periodic Costs			
Item	**EPA**	**LWG**	**Notes**
Long-term Monitoring and MNR	$38,426,000	$45,137,000	EPA/LWG Years 2, 4, 6, 8, 10, 14, 18, 22, 26, 30
Long-term O&M (Caps) and Institutional Controls	$5,972,000	-	EPA every 5 years
Long-term O&M (Caps)	-	$13,303,000	LWG years 5 and 10 only
Long-term Institutional Controls	-	$650,000	LWG every year after 5 years of construction
Long-term Institutional Controls	-	$50,000	LWG every 5 years
5-year Site Review	$308,000	$341,000	EPA/LWG every 5 years

Notes:
CY - cubic yard
DMM - dredge material management
DSL - Oregon Department of State Lands
EPA - U.S. Environmental Protection Agency
GAC - granular activated carbon
LWG - Lower Willamette Group
MNR - monitored natural recovery
NPV - net present value
O&M - Operations and Maintenance
TSCA - Toxic Substances Control Act

EPA's cost estimates also do not include any specific estimate of the costs for oversight of remedy implementation by EPA, DEQ, and the PRPs performing the remedy. EPA assumed rough total percentages for project management and construction management costs, totaling approximately $34.3 million for Alternative I. Based on historical agency oversight costs charged to the LWG during the RI/FS process, plus costs based on similar projects for responsible party oversight and contractor/construction management, the LWG's estimate for this cost category is double what EPA assumed.

The present value cost of a remedy that takes close to a decade, or more, to construct is heavily influenced by the discount rate. For Portland Harbor, EPA used a 7% discount rate, as suggested by 2000 guidance.[196] In its recent

[196] *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. USEPA 540-R-00-002 OSE 9355.0-75. July 2000.

Lower Duwamish Waterway FS, EPA used the discount rate of 2.3%, taken from the Office of Management and Budget Circular A-94, per EPA guidance.[197] The equivalent treasury rate for 2016 is 1.5%, which is a much more appropriate discount rate at a site where the PRPs include the United States, the State of Oregon, municipalities, public utilities, and many parties whose principal or only source of funding for cleanup are insurance funds outside their investment control. It is also the rate that EPA would presumably use in calculating required financial assurance: "The Agency believes that [financial assurance] based on a 7% discount rate could be insufficient to perform the work because funds called in from FA mechanisms are typically deposited into 'special accounts' or standby trusts, which are unlikely to grow at this annualized real rate."[198] The cost of EPA's typically required financial assurance mechanisms, such as trust funds, letters of credit, and surety bonds, far more accurately reflects actual remediation costs than hypothetical available returns on investment in the financial market. The consequence is to skew present value cost estimates low, particularly for alternatives of long duration, and make highly dredging-intensive remedies appear more cost-effective relative to other alternatives with shorter construction durations. Many other contributing factors are explained in detail in Attachments 22 and 23.

Construction durations are also significantly underestimated in EPA's analysis. Anchor QEA, LLC's review demonstrates that EPA's dredge production volumes, based on assumptions of 24 hours a day, 6 days a week dredging using incorrect dredging technology and less constrained offloading capacity, are significantly higher than what is feasible in Portland Harbor. The LWG assumed 1,600 cubic yards per day of dredging and 104 construction days per season, while EPA assumed 5,100 cubic yards per day of dredging and 122 construction days per season. As a result of these and other assumptions, the LWG assumes that construction durations for each alternative are roughly double what EPA assumed—meaning that Alternative I would take 14 years, not 7 years, to construct.

G. <u>EPA Fails to Fully Consider Many Implementability Challenges</u>

Just as EPA fails to accurately describe short-term impacts and realistic durations associated with the alternatives, it also fails to thoroughly describe and consider parameters associated with the implementability of the remedial alternatives. This includes, but is not limited to:

- Identifying and staging realistic sediment transload and water and sediment treatment facilities
- Evaluating whether dredge production rates included in the EPA 2016 draft Final FS can be maintained over the entire project schedule (e.g., contingencies for weather and equipment maintenance or breakdown and repair)
- Obtaining community acceptance, particularly of short-term impacts such as noise, light, and vehicle traffic
- Placing obstructions to the navigation channel and the requirements to move the dredge and its support vessels and structures to allow for the passage of ship traffic on an ongoing and continuous basis. (An illustration of the impact of passing vessels on dredging can be found at http://dofnw.com/animation/)
- Potentially treating large quantities of sediment

V. EPA Has Failed to Perform Even a Perfunctory Cost-effectiveness Analysis

CERCLA requires that remedies be cost-effective. In the Proposed Plan, EPA failed to perform even a perfunctory cost-effectiveness analysis and only purported to compare Alternatives E and I. A factually supported, quantitative analysis of cost-effectiveness, based on measures of effectiveness that are consistent with the NCP, reveals that the increased cost of dredging-intensive remedies, including Alternatives E and I, is not proportional to increased effectiveness when compared with less costly alternatives. EPA's has failed to demonstrate that Alternative I is cost-effective.

[197] Final Feasibility Study, Lower Duwamish Waterway Group (October 31, 2012), Appendix I, page I-5.
[198] *Guidance on Financial Assurance in Superfund Settlement Agreements and Unilateral Administrative Orders* (EPA, April 6, 2015).

A. CERCLA, the NCP, and EPA Guidance Require that Remedies Be Cost-effective

Cost plays an integral role in the Superfund remedy selection process, as demonstrated by CERCLA, the NCP, and EPA's own guidance.[199] CERCLA requires EPA to choose a remedy "that is protective of human health and the environment, *that is cost-effective*, and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable."[200]

To that end, the NCP places emphasis on cost-effectiveness at various stages throughout the remediation process. The NCP preamble explains, "[i]n analyzing an individual alternative, the decision-maker should compare...the relative magnitude of cost to effectiveness of that alternative. In comparing alternatives to one another, the decision-maker should examine incremental cost differences in relation to incremental differences in effectiveness."[201] Furthermore, "if the difference in effectiveness is small but the difference in cost is very large, a proportional relationship between the alternatives does not exist," and "[t]he more expensive remedy may not be cost-effective."[202]

With respect to the development and screening of remedial alternatives during the FS, the NCP allows for the elimination of alternatives that are not cost-effective. Specifically, the NCP provides: "[t]he costs of construction and any long-term costs to operate and maintain the alternatives shall be considered. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated."[203]

Cost-effectiveness is also emphasized during the detailed analysis of alternatives stage of the FS, with cost being listed as one of the nine criteria required to be evaluated for each alternative.[204] With respect to the selection of a remedy, the NCP requires that "[e]ach remedial action selected *shall* be cost-effective," so long as the threshold criteria of protectiveness and compliance with ARARs are met.[205] "Cost-effectiveness is determined by evaluating the following three of the five balancing criteria… to determine overall effectiveness: long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, and short-term effectiveness. Overall effectiveness is then compared to cost to ensure that the remedy is cost-effective."[206] "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness."[207]

EPA guidance reinforces the need to weigh remedial alternative cost against incremental risk reduction, stating that "[t]he evaluation of an alternative's cost-effectiveness is usually concerned with the reasonableness of the relationship between the effectiveness afforded by each alternative and its costs when compared to other available options."[208] A "[c]areful evaluation of site risks…help[s] to prevent implementation of costly remediation programs that may not be warranted."[209]

B. EPA Failed to Perform Even a Perfunctory Cost-effectiveness Analysis in the Proposed Plan

The Proposed Plan presents a "Rationale for Selecting the Preferred Alternative," which would be the appropriate section to compare and contrast the cost-effectiveness of the remedial alternatives. However, EPA fails to perform

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[199] EPA, *The Role of Cost in the Superfund Remedy Selection Process*, Publication 9200.3-23FS, 1 (Sept. 1996).
[200] 42 U.S.C. § 9621(b)(1) (emphasis added).
[201] 55 Fed. Reg. 8728.
[202] *Id*.
[203] 40 CFR § 300.430(e)(7)(iii). As the LWG previously commented, EPA's screening out of Alternative C in 2015 Draft FS Section 3 is inconsistent with guidance. Alternative C provides moderately better risk reduction than Alternative B at moderately additional cost. See Section 3 and 4 comments submitted by LWG to EPA on October 9, 2015.
[204] 40 CFR § 300.430(e)(9)(ii).
[205] 40 CFR 300.430(f)(1)(ii)(D) (emphasis added); *see also U.S. v. Am. Cyanamid Co.*, 786 F.Supp. 152 (D.R.I. 1992) ("The NCP directs EPA to prospectively choose a remedial action that EPA believes will clean-up the site for the least cost.").
[206] 40 CFR Section 300.430(f)(1)(ii)(D).
[207] *Id*.
[208] EPA, *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, OSWER 9355.0-85, 7-3 (Dec. 2005).
[209] EPA, *The Role of Cost in the Superfund Remedy Selection Process*, Publication 9200.3-23FS, 2 (Sept. 1996).

this required exercise. EPA Region 10 has previously stated that the correct place for cost-effectiveness evaluations, per the NCP, is after the FS (e.g., in the Proposed Plan).[210]

The Proposed Plan only compares Alternatives E and I. It does not measure, graph, evaluate, or compare the cost-effectiveness between or among any of the other alternatives. Alternatives B, D, F, and G are dismissed in two cursory sentences. Alternatives B and D because they "may not be [sic] meet the first threshold criteria,"[211] and Alternatives F and G because they "involve a significantly greater amount of construction area, time, impact to the environment and the community and cost more." [212] EPA's Proposed Plan ignores the NCP and guidance requirements that EPA compare all alternatives' "incremental cost differences in relation to incremental differences in effectiveness,"[213] and thereby fails to satisfy CERCLA's requirement that the selected remedy be cost-effective.

Even as to the very similar Alternatives E and I, EPA's limited reference to cost-effectiveness is insufficient to comply with CERCLA and the NCP's requirements that the selected remedy be cost-effective. The Proposed Plan devotes less than a page to the comparison between Alternatives E and I, summarily concluding that "Alternative I… is a more cost-effective alternative because it involves approximately 40 fewer acres of dredging in the navigation channel… and is approximately $58M less than Alternative E while achieving the same risk reduction."[214]

As demonstrated below, if EPA had performed a cost-effectiveness analysis among the alternatives, it would be apparent that Alternative I is not cost-effective relative to lower cost alternatives that achieve the same levels of effectiveness.

C. **Major Deficiencies in EPA's Effectiveness Analysis Must Be Corrected to Rationally Evaluate Cost-effectiveness**

To perform the NCP-required analysis of incremental cost differences in relation to incremental differences in effectiveness, EPA must have a valid analysis of short- and long-term effectiveness, which are two of the three balancing criteria used to determine overall effectiveness. Overall effectiveness is compared to cost to ensure that the remedy is cost-effective.[215]

EPA scarcely addresses these required elements of overall effectiveness, as discussed in Section IV. Instead, EPA's effectiveness analysis is limited to comparing SWACs (and resulting expected fish tissue concentrations) immediately after construction. The Proposed Plan provides that "[t]he effectiveness of each remedial alternative is evaluated in part by comparing each alternative's post-construction [SWAC] to the PRGs for each RAO in the SDUs."[216] This comparison is intended to "provide [] an assessment of how the different alternatives reduce sediment contaminant concentrations, which can then be used to calculate reductions in contaminant concentrations in fish tissue."[217]

It is inappropriate for EPA to evaluate overall effectiveness based only on SWACs immediately after construction, because EPA fails to consider the post-construction natural recovery and ENR that EPA suggests will meet PRGs in the long term. As discussed in Section IV.D, to analyze relative long-term effectiveness, EPA abandons quantitative estimates based on a calibrated and validated long-term model, and then replaces those estimates with the assumption that the Site will recover in 30 years, which is an assumption for which EPA does not provide a rationale.

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[210] Kristine Koch of EPA provided this answer in response to questions during EPA and LWG FS rollout meetings on August 3, 2015 about the absence of cost-effectiveness discussions in the 2016 FS.
[211] We disagree. See Section I.A, supra.
[212] Proposed Plan at 66.
[213] 55 Fed. Reg. 8728.
[214] Proposed Plan at 67.
[215] 40 CFR § 300.430(f)(1)(ii)(D).
[216] Proposed Plan at 49.
[217] Proposed Plan at 49.

Setting aside questions about the validity of predictive long-term models, the analysis below provides long-term SWAC estimates that are consistent with EPA's assumption that Alternative I would meet PRGs in 30 years. This analysis was accomplished by calculating the PCB half-life in Site sediments that would achieve EPA's PCB PRG of 9 ppb[218] in 30 years for Alternative I, which works out to a half-life of about 10 years.[219] This half-life was then applied to each alternative for comparative purposes. In addition to being derived from EPA's conclusion, this estimated rate of natural recovery is supported by empirical data from smallmouth bass fish tissue collected in 2002, 2007, and 2012.[220] Recent 2014 PCB sediment data appear to confirm the validity of this half-life estimate.[221] So, although EPA does not provide any explicit rationale for the 30-year recovery assumption in the Proposed Plan, that assumption appears consistent with valid estimates of the Site recovery rate based on empirical data that do not rely on predictive models.

Table 6 depicts SWAC estimates using this method, from the completion of construction of each alternative (according to EPA's estimates) to Year 30. Table 6 uses EPA's very optimistic construction durations (based on continuous dredging) and conservative initial condition SWAC of 208 ppb for PCBs (EPA 2016 SWAC), which is much higher than the SWAC of 85 ppb used in the EPA 2015 Draft FS (EPA 2015 SWAC). As discussed in Section I.C.2.b, the EPA 2016 SWAC results in risks that are inconsistent with the BLRAs and actual initial conditions are likely much lower. Table 6 also factors in the LWG's estimated Site PCB equilibrium of 20 ppb, which is the lowest likely achievable Site concentration based on the LWG's analysis of upstream PCB inputs to the Site.[222]

Table 6 demonstrates that Alternatives B and D reach a SWAC within 20% of EPA's post-construction SWAC estimate for Alternatives E and I (40 ppb) by Years 11-13—just 4 to 6 years after EPA estimates construction of Alternatives E and I would be complete. (EPA's accepted analytical accuracy for most organic compounds is at least 20%, and it is higher for most PCB measurements.[223]) Further, as noted by the green highlighted cells in Table 6, Alternatives E and I would be within the Site equilibrium range (20 to 24 ppb) as little as 1 year sooner than Alternative D and as little as 3 years sooner than Alternative B.

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[218] Note that the LWG disagrees that a long-term concentration of 9 ppb PCBs is actually achievable. The analysis below also considers that the long-term PCB equilibrium for the Site is likely to be no lower than 20 ppb (as supported by the analysis in "Sediment Equilibrium Estimates for the Revised Feasibility Study" (LWG, August 7, 2014.)

[219] Using Alternative I (the preferred alternative), EPA estimates a post-construction SWAC of 40 ppb at construction completion, which is 7 years after construction started. In order to reach a level of 9 ppb in the 23 years remaining within EPA's 30-year assumption, the site-wide concentration would need to halve every 10 years. This equates to 20 ppb at 17 years after construction started and 10 ppb at 27 years after construction started. Consequently, 9 ppb would be achieved at about 28 years after construction started.

[220] "Lower Willamette River Smallmouth Bass Data Monitored Natural Recovery Analysis." A presentation file from Anchor QEA provided to EPA on March 18, 2013. (Attachment 1)

[221] *Sediment sampling data report, Portland Harbor, Portland, Oregon*, prepared for de maximis Inc., (Kleinfelder, May 11, 2015). (Attachment 2)

[222] *Sediment Equilibrium Estimates for the Revised Feasibility Study* (LWG, August 7, 2014).

[223] Kennedy/Jenks and Integral, 2005. Portland Harbor RI/FS Round 2 Surface Sediment PCB Congeners Sample Selection Memo. Prepared for the Lower Willamette Group, Portland, OR. June 10, 2005; USEPA 2008. USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. OSWER 9240.1-48; USEPA-540-R-08-01.]

Table 6. PCB SWACs (ppb) Comparison Using EPA's 24 hour/day Assumption for Alternative Durations (using EPA's 2016 initial SWAC of 208 ppb).

EPA Alternatives	Years																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A (no action)	208	194	180	168	156	145	135	126	117	109	101	94	88	82	76	71	66	61	57	53	49	46	43	40	37	35	32	30	28	26
B				74	69	64	60	56	52	48	45	42	39	36	34	31	29	27	25	23	22	20	20	20	20	20	20	20	20	20
D						56	52	49	45	42	39	36	34	32	29	27	25	24	22	20	20	20	20	20	20	20	20	20	20	20
E/I							40	37	35	32	30	28	26	24	23	21	20	20	20	20	20	20	20	20	20	20	20	20	20	20
F													23	21	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
G																			20	20	20	20	20	20	20	20	20	20	20	20

Notes

	Duration of alternative construction
XX	Year construction is completed and EPA estimated SWAC at that time.
XX	Using an estimated natural recovery rate, the years that the alternative achieves a concentration approximately equivalent to the LWG-estimated site-wide equilibrium concentration of 20 ppb within a factor of plus 20% (i.e., plus or minus 20% is the EPA acceptable analytical accuracy for organic compounds). This equates to a concentration range of 20 to 24 ppb (i.e., 24 ppb is plus 20% of the equilibrium value of 20 ppb).

Measures of effectiveness over time depend significantly on the accuracy of construction duration estimates. As discussed in Section V.F, the LWG concludes that construction of EPA's alternatives is likely to take twice as long as EPA estimates. Table 7 uses the same methodology described above but assumes construction durations twice as long as EPA's, such that Alternatives E and I would be complete in Year 14. In addition, Table 7 initial SWACs are based on the EPA 2015 FS initial SWAC of 85 ppb, which is consistent with the BLRAs.

Table 7 demonstrates that Alternatives B and D reach a SWAC within 20% of EPA's post-construction SWAC estimate (from EPA's 2015 Draft FS) for Alternatives E and I (31 ppb) by approximately the same time that Alternatives E and I complete construction. Further, Alternatives B, D, E, and I all enter the equilibrium range (green range from 20 to 24 ppb) at about the same time (as does the no action Alternative A). This indicates that, when uncertainties associated with construction duration are accounted for, Alternatives B and D are equally effective as Alternative I, while including far less active remediation and construction.

Taking into account EPA's own 30-year recovery assumption and acknowledging the uncertainties associated with construction duration, Alternative I is highly unlikely to achieve measurably lower SWACs meaningfully sooner than other, less costly alternatives.

Further, the real world consequences of these differences in SWACs are minimal. Table 8 depicts the fish meals per month that children could safely consume (non-cancer risk) at various years after the start of remedy construction.[224] Table 8 uses EPA's starting SWAC of 208 ppb and assumed construction durations based on work proceeding 24 hours per day. Similar to the SWAC analyses above, Alternatives E and I would attain 4.3 fish meals per year immediately after construction by Year 7, and Alternative B and D would achieve the same level of fish consumption in just a few years later (by Years 11 to 13).[225]

However, Alternatives E and I would require much lower fish consumption levels[226] during an additional 3 years of construction as compared to Alternative B. Factoring in fish meals during construction, the average fish meals per year allowed under each alternative over the entire 30-year period shown in Table 8 would be:

- Alternative A – 2.7 fish meals/year
- Alternative B – 5.6 fish meals/year
- Alternative D – 5.9 fish meals/year
- Alternatives E and I – 6.6 fish meals/year
- Alternative F – 5.7 fish meals/year
- Alternative G – 4.1 fish meals/year

[224] As noted previously, EPA focuses many of the 2016 draft Final FS and Proposed Plan discussions on allowable fish meals for "people" based on a non-cancer endpoint, but in fact, these estimates are based on the child scenario, not the adult scenario.

[225] And, as noted in Section IV.C above, fish tissue concentrations are likely to remain elevated for 3-5 years following construction, minimizing the window of differential allowable fish consumption between the alternatives even further.

[226] EPA Proposed Plan page 58 indicates EPA assumed only 0.6 fish meals per year could be consumed during construction.

Table 7. PCB SWACs (ppb) Comparison Using LWG's 12 hour/day Assumption for Alternative Durations (using EPA's 2015 Initial SWAC of 85 ppb).

EPA Alternatives	Years																																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
A (no action)	85	79	74	69	64	59	55	51	48	45	41	39	36	33	31	29	27	25	23	22	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
B								49	46	42	40	37	34	32	30	28	26	24	22	21	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
D												40	37	35	32	30	28	26	24	23	21	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
E/I														31	29	27	25	23	22	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
F																										21	20	20	20	20	20	20	20	20	20	20	20
G																																				15	20

Notes

Duration of alternative construction

XX Year construction is completed and EPA estimated SWAC at that time.

XX Using an estimated natural recovery rate, the years that the alternative achieves a concentration approximately equivalent to the LWG-estimated site-wide equilibrium concentration of 20 ppb within a factor of plus 20% (i.e., plus or minus 20% is the EPA acceptable analytical accuracy for organic compounds). This equates to a concentration range of 20 to 24 ppb (i.e., 24 ppb is plus 20% of the equilibrium value of 20 ppb).

* Half-life set to rate that would achieve background PCB PRG of 9 ppb in 30 years (without applying the equilibrium asymptote at 20 ppb, which is consistent with EPA's approach). Based on EPA's text on page 4-6: "As a long-term model is not available to predict the time to meet the PRGs, interim targets for risks and HIs were established to evaluate the potential for achievement of PRGs in a reasonable time frame, which was considered to be 30 years, commensurate with the site-specific contaminants and conditions." This assumption is similar to the estimated natural recovery rate based on average smallmouth bass fish tissue half-lives using 2002, 2007, and 2012 data. Also, recent 2014 PCB sediment data appear to be approximately equivalent to this half-life.

Table 8. Fish Meals per Year (Non-cancer Child) Comparison Using EPA's 24 hour/day Assumption for Alternative Durations (using EPA's 2016 initial SWAC of 208 ppb).

EPA Alternatives	Years																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A (no action)	0.6	0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.8	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.4	3.7	4.0	4.3	4.7	5.1	5.5	5.9	6.4	7.0
Alt B	0.6	0.6	0.6	2.2	2.3	2.5	2.7	3.0	3.2	3.5	3.8	4.1	4.4	4.8	5.2	5.6	6.1	6.6	7.2	7.8	8.4	9.1	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
Alt D	0.6	0.6	0.6	0.6	0.6	2.9	3.2	3.5	3.7	4.1	4.4	4.8	5.2	5.6	6.1	6.6	7.1	7.7	8.3	9.0	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
Alts E/I	0.6	0.6	0.6	0.6	0.6	0.6	4.3	4.6	5.0	5.5	5.9	6.4	6.9	7.5	8.1	8.8	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
Alt F	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	8.0	8.6	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
Alt G	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3

Notes

	Duration of alternative construction (EPA Proposed Plan p. 58 indicates EPA will allow 0.6 fish meals per year during construction phase).
XX	Year construction is completed and EPA estimated allowable fish meals per year at that time.
XX	Using an estimated natural recovery rate, the years that the alternative achieves a number of fish meals approximately equivalent to the LWG-estimated site-wide equilibrium concentration of 20 ppb within a factor of plus 20% (i.e., plus or minus 20% is the EPA acceptable analytical accuracy for organic compounds).

Following EPA's assumptions, EPA's Alternative I would only allow an average of one additional fish meal per year over the entire 30-year period as compared to Alternative B, but with substantially greater and longer environmental and community impacts from construction. Further, this analysis does not account for the fact that fish consumption would likely need to be lower during construction than EPA assumes, because EPA did not quantify that dredging releases typically cause elevated fish tissue concentrations during and a few years after construction.[227] Thus, the real difference between Alternatives B and I's average fish meals per year over 30 years would be less than one additional fish meal per year.

Finally, EPA acknowledges but fails to quantify or evaluate that "Estimating the number of acceptable fish meals at the end of construction is not a precise calculation, but rather is a prediction that has some degree of uncertainty."[228] Thus, the uncertainty around the calculated SWACs and related numbers of fish meals provided by various alternatives means that the results are likely to be highly overlapping. Just accounting for the different estimates in construction durations results in no difference in the SWACs achieved over time by the alternatives as demonstrated in Tables 6 and 7. For example, in Table 6 (24 hour/day construction) Alternative B reaches the equilibrium range of 20 to 24 ppb by Year 20, while Alternative I reaches the same range by Year 14, but in Table 7 (12 hour/day construction) Alternative B and Alternative I both reach the same concentration range by Year 18. Calculating fish meals is an additional highly uncertain step beyond the SWAC uncertainty, and as a result, there is no real or measurable difference between any of the alternatives in terms of the number of fish people will be able to consume over the 30-year evaluation period proposed by EPA. EPA should compare real world outcomes of different alternatives (e.g., average additional fish meals per year), quantify the uncertainties in those outcomes, and provide some estimate of the time it takes different alternatives to achieve them.

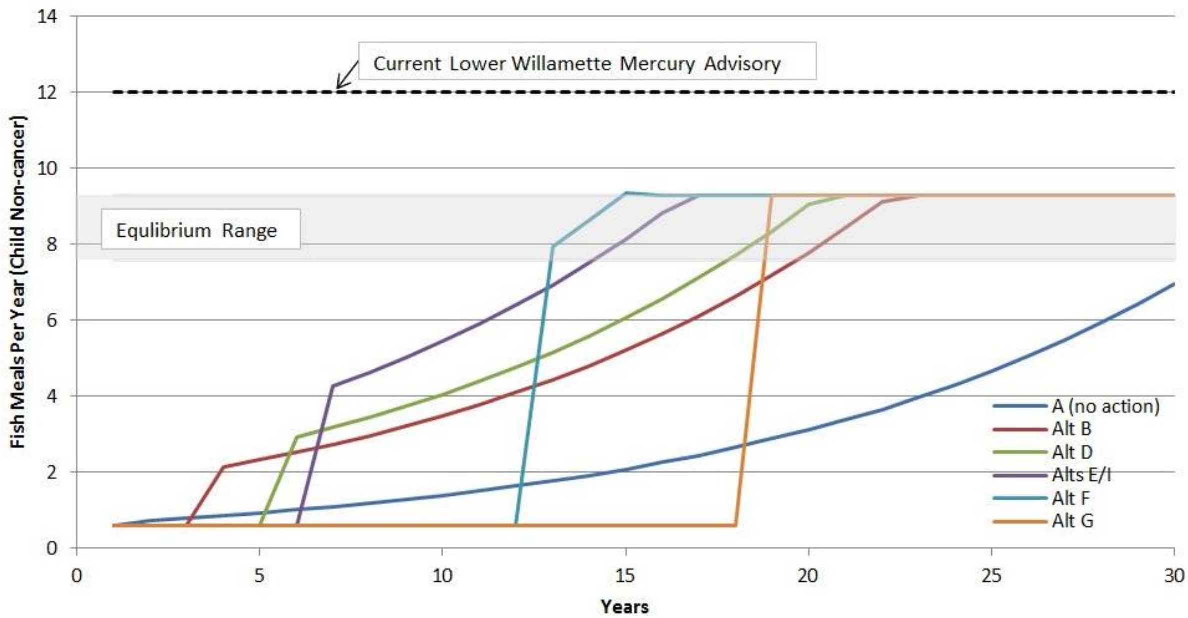
Figure 6 shows fish meals per year that can be consumed by adults for each remedy, over time, in the context of the current Portland Harbor mercury fish advisory and the estimated equilibrium range.

---

[227] See discussion in Sections I.C. and IV.C; LWG 2012 draft FS in Sections 6.2.7.3 and 8.2.2.4; Bridges, et al. 2010: Dredging Processes and Remedy Effectiveness: Relationship to the 4 Rs of Environmental Dredging. Todd S. Bridges, Karl E. Gustavson, Paul Schroeder, Stephen J. Ells, Donald Hayes, Steven C. Nadeau, Michael R. Palermo, and Clay Patmont. Integrated Environmental Assessment and Management. February 10, 2010. 2010 SETAC; IRTC p. 181; and "Sediment Monitored Natural Recovery Case Studies." Presentation at the Battelle Eighth International Conference on Remediation and Management of Contaminated Sediments. January 12-15, 2015. Carl Stivers and Clay Patmont of Anchor QEA.

[228] Proposed Plan p. 58.

Figure 6. Fish Meals/Year (child non-cancer scenario) for 2016 Draft Final FS Alternatives using EPA's Initial SWACs and Construction Durations. ("Years" represent years from construction start.)



As Figure 6 shows, all alternatives are likely to attain the equilibrium range (gray zone) supported number of fish meals within about the same 6-year period, which will still be less than the current mercury advisory for the same population (i.e., child/vulnerable). Given the uncertainties in this calculation, the actual real world outcomes in terms of fish meals per year for these alternatives is likely to be highly overlapping.

The cost-effectiveness analysis that follows uses these rational and accurate analyses, primarily of long-term effectiveness, to display what the cost-effectiveness analysis missing from EPA's Proposed Plan would show.

D. <u>Alternatives E and I are Not Cost-effective</u>

The following figures demonstrate that if EPA had performed an appropriate cost-effectiveness analysis, it would be apparent that Alternatives E and I are not cost-effective relative to other alternatives.

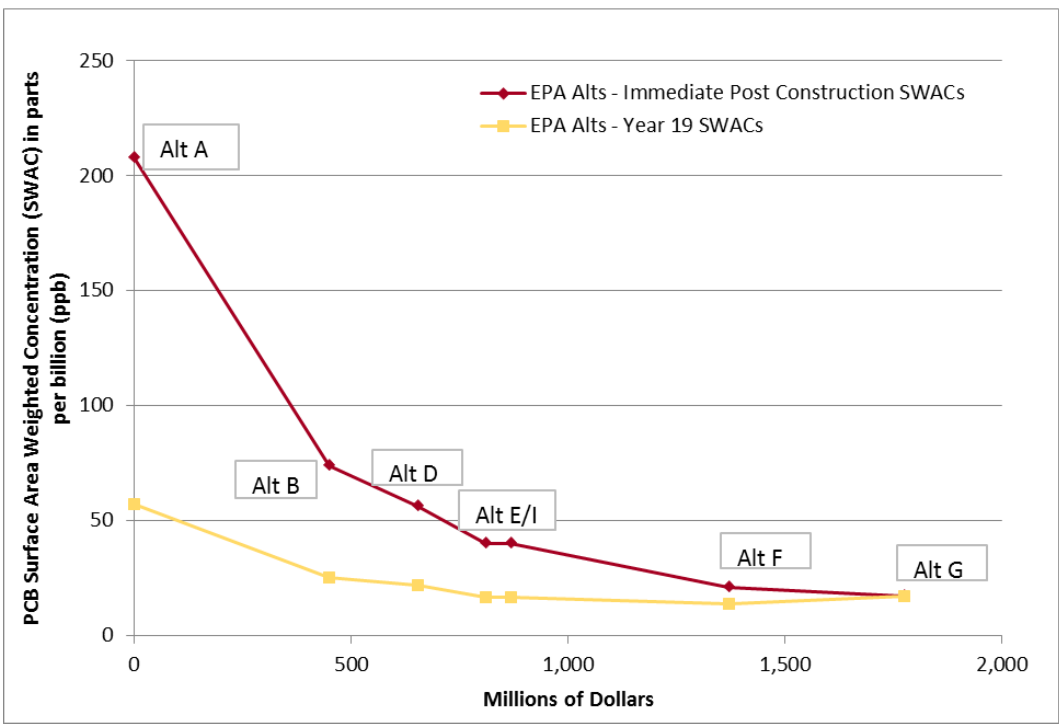
Figure 7 shows the relative additional effectiveness (as represented by SWACs) of each successively larger alternative, as compared to incremental increases in the costs of those alternatives. (Cost estimates are based on EPA's FS, which as noted in Section IV.F, significantly underestimate the true costs of the alternatives.) The red line is based solely on SWACs immediately after construction, the right most part of the line begins with EPA's unrealistically high initial condition SWAC of 208 ppb for Alternative A.

EPA focuses solely on the red line that implies relatively steep reductions in SWACs across the range of alternatives' costs. With this focus, EPA ignores the criterion of long-term effectiveness in evaluating overall effectiveness of the alternatives. A more appropriate way to evaluate cost-effectiveness among alternatives is to also evaluate the SWACs several years after construction.

The yellow line on Figure 7 shows the same alternatives evaluated 19 years after the construction of any alternative is started, given that Alternative G is estimated by EPA to be complete by Year 19 based on an optimistic 24 hour per day construction assumption. (The SWACs shown on the yellow line are the same as those presented in Table 6 above for Year 19 using the methods described there.) Clearly, the yellow (Year 19) line is much less steep than the red (immediate post construction) line, indicating that relatively little additional long-term SWAC reduction is achieved with each successively more costly alternative. Examining Year 19 SWACs, EPA's alternatives are at or near an asymptote of virtually no additional SWAC reduction by about the end of construction of Alternative D, if not Alternative B. It is worth comparing the weaker cost-effectiveness performance of EPA's alternatives as compared with the integrated alternatives from the 2012 LWG Draft FS. The integrated alternatives were designed to reduce risk faster, at lower cost. Figure 8 adds the LWG alternatives to compare with EPA's alternatives.[229] Examining Year 19 (yellow and blue lines), both EPA and the LWG's alternatives are at or near an asymptote of virtually no additional SWAC reduction by about Alternative D, if not Alternative B. The 2012 LWG Draft FS integrated alternatives perform better than EPA's alternatives by using both immediate post-construction SWACs (green line) and Year 19 SWACs (blue line), because lower SWACs are achieved at substantially lower costs. Figure 9 depicts the same information using the cost estimates developed by the LWG and summarized in Table 5.

Figure 10 shows the same relationship between SWAC reductions and costs, as measured by dividing the alternative's total cost by the PCB SWAC reduction achieved (i.e., cost in millions of dollars to achieve each incremental ppb reduction in the SWAC). Because this measure is very sensitive to the amount of SWAC reduction, Figure 10 uses an initial SWAC (Alternative A) of 85 ppb (instead of EPA's inflated 208 ppb) to compare EPA and the LWG's alternatives. (As noted elsewhere, EPA's 2015 Draft FS used 85 ppb and up to that time EPA and the LWG were in agreement for many years that the baseline SWAC for the Site was about 85 ppb.) As expected, EPA's Preferred Alternative (red and yellow bars) achieves each increment of SWAC reduction for a higher unit cost than EPA's Alternative B (red and yellow bars) either on an immediate post-construction or Year 19 basis. Similarly, all of EPA's alternatives are equally or less cost-effective (all red and yellow bars) as compared to similar LWG integrated alternatives (all blue and green bars). Unit cost measures are consistent with the NCP and show that EPA's larger alternatives (all alternatives from Alternative E upward) have substantially higher costs per unit of effectiveness as measured by SWAC reductions.[230] As noted above, EPA's costs appear to be optimistically low. Consequently, EPA's alternatives would all be even less cost-effective if more realistic (higher) alternative costs were used in any of these figures.

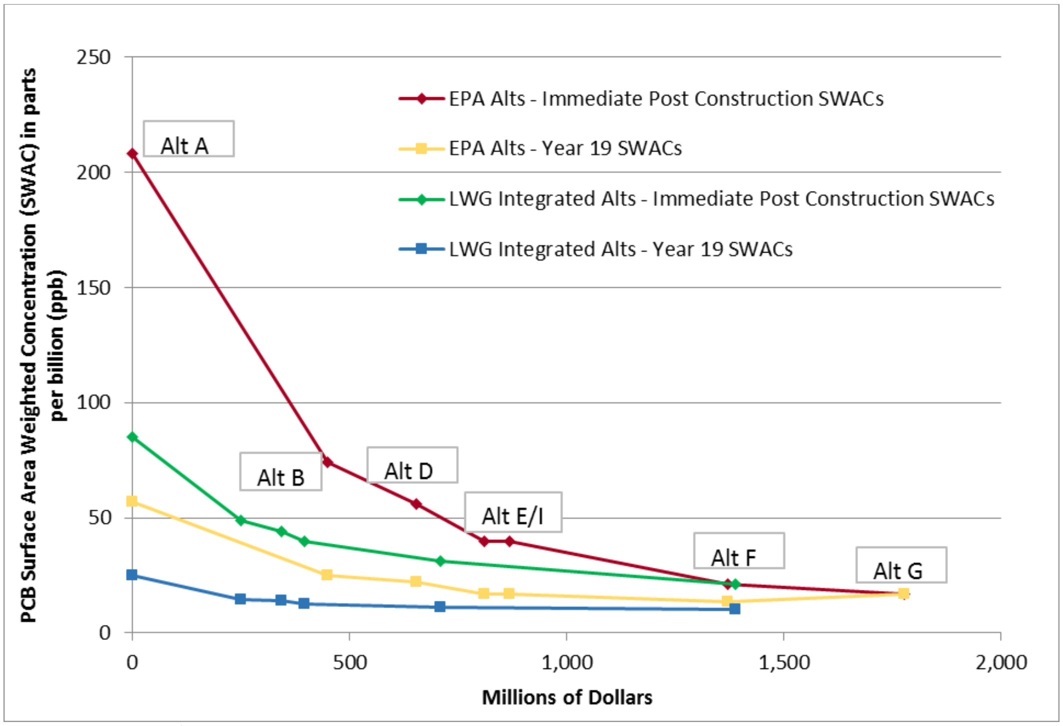
Figure 7. Comparison of EPA Alternative SWACs and Costs, Immediate Post Construction and 19 Years After Construction Start.



Note: Costs shown based on EPA estimates which appear to be optimistically low as discussed in Section V.F

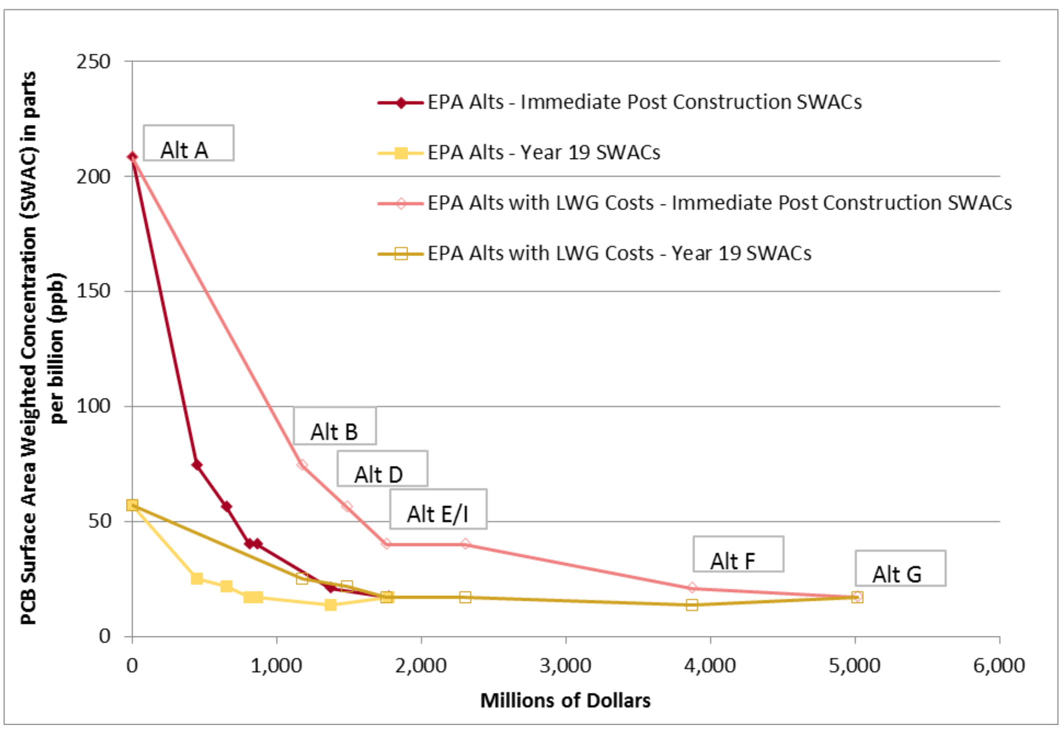
[229] The SWAC for LWG Alternative A is 85 ppb consistent with the LWG 2012 Draft FS and EPA 2015 FS as noted elsewhere.
[230] 55 Fed. Reg. 8728 ("if the difference in effectiveness is small but the difference in cost is very large, a proportional relationship between the alternatives does not exist," and "[t]he more expensive remedy may not be cost-effective").

Figure 8. Comparison of EPA and LWG Integrated Alternative SWACs and Costs, Immediate Post Construction and 19 Years after Construction Start.



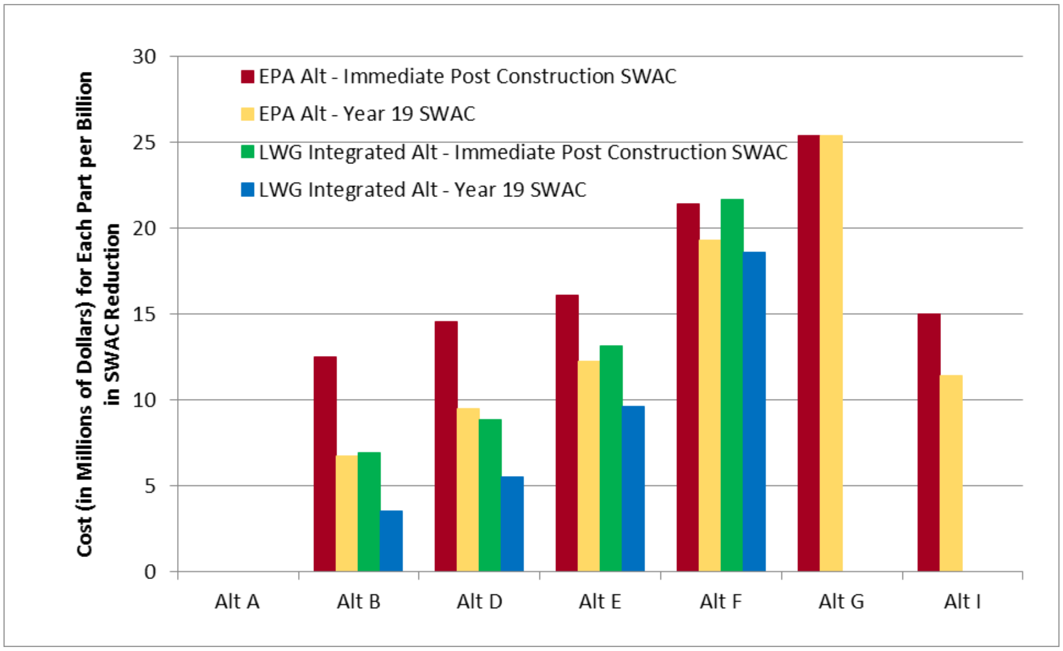
Note: Costs shown for EPA alternatives based on EPA estimates which appear to be optimistically low as discussed in Section V.F

Figure 9. Comparison of EPA and LWG Integrated Alternative SWACs and Costs, Immediate Post Construction and 19 Years after Construction Start. LWG Estimated Costs for EPA's Alternatives Shown.



Note: Costs shown based on EPA estimates which appear to be optimistically low as discussed in Section V.F

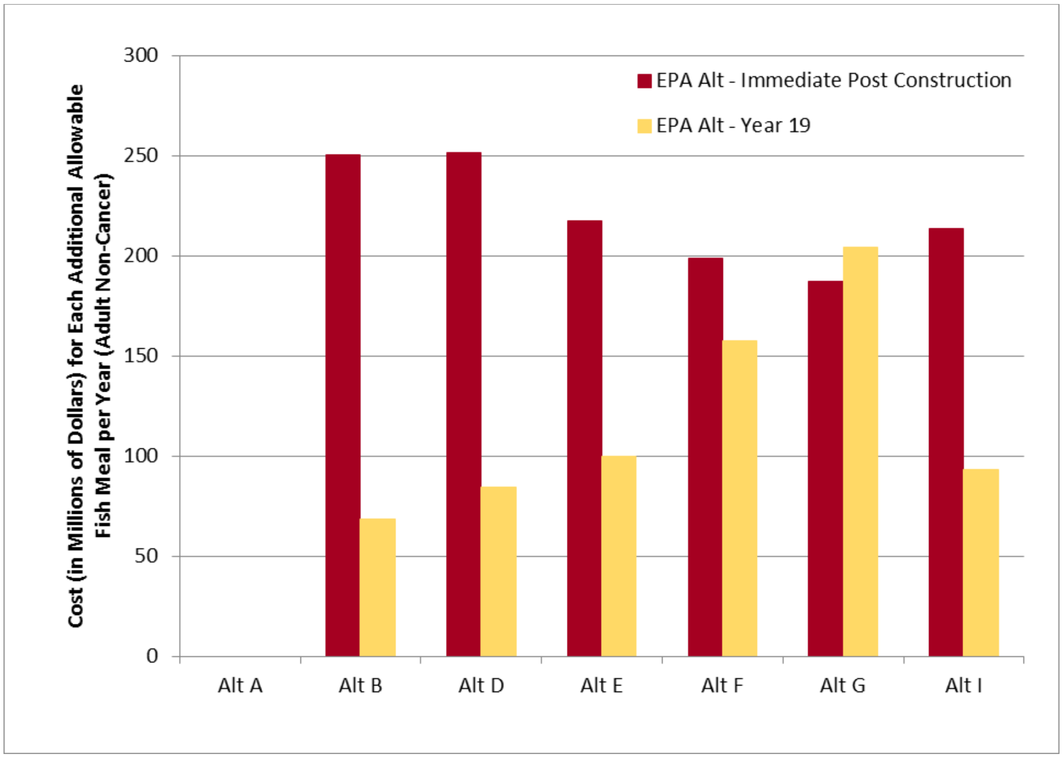
Figure 10. Cost for Each Part per Billion in PCB SWAC Reduction for EPA and LWG Alternatives.



Note: Costs shown based on EPA estimates which appear to be optimistically low as discussed in Section V.F

By way of further analysis in terms of cost versus risk reduction, Figure 11 reflects the unit costs of the alternatives for each additional allowable fish meal per year (beyond that provided by baseline conditions) for adult non-cancer risks consistent with the fish meal calculation assumptions in Table 8. Based on Year 19 allowable consumption rates (yellow bars), Figure 11 demonstrates that the larger alternatives have relatively higher unit costs for each additional fish meal allowed per year, and EPA's Preferred Alternative has a higher unit cost than Alternative B. Figure 11 also illustrates the dangers of EPA's sole focus on immediate post-construction conditions (red bars). The red bars imply lower unit costs for additional allowable fish meals with the larger alternatives, but this is only true if ongoing natural recovery after the construction period is ignored. Similar to effectiveness measured by SWAC reduction, effectiveness measured by additional allowable fish meals over the long term shows that Alternative I is equally or less effective than the much less costly Alternatives B and D. Also, as noted above, if EPA's entire 30-year period is examined (the period EPA assumes it will take until attainment of the PRGs), the average allowable annual fish meals for Alternative I (average of 31 fish meals/year) is only three more meals than for Alternative B (average of 28 fish meals/year).

Figure 11. Cost for Each Additional Allowable Fish Meal per Year for EPA Alternatives, Immediate Post Construction and at Year 19 after Construction Start.

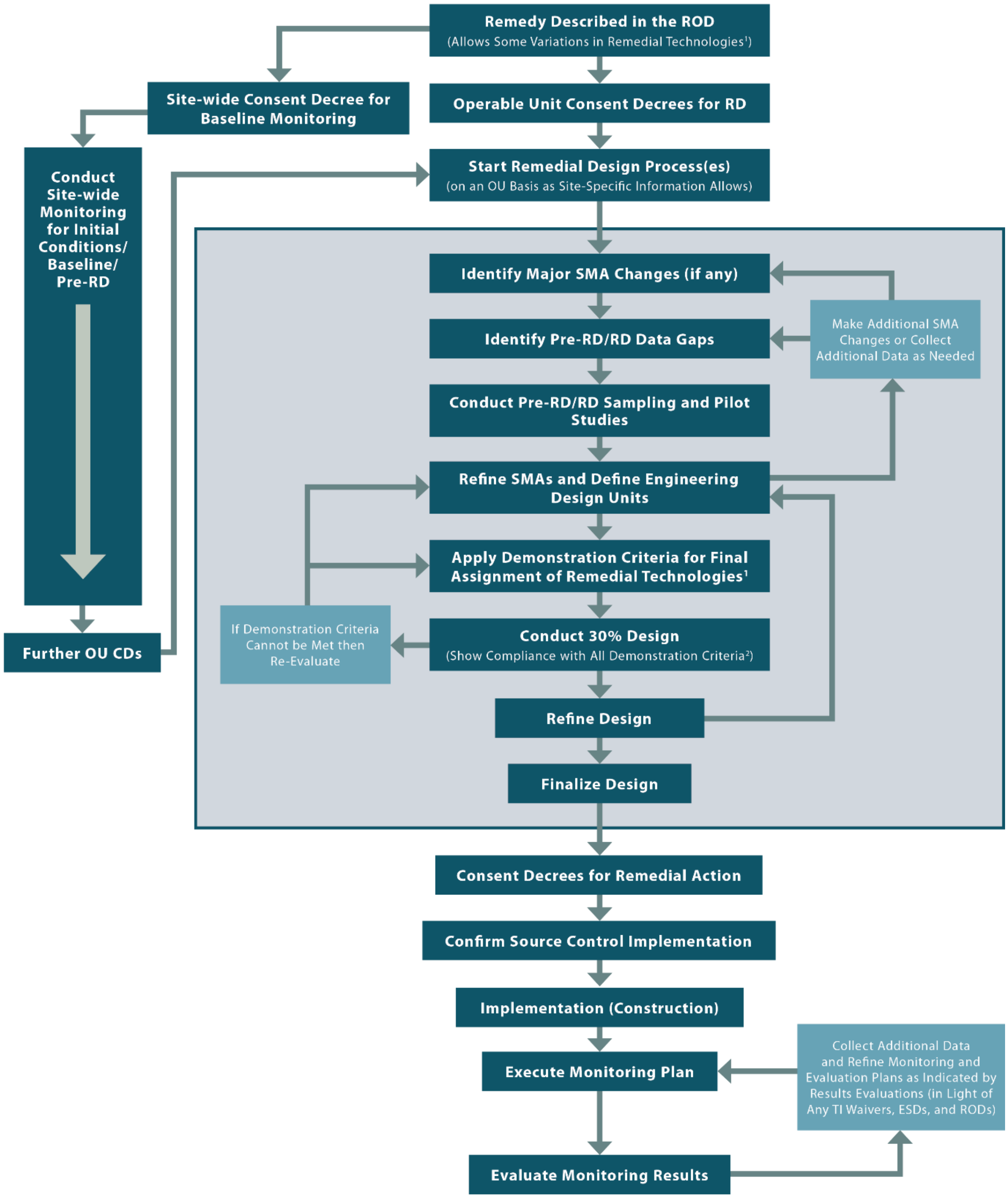


Note: Costs shown based on EPA estimates which appear to be optimistically low as discussed in Section V.F

VI. EPA's Remedy Selection Should include a Plan for How Cleanup will be Implemented Through Baseline Data Collection and Remedial Design and Implementation at Operable Units

Notably missing from EPA's Proposed Plan is a procedural and technical implementation roadmap of how cleanup of Portland Harbor will be accomplished. Having a clear understanding of that roadmap is critical to timely and successful cleanup. The LWG recommends that the ROD define a procedural process similar to Figure 12.

Figure 12. LWG Recommended Iterative Remedial Design/Remedial Action Approach



EPA should manage implementation of cleanup through the identification of operable units. After appropriate data needs are filled and pre-remedial engineering design studies are completed, some operable units may be ready to move into remedial design sooner than others. Remediation in operable units is a key CERCLA program management principle supporting EPA's "bias for action."

The National Contingency Plan provides:

> (ii) *Program management principles.* EPA generally shall consider the following general principles of program management during the remedial process:
>
> (A) Sites should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phased analysis and response is necessary or appropriate given the size or complexity of the site, or to expedite the completion of total site cleanup.[231]

Contemporaneous initiation of cleanup at some operable units while others undergo additional assessment is entirely consistent with the NCP:

> While the bias for action promotes multiple actions of limited scale, the program's ultimate goal continues to be to implement final remedies at sites. The scoping section of today's rule has been amended to make clear that the lead agency shall conduct strategic planning to identify the optimal set and sequence of actions necessary to address the site problems. Such actions may include, as appropriate, removal actions, interim actions and other types of operable units. Site management planning is a dynamic, ongoing, and informal strategic planning effort that generally starts as soon as sites are proposed for inclusion on the NPL and continues through the RI/FS and remedy selection process and the remedial design and remedial action phases, to deletion from the NPL.[232]

EPA's Sediment Guidance recommends exactly this approach: "Project managers may also consider separating the management of source areas from other, less concentrated areas by establishing separate operable units (OUs) for the site."[233]

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[231] 40 CFR §300.430(a)(1)(ii). The preamble to the 1990 revisions to the NCP explains,

> A bias for action is consistent with EPA's long-standing policy of responding by distinct operable units at sites as appropriate, rather than waiting to take one consolidated response action. The 1985 NCP originally codified this policy that remedial actions may be staged through the use of operable units.
>
> ***
>
> Consistent with the bias for action principle in today's rule, EPA will implement remedial actions in phases as appropriate using operable units to effectively manage site problems or expedite the reduction of risk posed by the site.
>
> ***
>
> EPA supports the operable unit concept as an efficient method of achieving safer and cleaner sites more quickly while striving to implement total site cleanups. Although the selection of each operable unit must be supported with sufficient site data and alternatives analyses, EPA allows the ROD for the operable unit to use data and analyses collected from any RI/FS performed for the site.

55 Fed. Reg. 8666, 8704-05.

[232] 55 Fed. Reg. at 8706. See also, 53 Fed. Reg. at 51423: "Where problems are reasonably severable, phased responses implemented through a sequence of operable units may promote more rapid risk reduction."

[233] EPA, *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, p. 2-22. EPA's decision to approach other large and diverse Superfund sites as a monolithic whole has been criticized by the scientific community. A 2005 report by the National Academies of Science reviewing EPA's work in the Coeur d'Alene River Basin concluded that EPA's decision to treat a large and diverse area as a single operable unit resulted in a slower, less effective and more uncertain cleanup:

> By combining these different problems into one OU and subjecting them to the process established in the NCP, EPA must attempt to answer all the questions for all the problems before it can attempt to remedy any of them. As a result, the agency must delay action on addressing the more tractable problems until it has all the information it needs to decide what to do about those that are less easily addressed, or, alternatively, it must propose remedies for some of the problems with inadequate information.
>
> ***
>
> As an area increases in complexity, the certainty of cost, volume, and remedial efficacy estimates decreases as does the certainty that selected decisions will be conducted. In reality, these large geographically complex sites like the Coeur d'Alene River basin cannot be

Breaking up the site into operable units would allow EPA to get cleanup started in areas where more information exists while less well-defined areas or areas of lower risk proceed on a parallel path through collection of baseline or "initial conditions" assessment. Figure 12 depicts our recommended programmatic approach to remedial design and implementation at Portland Harbor, which could allow different areas of the Site to move at different rates based upon site-specific information and information to be developed after the ROD.

VII. The Administrative Record, As Supplemented by These Comments, Demonstrates that EPA's Selection of its Preferred Alternative Would Be Arbitrary and Capricious

Appendix A provides additional information for the Administrative Record. This information was exchanged between EPA and the LWG during preparation of the RI/FS, provided by the LWG to EPA in the course of the LWG's work on the RI/FS or previously generated by EPA. The LWG previously recommended that most of these records be placed within the Administrative Record as appendices to relevant LWG deliverables; in most, if not all, cases, EPA required the LWG to remove the records from the deliverables. We are therefore incorporating these and similar records into our comments on the Proposed Plan for inclusion in the Administrative Record file pursuant to 40 CFR §300.815(b). The LWG and its members submitted Freedom of Information Act requests to EPA on March 9, 2016 (as clarified April 4, 2016) and August 11, 2016. EPA has not completed its responses to these requests. The LWG and its members may request that the Administrative Record be supplemented by information EPA provides after the public comment period closes.

Conclusion

EPA has departed so significantly from the baseline risk assessments that it cannot accurately describe the risk reduction attained by each of its alternatives. The unrealistic assumptions EPA has made about the practical and engineering details of its alternatives, together with the simplifying assumptions it has made about the physical, chemical, and temporal properties of the Site, limit EPA to subjective and conclusory evaluations of the performance of those alternatives at attaining its inaccurate risk reduction estimates, and they prevent a meaningful assessment of the impacts of those alternatives on the community and the environment. These errors, compounded with EPA's incomplete and imprecise cost estimating, make it impossible for EPA to shine any real light on why it is making the decision it proposes to make, or how that decision is more than throwing darts at the wall, flipping a coin, or making a sudden knee-jerk decision. A thoughtful review of the evidence before EPA leads instead to the conclusion that less aggressive, shorter duration alternatives, based on site-specific information and current data, are protective, would be as effective at reducing risks identified in the baseline risk assessments, would result in less short-term risk to people and the environment, and would attain the amount of risk reduction achievable through sediment remedies in about the same amount of time and at far less cost than EPA's Preferred Alternative.

In its October 19, 2015, letter to the NRRB, the LWG provided several recommendations on implementing the cleanup, including focusing on the most significant and pervasive risks, selecting cleanup goals that are aligned with the risk assessments and are achievable, treating principal threat waste only where it is more cost-effective than other disposal options, reducing the uncertainty about natural recovery, and maximizing flexibility in remedial design and implementation of the cleanup. Our review of the Proposed Plan has not changed those general recommendations:

- Reasonable PRGs based on appropriate risk management.
- RALs that are appropriately applied to surface sediments consistent with the methods and results of the BLRAs and that focus on active remediation of the highest contaminant concentrations:
  - PCB RAL of 1,000 ppb

remediated in a short time frame, and efforts to describe the entirety of the problem and chart a path to completion (as attempted in the Superfund process) become less realistic with increasing complexity of the site.

National Academy of Science, *Superfund and Mining Megasites Lessons Learned from the C'oeur d'Alene River Basin* (2005), pp. 420-21.

- – DDE RAL of 1,000 ppb
- – cPAH (as BaPEq) RAL of 20,000 ppb
- – Designated CBRAs consistent with the multiple lines of evidence evaluation of benthic toxicity in the BERA

- Flexible technology assignments assigned to SMAs or operable units, with an appropriate balance of removal and in-place technologies at the harbor-wide scale (e.g., capping, in situ treatment, and EMNR). We anticipate this will equate to approximately 50% dredging and 50% in-place technologies (by site-wide acreage). Technology assignment must take into account that the longer it takes to implement the remedy, the longer the impact to the river and the fish, and the longer it takes the system to recover.
- No identified PTW. Substantial product at the Gasco Sediment Site will be managed consistent with the 2009 Gasco Consent Order.
- Appropriate application of in situ and ex situ treatment of a significant volume of materials at the Site through application of the above appropriate RALs and technology assignments.
- Use of operable units to manage the Site based on localized chemical and physical characteristics.
- Exclude riverbank soils remedies (leaving those to be designed and implemented through either DEQ upland source control program or future sediment remedial designs).
- Refinement of technology assignment and process options in remedial design (e.g., types of dredging and dredge BMPs types of treatment, and habitat and flood mitigation methods).

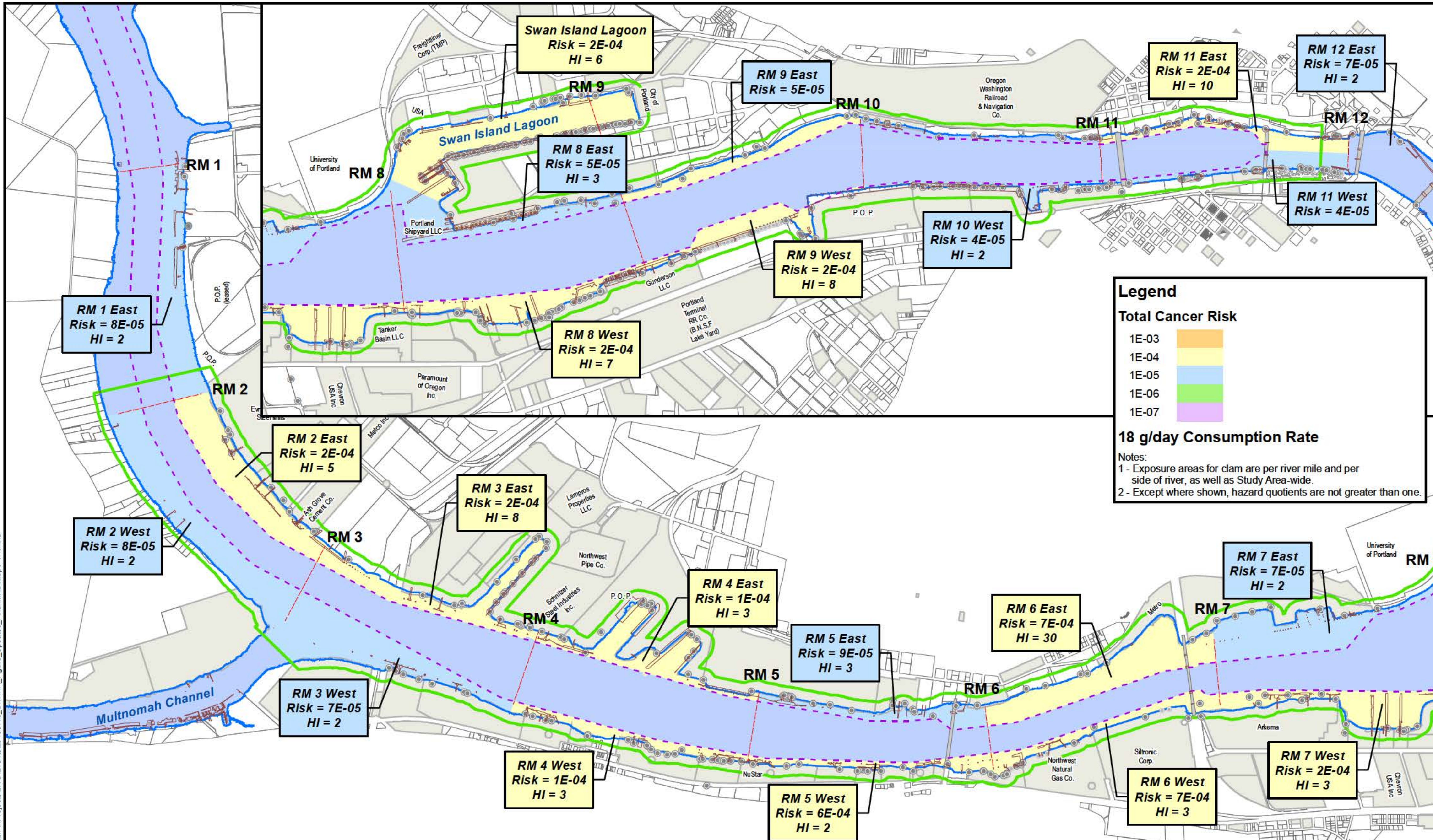
As discussed in these comments, such an alternative would be protective and compliant with ARARs and would be a cost-effective, implementable remedy. The areal extent of SMAs developed under this alternative would be defined based upon evaluation of data collected through additional baseline sampling and during remedial design, and the general balance of technology assignments would be refined or modified during remedial design as appropriate based upon site-specific engineering evaluations and design data. The LWG believes this remedy could be implemented through settlement within a reasonable timeframe following the ROD.

Sincerely,

The Lower Willamette Group

cc: Kristine Koch, US. Environmental Protection Agency, Region 10
Sean Sheldrake, U.S. Environmental Protection Agency, Region 10
Confederated Tribes and Bands of the Yakama Nation
Confederated Tribes of the Grand Ronde Community of Oregon
Confederated Tribes of Siletz Indians of Oregon
Confederated Tribes of the Umatilla Indian Reservation
Confederated Tribes of the Warm Springs Reservation of Oregon
Nez Perce Tribe
Oregon Department of Fish & Wildlife
United States Fish & Wildlife
Oregon Department of Environmental Quality

TAB 5



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Kennedy/Jenks Consultants
Engineers & Scientists

LWG
Lower Willamette Group

FEATURE SOURCES:
Transportation, Property, or Boundaries: Metro RLIS.
Channel & River Miles: US Army Corps of Engineers.
Bathymetric Information: David Evans and Associates, Inc.

Map 5-4-1
Portland Harbor RI/FS
Final Remedial Investigation Report
Appendix F: BHHRA
March 28, 2013

Risks from Clam Consumption, RME

TAB 6

DHS Oregon Department of Human Services

FAX COVER SHEET

Oregon State Public Health
Environmental & Occupational Epidemiology
503-731-4025
Fax: 503-872-5398

Date: 6/13/07	**Sender:** Julie Early
To: Cindy	**Office Name:**
Office Name:	**Address:** 800 NE Oregon St., #827
Address:	**City:** Portland
State: **Zip:**	**State:** OR **Zip:** 97232
Phone No.:	**Phone No.:** 503-731-4025
Fax No.: 503-295-4901	**Fax No.:** 503-872-5398
	Total Pages:

Re: Linnton Comm. Center Report – Portland Harbor

☐ **Urgent** ☐ **For review** ☐ **Please comment** ☐ **Please reply** ☐ **Please recycle**

Let me know if you have any ?'s.

1 [redacted] : Living in camp trailer and an old car. Came from Texas a few months ago. Move around every few days. Park on vacant industrial land and old roads and parks located between Willbridge and St. Helens. Fish in superfund area in Multnomah Channel and in the Willamette . Their estimated age is about forty or fifty. Found parked on road off Marina Way. Don't know how long they will stay in area. They had been catching crawdads and sturgeon wanted to know the best fishing places. Mostly cook in frying pan on cook stove or boil. Make "fish head soup". (soup made with the boiled heads of any kind of fish. They catch the fishermen before they discard the fishheads and ask for the heads. The heads are boiled and seasoned in a milky broth , eyeballs and all.) They say it's really good.

2 [redacted]: Live in a car. Move around up and down the river. Early teens late twenties. Fish for trout, sturgeon, steelhead bass squawfish. Catch squawfish for money. Bathe with river water. Do not drink river water. Park in abandoned industrial lots, sides of old roads. Move around every night. If park in same place every night police come. Don't know how long will stay in area but probably for summer. The "state" buys the squawfish for money. They pull in with a van at Diddlers Beach by the airport that has ice chests. If the squawfish are over 9" long they pay $6.00. If you have over 100 they pay $10. Cook fish over campfires on a grill or in a frying pan.

3 [redacted]. fishes off the shore for sturgeon, steelhead, salmon, bass crawdads whatever he can catch. Lives "up there" (off Skyline in Forest Park?). Would not disclose exact location where he camps. Fishing at beach in Linnton. "Lives in woods." " Don't always live in woods". Bathes and swims in river. Drinks creek water sometimes and buys water. Eats whatever he catches. Cooks the fish however he can. Sometimes buys bricquets and lighter fuel when its raining and too hard to start a fire. Puts net out for crawdads, pulls net up to the top of the water for a couple of days to let the clean water run through them for a couple of days before he eats them. "Otherwise they taste like mud" He boils them "like lobster".

4 [redacted] on trail off Newberry Rd. Catches catfish to sell to Vietnamese. Eats bass salmon and sturgeon. Fishes in Linnton area. bathes in creek. Just moved camp. Temporarily staying in Forest Park. Bathes in river when camped by river.

5 [redacted] stays in his boat at Freds Marina. Takes people fishing for money. Eats all fish, crawfish. Bathes in river, buys water. Eats "whatevers running". Cooks on a stove in his boat. Mostly fries his catch. Does not eat "junk fish".

6 [redacted] approximately fifty years old Lives in camp off Marina Way. Blue tarps are visible from road. Digs in trash at 7-11 for bottles for money. Friends give him fish or he eats fish with friends at their camps. Does not fish himself. Very uncommunicative. Very reclusive. Lives under tarps at side of Marina Way for years. Rides bike. Took 5 pamphlets to give to his friends"vietnam vets that live in the woods" " wont tell nothing else about them."

7 [redacted] stays in forest Park above Newberry. Fishes with John on Willamette and Multnomah Channel. Squawfish to sell. Eats sturgeon, bass catfish, "whatever is biting". Bathes in river. Gets $6 to $7 apiece for squawfish, Shad.

8 [redacted] lives in Forest Park when he is homeless or can't find friends to live with. Probably spends winters in houses when he can. Uses drugs. Fishes for bass whatever he can catch. Lives in tent on river bank when no one will let him stay at their house.

9 [redacted] would not disclose exact location of camp but live up trail on west side of the St. Johns Bridge in big canyon in Forest Park. There is a set of stairs and then a trail Each has own shelter behind the police impound lot. Fish for whatever they can catch. Wont eat squawfish, carp or suckers. Suckers are too bony. Drinks from creeks. Wont eat shad.

10 [redacted], just passing through. Stays in trees north of power poles Catches anything he can. Eats anything edible. Clams, carp, shad, suckers bathes in river. Throws out three of four lines pulls in with hands.

11 [redacted]. lives off river and in Forest Park. Catches whatever he can. Throws back carp suckers. Uses crawdads and clams for bait. Does not drink river water. Drinks from little creeks running into the Willamette.

12 [redacted] " a little nuts" fishes camps out on river bathes in river. Lives by power poles in camp most of the time. " Does not handle society well." Eats clams crawdads bass anything he can beg or catch. Drinks from creeks.

13 [redacted] lives in tree house "fort" above Linnton. Bathes in creek. "Fishes every once in awhile" Mostly catfish. Drinks from creeks bathes in creeks. Occassionally catches bass. Sometimes eats clams because easy to find and hungry.

14 [redacted]: Fishes in Linnton. Camps in St. Johns. Uncommunicative. Met on railroad tracks.

15 [redacted]: Lived in school bus, ambulance and several cars across from steel yard on Front Ave. in Linnton. Have lived in the area of the steel yard off Front Avenue in Linnton for years off and on.. Kept several cars running and would move them around to keep police at bay. . Have ten children aged two to 22 that lived with them in the vehicles. The state has towed their vehicles several times. Somehow they get them or others back. The state have taken the children away and put them in foster care. For some reason the teenage boys are back. The older girl is still with them and never left. One boy is about 18 and the other is 15. The 15 year old says he lives in a foster home but is always in Linnton. The community center pays the 15 year old for several hours on Sunday evenings to mop the gym floor and clean the bathrooms. . The state towed the bus and most of the vehicles away again about in February. The (b) (6) then began living in the back of a small white pickup with tarps and a makeshift camper. They still

park down on Front by the steel yard. The parents do not work. They do not fish. They eat fish when it is given to them by fishermen.. The steel yard is by a beach on the Willamette that is frequently used by fishermen. They cooked it and all their food in pans on a stove they had set up by the school bus. I do not know how they cook now, but probably set their stove up by the pickup.

16 [redacted] stays in his boat. He moves it up and down the river and channel. He bathes in the river. He usually cooks on a small camp stove.

17 [redacted] stays in a friends garage. He fishes on the east side of the river by the power poles. He uses a camp stove and frying pan. He eats whatever he catches. Does not eat suckers.

18 Two women met on railroad tracks by Linnton. Temporarily camped near Willbridge. Came to Portland to get married. Asked about good fishing spots.

19 Fat Man and girlfriend. Fish for everything. Whatever is biting. Currently camping at power poles. Always leave a big mess when they move camp. Have been around for years. Eat anything. Don't eat "junk fish" carp, squawfish or suckers. Haul water in plastic containers from gas station. Bathe in river. Usually fry fish. Sometimes barbecue depending on weather. Sometimes use wood, sometimes briquets. Fatman is approximately 50. His girlfriend is about 30.

20 [redacted] stays in van behind Texaco station. Fishes at power poles. Can't drive van due to DUI. Fishes for bass, catfish, squawfish for money. Uses a little fishing pole. Cooks on little campstove.

21 [redacted] move camps up and down river all the way from St. Helens to Willbridge. Fish for sturgeon, catfish, bass, croppie, squawfish for money.

22 [redacted] lives on beach below steel yard. He has a camp made of tarps. He cooks on fires. Bathes in river. Fishes for edible fish only. No suckers or carp. Sometimes drinks from river but heats the water good. .

23 [redacted] a black man about 50 years old has lived by the power poles in tarp and cardboard camp for 6 or 7 years. The "cops" tore his camp down last winter. Lived with girlfriend. When they tore his camp down he moved his camp to a cove by the railroad bridge. He uses a rope to get to his camp. Sometimes works as a pipefitter. Has money. He "just loves camping by river". "Doesn't like to be part of society." Relies on river for food. Does not eat "junk fish". Uses crawdads for bait.

Amanda Guay.
Dept. of Human Services
800 NE Oregon Street
Portland, Oregon 97232-2162

Pat Wagner
Linnton Community Center
10614 NW St. Helens Rd.
Portland, Oregon 97231

JUN 18 2004

June 6, 2004

Dear Amanda Guay,

This project was done in the winter and spring months. In the beginning I attempted to carry the project out myself with the help of (b) (6), a man that has lived and been homeless off and on in the Linnton area for years. (b) has a severe problem with alcohol. (b) lived in a camp on the river last summer and is as well acquainted with the transient population and their habits as a person can be. This approach did not work very well. People avoided me and would not talk. I sometimes felt afraid because the few I was involved with were not friendly or interested in talking with me.

After we realized this was not working (b) and I evaluated and changed our approach to the camp visits.. (b) made the visits by himself because the people would not communicate with me around. (b) enjoys their company. (b) had to spend time visiting them, drinking with them and fishing with them to get some of them to talk. Sometimes he spent the night with them around their campfires. . Even with this approach many did not want to answer many questions. (b) spent countless hours hiking the back trails and abandoned roads and railroad tracks where he had seen homeless people fishing and camping. (b) would just head out with his pockets full of beer and his fishing pole and would run into some that he has known for quite some time or strike up conversations with new people. He could not take notes during the conversations. (b) wrote notes in a notebook he kept in his pocket after he parted ways with the people. This project occurred between February and June.

(b) carried pamphlets in his pockets and would convey the information in the pamphlets about safe fish consumption when the time was appropriate and when he was most likely to get a positive reception. He tried to question them on their habits as best he could without pushing too hard and having them pull away and becoming uncommunicative. He gave each of these people pamphlets and sometimes extras for their friends. (b) said most seemed receptive to the information.

This population is mostly very transient. This project would have best been carried out during the summer months as that is when the population of homeless increases

In response to the questions provided by David Stone Ph.D

Most homeless people spoke to reported not seeing homeless children.

The following businesses have reported to me about homeless children.
Frank Berg, Plant Leader from OWENS CORNING 11910 NW St. Helens Rd. Portland, Oregon Phone: 273-1465, an industry with lots of riverfront property in the Superfund area reports having to tear down a camp with parents and a little girl about three or four years of age a couple of times. He eventually fenced his property to keep them off because it "broke his heart" when the little girl said" Do we have to move again Daddy."

RK Storage, a steel industry on NW Front Avenue, employees, Eric and others have reported the (b) (6) family for garbage and not taking care of their children to the police multiple times. At one point all ten of their children lived with them in vehicles parked by the steel yard. . The men in the steel yard were always afraid they were going to run over one of the children with their lift machines and trucks.

Enclosed is a newspaper article about one homeless family. Kuney Construction workers observed this man and his child hiking back up into the woods many times. As with most homeless families they were very secretive and elusive.

The police from North Precinct that covers the Linnton area will tell you that there are a very few homeless children living along the river or in Forest Park on occasion. They say that the parents hide their children during the day and only let them out at night. Speak to Sgt. Karl McDade of North precinct about this.

Crawfish, Crayfish and Crawdads are just different names for the same thing.

2000 copies of printed brochures were divided among the ARCO store, Seven Eleven, Freds Marina store, Linnton Feed Store and the Texaco in the Linnton area. . These are the places people buy bait and snacks for fishing trips. Brochures were posted in the windows and on some doors of these businesses. Store employees agreed to give the brochures to people purchasing bait.

Pat Wagner

Pat Wagner

ADDENDUM

As this project progressed in the spring we remembered from past summers groups of Hispanic men that migrate to work on Sauvie Island in the farmers fields during the spring and summer months. One large group of these men reside communally in a large house near the Sauvie Island Bridge every summer. When we went to Krugers Farm we observed about five or six Mexican men in the back of a pickup truck just returning from a fishing trip. They did not speak English well enough to communicate effectively with us but indicated they had been fishing in the river nearby.

We did our best to have our brochure translated to the Spanish language and are currently making 1000 copies to be distributed to the farmers, markets and stores on Sauvie Island. There are more brochures than currently needed, however, this population is transient and the brochures should last throughout the summer.

TAB 7

PB97-963148
EPA/541/R-97/165
January 1998

EPA Superfund Explanation of Significant Difference for the Record of Decision:

Salem Acres
Salem, MA
4/11/1997

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
JOHN F. KENNEDY FEDERAL BUILDING
BOSTON, MASSACHUSETTS 02203-0001

EXPLANATION OF SIGNIFICANT DIFFERENCE
SALEM ACRES SUPERFUND SITE
SALEM, MASSACHUSETTS

Site Name: Salem Acres Superfund Site

Location: Salem, Massachusetts

Lead Agency: U.S. Environmental Protection Agency

Support Agency: Massachusetts Department of Environmental Protection

Under Section 117(a) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and promulgated in 40 C.F.R. Sections 300.435(c)(2)(I) and 300.825(a)(2), if the United States Environmental Protection Agency (EPA) determines that the remedial action at the Site differs significantly in scope, performance or cost from the Record of Decision (ROD) for the Site, EPA shall publish an explanation of significant difference between the remedial action being undertaken and the remedial action set forth in the ROD and the reasons such changes are being made.

This Explanation of Significant Difference (ESD) contains a brief history of the Salem Acres Site, a description of the remedy selected in the ROD signed on March 25, 1993, and a description of and rationale for the change to the ROD.

This ESD and other supporting documents can be found in the Administrative Record located at EPA's Region I office at 90 Canal Street, Boston, Massachusetts, open Monday - Friday 8 a.m. - 1 p.m. and 2 p.m. - 5 p.m., and at the Salem Public Library, 370 Essex Street, Salem, Massachusetts, 01970.

I. Site History

Salem Acres Superfund Site (the Site) is a 234 acre parcel of land located in the cities of Salem and Peabody, MA. The contaminated portion of the Site comprises an area of approximately thirteen (13) acres located in the southerly portion of the parcel, and is entirely in Salem. The contamination on the thirteen acres consists of an old landfill, three debris piles, a fly ash pile and a series of sludge lagoons. There are three potentially responsible parties (PRPs) associated with the Site, the owner, DiBiase Salem Realty Trust, and two generators, the Massachusetts Electric Company and the South Essex Sewerage District. Each of the PRPs settled with EPA and DEP and each signed consent decrees to remediate a portion of the Site.

The landfill, debris piles and the fly ash pile were substantially remediated in 1995 and 1996 by DiBiase Salem Realty Trust and Massachusetts Electric Company, respectively. The South Essex Sewerage

District is currently remediating the sludge lagoons which is scheduled to be complete in late spring of 1997.

II. Summary of Remedy

The selected remedy consists of treatment of certain contaminants in-place and excavation and disposal of all contaminated materials off-site at permitted off-site landfills. On-site wastes and soils are to be remediated to the cleanup levels specified in the ROD.

The soil cleanup levels established in the ROD for specified contaminants were based on calculations performed as part of the 1992 Health Risk Assessment (HRA) which utilized toxicity data in effect at that time. This risk assessment was performed as part of the Remedial Investigation for the Site. The cleanup criteria established in the ROD has allowed for unrestricted future use of the property once the cleanup is complete.

III. Explanation of Significant Difference

As mentioned above; the cleanup levels established in the ROD for on-site wastes and soils were calculated as part of the 1992 Health Risk Assessment, conducted as part of the Remedial Investigation for the Site. The calculated levels were based on toxicity criteria in effect at that time or on background concentrations available for the site. This ESD will establish soil cleanup levels for six carcinogenic polyaromatic hydrocarbons (cPAHs), revise the cleanup level for one cPAH and revise the background concentration and thus the soil cleanup level for beryllium.

A. With regard to the cPAHs, the risk evaluation was based on toxicity data which was available for only one of the cPAHS - benzo(a)pyrene, which had an oral potency slope factor value of 12 $(mg/kg/day)^{-1}$ when the ROD was signed. The oral slope factor is EPA's terminology for describing how potent a compound may be in causing cancer, based on studies conducted in animals and human studies when available. The risk evaluation and the cleanup value specified in the ROD for all cPAHs [1.2 parts per million (ppm)] were based on the assumption that all cPAHs were of equal potency as benzo(a)pyrene.

Since that time, EPA has revised the oral potency factor for benzo(a)pyrene to its current value of 7.3 $(mg/kg/day)^{-1}$ (EPA 1997) rendering benzo(a)pyrene less potent than it was believed when the ROD was written. EPA has also published (EPA 1993) an interim recommendation for addressing the carcinogenic potential of the other six cPAHs. This is known as the relative potency factor approach. Using the relative potency factor approach, the oral slope factor for benzo(a)pyrene can be multiplied by a relative potency factor for each of the six cPAHs to derive relative oral slope factors for each cPAH. Five of the six cPAHs identified have resulting oral cancer slope factors one to three orders of magnitude less than the oral slope factor for benzo(a)pyrene. Through this ESD, EPA will be establishing cleanup levels for each of the seven cPAHs based on the availability of a new oral slope factor for benzo(a)pyrene and the adoption of the relative potency factor approach for cPAHs.

Please note, however, that the original acceptable risk level of 6.7×10^{-6} which was used to determine a cleanup level in the ROD for the combined effects of cPAHs *remains unchanged* (as do all assumptions regarding the nature and intensity of exposure). The incremental cancer risk level assigned to each of the seven cPAHs in this ESD is 9.5×10^{-7} or one-seventh of 6.7×10^{-6}. The resulting soil cleanup levels are presented in the following table.

COMPOUND	SOIL CLEANUP LEVEL, ppm		CANCER RISK
Benzo(a)anthracene	2.7		9.5×10^{-7}
Chrysene	266.7		9.5×10^{-7}
Benzo(b)fluoranthene	2.7		9.5×10^{-7}
Benzo(k)fluoranthene	26.7		9.5×10^{-7}
Benzo(a)pyrene	0.3		9.5×10^{-7}
Indeno(1,2,3-cd)pyrene	2.7		9.5×10^{-7}
Dibenz(a,h)anthracene	0.3		9.5×10^{-7}
		Total cPAH risk =	6.7×10^{-6}

In summary, the only thing that has changed is the associated cleanup concentrations of the cPAHS. The risk-based protectiveness of 6.7×10^{-6} established in the ROD remains the same. The result of cleaning up cPAHS to these new concentrations will allow for the same protectiveness that was sought as a remedial action goal under the ROD. The Site, once cleaned, will allow for unrestricted future use.

In addition to the ESD, EPA is taking this opportunity to articulate how compliance with all cleanup levels identified for soils at the Salem Acres Superfund Site will be determined. Consistent with Risk Assessment Guidance for Superfund (RAGS), Part A (EPA 1989) which calls for assessment of the reasonable maximum exposure, and Supplemental Guidance to RAGS: Calculating the Concentration Term (EPA 1992) which articulates that a 95% upper confidence limit on the arithmetic mean of contaminant concentrations is to be used when computing exposure, EPA Region I will use the 95% upper confidence limit on the arithmetic mean concentration of each compound of concern in soils at the Site and compare it to the appropriate cleanup level specified in the ROD as amended today by this ESD.

EPA recognizes that data obtained from sampling and analysis are never fully representative of actual human exposure. To account for the uncertainty in the data, EPA Region I has opted to use the 95 percent upper confidence limit for Superfund Sites (RAGS, EPA 1989) as embodied in the Supplemental Guidance to RAGS (EPA 1992). The 95% UCL provides reasonable confidence that the true site average of concentrations of compounds remaining in the soils are less than the cleanup levels established for the Site.

If the 95% upper confidence limit on the arithmetic mean concentration for any compound exceeds the cleanup limit, the Site is still considered above the cleanup level for the compound. On the other hand, if the 95% upper confidence limit on the arithmetic mean concentration for any compound is below the cleanup level, the Site is considered below the cleanup level for that particular compound (i.e., no further excavation will be necessary based on that compound of concern).

B. With regard to beryllium, the soil cleanup level established in the ROD was based on a very limited (two samples) characterization of site background. The lower of the two background concentrations (0.42 ppm of beryllium) was used as the cleanup level.

In an effort to better characterize naturally occurring levels of beryllium, twelve representative background samples were taken at various depths from undisturbed areas in close proximity to the site. The results show that beryllium is naturally present in the soils in concentrations that range from 0.50 ppm to 1.50 ppm, with an average concentration of 0.83 ppm (Memorandum dated April 4, 1997). The 95% upper confidence limit calculated for the arithmetic mean of 0.83 ppm is 1 ppm.

Given the variability in the data set, it is consistent with EPA practices to use the 95% upper confidence limit on the arithmetic mean (1 ppm) as representative of naturally occurring (background) beryllium concentrations. Thus through this ESD, EPA is redefining the background concentration of beryllium in soils as 1 ppm. EPA is replacing the former cleanup level for beryllium of 0.42 ppm with 1 ppm for compliance purposes. The excess lifetime cancer risk resulting from exposure to 1 ppm beryllium in soils given the exposure scenario and assumptions specified in the HRA is 2×10^{-6} which is consistent with EPA's goal for remedial actions (clean up to within the acceptable risk range of 1×10^{-4} to 1×10^{-6}).

As a consequence of this change, there may be a potential estimated cost savings of approximately $680,000 in remedial costs.

IV. Support Agency Comments

The Massachusetts Department of Environmental Protection has reviewed this ESD and has concurred with EPA in its issuance.

V. Affirmation of Statutory Determinations

Considering the new toxicity information for cPAHs that has been developed and the continued use of the original risk based cleanup goal of 6.7×10^{-6} for cPAHs, and the revision to the background value for beryllium based on more extensive data than was previously available, EPA believes the remedy as amended by this ESD remains protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to this remedial action, and is cost-effective. In addition, this remedy reflects EPA's commitment to utilize the most up-to-date scientific information and methodology available.

VI. Public Participation Activities

This ESD and supporting information are available for public review at the locations and times identified in the Introduction to this document. In addition, a notice of availability and brief description of the ESD will be provided to a local newspaper of general circulation, the Salem Evening News.

VII. Declaration

For the foregoing reasons, by my signature, EPA is issuing this Explanation of Significant Difference for the Salem Acres Superfund Site in Salem, Massachusetts.

April 11, 1997
Date

Frank Ciavattieri for
Linda M. Murphy, Director
Office of Remediation and Restoration

References

U.S. EPA 1989. Risk Assessment Guidance for Superfund. Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002.

U.S. EPA 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. Office of Solid Waste and Emergency Response, Washington, D.C. Publication 9285.7-081, May 1992.

U.S. EPA 1993. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. Office of Research and Development, Washington, D.C. EPA/600/R-93/089.

U.S. EPA 1997. Integrated Risk Information System (IRIS). Online database. National Center for Exposure Assessment, Cincinnati, OH.

Memorandum from Dharmarajan Iyer, URS Greiner, Inc. to Elaine Stanley, EPA dated April 4, 1997

TAB 8

SF File Number
98

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8, MONTANA OFFICE
FEDERAL BUILDING, 301 S. PARK, DRAWER 10096
HELENA, MONTANA 59626-0096

EXPLANATION OF SIGNIFICANT DIFFERENCES

Burlington Northern (Somers Plant) Site
Somers, Flathead County, Montana

United States Environmental Protection Agency
July 1998

I. INTRODUCTION

This Explanation of Significant Differences (ESD) is being issued by the U.S. Environmental Protection Agency (EPA) to modify certain remediation criteria established in the Record of Decision (ROD) issued by EPA on September 27, 1989 and modified by the previous ESD issued on June 26, 1992 for the Burlington Northern (Somers Plant) Site (hereby referred to as "Somers Plant" or the "Site") and identifies the documents that serve as the basis for the determination.

EPA, in consultation with the Montana Department of Environmental Quality (MDEQ), and after consideration of documents prepared pursuant to the first Five-Year Review of the Somers Plant and other documents in the Administrative Record, has determined that modifications to the remediation levels established in the 1989 ROD are required to incorporate criteria developed since the ROD was issued.

The modifications to the remedy described in this ESD do not fundamentally alter the overall approach of the remedy selected in the ROD. However, the modifications to the remediation goals at the site significantly change the scope and performance of the selected remedy. Therefore this ESD is required by the NCP and EPA guidance.

In accordance with Sections 117(c) and 121 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (Superfund), as amended, 42 U.S.C. Section 9601, et seq. ("CERCLA"), and the regulations at 40 C.F.R. Section 300.435(c)(2)(i), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), this ESD has been prepared for the following reasons:

- **to provide the public with an explanation of the nature of the changes to the remedy;**
- **to summarize the circumstances that led to the changes to the remedy; and**
- **to affirm that the revised remedy complies with all statutory requirements.**

MDEQ (formerly the Montana Department of Health and Environmental Sciences, MDHES) concurred on the ROD issued on September 27, 1989, and has participated in the review of information leading to this ESD, including the Five-Year Review Report which includes the Protectiveness Evaluation and the Five-Year Review Site Visit (Roy F. Weston, Inc., 1995a and 1995b). MDEQ has reviewed and concurred on this final ESD.

This document presents a summary of the changes to the selected remedy and a synopsis of information on the Site. The Administrative Record, which contains this ESD and the complete documentation supporting the revisions selected herein, is available for public review at the locations indicated at the end of this report.

II. SITE HISTORY AND BACKGROUND

The Burlington Northern (Somers Plant) Site is located in northwestern Montana in the unincorporated town of Somers, Flathead County. The Somers Plant was operated by Burlington Northern Railroad (BNRR) between 1901 and 1986, and covers approximately 80 acres. The plant treated railroad ties and other miscellaneous lumber products to protect the materials from weathering and insects. Treatment fluids used by BNRR included zinc chloride, chromated zinc chloride and creosote/petroleum preservative mixtures. The treatment process generated wastewater primarily consisting of steam condensate containing zinc chloride or creosote. Floor and shop washing, drippage from treated ties pulled from the retort onto the drip track and storage of treated ties on the property were other sources of process-generated wastewater. Prior to 1971, BNRR discharged wastewater into a lagoon (the "CERCLA Lagoon") located immediately south of the retort building. Overflow from this lagoon flowed in an open ditch from the facility into a swamp on the shore of Flathead Lake. Sometime prior to 1946, a pond formed in the swamp area (the "swamp pond") adjacent to Flathead Lake and waste material discharged through the open ditch accumulated there.

BNRR abandoned the CERCLA Lagoon and ditch in 1971 when the company constructed two new wastewater holding impoundments [the Resource Conservation and Recovery Act (RCRA) impoundments]. In 1984 BN implemented a recycling system and stopped all wastewater discharges.

In February 1984, the Montana Department of Health and Environmental Sciences (MDHES) sampled the soils at the Somers Plant. Based on the results of this investigation, the Site was proposed for inclusion on the Superfund National Priorities List (NPL) in 49 CFR 40320, October 15, 1984. The proposed listing cited potential adverse effects on Flathead Lake and the water supply for the town of Somers, which drew water from the lake.

In May 1985, EPA, BNRR and Sliters Corporation (a corporation which owns a portion of the site) signed an Administrative Order on Consent (AOC) (Docket No. CERCLA-VIII-85-02) providing for an Emergency Removal Action in the area of the swamp pond adjacent to Flathead Lake. The area was determined to pose an imminent and substantial hazard to Flathead Lake because of the presence of creosote contamination in water and soil located within two (2) feet of the shoreline. Pursuant to the 1985 AOC, BNRR removed contaminated soil and surface water from the swamp pond area and the drainage ditch. The soils were temporarily placed in the lined RCRA impoundments and eventually hauled to the BN RCRA-regulated facility in Paradise, Montana for treatment. The water was processed at the plant. The excavated areas were backfilled with clean soil and riprap was placed along the lakeshore.

In October 1985, EPA, BNRR, and Sliters Corporation signed another AOC (Docket No. CERCLA-VIII-85-07) for a Remedial Investigation and Feasibility Study (RI/FS). The purpose of the RI/FS was to determine the nature and extent of contamination at the Site, to evaluate the impacts of contamination on public health and the environment, and to formulate alternatives for remedial action. The field work to support the RI was performed from the Fall of 1985 to Fall 1988. An RI/FS Report (Remediation Technologies, Inc., 1989) was submitted to EPA in the spring of 1989.

The RCRA impoundments were closed in 1988 under the MDEQ Hazardous Waste Permitting Program. Subsequent to the closure, a groundwater monitoring well located adjacent to the impoundment indicated that groundwater was contaminated; therefore, groundwater corrective action was required.

After completion of the RI/FS, a ROD was signed on September 27, 1989 (EPA 1989a). The ROD selected a remedy and a contingency remedy for remediation of soil, groundwater and sediments, which were determined to pose a potential threat to human health and the environment. The selected remedy addressed the principal threats by removing the potential for direct contact with soils, by reducing the impact of the soils and sediments on groundwater and surface water and by treating the groundwater. The contingency remedy was to be implemented if the selected remedy was not determined to be effective. On December 20, 1991, the EPA entered into a Consent Decree (Civil Action No. CV-91-32-M-CCL) with BNRR and Burlington Northern, Inc. for Remedial Design/Remedial Action (RD/RA) of the selected remedy at the Site. The Consent Decree required performance of a Pilot Study to demonstrate the "practicability" of the innovative bioremediation component of the selected groundwater remedy. The Consent Decree required that the Pilot Study be conducted prior to any soil application on the Land Treatment Unit (LTU).

EPA issued an ESD in June 1992 (EPA, 1992) that modified the elements of the selected remedy, based on the "practicability" determination required in the ROD. The results of the Pilot Study were presented in the Remedial Design Investigation Report for the Former Somers Tie Plant (Remediation Technologies, Inc., 1991). The study was conducted to more accurately define and quantify the conditions under which the groundwater could be successfully remediated.

Operation of the 14.4 acre LTU commenced in 1994 following removal of soil from the CERCLA Lagoon to a 15 foot depth (22,300 cubic yards), Swamp Pond Area to a 12 foot depth (19,030 cubic yards), and the Drip Track/Retort Building (10,000 cubic yards). After the first year of LTU operation, the ROD remediation levels for soils were achieved. The second year of operation of the LTU produced a 19% reduction in carcinogenic Polycyclic Aromatic Hydrocarbons (cPAH) concentrations (RETEC 1995a). The cPAH reduction allowed BN to apply a second lift of soil to the LTU in the fall of 1995 in accordance with the 1989 ROD requirements.

The groundwater remedy consisting of five (5) extraction and ten (10) injection wells and a granular activated carbon (GAC) water treatment plant was put into operation at the end of April 1994 to capture and treat contaminants at the CERCLA Lagoon and downgradient of the CERCLA Lagoon. The system is designed to hydraulically contain Polycyclic Aromatic Hydrocarbons (PAH) contaminated groundwater within the boundary of the influence of the well fields. Extracted water is chemically and mechanically treated for free product, dissolved organics and iron at the site Water Treatment Plant prior to reinjection. Groundwater contamination at the site consists of Dense Non Aqueous Phase Liquids (DNAPL) within and adjacent to the CERCLA Lagoon and dissolved components downgradient from the lagoon.

Excavation activity in the swamp pond and slough areas resulted in the determination of the need for mitigation of damage to wetland environments. The Fish and Wildlife Service delineated and determined functional values of the wetland area in July 1993 (USFWS, 1994), which are described in the Wetlands Compensation Determination (EPA, 1994c). BNRR reconstructed the swamp pond in accordance with the plan and conducts semi-annual water quality sampling and assessment of vegetation recovery for the area.

A Five-Year Review of the Remedial Action at the Somers Plant was performed in April 1996. The objectives of the Five-Year Review were: (1) to verify that the remedy is operating and functioning as designed and, (2) to evaluate whether the remedial action selected for the site remains protective of human health and the environment. The Five-Year Review conducted for the Somers site was performed in accordance with the Office of Solid Waste and Emergency Response (OSWER) Directives 9355.7-02 entitled "Structure and Components of Five-Year Reviews", (EPA 1991) and 9355.7-02A, entitled "Supplemental Five-Year Review Guidance", (EPA 1994a).

The Five-Year Review of the Somers site was triggered by the initiation of a portion of the remedy by the responsible party, Burlington Northern Railroad, in 1991. The Five-Year Review includes recommendations for the evaluation of remediation levels for the site to ensure that the remedy is protective of human health and the environment and that the remediation levels are current and consistent with CERCLA Section 121, and EPA and State policy and guidance.

III. SUMMARY OF THE 1989 RECORD OF DECISION

The objectives of the remedy selected in the 1989 ROD are to reduce human exposure to soil, sediment and groundwater contaminants of concern. The components of the remedy are excavation and biological treatment of soils within an onsite LTU, and *in situ* biological treatment of contaminated groundwater within the water table aquifer, supplemented by extraction and treatment of contaminated water through a mechanical and chemical treatment process to remove free product, metals and particulates, and dissolved organics through oil/water separation, equalization, oxidation, particulate settling and granulated activated carbon filtration.

A list of the components of the original remedy selected for the site can be found on pages 40 through 46 of the 1989 ROD (EPA, 1989a). The remedy was modified by the 1992 ESD (EPA, 1992) based on the Pilot Study for ground water contaminants of concern. A brief summary of the original and modified remedy is provided below. The ROD remediation levels for contaminated soil and ground water are presented in Table 1.

- The soil remedy involved excavation of creosote and zinc contaminated soils in the CERCLA lagoon, drip track, drainage ditch, beneath the retort building and in the slough and beach areas. Some soil left below the water table in the CERCLA lagoon and swamp would be treated as part of the groundwater component of the remedy. The ROD included provisions for groundwater monitoring and post-closure care for up to 30 years or deed restrictions placed if hazardous constituents remained. Due to RCRA land disposal restrictions, a demonstration of no-migration of hazardous constituents was conducted to satisfy requirements.

- The original feasibility study alternative was modified for the selected remedy to exclude the excavation of the beach sediments. The sediments were not excavated due to a determination that the ecological risks to Flathead Lake from beach excavation outweighed the benefits of removing the contaminated sediments.

- Excavated areas were required to be backfilled with clean borrow soils and revegetated. The remedy also included replacement or restoration of wetlands lost during the remedial action.

- The ROD identified groundwater remedy involved the evaluation of the applicability of innovative technology, either hot water flushing of contaminated groundwater, ozone/UV or peroxide/UV treatment at the surface and *in situ* biological treatment of residual contamination.

  The 1991 Consent Decree required that a pilot test of the hot water flushing and *in situ* biological treatment technologies be conducted to evaluate their "practicability" in the low permeability hydrogeologic conditions at the Site. Implementation of the soil remedy was restricted until after the pilot test was conducted, as the contingency remedy involved deep excavation and incineration of soils. The remedy involved the installation of injection and recovery wells in the CERCLA Lagoon and the swamp pond area. Recovered groundwater would be treated in a chemical reactor in order to reduce contaminant levels.

- Identification and implementation of institutional controls to restrict use of groundwater downgradient of the contaminated areas was required.

- Monitoring activities required to assess the performance of the components of the remedy would be conducted throughout the life of the remedial activities. Activities involve monitoring of groundwater wells and semi-annual monitoring of the Somers municipal supply well until cleanup concentrations are achieved.

- The Site conditions will be reviewed no less than every five years after initiation of the remedial action to ensure that the remedy remains protective of human health and the environment.

In 1992, EPA modified the remedy selected for the site through an ESD. The ESD presented the "practicability" determination for the innovative bioremediation technology for the groundwater component. The significant differences between the remedy described in the 1989 ROD and the 1992 ESD are listed below:

1. Excavation of additional soils in the CERCLA Lagoon and the Swamp Pond Areas increasing the total excavated materials from 11,700 cubic yards to 41,000 cubic yards. Additional excavation was conducted to aid the remediation process.

2. Increase the size of the Land Treatment Facility from 10 acres to 14 acres to decrease the time required to meet remedial objectives and cleanup remediation levels. Procedure for completion of land treatment described in the ROD (p. 42) was not modified.

3. Elimination of the hot water flushing option of the groundwater remedy due to the low permeability of the aquifer materials. Excavation of additional soil in the CERCLA Lagoon would remove more source material and aid the remediation process.

4. Change in soil and groundwater cleanup times. Decrease the time to achieve soil remediation levels to 4 to 6 years rather than 10 years. Increase the estimate to achieve groundwater remediation levels from 10 to 15 years to 50 years.

IV. SUMMARY OF SIGNIFICANT DIFFERENCES TO THE REMEDY

The significant differences between the remedy selected in the 1989 ROD and the 1992 ESD and in this ESD are:

1. The soil remediation level for carcinogenic polycyclic aromatic hydrocarbon (cPAH) is revised from 36 to 57 milligrams per kilogram (mg/kg) calculated as benzo(a)pyrene (B(a)P) equivalents using the revised B(a)P cancer slope factor.

2. The limitations established in the 1989 ROD for pyrene, naphthalene and phenanthrene in soils are removed. EPA cites in part the rationale provided by field data, toxicological assessment and the language within the No-

Migration Petition as reasons for removing these requirements. Further discussion is provided below.

3. The soil remediation level for total non-carcinogenic PAH is revised from 1875 mg/kg to 1500 mg/kg based on the revisions to the Reference Dose (RfD) for naphthalene equivalents which has been revised from 0.005 to 0.004 mg/kg-day.

4. The groundwater remediation level for total non-carcinogenic PAH is revised from 0.3 μg/L to 40 μg/L based on the current procedure of not considering co-carcinogenicity and the change in the Reference Dose (RfD) equivalent to naphthalene noted in item 3. above.

5. The groundwater remediation level for total phenolics is revised from 15,000 μg/L to 6000 μg/L calculated, based on revisions in the RfD for Phenol and RfD values for other phenolic compounds.

Only those changes in Section IV paragraphs 1 through 5 above are being made to the remedy selected in the 1989 ROD and 1992 ESD. All other aspects of the selected remedy documented in 1989 ROD and 1992 ESD remain the same. A detailed rationale and background for the changes in this ESD follows.

Risk-Based Remedial Goals

Risk-based cleanup remediation levels established in the ROD for contaminated soils and groundwater were reviewed to determine the impact of changes in the toxicological assessment of contaminants of concern (COCs) including total PAHs, cPAHs and phenolic compounds using current EPA toxicological information and updated relative potency factor (RPF) and Toxicity Equivalency Factor (TEF) guidance (EPA, 1989b, EPA 1994b, EPA 1993). This review effort was performed to assess the degree of protectiveness afforded by the current risk-based remediation levels documented in the 1989 ROD for Somers.

The residential exposure scenarios were used as the basis for 1989 cleanup levels presented in the ROD for groundwater and soil. The site-specific exposure parameters established in the human health evaluation for these scenarios were used in the calculation of chemical concentrations for specific target risk levels. In the absence of site-specific information, standard default exposure parameters were used in the calculations. Risk-based remediation levels were also prepared for contaminants with MCLs for comparison purposes only (EPA, 1994e).

A summary of the results of the risk-based cleanup goal review effort is presented in Table 1.0. Details regarding the methods and input parameters used to develop the 1998 risk-based remediation levels presented in these tables are provided in the Supplemental Remedy Protectiveness Evaluation (Roy F. Weston, 1995b).

Soils Remediation Levels

The 1989 risk-based remediation levels for total carcinogenic and non-carcinogenic PAHs in soils differ from the 1998 risk-based remediation levels. The differences are based on revisions in the slope factor for B(a)P and the establishment of new RfD's for non-carcinogenic PAHs. Table 3 provides a summary of the slope factor and RfD revisions.

Total cPAH

The 1989 risk-based remedial remediation levels for total carcinogenic PAHs for soils, established using residential exposure scenarios differ from the 1998 risk-based remediation levels. The difference is due to revisions in the slope factor for B(a)P from 11.5 to 7.3 $(mg/kg\text{-}d)^{-1}$. Also, the 1989 remediation levels were applied to the sum of all cPAHs with the assumption that each cPAH was equal in carcinogenic potency to B(a)P. However, since promulgation of the ROD, cPAHs have been assigned RPFs which are used to convert individual cPAHs to B(a)P equivalent concentrations, thus resulting in less potent classification and having an effect of decreasing the estimated risk from cPAHs. The determination of compliance to the revised remediation levels for soils can be accomplished using EPA Region VIII Superfund Technical Guidance, Development of Toxicity Values for PAHs (EPA, 1994b).

Using the updated slope factor for B(a)P results in a change of the soil treatment cPAH limitation from 36 mg/kg to 57 mg/kg.

Total non-carcinogenic PAH

In 1989 non-carcinogenic effects of total PAHs were based upon the assumption that all PAHs were as toxic as naphthalene with an RfD of 0.005 mg/kg-d. Since promulgation of the ROD, the RfD for naphthalene has been revised from 0.005 to 0.004 mg/kg-d. Additionally, RfDs for other PAHs have been derived. As with the groundwater, those PAHs that have no RfD are conservatively evaluated as equal to most potent known RfD (naphthalene).

Application of the revised RfD produces a soil cleanup level for non-carcinogenic PAHs of 1500 mg/kg to replace the 1875 mg/kg level found in the 1989 ROD.

Naphthalene, Pyrene and Phenanthrene

EPA and MDHES established soil cleanup levels in the 1989 ROD that were based on both risk assessment results and proposed (Best Demonstrated Available Treatment) BDAT requirements for land disposal of the wastes found at the Site. These remediation levels include.

Contaminant(s)	Cleanup Goal	Source
Total cPAH	36.0 mg/kg	Risk Assessment

Total PAH	1,875 mg/kg	Risk Assessment
Naphthalene	8.0 mg/kg	BDAT Requirements
Phenanthrene	8.0 mg/kg	BDAT Requirements
Pyrene	7.3 mg/kg	BDAT Requirements

The remediation levels listed above that are based on BDAT requirements were incorporated within the 1988 ROD due to the land disposal restrictions (LDRs) that applied to the remedy (a land treatment unit) proposed for the wastes found in soils at the Site. The BDAT limitations were included in the ROD due to the lack of other numerical standards that applied to the contaminated soils. The BDAT limitations were derived from a demonstration using an incineration technology not a bioremediation technology as was selected for implementation at the Somers site.

It was recognized by both Burlington Northern and EPA at the time of the ROD that achievement of the pyrene level by land treatment would likely prove most difficult because the BDAT limitations were based on incineration as the applicable treatment technology. The No-Migration Petition for the Somers site was submitted by ReTec, Inc., as Appendix D of the Remedial Design investigation Report (December 1991). The petition evaluated migration potential for all contaminants of concern at the Site, including pyrene, naphthalene and phenanthrene. The petition was reviewed by EPA and MDEQ and commented on extensively by EPA. EPA approved the final No-Migration Petition with the issuance of the 1992 ESD on June 26, 1992. The study demonstrated that no migration of contaminants and no adverse impact to human health or the environment would occur during operation and closure of the LTU. 40 C.F.R. Section 268.6 allows EPA to approve a waiver of the Land Disposal Restrictions BDAT standard based on a successful No Migration Demonstration and Petition.

Removing the BDAT requirement for pyrene will not compromise the overall protectiveness of the selected remedy. Pyrene is now included in the list of total PAH compounds (no longer considered by EPA to be carcinogenic) whose sum total concentration must be remediated below the risk-based cleanup goal of 1,875 (modified to 1,500 by this ESD). By remediating the total PAHs below this level, EPA has determined that the residual concentrations of PAHs (including pyrene) will be protective of human health and the environment.

Field data available in BNRR's *LTU Annual Operations Reports* also indicate that BDAT requirements for both naphthalene and phenanthrene are achievable with the selected soils remedy. During operation of the Site LTU, remediation levels for these compounds are achieved prior to achievement of remediation levels for total carcinogenic PAHs. Thus, the standard set for total carcinogenic PAHs would ultimately govern the total time required to fully remediate a soil lift within the LTU.

With a potential for expediting the time required to remediate the contaminated soils at the Site while still maintaining the degree of protectiveness for human health and the environment, and EPA's approval of the No-Migration Petition, EPA is removing the soil treatment levels for pyrene, naphthalene and phenanthrene. As explained above, the degree of protectiveness for human health and the environment will be maintained by remediating the total PAH compounds to 1,875 mg/kg and the carcinogenic PAH compounds to the new risk-based goal of 57 mg/kg. All other requirements for remediating the contaminated soils within the LTU (as listed above) will remain in effect.

Only the initial treatment levels are being changed by this ESD. The ROD requirement for additional treatment of soils, after attaining the new initial treatment levels, until the annual reduction in cPAH is less than 20 percent, remains unchanged. The additional ROD requirement that health risks posed by direct contact with site soils be reduced to at least 1x10-5 also remains unchanged.

<u>Groundwater Remediation Levels</u>

Total non-carcinogenic PAHs

In 1989, the Risk Assessment for the BN Somers site identified a concentration for total PAHs of 50 μg/L as being protective against noncancer health effects. This level was calculated based on the assumption that all PAHs had an RfD equivalent to naphthalene (0.005 mg/kg-d). However, this risk-based value was not selected for incorporation in the ROD due to concerns at the time over carcinogenic promotion or co-carcinogenicity of noncarcinogenic PAHs. Therefore, a cleanup level for total PAHs of 0.300 μg/L was set, using a value one order of magnitude greater than the risk-based cleanup level for carcinogenic PAHs (0.03μg/L).

Currently, carcinogenic promotion by noncarcinogenic PAHs is not considered in estimating potential carcinogenic effects from exposure to PAHs (EPA, 1994c) and a health-based level using RfDs for noncarcinogenic effects is appropriate. As noted above, since issuance of the ROD in 1989, the RfD for naphthalene has been revised from 0.005 to 0.004 mg/kg-d, and many of the PAHs have been assigned individual RfDs. Those PAHs for which no RfD has been assigned have been assumed to be equal to the most potent known RfD (naphthalene = 0.004 mg/kg-d).

The recalculation of the health based clean-up goal is 40 μg/L. To determine compliance levels, exposure point concentrations (EPCs) for individual PAHs are recalculated based on the revised RfDs and converted to naphthalene equivalent concentrations using RfD ratios. These naphthalene equivalent concentrations are then summed to represent total PAHs present in groundwater for comparison to the revised clean-up level.

There is no change in the exposure risk to the public due to this revision in the remediation level for non-carcinogenic PAHs.

Total phenolics

For total phenolic compounds, the RfD for phenol has been revised to 0.6 mg/kg-d, resulting in a revised clean-up goal of 6000 μg/L which replaces the 1989 ROD level of 15,000. As with the cPAHs and PAHs, RfD values for other phenolic chemicals of concern have been derived (phenol, 2,4-dimethylphenol, 2-methylphenol, 4-methyphenol). Again, EPCs for individual phenolic compounds are converted to phenol equivalent concentrations using ratios of RfDs, which are summed to represent total phenolics present at the site for comparison to the revised clean-up level.

There is no change in the exposure risk to the public due to this change in the remediation level for total phenolics.

Carcinogenic PAHs

Although federal MCLs for cPAHs have been promulgated since the ROD was issued, no change is made to the ROD at this time because: (1) MDEQ is currently revising the Montana WQB-7 standards for these compounds and (2) BNSF will prepare a Technical Impracticability (TI) waiver application relative to groundwater cleanup at the Site. Updated groundwater standards will be addressed as part of the TI waiver analysis and application.

V. SUMMARY OF STATE COMMENTS AND AVAILABILITY OF ADMINISTRATIVE RECORD

As stated above, MDEQ has reviewed the documents that serve as the basis for this determination and has provided comments to EPA on the documents and on this ESD. All of the MDEQ comments were incorporated into the final reports. MDEQ has been provided with the opportunity to review and comment on this ESD and all of their comments have been incorporated.

Documents referenced within this ESD are part of the Administrative Record for the Somers Site. The administrative record will also contain any written public comments that may be received regarding this ESD. The complete administrative record for the Site is available for public review at the following location:

U.S. EPA Montana Office
Federal Building, Room 192
301 South Park, Box 10096
Helena, Montana 59626-0096
(406) 441-1150
Mon-Fri, 8:00 a.m. to 5:00 p.m.

Flathead County Public Library
247 1st Avenue East
Kalispell, Montana 59901

(406) 756-5690
Mon-Fri, 8:00 a.m. to 4:00 p.m.

VI. AFFIRMATION OF STATUTORY REQUIREMENTS

Considering the new information that has been developed and the changes that have been made to the selected remedy, EPA, in consultation with MDEQ, believes that the remedy remains protective of human health and the environment, complies with Federal and State requirements that both applicable or relevant and appropriate to this remedial action or involves appropriate waivers of these requirements, and is cost-effective. In addition, the revised remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for the Site.

VII. APPROVAL

Mark A. Simonich (signature) — 7/13/98

Mark A. Simonich, Director
Montana Department of Environmental Quality — Date

Max H. Dodson (signature) — 7/21/98

Max H. Dodson, ARA
Office of Ecosystems Protection and Remediation
U.S. Environmental Protection Agency — Date

REFERENCES

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Remediation Technologies, Inc. (RETEC). 1995a. BN-Somers Land Treatment Facility 1994 Operations Report. Somers, Montana. Prepared for Burlington Northern Railroad.

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Roy F. Weston, Inc. 1995a. Five-Year Review Site Visit Report. BN Somers Tie Plant. Somers, Montana. Prepared for the U.S. Environmental Protection Agency, Region VIII, Montana Operations.

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U.S. Environmental Protection Agency. 1994b. Region VIII Superfund Technical Guidance. Development of Toxicity Values for PAHs to use in Human Health Risk Assessments. Draft.

U.S. Environmental Protection Agency. 1994c. Letter on Wetlands Mitigation plan and Wetlands Compensation Determination. August 1994.

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U.S. Environmental Protection Agency. 1993. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency. 1992. Explanation of Significant Differences, Burlington Northern (Somers Plant) Site, Somers Montana, June 1992.

U.S. Environmental Protection Agency. 1991. Structure and Components of Five-Year Reviews, Office of Solid Waste and Emergency Response, OSWER Directive No. 9355.7-02, Washington D.C.

U.S. Environmental Protection Agency. 1989a. Region VIII Montana Operations Office, Record of Decision, BN-Somers Superfund Site, Somers, Montana.

U.S. Environmental Protection Agency. 1989b. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual. EPA/540/1-89-002, December 1989, Interim Final. Office of Emergency and Remedial Response, Washington D.C.

U.S. Fish and Wildlife Service. 1994. Wetlands Delineation and Evaluation, Burlington Northern Superfund Site, Somers, Montana. April 1994.

TABLE 1.0
COMPARISON OF 1989 AND 1995 RISK-BASED REMEDIATION LEVELS FOR BN-SOMERS [a,e]

Contaminants of Concern	Groundwater: 1989 Risk Based Goal[d] (µg/L)	Groundwater: Risk-Based 1995 Target Clean-up Concentration (µg/L)	Soil: 1989 Risk Based Goal (mg/kg)	Soil: Risk-Based 1995 Target Clean-up Concentration (mg/kg)
Total Carcinogenic PAHS [b]	0.030 µg/L	0.047 µg/L	36 mg/kg	57 mg/kg
Total PAHs - NonCancer Effects	0.300 µg/L Based on concern over possible co-carcinogenicity	40 µg/L Based on noncancer health effects calculated using naphthalene equivalent concentrations	1,875[c]	1,500
Phenol	—	6000	—	45,000
Total Phenolics	15,000	6000	3,000[c]	45,000

(a) Calculated using toxicity values shown in Table 2.0.
(b) Benzo(g,h,i)perylene assessed as a potential carcinogen in 1989; not classifiable as to human carcinogenicity and assessed as a noncarcinogen in 1995.
(c) Value cited as an excavation concentration.
(d) Values obtained from 1989 ROD for BN-Somers.
(e) Methods for comparing site concentrations to risk-based remediation levels have been revised since 1989. See text for further detail.
— Risk-based value not used as goal in 1989 ROD.

TABLE 2.0
COMPARISON OF TOXICITY VALUES USED FOR RISK CHARACTERIZATION AT BN-SOMERS
1989 AND 1998 VALUES

Contaminant of Concern	1989 Values[a] RfD (mg/kg-d)	1989 Values[a] oSF $(mg/kg\text{-}d)^{-1}$	1998 Values[c] RfD (mg/kg-d)	1998 Values[c] oSF $(mg/kg\text{-}d)^{-1}$ [b]
PAHs:				
Naphthalene	0.05 to 0.005[d]		0.004	
Acenaphthylene	0.03		NA	
Acenaphthene	0.20		0.06	
Fluorene	0.07*		0.04	
Phenanthrene	0.07*		NA	
Fluoranthene	0.07*		0.04	
Pyrene	0.06		0.03	
Benzo(a)anthracene	0.07*	11.5	NA	0.73
Chrysene	0.07*	11.5	NA	0.0073
Benzo(b)fluoranthene	0.07*	11.5	NA	0.73
Benzo(k)fluoranthene	0.07*	11.5	NA	0.073
Benzo(a)pyrene	0.07*	11.5	NA	7.3
Indeno(1,2,3-c,d)pyrene	0.07*	11.5	NA	0.73
Dibenzo(a,h)anthracene	0.07*	11.5	NA	7.3
Benzo(g,h,i)perylene[e]	0.07*	11.5	NA	--
2,4-dimethylphenol	NA		0.02	
2-methylphenol	NA		0.05	
4-methylphenol	NA		NA	
Phenol	0.04		0.6	
Zinc	0.21		0.3	

(a) Values from Table 2 of the 1989 ROD
(b) PAH specific Slope Factors calculated from B(a)P by multiplying by RPF (see text)
(c) Values obtained through reviews of IRIS, HEAST and Safe Drinking Water Guidance (EPA, 1995, 1994d, 1994e)
(d) Provided range of RfDs for Naphthalene, however used most stringent (0.005) in calculations
(e) Assessed as a potential carcinogen in 1989; not classifiable as to human carcinogenicity and assessed as a non carcinogen in 1998
* Value assumed equal to average RfD for other noncarcinogenic PAHs
NA Not Available

TAB 9

PB98-963149
EPA 541-R98-175
March 1999

EPA Superfund
Explanation of Significant Difference for the Record of Decision:

Petrochem Recycling Corp./ Ekotek Plant Salt Lake City, UT 12/9/1997

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
999 18th STREET - SUITE 500
DENVER, COLORADO 80202-2466

EXPLANATION OF SIGNIFICANT DIFFERENCES

Petrochem Recycling Corp./Ekotek, Inc., Superfund Site
Salt Lake County, Salt Lake City, Utah

December 1997

PETROCHEM RECYCLING CORP./EKOTEK, INC., SUPERFUND SITE
EXPLANATION OF SIGNIFICANT DIFFERENCES
DECEMBER 1997

I. INTRODUCTION

This Explanation of Significant Differences (ESD) is being issued by the U.S. Environmental Protection Agency (EPA) to modify certain remediation criteria established in the Record of Decision signed by EPA on September 27, 1996 (ROD), and certain other components of the ROD, as described herein, which will be implemented at the Petrochem Recycling Corp./Ekotek, Inc., Superfund Site, located in Salt Lake City, Utah (Petrochem Site or Site).

The changes to the ROD have been made as a result of new information that EPA received subsequent to the issuance of the ROD. These changes do not fundamentally alter the site-wide remedy presented in the ROD. The site-wide remedy for the Petrochem Site remains protective of human health and the environment. This ESD is issued by EPA, the lead agency at the Site, after consultation with the Utah Department of Environmental Quality (UDEQ), the support agency at the Site.

The modifications to the remedy described in this ESD do not alter the selected remedy in any fundamental aspect regarding scope, cost, or performance. In accordance with Sections 117(c) and 121 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund), as amended, 42 U.S.C. Section 9601, et seq. ("CERCLA"), and the regulations at 40 C.F.R. Section 300.435(c)(2)(I), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), this ESD has been prepared for the following reasons:

- to provide the public with an explanation of the nature of the changes to the remedy;
- to summarize the circumstances that led to the changes to the remedy; and
- to affirm that the revised remedy complies with all statutory requirements.

This document presents a summary of the changes to the selected remedy and a synopsis of information on the Site. The Administrative Record, which contains the ESD and this documentation supporting the revisions, is available for public review at the locations indicated at the end of this report.

II. SITE HISTORY AND BACKGROUND

a. Location

The Petrochem/Ekotek Site (the Site) is located in Township 1 North, Range 1 West, Section 23, and occupies approximately seven acres in an industrial corridor in the northern section of Salt Lake City, Utah.

b. Operational History

The Site was originally owned and operated as an oil refinery by O. C. Allen Oil Company, from 1953 to 1968. In 1968, Flinco, Inc. purchased the facility and operated the refinery until 1978. During that time Flinco changed its name to Bonus International Corp. In 1978 Axel Johnson, Inc., acquired the facility and operated it through its Delaware-based subsidiary, Ekotek, Inc. At this time, Ekotek, Inc. converted the Site into a hazardous waste storage and treatment, and petroleum recycling facility. Steven Self and Steve Miller purchased the site from Axel Johnson, Inc. in 1981 and reincorporated as Ekotek Incorporated, a Utah corporation. From 1980 to 1987, the facility operated under Resource Conservation and Recovery Act (RCRA) interim status, and received a hazardous waste storage permit in July 1987 for a limited number of these activities. Ekotek, Inc. declared bankruptcy in November of 1987. Petrochem Recycling Corp. leased the facility in 1987 from Ekotek, Inc. and continued operations until February 1988. The Ekotek bankruptcy estate released the property (Parcel Numbers 0823407001 and 0823407002) pursuant to state statute, Utah Code Annotated Section 59-2-1336. Delinquent County taxes attributed to the property have not been paid. Ownership of the Site is uncertain at present following the bankruptcy proceedings of Ekotek Incorporated, the owner of the Site in 1989. A transfer of title to the property to either the county or a potential purchaser may occur as a result of a final tax sale. The tax sale must be initiated within four and a half years after the initial date of the delinquent taxes.

c. History of Site Investigations

In 1980, Ekotek, Inc., filed a RCRA Part A permit application and achieved Interim Status. A RCRA Part B permit was issued in 1987 to Ekotek, Inc. Site operations were shut down in February 1988, after the issuance to Petrochem Recycling Corporation of a Notice of Violation by the Utah Bureau of Solid and Hazardous Waste and by the Bureau of Air Quality. In November 1988, Region VIII EPA Emergency Response Branch initiated a removal action at the site.

Sources of contamination at the Site included approximately 60 aboveground tanks, 1200 drums and 1500 smaller containers, three surface impoundments, an underground drain field, numerous piles and pits of waste material, underground tanks, incineration furnaces, and contaminated soils. Contaminants associated with on-site sources include a wide range of organic substances such as chlorinated solvents and other volatile organic compounds, polynuclear aromatic hydrocarbons, phthalates, pesticides, Aroclor 1260, dioxin and furans. Heavy metals are also present in on-site sources.

On August, 2, 1989, an Administrative Order on Consent (AOC) for Emergency Surface Removal (Docket CERCLA-VIII-89-25) was issued to 27 Potentially Responsible Parties (PRPs) to undertake actions to clean up the Site. These PRPs operated as members of a voluntary association termed the Ekotek Site Remediation Committee (ESRC). As part of the emergency response, the ESRC removed surface and underground storage tanks, containers, contaminated sludges, pooled liquids, and processing equipment from the Site.

EPA began site assessment field operations in November 1989, at which time all contaminant sources discussed above were present on-site. Pursuant to section 105 of CERCLA, 42 U.S.C. Section 9605, EPA proposed the Site for listing on the National Priorities List (NPL), set forth at 40 C.F.R. Part 300, Appendix B, by publication in the Federal Register on July 29, 1991; and listed the Site on the NPL promulgated on October 14, 1992; 57 Fed. Reg. 47180, 47200 (October 14, 1992). Only one operable unit has been designated for the Site.

An Administrative Order on Consent (AOC) for the performance of the Remedial Investigation/Feasibility Study (RI/FS) was signed in July 1992 (Docket No. CERCLA (106) VIII-92-21). Members of the ESRC were Respondents for the RI/FS AOC. The Phase I field investigation was undertaken from December 1992 to March 1993 and Phase II investigations were conducted from August to October 1993. A final RI report was issued in July 1994 and the final FS report was issued in January 1995. Two addenda to the FS were submitted on February 24, 1995 and April 7, 1995.

The hazardous substances present at the site and the data or information documenting a release or threatened release of a hazardous substance at or in connection with the Site is described in the Administrative Record for the Site, including but not limited to the RI Report. The release migration, including present and potential future pathways, possible or known routes of exposure of the hazardous substances, population at risk, and threats to human health and the environment are described in the Administrative Record for the Site, including but not limited to the Baseline Risk Assessment for the Site.

Pursuant to Section 117 of CERCLA, 42 U.S.C. § 9617, EPA published notice of the completion of the FS and of the proposed plan for remedial action on July 19, 1995, in two major local newspaper of general circulation. EPA provided extensive opportunity for written and oral comments from the public on the proposed plan for remedial action. A copy of the transcript of the public meeting is available to the public as part of the administrative record upon which the Ecosystems Protection and Remediation Assistant Regional Administrator based the selection of the response action.

The decision by EPA on the remedial action to be implemented at the Site is embodied in a final Record of Decision (ROD) executed on September 27, 1996. The State had a reasonable opportunity to review and comment on the remedial action and the ROD. The ROD includes EPA's explanation for any significant differences between the final plan and the proposed plan as well as a responsiveness summary to the public comments received. Notice of the final plan was published in accordance with Section 117(b) of CERCLA, 42 U.S.C. § 9617(b). The ROD is supported by an administrative record that contains the documents and information upon which EPA based the selection of the response action.

Since February, 1997, EPA and the ESRC representatives have been in negotiations for an agreement to implement the remedy selected in the ROD. This agreement, in the form of a consent decree for remedial design and remedial action (RD/RA), if agreed upon, will be filed in the U.S. District Court for Utah. Since the time of the ROD, EPA has obtained new information which has resulted in the need for this ESD. The consent decree would provide for implementation of the remedy selected in the ROD including the modifications of this ESD.

III. DESCRIPTION OF THE ROD

The purpose of the remedy is to eliminate the pathway of direct exposure to soils of an industrial worker through excavation and offsite disposal of hot spot soils; containment onsite of low-level contaminated soils under 42-inch soil cap; eliminate partitioning of LNAPL to the ground water through removal and treatment of LNAPL; and eliminate the potential future ingestion of contaminated drinking water through intrinsic remediation/attenuation of the ground water.

The components of the selected remedy include: Remove/Dispose Hot Spot Soils; Consolidate/Cap Soils that Exceed Soil Performance Standards; Partial Removal/Disposal of Soil and Buried Debris and Cap Remaining Debris; Remove/Treat 100% LNAPL; Intrinsic Remediation of Ground Water; and Access and Land Use Restrictions for the Petrochem/Ekotek Site.

The changes documented in this ESD are based on new information that EPA received subsequent to the issuance of the ROD. EPA determined that the information supports the need to correct and/or clarify certain aspects of the remedy described in the ROD. These changes do not fundamentally alter the overall approach of the site-wide remedy or any individual component of the site-wide remedy. The changes to the performance standards in this ESD may alter the amount of soil which exceeds the Hot Spot performance standards and which must be sent for offsite disposal as well as alter the amount of soil consolidated and contained onsite under the 42 inch cap. The volumes specified in the ROD were estimates. The actual volumes will be determined during the implementation of the remedy.

IV. SIGNIFICANT DIFFERENCES TO THE REMEDY

The significant differences between the remedy described in the 1996 ROD and in this ESD are:

1. The Soil Performance Standard for 2,3,7,8,-TCDD(TEF) will be revised from 1.86E-06 mg/kg to 3.7E-05 mg/kg for cancer risk of 1E-06 (site wide) and the Soil Hot Spot Performance Standard will be revised from 0.186 ug/kg to 3.7 ug/kg for cancer risk of 1E-04 (hot spot);

2. The Soil Performance Standard for PCBs will be revised from 0.15 mg/kg to 2.7 mg/kg (ppm);

3. The Soil Hot Spots Performance Standard for PCBs will be revised from 10 mg/kg to 25 mg/kg (ppm); and

4. The Contingency Measures section of the ROD will be revised to permit, as an alternative to discharge to the POTW, the discharge of ground water to re-injection wells or to a surface water/storm drain via the substantive requirements of a UPDES permit.

Only those changes described in Section IV, Paragraphs 1 through 4 above are being made to the selected remedy described in the 1996 ROD. All other aspects of the selected remedy documented in the 1996 ROD remain the same. A more detailed description of the revised components to the remedy follows.

V. DETAILED DESCRIPTION OF CHANGES TO THE ROD

1. Soil Performance Standard for 2,3,7,8,-TCDD(TEF).

The algorithms, exposure assumptions, and toxicity values used in the calculation of the remediation levels for 2,3,7,8,-TCDD(TEF) [dioxin] were re-examined. It was determined that a numerical entry error occurred during the original calculation of the dioxin performance standard. New values, 0.037 ug/kg (3.7E-05 mg/kg) for cancer risk of 1E-06 (site wide) and 3.7 ug/kg (3.7E-03 mg/kg) for cancer risk of 1E-04 (hot spots) were calculated based upon the same equations and assumptions in the August 2, 1994 Baseline Human Health Risk Assessment for the Petrochem Site for the commercial and industrial worker for exposure to soil via ingestion and dermal absorption, but with the correct numerical entries.

The revised Soil Performance Standard (SPS) for TCDD is derived based upon the following formula:

$$SPS= \frac{TR*BW*AT*365\ days/year}{EF*ED*[(SF_0*1\text{-}06*IR)+(SF_0*0.9*1E\text{-}06*SA*AF*ABS)]}$$

TR (target risk) 1E-06
BW (body weight) 70 kg
AT (averaging time) 70 years
EF (exposure frequency) 250 days/year
ED (exposure duration) 25 years
SF_0 (slope factor oral) 1.5E+05 mg/kg-day^{-1}
1E-06 kg/mg (conversion factor)
IR (ingestion rate for soil) 50 mg/day
0.9 (adjustment factor for conversion from administered to absorbed dose for TCDD)
SA (Skin surface area) 3100 cm^2
AF (Soil to skin adherence factor) 0.016 mg/cm^2
ABS (absorption factor) 0.03

The SPS formula augments the risk based concentration (RBC) formula utilized in the risk assessment by incorporating an adjustment factor to convert administered to absorbed dose . Additionally, a default value of 0.87 was utilized in the risk assessment for ABS (fractional absorption factor). The default value was updated to 0.03 as per Dermal Exposure Guidance, (EPA/600/8-91/011E, January 1992). Lastly, based upon a recent update to the Exposure Factors Handbook (EPA/600/P-95/002Ba, August 1996) the AF (Soil to skin adherence factor) was updated from 1 to 0.016 mg/cm^2-day.

2. Soil Performance Standard for PCBs.

EPA relies upon the Agency's Integrated Risk Information System (IRIS) for calculation of risk-based cleanup concentrations. IRIS, an electronic data base containing EPA's information on human health effects, was revised for polychlorinated biphenyls (PCBs) on June 1, 1997. Specifically, the slope factor for PCBs was revised subsequent to the release of the ROD, and several new slope factors (including those for the central tendency exposure condition) of PCBs became available. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per mg/kg/day. EPA recommends the use of a new slope factor of 2.0 per mg/kg-day, updated from 7.7 mg/kg-day, for the reasonable maximum exposure condition for PCBs in soil that are high risk and persistent. This slope factor is appropriate for deriving Soil Performance Standards for Aroclors 1260 and 1254 (PCB types found at Site) at the Site because these chemicals are high risk and persistent and the medium of exposure is in soil. The revised Soil Performance Standard of 2.7 mg/kg is based upon the same equations and assumptions in the August 2, 1994 Baseline Human Health Risk Assessment for the Petrochem Site for the commercial and industrial worker for exposure to soil via ingestion and dermal absorption, but utilizing in those equations the new slope factor and the updated AF (Soil to skin adherence factor) detailed in Section V.1..

3. Soil Hot Spot Performance Standard for PCBs

EPA carefully reviewed its *Guidance on Remedial Actions for Superfund Sites with PCBs Contamination,* OSWER Directive 9355.4-01, before making its decision to change PCB cleanup levels at the Petrochem Site. The *Guidance* describes how to develop remedial alternatives that are consistent with PCB-related Applicable or Relevant and Appropriate Requirements (ARARs) and "to-be-considered" criteria.

The guidance states that, for sites in *industrial* areas, cleanup actions should be considered when PCB levels range from 10 to 25 parts per million (ppm). Among the reasons for choosing 25 ppm are:

- there is less access in industrial areas than in other areas and, therefore, less frequency of exposure and less risk posed by the PCBs; and
- a 42-inch cap that covers PCB-containing soils further reduces access to the contaminants.

This cleanup level is consistent with the PCB Spill Policy, which recommends a cleanup level of 25 to 50 ppm for sites in *industrial* or other *reduced access* areas." The cleanup level is also consistent with the PCB guidance document. At the Petrochem Site, the PCB level remaining on site will not exceed 25 ppm.

4. Groundwater Contingency Measures: Discharge of Ground Water.

At the time of the ROD it was assumed that the POTW would be able to accept treated ground water generated from either the containment and/or the arsenic remediation contingency plans, if invoked. Based upon potential capacity issues at the POTW, an additional alternative may be considered permitting treated ground water to also be discharged to the underlying aquifer via re-injection wells or to a surface water/storm drain. These alternative measures for disposal of treated ground water would be evaluated at the time EPA determines they are needed, depending on whether either or both of the groundwater contingency measures (for containment and for arsenic) are invoked and if, in fact, capacity issues do exist at the POTW for the amounts of ground water being disposed. Discharge to a surface water/storm drain would comply with the requirements of a UPDES permit.

These additional components must also comply with all applicable and relevant and appropriate requirements (ARARs), pursuant to Section 121 of CERCLA. In addition to the ARARs set forth in the ROD, these revised activities must comply with Section 3020 of the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. Section 6901, et seq., which bans the injection of contaminated materials into drinking water formations unless specified conditions are met, designated by EPA as a relevant and appropriate requirement; and the Underground Injection Control program regulations at 40 C.F.R. Parts 144-147, which establish standards for construction and operation of injection wells and provide for the protection of underground sources of drinking water by ensuring that injected waters meet MCLs and risk based concentrations. The UIC regulations are designated by EPA as applicable to the activity described above.

VI. SUMMARY OF STATE COMMENTS AND AVAILABILITY OF ADMINISTRATIVE RECORD

UDEQ has been provided with the opportunity to review and comment on this ESD and the documents that serve as the basis for this ESD. UDEQ commented to EPA on these documents, and supports the changes to the Soil Performance Standard for 2,3,7,8-TCDD(TEF) and the Soil Performance Standard for PCBs. UDEQ, however, does not support the change to the Soil Hot Spot Performance Standard for PCBs based, in part, on its interpretation of EPA's PCB Spill Cleanup Policy. Finally, UDEQ supports the ground water contingency measure change. UDEQ's comments, dated October 30, 1997, can be found in the Administrative Record for the Site.

Documents referenced within this ESD are part of the Administrative Record for the Petrochem/Ekotek Inc. Site. The complete administrative record for the Site is available for public review at the following locations:

EPA Superfund Records Center
999 18th Street, Fifth Floor
Denver, Colorado 80202
Hours: Monday-Friday 8:00am - 4:30pm
Telephone: (303) 312-6473

Mr. Walter Jones
Marriott Library
Western Americana and Special Collections
University of Utah
Salt Lake City, UT 84122
Telephone: (801) 581-8863

VII. AFFIRMATION OF STATUTORY REQUIREMENTS

Considering the new information that has been developed and the changes that have been made to the selected remedy, EPA, in consultation with UDEQ, believes that the remedy remains protective of human health and the environment, complies with Federal and State requirements that are both applicable or relevant and appropriate to this remedial action or involves appropriate waivers of these requirements, and is cost-effective. In addition, the revised remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for the Site.

VIII. APPROVAL

Max H. Dodson

Max H. Dodson, Assistant Regional Administrator
Office of Ecosystems Protection and Remediation

12/9/97
Date

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TAB 10

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ANCHOR QEA

Memorandum

August 2, 2017

To: Bob Wyatt, NW Natural

From: Amy Nelson and Taku Fuji, Anchor QEA, LLC

cc: Patty Dost, Pearl Legal Group

Ryan Barth, Carl Stivers, and Ben Hung, Anchor QEA, LLC

Re: USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels and Remedial Action Levels in Portland Harbor

Introduction

This memorandum summarizes the January 2017 U.S. Environmental Protection Agency (USEPA) updates to the human health toxicity values for benzo(a)pyrene (BaP) and their potential impacts on cleanup levels and remedial action levels (RALs) identified in the January 3, 2017 Record of Decision (ROD; USEPA 2017a) at the Portland Harbor Superfund Site (Site). USEPA's January 19, 2017 updates to *Toxicological Review of Benzo(a)pyrene (CASRN 50-32-8): Executive Summary. Integrated Risk Information System (IRIS)* (USEPA 2017b) include the following toxicity value changes:

- The oral cancer slope factor (CSF) decreased from 7.3 per milligram per kilogram-day (per mg/kg-day) to 1 per mg/kg-day. In general, the use of a lower BaP CSF results in lower BaP and carcinogenic polycyclic aromatic hydrocarbon (cPAH) risk estimates.
- A non-cancer oral reference dose (RfD) of 0.0003 per mg/kg-day was added; previously, USEPA did not identify an RfD for BaP in IRIS. Thus, BaP non-cancer risks had not been previously estimated.

Cleanup Levels

USEPA calculated preliminary remediation goals (PRGs) in the *Portland Harbor Feasibility Study* (FS; USEPA 2016) for each remedial action objective (RAO). In the ROD, USEPA set cleanup levels by media using the PRGs from the FS. Sediment and riverbank soil cPAH cleanup levels (expressed as BaP equivalents) presented in the ROD are based on PRGs developed using the 1987 BaP CSF (representing 1×10^{-6} risk level), rather than the 2017 BaP CSF.

This technical memorandum recalculates the cPAH PRGs presented in the FS and ROD using the new BaP CSF.[1] We have not modified any other variable or USEPA's equations themselves.

[1] USEPA cleanup levels (and RALs) incorporate rounding in one or more steps in the calculation, so recalculated concentrations are approximate.

Nearshore Sediment Cleanup Levels

The "riverbank soil/sediment" nearshore sediment cleanup level for cPAH of 12 micrograms per kilogram (µg/kg), as presented in Table 17 of the ROD (USEPA 2017a), is the minimum amount of cPAH PRGs by media developed in the FS and represents the human health sediment direct contact pathway specific to beaches. The USEPA FS also includes a separate RAO 1 cPAH PRG of 106 µg/kg for the sediment direct contact exposure evaluated in the Baseline Human Health Risk Assessment (BHHRA) for nearshore areas (i.e., outside the channel and not at beaches; identified in the FS as "in-water" PRGs). Although ROD Table 17 does not include that in-water value and defaults to the lower 12-µg/kg value based on beach exposures, the 106-µg/kg PRG is used to define "highly toxic" principal threat waste (PTW) concentrations in the ROD and to evaluate risk reduction for USEPA's selected remedy (USEPA 2017a, Table 6 and Appendix IV, Table J.2.2-1c).

If the updated BaP CSF was applied, the cleanup level based on the RAO 1 direct contact PRG applicable to beaches would increase from 12 µg/kg to approximately 85 µg/kg. The risk-based PRG for beach contact (recreational beach user) presented in the ROD is a cancer-based goal that happens to be the same number as the background value (a value USEPA estimated using a total polycyclic aromatic hydrocarbon [TPAH] to cPAH regression equation). Therefore, the updated BaP cleanup level of 85 µg/kg would lead to the risk-based goal being greater than USEPA's background value.

Using the updated BaP CSF, the cPAH RAO 1 in-water sediment direct contact PRG (based on cancer risks for the tribal fisher and applicable to nearshore sediments outside beach areas) would increase from 106 µg/kg to approximately 773 µg/kg.

Navigation Channel Sediment Cleanup Levels

Per USEPA's ROD Table 17 footnote (USEPA 2017a), the cPAH cleanup level of 3,950 µg/kg for navigation channel sediment is based on the RAO 2 sediment PRG protective of clam consumption by humans. Applying the updated BaP CSF to USEPA's cPAH clam PRG equation (USEPA FS Appendix D, as updated in the ROD), the resulting sediment cleanup level would increase from 3,950 µg/kg to approximately 108,000 µg/kg. Due to the log-log biota-sediment accumulation regression equation used in developing this PRG, the increase is not directly 7.3-fold as it is for the sediment direct contact PRGs applied for nearshore sediments.

Surface Water Cleanup Levels

Surface water cleanup levels in the ROD were selected based on the lower of RAO 3 and 7 PRGs from the FS (USEPA 2016). The ROD surface water cleanup level for cPAH (0.00012 µg/L) is equivalent to the RAO 3 PRG, which is based on federal human health water quality criteria protective of fish consumption. This value is lower than the RAO 7 ecological-based value for BaP (0.014 µg/L).

Application of USEPA's updated CSF would affect both the Oregon and federal human health water quality BaP criteria. The updated BaP CSF would increase the federal criteria and therefore, the ROD surface water cleanup level for BaP from 0.00012 µg/L to approximately 0.0009 µg/L. Similarly, the Oregon criteria would increase from 0.0013 µg/L to 0.0095 µg/L. Per the current ambient water quality criteria document for BaP (USEPA 2015), USEPA planned to update the human health criteria for BaP following the finalization of the IRIS update.

USEPA's No Action site-wide average surface water cPAH concentration (approximately 0.0008 µg/L, per ROD Appendix IV Figure 4.2-8b provided in the ROD [USEPA 2017a]) is less than the revised surface water cleanup level of 0.0009 µg/L. Following USEPA's FS evaluation methods, this would mean that the site already achieves the revised cleanup level.

Non-cancer PRGs

Prior to the BaP toxicity value update, a USEPA-approved non-cancer RfD did not exist for BaP and, as such, non-cancer hazards were not quantified in the Site human health risk assessment for BaP (Kennedy/Jenks Consultants 2013). However, USEPA apparently used this new toxicity value[2] to develop non-cancer RAO 1 PRGs for cPAH (FS Table B3-4; USEPA 2017a). These PRGs were not summarized in USEPA FS Section 2 and do not appear to be used in the FS or ROD evaluations. Because cPAH is a chemical sum made up of specific carcinogenic PAHs, it is unclear whether USEPA intended these PRGs to be applied to cPAH or only to BaP. However, the non-cancer cPAH RAO 1 PRGs in Table B3-4 of the USEPA FS are orders of magnitude higher than the cancer-based RAO 1 PRGs (i.e., the minimum non-cancer cPAH PRG is 91,470 µg/kg).

Remedial Action Levels and Principal Threat Waste Highly Toxic Threshold

The selected remedy identified in the ROD (USEPA 2017a) includes RALs and PTW highly toxic sediment concentrations, above which USEPA's remedy requires active remediation. PAH RALs for sediment identified in USEPA's ROD are TPAH concentrations determined by USEPA using RAL curves, the cPAH to TPAH correlation regression analysis, and USEPA's professional judgment regarding the acceptability of surface-weighted average concentrations (SWACs) achieved relative to various PRGs. Therefore, revised RALs cannot be directly recalculated using the updated BaP CSF. Nonetheless, USEPA's RAL determination methods can be mimicked using the updated PRGs through two approaches: 1) a proportional adjustment approach; and 2) a risk-reduction approach.

For the first approach, we used USEPA's correlation relationship between cPAH PRGs and TPAH RALs to estimate revised RALs. For the second approach, we also used post-construction SWACs associated with various RALs and compared them to the revised PRGs to see if higher RALs would

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[2] Though USEPA cites the RfD as a 2004 number, it did not exist at that time, and it was not used in the baseline human health risk assessment.

still meet USEPA's interim target risk levels, similar to USEPA's FS methods for post-construction risk estimation. Each of these approaches are detailed below.

Nearshore Sediment RAL

The selected remedy identified in the ROD includes a TPAH RAL of 13,000 µg/kg applicable to nearshore sediments. The ROD cleanup levels associated with the nearshore sediment direct contact include 23,000 µg /kg TPAH (RAO 5 benthic risk PRG) and 12 µg/kg cPAH (RAO 1 beach direct contact PRG). As noted above, USEPA identifies the sediment direct contact PRG for beach sediments as the cleanup level for RAO 1, which is inconsistent with the RAO 1 exposure scenario evaluated in the BHHRA for nearshore sediments outside of beach areas. However, USEPA developed the TPAH RALs based upon the 106-µg/kg cPAH PRG (USEPA 2016, Figure 3.4-2). Further, USEPA's updated calculation of residual and post construction risks (USEPA 2017a, Appendix IV, Appendix J) evaluates achievement of RAO 1 in nearshore sediments for each alternative, including the selected alternative, using the in-water sediment RAO 1 cPAH PRG of 106 µg/kg. Consequently, we used the same PRG for our revised RAL estimates.

Proportional Adjustment Approach

The ROD TPAH RAL of 13,000 µg/kg converts to 1,500 µg/kg cPAH using USEPA's cPAH to TPAH regression, which is approximately 14 times the USEPA's RAO 1 in-water sediment cPAH PRG of 106 µg/kg. Proportionally adjusting USEPA's RAL by applying a 14-fold increase to the revised RAO 1 in-water cPAH PRG (773 µg/kg) results in an estimated revised RAL for the nearshore of 92,000 µg/kg TPAH (converted from 10,800 µg/kg cPAH using the regression and rounding to two significant figures, consistent with USEPA's RALs).[3] Figure 1 shows the sediment management areas (SMAs) associated with an alternative where the only modification to the selected remedy is revision of the nearshore TPAH RAL from 13,000 µg/kg to 92,000 µg/kg. Total SMA acreage (areas exceeding all RALs plus all PTW) decreases from 355 acres for the selected remedy (red area) to 326 acres (yellow plus green areas). Though the proportionally adjusted nearshore TPAH RAL results in only an approximately eight percent decrease in total SMAs, the revised RAL primarily reduces the SMA extents upstream and downstream of Gasco (only in the nearshore area, which is where the revised RAL would be applied).

[3] TPAH RAL for the nearshore sediments is 125 times the USEPA's RAO 1 beach PRG. Proportional adjustment results in a revised cPAH RAL of 10,600 µg/kg (approximately 91,000 µg/kg TPAH).

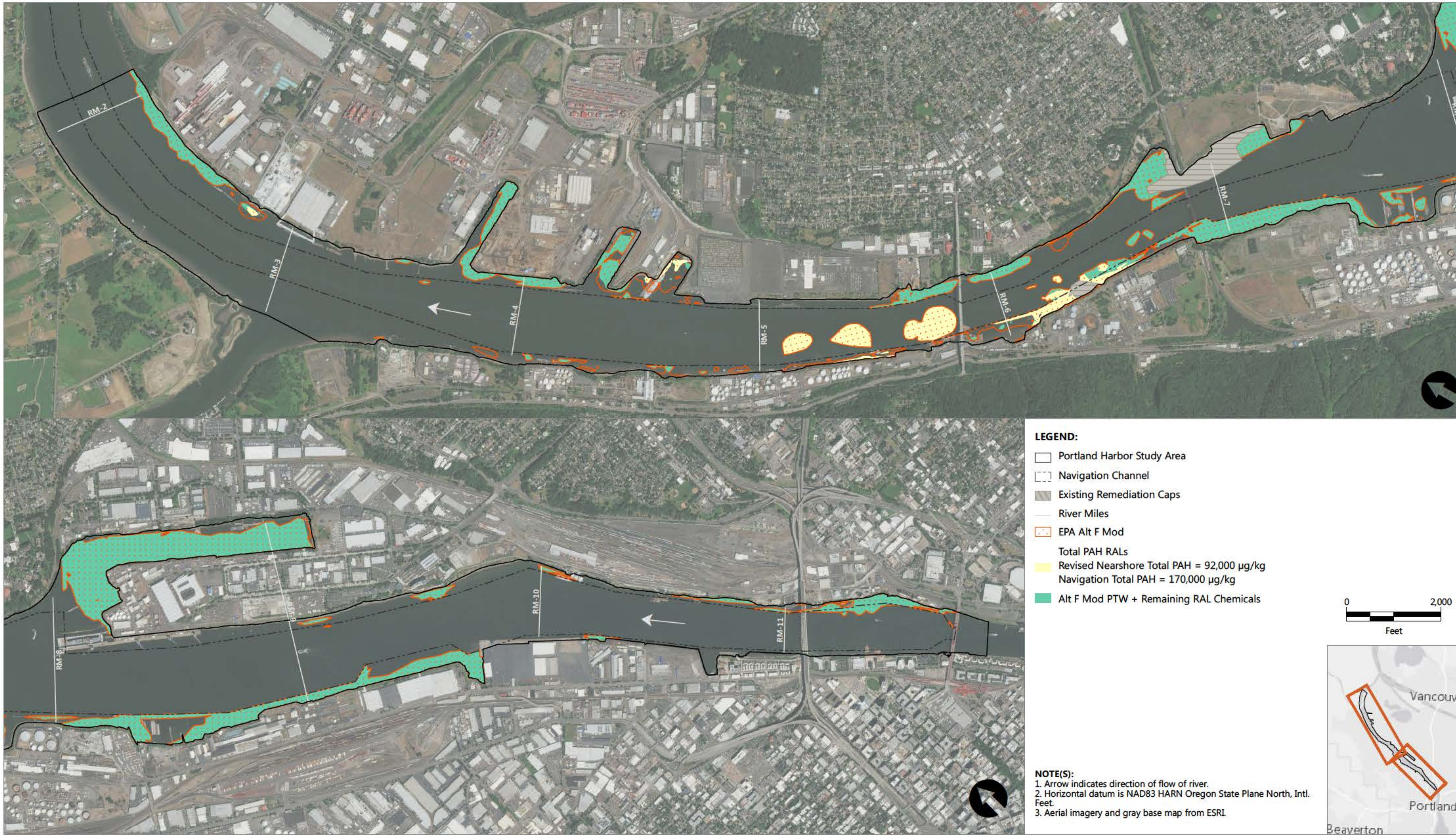

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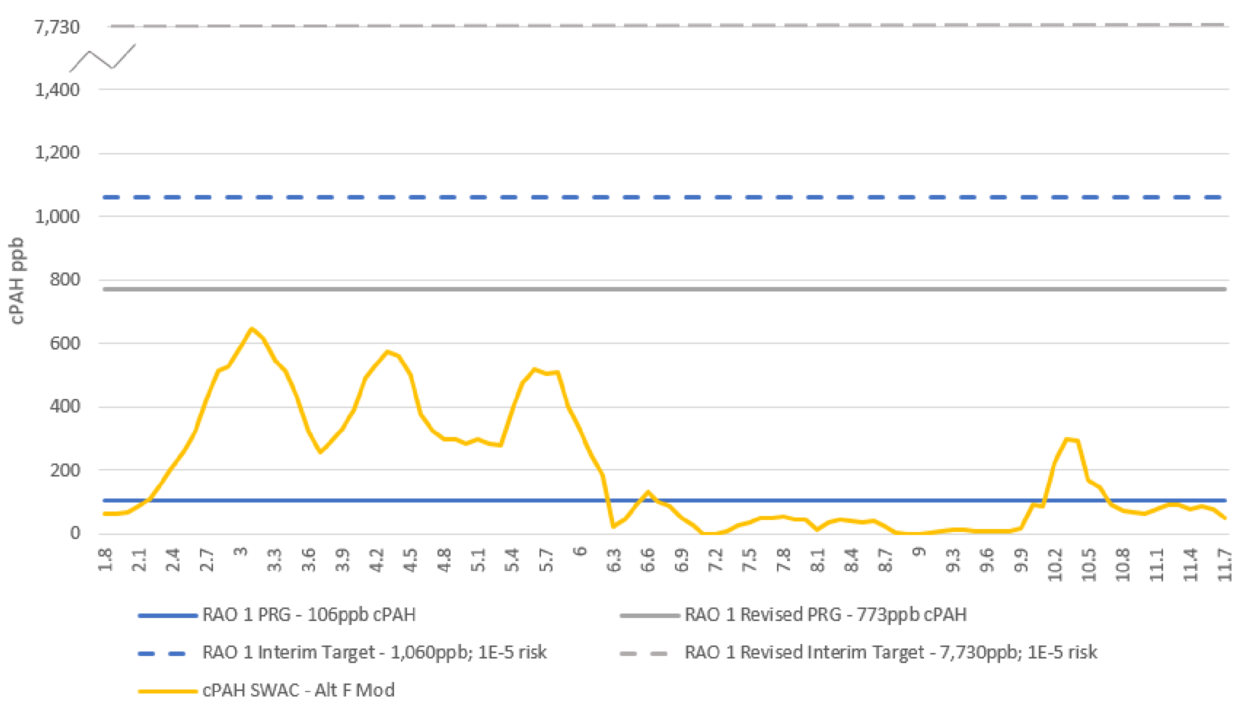
Figure 1
Sediment Management Areas (SMAs) Using Revised Nearshore TPAH RAL
Portland Harbor Record of Decision Review
Gasco Sediments Cleanup Action

Risk Reduction Approach

PRGs were developed at a $1x10^{-6}$ level (USEPA 2016). USEPA set interim targets for risks to evaluate the potential for achievement of PRGs in a "reasonable time frame." For RAO 1, USEPA set the interim target at $1x10^{-5}$ cumulative risk (i.e., the total risk of the contaminants of concern evaluated in USEPA's FS). Therefore, risk reduction from cPAHs for river miles (RMs) where cPAHs compose most of the cumulative risk can be used to develop a revised TPAH RAL, and an interim target-based concentration was estimated from the revised cPAH PRG. These evaluations are discussed below, with a focus in this example on the west side of the river where, according to USEPA's ROD, cPAHs compose most of the cumulative risk in select RMs.

USEPA's selected remedy (Alternative F Modified) in the ROD contains several RM SWACs (as reported in the USEPA FS Appendix J tables provided in the ROD) that exceed USEPA's RAO 1 in-water direct contact cPAH PRG (Figure 2) but meet the interim target at a cancer risk level of $1x10^{-5}$. When the revised PRG is used, all RM SWACs associated with USEPA's selected remedy are less than the revised PRG and much less than the revised $1x10^{-5}$ interim target level.

Figure 2
USEPA-selected Remedy Post-construction cPAH SWACs Using USEPA App J 0.5 RM SWACs – West

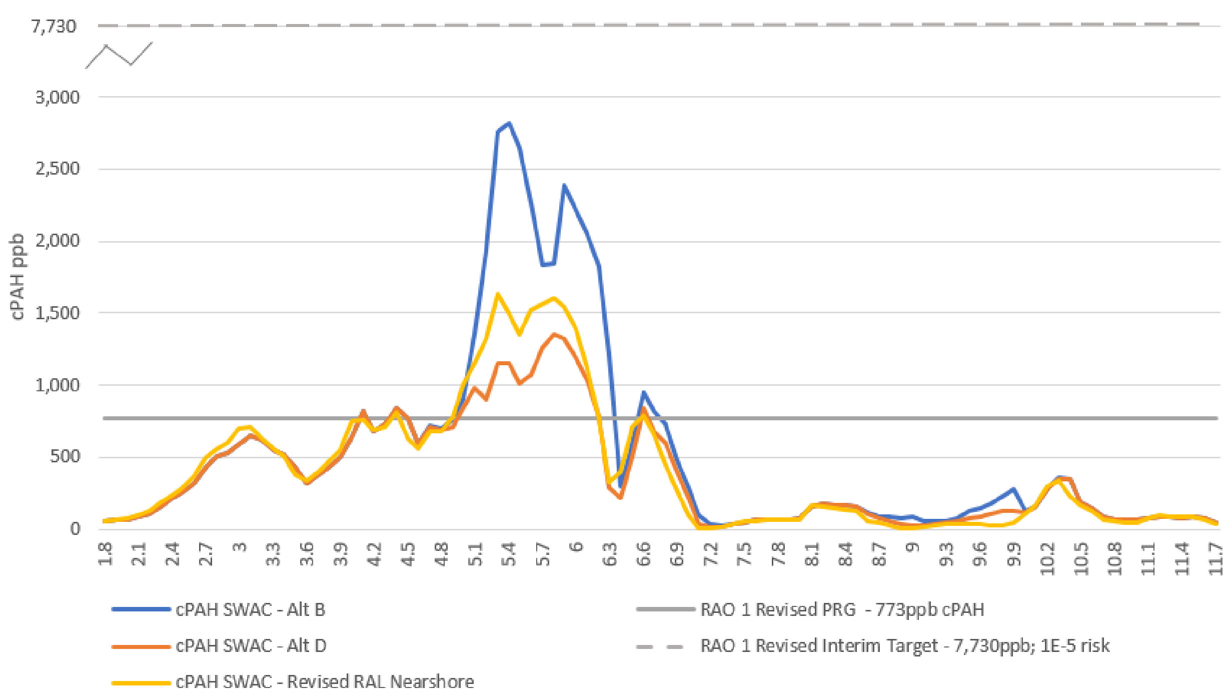


To identify which RAL could be applied and still meet USEPA's interim targets, post-construction SWACs were compared to the revised PRG and interim target level using USEPA's Appendix J SWACs (based on rolling 0.5 RM segments) for Alternatives B and D and Anchor QEA-estimated SWACs for the estimated RAL based on proportional adjustment

As shown in Figure 3, USEPA's Alternative B (RAL of 170,000 µg/kg) meets the revised PRG in most RMs. Similar to USEPA's Alternative D, revision of the nearshore TPAH RAL from 13,000 µg/kg to 92,000 µg/kg results in estimated post-construction SWACs that achieve the revised PRG at more RMs than for Alternative B. All SWACs in Figure 3 are well below the revised interim target.

Based on these SWACs and the revised RAO 1 in-water direct contact cPAH PRG applicable to nearshore sediments (773 µg/kg), a revised TPAH RAL for nearshore sediment that would likely meet USEPA's objectives for risk reduction could increase from 13,000 µg/kg to a range of 92,000 µg/kg to 170,000 µg/kg, a 7- to 13-fold increase.

Figure 3
Post-construction cPAH SWACs Using USEPA App J 0.5 RM SWACs Revised RAL – West



Navigation Channel Sediment RAL

USEPA's selected remedy in the ROD includes a TPAH RAL of 170,000 µg/kg applicable to navigation channel sediments. The cleanup levels associated with the navigation channel include 23,000 µg/kg TPAH (RAO 5 benthic risk PRG) and 3,950 µg/kg cPAH (RAO 2 PRG). As described above, the RAO 2 cPAH cleanup level increases to 108,000 μg/kg using the revised CSF. Potential impacts to the navigation channel TPAH RAL from application of the revised RAO 2 cPAH cleanup level are summarized below.

Proportional Adjustment Approach

The ROD TPAH RAL of 170,000 μg/kg converts to approximately 20,000 μg/kg cPAH using USEPA's cPAH to TPAH regression, which is approximately five times the ROD RAO 2 cPAH cleanup level. Proportionally adjusting USEPA's RAL by applying a five-fold increase to the revised RAO 2 cPAH cleanup level (108,000 μg/kg) results in an estimated revised RAL for the navigation channel of 540,000 μg/kg cPAH (more than 4,000,000 μg/kg TPAH).

Risk Reduction Approach

The revised RAO 2 cPAH cleanup level (108,000 μg/kg) exceeds the ROD cPAH PTW highly toxic threshold (106,000 μg/kg). USEPA's No Action SWACs for all RMs in the navigation channel (per the USEPA ROD, Appendix IV, Appendix J tables) already achieve the revised RAO 2 cPAH cleanup level. Therefore, a TPAH RAL would no longer be needed to be protective of the revised PAH human health cleanup level.

Revised SMAs associated with applying a revised nearshore TPAH RAL of 92,000 μg/kg and eliminating a navigation channel TPAH RAL are shown in Figure 4 as compared to the SMAs associated with USEPA's selected remedy. The RAL revisions eliminate nearly all SMAs in the navigation channel; those remaining are associated with elevated PCB concentrations (green areas). Total SMA extents decreases by approximately 14 percent from 355 acres associated with USEPA's selected remedy to 304 acres through revising nearshore and navigation channel TPAH RALs. The TPAH areas associated with Alternative B (blue areas) are included for comparison with the TPAH areas associated with the revised nearshore and navigation channel RALs (yellow areas).

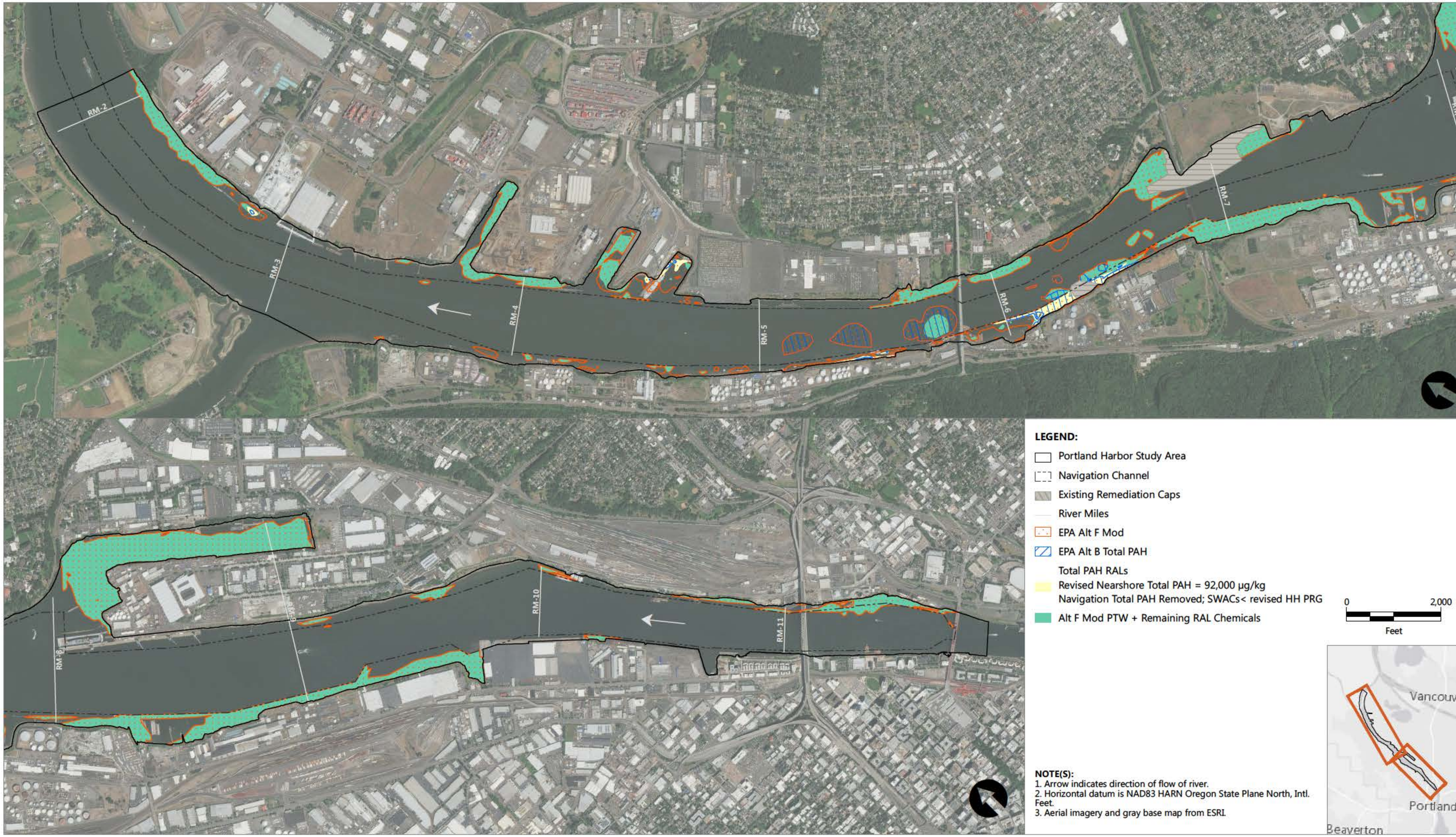


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Figure 4
Sediment Management Areas (SMAs) Using Revised Nearshore and Navigation Channel TPAH RALs
Portland Harbor Record of Decision Review
Gasco Sediments Cleanup Action

Principal Threat Waste

PTW highly toxic is a risk-based action level based on the RAO 1 in-water direct contact cPAH PRG; therefore, a revised threshold can be calculated following USEPA's methods using the revised BaP CSF. The PTW highly toxic cPAH concentration increases from 106,000 µg/kg to 773,000 µg/kg when applying the new BaP CSF. USEPA's No Action sediment concentrations are less than this revised PTW highly toxic threshold; therefore, no PTW highly toxic areas would exist at the Site for cPAHs.

References

Anchor QEA, LLC, 2016. Technical memorandum to: NW Natural. Regarding: Critique of EPA PRGs and RALs. Portland Harbor Feasibility Study. Attachment 2 of NW Natural September 6, 2016 Comments on EPA's June 8, 2016 Proposed Plan and Draft Final Feasibility Study for the Portland Harbor Superfund Site. September 6, 2016.

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Appendix A5

TCT Meeting Materials, January 11, 2018

Changes to the Portland Harbor Remedy based on Updated Human Health Toxicity Values for Benzo(a)Pyrene

January 11, 2018

Overview

- EPA updated the cancer slope factor (CSF) for benzo(a)pyrene (BAP) after the Portland Harbor ROD was issued
  - Revised from 7.3 mg/kg-day to 1 mg/kg-day
- Potentially changes risk-based direct contact and clam consumption cleanup levels for carcinogenic PAHs (CPAHs) that are based on BAP equivalents
- Potentially changes risk-based highly toxic principal threat waste threshold for CPAHs
- Requires evaluation of potential RAL changes related to cPAH direct contact and clam consumption risk
  - Must also consider impact of potential RAL change on RAOs 3 and 5

Proposed cPAH CUL Changes

- EPA proposes to change the cPAH cleanup levels based on the updated cancer slope factor (CSF) for benzo(a)pyrene (BAP)
- EPA proposes separate beach and in-water sediment direct contact CULs
  - Updated recreational beach CUL: 12 µg/kg to 85 µg/kg
  - Updated in-water sediment CUL: 106 µg/kg to 774 µg/kg
  - Updated clam consumption CUL: 3950 µg/kg to 107,600 µg/kg
  - Updated highly toxic PTW threshold: 106,000 µg/kg to 774,000 µg/kg
- Total PAH benthic risk CUL (RAO 5) of 23,000 µg/kg is unaffected by this change

Proposed Nearshore* Total PAH RAL Change

- EPA proposes that the current total PAH nearshore * RAL of 13,000 µg/kg should be changed to 30,000 µg/kg:
  - Change is necessitated based on BAP CSF change
  - EPA conducted an analysis that showed that a total PAH RAL of 30,000 µg/kg addresses all areas with cPAH exceeding 774 µg/kg on a rolling river mile SWAC basis (½ mile increments)
  - Small areas with cPAHs below 774 µg/kg on a SWAC basis but with total PAHs above the proposed 30,000 µg/kg will still remain (e.g., RM 2.8 east, RM 6.5 east and upper end of Swan Island Lagoon)

*Outside the Navigation Channel

Proposed Navigation Channel Total PAH RAL

- EPA proposes that the current total PAH navigation channel RAL of 170,000 µg/kg should be retained:
  - PAH contamination above 170,000 µg/kg is limited to the area between RM 5 -7
  - The current navigation channel RAL is well above the RAO 5 total PAH CUL of 23,000 µg/kg
  - Lack of sediment deposition observed within the navigation channel between RM 5 – 7 may limit achievement of RAO 5 through natural recovery in this reach if the RAL is increased
  - Increase in PAH loading to surface water has been observed downstream of RM 6.3
  - Increasing the total PAH RAL to 230,000 µg/kg (10X the total PAH Benthic CUL) results in minimal change to remedial footprint based on existing surface sediment data and may not achieve the ROD specified protectiveness standards for RAOs 3 and 5

CUL, PTW and RAL Change Summary

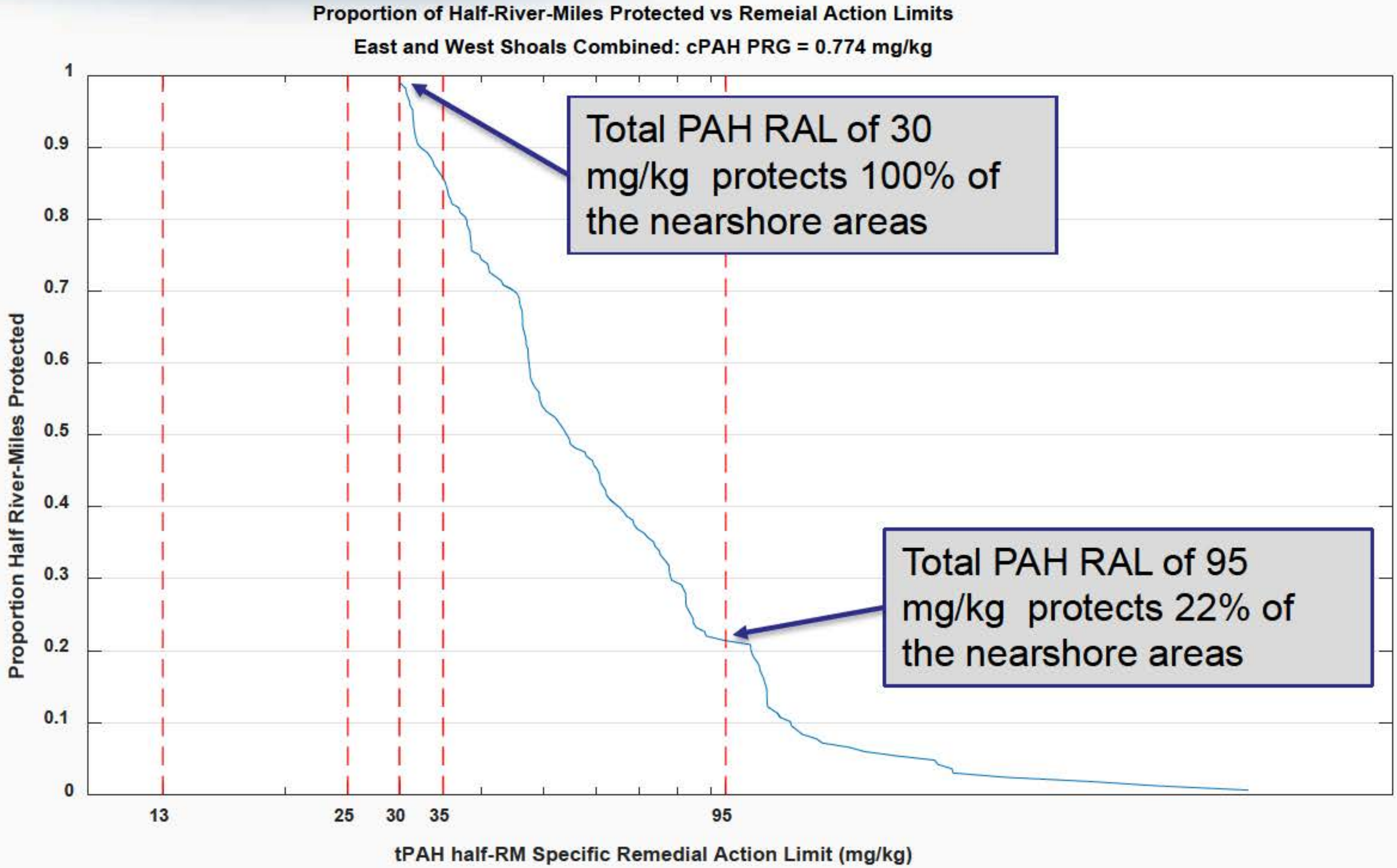
Scenario	Application Area	ROD Value	Updated Value
Direct Contact cPAH Beach Sediment CUL (RAO 1)	Beach Areas	12 µg/kg	85 µg/kg
Direct Contact cPAH In-Water Sediment CUL (RAO 1)	Nearshore sediment (excluding beach areas)	Not Included	774 µg/kg
Clam Consumption cPAH Tissue Target Level (RAO 2)	Site-Wide	7.1 µg/kg	51.6 µg/kg
Clam Consumption cPAH Sediment CUL (RAO 2)	Site-Wide	3,950 µg/kg	107,600 µg/kg
Benthic Risk total PAH Sediment CUL (RAO 5)	Site-Wide	23,000 µg/kg	23,000 µg/kg *
Highly Toxic cPAH PTW Threshold	Site-Wide	106,000 µg/kg	774,000 µg/kg
Nearshore total PAH RAL	Nearshore Sediment (Outside the Navigation Channel)	13,000 µg/kg	30,000 µg/kg
Navigation Channel total PAH RAL	Navigation Channel Sediment	170,000 µg/kg	170,000 µg/kg *

* No Change Proposed

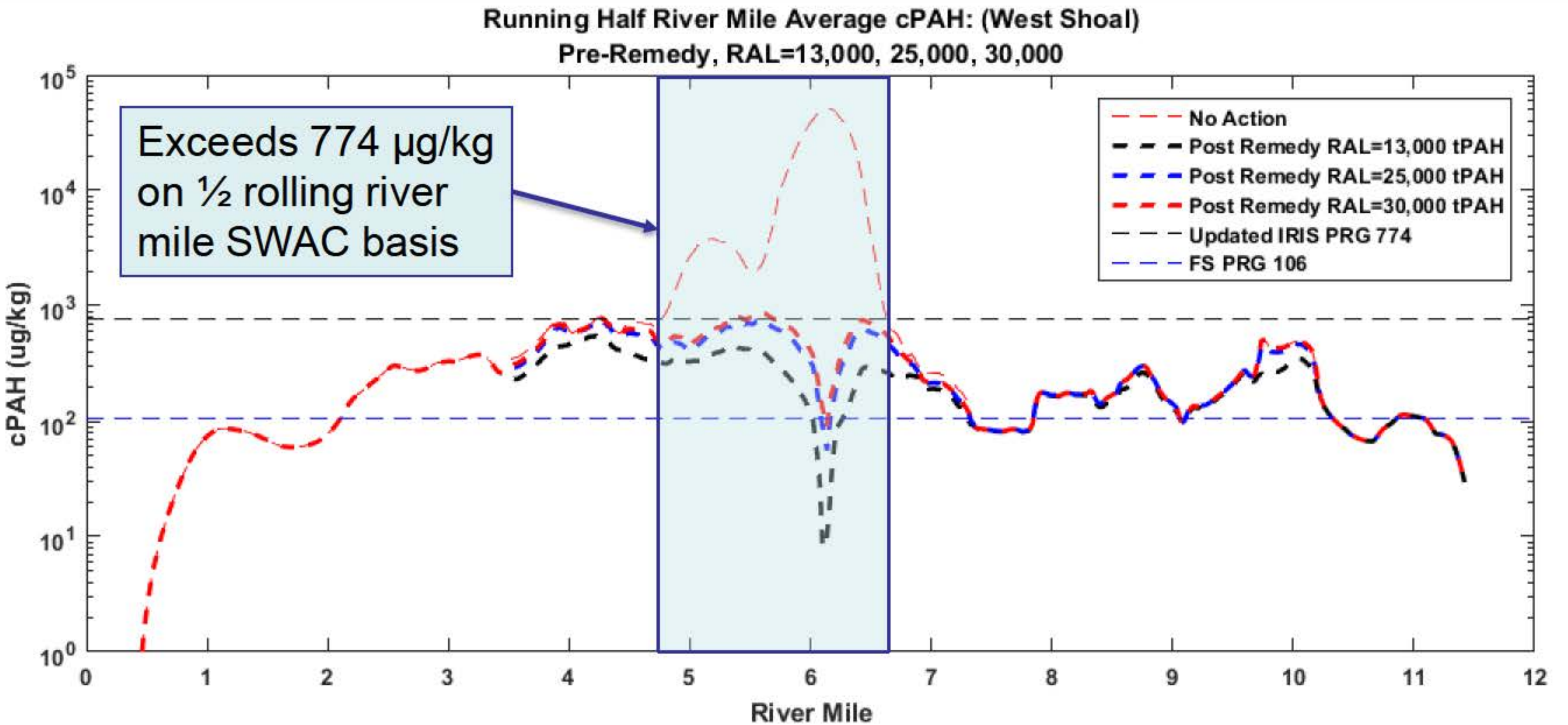
RAL Change Evaluation Summary

Criteria	Retain Nearshore RAL (13,000 µg/kg)	Adjust Nearshore RAL (30,000 µg/kg)	Retain Nav. Channel RAL (170,000 µg/kg)	Adjust Nav. Channel RAL (230,000 µg/kg)
Protective (Achieves RAOs)	Yes	Yes	Yes	No
Remediates areas not posing risk	Yes	Minimal	No	No
Achieves ARARs (WQS)	Potentially	Unknown	Potentially	Unknown
Ease of Implementation	Easy	Moderate	Easy	Moderate
PRP Acceptance	No	Yes	Potentially	Yes
State Acceptance	No	Yes	Yes	No

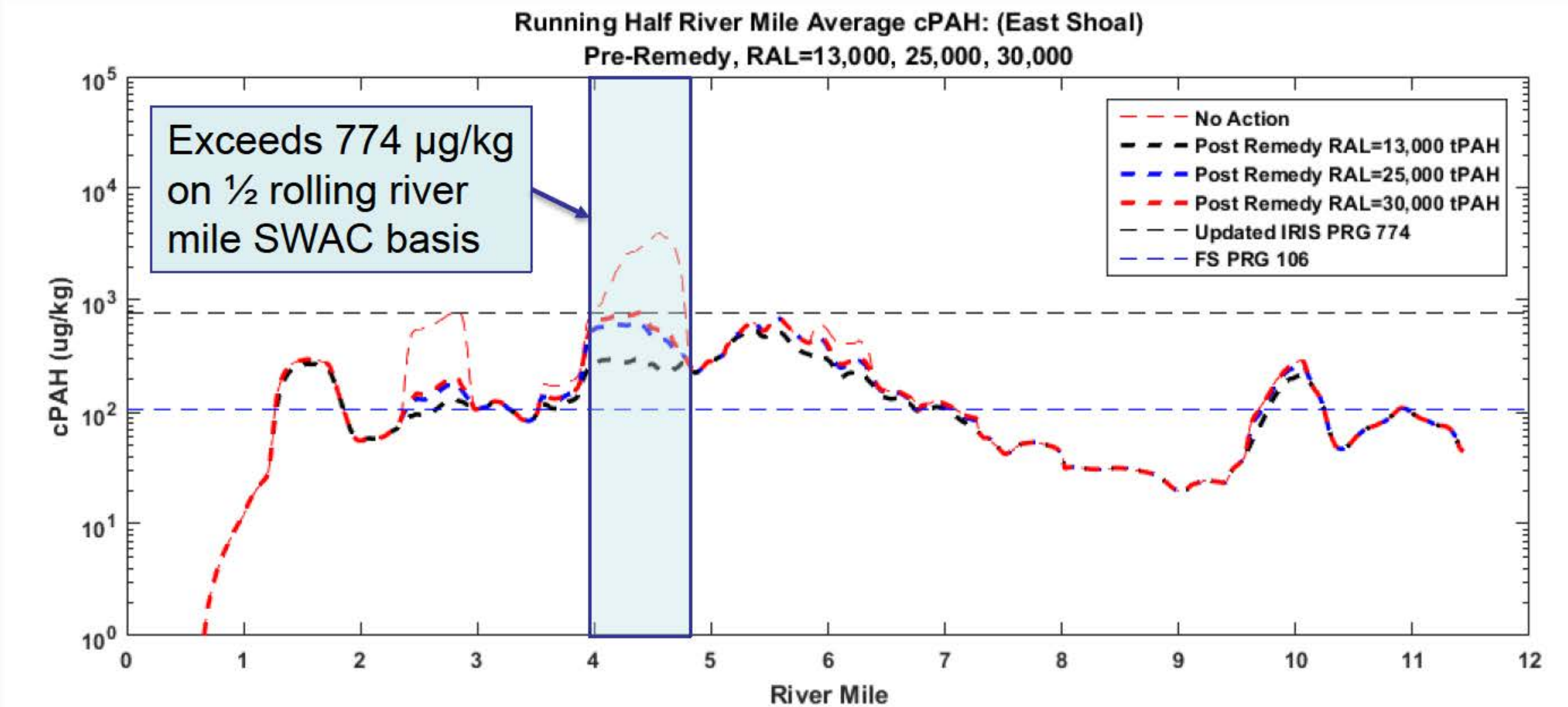
Backup Slides for Discussion



Proportion of Half-River-Miles Protected vs Remeial Action Limits
East and West Shoals Combined: cPAH PRG = 0.774 mg/kg
Proportion Half River-Miles Protected
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
13
25
30
35
95
tPAH half-RM Specific Remedial Action Limit (mg/kg)
Total PAH RAL of 30 mg/kg protects 100% of the nearshore areas
Total PAH RAL of 95 mg/kg protects 22% of the nearshore areas

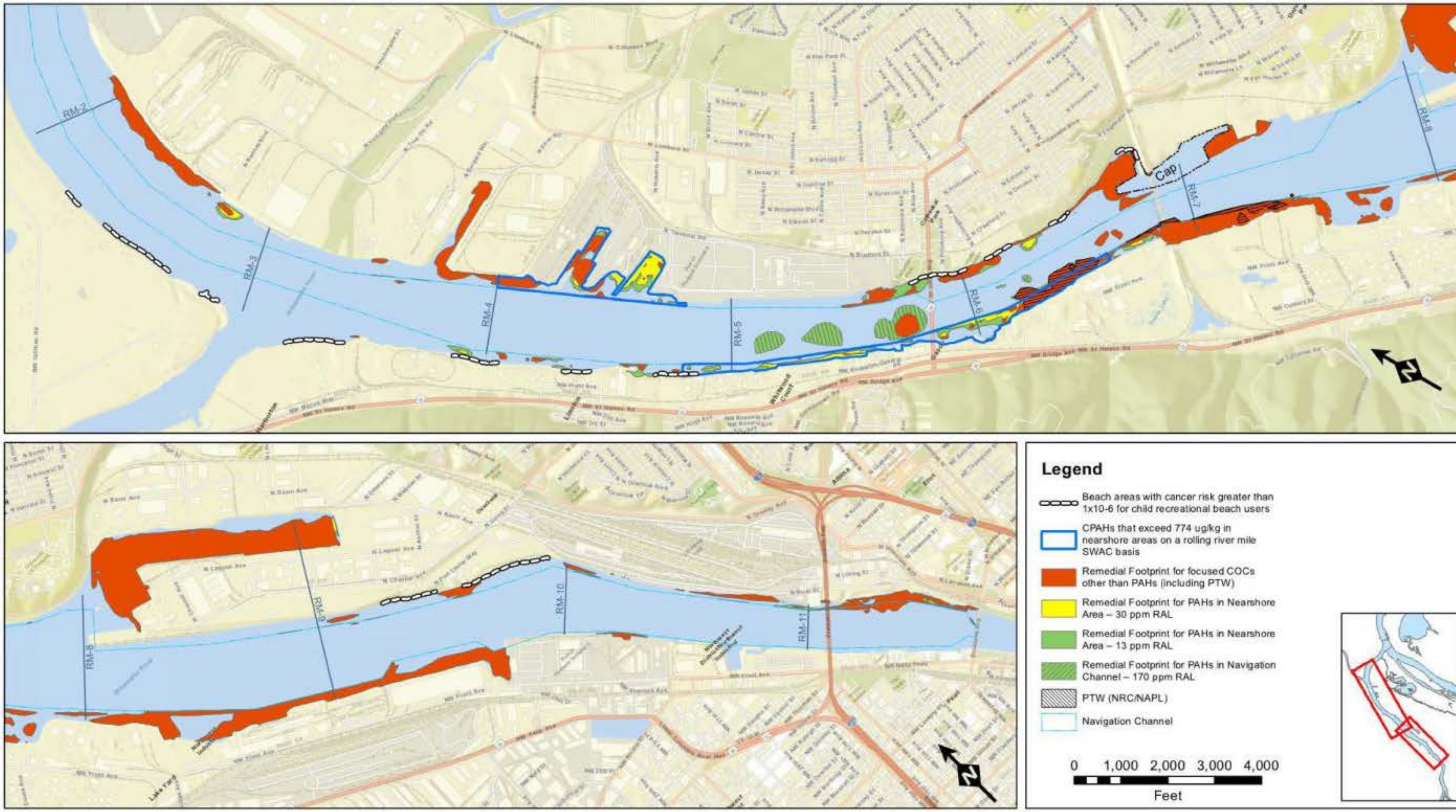


Note: cPAH ½ rolling river mile SWAC was estimated assuming cleanup above total PAH RAL for each scenario



Note: cPAH ½ rolling river mile SWAC was estimated assuming cleanup above total PAH RAL for each scenario

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY



Source Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User

Figure X-X. Selected Remedy Footprint comparison

Path: E:_Projects\Portland Harbor\GIS\MapDocuments\Post ROD Phase\PAH analysis\FigX-X_SMAs-based-on-PAHs-30ppm.mxd

Date: 1/2/2018

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

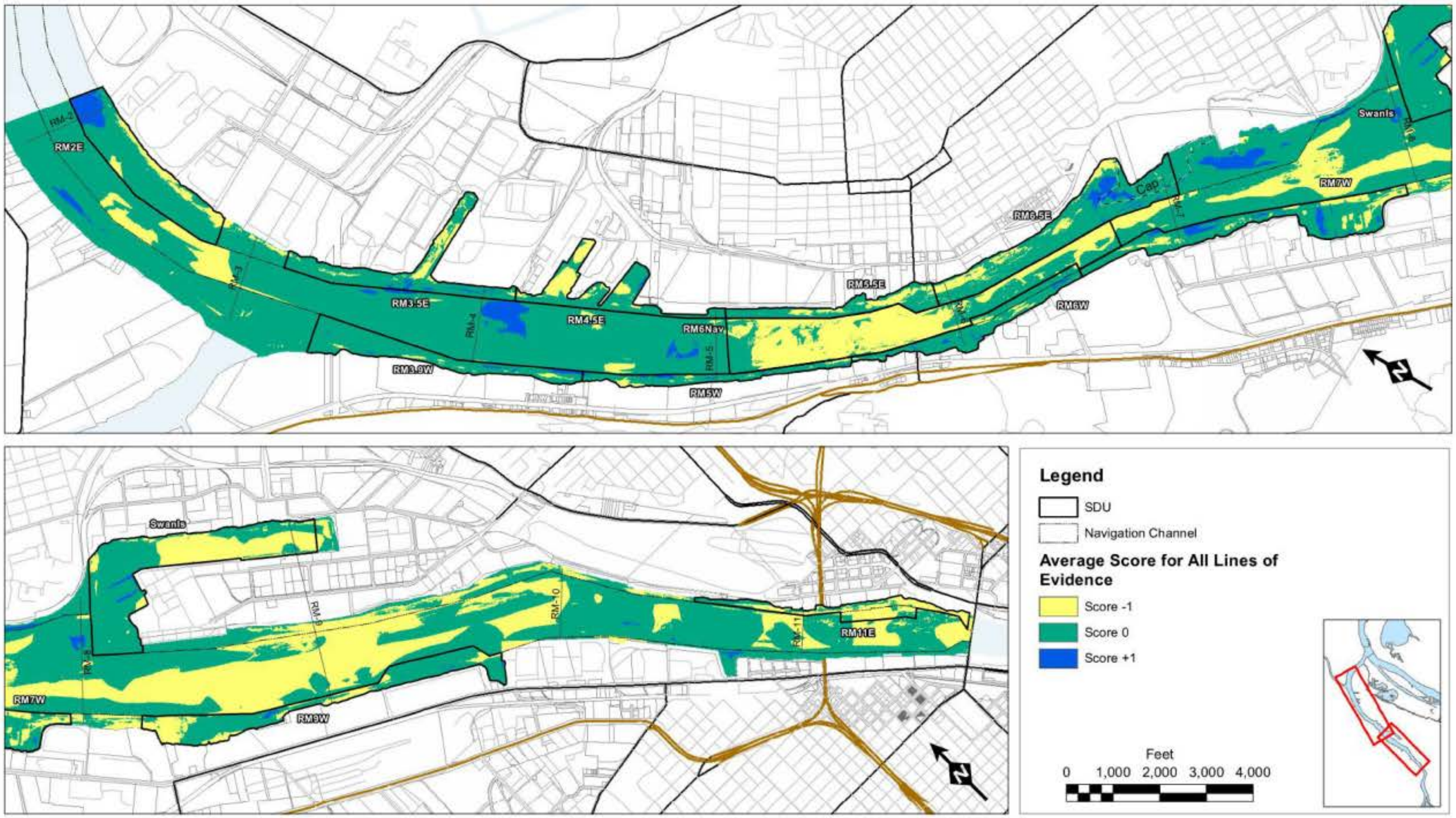


Figure D8-7. Average Score for Six Lines of Evidence

Path: E:_Projects\Portland Harbor\GIS\MapDocuments\FS Figures\Appendix D\FigureD8-x_MNR-Scoring.mxd, Created by: MLF

Date: 5/23/2016

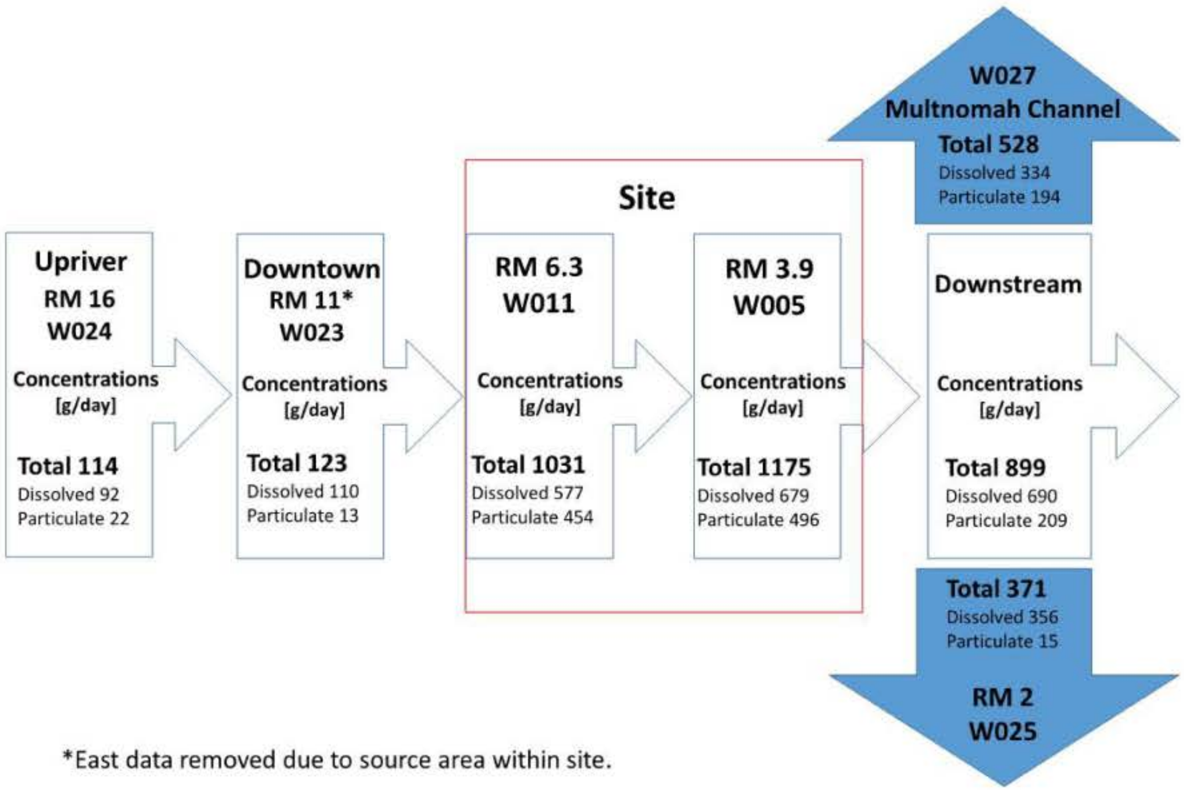


Figure 1.2-23a Portland Harbor Superfund Site PAH Loading Low Flow (Sept 2006) 8,730 cfs

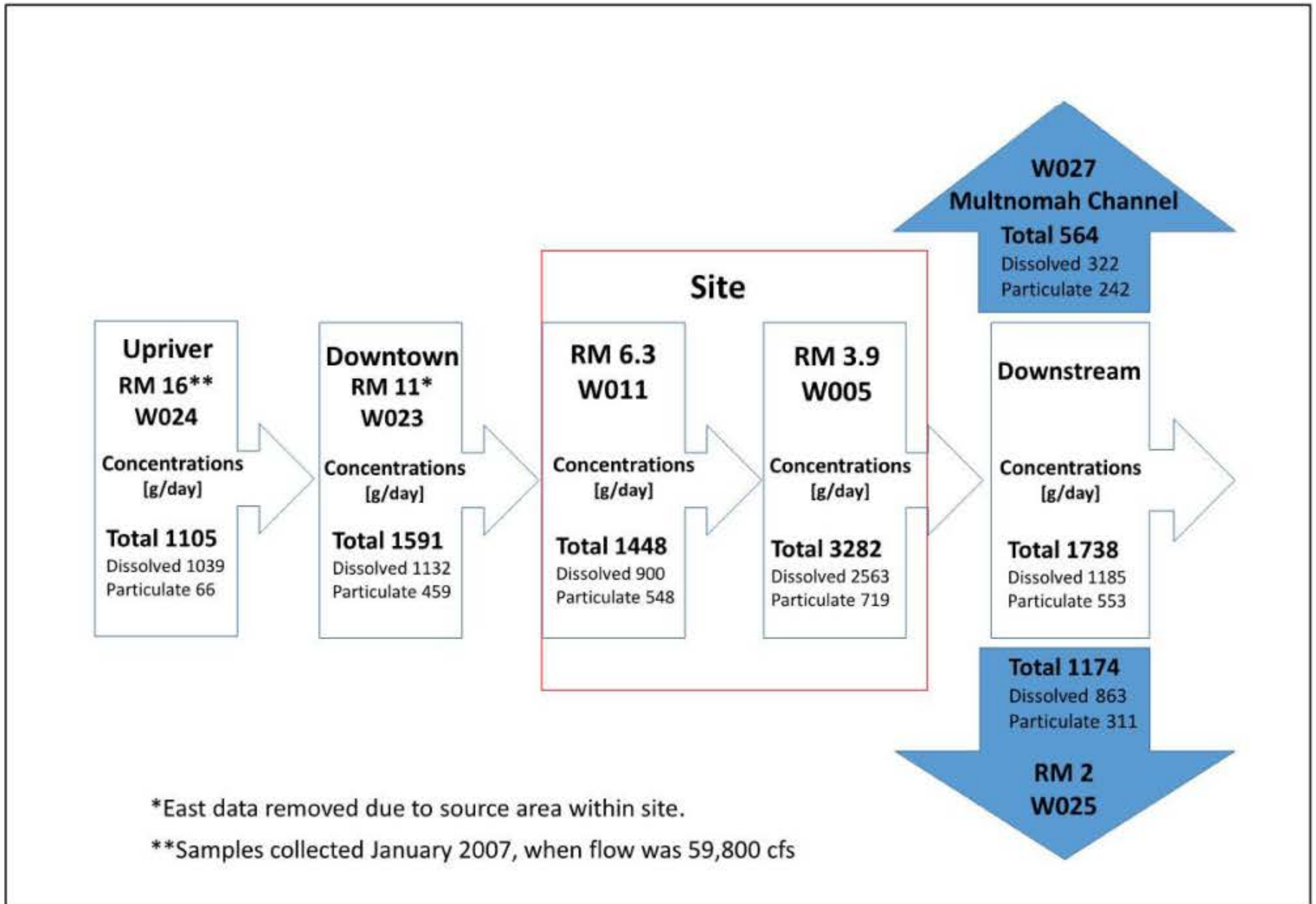


Figure 1.2-23c Portland Harbor Superfund Site PAH Loading High Flow (Feb-Mar 2007) 60,900 cfs

Remedial Footprint Area Summary

Scenario	Remedial Footprint (Acres)			Notes
	Current Remedy	Nearshore Total PAH RAL Change from 13 to 30 ppm	Remedial Footprint Change	
Total Remedial Area (All focused COCs)	364	340	24	Totals do not include 28 acres of ENR in Swan Island Lagoon
Contribution of PAHs to Remedial Area	66	42	24	Contribution of PAHs based on applicable RAL
Remedial Area below In-Water Sediment cPAH CUL (774 µg/kg)	18	3	15	Nearshore areas that do not pose risk based on comparison to revised in-water cPAH CUL
Navigation Channel NAPL/NRC PTW	6	6	0	No change in NAPL/NRC remedial footprint

Evaluation of Potential Modifications to Total PAH Navigation Channel RAL

The purpose of this memo is to evaluate whether the total PAH Navigation Channel RAL of 170,000 µg/kg identified in the ROD should be modified based on changes in carcinogenic PAH cleanup levels due to the post-ROD change to the benzo(a)pyrene slope factor. Additional information on this change is provided by EPA in the *IRIS Toxicological Review of Benzo[a]pyrene, dated January 2017* (https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=136).

Human Health Risk:

Within the navigation channel, the current cleanup level is 3,950 ppb CPAHs and is based on the clam consumption exposure pathway. Direct contact with contaminated sediment is not considered a complete exposure pathway in the navigation channel. Surface water exposure pathways (ingestion, inhalation and dermal contact) are complete within the navigation channel. Although it is known that contaminated sediments contribute to surface water COCs, there is not a sediment cleanup levels associated with the protection of drinking water. Due to the non-linear relationship between PAHs in sediment and clam tissue, reducing the benzo(a)pyrene slope factor by a factor of 7.3 results in an increase in the clam consumption cleanup level from 3,950 µg/kg to 107,600 µg/kg. Surface sediment data collected during the Portland Harbor site indicate that while some individual samples have total carcinogenic PAHs measured as benzo(a)pyrene equivalents (BaP Eq) above 107,600 µg/kg, this concentration is not exceeded on a rolling ½ river mile surface weighted average concentration (SWAC) basis (See Appendix IV of the ROD). ***As a result, remediation of PAH contaminated sediments within the Navigation Channel is not required to protect human health based on the clam consumption exposure scenario (RAO 2).***

Ecological Risk:

PAH contaminated sediments within the Navigation Channel also pose risks to ecological receptors. The Portland Harbor ROD established 23,000 µg/kg as the total PAH sediment cleanup level for protection of the benthic community. The current total PAH remedial action level (RAL) applicable to the Navigation Channel is 170,000 µg/kg, a value which is already 7.4 times the total PAH cleanup level of 23,000 µg/kg.

For RAO 5 (benthic risk), the evaluation of protectiveness and long-term effectiveness and permanence as presented in Table 22 of the ROD was based on the percentage of the site that exceeds 10 times the benthic cleanup level. In addition, Section 15.1.2 of the ROD states "At the end of cleanup construction, the Selected Remedy will address 72% of the area based on 10 times unacceptable benthic risks. The remainder of the benthic risk areas will be left to MNR and evaluated in 5-year reviews." The areas that exceed the Navigation Channel RAL within the for PAHs are isolated to areas between RM 5 and 6.6 (Figure 1). As shown in Figure 2, this area of the Site is less conducive to MNR based on a multiple line of evidence evaluation presented in the Portland Harbor FS that considered sediment deposition rates, consistency of deposition, sediment grain size, propwash potential, subsurface to surface sediment concentration ratios, and wind and wake generated waves. This information suggests that MNR will not be as effective at reducing PAH concentrations in this portion of the site than other areas of the site. ***As a result, increasing the total PAH Navigation Channel RAL may further limit the ability of the Portland Harbor remedy to achieve RAO 5 due to the limited effectiveness of MNR within the Navigation Channel between RM 5 and 7.***

In addition to benthic risk, remediation of PAH contaminated sediments within the Navigation Channel will facilitate achievement of RAOs 3 and 7 which are focused on reducing risks to human health and the environment from ingestion and direct contact with COCs in surface water. Sediments within the navigation channel are significantly elevated in cPAH concentration and are likely contribute to cPAH exceedances of the human health and ecological AWQCs. As shown in Figures 3 and 4, taken from Section 1 of the Portland Harbor FS, total PAH surface water load increases from 1031 to 1175 g/day under low flow conditions and from 1448 to 3282 g/day under high flow conditions between RM 6.3 and 3.9. This suggests that the high levels of PAH contamination within the Navigation Channel between RM 5 and 6.6are contributing to the increased PAH load observed between RM 6.3 and 3.9. Although the source of PAH contamination to the water column likely includes contaminated sediments in both the nearshore area and Navigation Channel, remediation of PAH contaminated sediments within the Navigation Channel is expected to contribute to a reduction of PAH water column concentrations and facilitate progress towards achieving RAOs 3 and 7. ***As a result, increasing the total PAH Navigation Channel RAL may limit the ability of the Portland Harbor remedy to achieve RAOs 3 and 7 downstream of RM 6.3.***

Summary:

Remediation of PAH contaminated sediments within the navigation channel is not required to reduce shellfish consumption risk to achieve RAO 2. However, RAOs 3, 5, and 7 are not affected by the IRIS change. Due to the exceedances of the benthic cleanup levels in the navigation channel between RM 5 and 7, the limited effectiveness of MNR in that area, and due to the contribution of PAH contaminated sediments within the Navigation Channel to surface water loading downstream of RM 6.3, increasing the total PAH Navigation Channel RAL in response to the benzo(a)pyrene slope factor is not warranted in the navigation channel area.

Figure 1 – Distribution of PAHs within the Navigation Channel above 170,000 µg/kg

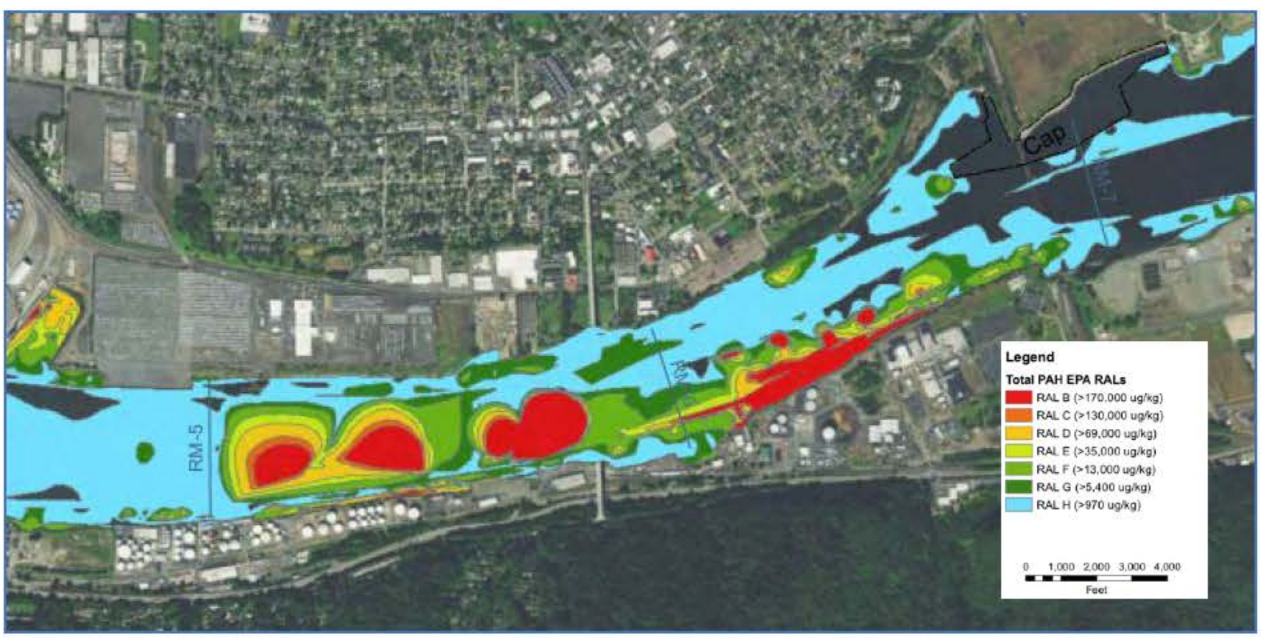


Figure 2 – MNR Average Score for Six Lines of Evidence

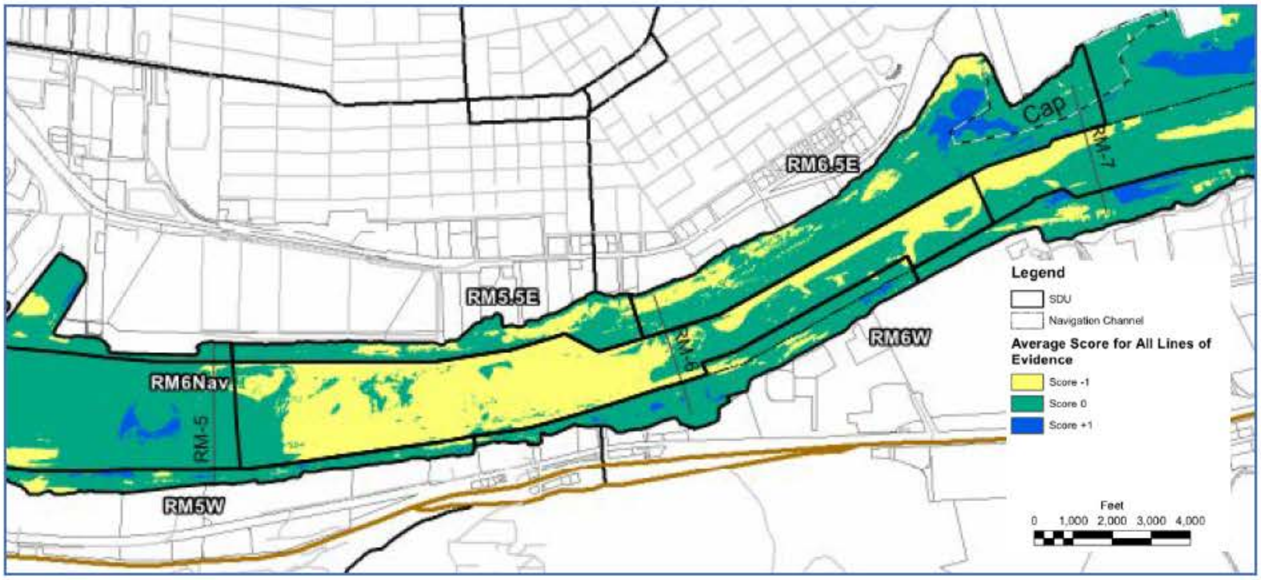


Figure 3 – PAH Loading under Low Flow Conditions

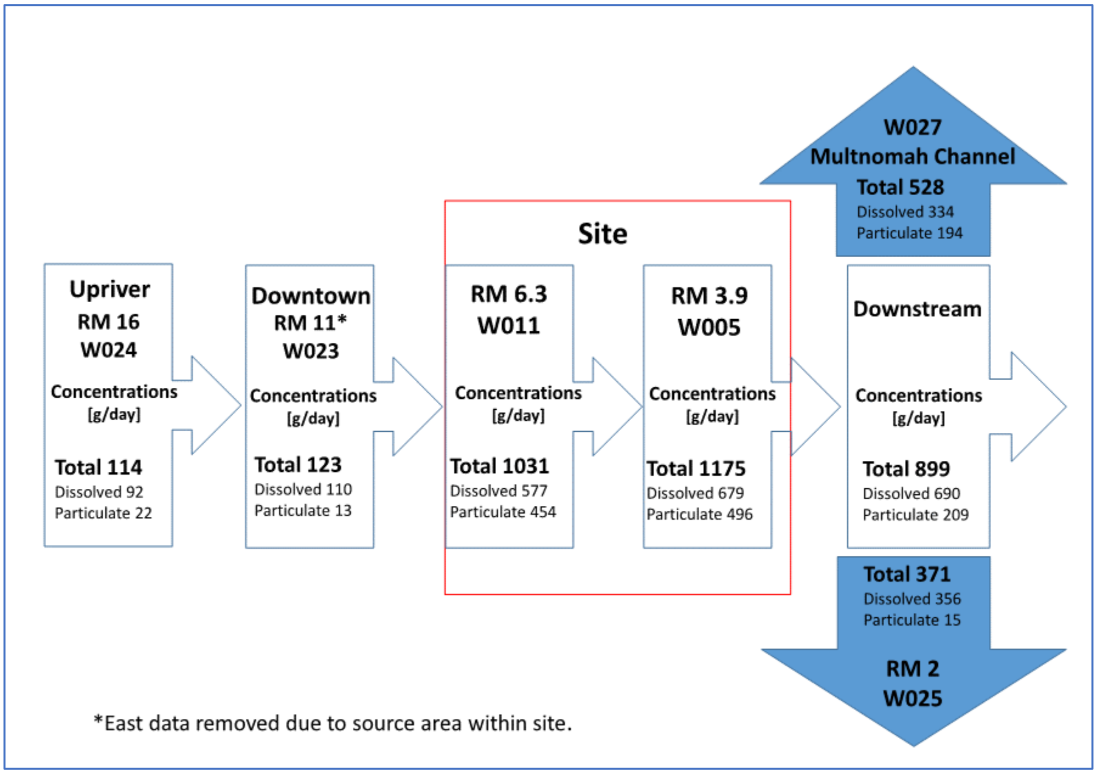
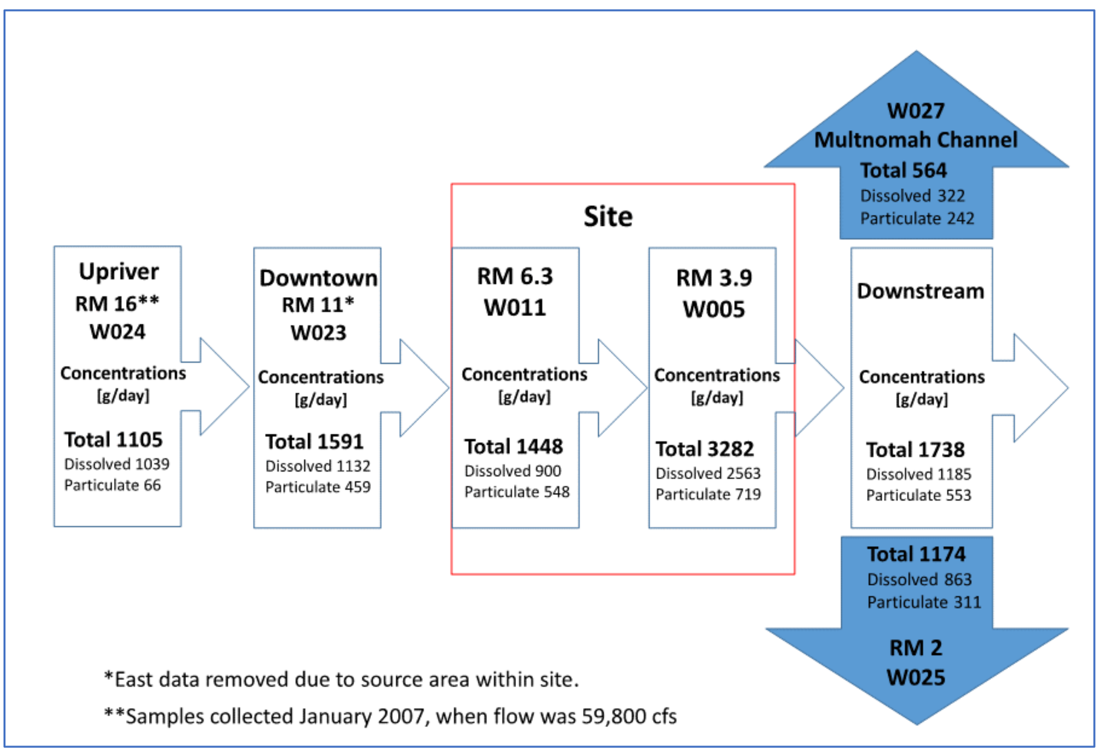
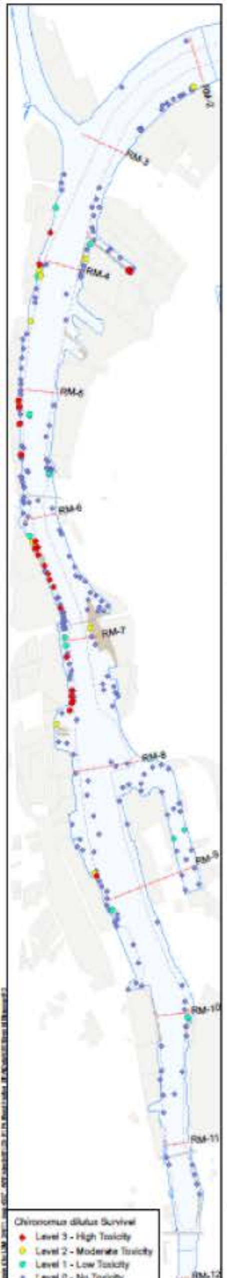


Figure 4 – PAH Loading under High Flow Conditions

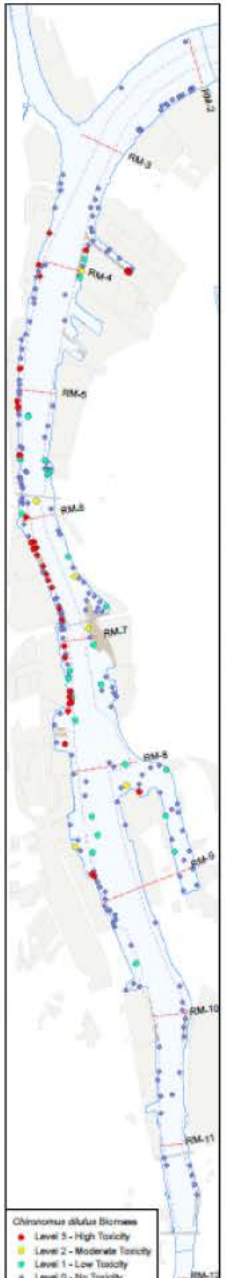


Appendix A6

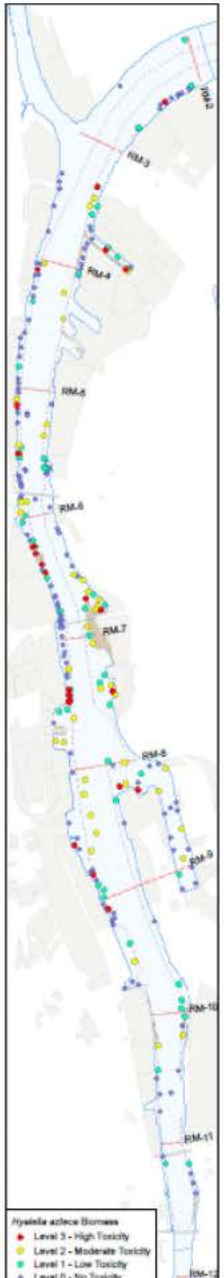
9-7-17 Email from Kevin Parrett (DEQ), Subject: PH Benthic Risk - 8-23-17.pptx



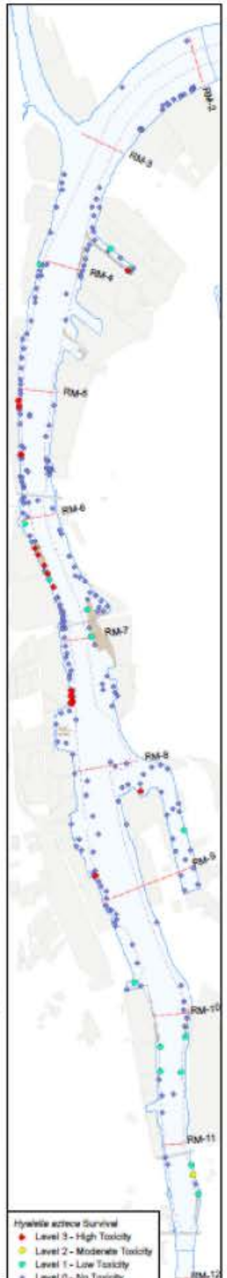
Map 6-2
Chironomus dilutus Survival
Bioassay Results



Map 6-3
Chironomus dilutus Biomass
Bioassay Results



Map 6-4
Hyalella azteca Biomass
Bioassay Results



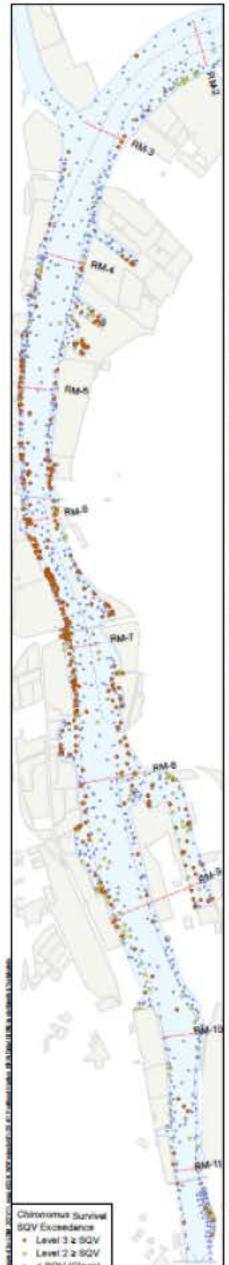
Map 6-5
Hyalella azteca Survival
Bioassay Results

Portland Harbor RI/FS
Baseline Ecological Risk Assessment

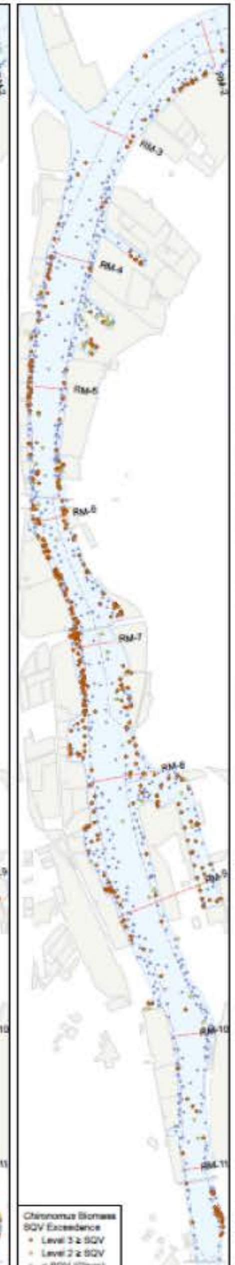
Windward environmental LLC
LWG Lower Willamette Group

0 1,000 2,000 3,000 4,000 Feet

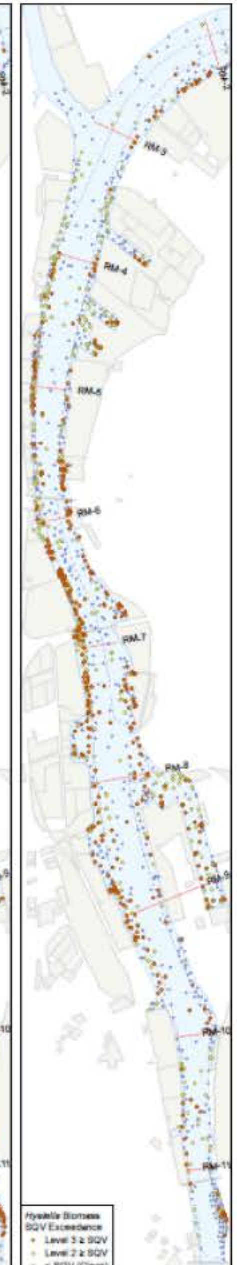
Map Features
Bridge
Upland ECSI Site (2008)
Dredge/Cap Remedy
River Mile
Navigation Channel
River Edge + 13 ft NAVD



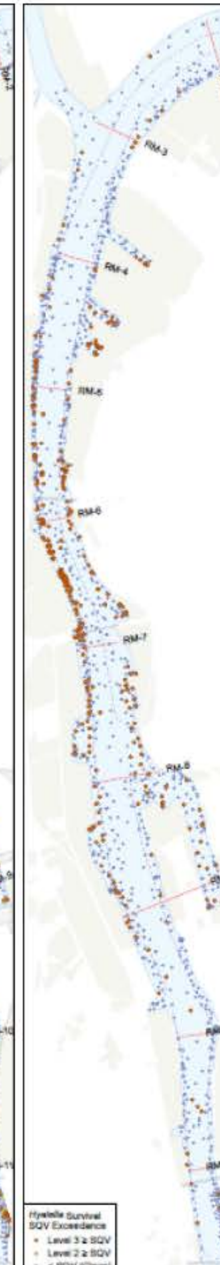
Map 6-7
Exceedance of Site-Specific FPM SQVs
based on *Chironomus dilutus* Survival



Map 6-8
Exceedance of Site-Specific FPM SQVs
based on *Chironomus dilutus* Biomass



Map 6-9
Exceedance of Site-Specific FPM SQVs
based on *Hyalella azteca* Biomass



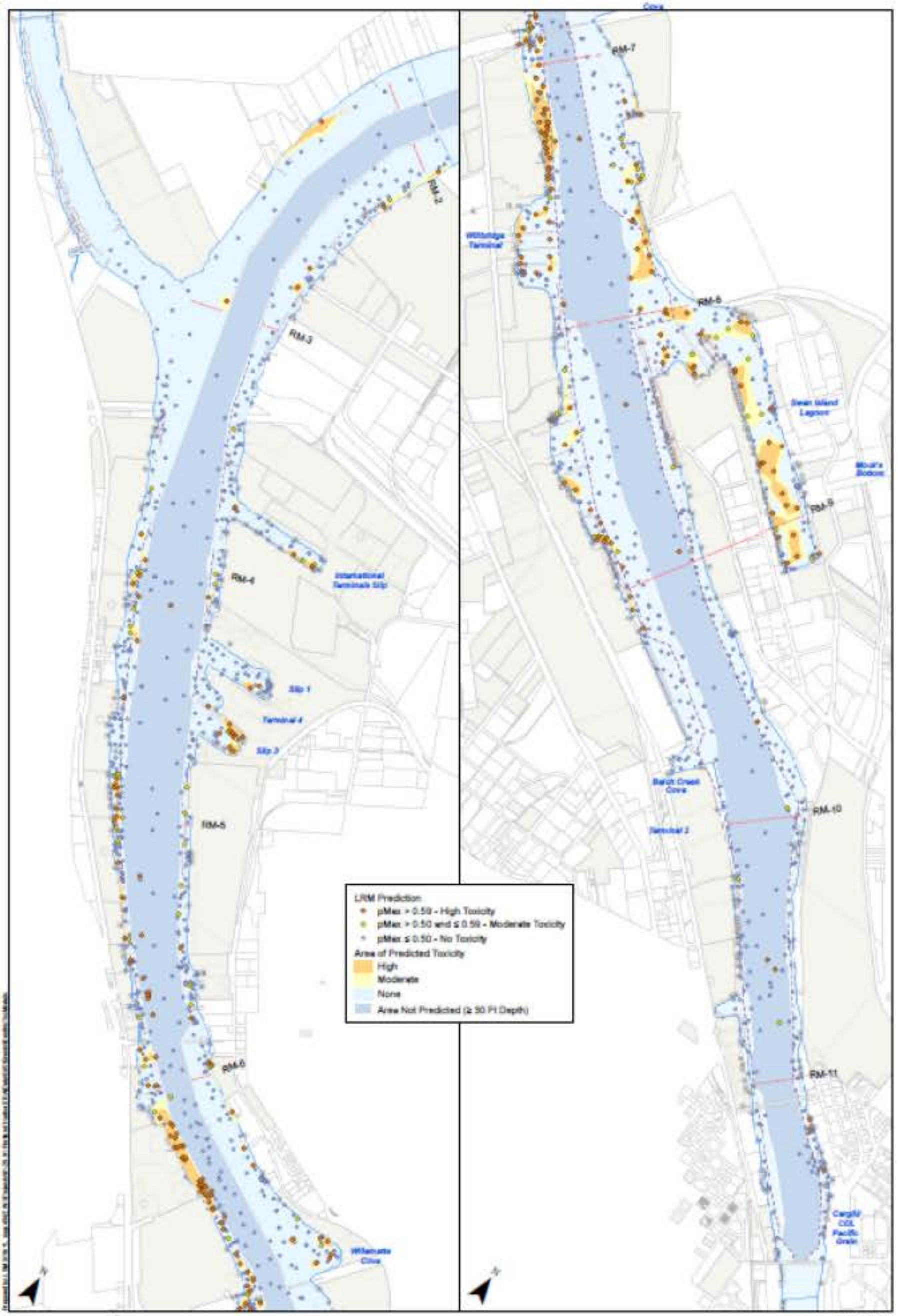
Map 6-10
Exceedance of Site-Specific FPM SQVs
based on *Hyalella azteca* Survival

Portland Harbor RI/FS
Baseline Ecological Risk Assessment

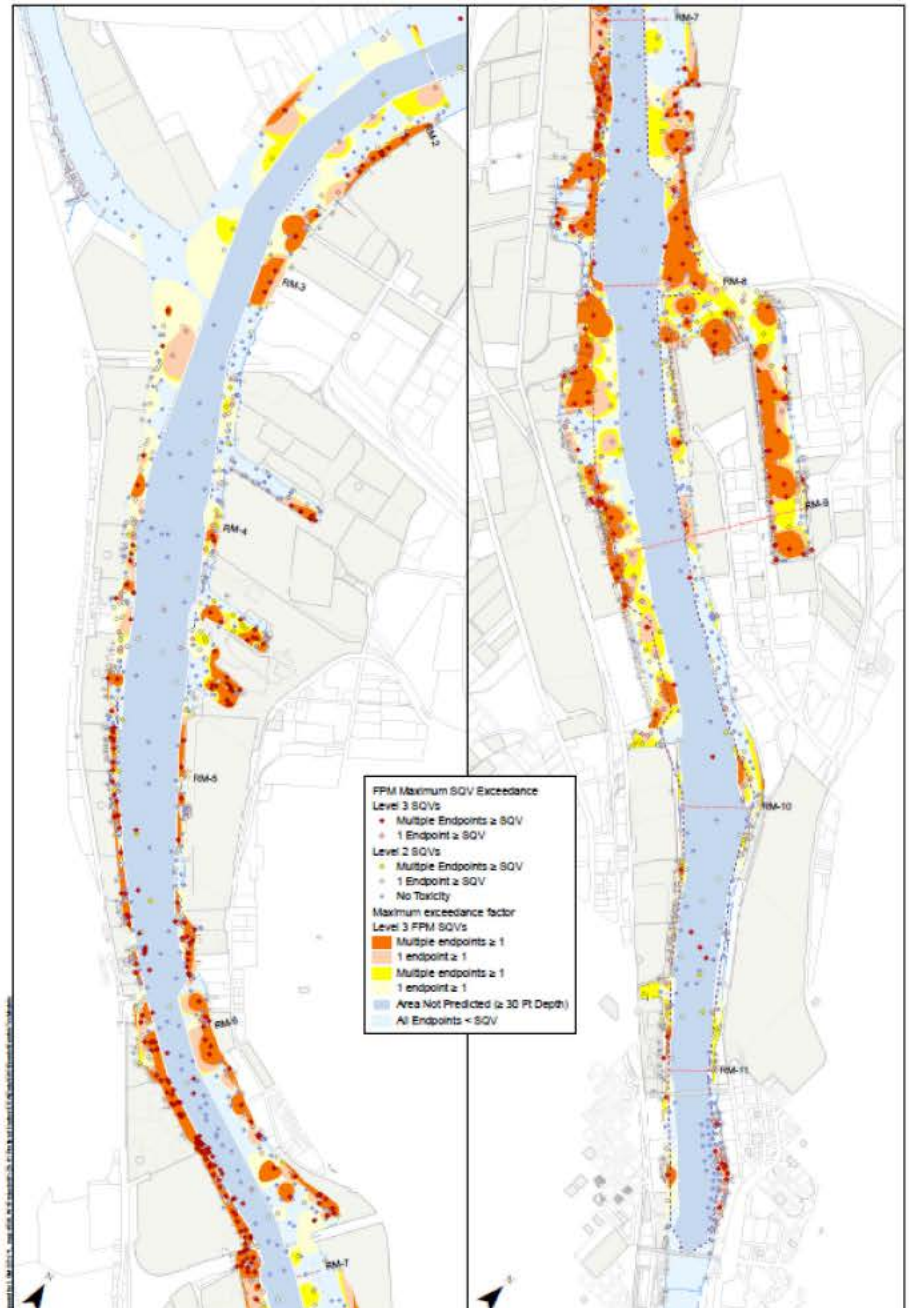
Windward environmental LLC
LWG Lower Willamette Group

0 1,000 2,000 3,000 4,000 Feet

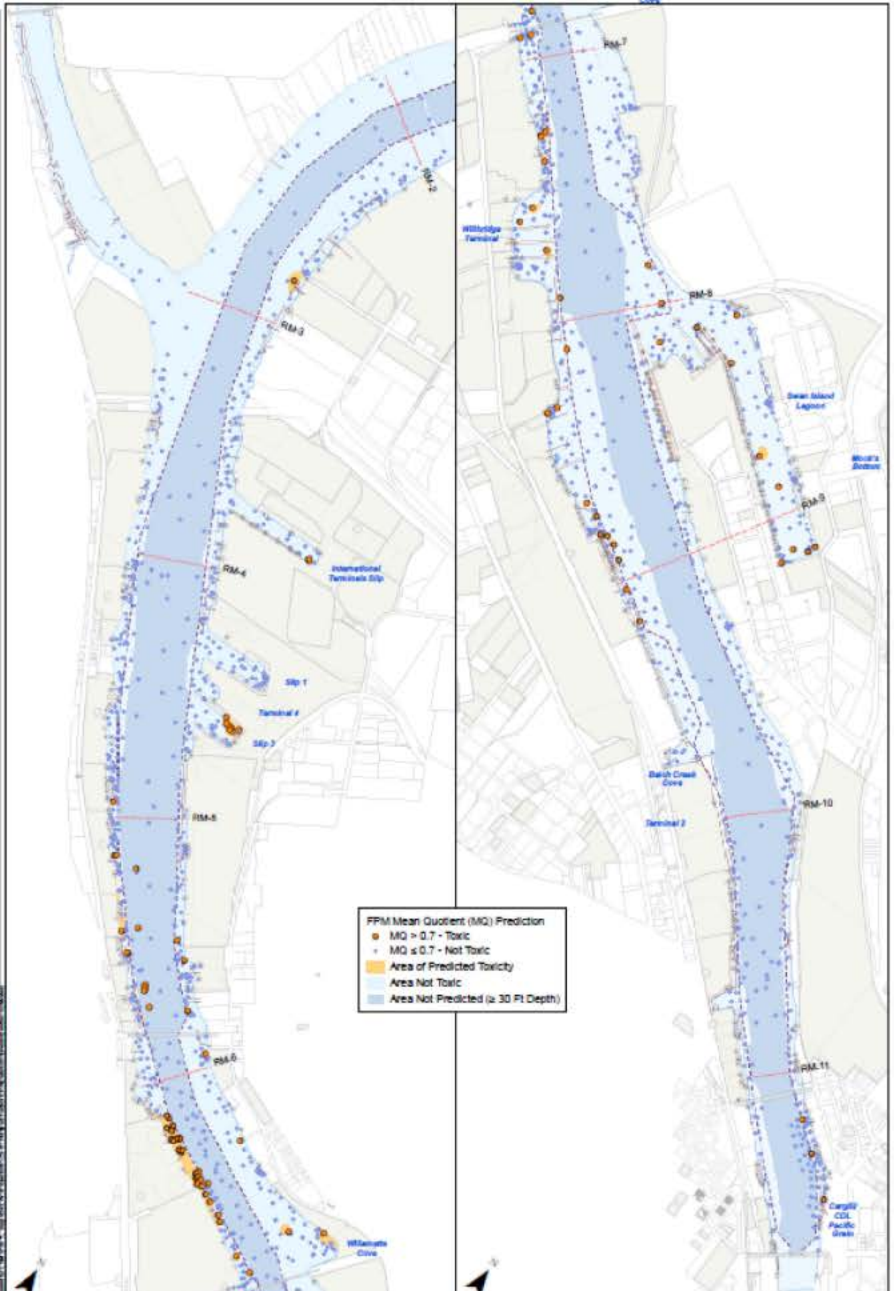
Map Features
Bridge
River Mile
Navigation Channel
Background Taxlot (7/08)
Upland ECSI Site (2008)
River Edge +13 ft NAVD



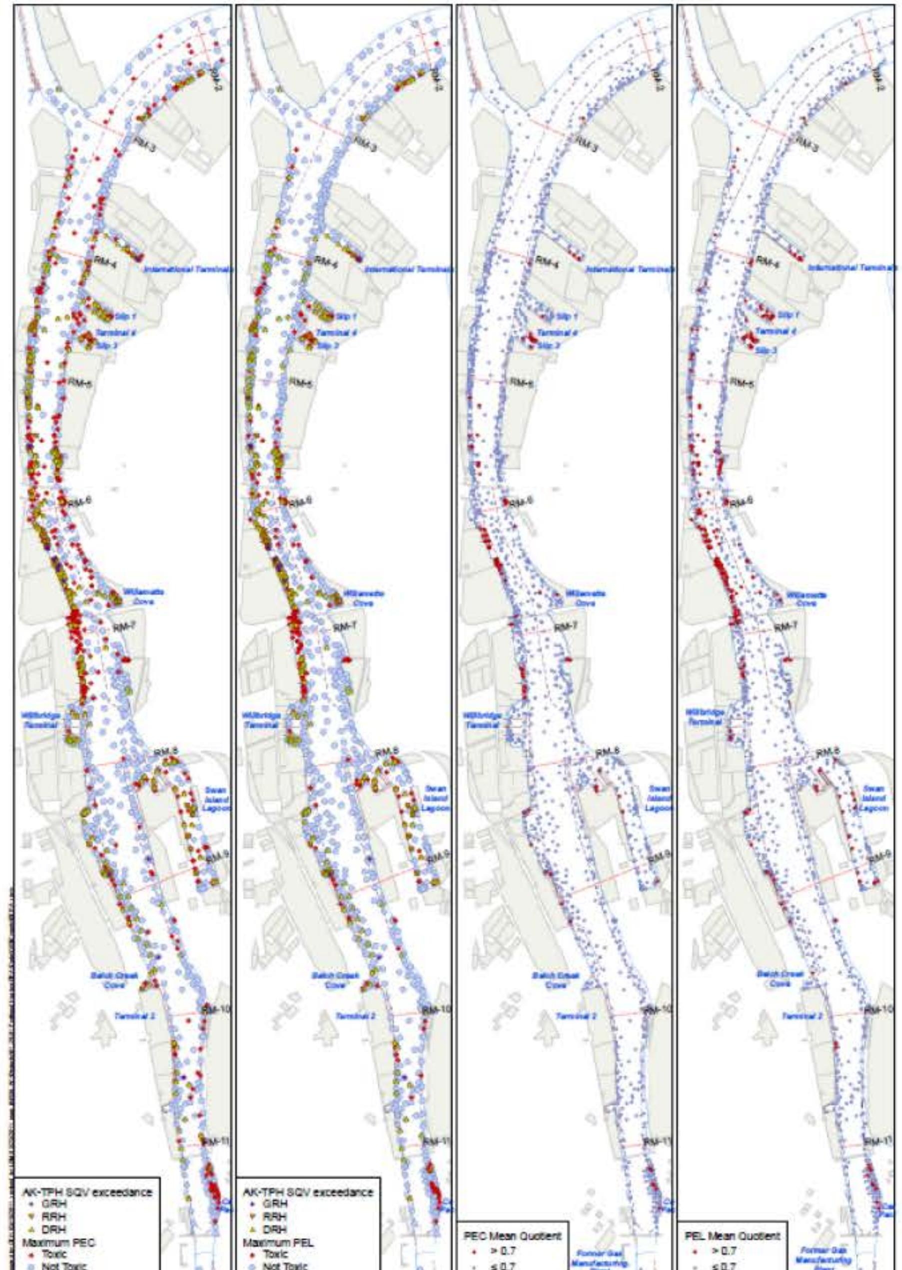
Map 6-11
Portland Harbor RI/FS
Baseline Ecological Risk Assessment
Benthic Toxicity Predicted from Site-Specific LRM pMax



Map 6-12
Portland Harbor RI/FS
Baseline Ecological Risk Assessment
Number of Endpoints Exceeding FPM SQVs
Based on Maximum Exceedance



Map 6-17
Portland Harbor RI/FS
Baseline Ecological Risk Assessment
Benthic Toxicity Predicted from FPM Mean Quotients



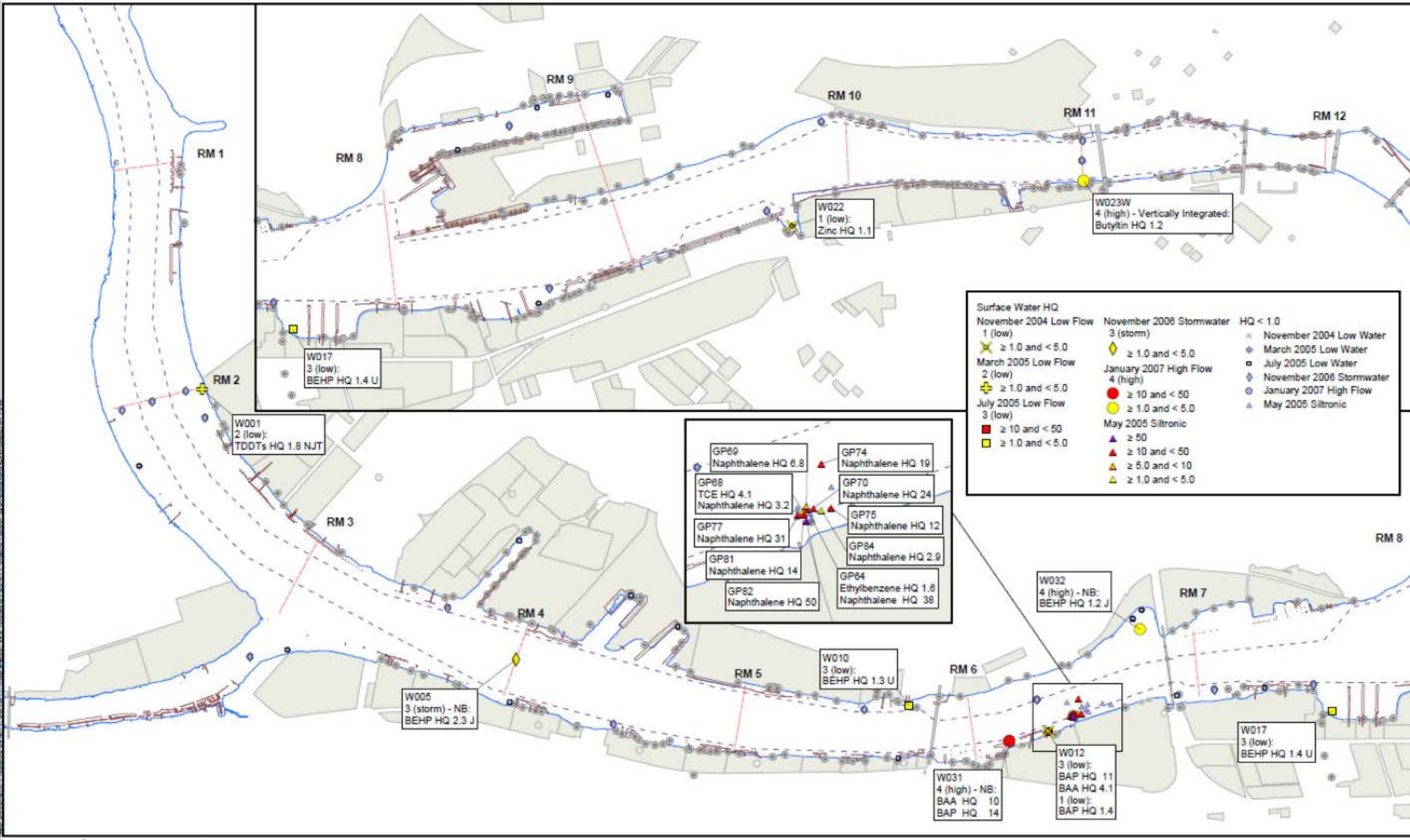
Map 6-18
Maximum Exceedance and No/Low Toxicity Based on PEC

Map 6-19
Maximum Exceedance and No/Low Toxicity Based on PEL

Map 6-20
Exceedance Based on PEC Mean Quotient

Map 6-21
Exceedance Based on PEL Mean Quotient

Portland Harbor RI/FS
Baseline Ecological Risk Assessment



Windward environmental LLC

LWG Lower Willamette Group

FEATURE SOURCES:
Transportation, Property, or Boundaries: Metro RLIS.
Channel & River Miles: US Army Corps of Engineers.
Bathymetric Information: David Evans and Associates, Inc.

0 1,000 2,000 3,000 4,000 5,000 Feet

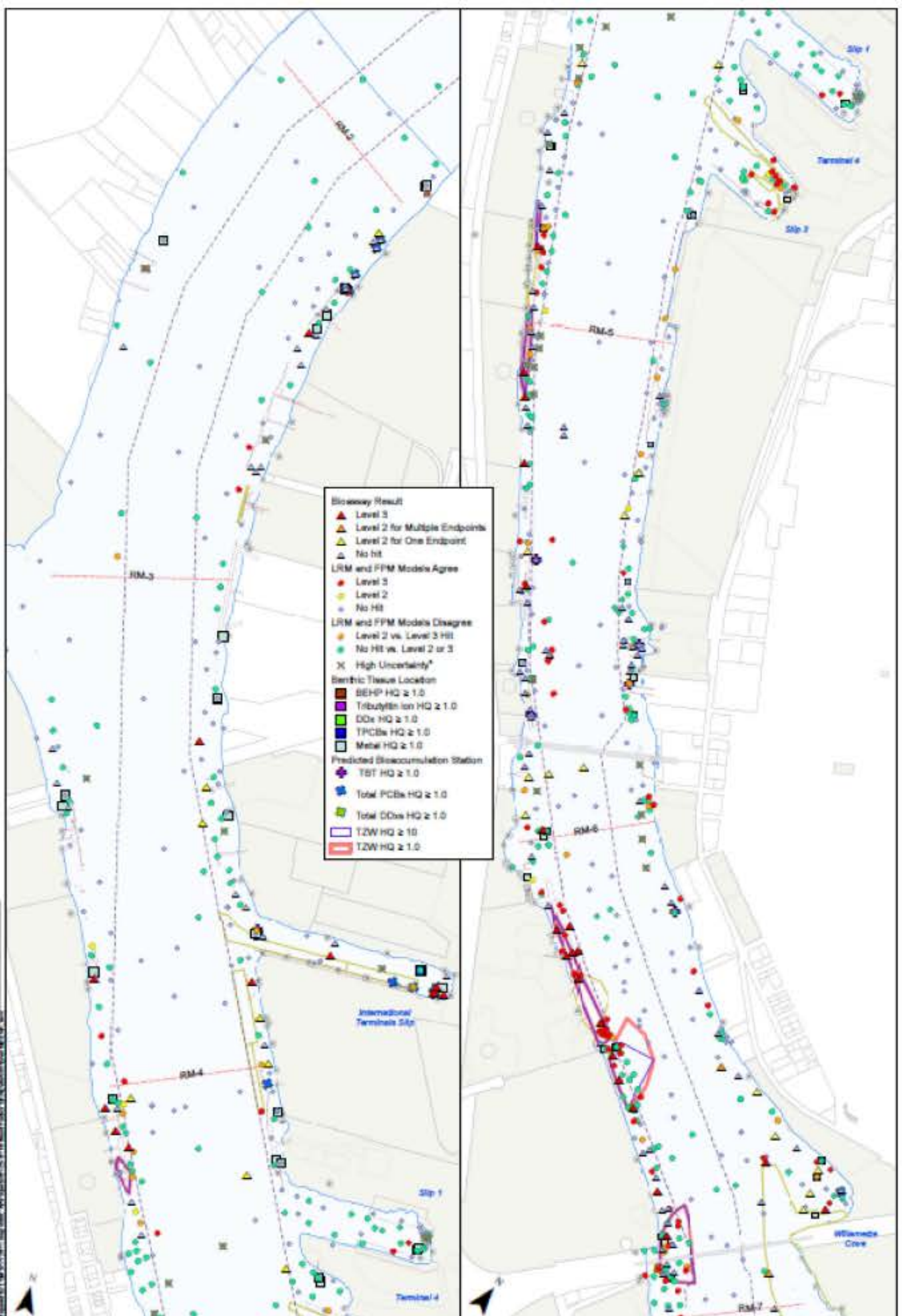
Map Features

Outfalls
- Outfall
- Dock Drain
- Roof Drain

- Bridges
- Docks and Structures
- Upland ECSI Sites (2008)

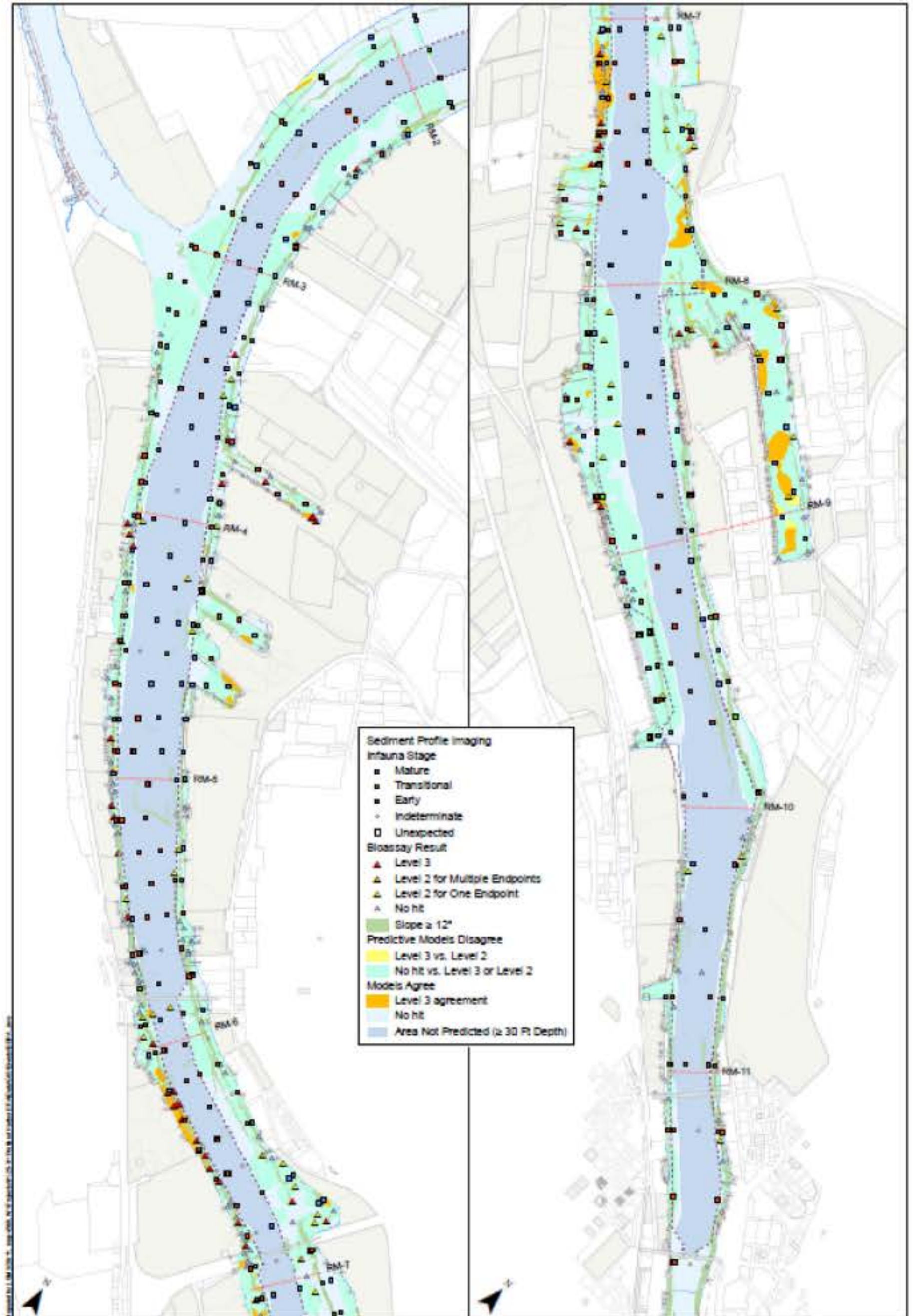
- River Miles
- Navigation Channel
- River Edge +13 ft NAVD

Map 6-27
Portland Harbor RI/FS
Baseline Ecological Risk Assessment
Surface Water HQs for Sampling Locations in the Portland Harbor Study Area



*Location where predicted risk comes from one analyte, which is associated with high false positives exceeding an SQV (4-Methylphenol, Total Endosulfans, or Chromium)

Map 6-28a
Portland Harbor RI/FS
Baseline Ecological Risk Assessment
Benthic Weight of Evidence in
RM 1.9 to RM 7



Map 6-29
Portland Harbor RI/FS
Baseline Ecological Risk Assessment
Benthic Infaunal Stages and
Empirical and Modeled Toxicity

Appendix A7

9-7-17 Email from Kevin Parrett (DEQ), Subject: PAH Water Impacts.pptx

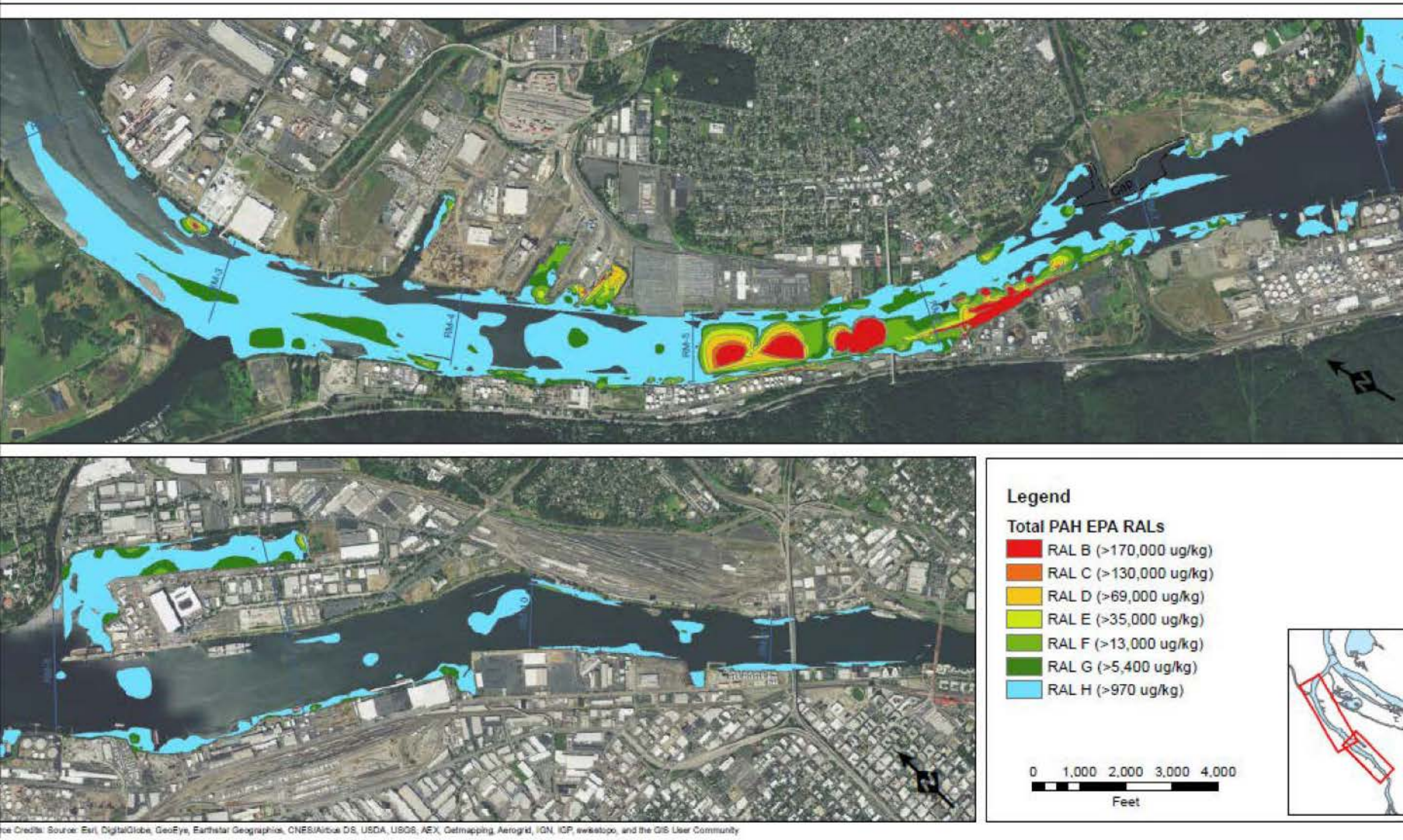


Figure 3.4-8. Total PAH RAL Contours

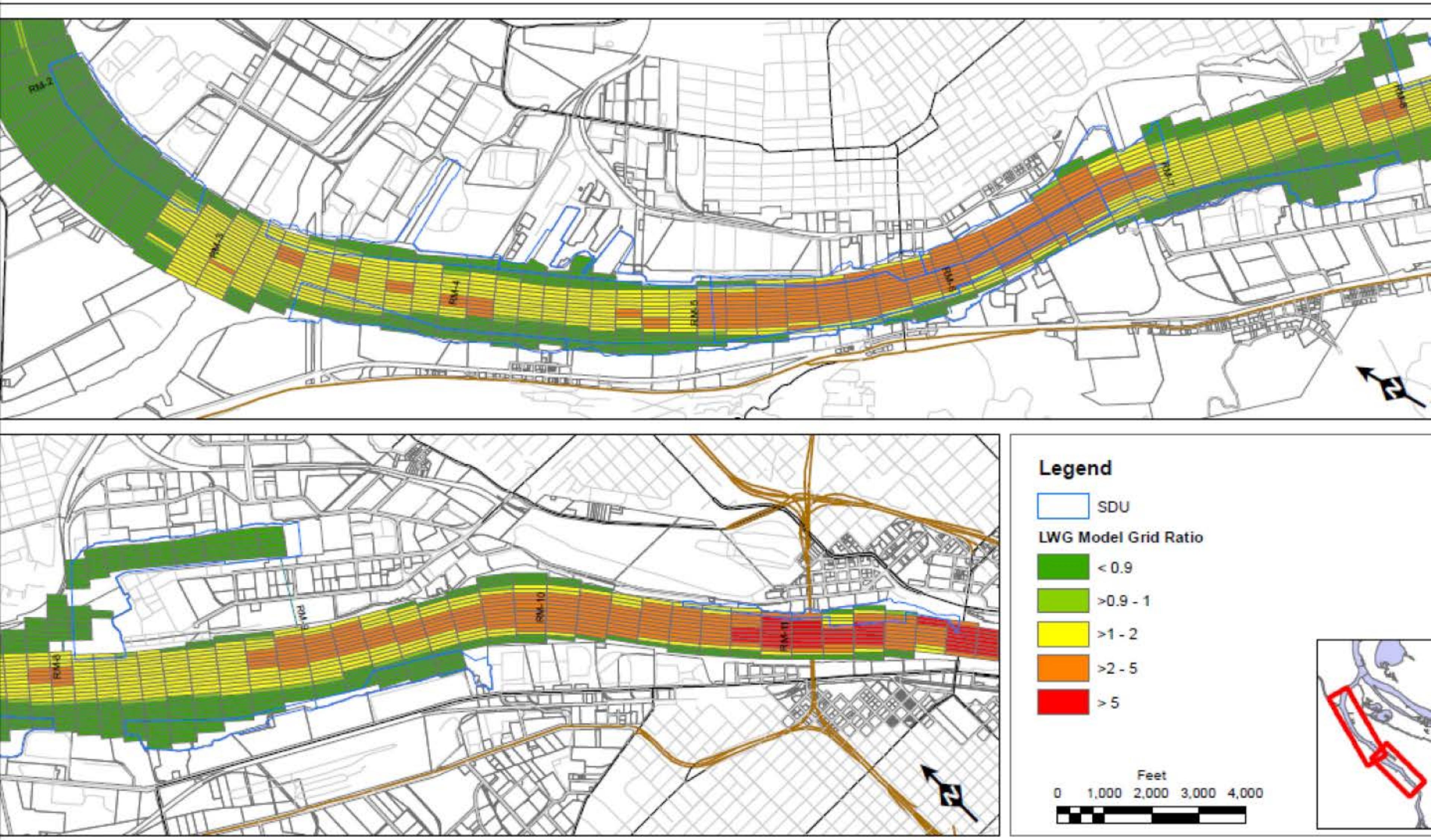


Figure 3.4-18c. Ratio of Bed Shear Stress (Pa) to Critical Bed Stress for Erosion (Pa) at Peak of Two-year Flood

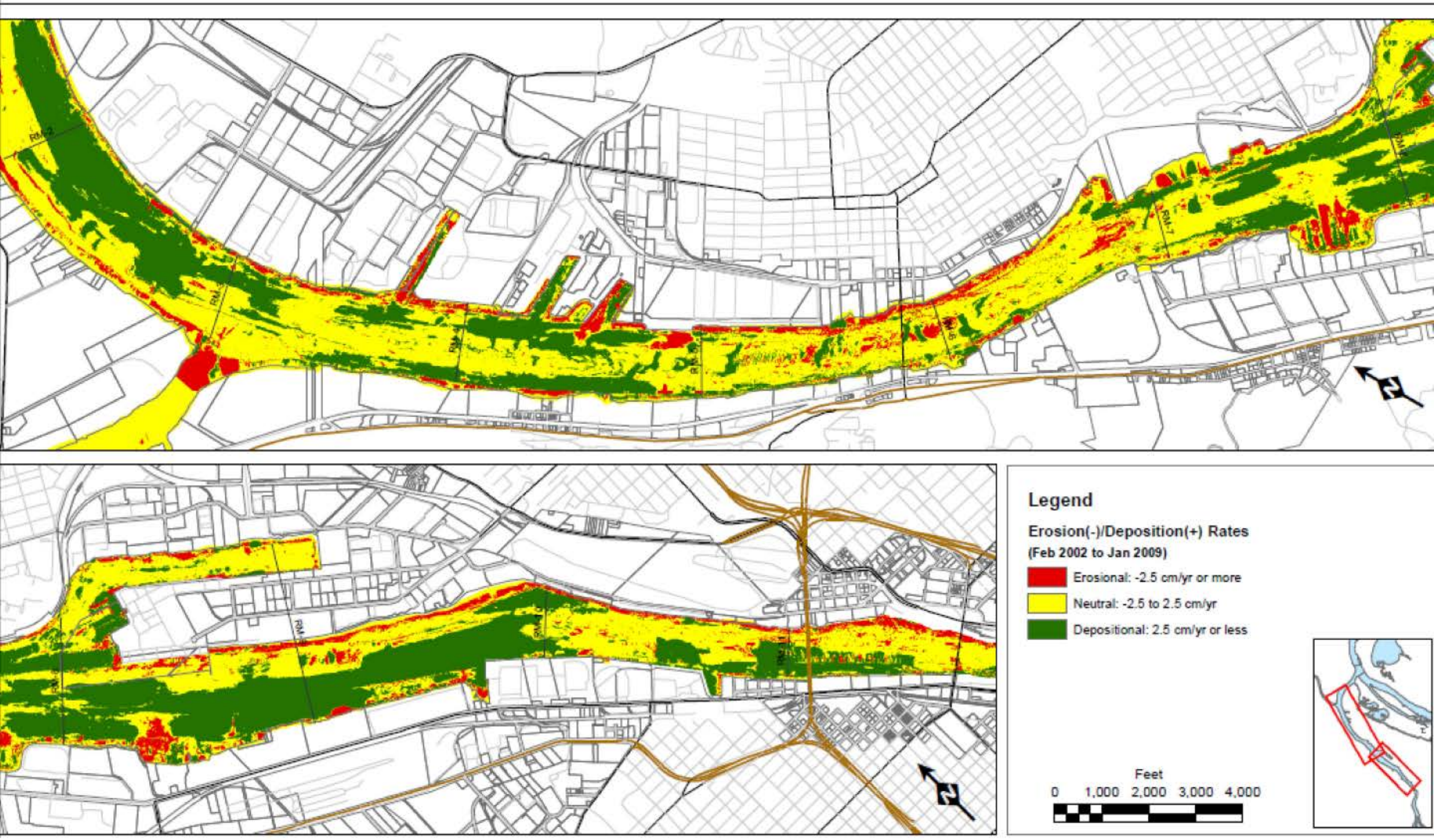
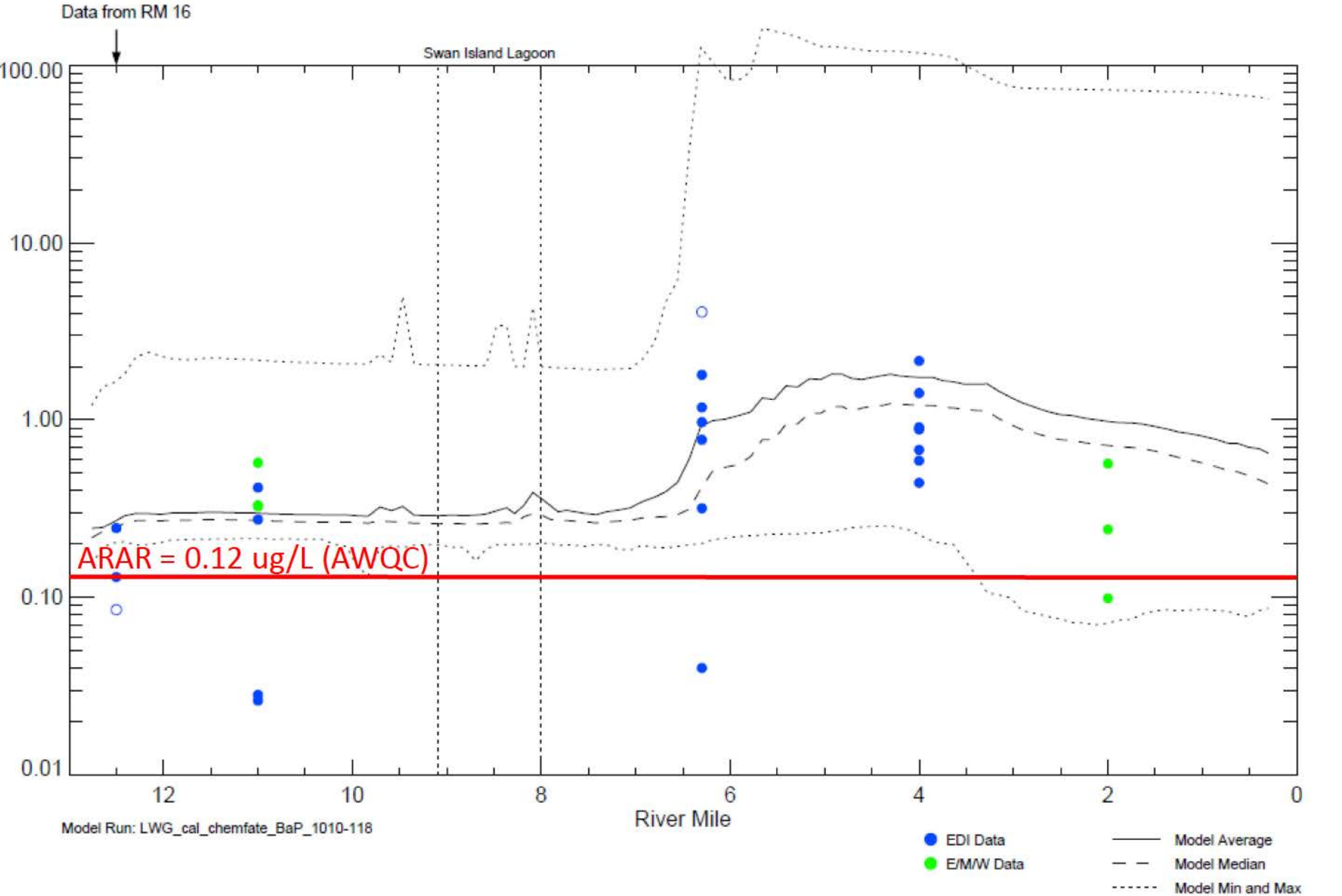
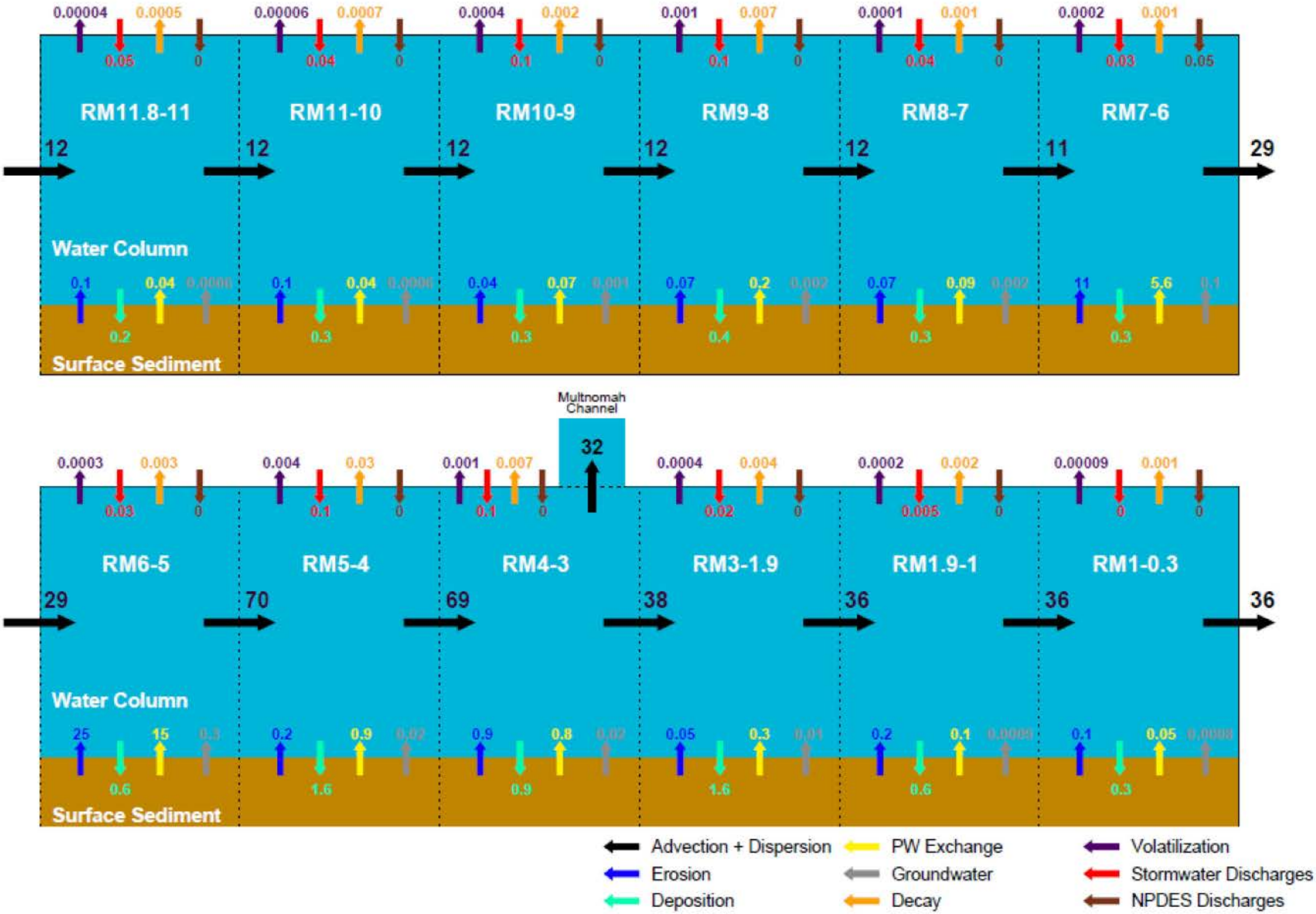


Figure 3.4-20. Sediment Deposition Rates


Data from RM 16
Swan Island Lagoon
100.00
10.00
1.00
0.10
0.01
ARAR = 0.12 ug/L (AWQC)
12
10
8
6
4
2
0
River Mile
Model Run: LWG_cal_chemfate_BaP_1010-118
EDI Data
E/M/W Data
Model Average
Model Median
Model Min and Max

Units are kilograms/year



Appendix A8

Memorandum from Five Tribes with Comments, Subject: Review of NW Natural Memorandum on USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels in Portland Harbor, September 26, 2017

IEc

MEMORANDUM | September 26, 2017

TO Sean Sheldrake, United States Environmental Protection Agency (EPA)

FROM Gail Fricano, Rachel DelVecchio, and Dr. Rita Cabral (Industrial Economics, Inc.)

SUBJECT Review of NW Natural Memorandum on USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels in Portland Harbor

PURPOSE

This memorandum provides comments on behalf of the Five Tribes[1] on the August 2, 2017, NW Natural memorandum titled "USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels in Portland Harbor" (from Amy Nelson and Taku Fuji, Anchor QEA, to Bob Wyatt, NW Natural).

OVERARCHING CONCERNS

1. The NW Natural memorandum advocates for increasing cleanup levels and remedial action levels (RALs) for polycyclic aromatic hydrocarbons (PAHs) at the Portland Harbor Superfund Site (PHSS) based on EPA's January 19, 2017, updates to the benzo(a)pyrene cancer slope factor (CSF) in the Integrated Risk and Information System (IRIS). Modifying the cleanup levels and RALs would constitute a major change to the Record of Decision (ROD). In particular, a change to the RALs would warrant a ROD amendment. Issuing a ROD amendment is a very lengthy process that would significantly delay the cleanup schedule, likely by several years. As iterated in past comments to EPA, the Five Tribes urge EPA to achieve a timely and thorough cleanup of the PHSS in order to restore its myriad uses to the public and achieve a healthy ecosystem as quickly as possible. The community has waited long enough for a cleanup plan. We urge EPA to keep on schedule and begin in-water cleanup as soon as possible. We are deeply concerned about the effects of considering changes to the RALs on the project schedule.

2. EPA's cleanup plan was developed with meaningful input from the Five Tribes and other tribal, state, and federal partners, as well as the community and other interested parties. The Five Tribes have frequently provided input on numerous technical issues over many years. In developing the ROD, EPA weighed feedback provided at government-to-government consultations with the Five

[1] The five tribes are the Confederated Tribes of the Grand Ronde Community of Oregon, the Nez Perce Tribe, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes of the Warm Springs Reservation of Oregon.

Tribes, as well as our written comments on the Proposed Plan provided during the public comment period. If EPA is considering changing the PAH RALs, a change that would likely require a ROD amendment, the Five Tribes assert our right to request government-to-government consultations with EPA so that our input on such an important potential change may be fully considered.

TECHNICAL COMMENTS

3. NW Natural's proposed change to the navigation channel cleanup level and RAL is based on the ROD remedial action objective (RAO) 2 (clam consumption by humans) cleanup level of 3,950 ug/kg carcinogenic PAH (cPAH). The ROD RAO 5 (benthic risk) cleanup level of 23,000 ug/kg total PAH (TPAH) that is also applicable to the navigation channel is not affected by the CSF update because the CSF is relevant to human health risk and not ecological risk. It appears that converting 23,000 ug/kg TPAH to cPAH using EPA's regression would yield a cPAH concentration of approximately 2,700 ug/kg. This value is substantially lower than NW Natural's proposed cPAH cleanup level of 108,000 ug/kg based on the ROD's RAO 2 cleanup level and the updated CSF. We are uncertain whether we are correctly applying the relevant risk-based concepts in this case, but the cleanup level should always default to the lowest value across RAOs; with the CSF update, the appropriate value for the navigation channel sediment cleanup level may now be based on RAO 5.

4. The ROD cPAH surface water cleanup level is based on the federal human health water quality criteria protective of fish consumption. NW Natural proposes changing the surface water cleanup level by applying the CSF update to the federal criteria. The federal criteria went through an extensive public review process and are published in the Federal Register (80 FR 36986). These criteria constitute applicable or relevant and appropriate requirements (ARARs) for the PHSS. Thus, the published values must be applied at the PHSS and cannot be changed without a rulemaking. Similarly, the Oregon water quality standards are promulgated standards that cannot be changed without a rulemaking.

5. The development of cPAH RALs for the nearshore area and navigation channel based on the updated CSF is not a straightforward exercise. NW Natural's two approaches to revising the RALs, "proportional adjustment approach" and "risk reduction approach," are inconsistent with the approach that EPA presented in the ROD, which instead considers surface-weighted average concentration (SWAC) reductions for a spectrum of RAL options. It may not be appropriate to adjust the RALs based on a direct relationship with cleanup levels. This inconsistency in methodology highlights the importance of careful consideration and discussion among EPA and their tribal, state, and federal partners of methods presented in the NW Natural memorandum, as well as alternative methods.

6. The CSF update to benzo(a)pyrene is only applicable to human health pathways and, as we assert above, is only relevant to sediment unless new federal and state water quality criteria are promulgated. EPA would need to evaluate whether NW Natural's proposed sediment RALs for the nearshore area and navigation channel are likely to achieve the surface water cleanup levels. In addition, as noted above, EPA must determine whether ecological pathways become driving factors of PAH cleanup (i.e., provide the basis for the PAH RAL) if the CSF update is applied to human health-based cleanup levels. Lastly, if PAH RALs were to be changed, EPA must determine the extent to which areas formerly considered PAH-driven areas now require cleanup due to the presence of other focused contaminants of concern (COCs) or non-aqueous phase liquid (NAPL)/not reliably contained (NRC) principal threat waste (PTW).

Appendix A9

Memorandum from Five Tribes with Comments on TCT Meeting, Subject: Terminal 4 Negotiations Regarding Human Health Risk and Remedial Actions Levels (RALs), October 11, 2017

IEc

MEMORANDUM | October 11, 2017

TO Michelle Pirzadeh, United States Environmental Protection Agency (EPA)

FROM Gail Fricano and Rachel DelVecchio (Industrial Economics, Inc.)

SUBJECT Terminal 4 Negotiations Regarding Human Health Risk and Remedial Action Levels (RALs)

PURPOSE

This memorandum provides comments on behalf of the Five Tribes[1] on topics raised by the Port of Portland (Port) related to implementation of the Portland Harbor Superfund Site (Site) Record of Decision (ROD) at Terminal 4 (T4). Our comments focus on two issues raised in a series of briefing papers developed by the Port and shared with the United States Environmental Protection Agency (EPA) on August 16, 2017, titled "Terminal 4 Overview" (3 pp. plus figure) and "Human Health Direct Contact Risk at Terminal 4" (3 pp.). The issues are: (1) whether the human health direct contact pathway at T4 is complete, and if not, whether EPA's cleanup standards should be relaxed; and (2) whether navigation channel remedial action levels (RALs) should be applied at T4 rather than the Site-wide RALs. We have serious concerns about the Port's perceptions of and implied proposals regarding these issues, and we urge EPA to fully consider our comments below during upcoming discussions with the Port. In addition, we note that many of the comments we provided to EPA on October 9 related to Pre-RD Group negotiations also apply to discussions with T4, as described below.

HUMAN HEALTH DIRECT CONTACT RISK

The Port asserts that the human health risk exposure pathway may not be complete across the entirety of T4 due to site-specific characteristics including relatively deep (-30 to -40 feet Columbia River Datum) waters, the Baseline Human Health Risk Assessment's determination that beach use was not an applicable exposure scenario at T4, and the active, secure nature of the marine terminal facility that would limit human access to the area. The Port does not propose a specific resolution related to these assertions, but rather requests that EPA work with the Port to create a Remedial Design/Remedial Action process that accounts for these site-specific conditions at T4. The Port implies that cleanup levels should be relaxed because of the alleged lack of direct human contact at T4. The Five Tribes do not support relaxing cleanup levels at T4, and we urge EPA to consider the following points when discussing a path forward with the Port.

---

[1] The five tribes are the Confederated Tribes of the Grand Ronde Community of Oregon, the Nez Perce Tribe, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes of the Warm Springs Reservation of Oregon.

1. EPA must develop a remedy that is protective of Tribal treaty rights, which provide for Tribal fishing throughout the Site, including T4.
2. The Port asserts that it "operates an active, secure marine terminal facility," and "direct contact exposures are further limited by active marine terminal operations, including frequent vessel calls " (Human Health Direct Contact Risk at Terminal 4 briefing paper, p. 2). While we agree that these characteristics presently limit recreational access to the river, it is unknown whether this area will remain an active, secure facility in the future, for instance, in 100 years or more. The remedy must be protective in perpetuity, and current security measures at T4 do not provide sufficient assurance that recreational users will not access the area in the future. Further, it is uncertain whether these characteristics ensure a complete absence of recreational access, as institutional controls at Superfund sites are widely acknowledged to not be entirely effective. In addition, EPA must ensure that a remedy is protective of workers at T4, who also may be directly exposed to contamination, including contaminated sediments.
3. EPA must develop a remedy that is protective of ecological resources at T4. Regardless of human health direct contact within T4, fish, invertebrates, and other biota inhabit T4. Furthermore, fish that are exposed to contamination within T4 may move out of T4, thereby exposing fishers in other areas of the Site to T4 contamination.

APPLICATION OF RALS

The Port implies that, due to the prevailing navigational use and deep water at Slip 3 within T4, the navigation channel RALs are the appropriate RALs to apply at Slip 3, rather than the Site-wide RALs assigned to this area in the ROD.[2] The Five Tribes do not support the Port's argument. The ROD requires that Site-wide RALs be applied to future maintenance dredge (FMD) areas, such as Slip 3. FMD areas are typically nearshore areas with direct human contact. As noted in the Human Health Direct Contact Risk section above, direct human contact is a complete pathway at T4, including Slip 3. The navigation channel RALs are not protective of direct human contact and must not be applied at Slip 3.

ACHIEVING A TIMELY CLEANUP

We do not support a reexamination of Remedial Investigation/Feasibility Study (RI/FS) and ROD assumptions regarding exposure and their implications for cleanup levels and RALs, either for the Site collectively or for individual areas of the Site. Such an approach reopens analyses that were performed by EPA and potentially responsible parties (PRPs) with substantial input from EPA's Memorandum of Understanding (MOU) partners over a period of more than 10 years. The changes that the Port proposes may reopen the RI/FS

[2] The Port's briefing papers do not specifically assert that navigation channel RALs should be applied at Slip 3. However, they have made this assertion in discussions with EPA.

and at a minimum would reopen the ROD. A ROD amendment would likely be required to change the application of cleanup levels or RALs. Such a change would delay cleanup by at least several years. We strongly urge EPA to adhere to the ROD and achieve a timely cleanup.

REITERATION OF COMMENTS ON PRE-RD GROUP NEGOTIATIONS

The Five Tribes submitted comments to EPA on October 9 expressing significant concerns regarding the process and substance of EPA's negotiations with the Pre-RD Group. Although we have not seen a draft Administrative Order on Consent (AOC) or draft work plan for T4 negotiations, we stress that our comments on the Pre-RD Group negotiations also apply to any discussions or negotiations with T4. Key issues include:

1. EPA must provide the Five Tribes, as well as MOU partners more broadly, the opportunity for meaningful involvement in the cleanup process, consistent with past practices, the MOU signed by EPA and Technical Coordinating Team (TCT) members, and EPA's trust and consultation responsibilities to the Five Tribes. This includes providing MOU partners with sufficient time and opportunity to provide feedback on all drafts of documents and other correspondence related to cleanup and negotiations, including but not limited to position papers, AOCs, scopes of work, work plans, and assertions, positions, and other views or considerations expressed by EPA or the Port by email, verbally, at meetings, or otherwise. The Five Tribes cannot emphasize enough the importance of EPA transparency with the TCT. If EPA is not transparent with the TCT regarding T4 discussions and negotiations and does not provide for meaningful TCT involvement, the Five Tribes will be required to consider invoking dispute resolution provisions in the MOU.
2. Work plans must not be attached to AOCs, but rather developed with full TCT participation and finalized after AOCs are signed.
3. AOCs must require PRPs to fund Tribal Response Costs.
4. The scope of AOCs should encompass Remedial Design and should not be limited to one sampling event.
5. As discussed on the October 10 TCT call, the AOC must not provide PRPs the opportunity to appeal dispute resolutions issued by the Regional Administrator to the EPA Administrator.
6. Work plans must be based on statistically valid designs.
7. Work plan objectives and data uses must be consistent with the ROD.
8. EPA must not entertain PRP efforts designed to reopen the RI/FS, which was developed over more than ten years and represents a joint effort between EPA and the PRPs with significant input from governmental partners, including the

Five Tribes. Efforts to reopen the RI/FS are clearly stall tactics intended to postpone cleanup. EPA must move forward with the current RI/FS in order to achieve a timely cleanup.

Appendix A10

Elliott Laws Memorandum on cPAH Cleanup Level Issues, June 30, 2017

Administrator McCarthy signed EPA's Portland Harbor Record of Decision on January 3, 2017. On January 19, 2017, EPA announced the release of the *IRIS Toxicological Review of Benzo[a]pyrene (Final Report)* (https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=136). The updated benzo[a]pyrene (BaP) toxicity values provided in the final IRIS report would significantly change the remediation goals established just two weeks earlier in the Portland Harbor ROD, eliminating more than $100 million of unnecessary cleanup.

EPA's ROD sets two (but applies three) sediment cleanup levels for carcinogenic polycyclic aromatic hydrocarbons (cPAHs), calculated as BaP equivalents (BaP eq):

(1) For nearshore areas of Portland Harbor, EPA's ROD identifies a cPAH (BaP eq) cleanup level of 12 µg/kg based upon human health direct contact with sediments. EPA's June 2016 Final Feasibility Study selected cPAH preliminary remediation goals of 12 µg/kg for direct contact with beach sediments and 106 µg/kg for sediments that are mostly or always under water. *See* FS Table 2.2-4. As part of the ROD, EPA provided an updated calculation of residual and post construction direct contact risk estimates that evaluates its selected remedy against the 106 µg/kg cPAH PRG for in-water sediments rather than the 12 µg/kg cPAH PRG for beach sediments. *See*, *Portland Harbor RI/FS Appendix J – Update, Calculation of Residual and Post Construction Risk Estimates*, Table J2.2-2c. This is consistent with EPA's baseline human health risk assessment (BHHRA) for in-water exposures, and so it appears that the 12 µg/kg cPAH cleanup level in ROD Table 17 is an error if applicable to in-water sediments (as opposed to beach sediments). (We note also that "highly toxic" principal threat waste concentrations are based on the 106 µg/kg in-water sediment direct contact PRG, rather than the beach PRG. *See* ROD, Table 6.) The appropriate cleanup level for human direct contact with nearshore sediment, based upon the assumptions and methods of the EPA BHHRA, should be 106 µg/kg.

(2) In deep water areas of the site, principally the navigation channel, EPA selected a cPAH cleanup level of 3950 µg/kg based on human consumption of clams.

See ROD, Table 17.

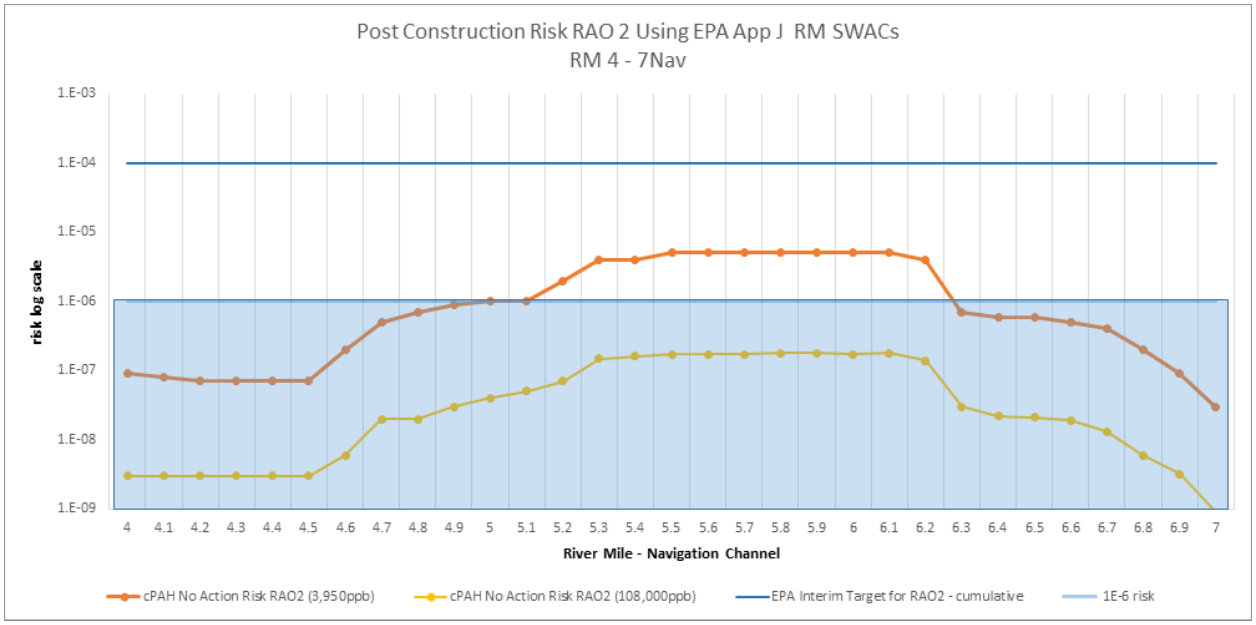
If the cPAH RGs were recalculated using the updated IRIS cancer slope factor and all of the same assumptions, exposure scenarios and methodologies employed in EPA's FS, the RGs would change significantly:

- The in-water sediment direct exposure cPAH RG would increase from 106 µg/kg to 773 µg/kg.
- The beach sediment direct exposure cPAH RG would increase from 12 µg/kg to 85 µg/kg.
- The clam consumption exposure cPAH RG would increase from 3,950 µg/kg to 108,000 µg/kg.

Further, the cPAH "highly toxic" principal threat waste threshold would increase from 106,000 µg/kg to 773,000 µg/kg.

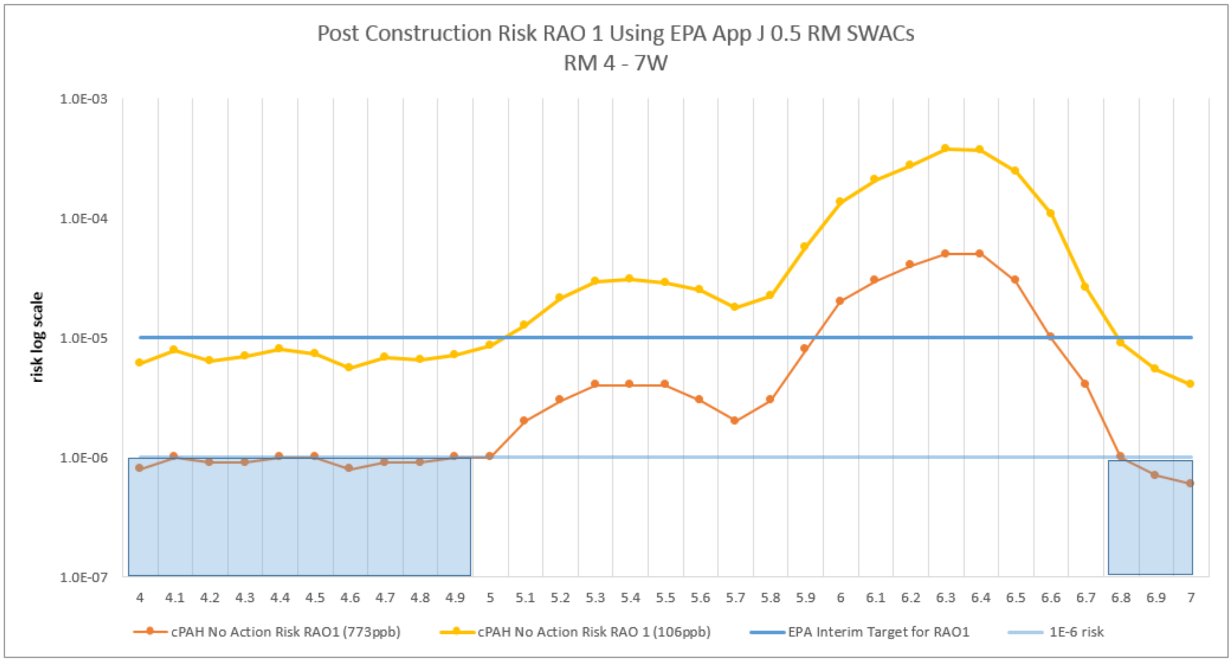
The net result of these changes, based upon the methodologies in EPA's updated calculation of residual and post-construction risks, is that no areas of the site would exceed a 1 x 10^{-6} cPAH clam consumption risk, and all areas downstream of RM 6 (the approximate downstream edge of the Gasco site) would meet the 1x 10^{-5} interim risk threshold for cPAH direct contact based on the no action alternative. In other words, based upon the existing data set, all areas of the site other than in the immediate vicinity of Gasco do not present cPAH risks outside EPA's acceptable risk range based upon EPA's current BaP cancer slope factor.

Here is a simple graph showing "no action" cPAH clam consumption risks in the navigation channel using EPA's SWACs and methodologies:



The orange line depicts risks calculated by EPA relative to the RG set by EPA's January 6 ROD; the yellow line shows risk using updated RGs with the BaP cancer slope factor published on January 19. We have previously noted our concerns about application of a cleanup level based upon clam consumption in deep waters, including the fact that no such risk was identified in the BHHRA. Even if this were a valid risk scenario, however, no risk would exist based upon EPA's current toxicity values.

This graph shows similar risk comparisons for direct contact with in-water sediment:



Again, based upon the updated cancer slope factor, potential unacceptable risk for BaP in-water sediment direct contact downstream of the immediate vicinity of the Gasco is either below EPA's interim risk threshold or non-existent. No cleanup in these areas is necessary, based upon EPA's best and most current science.

The cPAH cleanup levels in the ROD should be updated now, before significant pre-design or design work begins. Updating the values requires only a straightforward mathematical calculation and does not involve review or revision of any of EPA's assumptions or methodologies in the BHHRA. An Explanation of Significant Difference that makes these corrections now could save millions of dollars of remedial design work and avoid tens, perhaps hundreds, of millions of dollars of unnecessary cleanup.

Appendix A11

Memorandum from Yakama Nation, Subject: Review of NW Natural Memo on proposed updates to Record of Decision cleanup level and remedial action level for Benzo(a)pyrene at the Portland Harbor cleanup site, October 12, 2017

MEMORANDUM

Yakama Nation Fisheries

Columbia River
Honor. Protect. Restore.

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October 12, 2017

To: Sean Sheldrake, United States Environmental Protection Agency (EPA)
From: Laura Shira, P.E., Environmental Engineer
Re: Review of NW Natural Memo on proposed updates to Record of Decision cleanup level and remedial action level for Benzo(a)pyrene at the Portland Harbor cleanup site

This memo provides technical comments and concerns on the August 2, 2017, NW Natural memorandum titled "USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels in Portland Harbor" from Anchor QEA and Pearl Legal Group, to NW Natural. NW Natural advocates for increasing cleanup levels (CULs) and remedial action levels (RALs) for polycyclic aromatic hydrocarbons (PAHs) within the Record of Decision (ROD) at the Portland Harbor Superfund Site (site) based on EPA's January 19, 2017 updates to the benzo(a)pyrene (BaP) cancer slope factor (CSF) in the Integrated Risk and Information System (IRIS).

Although we acknowledge changes to IRIS as science-based, the Yakama Nation has significant concerns about the effects of the proposed changes on the project schedule and the protectiveness of the cleanup. With the limited information we have been presented it is impossible to evaluate the merits of the back-of-the envelope calculations provided by NW Natural. If EPA is considering making changes to the CULs and/or RALs, that process must include an analysis of the pros and cons of these changes with respect to overall project timeline, budgets, and protectiveness; and an in-depth evaluation of how any changes to the ROD resulting from these recommendations will address human and ecological risk at the Portland Site. Modifying the CULs and RALs as suggested would constitute a major change to the ROD. In fact, NW Natural's proposal suggests that modified RALs could potentially decrease the area actively cleaned up by greater than 10% (from 355 acres to as little as 304 acres). The Yakama Nation urges EPA to maintain RALs set in the ROD and keep on schedule for in-water cleanup. However, if EPA is considering changing the PAH RALs, or any changes that would require a change to the ROD including an Explanation of Significant Differences or amendment, the Yakama Nation requires meaningful engagement as prescribed in the 2001 Memorandum of Understanding (MOU) and EPA must offer government to government consultation on proposed changes before a decision is made.

At this point, without adequate information to review, we offer the following preliminary comments.

<u>Technical and Procedural Comments</u>:

The Yakama Nation supports the technical comments submitted on behalf of the Five Tribes by IEc on September 26, 2017. Below are our technical comments:

1. A change to the RALs or even CULs would warrant a change to the ROD which would significantly delay the cleanup schedule, likely by several years. The impacts of significant delays and their associated costs should be considered if this is the path EPA chooses to take.
    a. The water quality standards in the ROD are Federal and State standards that have been promulgated under the Clean Water Act. Until these standards are changed via a formal rule making process the water quality criteria used for CULs and RALs developed in the ROD are applicable or relevant and appropriate requirements and must stand as is.
    b. The update to the IRIS database may affect the water quality standards in future rule making processes but so will other factors that have yet to be determined.
2. In addition, the update to RALs or CULs is not as simple as plugging in a new cancer slope factor for BaP. All of the risks for all COCs associated with each area will need to be re-evaluated to ensure the remedy is protective of human health and the environment. For example:
    a. The revised IRIS data do not affect or consider ecological risk. Proposed changes to the navigation channel CUL and RAL must also consider ecological risk.
    b. NW Natural's proposed sediment CUL and RAL would need to be evaluated to determine whether they are likely to achieve surface water cleanup levels within porewater and the water column.
    c. NW Natural's two approaches to calculating the proposed CULs and RALs are not consistent with EPA's surface-weighted average concentration (SWAC) methodology presented in the ROD.
    d. If the proposed CUL and/or RAL changes are considered, sediment management areas (SMAs) would need to be re-evaluated to determine the extent to which areas formerly considered PAH risk-driven areas now require cleanup due to the presence of other focused contaminants of concern (COCs), non-aqueous phase liquid (NAPL), not reliably contained (NRC), and/or principal threat waste (PTW).

A change in the RAL or CUL would not be a quick process and would likely introduce much uncertainty to where the Portland Harbor remedy is headed. It is likely PRPs would want to delay any work until EPA made a final decision of RALs and CULs, if it chooses to revise either. We must reiterate any change the ROD will require meaningful involvement with the Yakama Nation and EPA must offer to consult on its proposal before it makes a final decision. Because of the gravity of this issue the proposal must be supported by in-depth scientifically sound evaluation that will explain if and how the change to the BaP cancer slope factor will truly justify a significant reduction in the active remediation at the facility or if other factors such as ecological risks and ARARs will negate any major reduction active remediation.

PH NW Natural Proposed CUL and RAL ROD changes (8/2/2017)

Comparison of Portland Harbor ROD vs. NW Natural Proposed Cleanup Levels and Remedial Action Levels.

media		RAO		ROD*		Proposed (NWNatl		Criteria	Chemical
Sediment/soil	riverbank	1	HH - direct contact	12	ug/kg	85	ug/kg	CUL	cPAHs (BaP equiv)
sediment	intermed (btwn be	1	HH - direct contact	***106	ug/kg	773	ug/kg	CUL	cPAHs (BaP equiv)
sediment	nearshore	1	HH - tribal user - direct contact	106	ug/kg	773	ug/kg	CUL	cPAHs (BaP equiv)
sediment	nav channel	2	HH - clam consumption	3,950	ug/kg	108,000	ug/kg	CUL	cPAHs (BaP equiv)
sediment	nav channel	5	ECO - benthic	23,000	ug/kg			CUL	TPAH
sediment	beaches			12	ug/kg			BKGRD	cPAHs (BaP equiv)
sediment	all			106,000	ug/kg			PTW	cPAHs (BaP equiv)
sediment	all			870,000	ug/kg			PTW	TPAH
sediment	nearshore			1,500	ug/kg	10,800	ug/kg	RAL	cPAHs (BaP equiv)
sediment	nearshore (all?)			13,000	ug/kg	**92,000	ug/kg	RAL	TPAH
sediment	nav channel			20,000	ug/kg	540,000	ug/kg	RAL	cPAHs (BaP equiv)
sediment	nav channel			170,000	ug/kg	4,000,000	ug/kg	RAL	TPAH
surface water		3	HH- fish consumption	0.0001	ug/L	0.0009	ug/L	CUL	cPAHs (BaP equiv)
surface water		7	ECO -	0.014	ug/L			CUL	cPAHs (BaP equiv)

NW Natural's proposal, if accepted in full, would result in a decreased SMA area from 355 acreas (ROD) to 304 or 326 acres (proposed).

Table 17, ROD cleanup value

Table 6, ROD PTW value

Table 19, ROD RALs

* if the ROD values listed are not high-lighted, then NWNatural caluculated them or pulled them from elsewhere, including Non-ROD documents

** based on tribal use PRGs of 773 ug/kg

*** PRG used for many of the RAL calcs

Appendix A12

April 24, 2018 Memorandum from Portland Harbor ESD Team to EPA Region 10, Subject: Comments received verbally from TCT members during reading room reviews on March 21, April 4 and April 18, 2018

MEMORANDUM

To: EPA Region 10 Portland Harbor ESD File

From: Portland Harbor ESD Team

Date: April 24, 2018

Subject: Comments received verbally from TCT members during reading room reviews on March 21, April 4 and April 18, 2018

COMMENTS CAPTURED DURING ESD READING ROOM EVENTS

March 21 Comments

- Fix 2nd bullet on Summary of Significant Changes to clarify that the sediment CUL is based on the tribal fish direct contact exposure scenario and applicable to all nearshore sediments, except for recreational beach areas.
- Section 4.0 it is recommended to clarify the distinction between cPAH and Total PAH.
- Add text that documents additional data may revise RAO3 and RAO4 impacts as a result of this ESD.
- Footnote on decision summary table that Yakama Nation is currently evaluating
- Add note about rolling river miles for RAO 1 and 2 calculations to RAO Evaluation section (Page 27).

April 4 Comments

- Need to index key documents supporting Proposed ESD decisions in Appendix A
- Include TPAH conversion equation in the document
- Add a PAH figure showing relationship on this topic
- Change color of hatch area in the PAH areas in the Nav Channel
- Indicate what decision unit scale is used in the Figures and Tables
- Add ROD errata to Appendix B and refer to this errata in the text
- Compile additional key supporting documents used in the decision process for the Proposed ESD

April 18 Comments

- Add Fish/**Shellfish** tissue in updated Table 17 in Appendix A
- DEQ will be sending editorial comments in a separate markup of the Draft ESD

Appendix A13

April 19, 2018 e-mail from Sarah Greenfield (DEQ), Subject: DEQ Comments on ESD

19 APRIL 2018 E-MAIL FROM SARAH GREENFIELD (DEQ)

From: GREENFIELD Sarah <Sarah.GREENFIELD@state.or.us>
Sent: Thursday, April 19, 2018 3:40 PM
To: Sheldrake, Sean <sheldrake.sean@epa.gov>; Coffey, Scott <CoffeySE@cdmsmith.com>
Cc: MCCLINCY Matt <Matt.MCCLINCY@state.or.us>; NOVAK Madi <Madi.NOVAK@state.or.us>
Subject: DEQ Comments on ESD

Sean and Scott-
Thank you both for a very productive meeting yesterday. We're looking forward to further discussions on in-water/source control overlays along the banks in our meeting next week. In the meantime, DEQ has compiled a number of mostly editorial comments on EPA's proposed ESD. We still have a couple folks who are planning to review, but I wanted to get you these initial thoughts sooner than later. We'll plan to get any remaining comments to you by end of next week. Please let me know if that works with your schedule.
As always, feel free to give me a call if you have questions.
Thanks!

Sarah Greenfield, PE
NW Region Cleanup Program
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Appendix A14

April 27, 2018 e-mail from Sarah Greenfield (DEQ), Subject: DEQ Comments on ESD

27 APRIL 2018 E-MAIL FROM SARAH GREENFIELD (DEQ)

From: GREENFIELD Sarah <Sarah.GREENFIELD@state.or.us>
Sent: Friday, April 27, 2018 4:40 PM
To: Sheldrake, Sean <sheldrake.sean@epa.gov>; Coffey, Scott <CoffeySE@cdmsmith.com>
Subject: RE: DEQ Comments on ESD

Sean and Scott-
DEQ folks had a couple additional minor comments on the ESD.

- Section 2.2, Nature and Extent of Contamination, page 12, paragraph 1. The ESD definition of the "shallow region" should be consistent with the definition provided in the ROD. This section of the ESD states "the shallow region, defined as shoreward of the riverbed elevation of 4 ft below mean low water…" while ROD Section 14.2.4 states "The shallow region is defined as shoreward of the riverbed elevation of approximately -2 ft CRD."
- Section 2.2, Nature and Extent of Contamination, page 13, paragraph 1. "Subsurface contamination was detected as deep as 34 ft." The text should clarify the relevant datum. DEQ assumes this is referring to 34 ft bml.

Thanks and I hope you have a great weekend!

Sarah Greenfield, ODEQ
700 NE Multnomah Street, Suite 600,
Portland, OR 97232
(503) 229-5245

From: GREENFIELD Sarah
Sent: Thursday, April 19, 2018 3:40 PM
To: 'Sheldrake, Sean' <sheldrake.sean@epa.gov>; Scott Coffey <coffeyse@cdmsmith.com>
Cc: MCCLINCY Matt <Matt.MCCLINCY@state.or.us>; NOVAK Madi <Madi.NOVAK@state.or.us>
Subject: DEQ Comments on ESD

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As always, feel free to give me a call if you have questions.
Thanks!

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Appendix A15

cPAH Sediment CUL Summary

cPAH Sediment CUL Summary

Overview

- The RAO 2 PRG for cPAHs was incorrectly presented in the Portland Harbor FS, Proposed Plan and Record of Decision
- The error resulted from inputting the acceptable tissue concentration into the log-log tissue/sediment regression equation in units of ug/kg rather than mg/kg
- No other chemicals are affected by this error
- Correcting the error results in a 100-fold decrease in the RAO 2 sediment CUL for cPAHs
- The error has a minimal effect on the protectiveness of the selected remedy
    - Increases the maximum post construction risk for the Selected Remedy from 3×10^{-8} to 3×10^{-6} within the Navigation Channel between RM 4.5 and RM 6

cPAH Target Tissue Levels

- Target Tissue Levels for cPAHs are based on the benzo(a)pyrene cancer slope factor (CSF)
- Target Tissue Levels are unaffected by error and calculated based on the following formula:

$$PRG_{tissue} = \frac{TR \times AT_c}{EF \times CR_{adj} \times CSF \times 0.001 kg / g}$$

- Target Tissue Level Pre-BaP CSF Change: 7.1 µg/kg
- Target Tissue Level Post-BaP CSF Change: 51.6 µg/kg

cPAH Sediment Cleanup Levels

- Sediment Cleanup Levels for cPAH are based on the following equation describing the relationship between BaP in sediment and clam tissue:

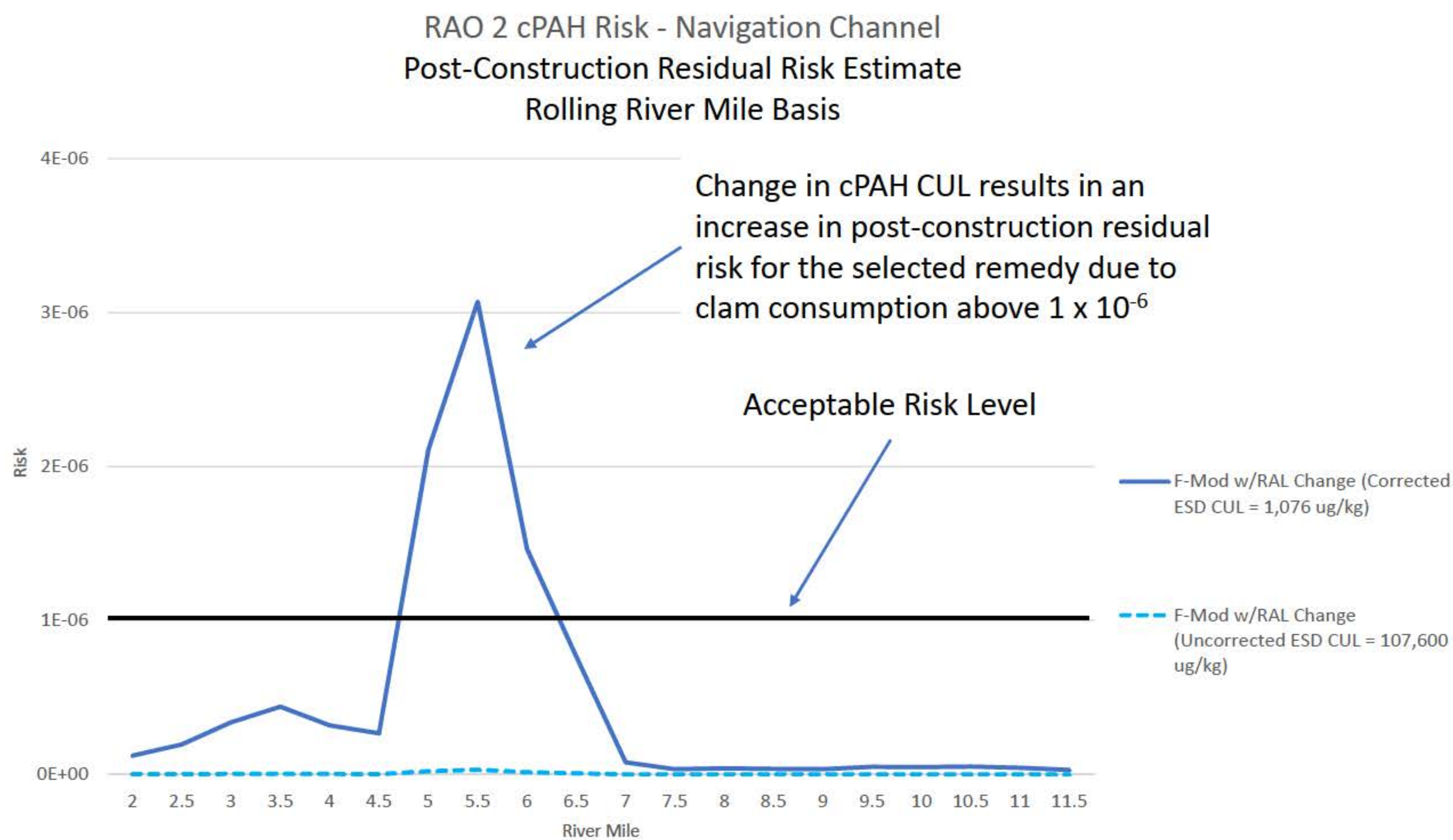
$$PRG_{\text{sed}} = e^{\left[\frac{(\ln(C_{\text{tissue}}) - \ln(f_{lipid})) - \ln(CF) + 2.47}{0.60}\right] + \ln(f_{oc})}$$

- Error was based on use inputting acceptable tissue level into above equation in units of µg/kg rather than mg/kg
  - An acceptable tissue concentration of 7.1 µg/kg results in a sediment PRG of 3,950 µg/kg
  - An acceptable tissue concentration of 0.0071 mg/kg results in a sediment PRG of 0.0395 mg/kg (39.5 µg/kg) – a 100X reduction
  - The sediment cleanup levels following the BaP CSF change are similarly reduced 100X from 107,600 µg/kg to 1,076 µg/kg

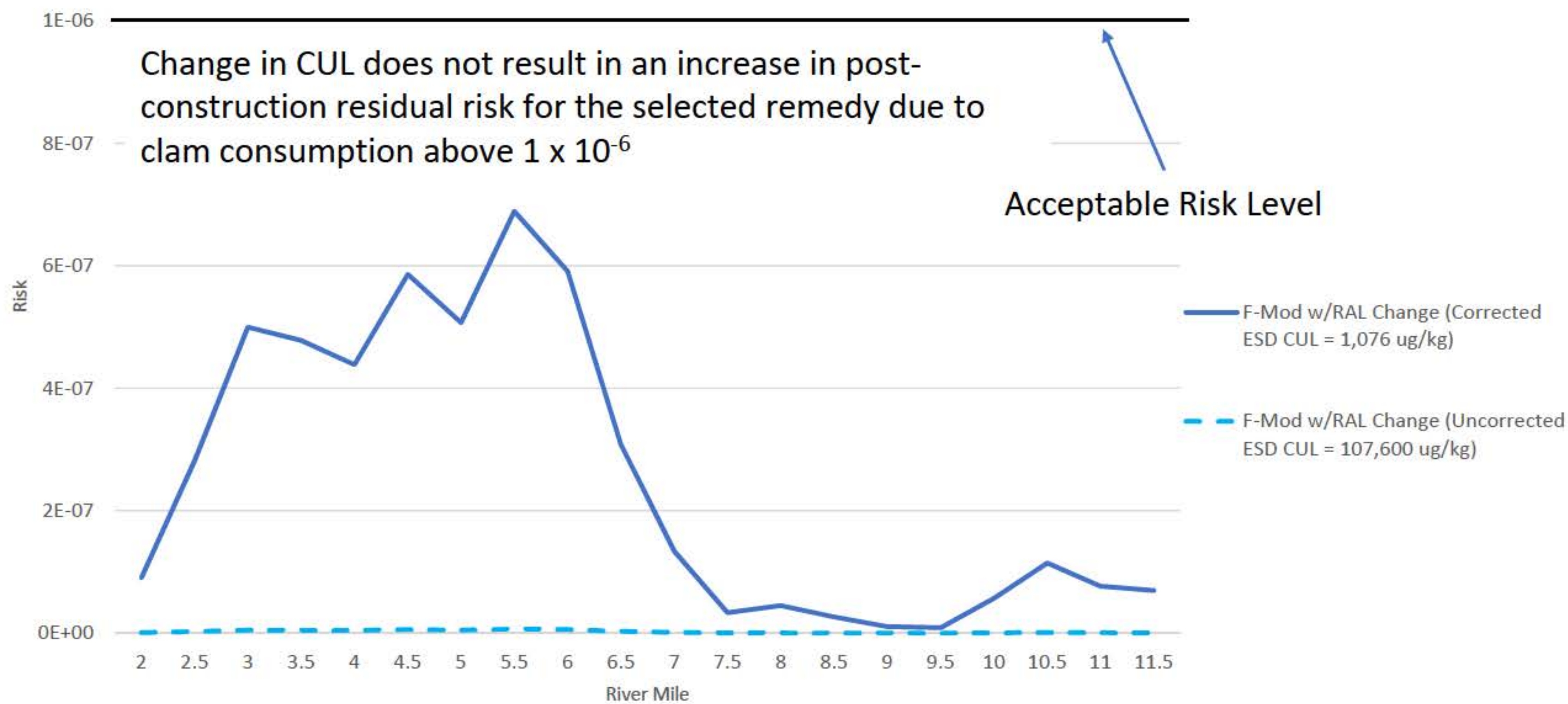
Target Tissue Level and Sediment Cleanup Level Summary

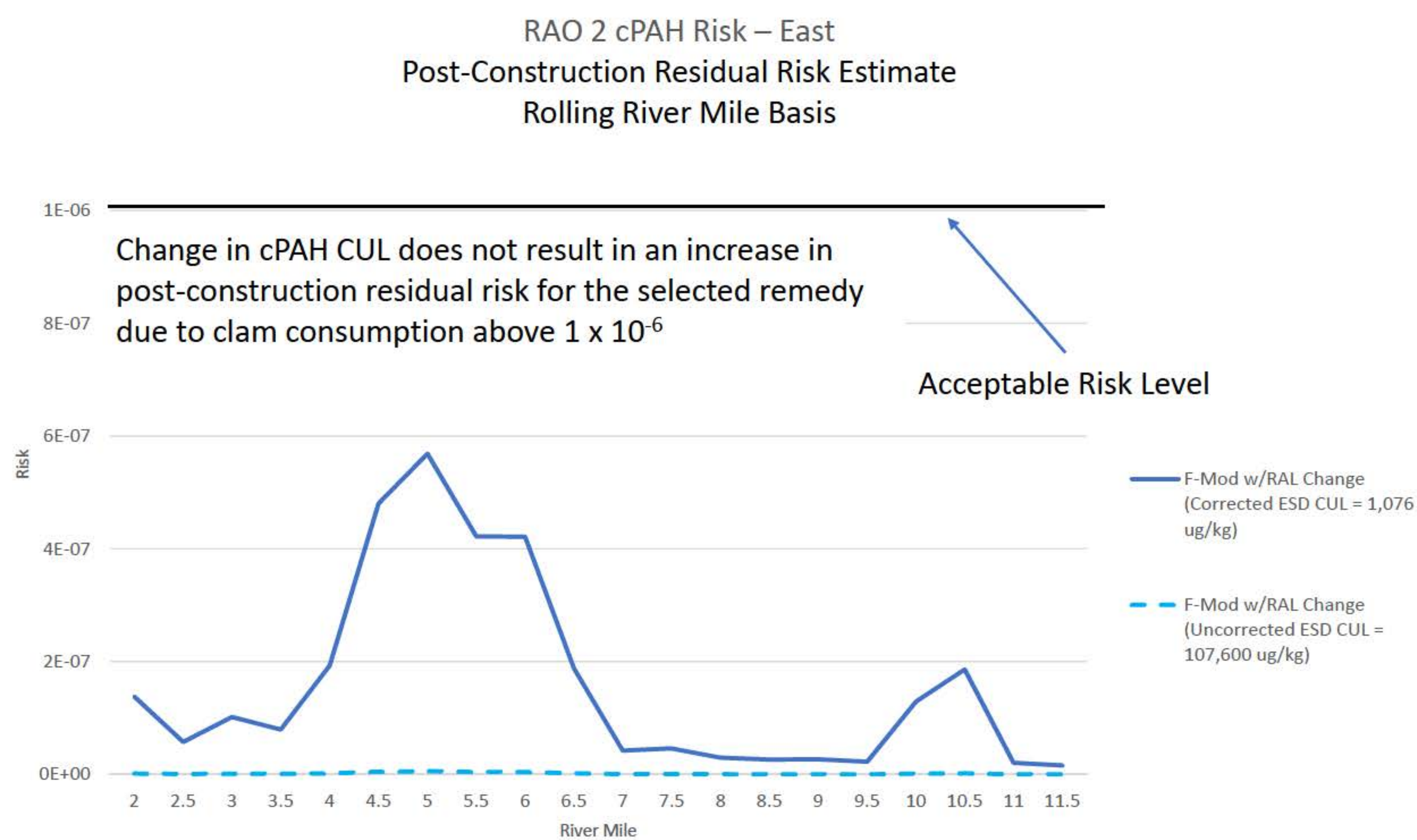
Scenario	Target Tissue Level	Sediment Cleanup Level
ROD Value	7.1 µg/kg	3,950 µg/kg
Corrected ROD Value	0.0071 mg/kg	39.5 µg/kg
ESD Value	51.6 µg/kg	107,600 µg/kg
Corrected ESD Value	0.0516 mg/kg	1,076 µg/kg

Note: Corrected target tissue levels represent a change in units from µg/kg to mg/kg only; the value is the same.

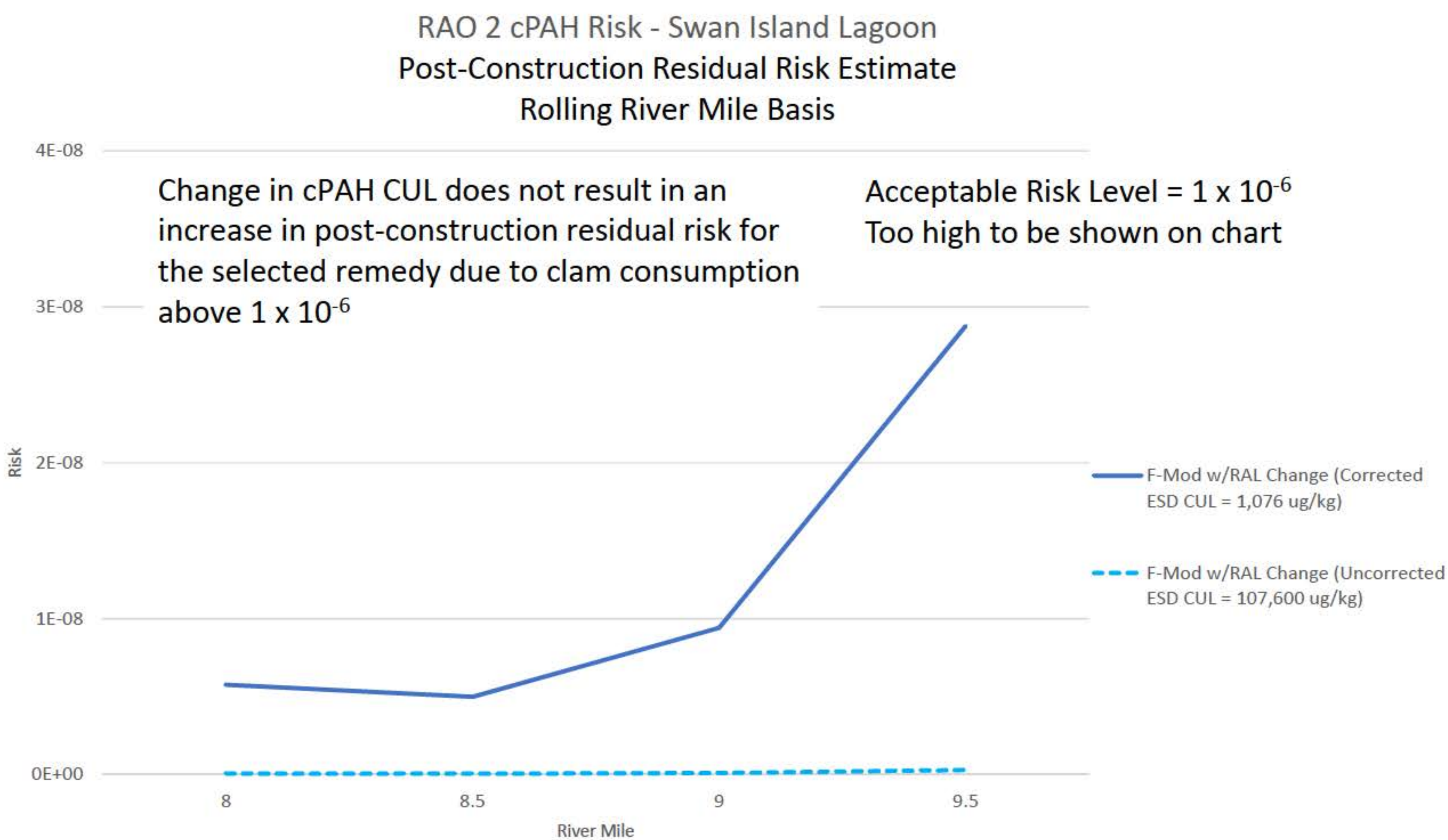

RAO 2 cPAH Risk - Navigation Channel
Post-Construction Residual Risk Estimate
Rolling River Mile Basis
Change in cPAH CUL results in an increase in post-construction residual risk for the selected remedy due to clam consumption above 1 x 10-6
Acceptable Risk Level
Risk
4E-06
3E-06
2E-06
1E-06
0E+00
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
River Mile
F-Mod w/RAL Change (Corrected ESD CUL = 1,076 ug/kg)
F-Mod w/RAL Change (Uncorrected ESD CUL = 107,600 ug/kg)

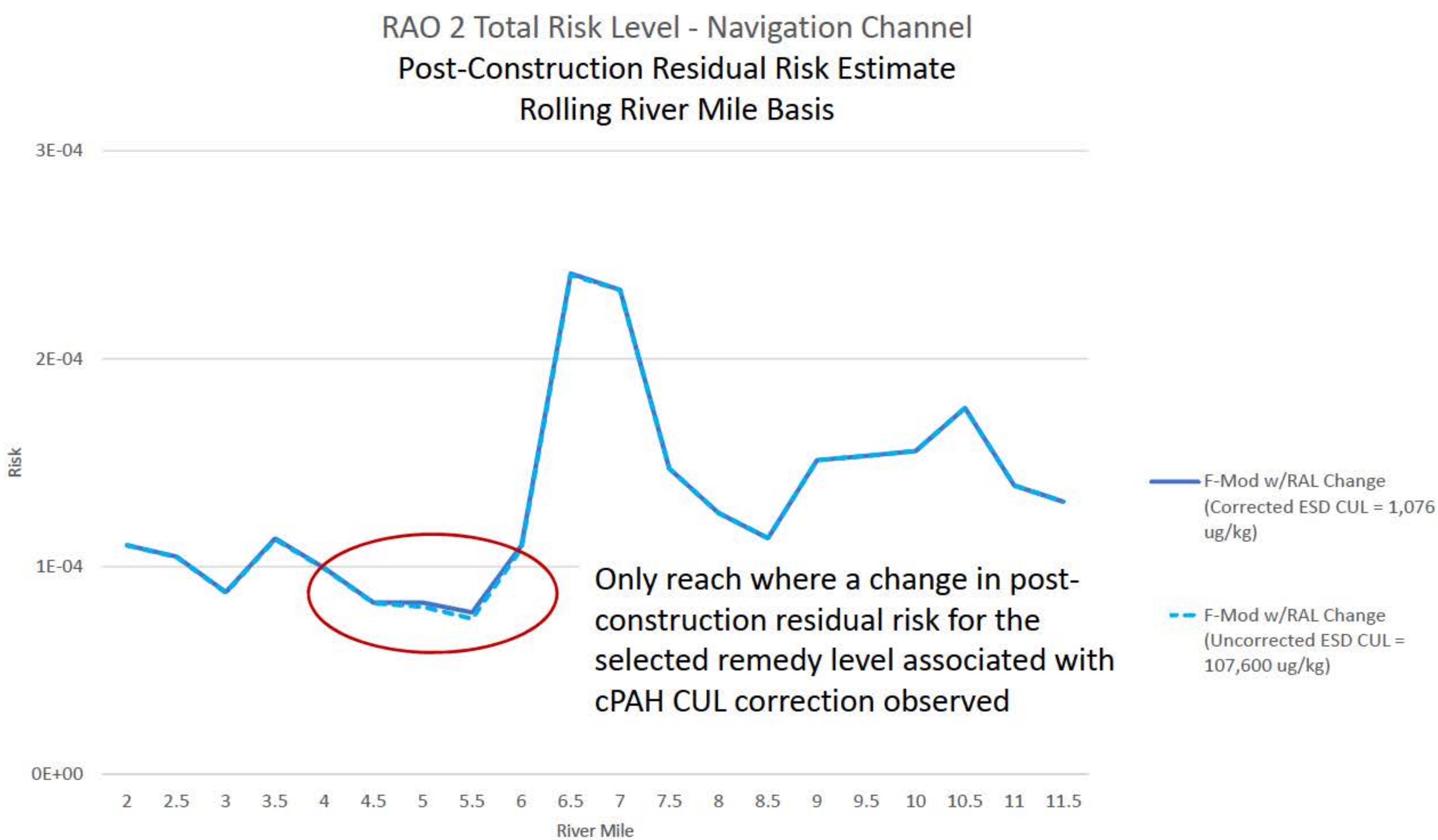
RAO 2 cPAH Risk – West
Post-Construction Residual Risk Estimate
Rolling River Mile Basis





RAO 2 cPAH Risk – East
Post-Construction Residual Risk Estimate
Rolling River Mile Basis
Change in cPAH CUL does not result in an increase in post-construction residual risk for the selected remedy due to clam consumption above 1 x 10-6
Acceptable Risk Level
1E-06
8E-07
6E-07
4E-07
2E-07
0E+00
Risk
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
River Mile
F-Mod w/RAL Change (Corrected ESD CUL = 1,076 ug/kg)
F-Mod w/RAL Change (Uncorrected ESD CUL = 107,600 ug/kg)

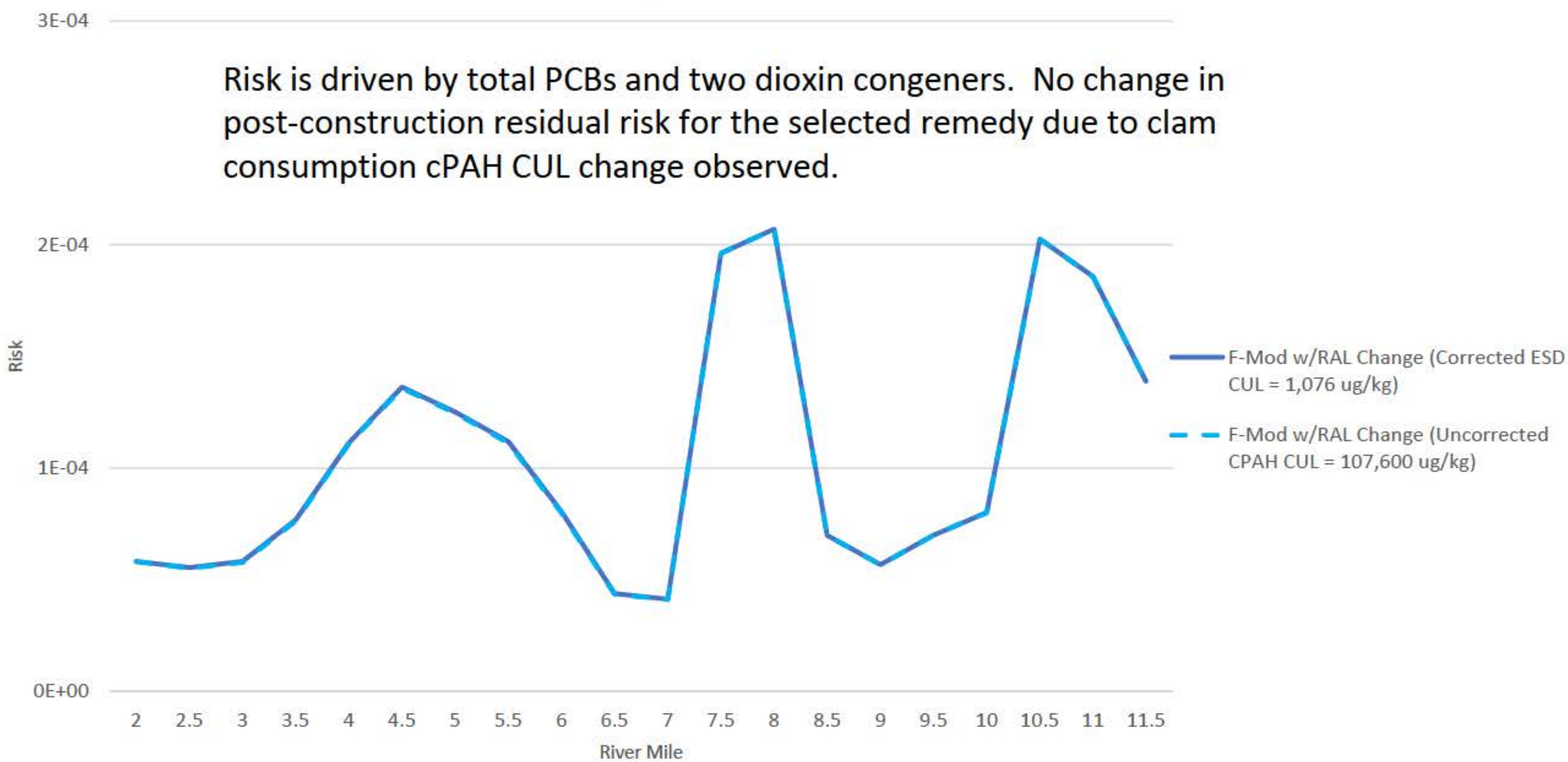

RAO 2 cPAH Risk - Swan Island Lagoon
Post-Construction Residual Risk Estimate
Rolling River Mile Basis
Change in cPAH CUL does not result in an increase in post-construction residual risk for the selected remedy due to clam consumption above 1 x 10-6
Acceptable Risk Level = 1 x 10-6
Too high to be shown on chart
Risk
4E-08
3E-08
2E-08
1E-08
0E+00
8
8.5
9
9.5
River Mile
F-Mod w/RAL Change (Corrected ESD CUL = 1,076 ug/kg)
F-Mod w/RAL Change (Uncorrected ESD CUL = 107,600 ug/kg)

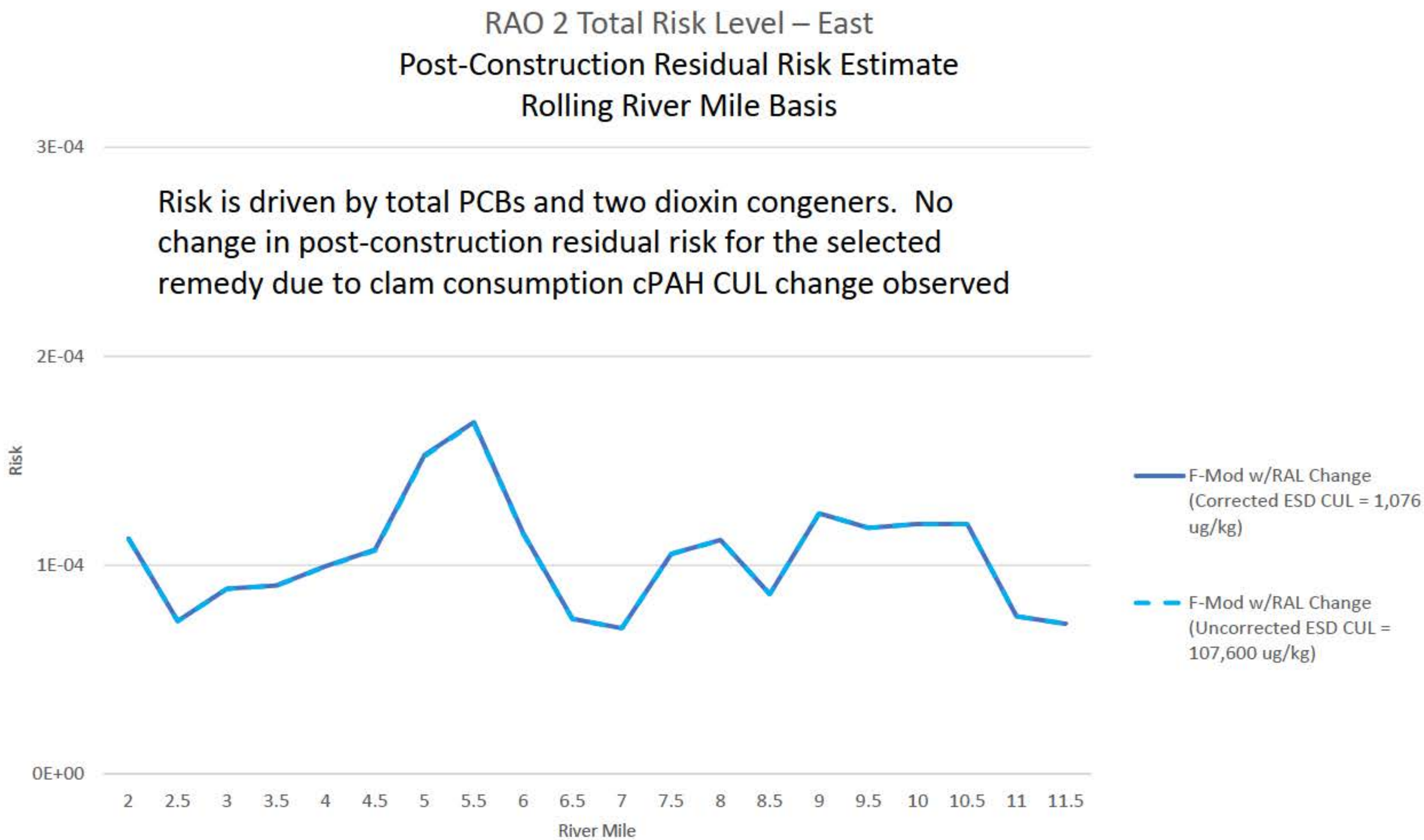

RAO 2 Total Risk Level - Navigation Channel
Post-Construction Residual Risk Estimate
Rolling River Mile Basis
3E-04
2E-04
1E-04
0E+00
Risk
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
River Mile
Only reach where a change in post-construction residual risk for the selected remedy level associated with cPAH CUL correction observed
F-Mod w/RAL Change (Corrected ESD CUL = 1,076 ug/kg)
F-Mod w/RAL Change (Uncorrected ESD CUL = 107,600 ug/kg)

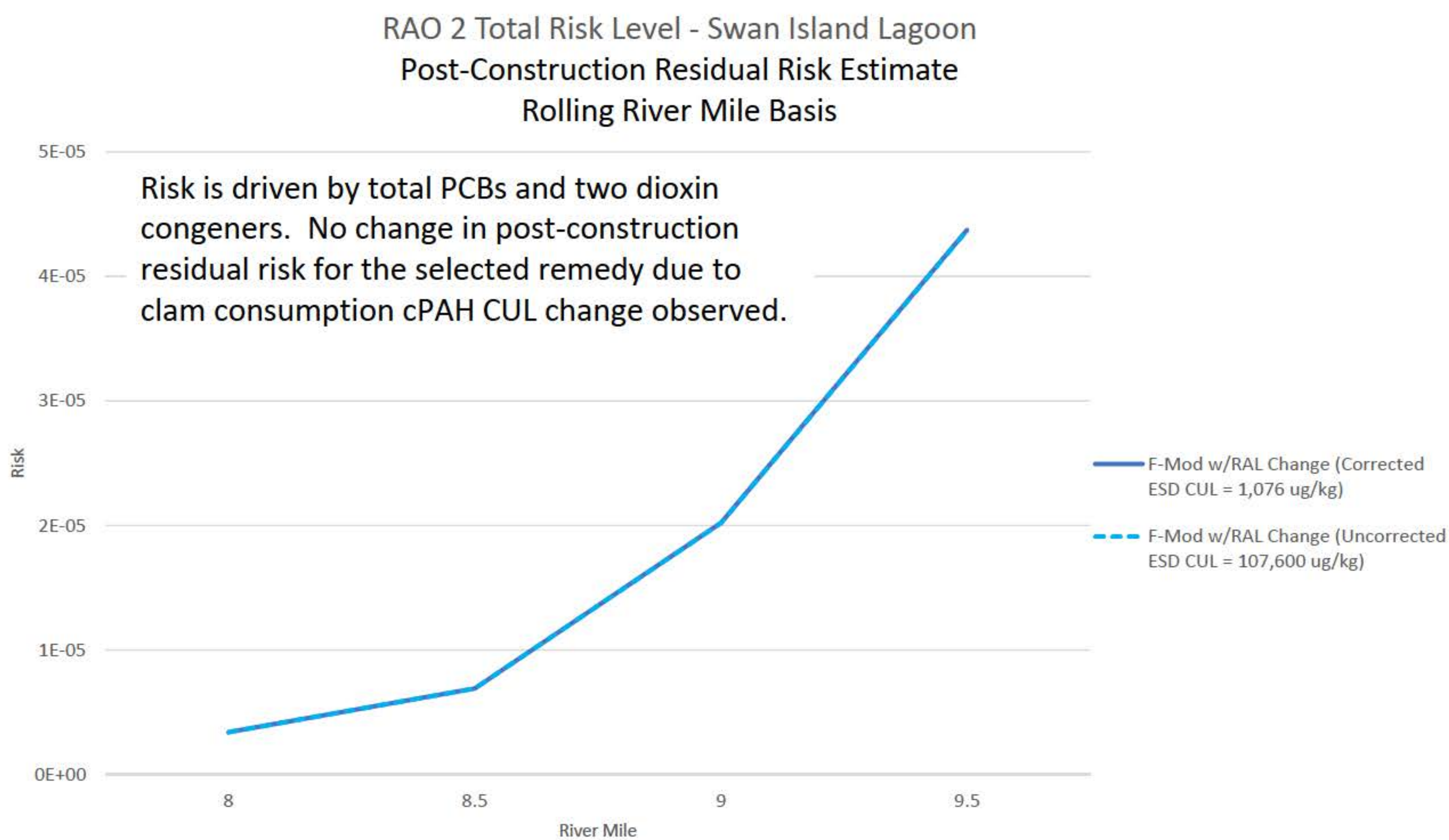
RAO 2 Total Risk Level – West

Post-Construction Residual Risk Estimate

Rolling River Mile Basis




RAO 2 Total Risk Level – East
Post-Construction Residual Risk Estimate
Rolling River Mile Basis
Risk is driven by total PCBs and two dioxin congeners. No change in post-construction residual risk for the selected remedy due to clam consumption cPAH CUL change observed
3E-04
2E-04
1E-04
0E+00
Risk
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
River Mile
F-Mod w/RAL Change (Corrected ESD CUL = 1,076 ug/kg)
F-Mod w/RAL Change (Uncorrected ESD CUL = 107,600 ug/kg)


RAO 2 Total Risk Level - Swan Island Lagoon
Post-Construction Residual Risk Estimate
Rolling River Mile Basis
Risk is driven by total PCBs and two dioxin congeners. No change in post-construction residual risk for the selected remedy due to clam consumption cPAH CUL change observed.
5E-05
4E-05
3E-05
2E-05
1E-05
0E+00
Risk
8
8.5
9
9.5
River Mile
F-Mod w/RAL Change (Corrected ESD CUL = 1,076 ug/kg)
F-Mod w/RAL Change (Uncorrected ESD CUL = 107,600 ug/kg)

Appendix A16

October 2, 2018 NW Natural Memorandum to Jim Woolford from Bob Wyatt Regarding: Portland Harbor cPAH Cleanup Level Update

220 NW 2ND AVENUE
PORTLAND, OR 97209
TEL 503.226.4211
www.nwnatural.com

To: Jim Woolford
From: Bob Wyatt
Date: October 2, 2018
Regarding: Portland Harbor cPAH Cleanup Level Update

Jim,

NW Natural very much appreciates the opportunity to provide you with more detail on our additional analysis of how the PAH cleanup criteria for Portland Harbor should be revised to reflect the updated IRIS cancer slope factor for benzo(a)pyrene (BaP). During our September 11 meeting, we provided an overview of our evaluation of three of the key factors EPA is considering at Portland Harbor. We also discussed the fact that EPA has determined that the direct contact risk associated with BaP is now approximately seven times less than was previously thought, and the risk of consuming shellfish in contact with sediments is approximately 27 times less than previously calculated. As we mentioned during the meeting, we believe EPA's revised cleanup requirements at Portland Harbor for cPAH and TPAH should reflect the magnitude of these changes. The three factors and our summary positions were:

1. *Human consumption of clams harvested from the navigation channel*. The Baseline Human Health Risk Assessment concluded that there is no human health risk from clam consumption in the navigation channel. That means that there should be no remedy required for that pathway. Even if clam consumption *had* been identified as a pathway for the navigation channel, no active remediation would be required. Cleanup in nearshore areas would reduce potential risks from clam consumption to well within EPA's acceptable risk range for the site. In fact, according to EPA's ROD residual risk evaluation, current clam consumption risks in navigation channel sediments are already within EPA's acceptable risk range.

2. *Protection of Surface Water.* The ambient water quality cleanup level for BaP based on the revised IRIS cancer slope factor should be 0.0009 µg/l. It is reasonable for EPA to apply a revised water quality criteria at Portland Harbor. Further, as ROD Appendix IV, Figure 4.2-8b shows, predicted surface water cPAH concentrations associated with the site for the "no action" alternative are already below the updated cleanup level and well below the most stringent Oregon water quality standard. Therefore, no cPAH cleanup of sediments is necessary to protect surface water quality for PAHs.

3. *Benthic Risk.* The revised cancer slope factor for BaP does not affect the calculation of benthic risk. EPA's ROD allows for delineation of benthic risk areas for active cleanup using the multiple lines of evidence approach used in the BERA. The ROD responsiveness summary clarifies that additional lines of evidence (e.g. toxicity testing) may be used to "refine delineation of benthic risk areas in areas that are not driven by risk via another RAO." Because PAH cleanup in the

navigation channel is not driven by risks to human health or protection of surface water, the application of TPAH RALs in the navigation channel is not necessary to protect the benthic community.

Our detailed supporting analysis is provided below.

Reconciliation of Updated B(a)P Toxicity Information and Portland Harbor Remedial Action Objectives Key Technical Issues

On January 19, 2017, EPA updated its Integrated Risk Information System (IRIS) by decreasing the oral cancer slope factor for benzo(a)pyrene (BaP) from 7.3 per mg/kg-day to 1 per mg/kg-day. This update reflects an approximate seven-fold decrease in calculated post-construction cancer risk from direct contact with BaP and, due to the log-log biota sediment accumulation regression equation used at Portland Harbor, an approximate 27-fold decrease in calculated post-construction cancer risk from shellfish consumption. Carcinogenic PAH cleanup levels for Portland Harbor, which are expressed as BaP equivalent values, should be updated as follows:

		ROD cleanup level	Updated cleanup level
In-water direct contact sediment	RAO 1	106 µg/kg[1]	774 µg/kg
Shellfish consumption sediment	RAO 2	39.5[2] µg/kg	1,080[3] µg/kg
Surface water	RAO 3	0.00012 µg/l	0.0009 µg/l[4]

[1] EPA's Baseline Human Health Risk Assessment identified potential risk from direct contact with cPAHs in nearshore in-water sediment to in-water workers, fishers, and divers. Based upon the BHHRA, EPA developed a direct contact PRG of 106 µg/kg for in-water sediment to be protective of tribal fishers. In the ROD, however, EPA selected a cPAH direct contact sediment cleanup level of 12 µg/kg, based upon background concentrations (which are equivalent to the PRG for the child recreational beach exposure scenario). Although EPA's cPAH in-water sediment cleanup level is based upon a child recreational beach exposure assumption, virtually all of EPA's evaluations supporting its remedy selection for nearshore sediments are based upon the 106 µg/kg PRG for tribal fishers. For example, the Remedial Action Levels for Total PAHs developed in the Feasibility Study and used to define action areas in the ROD were based on the 106 µg/kg cPAH PRG for in-water sediment exposure. The "highly toxic" principal threat waste concentration in the Feasibility Study and ROD is also based on the 106 µg/kg cPAH PRG. Most importantly, the Feasibility Study evaluated the performance of all alternatives (including the selected alternative) for EPA's Remedial Action Objective 1 (reduce risks to people from direct contact with chemicals in sediment and beaches) against the 106 µg/kg tribal fisher PRG. EPA's residual risk evaluations led it to conclude that its selected remedy would be protective of direct contact with sediments "immediately after construction." However, even a cursory review of EPA's residual risk tables in the final Feasibility Study reveals that the 12 µg/kg cPAH sediment cleanup level would not be met in almost every segment of the river at the rolling half-mile scale evaluated for RAO 1 immediately following construction.

[2] Portland Harbor ROD Table 17 sets the shellfish consumption sediment cleanup level at 3,950 µg/kg applicable to navigation channel sediments. We understand that EPA has identified an apparent unit error in the calculation of the preliminary remediation goal for shellfish consumption and believes the PRG should have been set at 39.5 µg/kg based on the former cancer slope factor. We have used the more conservative value in this table.

[3] Updated following equation presented in Appendix B of EPA's Feasibility Study.

[4] EPA's surface water cleanup level for Portland Harbor is based on the federal ambient water quality criteria rather than the risk assessment. In 2015, EPA stated that it "anticipates updating the AWQC for benzo(a)pyrene following finalization of EPA's IRIS toxicological assessment." *Update of Human Health Ambient Water Quality*

As we have previously presented to EPA,[5] adjusted nearshore RALs corresponding to the updated in-water direct contact sediment cleanup level could range from approximately 92,000 to 170,000 µg/kg.[6] The highly toxic principal threat waste (PTW) threshold would increase to 774,000 µg/kg.

We understand that EPA is concerned about redefining areas of active remedy to correspond to the updated IRIS assessment on three grounds: risk associated with human consumption of clams harvested from the navigation channel, protection of surface water, and benthic risk.

1. *Human consumption of clams harvested from the navigation channel*

The clam consumption cleanup level is the only human health-related cPAH or PAH cleanup level in the ROD applicable to the navigation channel. EPA's Baseline Human Health Risk Assessment (BHRRA) did not identify human consumption of clams harvested from the navigation channel as a complete exposure pathway and therefore did not assess potential risks associated with such consumption. In directing the exposure pathways to be evaluated in the BHRRA, EPA stated,

> It is unclear whether the maximum consumption rate for shellfish assumed in the risk assessment (18 g/day which is a little more than 1 pound per month (one pound in 3.6 weeks)) is sustainable at some or all of the areas where bivalves were collected, now or in the future. EPA believes that sufficient information exists to support the clam consumption scenario. However, EPA acknowledges that an appropriate exposure area should be determined in consideration of water depth (i.e. nearshore areas) and the area over which a sustainable shellfish harvest consistent with the clam consumption is possible.[7]

Accordingly, the final BHHRA identified <u>no human health risk</u> from clams harvested in the navigation channel.[8] EPA never deviated from this risk finding prior to the ROD, when it acknowledged that it could not technically support a cPAH sediment cleanup level based on fish consumption and substituted the clam consumption scenario[9] as a justification for petroleum cleanup in the navigation channel.[10]

Even if this risk pathway were supported by EPA's risk assessment, extensive remediation in the navigation channel is not necessary to address it. As shown in the figure below, cleanup in nearshore areas to even the least conservative adjusted TPAH RAL would reduce potential risks from clam

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Criteria: Benzo(a)pyrene 50-32-8, EPA 820-R-15-012 (June 2015). As a point of comparison, Oregon's water quality criteria for BaP (water + organism) is 0.0013 µg/l. OAR 340-041-8033, Table 40.

[5] *See,* Memorandum, *USEPA Updates to Human Health Toxicity Values for Benzo(a)pyrene and Potential Effects on Cleanup Levels and Remedial Action Levels in Portland Harbor* (Anchor QEA, August 2, 2017).

[6] Upper bound of TPAH RAL of 170,000 µg/kg equivalent to Alternative B in the FS.

[7] EPA Comments on Comprehensive Round 2 Site Summary and Data Gaps Analysis Report (January 15, 2008), page 26.

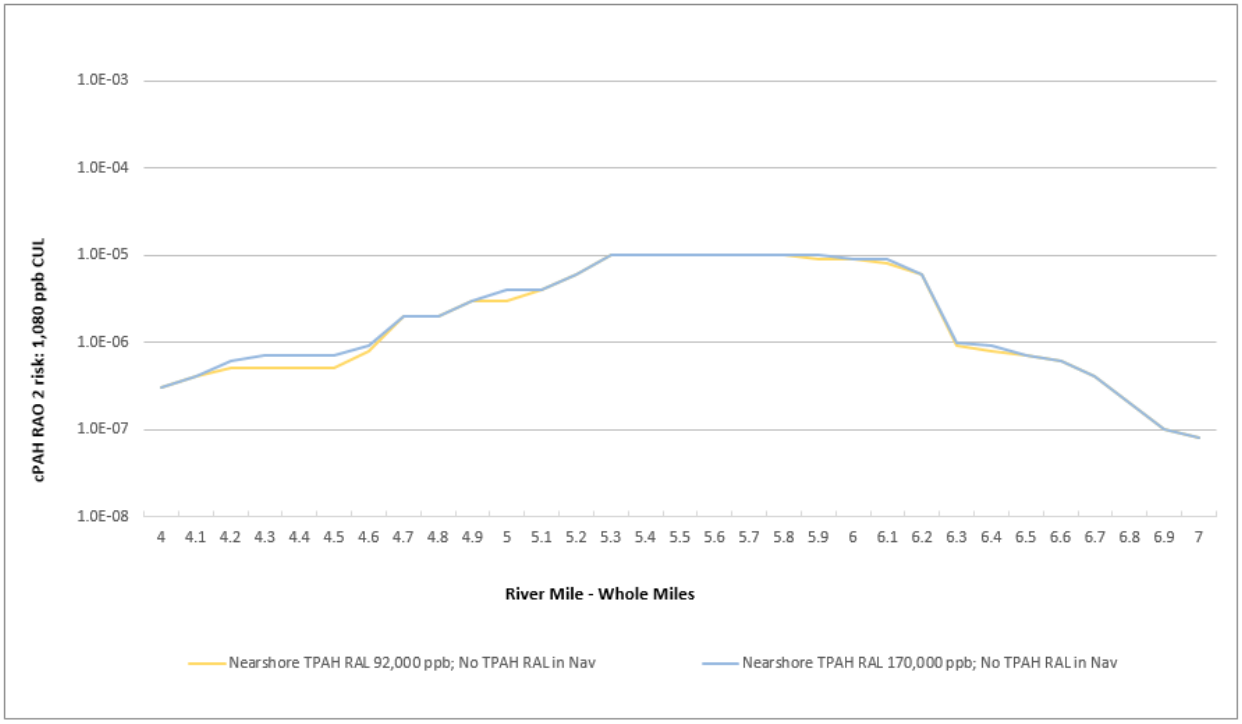
[8] See Map 5-4.1 (Portland Harbor RI/FS Appendix F, March 28, 2013 – Risks from Clam Consumption, RME).

[9] *See Portland Harbor RI/FS, Revised Draft Bioaccumulation Modeling Report* (June 19, 2015), Table 4-1.

[10] See also EPA's April 21, 2010 letter providing direction on PRGs for use in the Feasibility Study and attached Table 1 ("B(a)P HH Clam Consumption. EPA considered making alternative water depth or consumption exposure assumptions but prefers using assumptions consistent with the risk assessment.")

consumption to well within EPA's acceptable risk range[11] at the completion of construction without any active TPAH cleanup in the navigation channel.[12] In fact, according to EPA's ROD residual risk evaluation, current clam consumption risks in navigation channel sediments are within EPA's acceptable risk range at the updated cleanup level.

Post Construction Clam Consumption Risk
RM 4-7 Whole River Miles
Log Scale



2. *Protection of Surface Water*

As noted above, EPA anticipates updating the BaP ambient water quality criteria consistent with the 2017 toxicological assessment. The updated cleanup level for protection of surface water should be 0.0009 µg/l. Because remedy implementation is still a number of years in the future, the new water quality criteria will almost certainly be in effect at the time cleanup commences. The most stringent Oregon water quality standard (0.0013 µg/l) is less stringent than the EPA AWQC.

EPA's FS estimated surface water concentrations following implementation of the various remedial alternatives. As ROD Appendix IV, Figure 4.2-8b (below) shows, predicted surface water cPAH concentrations associated with the site for the "no action" alternative are already below the updated cleanup level and well below the most stringent Oregon water quality standard.[13] Therefore, no

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[11] Carcinogenic risk between 10-6 and 10-4 per National Contingency Plan (NCP), 40 CFR 300.430(e)

[12] Figure shows residual risk calculated on a whole river mile basis, the smallest scale evaluated in the BHRRA for consumption scenarios not limited by water depth. See BHHRA §3.4.5.

[13] Note that EPA's selected alternative, F Mod, would not itself attain protection of the current cPAH cleanup level immediately following construction of remedial actions.

petroleum cleanup of sediments is necessary to protect surface water quality for PAHs, but application of adjusted TPAH RALs in the nearshore and remediation of areas of PTW-NAPL will reduce cPAH water concentrations below current levels.

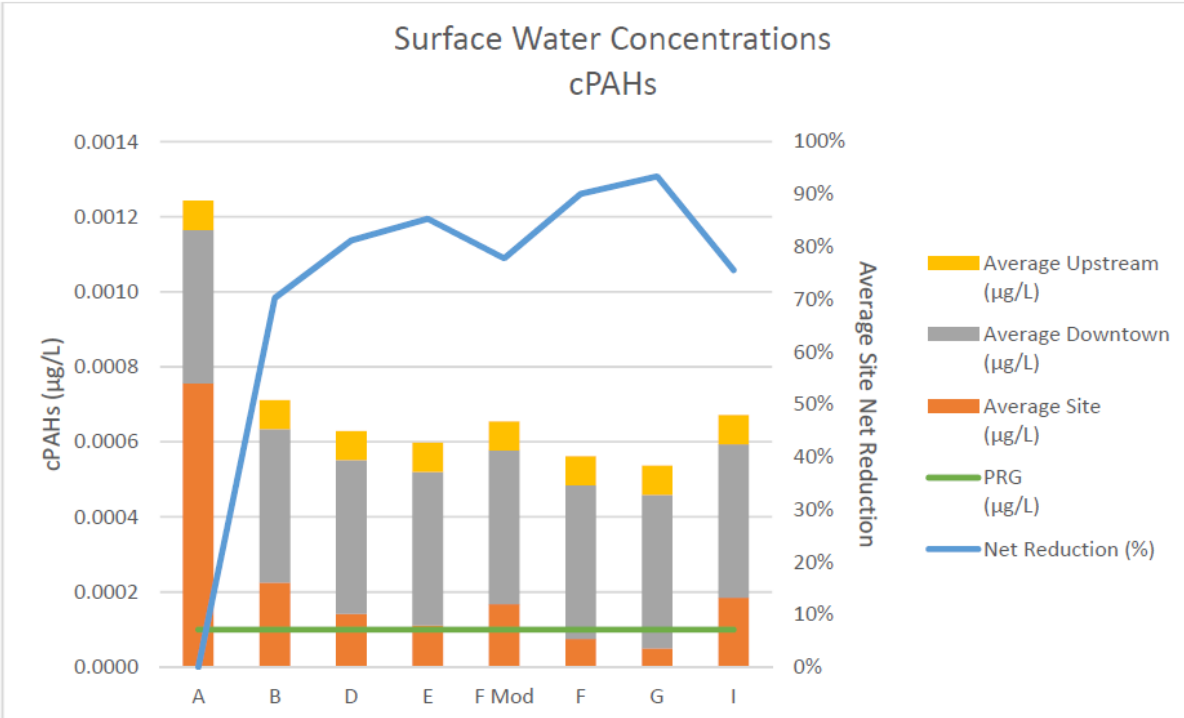

Figure 4.2-8b. Predicted surface water cPAH concentration reductions.

3. *Benthic Risk*

The assessment of potential ecological risk (RAO 5) would, of course, not be affected by the change in the human health cancer slope factor. Table 17 of the ROD does not identify the basis for the PAH PRG of 23,000 ppb, but we understand it to be for protection of benthic organisms.

EPA's Baseline Ecological Risk Assessment (BERA) used a multiple lines of evidence approach to evaluate benthic risk. Although EPA adopted a different approach for estimating benthic risk in the ROD,[14] the ROD responsiveness summary clarifies that additional lines of evidence (e.g., toxicity testing) may be used to "refine delineation of benthic risk areas in areas that are not driven by risk via another RAO." Because, as discussed above, petroleum cleanup in the navigation channel is not driven by risks to human health or protection of surface water, EPA's ROD allows for delineation of benthic risk areas for active cleanup using the multiple lines of evidence approach used in the BERA. Therefore, application of TPAH RALs in the navigation channel is not necessary to protect the benthic community.

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[14] *See, e.g.,* Portland Harbor RI Appendix G, p. 774 ("[u]nacceptable risks to benthic invertebrates are located in approximately 4-8 percent of the Site,"); *cf.* ROD, Appendix IV, Table 4.2-7 (1,289 acres of benthic risk within the 2,190 acre Portland Harbor Site, or approximately 59% of the Site).

Conclusion

EPA's risk assessment did not identify human consumption of clams from the navigation channel as a risk. Even if it had, cleanup of petroleum in the nearshore areas to even the least conservative adjusted TPAH RAL would reduce potential risks from clam consumption to well within EPA's NCP acceptable risk range at the completion of construction without any active TPAH cleanup in the navigation channel. Site contributions to cPAH surface water concentrations are already below the updated cleanup level at the no action alternatives, and those concentrations will be further reduced through active remediation of areas defined by nearshore TPAH RALs and PTW-NAPL. Benthic risk can be delineated and addressed consistent with the ROD through the multiple lines of evidence approach used in the BERA.

Appendix B

Errata Memorandum

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
ENVIRONMENTAL CLEANUP

April 3, 2018

MEMORANDUM

SUBJECT: Errata for Portland Harbor Superfund Site Record of Decision, Version 1.0

FROM: Sean Sheldrake, Remedial Project Manager
Office of Environmental Cleanup

TO: Portland Harbor site file

This memorandum documents minor errors identified in the Portland Harbor Superfund Site Record of Decision, dated January 2017. Redlined corrections for the items below are attached:

1. List of Acronyms, page xii. The acronym for HxCDF should be hexachlorodibenzofuran instead of 1,2,3,7,8,9-hexachlorodibenzofuran. The acronym for polybrominated diphenyl ether (PDBE) was also added to the list of acronyms.

2. Section 6.5.1, Contaminants of Concern, page 20. The last bullet under "Highly Toxic" listed as 1,2,3,4,6,7,8-hexachlorodibenzofuran (HxCDF) should be 1,2,3,4,7,8-hexachlorodibenzofuran (HxCDF).

3. Section 6.6.6, River Banks, pages 24-26. As shown in the attachment, the ECSI site IDs for Willamette Cove, Hampton Lumber and Glacier NW were corrected, and descriptions for Premier Edible Oils and US Navy Reserve were added.

4. Appendix I, ROD Figure 7. In a label on this figure, the Upriver Reach should be defined as River Mile 16.6 to 28.4, instead of River Mile 16.7 to 28.4 that was shown.

5. Appendix II, ROD Table 1. Four abbreviations in this table should be updated to include the correct congener for each abbreviation:

    a. HxCDF should be 1,2,3,4,7,8-hexachlorodibenzofuran

    b. PeCDD should be 1,2,3,7,8-pentachlorodibenzo-p-dioxin

    c. PeCDF should be 2,3,4,7,8-pentachlorodibenzofuran

    d. TCDF should be 2,3,7,8-tetrachlorodibenzofuran

6. Appendix II, ROD Table 2 and Table 3. Two abbreviations in each table should be updated to include the correct congener for each abbreviation:

    a. PeCDD should be 1,2,3,7,8-pentachlorodibenzo-p-dioxin

    b. PeCDF should be 2,3,4,7,8-pentachlorodibenzofuran

7. Appendix II, ROD Table 4. In the abbreviations list, the abbreviation for HxCDF should be 1,2,3,4,7,8-hexachlorodibenzofuran instead of 1,2,3,7,8,9-hexachlorodibenzofuran.

8. Appendix II, ROD Table 6. The contaminant listed as 1,2,3,4,6,7,8- HxCDF should be 1,2,3,4,7,8-HxCDF.

9. Appendix II, ROD Table 17. Revisions to this table include:

    a. The groundwater cleanup level of 9.9 µg/L listed for cis-1,2-Dichloroethene should be 70 µg/L.

    b. The fish tissue target concentration of 0.031 mg/kg listed for mercury should be 0.03 mg/kg.

    c. The river bank soil/sediment PAH cleanup level of 23000 µg/kg is a risk-based value so an "R" should be added to the basis column for this contaminant.

    d. The contaminant listed as TPH-Diesel (C10-C12 Aliphatic) should be Aliphatic Hydrocarbons C10-C12.

    e. The contaminant listed as 2,4,5-Trichlorophenol in the table should be 2,4,5-TP (Silvex). The full name for this contaminant, 2-(2,4,5-Trichlorophenoxy)propionic acid, should be added to the abbreviations.

    f. The abbreviation for HxCDF should be hexachlorodibenzofuran instead of 1,2,3,7,8,9-hexachlorodibenzofuran.

10. Appendix II, ROD Table 21. Revisions to this table include:

    a. This table does not have footnote 4 so the "(4)" in first column by Total PAHs should be deleted.

    b. The table should include µg/kg as the units for the values listed in this table.

    c. The additional contaminant listed as 1,2,3,4,6,7,8-HxCDF should be 1,2,3,4,7,8-HxCDF.

11. Appendix II, ROD Table 22. The reference to Oregon Health Authority (OHA) fish advisory regarding allowable fish meals under the no action Alternative A on pages

1, 3, 5 and 6 should be revised. The calculations are based on the HHRA assumptions and not a OHA advisory. The acronym for OHA should also be removed from page 9.

12. Appendix IV, Appendix J, Section J2.3, page J-4. The last paragraph on this page should state that Tables J2.3-4a-j and Tables J2.3-5a-g show noncancer HQ values instead of HI values.

13. Appendix IV, Appendix J, Table J2.3-5f. The values in this table show cancer risk estimates but should show HQ values. Corrected values are provided in Table J2.3-5f are included as an attachment to this memo.

14. Appendix IV, Appendix J, Tables J2.3-4a through J2.3-4j. In the title of each table, “HI” should be replaced with “HQ” because the values pertain to a single contaminant.

15. Appendix IV, Appendix J, Tables J2.3-5a through J2.3-5g. In the title of each table, “Risk” should be replaced with “HQ” because the values shown are HQs and not risk values.

The attachment shows redlined corrections for each of the items above except for items 13 and 14. Due to the number of pages, redlined corrections showing the title changes to Tables J2.3-4a through J2.3-4j and J2.3-5a through J2.3-5g are not attached. The errors listed above do not affect the remedy. As such, they do not require an Explanation of Significant Differences or other amendment. This memorandum will be added to the site file.

Attachment

EFH	Essential Fish Habitat
ENR	enhanced natural recovery
E.O.	Executive Order
eq	equivalent
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
ESA	Endangered Species Act
ESD	Explanation of Significant Differences
FEMA	Federal Emergency Management Agency
FFA	Fill, Fine-grained Facies of Flood Deposits, and Recent Alluvium
FMD	future maintenance dredge
F Mod	Alternative F (Modified)
FS	feasibility study
ft	feet
g/day	grams per day
HEA	Habitat Equivalency Analysis
HEC-RAS	Hydrologic Engineering Center River Analysis System
HI	hazard index
HQ	hazard quotient
HST	hydrodynamic and sediment transport
HxCDF	~~1,2,3,7,8,9~~ hexachlorodibenzofuran
IC	institutional control
ICIAP	Institutional Controls Implementation and Assurance Plan
ISA	initial study area
LDR	land disposal restriction
LOE	line of evidence
LWG	Lower Willamette Group
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MCPP	2-(4-chloro-2-methylphenoxy)propanoic acid
mg/kg-day	milligrams per kilogram per day
MGP	manufactured gas production
MNR	monitored natural recovery
MOU	memorandum of understanding
NAPL	non-aqueous-phase liquid
NCP	National Contingency Plan
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRWQC	National Recommended Water Quality Criteria
OAR	Oregon State Administrative Rules
ODFW	Oregon Department of Fish and Wildlife

OHA	Oregon Health Authority
OHSRA	Oregon Hazardous Substance Remedial Action
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
O&M	operation and maintenance
PAH	polycyclic aromatic hydrocarbon
PA/SI	preliminary assessment/site investigation
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxin
PCDD/F	polychlorinated dibenzo-p-dioxin/furan
PCDF	polychlorinated dibenzofuran
PCP	pentachlorophenol
PDBE	polybrominated diphenyl ether
PeCDD	pentachlorodibenzo-p-dioxin
PeCDF	pentachlorodibenzofuran
pg/L	pictogram per liter
ppm	parts per million
PRP	potentially responsible party
PTW	principal threat waste
RAL	remedial action level
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RHV	Relative Habitat Value
RI	remedial investigation
RI/FS	remedial investigation and feasibility study
RM	river mile
RME	reasonable maximum exposure
RNA	regulated navigation area
ROD	Record of Decision
RSL	regional screening level
SDU	sediment decision unit
SDWA	Safe Drinking Water Act
SF	slope factor
Site	Portland Harbor Superfund Site
SLERA	screening-level ecological risk assessment
SMA	sediment management area
SPCC	Spill Prevention, Containment and Countermeasure Plan
SQV	sediment quality value
SVOC	semivolatile organic compound
SWAC	surface area weighted average concentration
TAG	technical assistance grant
TBC	to be considered

shellfish, and mammals, and can cause adverse reproductive effects such as eggshell thinning in birds.

Principal Threat Waste

Principal threat waste (PTW) is defined as source material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air or that acts as a source for direct exposure. Further, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

PTW was identified based on a 10^{-3} cancer risk (highly toxic) or NAPL within the sediment bed (source material) and on an evaluation of mobility of contaminants in the sediment. “Reliably contained” was not used in identifying PTW but rather was used to determine how to address it through cleanup and whether there are concentrations of PTW that could be reliably contained. The following criteria were utilized to identify PTW:

- **Source Material:** NAPL has been identified in subsurface sediment offshore of the Arkema and Gasco facilities (RM 6 through RM 7.5) as globules or blebs of product in surface and subsurface sediment. However, areas of NAPL have not been fully delineated. Figure 8 in Appendix I identifies the general locations where NAPL was observed. NAPL observed offshore of the Arkema facility contained chlorobenzene with dissolved DDT. NAPL observed at the Gasco facility contained PAHs and other aromatic hydrocarbons.

- **Highly Toxic:** The following COCs were found at concentrations exceeding a 10^{-3} risk level at the Site based on consumption of fish, using the assumptions and methodology presented in the baseline human health risk assessment (BHHRA) summarized in Section 8.1 and on Table 6 in Appendix II:

  - PCBs
  - Carcinogenic PAHs (cPAHs)
  - DDx
  - 2,3,7,8-TCDD
  - 2,3,7,8-tetrachlorodibenzofuran (TCDF)
  - 1,2,3,7,8-pentachlorodibenzo-p-dioxin (PeCDD)
  - 2,3,4,7,8-pentachlorodibenzofuran (PeCDF)
  - 1,2,3,4~~,6~~,7,8-hexachlorodibenzofuran (HxCDF)

- **PTW That Cannot be Reliably Contained:** A capping model was utilized in the FS (Appendix D) to identify PTW that cannot be reliably contained by a cap. Representative Site conditions and capping options were modeled to determine the maximum concentration of COCs in PTW material that would not exceed ambient water quality criteria (AWQC) in the sediment cap pore water after a period of 100 years. This assumption was used in developing the remedial alternative cost estimates in the FS

Contaminants were detected in a majority of fish and invertebrate species sampled throughout the Site. Contaminant concentrations varied within and between different species, and concentrations in fish tissue were generally greater than in invertebrates. Concentrations of bioaccumulative compounds, such as PCBs and DDx, were often found at greater concentrations in organisms higher up the food chain and correlated with areas of elevated concentrations in sediment. Biota samples from within the Site exhibited greater concentrations for most contaminants than background biota samples that were collected from the upriver reaches and above Willamette Falls. Areas of elevated concentrations of some contaminants were found in resident species, reflecting high concentrations in nearby surface sediment and biological uptake by species with small home ranges.

Selected PCB and DDx results for resident fish species (smallmouth bass, brown bullhead, black crappie, and carp), adult Chinook salmon, and sturgeon are briefly summarized in Table 8 in Appendix II. These contaminants were selected because they commonly bioaccumulate and these species were evaluated in the BHHRA. Full results for all contaminants are included in RI Table 5.6-1.

6.6.6. River Banks

River banks are defined as the area from the top of bank down to the river. River bank data were collected under DEQ-led investigations. Contaminants detected in river bank material at levels that pose a risk to human health, the environment, or for recontamination to any implemented remedy, are summarized below by RM on the east and west sides of the river. Properties with known contaminated river banks are shown in Figure 9 in Appendix I and river bank contaminants are summarized on Table 5 in Appendix II).

East Side of Willamette River

RM 2: Evraz Oregon Steel Mill (Environmental Cleanup Site Information [ECSI] Site ID 141[5]) – Contaminants present in the river bank include PCBs and metals (arsenic, cadmium, chromium, copper, lead, manganese, and zinc).

RM 3.5: Premier Edible Oils (ECSI Site ID 2013) – Contaminants may include mercury, cobalt, antimony, barium, PAHs, zinc, copper, manganese, arsenic, carbazole, dibenzofuran, methylnaphthalene, petroleum hydrocarbons, BTEX, chlorinated solvents, and bis(2-ethylhexyl)phthalate.

Schnitzer Steel Industries (ECSI Site ID 2355) – Results of soil samples collected under the docks along the south shore of the International Slip indicate that contaminants are PCBs and dioxins.

RM 5.5: MarCom South (ECSI Site ID 2350) – Further investigation of the nature and extent of contamination in the bank was conducted in 2012. Contaminants are PAHs and metals (arsenic, cadmium, chromium, copper, zinc).

[5] Site ID number is from DEQ's ECSI database.

RM 7: Willamette Cove (ECSI Site ID 20662363) – River bank contaminants are PCBs, dioxins/furans, metals (lead, mercury, nickel, and copper), and PAHs.

RM 8.5: Swan Island Shipyard (ECSI Site ID 271) – Recent sampling results for indicate that contaminants include metals (arsenic, cadmium, chromium, copper, lead, mercury, and zinc), PAHs, PCBs, and tributyltin. Contaminants in river bank soils in OU5 include metals (arsenic, copper, lead, and zinc), PAHs, and PCBs.

US Navy Reserve (ECSI Site ID 5109) – Tank was removed from this property in 1993. DEQ identified this site as needing further investigation.

West Side of Willamette River

RM 4: Kinder Morgan Linnton Bulk Terminal (ECSI Site ID 1096) – Contaminants are petroleum constituents (benzene, toluene, ethylbenzene, xylenes, and PAHs) and metals (arsenic and lead).

RM 6: NW Natural/Gasco (ECSI Site ID 84) – Contamination associated with historical MGP waste are known to be located in the river bank. Contaminants include PAHs, gasolinerange hydrocarbons, diesel-range hydrocarbons, residual-range hydrocarbons, cyanide, and metals (zinc).

RM 6 to RM 7: Siltronic (ECSI Site ID 183) – Contamination associated with historical MGP waste is known to be present in the northern portion of the Siltronic river bank. River bank contaminants include PAHs, gasoline-range hydrocarbons, diesel-range hydrocarbons, residual-range hydrocarbon and cyanide and metals (zinc).

Burlington Northern Santa Fe Railway Company (BNSF) Railroad Bridge – Contamination associated with pesticide and herbicide releases from Rhone Poulenc and Arkema are known to be present in the river bank below and adjacent to the BNSF railroad bridge. River bank contaminants include dioxin/furans, metals (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, insecticides (DDD, DDE, DDT, aldrin, alpha-hexachlorocyclohexane, alpha-chlordane, beta-BHC, cis-nonachlor, delta-BHC, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, endrin ketone, gamma-BHC, gamma-chlordane heptachlor, heptachlor epoxide, hexachlorobutadiene, methoxychlor, mirex, oxychlordane, and transnonachlor), PCBs, semi-volatile organic compounds (SVOCs) (acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, benzoic acid, benzyl alcohol, BEHP, butylbenzylphthalate, chrysene, bibenzo(a,h)anthracene, dimethylphthalate, di-n-butylphthalate, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene and pyrene) (AMEC 2011).

RM 7 to RM 8: Arkema (ECSI Site ID 398) – River bank contaminants include DDT, dioxin/furans, PCBs, and metals (chromium and lead).

GS Roofing (ECSI Site ID 117) – River bank contaminants include total petroleum hydrocarbons and metals (arsenic, chromium, mercury, nickel, selenium).

RM 8: Hampton Lumber (ECSI Site ID 5761) and Glacier NW (ECSI Site ID 2378~~1239~~) – River bank contaminants include steel mill slag fill.

RM 9: Gunderson (ECSI Site ID 1155) – River bank contaminants include metals (lead, nickel, and zinc), and PCBs.

RM 10: Sulzer Bingham Pumps (ECSI Site ID 1235) – River bank contaminants include PCBs and metals (arsenic, copper, lead, manganese, and zinc).

6.6.7. RCRA Hazardous Waste in Media

RCRA characteristic hazardous waste criteria and disposal requirements are discussed in Section 3.4.9.1 in the FS (EPA 2016b) and in Sections 14 and 15 below. Based on current information, two areas of the Site have listed hazardous waste commingled in the sediment, either under RCRA hazardous waste listings or under Oregon's hazardous waste law, offshore of the Arkema and Siltronic/Gasco facilities.

6.7. Computer Models Used For Fate and Transport

6.7.1. Hydrodynamic and Sediment Transport Models

Numerical hydrodynamic and sediment transport (HST) models were conducted to complement the empirical observations and gain a further understanding of physical system dynamics. The models were used to predict the potential impact of extreme (flood) events on Site sediment stability, particularly the potential for buried contaminated sediments to be re-exposed, and to better understand the complex hydrodynamics (i.e., the movement of surface water) of the lower Willamette River system. The models were also used to predict the bed elevation changes (i.e., the areas and magnitude of erosion and deposition in the Site) that would result from five different high-flow scenarios. A range of high-flow simulations were run because bed response can be a function of long-term hydrographic conditions that exist leading up to a flood event. The development and results of the HST model are discussed in the RI report (EPA 2016a).

6.7.2. Mass Transfer Model

The RI also evaluated contaminant mass inputs from external sources and internal mass transfer mechanisms for a subset of contaminants within the Site on a Site-wide basis. Mass transfer models for these contaminants are presented on RI Figures 10.2-2, 10.2-5, 10.2-8, 10.2-11a, 10.2-14, 10.2-17, 10.2-20, 10.2-29, 10.2-32, 10.2-35, and 10.2-38. With all surface water, sediment, and sediment trap sample results taken together, there is evidence that contaminants from the Site are migrating downstream, especially from erosional areas, to either the Columbia River or Multnomah Channel and that the mass flux of contaminants exiting the downstream end of the Site in surface water is greater than the flux entering the Site.

External sources include upstream loading (via surface water and sediment bedload), "lateral" external loading such as stormwater runoff permitted discharges (point-source, non-stormwater),

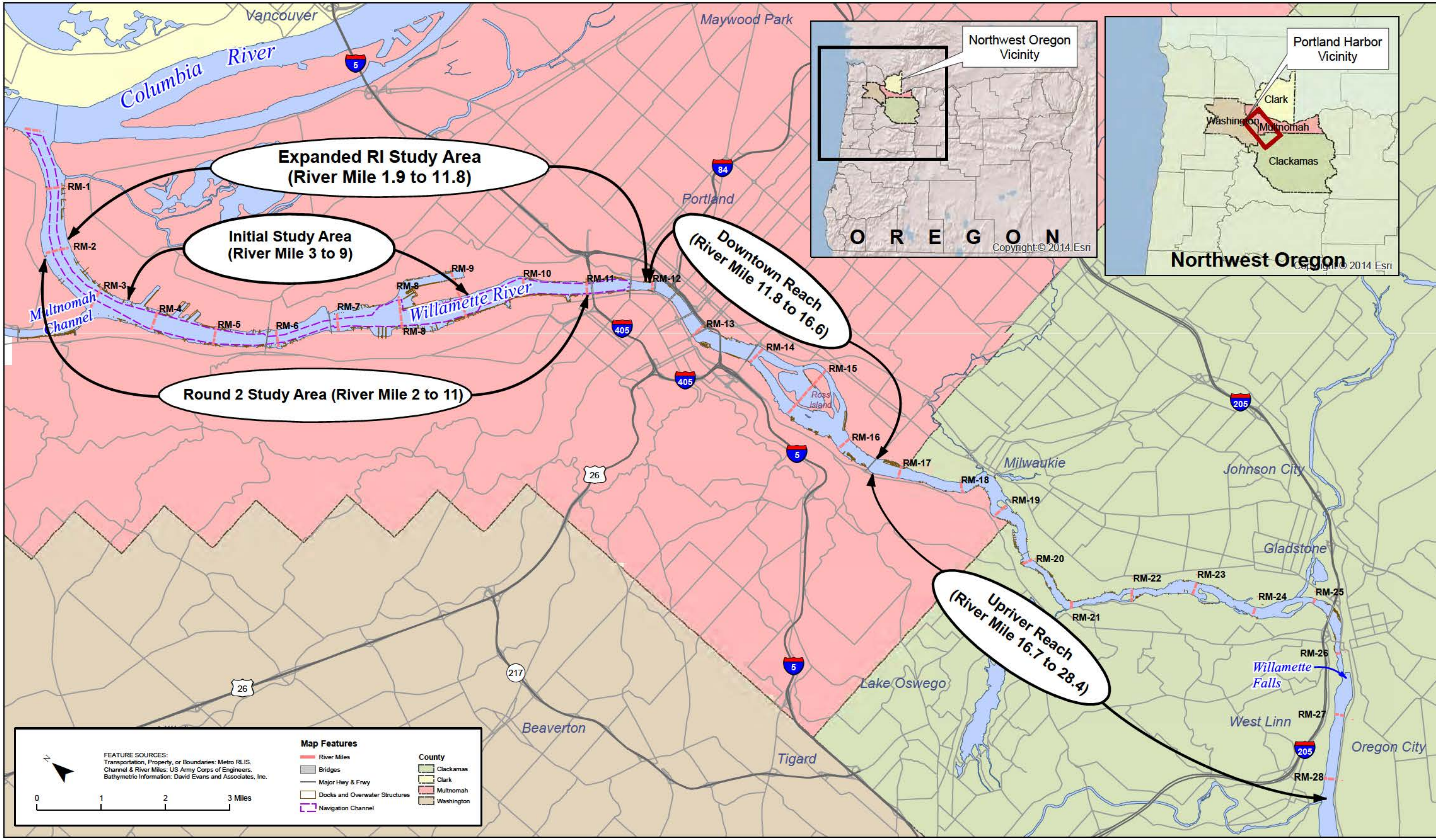

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Figure 7. Portland Harbor Study Area and Vicinity

Portland Harbor Superfund Site

Table 1. Summary of Contaminants of Concern in Sediment

Contaminant	Units	Surface				Subsurface			
		Frequency of Detection	Min-Max	Mean	Median	Frequency of Detection	Min-Max	Mean	Median
Aldrin	µg/kg	254/1081	0.00333 - 691	5	0.5	127/1102	0.11 - 1,340	24	0.85
Arsenic	mg/kg	1348/1473	0.7 - 132	5	3.7	1429/1492	0.5 - 51	4	3.6
BEHP	µg/kg	884/1438	7 - 440,000	1,061	150	595/1496	2.4 - 18,000	355	95
Cadmium	mg/kg	1332/1460	0.0156 - 10	0.41	0.25	1377/1469	0.011 - 44	0.42	0.27
Chlordanes	µg/kg	723/1103	0.063 - 669	6	1.2	607/1103	0.11 - 2300	21	2.1
Copper	mg/kg	1457/1461	6.19 - 2,830	58	38.7	1481/1481	9.42 - 3,290	56	36
DDD	µg/kg	982/1179	0.051 - 11,000	43	2.3	969/1298	0.087 - 690,000	2483	4.5
DDE	µg/kg	964/1176	0.052 - 2,240	16	15.97	846/1298	0.054 - 24,000	81	3.9
DDT	µg/kg	801/1165	0.0613 - 81,000	259	2.19	755/1275	0.069 - 3,500,000	5,201	3.5
DDx	µg/kg	1072/1179	0.13 - 85,000	267	8.3	1065/1294	0.18 - 3,600,000	4,756	14
Dieldrin	µg/kg	238/1121	0.00834 - 356	3	0.28	72/1134	0.038 - 100	4	0.43
gamma-BHC	µg/kg	198/1126	0.0031 - 430	4	1.2	114/1145	0.052 - 172	5	1.29
Hexachlorobenzene	µg/kg	7/50	0.28 - 3	1	0.66	210/1270	0.066 - 14,000	78	0.94
HxCDF	µg/kg	201/222	0.000043 - 66	0.347	0.00127	183/250	0.000014 - 41	0.374	0.0023
Lead	mg/kg	1469/1484	1.1 - 13,400	49	15.8	1528/1536	1.54 - 3330	47	20
Mercury	mg/kg	1331/1452	0.005 - 65	0.144	0.068	1316/1395	0.004 - 17	0.192	0.089
PAHs, total	µg/kg	1559/1580	6.3 - 7,300,000	26,006	1,200	1553/1620	3.3 - 53,000,000	234,036	1,400
cPAHs (BaP eq)	µg/kg	1533/1580	0.42 - 450,000	2,477	130	1485/1620	0.26 - 1,300,000	9,163	140
PeCDD	µg/kg	131/222	0.00002 - 0.021	0.001	0.000219	128/251	0.000018 - 0.058	0.002	0.00035
PeCDF	µg/kg	175/222	0.000026 - 9	0.058	0.000551	168/251	0.000024 - 11	0.125	0.00069
TCDD	µg/kg	46/222	0.00004 - 0.111	0.003	0.00035	74/251	0.000045 - 0.084	0.003	0.00048
TCDF	µg/kg	139/222	0.000058 - 14	0.11	0.00088	125/250	0.000095 - 15	0.207	0.00164

Table 1. Summary of Contaminants of Concern in Sediment

Contaminant	Units	Surface				Subsurface			
		Frequency of Detection	Min-Max	Mean	Median	Frequency of Detection	Min-Max	Mean	Median
PCBs (Aroclors)	µg/kg	725/984	6.2 - 6,000	162	40	744/1294	3.8 - 26,000	311	83
PCBs (congeners)	µg/kg	244/244	1.7 - 35,000	467	36	149/153	0.4 - 37,000	705	100
Tributyltin	µg/kg	321/342	0.45 - 47,000	480	22	213/397	0.32 - 90,000	1,469	29
Zinc	mg/kg	1490/1490	3.68 - 4,220	153	106	1521/1521	24 - 9,000	148	105

Focused contaminants of concern are shown in **bold.**

Abbreviations:
BEHP - bis(2-ethylhexyl)phthalate
BaP eq - benzo(a)pyrene equivalent
cPAH - carcinogenic polycyclic aromatic hydrocarbon
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethene
DDT - dichlorodiphenyltrichloroethane
DDx - DDD + DDE + DDT
HxCDF - 1,2,3,4,7,8,~~9~~-hexachlorodibenzofuran
max - maximum
mg/kg - milligram per kilogram
min - minimum
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PeCDD - 1,2,3,7,8-pentachlorodibenzo-p-dioxin
PeCDF - 2,3,4,7,8-pentachlorodibenzofuran
TCDD - 2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDF - 2,3,7,8-tetrachlorodibenzofurans
µg/kg - microgram per kilogram

Table 2. Summary of Contaminants of Concern in Surface Water

Contaminant	Units	Frequency of Detection	Minimum	Maximum	Mean	Median
Aldrin	µg/L	124/268	0.0000001	0.005	0.00004	0.000001
Arsenic	µg/L	295/346	0.18	0.75	0.39	0.39
BEHP	µg/L	37/226	0.004	64	4.09	1.00
Benzo(a)anthracene	µg/L	132/335	0.00003	0.27	0.006	0.0005
Benzo(a)pyrene	µg/L	107/335	0.00002	0.19	0.005	0.0005
Benzo(b)fluoranthene	µg/L	128/335	0.00002	0.13	0.004	0.0004
Benzo(k)fluoranthene	µg/L	13/179	0.0017	0.13	0.032	0.007
Chlordanes	µg/L	166/268	0.0000001	0.002	0.0001	0.00002
Chromium	µg/L	164/346	0.1	1.92	0.53	0.38
Copper	µg/L	344/346	0.37	3.68	1.02	0.87
DDD	µg/L	177/268	0.000001	0.003	0.0002	0.00004
DDE	µg/L	180/268	0.000003	0.001	0.00007	0.00004
DDT	µg/L	183/268	0.000001	0.02	0.0004	0.00003
DDx	µg/L	200/268	0.000008	0.02	0.0006	0.0001
Dioxin/Furan (TCDD eq)	µg/L	147/149	0.0000000003	0.0000009	0.00000006	0.00000002
Ethylbenzene	µg/L	8/23	0.55	11.4	3.09	1.65
Hexachlorobenzene	µg/L	165/353	0.000001	0.007	0.0001	0.00002
MCPP	µg/L	7/164	7.3	34	15	13
Naphthalene	µg/L	55/358	0.001	605	44	0.02
PAHs	µg/L	262/335	0.0001	7.4	0.07	0.01
PAHs (BaP eq)	µg/L	193/335	0.0000001	0.27	0.005	0.0002
PCBs	µg/L	735/876	0.000007	0.02	0.001	0.0002
Pentachlorophenol	µg/L	0/178	ND	ND	ND	ND
PeCDD	µg/L	65/149	0.000000002	0.0000005	0.00000002	0.00000001
PeCDF	µg/L	51/149	0.000000002	0.0000003	0.00000003	0.00000001
TCDD	µg/L	7/149	0.000000005	0.0000003	0.00000004	0.00000001
TCDD TEQ	µg/L	237/240	0.00000000004	0.0000009	0.00000004	0.000000006
Tributyltin	µg/L	11/167	0.001	0.004	0.002	0.001
Zinc	µg/L	208/346	0.9	58	3.68	2.74

Focused contaminants of concern are shown in **bold**.

Abbreviations:

BEHP - bis(2-ethylhexyl)phthalate

BaP eq - benzo(a)pyrene equivalent

cPAH - carcinogenic polycyclic aromatic hydrocarbon

DDD - dichlorodiphenyldichloroethane

Table 2. Summary of Contaminants of Concern in Surface Water

Abbreviations (continued)
DDE - dichlorodiphenyldichloroethene
DDT - dichlorodiphenyltrichloroethane
DDx - DDD + DDE + DDT
MCPP - 2-(4-chloro-2-methylphenoxy)propanoic acid
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PeCDD - 1,2,3,7,8-pentachlorodibenzo-p-dioxin
PeCDF - 2,3,4,7,8-pentachlorodibenzofuran
TCDD - 2,3,7,8-tetrachlorodibenzo-p-dioxin
TEQ - toxic equivalent concentration
µg/L - microgram per liter

Table 3. Summary of Contaminants of Concern in Pore Water and Transition Zone Water

Contaminant	Units	Frequency of Detection	Minimum	Maximum	Mean	Median
Acenaphthene	µg/L	160/170	0.0031	680	41	3.1
Anthracene	µg/L	129/170	0.0027	257	7.2	0.14
Arsenic	µg/L	202/237	0.30	77	12	8
Benzene	µg/L	166/316	0.14	8,200	537	4.6
Benzo(a)anthracene	µg/L	80/170	0.0035	147	5.6	0.14
Benzo(a)pyrene	µg/L	70/170	0.0025	144	7.1	0.14
Benzo(b)fluoranthene	µg/L	59/170	0.0042	126	7.3	0.21
Benzo(g,h,i)perylene	µg/L	69/170	0.0041	54	4.5	0.13
Benzo(k)fluoranthene	µg/L	50/170	0.004	30	2.6	0.25
Cadmium	µg/L	119/188	0.004	36	0.48	0.099
Chlorobenzene	µg/L	66/312	0.15	30,000	856	2.1
Chromium	µg/L	147/228	0.2	147	13	4.1
Chrysene	µg/L	82/170	0.0033	174	6.3	0.11
Copper	µg/L	88/210	0.03	182	19	8.3
Cyanide	mg/L	52/61	0.004	23	1.03	0.18
1,1-DCE	µg/L	38/312	0.18	283	29	3.2
cis-1,2-DCE	µg/L	109/275	0.12	574,000	7,185	8.5
2,4-Dichlorophenoxyacetic acid	µg/L	10/18	0.12	0.97	0.32	0.18
DDD	µg/L	18/31	0.029	2.5	0.64	0.18
DDE	µg/L	10/31	0.0039	0.24	0.09	0.07
DDT	µg/L	14/31	0.0075	3.2	0.79	0.75
DDx	µg/L	22/31	0.0075	5.7	1.1	0.17
Dibenzo(a,h)anthracene	µg/L	50/170	0.0024	11.7	0.89	0.07
Ethylbenzene	µg/L	116/316	0.09	905	104	5.3
Fluoranthene	µg/L	116/170	0.0055	407	16.1	0.87
Fluorene	µg/L	135/170	0.0075	304	15.3	1.90
Indeno(1,2,3-cd)pyrene	µg/L	68/170	0.0037	53	4.0	0.11
Lead	µg/L	116/237	0.01	166	13.8	4.7
Manganese	µg/L	279/279	23	66,200	4,503	2,710
2-Methylnaphthalene	µg/L	49/157	0.0078	1,260	138	0.94
Naphthalene	µg/L	183/369	0.048	19,700	2,342	15
PAHs	µg/L	165/170	0.0025	21,000	1,470	8.1
cPAHs (BaP eq)	µg/L	104/170	0.0000033	188	6.3	0.06
PCE	µg/L	23/312	0.14	12,000	596	1.7
Pentachlorophenol	µg/L	0/11	ND	ND	ND	ND
PeCDD	µg/L	0/6	ND	ND	ND	ND
PeCDF	µg/L	1/6	0.0000013	0.0000013	0.0000013	0.0000013
Perchlorate	µg/L	21/42	105	210,000	61,002	49,900
Phenanthrene	µg/L	125/170	0.012	1,510	50	3.1

Table 3. Summary of Contaminants of Concern in Pore Water and Transition Zone Water

Contaminant	Units	Frequency of Detection	Minimum	Maximum	Mean	Median
Pyrene	µg/L	121/170	0.012	409	17	0.87
Silvex	µg/L	4/18	0.76	22	7.0	2.6
TCDD	µg/L	0/6	ND	ND	ND	ND
TCE	µg/L	73/312	0.14	585,000	9,788	1.9
Toluene	µg/L	168/316	0.2	821	26	1.7
TPH-Diesel	µg/L	93/135	26	28,800	1,522	600
Vanadium	µg/L	9/24	11.6	379	91	40
Vinyl chloride	µg/L	130/312	0.06	28,900	421	2.5
Xylene	µg/L	144/316	0.11	1,430	86	2.6
Zinc	µg/L	144/237	0.95	983	64	17

Focused contaminants of concern are shown in **bold**.

Abbreviations:
BaP eq - benzo(a)pyrene equivalent
cPAH - carcinogenic polycyclic aromatic hydrocarbon
DCE - dichloroethene
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethene
DDT - dichlorodiphenyltrichloroethane
DDx - DDD + DDE + DDT
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PCE - tetrachloroethene
PeCDD - 1,2,3,7,8-pentachlorodibenzo-p-dioxin
PeCDF - 2,3,4,7,8-pentachlorodibenzofuran
TCDD - 2,3,7,8-tetrachlorodibenzo-p-dioxin
TPH - total petroleum hydrocarbon
µg/L - microgram per liter

Table 4. Summary of Contaminants of Concern in Fish Tissue

Contaminant	Units	Fillet						Whole Body			
		Frequency of Detection	Minimum	Maximum	Min - Max	Mean	Median	Frequency of Detection	Min - Max	Mean	Median
Aldrin	µg/kg	15/53	0.005	0.119	0.005 - 0.119	0.05335	0.0541	47/141	0.00532 - 0.163	2.19	0.5
Arsenic	mg/kg	53/53	0.02	0.538	0.02 - 0.538	0.156962264	0.16	141/141	0.034 - 1.06	0.254618897	0.22
BEHP	µg/kg	4/33	69	130	69 - 130	96.5	98	20/124	44 - 87,000	8487	220
Cadmium	mg/kg	21/53	0.001	0.009	0.001 - 0.009	0.002952381	0.002	116/141	0.002 - 0.108	0.015750889	0.0093
Chlordanes	µg/kg	40/53	0.915	11.8	0.915 - 11.8	3.787125	1.765	97/141	0.59 - 67	9.42	9.13
Copper	mg/kg	53/53	0.127	1.12	0.127 - 1.12	0.360792453	0.335	141/141	0.365 - 7.16	1.09	0.9525
DDE	µg/kg	53/53	4.98	253	4.98 - 253	38.89641509	15	134/141	7 - 657	93	75
DDx	µg/kg	53/53	6.41	494	6.4 - 494	64.51132075	26	141/141	12.7 - 3,060	166.1120567	99.6
Dieldrin	µg/kg	33/53	0.183	3.3	0.183 - 3.3	0.936909091	0.436	78/141	0.23 - 24	3.106544304	2.11
Hexachlorobenzene	µg/kg	32/53	0.24	140	0.240 - 140	5.5	0.49	68/141	0.62 - 8.1	2.15	1.8
1,2,3,4,7,8-HxCDF	µg/kg	30/32	0.000013	0.00588	0.000013 - 0.00588	0.00062	0.00008	98/102	0.000051 - 0.0771	0.00187	0.00029
Mercury	mg/kg	53/53	0.035	0.349	0.035 - 0.349	0.13	0.096	141/141	0.01014 - 0.494	0.065	0.047
cPAHs (BaP eq)	µg/kg	10/38	0.00799	3.38	0.00799 - 3.38	0.79	0.04	24/127	0.0020 - 1.64	0.36	0.11895
PBDEs	µg/kg	26/32	8.28	82.3	8.28 - 82.3	27.5	11.2	No whole body results			
PCBs	µg/kg	53/53	19.6	19700	19.6 - 19700	650.9283019	96.2	141/141	30 - 25,100	842	301
1,2,3,7,8-PeCDD	µg/kg	31/32	0.0000615	0.00186	0.0000615 - 0.00186	0.00043	0.00017	96/102	0.000091 - 0.0128	0.00093	0.00069
2,3,4,7,8-PeCDF	µg/kg	30/32	0.000079	0.0188	0.000079 - 0.0188	0.00111	0.00029	100/102	0.000169 - 0.108	0.00273	0.00077
Pentachlorophenol	µg/kg	0/33	NA	NA	ND	ND	ND	1/123	400	NA	NA
2,3,7,8-TCDD	µg/kg	32/32	0.000055	0.000877	0.000055 - 0.000877	0.00023	0.00011	92/102	0.000119 - 0.00172	0.00048	0.00042
2,3,7,8-TCDF	µg/kg	32/32	0.000055	0.0174	0.000055 - 0.0174	0.00023	0.00011	102/102	0.000312 - 0.123	0.00517	0.00197
Tributyltin	µg/kg	12/27	0.48	11	0.48 - 7	3.84	3.75	29/62	0.61 - 8.6	3.1	2.5

Focused contaminants of concern are shown in **bold**.

Abbreviations:
BEHP - bis(2-ethylhexyl)phthalate
BaP eq - benzo(a)pyrene equivalent
cPAH - carcinogenic polycyclic aromatic hydrocarbon
DDE - dichlorodiphenyldichloroethene
DDx - DDD + DDE + DDT
HxCDF - 1,2,3,4 7,8~~,9~~-hexachlorodibenzofuran
max - maximum
mg/kg - milligram per kilogram
min - minimum
PBDE - polybrominated diphenyl ether
PCB - polychlorinated biphenyl
PeCDD - pentachlorodibenzo-p-dioxin
PeCDF - pentachlorodibenzofuran
TCDD - 2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDF - tetrachlorodibenzofurans
µg/kg - microgram per kilogram

Table 6. Concentrations of PTW Defined as "Highly Toxic"

Contaminant	Highly Toxic PTW Threshold (µg/kg) (10^{-3} risk)
PCBs	200
2,3,7,8-TCDD	0.01
2,3,7,8-TCDF	0.6
1,2,3,7,8-PeCDD	0.01
2,3,4,7,8-PeCDF	0.2
1,2,3,4, ~~6,~~7,8-HxCDF	0.04
DDx	7,050
cPAHs (BaP eq)	106,000

Abbreviations:
cPAH (BaP eq) – carcinogenic PAHs (benzo(a)pyrene equivalent)
DDx – dichlorodiphenyldichloroethane + dichlorodiphenyldichloroethene + dichlorodiphenyltrichloroethane
HxCDF – hexachlorodibenzofuran
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PeCDD – pentachlorodibenzo-p-dioxin
PeCDF – pentachlorodibenzofuran
PTW – principal threat waste
TCDD – tetrachlorodibenzo-p-dioxin
TCDF – tetrachlorodibenzofuran
µg/kg – microgram per kilogram

Table 17. Summary of Cleanup Levels or Targets by Media

	Surface Water (1)			Groundwater (2)			River Bank Soil/Sediment (3)			Fish Tissue (4)		
Contaminant	**Unit**	**Conc.**	**Basis**	**Unit**	**Conc.**	**Basis**	**Unit**	**Conc.**	**Basis**	**Unit**	**Conc.**	**Basis**
Aldrin	µg/L	0.00000077	A				µg/kg	2	R	µg/kg	0.06	R
Arsenic	µg/L	0.018	A	µg/L	0.018	A	mg/kg	3	B	mg/kg	0.001	R
Benzene				µg/L	0.44	A						
BEHP	µg/L	0.2	A				µg/kg	135	R	µg/kg	72	R
Cadmium				µg/L	0.091	A/R(5)	mg/kg	0.51	R			
Chlordanes	µg/L	0.000081	A				µg/kg	1.4	R	µg/kg	3	R
Chlorobenzene				µg/L	64	R						
Chromium	µg/L	100	A	µg/L	11	A						
Copper	µg/L	2.74	A	µg/L	2.74	A/R	mg/kg	359	R			
Cyanide				µg/L	4	A						
DDx	µg/L	0.01	R	µg/L	0.001	A	µg/kg	6.1	R	µg/kg	3	R
DDD	µg/L	0.000031	A	µg/L	0.000031	A	µg/kg	114	R			
DDE	µg/L	0.000018	A	µg/L	0.000018	A	µg/kg	226	R			
DDT	µg/L	0.000022	A	µg/L	0.000022	A	µg/kg	246	R			
1,1-Dichloroethene				µg/L	7	A						
cis-1,2-Dichloroethene				µg/L	~~9.9~~ 70	A						
Dieldrin							µg/kg	0.07	R	µg/kg	0.06	R
2,4-Dichlorophenoxyacetic acid				µg/L	70	A						
Ethylbenzene	µg/L	7.3	R	µg/L	7.3	R						
Hexachlorobenzene	µg/L	0.000029	A							µg/kg	0.6	R
Lindane							µg/kg	5	R			
Lead				µg/L	0.54	A/R	mg/kg	196	R			
Manganese				µg/L	430	R						
MCPP	µg/L	16	R									
Mercury							mg/kg	0.085	R	mg/kg	0.031	A
Pentachlorophenol	µg/L	0.03	A	µg/L	0.03	A				µg/kg	2.5	R
Perchlorate				µg/L	15	A						
PBDEs										µg/kg	26	R
PCBs	µg/L	0.0000064	A	µg/L	0.014	A/R	µg/kg	9	B	µg/kg	0.25 (6)	R
PAHs							µg/kg	23000	R			
cPAHs (BaP eq)	µg/L	0.00012	A	µg/L	0.00012	A	µg/kg	12 (7)	B	µg/kg	7.1	R
Acenaphthene				µg/L	23	R						
Acenaphthylene												
Anthracene				µg/L	0.73	R						
Benzo(a)anthracene	µg/L	0.0012	A	µg/L	0.0012	A						
Benzo(a)pyrene	µg/L	0.00012	A	µg/L	0.00012	A						
Benzo(b)fluoranthene	µg/L	0.0012	A	µg/L	0.0012	A						
Benzo(g,h,i)perylene												
Benzo(k)fluoranthene	µg/L	0.0013	A	µg/L	0.0013	A						
Chrysene	µg/L	0.0013	A	µg/L	0.0013	A						
Dibenz(a,h)anthracene	µg/L	0.00012	A	µg/L	0.00012	A						
Fluoranthene												
Fluorene												
Indeno(1,2,3-c,d)pyrene	µg/L	0.0012	A	µg/L	0.0012	A						
2-Methylnaphthalene												
Naphthalene	µg/L	12	R									
Phenanthrene												
Pyrene												
Dioxins/Furans (2,3,7,8-TCDD eq)	µg/L	0.0000000005	A									
1,2,3,4,7,8-HxCDF							µg/kg	0.0004	B	µg/kg	0.00008	R
1,2,3,7,8-PeCDD							µg/kg	0.0002	B	µg/kg	0.000008	R
2,3,4,7,8-PeCDF							µg/kg	0.0003	B	µg/kg	0.00003	R
2,3,7,8-TCDF							µg/kg	0.00040658	R	µg/kg	0.00008	R
2,3,7,8-TCDD							µg/kg	0.0002	B	µg/kg	0.000008	R
Tetrachloroethene				µg/L	0.24	A						
Toluene				µg/L	9.8	R						
TPH-Diesel							mg/kg	91	R			
Aliphatic Hydrocarbons C10-C12 ~~TPH-Diesel (C10-12 Aliphatic)~~				µg/L	2.6	R						
Tributyltin	µg/L	0.063	A				µg/kg	3080	R			
Trichloroethene				µg/L	0.6	A						
2,4,5-TP (Silvex) ~~2,4,5-Trichlorophenol~~				µg/L	50	A						
Vanadium				µg/L	20	R						
Vinyl Chloride				µg/L	0.022	A						
Xylenes				µg/L	13	R						
Zinc	µg/L	36.5	R	µg/L	36.5	R	mg/kg	459	R			

Notes:

(1) Surface Water Cleanup Levels - RAOs 3 and 7

(2) Groundwater Cleanup Levels - RAOs 4 and 8

(3) Sediment Cleanup Levels - RAOs 1 and 5

(4) Fish Tissue Targets - RAOs 2 and 6

(5) A/R indicates that the ARARs-based number and the risk-based number are the same.

(6) The tissue target is a risk-based number and does not represent background levels. Additional data will be collected to determine background fish tissue concentrations for PCBs during design and construction of the Selected Remedy.

(7) The cleanup level for cPAHs of 12 µg/kg is based on direct contact with sediment and is applicable to nearshore sediment. The cleanup level applicable to sediments in the navigation channel is 3,950 µg/kg and is based on human consumption of clams.

Abbreviations:

2,4,5-TP (Silvex) - 2-(2,4,5-Trichlorophenoxy)propionic acid, also known as Silvex

ARAR - applicable or relevant and appropriate requirement

B - Background-based number

BEHP - bis(2-ethylhexyl)phthalate

BaP eq - benzo(a)pyrene equivalent

C - carbon

Table 17. Summary of Cleanup Levels or Targets by Media

Abbreviations (continued):
Conc - concentration
cPAH - carcinogenic polycyclic aromatic hydrocarbon
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethene
DDT - dichlorodiphenyltrichloroethane
DDx - DDD + DDE + DDT
HxCDF - ~~1,2,3,7,8,9~~ hexachlorodibenzofuran
MCPP - 2-(4-chloro-2-methylphenoxy)propanoic acid
mg/kg - milligram per kilogram
PAH - polycyclic aromatic hydrocarbon
PBDE - polybrominated diphenyl ether
PCB - polychlorinated biphenyl
PeCDD - pentachlorodibenzo-p-dioxin
PeCDF - pentachlorodibenzofuran
R - risk-based number
RAO - remedial action objective
TCDD - tetrachlorodibenzo-p-dioxin
TCDF - tetrachlorodibenzofurans
TPH - total petroleum hydrocarbons
µg/kg - microgram per kilogram
µg/L - microgram per liter

Table 21. Sediment RALs and PTW Thresholds for Selected Remedy

Contaminants	Site Wide RALs[1] (µg/kg)	PTW Thresholds [2] (µg/kg)	Navigation Channel RALs (µg/kg)
Focused COCs			
PCBs	75	200	1,000
Total PAHs ~~[4]~~	13,000	NA	170,000
2,3,7,8-TCDD	0.0006	0.01	0.002
1,2,3,7,8-PeCDD	0.0008	0.01	0.003
2,3,4,7,8-PeCDF	0.2	0.2	1
DDx	160	7,050	650
Additional Contaminants			
2,3,7,8-TCDF	NA	0.6	NA
1,2,3,4,~~6,~~7,8-HxCDF	NA	0.04	NA
cPAHs (BaP Eq)	NA	106,000	NA
Chlorobenzene	NA	>320	NA
Naphthalene	NA	>140,000	NA

Notes:
1 – Site wide includes all areas of the Site except the navigation channel. FMD areas are subject to these RALs.
2 – PTW thresholds are based on highly toxic PTW values (10^{-3} risk) except chlorobenzene and naphthalene, which are threshold values for not reliably contained PTW.

Abbreviations:
BaP Eq – benzo(a)pyrene equivalent
cPAH –carcinogenic polycyclic aromatic hydrocarbon
COC – Contaminant of concern
DDx – dichlorodiphenyldichloroethane + dichlorodiphenyldichloroethene + dichlorodiphenyltrichloroethane
FMD – future maintenance dredge
HxCDF - hexachlorodibenzofuran
NA – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PeCDD – pentachlorodibenzo-p-dioxin
PeCDF – pentachlorodibenzofuran
PTW – principal threat waste
RAL – remedial action level
TCDD – tetrachlorodibenzo-p-dioxin
TCDF – tetrachlorodibenzofuran
µg/kg – microgram per kilogram
> – greater than

Table 22. Detailed Comparative Analysis of Remedial Alternatives

Expected Outcomes at Construction Completion	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F Mod	Alternative F	Alternative G	Alternative I
Summary of Alternative	NO ACTION	Cap, dredge, in-situ treatment and enhanced natural recovery (ENR) of: 201 acres of sediments 9,633 lineal feet (lf) of river bank	Cap, dredge, in-situ treatment and ENR of: 267 acres of sediments 13,887 lf of river bank	Cap, dredge, and ENR of: 329 acres of sediment 18,231 lf of river bank	Cap, dredge, and ENR of: 394 acres of sediment 23,305 lf of river bank	Cap, dredge, and ENR of: 533 acres of sediments 23,305 lf of river bank	Cap, dredge, and ENR of: 776 acres of sediments 26,362 lf of river bank	Cap, dredging, and ENR of: 291 acres of sediments 19,472 lf of river bank
Overall Protectiveness								
Risk at Construction Completion (Interim Target [IT]) **Site Wide Human Health (HH):** **Remedial Action Objective (RAO) 1[1]: IT: $1x10^{-5}$** **RAO 2: IT for cancer risk: $1x10^{-4}$** **RAO 2: IT for non-cancer risk in child: Hazard Index (HI) = 10** **RAO 2: IT for non-cancer risk in infant: Hazard Index (HI) = 1,320** **RAO 3: IT: 10 times cleanup level** **RAO 4: IT: not calculated** **Site Wide Ecological (Eco):** **RAO 5[2]: IT: address 50 percent (%) of benthic risk area** **RAO 6: IT: Hazard Quotient (HQ) 10** **RAO 7: IT: not calculated** **RAO8: IT: not calculated** **Source Control** **RAO 9: IT: not calculated**	No risk reduction	May Not Be Protective Site Wide HH: RAO 1: $4.8x10^{-5}$ RAO 2: $2.3x10^{-4}$ RAO 2: (Child HI): 25 RAO 2: (Infant HI): 417 RAO 3: Does not achieve ITs RAO 4: 16% addressed Site Wide Eco: RAO 5[2]: 48% addressed RAO 6: Maximum HQ (BEHP) = 19 RAO 7: Not calculated RAO 8: 16% addressed RAO 9: 32% addressed	May Not Be Protective Site Wide HH: RAO 1: $2.2x10^{-5}$ RAO 2: $2.0x10^{-4}$ RAO 2: (Child HI): 21 RAO 2: (Infant HI): 358 RAO 3: Does not achieve ITs RAO 4: 23% addressed Site Wide Eco: RAO 5[2]: 64% addressed RAO 6: Maximum HQ (BEHP) = 17 RAO 7: Not calculated RAO 8: 23% addressed RAO 9: 46% addressed	Protective Site Wide HH: RAO 1: $1.5x10^{-5}$ RAO 2: $1.7x10^{-4}$ RAO 2: (Child HI): 18 RAO 2: (Infant HI): 305 RAO 3: Does not achieve ITs RAO 4: 32% addressed Site Wide Eco: RAO 5[2]: 73% addressed RAO 6: Maximum HQ (BEHP) = 15 RAO 7: Not calculated RAO 8: 32% addressed RAO 9: 61% addressed	Protective Site Wide HH: RAO 1: $1.0x10^{-5}$ RAO 2: $1.5x10^{-4}$ RAO 2: (Child HI): 15 RAO 2: (Infant HI): 259 RAO 3: Achieves ITs RAO 4: 39% addressed Site-Wide Eco: RAO 5[2]: 72% addressed RAO 6: Maximum HQ (BEHP) = 5 RAO 7: Not calculated RAO 8: 39% addressed RAO 9: 78% addressed	Protective Site Wide HH: RAO 1: $1.0x10^{-5}$ RAO 2: $1.2x10^{-4}$ RAO 2: (Child HI): 13 RAO 2: (Infant HI): 213 RAO 3: Achieves ITs RAO 4: 46% addressed Site Wide Eco: RAO 5[2]: 87% addressed RAO 6: Maximum HQ (BEHP) = 5 RAO 7: Not calculated RAO 8: 46% addressed RAO 9: 78% addressed	Protective Site Wide HH: RAO 1: $7.2x10^{-6}$ RAO 2: $8.9x10^{-5}$ RAO 2: (Child HI): 9 RAO 2: (Infant HI): 157 RAO 3: Achieves ITs RAO 4: 62% addressed Site Wide Eco: RAO 5[2]: 93% addressed RAO 6: Maximum HQ (BEHP) = 53 RAO 7: Not calculated RAO 8: 62% addressed RAO 9: 88% addressed	Protective Site Wide HH: RAO 1: $1.8x10^{-5}$ RAO 2: $1.7x10^{-4}$ RAO 2: (Child HI): 18 RAO 2: (Infant HI): 307 RAO 3: Does not achieve ITs RAO 4: 33% addressed Site Wide Eco: RAO 5[2]: 64% addressed RAO 6: Maximum HQ (BEHP) = 19 RAO 7: Not calculated RAO 8: 33% addressed RAO 9: 65% addressed
Allowable Fish Meals/Year (yr) at Construction Completion[3] (RAO 2)	Current allowance based on ~~Oregon Health Authority (OHA) advisories~~ human health risk assessment assumptions (4 fish meals/yr [$1 x 10^{-5}$]; 3 fish meals [child HI 71]; 0.2 fish meal [breastfeeding infant HI of 1,123])	10 fish meals/yr ($1 x 10^{-5}$ risk) 9 fish meals/yr (child) 0.5 fish meal/yr (breastfeeding infant)	11 fish meals/yr ($1 x 10^{-5}$ risk) 10 fish meals/yr (child) 0.6 fish meal/yr (breastfeeding infant)	13 fish meals/yr ($1 x 10^{-5}$ risk) 12 fish meals/yr (child) 0.7 fish meal/yr (breastfeeding infant)	16 fish meals/yr ($1 x 10^{-5}$ risk) 14 fish meals/yr (child) 1 fish meal/yr (breastfeeding infant)	19 fish meals/yr ($1 x 10^{-5}$ risk) 18 fish meals/yr (child) 1 fish meal/yr (breastfeeding infant)	26 fish meals/yr ($1 x 10^{-5}$ risk) 24 fish meals/yr (child) 2 fish meal/yr (breastfeeding infant)	13 fish meals/yr ($1 x 10^{-5}$ risk) 12 fish meals/yr (child) 0.7 fish meal/yr (breastfeeding infant)
Direct Contact Surface Water (RAO 3) (IT: 10 times cleanup level)	Exceedances of surface water cleanup levels continue	ITs are not achieved for polychlorinated biphenyls (PCBs) and tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalent concentration (TEQ)	ITs are not achieved for PCBs and TCDD TEQ	ITs are not achieved for PCBs	ITs achieved	ITs achieved	ITs achieved	ITs are not achieved for PCBs
Groundwater Plumes Addressed (%) (RAO 4)	0% - continued migration to sediment and surface water	16% addressed	23% addressed	32% addressed	39% addressed	46% addressed	62% addressed	33% addressed

Table 22. Detailed Comparative Analysis of Remedial Alternatives

Expected Outcomes at Construction Completion	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F Mod	Alternative F	Alternative G	Alternative I
Summary of Alternative	NO ACTION	Cap, dredge, in-situ treatment and enhanced natural recovery (ENR) of: 201 acres of sediments 9,633 lineal feet (lf) of river bank	Cap, dredge, in-situ treatment and ENR of: 267 acres of sediments 13,887 lf of river bank	Cap, dredge, and ENR of: 329 acres of sediment 18,231 lf of river bank	Cap, dredge, and ENR of: 394 acres of sediment 23,305 lf of river bank	Cap, dredge, and ENR of: 533 acres of sediments 23,305 lf of river bank	Cap, dredge, and ENR of: 776 acres of sediments 26,362 lf of river bank	Cap, dredging, and ENR of: 291 acres of sediments 19,472 lf of river bank
River Banks Addressed (%) (RAO 9)	0% - continued migration from river banks to sediment/ surface water.	32% of river banks addressed	46% of river banks addressed	61% river banks addressed	78% river banks addressed	78% river banks addressed	88% river banks addressed	65% river banks addressed
Benthic Areas Addressed (%) (RAO 5)[2] (IT: 50 % addressed)	0% - No reduction in benthic risk	48% of benthic areas addressed	64% of benthic areas addressed	73% of benthic areas addressed	72% of benthic areas addressed	87% of benthic areas addressed	93% of benthic areas addressed	64% of benthic areas addressed
Consumption of Prey (RAO 6) (IT: Eco HQ=10)	No reduction in HQ.	Does not achieve IT River mile (RM) scale: Maximum HQ = 19 (BEHP) Sediment decision unit (SDU) scale: Maximum HQ=7 (BEHP)	Does not achieve IT RM scale: Maximum HQ = 17 (BEHP) SDU scale: Maximum HQ=5 (BEHP)	Does not achieve IT RM scale: Maximum HQ = 15 (BEHP) SDU scale: Maximum HQ=4 (BEHP)	Achieves IT for RM and SDU scale RM Scale: Maximum HQ = 5 (BEHP) SDU Scale: Maximum HQ = 3 (BEHP)	Achieves IT for RM and SDU scale RM Scale: Maximum HQ = 5 (BEHP) SDU Scale: Maximum HQ = 3 (BEHP)	Achieves IT for RM and SDU scale RM Scale: Maximum HQ = 3 (BEHP) SDU Scale: Maximum HQ = 1 (BEHP)	Does not achieve IT RM scale: Maximum HQ = 19 (BEHP) SDU scale: Maximum HQ=3 (BEHP)
Direct Contact Surface Water (RAO 7)	Exceedances of surface water cleanup levels would continue.	Not quantifiable. Time to achieve cleanup levels through monitored natural recovery (MNR) uncertain.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.
COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)								
Chemical-specific ARARs	Would not meet water quality criteria (WQCs) and maximum contaminant levels (MCLs).	Would not be achieved	Complies	Complies	Complies	Complies	Complies	Complies
Location-specific ARARs	No location-specific ARARs	Complies. Addressed during design and implementation	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.
Action-specific ARARs	No action-specific ARARs	Complies. Addressed during design and implementation. 15 acres of mitigation	Same as Alternative B. 25 acres of mitigation	Same as Alternative B. 35 acres of mitigation	Same as Alternative B. 60 acres of mitigation	Same as Alternative B. 60 acres of mitigation	Same as Alternative B. 86 acres of mitigation	Same as Alternative B. 34 acres of mitigation
LONG-TERM EFFECTIVENESS AND PERMANENCE								

Table 22. Detailed Comparative Analysis of Remedial Alternatives

Expected Outcomes at Construction Completion	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F Mod	Alternative F	Alternative G	Alternative I
Summary of Alternative	NO ACTION	Cap, dredge, in-situ treatment and enhanced natural recovery (ENR) of: 201 acres of sediments 9,633 lineal feet (lf) of river bank	Cap, dredge, in-situ treatment and ENR of: 267 acres of sediments 13,887 lf of river bank	Cap, dredge, and ENR of: 329 acres of sediment 18,231 lf of river bank	Cap, dredge, and ENR of: 394 acres of sediment 23,305 lf of river bank	Cap, dredge, and ENR of: 533 acres of sediments 23,305 lf of river bank	Cap, dredge, and ENR of: 776 acres of sediments 26,362 lf of river bank	Cap, dredging, and ENR of: 291 acres of sediments 19,472 lf of river bank
Magnitude of Residual Risk (Post Construction [PC] Risk) **RAO 1**	Existing risk remains. Ability for natural recovery unlikely since in-river sources remain.	Sediment: Post Construction risk: 4.8×10^{-5}	Sediment: Post Construction risk: 2.2×10^{-5}	Sediment: Post Construction risk: 1.5×10^{-5}	Sediment: Post Construction risk: 1.0×10^{-5}	Sediment: Post Construction risk: 1.0×10^{-5}	Sediment: Post Construction risk: 7.2×10^{-6}	Sediment: Post Construction risk: 1.8×10^{-5}
RAO 2 (Allowable Fish Meals at Construction Completion)	Existing risk remains. Ability for natural recovery unlikely since in-river sources remain. ~~OHA f~~Fish advisories would continue.	(see fish meal information under Overall Protectiveness)						
RAO 3 - Direct Contact Surface Water (Risk at Construction Completion vs. Risk at Cleanup Level for each Contaminant of Concern [COC])	Existing risk remains. Ability for natural recovery unlikely since in-river sources remain.	PCBs – 16 times > cleanup levels TCDD TEQ – 13 times > cleanup level Carcinogenic polycyclic aromatic hydrocarbon (cPAH) – 2 times cleanup level	PCBs – 13 times > cleanup levels TCDD TEQ – 11 times > cleanup levels	PCBs – 12 times > cleanup levels TCDD TEQ – 8 times > cleanup levels	PCBs – 10 times > cleanup levels TCDD TEQ – 7 times > cleanup levels	PCBs – 8 times > cleanup levels TCDD TEQ – 7 times > cleanup levels	PCBs – 6 times > cleanup levels TCDD TEQ – 5 times > cleanup levels	PCBs – 12 times > cleanup levels TCDD TEQ – 9 times > cleanup level cPAH – 2 times cleanup level
RAO 4 Migration Groundwater to Sediment/Surface Water (Contaminated Groundwater Plumes not Addressed)	Existing risk remains. Ability for natural recovery unlikely since in-river sources remain.	84% not addressed. The magnitude residual risk is uncertain because it is likely that not all contaminated pore water will be addressed.	77% not addressed. Same as Alternative B	68% not addressed. Same as Alternative B	61% not addressed Same as Alternative B	54% not addressed. Same as Alternative B	38% not addressed. Same as Alternative B	67% not addressed. Same as Alternative B
RAO 5[2] Benthic Organisms (Benthic Areas not Addressed)	Existing risk remains. Ability for natural recovery unlikely since in-river sources remain.	52% not addressed. Degree of recovery is uncertain because it is likely that an insufficient amount of the benthic risk areas will be addressed.	36% not addressed. Same as Alternative B	27% not addressed. Same as Alternative B	28 % not addressed Same as Alternative B	13% not addressed. Same as Alternative B	7% not addressed. Same as Alternative B	36% not addressed. Same as Alternative B

Table 22. Detailed Comparative Analysis of Remedial Alternatives

Expected Outcomes at Construction Completion	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F Mod	Alternative F	Alternative G	Alternative I
Summary of Alternative	NO ACTION	Cap, dredge, in-situ treatment and enhanced natural recovery (ENR) of: 201 acres of sediments 9,633 lineal feet (lf) of river bank	Cap, dredge, in-situ treatment and ENR of: 267 acres of sediments 13,887 lf of river bank	Cap, dredge, and ENR of: 329 acres of sediment 18,231 lf of river bank	Cap, dredge, and ENR of: 394 acres of sediment 23,305 lf of river bank	Cap, dredge, and ENR of: 533 acres of sediments 23,305 lf of river bank	Cap, dredge, and ENR of: 776 acres of sediments 26,362 lf of river bank	Cap, dredging, and ENR of: 291 acres of sediments 19,472 lf of river bank
RAO 6 **Consumption of Prey**	Existing risk remains. Ability for natural recovery unlikely since in-river sources remain.	Maximum HQ is greater than 1 for the following COCs: RM scale: BEHP – 19 times PCBs – 5 times TCDF – 6 times PeCDF – 4 times HxCDF – 3 times SDU scale: BEHP – 7 times PCBs – 4 times TCDF – 3 times PeCDF – 2 times HxCDF – 2 times	Maximum HQ is greater than 1 for the following COCs: RM scale: BEHP – 17 times PCBs – 3 times TCDF – 4 times PeCDF – 3 times HxCDF – 2 times SDU scale: BEHP – 5 times PCBs – 2 times TCDF – 3 times PeCDF– 2 times	Maximum HQ is greater than 1 for the following COCs: RM scale: BEHP – 15 times PCBs – 2 times TCDF – 1.4 times SDU scale: BEHP – 4 times	Maximum HQ is greater than 1 for the following COCs: RM scale: BEHP – 5 times SDU scale: BEHP – 3 times	Maximum HQ is greater than 1 for the following COCs: RM scale: BEHP – 5 times SDU scale: BEHP – 3 times	Maximum HQ is greater than 1 for the following COCs: RM scale: BEHP – 3 times	Maximum HQ is greater than 1 for the following COCs: RM scale: BEHP – 19 times PCBs – 2 times SDU scale: BEHP – 4 times
RAO 7 **Direct Contact Surface Water**	Existing risk remains. Ability for natural recovery unlikely since in-river sources remain.	Not quantifiable. Time to achieve protectiveness through MNR uncertain.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.
RAO 8 **Migration Groundwater to Sediment/Surface Water** **(Groundwater Plumes not Addressed)**	Existing risk remains. Ability for natural recovery unlikely since in-river sources remain.	84% not addressed The magnitude residual risk is uncertain because it is likely that not all contaminated pore water will be addressed.	77% not addressed Same as Alternative B	68% not addressed Same as Alternative B	61% not addressed Same as Alternative B	54% not addressed Same as Alternative B	38% not addressed Same as Alternative B	67% not addressed Same as alternative B
RAO 9 **Migration River Banks** **(Contaminated River Banks not Addressed)**	Existing risk remains.	68% not addressed The magnitude residual risk is uncertain because it is likely that not all contaminated river banks will be addressed with this alternative.	54% not addressed Same as Alternative B	39% not addressed Same as Alternative B	22% not addressed Same as Alternative B	22% not addressed Same as Alternative B	12% not addressed Same as Alternative B	35% not addressed Same as Alternative B

Table 22. Detailed Comparative Analysis of Remedial Alternatives

Expected Outcomes at Construction Completion	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F Mod	Alternative F	Alternative G	Alternative I
Summary of Alternative	NO ACTION	Cap, dredge, in-situ treatment and enhanced natural recovery (ENR) of: 201 acres of sediments 9,633 lineal feet (lf) of river bank	Cap, dredge, in-situ treatment and ENR of: 267 acres of sediments 13,887 lf of river bank	Cap, dredge, and ENR of: 329 acres of sediment 18,231 lf of river bank	Cap, dredge, and ENR of: 394 acres of sediment 23,305 lf of river bank	Cap, dredge, and ENR of: 533 acres of sediments 23,305 lf of river bank	Cap, dredge, and ENR of: 776 acres of sediments 26,362 lf of river bank	Cap, dredging, and ENR of: 291 acres of sediments 19,472 lf of river bank
Adequacy and Reliability of Controls	No engineering controls ~~OHA f~~Fish advisories may not prevent human exposure.	Technologies are proven and reliable Operation and maintenance (O&M) of caps Long-term monitoring Periodic inspections and sampling of media and fish Institutional Controls (ICs): - Fish advisories - Land-use restrictions - regulated navigation areas (RNAs) to protect caps RNA Areas Capped: 28.3 acres MNR Area: 1,966 acres	Technologies are proven and reliable O&M of caps Long-term monitoring Periodic inspections and sampling of media and fish ICs: Same as Alternative B RNA Areas Capped: 55.8 acres MNR Area: 1,900 acres	Technologies are proven and reliable O&M of caps Long-term monitoring Periodic inspections and sampling of media and fish ICs: Same as Alternative B RNA Areas Capped: 81.0 acres MNR Area: 1,838 acres	Technologies are proven and reliable O&M of caps Long-term monitoring Periodic inspections and sampling of media and fish ICs: Same as Alternative B RNA Areas Capped: 150.2 acres MNR Area: 1,774 acres	Technologies are proven and reliable O&M of caps Long-term monitoring Periodic inspections and sampling of media and fish ICs: Same as Alternative B RNA Areas Capped: 150.2 acres MNR Area: 1,634 acres	Technologies are proven and reliable O&M of caps Long-term monitoring Periodic inspections and sampling of media and fish ICs: Same as Alternative B RNA Areas Capped: 231.4 acres MNR Area: 1,391 acres	Technologies are proven and reliable O&M of caps Long-term monitoring Periodic inspections and sampling of media and fish ICs: Same as Alternative B RNA Areas Capped: 81.0 acres MNR Area: 1,876 acres
REDUCTION OF TOXICITY, MOBILITY OR VOLUME THROUGH TREATMENT								
Treatment Process Used	None	Activated carbon Organophilic clay Solidification/stabilization Thermal desorption	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.
Amount Destroyed or Treated *In-situ treatment includes areas within and outside of sediment management areas (SMAs).	None	In-situ treatment*: 70 acres Ex-situ treatment: 191,573 cubic yards (cy)	In-situ treatment*: 108 acres Ex-situ treatment: 191,573 cy	In-situ treatment*: 109 acres Ex-situ treatment: 191,573 cy	In-situ treatment*: 133 acres Ex-situ treatment: 191,573 cy	In-situ treatment*: 145 acres Ex-situ treatment: 191,573 cy	In-situ treatment*: 184 acres Ex-situ treatment: 191,573 cy	In-situ treatment*: 113 acres Ex-situ treatment: 191,573 cy
Reduction in Toxicity, Mobility, or Volume	None	• Broadcast activated carbon (AC): 6.7 acres • Reactive Caps: 23 acres • Reactive residual layer: 36 acres • Significantly augmented reactive cap: 3.8 acres	• Broadcast AC: 3.2 acres • Reactive Caps: 40 acres • Reactive residual layer: 61 acres • Significantly augmented reactive cap: 3.8 acres	• Broadcast AC: 0 acres • Reactive Caps: 60 acres • Reactive residual layer: 45 acres • Significantly augmented reactive cap: 3.8 acres	• Broadcast AC: 0 acres • Reactive Caps: 83 acres • Reactive residual layer: 46 acres • Significantly augmented reactive cap: 3.8 acres	• Broadcast AC: 0 acres • Reactive Caps: 83 acres • Reactive residual layer: 58 acres • Significantly augmented reactive cap: 3.8 acres	• Broadcast AC: 0 acres • Reactive caps: 101 acres • Reactive residual layer: 80 acres • Significantly augmented reactive cap: 3.8 acres	• Broadcast AC: 0 acres • Reactive Caps: 64 acres • Reactive residual layer: 46 acres • Significantly augmented reactive cap: 3.8 acres

Table 22. Detailed Comparative Analysis of Remedial Alternatives

Expected Outcomes at Construction Completion	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F Mod	Alternative F	Alternative G	Alternative I
Summary of Alternative	NO ACTION	Cap, dredge, in-situ treatment and enhanced natural recovery (ENR) of: 201 acres of sediments 9,633 lineal feet (lf) of river bank	Cap, dredge, in-situ treatment and ENR of: 267 acres of sediments 13,887 lf of river bank	Cap, dredge, and ENR of: 329 acres of sediment 18,231 lf of river bank	Cap, dredge, and ENR of: 394 acres of sediment 23,305 lf of river bank	Cap, dredge, and ENR of: 533 acres of sediments 23,305 lf of river bank	Cap, dredge, and ENR of: 776 acres of sediments 26,362 lf of river bank	Cap, dredging, and ENR of: 291 acres of sediments 19,472 lf of river bank
Irreversible Treatment	None	Permanent and Irreversible Treatment Activated carbon Low-temperature thermal desorption Solidification/stabilization forms stable solids that are non-hazardous or less-hazardous than the original materials	Same as Alternative B	Same as Alternative B	Same as Alternative B	Same as Alternative B	Same as Alternative B	Same as Alternative B
Type and Quantity of Residuals Remaining after Treatment	Contaminated sediment and soil remains.	Principal threat waste (PTW) addressed: 37 % PTW remaining: 63%	PTW addressed: 57 % PTW remaining: 43 %	PTW addressed: 100% PTW remaining: 0%	PTW addressed: 100% PTW remaining: 0%	PTW addressed: 100% PTW remaining: 0%	PTW addressed: 100% PTW remaining: 0%	PTW addressed: 100% PTW remaining: 0%
SHORT-TERM EFFECTIVENESS								
Community Protection	Continued risks to community from no action. ~~OHA f~~Fish advisories would continue.	Community Impacts: 4 months per year for 4 years. • Temporary noise, light, odors, air quality impacts. • Disruptions to river use • potential for waterborne accidents during construction Addressed with health and safety (H&S) plans and use of best management practices (BMPs). Fish consumption advisories would continue until RAO achieved.	Community Impacts: 4 months per year for 6 years. Same as Alternative B	Community Impacts: 4 months per year for 7 years. Same as Alternative B	Community Impacts: 4 month per year for 13 years. Same as Alternative B	Community Impacts: 4 months per year for 13 years. Same as Alternative B	Community Impacts: 4 months per year for 19 years. Same as Alternative B	Community Impacts for 4 months per year for 7 years. Same as Alternative E

Table 22. Detailed Comparative Analysis of Remedial Alternatives

Expected Outcomes at Construction Completion	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F Mod	Alternative F	Alternative G	Alternative I
Summary of Alternative	NO ACTION	Cap, dredge, in-situ treatment and enhanced natural recovery (ENR) of: 201 acres of sediments 9,633 lineal feet (lf) of river bank	Cap, dredge, in-situ treatment and ENR of: 267 acres of sediments 13,887 lf of river bank	Cap, dredge, and ENR of: 329 acres of sediment 18,231 lf of river bank	Cap, dredge, and ENR of: 394 acres of sediment 23,305 lf of river bank	Cap, dredge, and ENR of: 533 acres of sediments 23,305 lf of river bank	Cap, dredge, and ENR of: 776 acres of sediments 26,362 lf of river bank	Cap, dredging, and ENR of: 291 acres of sediments 19,472 lf of river bank
Worker Protection	No risk to workers	Risks to workers for 4-5 months per year for 4 years. • Physical hazards during construction. • Increased accident risks from heavy equipment, transport of materials, and increased vessel traffic. Addressed with H&S Plans and BMPs.	Risks to worker for 4-5 months per year for 6 years. Same as Alternative B	Risks to workers for 4-5 months per year for 7 years. Same as Alternative B	Risks to workers for 4-5 months per year for 13 years. Same as Alternative B	Risks to workers for 4-5 months per year for 13 years. Same as Alternative B	Risks to workers for 4-5 months per year for 19 years. Same as Alternative B	Same as Alternative E.
Environmental Impacts (Impacts of Construction Activities)	Continued impact from existing conditions.	Impact time frame: 4 months per year for 4 years. • Temporary loss of benthos and habitat, increased emissions from construction and transportation equipment. • Exposure to contamination greater than PRGs during MNR period Addressed with BMPs, engineering control measures, emissions control strategies.	Impact time frame: 4 months per year for 6 years. Same as Alternative B	Impact time frame: 4 months per year for 7 years. Same as Alternative B	Impact time frame: 4 months per year for 13 years. Same as Alternative B	Impact time frame: 4 months per year for 13 years. Same as Alternative B	Impact time frame: 4 months per year for 19 years. Same as Alternative B	Same as Alternative E.
Time Until Action is Complete	Not applicable.	Construction time: 4 years Estimated time to achieve RAOs is uncertain, but unlikely to occur in a reasonable timeframe.	Construction time: 6 years Same as Alternative B	Construction time: 7 years Same as Alternative B	Construction time: 13 years Same as Alternative B	Construction time: 13 years Same as Alternative B	Construction time: 19 years Same as Alternative B	Construction time: 7 years Same as Alternative B
IMPLEMENTABILITY								

Table 22. Detailed Comparative Analysis of Remedial Alternatives

Expected Outcomes at Construction Completion	Alternative A	Alternative B	Alternative D	Alternative E	Alternative F Mod	Alternative F	Alternative G	Alternative I
Summary of Alternative	NO ACTION	Cap, dredge, in-situ treatment and enhanced natural recovery (ENR) of: 201 acres of sediments 9,633 lineal feet (lf) of river bank	Cap, dredge, in-situ treatment and ENR of: 267 acres of sediments 13,887 lf of river bank	Cap, dredge, and ENR of: 329 acres of sediment 18,231 lf of river bank	Cap, dredge, and ENR of: 394 acres of sediment 23,305 lf of river bank	Cap, dredge, and ENR of: 533 acres of sediments 23,305 lf of river bank	Cap, dredge, and ENR of: 776 acres of sediments 26,362 lf of river bank	Cap, dredging, and ENR of: 291 acres of sediments 19,472 lf of river bank
Ability to Construct and Operate	No construction or operation	Technologies successfully implemented at other Superfund sites. Material handling: 627,652 cy of sediment/soil 495,931 cy of fill	Same as Alternative B, except: Material handling: 1,181,238 cy of sediment/soil 727,154 cy of fill	Same as Alternative B, except: Material handling: 2,024,222 cy of sediment/soil 957,630 cy of fill	Same as Alternative B, except: Material handling: 3,017,189 cy of sediment/soil 1,339,587 cy of fill	Same as Alternative B, except: Material handling: 4,585,401 cy of sediment/soil 1,565,247 cy of fill	Same as Alternative B, except: Material handling: 7,396,598 cy of sediment/soil 2,257,357 cy of fill	Same as Alternative B, except: Material handling: 1,752,374 cy of sediment/soil 900,271 cy of fill,000 cy of fill
Ease of Doing More Action, if Needed	May require ROD amendment in the future.	Easy	Easy	Easy	Easy	Easy	Easy	Easy
Ability to Monitor Effectiveness	No monitoring required. Ongoing exposure and risks would continue	Monitoring of: RNAs: 28 acres of caps Capped areas (includes river banks): 39 acres MNR: 1,966 acres ICs: Fish Advisories COCs: fish tissue, surface water, pore water, sediment	Monitoring of: RNAs: 56 acres of caps Capped areas (includes river banks): 71 acres MNR: 1,900 acres ICs: Fish Advisories COCs: fish tissue, surface water, pore water, sediment	Monitoring of: RNAs: 81 acres of caps Capped areas (includes river banks): 101 acres MNR: 1,838 acres ICs: Fish Advisories COCs: fish tissue, surface water, pore water, sediment	Monitoring of: RNAs: 150 acres of caps Capped areas (includes river banks): 176 acres MNR: 1,774 acres ICs: Fish Advisories COCs: fish tissue, surface water, pore water, sediment	Monitoring of: RNAs: 150 acres of caps Capped areas (includes river banks): 176 acres MNR: 1,634 acres ICs: Fish Advisories COCs: fish tissue, surface water, pore water, sediment	Monitoring of: RNAs: 231 acres of caps Capped areas (includes river banks): 260 acres MNR: 1,391 acres ICs: Fish Advisories COCs: fish tissue, surface water, pore water, sediment	Monitoring of: RNAs: 81 acres of caps Capped areas (includes river banks): 102 acres MNR: 1,876 acres ICs: Fish Advisories COCs: fish tissue, surface water, pore water, sediment
Ability to Obtain Approvals and Coordinate with Other Agencies	No approvals necessary.	Approvals and coordination with other agencies possible. Waste left in 2,088 acres of the Site.	Approvals and coordination with other agencies possible. Waste left in 2,032 acres of the Site.	Approvals and coordination with other agencies possible. Waste left in 1,964 acres of the Site.	Approvals and coordination with other agencies possible. Waste left in 1,920 acres of the Site.	Approvals and coordination with other agencies possible. Waste left in 1,780 acres of the Site.	Approvals and coordination with other agencies possible. Waste left in 1,596 acres of the Site.	Approvals and coordination with other agencies possible. Waste left in 2,000 acres of the Site.
COST								
Capital Cost	$0	$352,097,000	$556,004,000	$827,465,000	$1,184,607,000	$1,629,407,000	$2,500,545,000	$751,359,000
Periodic Cost	$0	$290,324,000	$397,028,000	$412,332,000	$524,028,000	$549,512,000	$708,114,000	$421,940,000
Present Value Cost	$0	$451,460,000	$653,700,000	$869,530,000	$1,054,200,000	$1,371,170,000	$1,777,320,000	$811,290,000

Table 22. Detailed Comparative Analysis of Remedial Alternatives

Acronyms:

AC – activated carbon	ARAR – applicable or relevant and appropriate	BEHP – bis(2-ethyl-hexyl)phthalate	BMP – best management practice
COC – contaminant of concern	cPAH – carcinogenic polycyclic aromatic hydrocarbon	cy – cubic yard	DDD – Dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethane	DDT – dichlorodiphenyltrichloroethane	DMM - disposed material management	eco – ecological
ENR – enhanced natural recovery	HQ – Hazard Quotient	H&S – health and safety	HxCDF - hexachlorodibenzofuran
HH – human health	IC- institutional control	IT – interim target	lf – lineal feet
MCL – maximum contaminant limit	MNR – monitored natural recovery	O&M – operation and maintenance	~~OHA – Oregon Health Authority~~
PeCDF – pentachlorodibenzofuran	PCB – polychlorinated biphenyl	PC – post construction	PTW – principal threat waste
RNA – regulated navigation area	RAO – remedial action objective	RM – river mile	SDU – sediment decision unit
SMA – sediment management area	TCDD – tetrachlorodibenzo-p-dioxin	TCDF – tetrachlorodibenzofuran	TEQ – toxic equivalent concentration
yr – year	% – percent		

Notes:

1 – Residual risk estimates are based on direct contact exposure to shallow sediments. There is insufficient data to estimate post construction risks based on exposure to beach sediments.

2 – Percentage is based on percentage of the Site that exceeds 10 times the benthic cleanup level.

3 – Allowable fish meals at completion represents the number of fish meals associated with a post-construction carcinogenic risk of $1x10^{-5}$ and an adult consumption rate based on a 142 g/day fish consumption rate and an 8 ounce fish meal. The child consumption rate based on a 60 g/day fish consumption rate and a 3.5 ounce fish meal.

cancer risks for RAO 1 are presented in **Tables J2.2-2a-e**. Residual non-cancer hazard for RAO 1 was not evaluated, as there are no PRGs for RAO 1 COCs based on non-cancer effects.

J2.3 POST-CONSTRUCTION RISK ESTIMATES FOR RAO 2

Post-construction risks for RAO 2 were estimated on a on a site-wide basis, a rolling river mile scale (1-mile average concentration), and by SDU. Site-wide post-construction risks were calculated using the site-wide weighted average sediment concentrations calculated for each COC (see Section J2). These sediment concentrations were input into the FWM (Appendix B1) to calculate COC concentrations in tissue. Surface water concentrations in this analysis was set to zero in order to directly assess the contribution from post-construction sediment concentrations on the post-construction risk estimate. COC concentrations in fillet tissue were calculated using the fillet-whole body concentration ratios presented in Appendix B3 (Table B3-3), and a mean exposure concentration was calculated as the average of fillet concentration in sculpin, largescale sucker, carp, and smallmouth bass (with largescale sucker as a surrogate for brown bullhead and sculpin as a surrogate for black crappie). Post-construction cancer risks and noncancer HIs were calculated using the same equations used for residual risk (equations J1-2 and J1-3, respectively). The risk-based tissue PRGs presented in Table B3-5 assuming a consumption rate of 142 g/day were used for this evaluation. Post-construction risk and hazard estimates are presented in **Tables J2.3-1a-g**.

Post-construction risks on a rolling river mile and SDU scale were calculated using the sediment PRGs based on a consumption rate of 49 g/day (Table B3-5), using the following equation:

$$Cancer\ risk = \left(\frac{Conc_a}{PRG_a} + \frac{Conc_b}{PRG_b} + \frac{Conc_c}{PRG_c} + \ldots + \frac{Conc_i}{PRG_i} \right) \times 10^{-6} \qquad \text{Equation J2-2}$$

Noncancer hazard was calculated using the sediment PRGs presented in Table 2.2-5 for the child or infant the following equation:

$$Hazard\ Index = \left(\frac{Conc_a}{PRG_a} + \frac{Conc_b}{PRG_b} + \frac{Conc_c}{PRG_c} + \ldots + \frac{Conc_i}{PRG_i} \right) \qquad \text{Equation J2-3}$$

Post construction risks were calculated for 0.1 mile incremental average surface concentration for each COC. Concentrations averaged on a 1 river mile scale are presented in **Tables J2.3-2a-m.** Site-wide post-construction risk estimates for individual COCs are presented in **Tables J2.3-3a-k** (cancer risk), **Tables J2.3-4a-j** (noncancer ~~HI~~ HQ), and **Tables J2.3-5a-g** (noncancer ~~HI~~ HQ-infant). Cumulative post-construction risk and HI estimates are presented in **Tables J2.3-6a-c**.

Table J2.3-5f
RAO 2 Rolling River Mile HQ~~Risk~~ Estimates Infant - 2,3,7,8-TCDD
Portland Harbor Superfund Site
Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
1.8	East	4.85	4.70	4.64	4.56	4.47	4.47	4.43	4.56
1.9	East	5.06	4.70	4.62	4.41	4.25	4.25	4.20	4.41
2	East	5.59	4.90	4.77	4.52	4.09	4.09	3.94	4.52
2.1	East	5.88	5.19	5.06	4.80	3.98	3.98	3.77	4.80
2.2	East	5.52	4.85	4.72	4.47	3.59	3.59	3.30	4.47
2.3	East	5.22	4.52	4.38	4.11	3.16	3.16	2.81	4.11
2.4	East	5.00	4.30	4.13	3.83	2.86	2.86	2.48	3.84
2.5	East	4.89	4.17	4.00	3.72	2.76	2.76	2.38	3.73
2.6	East	4.84	4.10	3.94	3.68	2.70	2.70	2.32	3.69
2.7	East	4.92	4.18	4.02	3.76	2.73	2.73	2.34	3.77
2.8	East	4.96	4.28	4.14	3.88	2.80	2.80	2.38	3.89
2.9	East	4.55	4.11	4.00	3.88	2.87	2.87	2.46	3.89
3	East	4.27	4.27	3.98	3.94	3.21	3.21	2.90	3.95
3.1	East	4.26	4.26	3.95	3.90	3.71	3.71	3.42	3.91
3.2	East	4.51	4.50	4.17	4.12	4.03	4.03	3.79	4.13
3.3	East	6.53	5.73	4.30	4.15	3.78	3.78	3.40	4.16
3.4	East	8.11	6.30	4.42	4.30	3.87	3.87	3.42	4.30
3.5	East	8.55	6.61	4.61	4.43	3.91	3.91	3.37	4.43
3.6	East	9.21	7.15	4.96	4.47	3.89	3.89	3.29	4.47
3.7	East	10.11	7.99	5.72	4.67	3.87	3.87	3.19	4.67
3.8	East	10.39	8.22	5.91	4.83	3.98	3.98	3.22	4.83
3.9	East	10.04	8.08	5.91	4.79	3.53	3.53	2.68	4.79
4	East	9.18	7.34	5.53	4.45	2.90	2.90	1.95	4.45
4.1	East	8.46	6.69	4.90	3.83	2.29	2.29	1.35	3.83
4.2	East	7.93	6.26	4.35	3.22	1.71	1.71	0.82	3.22
4.3	East	6.55	5.36	4.32	3.01	1.46	1.46	0.59	3.01
4.4	East	5.11	5.05	4.43	3.02	1.45	1.45	0.62	3.02
4.5	East	5.13	5.08	4.44	3.07	1.53	1.53	0.74	3.07
4.6	East	4.98	4.95	4.41	3.38	1.89	1.89	1.11	3.38
4.7	East	4.57	4.55	4.03	3.58	2.31	2.31	1.59	3.58
4.8	East	5.00	4.97	4.44	3.99	2.72	2.72	2.03	3.99
4.9	East	5.33	5.30	4.77	4.45	3.64	3.64	2.70	4.45
5	East	6.15	6.12	5.50	5.17	4.88	4.88	3.84	5.15
5.1	East	7.41	7.37	6.79	6.48	6.05	6.05	4.58	6.24
5.2	East	8.65	8.65	8.63	8.57	7.57	7.57	5.62	7.59
5.3	East	8.42	8.42	8.42	8.29	7.14	7.14	5.34	7.14
5.4	East	7.19	7.19	7.19	7.08	6.06	6.06	4.39	6.06
5.5	East	6.39	6.39	6.39	6.29	5.33	5.33	3.77	5.35
5.6	East	5.54	5.54	5.54	5.44	4.48	4.48	3.07	4.59
5.7	East	4.78	4.77	4.77	4.68	3.71	3.71	2.40	3.92
5.8	East	4.21	4.20	4.12	4.04	3.15	3.15	1.97	3.43
5.9	East	3.70	3.70	3.52	3.42	2.54	2.54	1.64	2.98
6	East	3.18	3.18	2.90	2.80	1.99	1.99	1.26	2.53
6.1	East	2.89	2.89	2.39	2.31	1.63	1.63	1.16	2.35
6.2	East	3.88	3.15	2.19	2.14	1.73	1.73	1.31	2.69
6.3	East	10.55	4.92	2.13	2.10	1.76	1.76	1.26	4.55

Table J2.3-5f

RAO 2 Rolling River Mile HQ~~Risk~~ Estimates Infant - 2,3,7,8-TCDD

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
6.4	East	13.99	6.02	2.44	2.40	2.07	2.07	1.58	5.69
6.5	East	13.57	5.91	2.49	2.45	2.16	2.16	1.73	5.61
6.6	East	13.10	5.87	2.64	2.61	2.37	2.37	1.96	5.59
6.7	East	16.55	6.62	2.96	2.93	2.75	2.75	2.39	9.49
6.8	East	18.85	7.65	3.24	3.22	3.05	3.05	2.72	12.08
6.9	East	18.79	7.98	3.43	3.42	3.21	3.21	2.91	12.19
7	East	18.28	7.95	3.66	3.64	3.44	3.44	3.15	11.98
7.1	East	18.13	7.86	3.72	3.70	3.52	3.52	3.24	11.89
7.2	East	18.34	7.92	3.85	3.84	3.66	3.66	3.42	12.33
7.3	East	14.77	7.14	4.17	4.16	4.00	4.00	3.79	12.12
7.4	East	12.56	6.66	4.29	4.29	4.17	4.17	3.94	12.42
7.5	East	13.50	7.28	4.76	4.76	4.64	4.64	4.31	13.39
7.6	East	14.71	7.67	5.00	5.00	4.86	4.86	4.23	14.15
7.7	East	10.65	6.64	4.61	4.61	4.46	4.46	3.77	9.15
7.8	East	7.06	4.94	4.27	4.27	4.07	4.07	3.27	4.85
7.9	East	6.56	4.17	4.15	4.14	4.08	4.08	3.18	4.16
8	East	6.81	3.90	3.90	3.90	3.84	3.84	2.79	3.90
8.1	East	7.49	4.11	4.11	4.11	4.04	4.04	2.83	4.11
8.2	East	7.39	4.06	4.06	4.05	3.99	3.99	2.79	4.05
8.3	East	7.10	3.97	3.97	3.97	3.91	3.91	2.93	3.97
8.4	East	6.85	3.82	3.82	3.82	3.76	3.76	3.00	3.82
8.5	East	6.44	3.29	3.29	3.28	3.21	3.21	2.50	3.28
8.6	East	5.70	3.08	3.08	3.08	2.93	2.93	2.53	3.08
8.7	East	4.68	3.72	3.72	3.72	3.48	3.48	2.82	3.72
8.8	East	3.92	3.92	3.92	3.92	3.74	3.74	3.10	3.92
8.9	East	3.97	3.97	3.97	3.97	3.80	3.80	3.18	3.97
9	East	4.10	4.10	4.10	4.10	3.92	3.92	3.29	4.10
9.1	East	4.24	4.24	4.24	4.24	3.82	3.82	3.04	4.24
9.2	East	4.46	4.46	4.46	4.46	3.77	3.77	2.74	4.46
9.3	East	4.88	4.88	4.88	4.88	4.20	4.20	2.98	4.88
9.4	East	5.46	5.46	5.46	5.46	4.81	4.81	3.63	5.46
9.5	East	6.07	6.07	6.07	6.07	5.43	5.43	4.40	6.07
9.6	East	6.48	6.48	6.47	6.40	5.69	5.69	4.76	6.40
9.7	East	6.92	6.91	6.91	6.83	6.08	6.08	5.22	6.83
9.8	East	7.54	7.53	7.53	7.44	6.66	6.66	5.67	7.45
9.9	East	8.24	8.23	8.23	8.14	7.29	7.29	6.20	8.14
10	East	8.96	8.96	8.95	8.85	7.90	7.90	6.66	8.86
10.1	East	9.61	9.61	9.60	9.50	8.64	8.64	7.40	9.50
10.2	East	10.37	10.37	10.36	10.23	9.25	9.25	8.16	10.24
10.3	East	11.40	11.39	11.39	10.79	9.23	9.23	8.28	10.80
10.4	East	12.37	12.36	12.35	11.33	9.16	9.16	7.84	11.33
10.5	East	12.98	12.97	12.96	11.83	8.70	8.70	6.68	11.84
10.6	East	14.09	14.09	14.02	12.80	9.42	9.42	6.67	12.81
10.7	East	15.50	14.97	14.30	12.75	9.12	9.12	6.41	12.75
10.8	East	17.73	16.87	15.34	13.10	8.87	8.87	5.39	13.10
10.9	East	20.47	17.76	14.57	11.62	7.40	7.40	4.18	11.62

Table J2.3-5f

RAO 2 Rolling River Mile HQ~~Risk~~ Estimates Infant - 2,3,7,8-TCDD

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
11	East	22.43	17.54	13.88	10.46	6.21	6.21	3.29	10.46
11.1	East	22.12	17.19	13.46	9.93	5.71	5.71	2.90	9.93
11.2	East	21.38	16.64	13.05	9.54	5.76	5.76	2.51	9.54
11.3	East	22.09	16.77	12.74	9.37	5.71	5.71	2.17	9.37
11.4	East	22.84	16.84	12.29	8.93	5.32	5.32	1.64	8.93
11.5	East	23.41	16.84	11.86	8.17	5.12	5.12	1.75	8.17
11.6	East	24.24	16.70	11.08	7.10	4.10	4.10	1.43	7.10
11.7	East	24.66	16.65	10.98	6.79	3.85	3.85	0.92	6.79
1.8	Nav Channel	2.10	2.10	2.10	2.10	2.10	2.10	2.02	2.10
1.9	Nav Channel	2.12	2.12	2.12	2.12	2.12	2.12	1.92	2.12
2	Nav Channel	2.18	2.18	2.18	2.18	2.18	2.18	1.96	2.18
2.1	Nav Channel	2.28	2.28	2.28	2.28	2.28	2.28	2.05	2.28
2.2	Nav Channel	2.37	2.37	2.37	2.37	2.37	2.37	2.15	2.37
2.3	Nav Channel	2.45	2.45	2.45	2.45	2.45	2.45	2.23	2.45
2.4	Nav Channel	2.52	2.52	2.52	2.52	2.52	2.52	2.30	2.52
2.5	Nav Channel	2.62	2.62	2.62	2.62	2.62	2.62	2.39	2.62
2.6	Nav Channel	2.73	2.73	2.73	2.73	2.73	2.73	2.50	2.73
2.7	Nav Channel	2.84	2.84	2.84	2.84	2.84	2.84	2.62	2.84
2.8	Nav Channel	2.96	2.96	2.96	2.96	2.96	2.96	2.81	2.96
2.9	Nav Channel	3.08	3.08	3.08	3.08	3.08	3.08	2.99	3.08
3	Nav Channel	3.20	3.20	3.20	3.20	3.20	3.13	2.93	3.20
3.1	Nav Channel	3.32	3.32	3.32	3.31	3.31	3.11	2.69	3.31
3.2	Nav Channel	3.43	3.43	3.43	3.42	3.42	3.11	2.44	3.42
3.3	Nav Channel	3.51	3.51	3.51	3.50	3.50	3.18	2.46	3.50
3.4	Nav Channel	3.57	3.57	3.57	3.56	3.56	3.26	2.59	3.56
3.5	Nav Channel	3.61	3.61	3.61	3.60	3.60	3.32	2.64	3.60
3.6	Nav Channel	3.61	3.61	3.61	3.61	3.61	3.34	2.64	3.61
3.7	Nav Channel	3.57	3.57	3.57	3.57	3.57	3.32	2.66	3.57
3.8	Nav Channel	3.51	3.51	3.51	3.51	3.51	3.27	2.66	3.51
3.9	Nav Channel	3.45	3.45	3.45	3.45	3.45	3.23	2.67	3.45
4	Nav Channel	3.38	3.38	3.38	3.38	3.38	3.19	2.70	3.38
4.1	Nav Channel	3.29	3.29	3.29	3.29	3.29	3.18	2.77	3.29
4.2	Nav Channel	3.18	3.18	3.18	3.18	3.18	3.13	2.89	3.18
4.3	Nav Channel	3.06	3.06	3.06	3.06	3.06	3.04	2.85	3.06
4.4	Nav Channel	2.95	2.95	2.95	2.95	2.95	2.93	2.73	2.95
4.5	Nav Channel	2.86	2.86	2.86	2.86	2.86	2.83	2.67	2.86
4.6	Nav Channel	2.79	2.79	2.73	2.69	2.79	2.63	2.49	2.79
4.7	Nav Channel	2.77	2.68	2.54	2.47	2.68	2.37	2.20	2.68
4.8	Nav Channel	2.77	2.67	2.44	2.31	2.67	2.16	1.96	2.67
4.9	Nav Channel	2.79	2.58	2.27	2.11	2.58	1.92	1.71	2.58
5	Nav Channel	2.82	2.54	2.16	1.96	2.54	1.70	1.51	2.54
5.1	Nav Channel	2.90	2.59	2.19	1.96	2.59	1.59	1.35	2.59
5.2	Nav Channel	3.06	2.57	2.11	1.86	2.57	1.45	1.19	2.57
5.3	Nav Channel	3.34	2.57	2.07	1.81	2.57	1.37	1.08	2.57
5.4	Nav Channel	3.61	2.79	2.25	1.95	2.79	1.29	0.95	2.79
5.5	Nav Channel	3.93	3.06	2.49	2.15	3.06	1.40	0.89	3.06

Table J2.3-5f

RAO 2 Rolling River Mile HQ~~Risk~~ Estimates Infant - 2,3,7,8-TCDD

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
5.6	Nav Channel	4.42	3.49	2.97	2.61	3.49	1.80	1.20	3.49
5.7	Nav Channel	5.07	4.16	3.59	3.16	4.16	2.18	1.40	4.12
5.8	Nav Channel	6.09	4.94	4.40	3.97	4.94	2.87	1.97	4.88
5.9	Nav Channel	7.59	6.41	5.94	5.50	6.41	4.35	3.24	6.35
6	Nav Channel	9.85	8.44	8.02	7.60	8.44	6.29	4.76	8.37
6.1	Nav Channel	12.98	11.42	10.01	9.24	11.22	6.94	5.34	11.15
6.2	Nav Channel	16.70	15.36	12.90	11.51	14.47	7.26	5.44	14.39
6.3	Nav Channel	20.53	19.57	17.03	15.60	18.64	8.60	5.71	18.56
6.4	Nav Channel	23.87	22.91	20.34	18.90	21.95	11.45	7.30	21.87
6.5	Nav Channel	26.17	25.16	22.60	21.22	24.21	13.89	9.97	24.18
6.6	Nav Channel	27.65	26.56	24.05	22.70	25.63	15.58	11.86	25.63
6.7	Nav Channel	28.18	27.18	24.88	23.69	26.26	16.90	13.41	26.32
6.8	Nav Channel	27.84	27.10	24.95	23.86	26.20	17.42	13.80	26.28
6.9	Nav Channel	26.60	26.05	24.00	22.98	25.17	16.71	12.96	25.25
7	Nav Channel	24.42	24.18	22.23	21.27	23.34	15.05	11.43	23.42
7.1	Nav Channel	21.33	21.19	20.28	19.70	20.58	14.34	10.69	20.66
7.2	Nav Channel	17.77	17.64	17.64	17.60	17.64	14.20	10.64	17.70
7.3	Nav Channel	14.66	14.55	14.55	14.52	14.55	13.22	10.68	14.60
7.4	Nav Channel	12.24	12.15	12.15	12.12	12.15	11.34	9.85	12.20
7.5	Nav Channel	10.56	10.51	10.51	10.48	10.50	9.79	8.50	10.52
7.6	Nav Channel	9.35	9.35	9.35	9.34	9.34	8.70	7.44	9.34
7.7	Nav Channel	8.56	8.55	8.55	8.55	8.55	7.94	6.74	8.55
7.8	Nav Channel	7.94	7.94	7.94	7.93	7.94	7.34	6.34	7.94
7.9	Nav Channel	7.45	7.45	7.45	7.42	7.45	6.91	6.14	7.45
8	Nav Channel	7.09	7.09	7.09	7.05	7.09	6.74	6.20	7.09
8.1	Nav Channel	6.83	6.83	6.83	6.75	6.83	6.69	6.34	6.83
8.2	Nav Channel	6.51	6.51	6.51	6.39	6.51	6.38	6.26	6.51
8.3	Nav Channel	6.30	6.26	6.25	6.11	6.24	6.11	6.02	6.24
8.4	Nav Channel	6.21	6.07	6.06	5.92	6.05	5.88	5.76	6.05
8.5	Nav Channel	6.12	5.89	5.89	5.73	5.87	5.52	5.31	5.87
8.6	Nav Channel	6.26	6.02	5.99	5.81	6.00	5.48	5.28	6.00
8.7	Nav Channel	6.52	6.29	6.24	6.04	6.24	5.51	5.27	6.24
8.8	Nav Channel	6.83	6.59	6.53	6.32	6.53	5.49	5.14	6.53
8.9	Nav Channel	7.19	6.94	6.89	6.69	6.88	5.78	5.28	6.88
9	Nav Channel	7.63	7.38	7.32	7.14	7.31	6.19	5.65	7.31
9.1	Nav Channel	8.10	7.84	7.78	7.65	7.77	6.66	6.07	7.77
9.2	Nav Channel	8.56	8.29	8.22	8.14	8.22	7.08	6.42	8.22
9.3	Nav Channel	8.87	8.65	8.59	8.52	8.60	7.41	6.74	8.60
9.4	Nav Channel	9.12	9.02	8.96	8.89	8.97	7.79	7.01	8.97
9.5	Nav Channel	9.49	9.48	9.42	9.35	9.44	8.16	7.26	9.44
9.6	Nav Channel	9.94	9.94	9.91	9.87	9.90	8.82	7.91	9.90
9.7	Nav Channel	10.28	10.28	10.27	10.25	10.26	9.44	8.44	10.26
9.8	Nav Channel	10.46	10.46	10.46	10.46	10.46	9.61	8.34	10.46
9.9	Nav Channel	10.51	10.51	10.51	10.51	10.51	9.13	7.83	10.51
10	Nav Channel	10.50	10.50	10.50	10.50	10.50	8.97	7.41	10.50
10.1	Nav Channel	10.47	10.47	10.47	10.47	10.47	8.89	7.30	10.47

Table J2.3-5f

RAO 2 Rolling River Mile HQ~~Risk~~ Estimates Infant - 2,3,7,8-TCDD

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
10.2	Nav Channel	10.55	10.55	10.55	10.55	10.55	8.91	7.29	10.55
10.3	Nav Channel	10.75	10.75	10.75	10.75	10.75	9.01	7.29	10.75
10.4	Nav Channel	11.05	11.05	11.05	11.05	11.05	9.12	6.83	11.05
10.5	Nav Channel	11.33	11.33	11.33	11.33	11.33	9.36	6.67	11.33
10.6	Nav Channel	11.66	11.66	11.66	11.66	11.66	9.57	6.69	11.66
10.7	Nav Channel	12.32	12.23	12.16	12.12	12.12	9.95	7.11	12.12
10.8	Nav Channel	13.35	12.80	12.67	12.52	12.52	10.61	8.14	12.52
10.9	Nav Channel	14.86	14.10	13.75	13.24	13.24	11.75	9.26	13.24
11	Nav Channel	16.03	15.27	14.93	14.41	14.41	12.91	10.64	14.41
11.1	Nav Channel	16.60	15.83	15.48	14.96	14.96	13.51	11.27	14.96
11.2	Nav Channel	17.10	16.26	15.89	15.33	15.33	13.88	11.54	15.33
11.3	Nav Channel	17.74	16.81	16.39	15.76	15.76	14.26	11.77	15.76
11.4	Nav Channel	18.33	17.28	16.81	16.09	16.09	14.62	12.85	16.09
11.5	Nav Channel	18.94	17.73	17.20	16.38	16.38	15.18	14.10	16.38
11.6	Nav Channel	19.48	18.07	17.45	16.49	16.49	15.09	14.01	16.49
11.7	Nav Channel	19.79	18.28	17.66	16.58	16.58	14.92	13.71	16.58
1.8	West	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73
1.9	West	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.58
2	West	2.41	2.41	2.41	2.41	2.41	2.41	2.41	2.41
2.1	West	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
2.2	West	2.25	2.25	2.25	2.25	2.25	2.25	2.24	2.25
2.3	West	2.33	2.33	2.33	2.33	2.33	2.33	2.30	2.33
2.4	West	2.50	2.50	2.50	2.50	2.50	2.50	2.38	2.50
2.5	West	2.72	2.72	2.72	2.72	2.72	2.72	2.45	2.72
2.6	West	2.95	2.95	2.95	2.95	2.95	2.95	2.59	2.95
2.7	West	3.17	3.17	3.17	3.17	3.17	3.17	2.78	3.17
2.8	West	3.38	3.38	3.38	3.38	3.38	3.38	2.84	3.38
2.9	West	3.70	3.70	3.70	3.70	3.70	3.70	3.07	3.70
3	West	4.08	4.08	4.08	4.08	4.07	4.07	3.39	4.08
3.1	West	4.55	4.55	4.55	4.55	4.55	4.55	3.84	4.55
3.2	West	5.05	5.05	5.05	5.05	5.04	5.04	4.33	5.05
3.3	West	5.62	5.62	5.62	5.62	5.61	5.61	4.83	5.62
3.4	West	6.18	6.18	6.18	6.18	6.09	6.09	5.17	6.18
3.5	West	6.96	6.96	6.96	6.94	6.72	6.72	5.73	6.94
3.6	West	7.89	7.89	7.89	7.86	7.54	7.54	6.38	7.86
3.7	West	9.19	9.19	9.19	9.16	8.69	8.69	7.15	9.16
3.8	West	10.85	10.85	10.85	10.81	10.00	10.00	7.75	10.81
3.9	West	13.69	13.69	13.69	13.64	12.55	12.55	8.25	13.64
4	West	16.72	16.72	16.72	16.65	15.43	15.43	9.02	16.65
4.1	West	20.12	20.12	20.12	20.05	18.23	18.23	9.80	20.05
4.2	West	23.87	23.87	23.87	23.79	19.88	19.88	9.93	23.79
4.3	West	25.61	25.61	25.61	25.53	21.23	21.23	10.70	25.53
4.4	West	25.70	25.70	25.70	25.61	21.41	21.41	11.08	25.61
4.5	West	25.66	25.66	25.66	25.61	21.41	21.41	10.92	25.61
4.6	West	25.49	25.49	25.49	25.44	21.26	21.26	10.71	25.44
4.7	West	25.11	25.11	25.08	24.91	20.60	20.60	10.29	24.91

Table J2.3-5f

RAO 2 Rolling River Mile HQ~~Risk~~ Estimates Infant - 2,3,7,8-TCDD

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
4.8	West	24.72	24.72	24.63	24.36	20.30	20.30	10.79	24.36
4.9	West	22.85	22.82	22.49	22.15	18.00	18.00	10.82	22.15
5	West	19.90	19.81	19.22	18.77	14.38	14.38	9.53	18.77
5.1	West	16.60	16.51	15.83	15.34	11.35	11.35	7.80	15.34
5.2	West	12.00	11.90	11.17	10.64	9.25	9.25	6.59	10.64
5.3	West	9.04	8.94	8.17	7.60	6.50	6.50	4.21	7.60
5.4	West	8.49	8.38	7.63	6.96	5.58	5.58	3.16	7.10
5.5	West	8.78	8.69	7.93	7.28	5.84	5.84	3.31	7.51
5.6	West	8.84	8.59	7.82	7.16	5.35	5.35	2.66	7.44
5.7	West	8.63	7.88	7.01	6.48	4.92	4.92	2.33	6.76
5.8	West	8.28	6.92	6.13	5.72	4.28	4.28	2.08	5.99
5.9	West	8.13	6.11	5.53	5.17	3.80	3.80	1.97	5.43
6	West	8.37	5.64	5.25	4.96	3.66	3.66	1.96	5.22
6.1	West	8.91	5.65	5.29	4.96	3.52	3.52	1.91	4.97
6.2	West	9.63	6.42	6.05	5.68	3.64	3.64	1.69	5.06
6.3	West	12.09	8.45	8.03	6.39	3.17	3.17	1.40	4.52
6.4	West	59.62	12.02	8.20	6.20	2.75	2.75	1.14	3.65
6.5	West	245.44	12.88	8.02	5.08	1.66	1.66	0.44	2.21
6.6	West	260.49	14.11	8.64	4.86	1.27	1.27	0.38	1.28
6.7	West	248.62	13.74	8.25	4.56	1.18	1.18	0.35	1.18
6.8	West	261.77	13.52	8.07	4.47	1.17	1.17	0.36	1.18
6.9	West	279.09	13.69	8.21	4.55	1.20	1.20	0.38	1.20
7	West	274.08	14.13	8.59	4.73	1.36	1.36	0.38	1.36
7.1	West	228.98	14.67	10.01	6.39	3.37	3.37	1.07	3.37
7.2	West	193.17	13.80	9.90	6.75	4.23	4.23	2.14	4.23
7.3	West	166.38	11.97	8.63	6.58	4.81	4.81	2.13	4.81
7.4	West	139.89	9.83	8.41	6.64	5.23	5.23	2.17	5.23
7.5	West	42.77	9.79	8.86	7.55	5.97	5.97	2.27	6.09
7.6	West	36.56	10.03	9.46	8.63	7.03	7.03	2.33	7.51
7.7	West	36.24	11.75	11.47	10.66	8.50	8.50	2.38	9.51
7.8	West	26.62	14.44	14.20	12.98	9.26	9.26	2.39	11.83
7.9	West	17.70	16.97	16.76	13.56	9.08	9.08	2.22	12.52
8	West	19.82	19.78	19.69	14.07	9.84	9.84	3.34	13.15
8.1	West	27.91	27.76	27.75	17.08	10.56	10.56	4.20	16.45
8.2	West	37.22	37.06	37.05	19.05	10.14	10.14	3.51	18.69
8.3	West	53.86	51.11	49.57	20.71	10.10	10.10	3.65	20.61
8.4	West	78.34	54.13	52.01	21.18	9.93	9.93	3.71	21.09
8.5	West	93.34	56.92	52.07	20.67	9.44	9.44	3.76	20.67
8.6	West	105.53	63.09	52.66	19.44	8.47	8.47	3.82	19.44
8.7	West	112.25	65.42	53.07	17.96	7.19	7.19	3.97	17.96
8.8	West	113.97	67.75	54.78	18.26	8.12	8.12	5.36	18.26
8.9	West	118.75	71.09	57.73	22.87	13.02	13.02	10.00	22.87
9	West	122.80	72.23	58.04	25.47	13.84	13.84	10.58	25.47
9.1	West	120.17	64.80	49.22	22.26	12.84	12.84	10.40	22.26
9.2	West	107.14	52.85	36.65	19.05	12.74	12.74	10.33	19.05
9.3	West	95.25	42.56	25.26	18.60	13.15	13.15	10.66	18.60

Table J2.3-5f

RAO 2 Rolling River Mile HQ~~Risk~~ Estimates Infant - 2,3,7,8-TCDD

Portland Harbor Superfund Site

Portland, Oregon

		Alternative							
River Mile	Segment	A	B	D	E	F Mod	F	G	I
9.4	West	71.16	44.24	26.56	19.70	13.90	13.90	11.26	19.70
9.5	West	53.88	42.32	27.71	20.59	14.55	14.55	11.80	20.59
9.6	West	39.72	35.29	27.71	22.07	15.63	15.63	12.69	22.07
9.7	West	34.58	33.89	28.19	23.17	16.43	16.43	13.27	23.17
9.8	West	28.08	27.35	22.33	20.57	15.03	15.03	12.31	20.57
9.9	West	22.82	21.93	15.81	13.69	8.40	8.40	6.42	13.70
10	West	20.59	19.46	11.67	8.97	5.59	5.59	4.29	8.97
10.1	West	21.27	19.96	9.40	6.21	4.44	4.44	3.31	6.21
10.2	West	22.02	21.48	11.21	10.19	8.57	8.57	6.18	10.20
10.3	West	15.31	15.31	15.30	14.96	13.86	13.86	9.35	14.97
10.4	West	15.20	15.20	15.19	14.91	13.99	13.99	10.21	14.91
10.5	West	15.16	15.16	15.15	14.90	14.08	14.08	10.73	14.90
10.6	West	15.00	15.00	14.99	14.76	14.01	14.01	10.97	14.76
10.7	West	14.85	14.85	14.84	14.62	13.95	13.95	11.24	14.63
10.8	West	14.56	14.56	14.56	14.56	14.44	14.44	11.84	14.56
10.9	West	14.20	14.20	14.20	14.20	14.20	14.20	11.89	14.20
11	West	13.58	13.58	13.58	13.58	13.58	13.58	11.44	13.58
11.1	West	12.92	12.92	12.92	12.92	12.92	12.92	10.86	12.92
11.2	West	11.46	11.46	11.46	11.46	11.46	11.46	10.08	11.46
11.3	West	9.93	9.93	9.93	9.93	9.93	9.93	9.91	9.93
11.4	West	9.12	9.12	9.12	9.12	9.12	9.12	9.11	9.12
11.5	West	8.22	8.22	8.22	8.22	8.22	8.22	8.21	8.22
11.6	West	7.33	7.33	7.33	7.33	7.33	7.33	7.31	7.33
11.7	West	6.68	6.68	6.68	6.68	6.68	6.68	6.66	6.68
7.6	Swan Isl	10.47	0.70	0.70	0.43	0.09	0.09	0.04	0.43
7.7	Swan Isl	11.52	0.68	0.67	0.43	0.10	0.10	0.04	0.43
7.8	Swan Isl	11.47	0.78	0.71	0.44	0.12	0.12	0.04	0.44
7.9	Swan Isl	10.79	0.71	0.64	0.40	0.12	0.12	0.05	0.40
8	Swan Isl	10.32	0.66	0.60	0.38	0.13	0.13	0.06	0.38
8.1	Swan Isl	10.25	0.65	0.59	0.38	0.14	0.14	0.06	0.38
8.2	Swan Isl	10.32	0.68	0.62	0.42	0.20	0.20	0.13	0.42
8.3	Swan Isl	10.67	0.77	0.65	0.44	0.23	0.23	0.16	0.44
8.4	Swan Isl	11.15	0.86	0.64	0.44	0.24	0.24	0.17	0.44
8.5	Swan Isl	11.69	0.92	0.64	0.45	0.24	0.24	0.18	0.45
8.6	Swan Isl	12.29	1.42	0.87	0.71	0.30	0.30	0.22	0.93
8.7	Swan Isl	12.50	2.54	1.60	1.39	0.59	0.59	0.48	1.99
8.8	Swan Isl	12.74	2.83	1.76	1.59	0.68	0.68	0.57	2.30
8.9	Swan Isl	13.68	3.21	1.98	1.79	0.75	0.75	0.64	2.61
9	Swan Isl	14.82	3.67	2.25	2.04	0.84	0.84	0.71	2.99
9.1	Swan Isl	15.27	3.92	2.40	2.17	0.88	0.88	0.75	3.19
9.2	Swan Isl	16.27	4.61	2.74	2.49	0.92	0.92	0.78	3.74
9.3	Swan Isl	17.05	5.57	3.33	3.10	1.06	1.06	0.87	4.76
9.4	Swan Isl	17.69	7.54	4.76	4.47	1.44	1.44	1.16	6.97
9.5	Swan Isl	16.87	11.53	7.52	7.07	2.17	2.17	1.76	11.28
9.6	Swan Isl	15.20	15.20	11.20	10.19	3.98	3.98	3.36	15.20

Appendix C

Oregon Department of Environmental Quality
Letter Supporting EPA's Explanation of Significant Differences

Pending ODEQ submittal after public review/comment period

Appendix D

Five Tribes
Letter Supporting EPA's Explanation of Significant Differences

IEc

MEMORANDUM | February 12, 2018

TO Sean Sheldrake, United States Environmental Protection Agency (EPA)

FROM Gail Fricano, Rachel DelVecchio, and Dr. Rita Cabral (Industrial Economics, Inc.)

SUBJECT Proposed Changes to Portland Harbor Superfund Site (PHSS) Remedy due to Updated Human Health Toxicity Values for Benzo(a)pyrene

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OVERVIEW

This memorandum provides technical comments on behalf of the Five Tribes[1] regarding EPA's proposed approach to modifying the PHSS remedy in order to address the Integrated Risk and Information System (IRIS) update to the cancer slope factor for benzo(a)pyrene. Our comments are specific to the approach described in materials provided by EPA (Attachment A) and discussed on a conference call with EPA and the PHSS Technical Coordinating Team (TCT) on January 11, 2018 (referred to as "EPA's proposed approach" in this memorandum).

The Five Tribes support EPA's proposed approach regarding updating cleanup levels and remedial action levels (RALs) in response to the IRIS benzo(a)pyrene revision. They also support EPA's use of an Explanation of Significant Differences (ESD), rather than a Record of Decision (ROD) amendment, to make these changes. EPA's approach and the rationale for the Five Tribes' support are outlined in the following sections. Note that if EPA modifies this approach in any way, the Five Tribes would need to evaluate the modified approach to determine whether they support it.

Notwithstanding their technical support for EPA's proposed approach for modifying the PHSS remedy to address the IRIS update, the Five Tribes are concerned about EPA's recent conduct relating to coordination and consultation with the Five Tribes in derogation of the EPA's trust duty to the Tribes. The Five Tribes hope that EPA will honor the spirit and letter of the Memorandum of Understanding for Portland Harbor Superfund Site and also coordinate and consult with the Five Tribes in a manner consistent with EPA's consultation obligations embodied in Executive Order 13175 and applicable statutes, such as CERCLA § 126(a). The Five Tribes expressly reserve their rights to address the foregoing concerns with EPA leadership.

SUPPORT FOR EPA'S PROPOSED APPROACH

EPA's IRIS posted an updated benzo(a)pyrene cancer slope factor on January 19, 2017. This update reflects the current scientific understanding that this contaminant is less

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[1] The five tribes are the Confederated Tribes of the Grand Ronde Community of Oregon, the Nez Perce Tribe, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes of the Warm Springs Reservation of Oregon.

carcinogenic than previously known. Subsequently, EPA has contemplated the implications of this update on PHSS cleanup levels and RALs for polycyclic aromatic hydrocarbons (PAHs; carcinogenic PAH (cPAH) cleanup levels and total PAH RALs are based on benzo(a)pyrene). Conceptually, we support updates to the PHSS remedy that reflect best available science and believe that changes to the remedy are warranted in this case.

Below, we briefly describe EPA's proposed approach and our support for each element.

cPAH Cleanup Levels:

EPA proposes increasing the navigation channel cleanup level (based on clam consumption) from 3,950 µg/kg to 107,600 µg/kg.[2] EPA also proposes developing separate cleanup levels for beach and nearshore (i.e., in-water areas outside the navigation channel) sediments. The beach cleanup level (based on direct contact with beach sediments) would increase from 12 ug/kg to 85 ug/kg. The nearshore sediment cleanup level would increase from 106 µg/kg (the previous relevant preliminary remediation goal for direct contact with nearshore sediments outside beach areas) to 774 µg/kg.

We support these revised cleanup levels, which appropriately apply the updated benzo(a)pyrene cancer slope factor to the previous cleanup levels. We also agree that separate nearshore and beach cleanup levels more accurately reflect the Baseline Human Health Risk Assessment risk scenarios.

Principal Threat Waste (PTW):

EPA proposes increasing the highly toxic PTW threshold from 106,000 µg/kg to 774,000 µg/kg. We support this change, which appropriately applies the updated benzo(a)pyrene cancer slope factor to the previous highly toxic PTW threshold.

Total PAH RALs:

EPA proposes increasing the nearshore RAL from 13,000 µg/kg to 30,000 µg/kg and retaining the current navigation channel RAL of 170,000 µg/kg.

We support increasing the nearshore RAL to 30,000 µg/kg. This revised RAL is expected to achieve the revised cleanup levels.[3] At the same time, the revised RAL greatly minimizes remediation of areas that do not pose risk.[4]

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[2] The site-wide total PAH benthic risk cleanup level of 23,000 µg/kg is unaffected by the IRIS update.

[3] The revised RAL would result in achievement of the revised nearshore sediment cPAH cleanup level immediately following construction on a rolling river mile surface area weighted average concentration (SWAC) basis.

We support no change to the navigation channel RAL. Although remediation is no longer required to reduce the clam consumption risk, based on the updated sediment cPAH cleanup level for the navigation channel, it is required to achieve protection of benthic ecological receptors via the sediment pathway and human and ecological receptors via the surface water pathway. Thus, the navigation channel RAL should remain at 170,000 µg/kg.

In summary, EPA's proposed approach incorporates best available science while also remaining protective of human health and the environment and greatly minimizing cleanup of areas that do not pose risk.

MECHANISM FOR IMPLEMENTING CHANGES

The Five Tribes support the use of an ESD to implement the above changes, provided a public comment period is incorporated into the ESD process. We do not support the use of a ROD amendment. A ROD amendment is a lengthy process on the order of several years, while an ESD is a more streamlined process which would allow cleanup to proceed in a more expeditious manner. A ROD amendment may also provide an avenue for parties to challenge other elements of the ROD and advocate for additional changes beyond those related to the IRIS update. The ROD represents over a decade of collaborative decision making and consensus building with the TCT, the potentially responsible parties, and the public. Thus, changes to the ROD should be limited to addressing updates to best available science and other targeted instances.

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[4] The revised RAL would trigger cleanup in a total of 3 acres that already meet sediment cPAH cleanup levels on a rolling river mile SWAC basis.

ATTACHMENT A | MATERIALS PROVIDED BY EPA

Evaluation of Potential Modifications to Total PAH Navigation Channel RAL

The purpose of this memo is to evaluate whether the total PAH Navigation Channel RAL of 170,000 µg/kg identified in the ROD should be modified based on changes in carcinogenic PAH cleanup levels due to the post-ROD change to the benzo(a)pyrene slope factor. Additional information on this change is provided by EPA in the *IRIS Toxicological Review of Benzo[a]pyrene, dated January 2017* (https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=136).

Human Health Risk:

Within the navigation channel, the current cleanup level is 3,950 ppb CPAHs and is based on the clam consumption exposure pathway. Direct contact with contaminated sediment is not considered a complete exposure pathway in the navigation channel. Surface water exposure pathways (ingestion, inhalation and dermal contact) are complete within the navigation channel. Although it is known that contaminated sediments contribute to surface water COCs, there is not a sediment cleanup levels associated with the protection of drinking water. Due to the non-linear relationship between PAHs in sediment and clam tissue, reducing the benzo(a)pyrene slope factor by a factor of 7.3 results in an increase in the clam consumption cleanup level from 3,950 µg/kg to 107,600 µg/kg. Surface sediment data collected during the Portland Harbor site indicate that while some individual samples have total carcinogenic PAHs measured as benzo(a)pyrene equivalents (BaP Eq) above 107,600 µg/kg, this concentration is not exceeded on a rolling ½ river mile surface weighted average concentration (SWAC) basis (See Appendix IV of the ROD). ***As a result, remediation of PAH contaminated sediments within the Navigation Channel is not required to protect human health based on the clam consumption exposure scenario (RAO 2).***

Ecological Risk:

PAH contaminated sediments within the Navigation Channel also pose risks to ecological receptors. The Portland Harbor ROD established 23,000 µg/kg as the total PAH sediment cleanup level for protection of the benthic community. The current total PAH remedial action level (RAL) applicable to the Navigation Channel is 170,000 µg/kg, a value which is already 7.4 times the total PAH cleanup level of 23,000 µg/kg.

For RAO 5 (benthic risk), the evaluation of protectiveness and long-term effectiveness and permanence as presented in Table 22 of the ROD was based on the percentage of the site that exceeds 10 times the benthic cleanup level. In addition, Section 15.1.2 of the ROD states "At the end of cleanup construction, the Selected Remedy will address 72% of the area based on 10 times unacceptable benthic risks. The remainder of the benthic risk areas will be left to MNR and evaluated in 5-year reviews." The areas that exceed the Navigation Channel RAL within the for PAHs are isolated to areas between RM 5 and 6.6 (Figure 1). As shown in Figure 2, this area of the Site is less conducive to MNR based on a multiple line of evidence evaluation presented in the Portland Harbor FS that considered sediment deposition rates, consistency of deposition, sediment grain size, propwash potential, subsurface to surface sediment concentration ratios, and wind and wake generated waves. This information suggests that MNR will not be as effective at reducing PAH concentrations in this portion of the site than other areas of the site. ***As a result, increasing the total PAH Navigation Channel RAL may further limit the ability of the Portland Harbor remedy to achieve RAO 5 due to the limited effectiveness of MNR within the Navigation Channel between RM 5 and 7.***

In addition to benthic risk, remediation of PAH contaminated sediments within the Navigation Channel will facilitate achievement of RAOs 3 and 7 which are focused on reducing risks to human health and the environment from ingestion and direct contact with COCs in surface water. Sediments within the navigation channel are significantly elevated in cPAH concentration and are likely contribute to cPAH exceedances of the human health and ecological AWQCs. As shown in Figures 3 and 4, taken from Section 1 of the Portland Harbor FS, total PAH surface water load increases from 1031 to 1175 g/day under low flow conditions and from 1448 to 3282 g/day under high flow conditions between RM 6.3 and 3.9. This suggests that the high levels of PAH contamination within the Navigation Channel between RM 5 and 6.6are contributing to the increased PAH load observed between RM 6.3 and 3.9. Although the source of PAH contamination to the water column likely includes contaminated sediments in both the nearshore area and Navigation Channel, remediation of PAH contaminated sediments within the Navigation Channel is expected to contribute to a reduction of PAH water column concentrations and facilitate progress towards achieving RAOs 3 and 7. ***As a result, increasing the total PAH Navigation Channel RAL may limit the ability of the Portland Harbor remedy to achieve RAOs 3 and 7 downstream of RM 6.3.***

<u>Summary:</u>

Remediation of PAH contaminated sediments within the navigation channel is not required to reduce shellfish consumption risk to achieve RAO 2. However, RAOs 3, 5, and 7 are not affected by the IRIS change. Due to the exceedances of the benthic cleanup levels in the navigation channel between RM 5 and 7, the limited effectiveness of MNR in that area, and due to the contribution of PAH contaminated sediments within the Navigation Channel to surface water loading downstream of RM 6.3, increasing the total PAH Navigation Channel RAL in response to the benzo(a)pyrene slope factor is not warranted in the navigation channel area.

Figure 1 – Distribution of PAHs within the Navigation Channel above 170,000 µg/kg

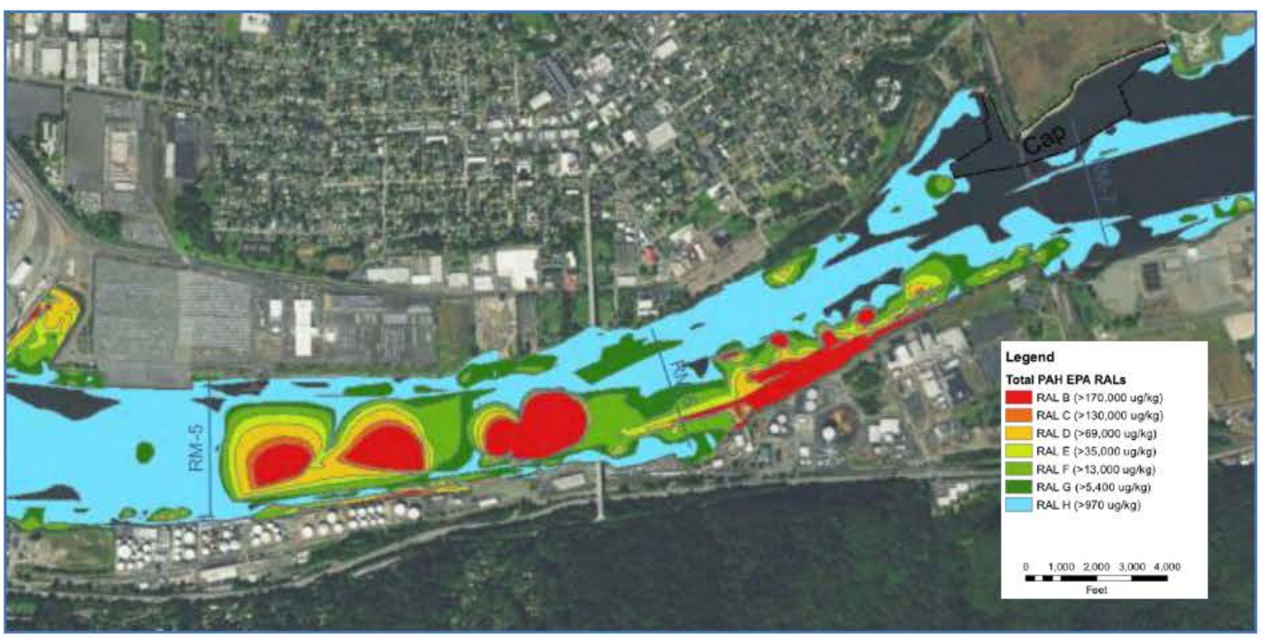


Figure 2 – MNR Average Score for Six Lines of Evidence

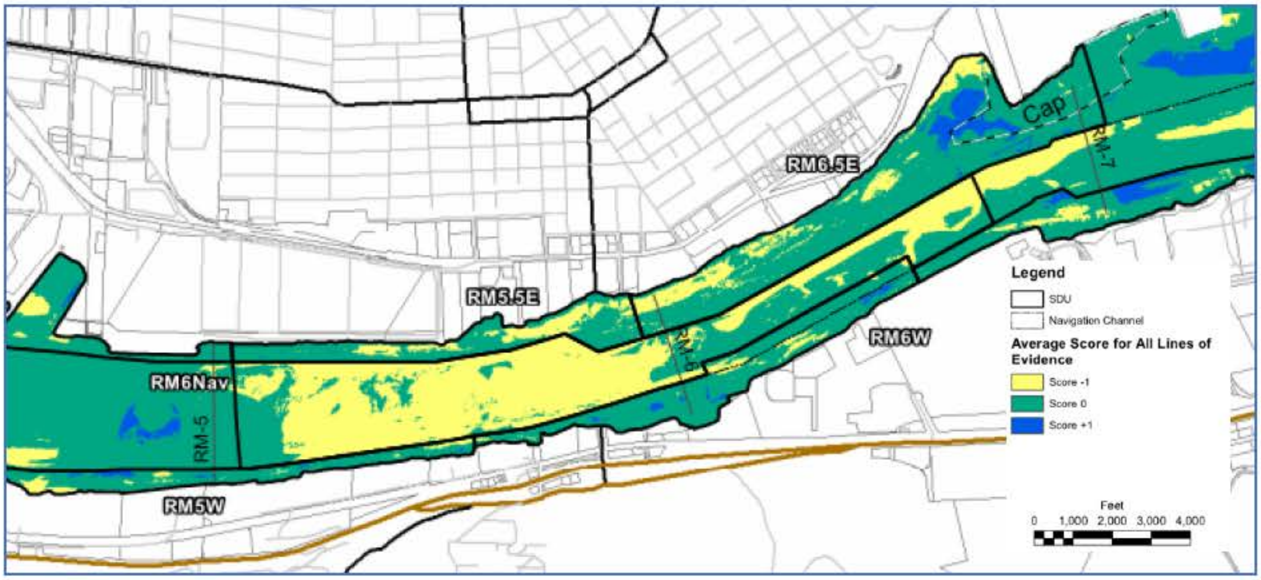


Figure 3 – PAH Loading under Low Flow Conditions

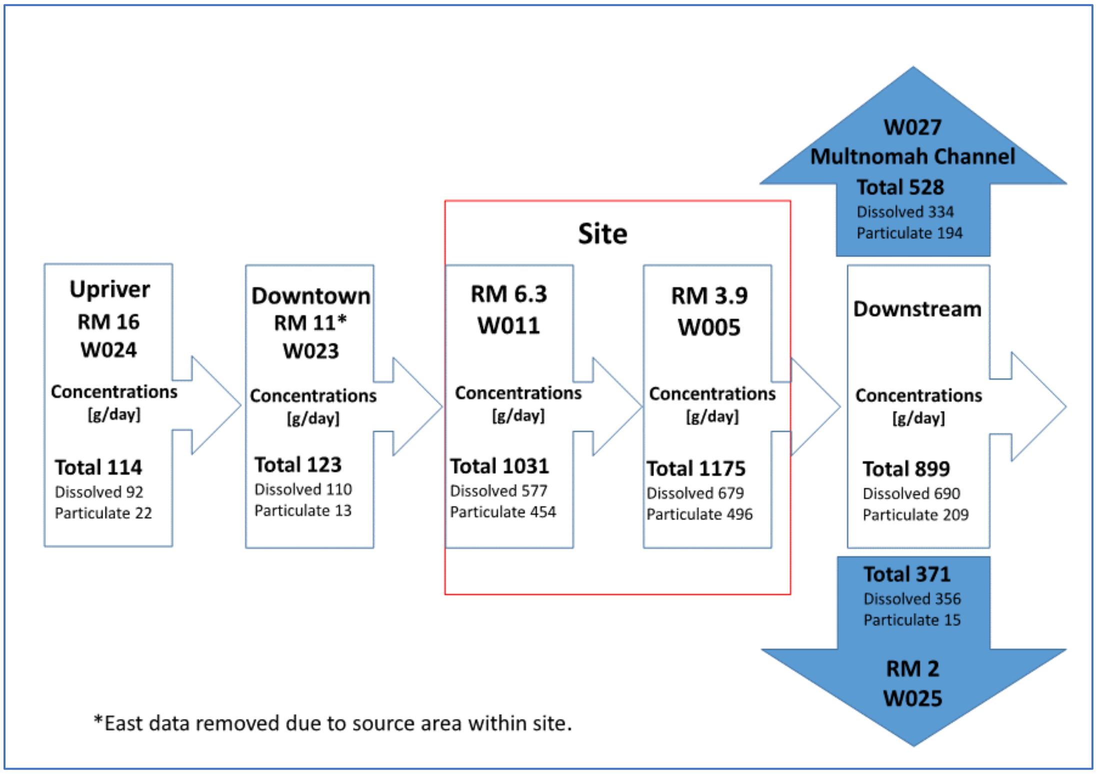
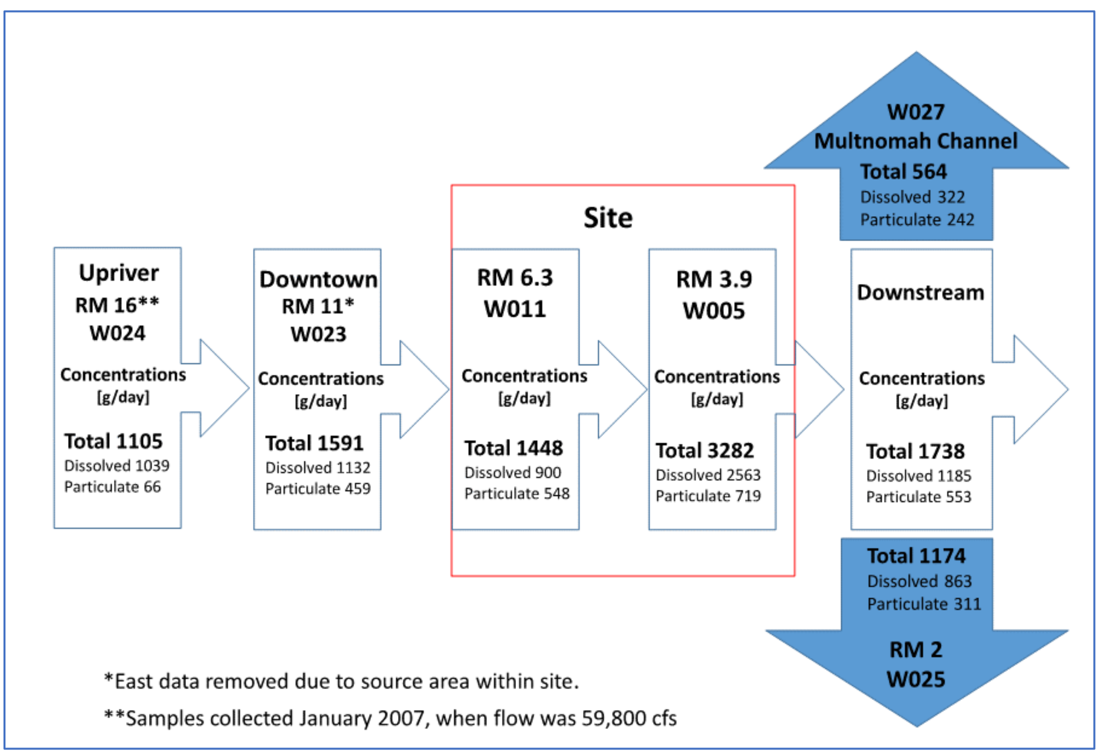


Figure 4 – PAH Loading under High Flow Conditions



Changes to the Portland Harbor Remedy based on Updated Human Health Toxicity Values for Benzo(a)Pyrene

January 11, 2018

Overview

- EPA updated the cancer slope factor (CSF) for benzo(a)pyrene (BAP) after the Portland Harbor ROD was issued
  - Revised from 7.3 mg/kg-day to 1 mg/kg-day
- Potentially changes risk-based direct contact and clam consumption cleanup levels for carcinogenic PAHs (CPAHs) that are based on BAP equivalents
- Potentially changes risk-based highly toxic principal threat waste threshold for CPAHs
- Requires evaluation of potential RAL changes related to cPAH direct contact and clam consumption risk
  - Must also consider impact of potential RAL change on RAOs 3 and 5

Proposed cPAH CUL Changes

- EPA proposes to change the cPAH cleanup levels based on the updated cancer slope factor (CSF) for benzo(a)pyrene (BAP)
- EPA proposes separate beach and in-water sediment direct contact CULs
  - Updated recreational beach CUL: 12 μg/kg to 85 μg/kg
  - Updated in-water sediment CUL: 106 μg/kg to 774 μg/kg
  - Updated clam consumption CUL: 3950 μg/kg to 107,600 μg/kg
  - Updated highly toxic PTW threshold: 106,000 μg/kg to 774,000 μg/kg
- Total PAH benthic risk CUL (RAO 5) of 23,000 μg/kg is unaffected by this change

Proposed Nearshore* Total PAH RAL Change

- EPA proposes that the current total PAH nearshore * RAL of 13,000 µg/kg should be changed to 30,000 µg/kg:
  - Change is necessitated based on BAP CSF change
  - EPA conducted an analysis that showed that a total PAH RAL of 30,000 µg/kg addresses all areas with cPAH exceeding 774 µg/kg on a rolling river mile SWAC basis (½ mile increments)
  - Small areas with cPAHs below 774 µg/kg on a SWAC basis but with total PAHs above the proposed 30,000 µg/kg will still remain (e.g., RM 2.8 east, RM 6.5 east and upper end of Swan Island Lagoon)

*Outside the Navigation Channel

Proposed Navigation Channel Total PAH RAL

- EPA proposes that the current total PAH navigation channel RAL of 170,000 µg/kg should be retained:
  - PAH contamination above 170,000 µg/kg is limited to the area between RM 5 -7
  - The current navigation channel RAL is well above the RAO 5 total PAH CUL of 23,000 µg/kg
  - Lack of sediment deposition observed within the navigation channel between RM 5 – 7 may limit achievement of RAO 5 through natural recovery in this reach if the RAL is increased
  - Increase in PAH loading to surface water has been observed downstream of RM 6.3
  - Increasing the total PAH RAL to 230,000 µg/kg (10X the total PAH Benthic CUL) results in minimal change to remedial footprint based on existing surface sediment data and may not achieve the ROD specified protectiveness standards for RAOs 3 and 5

CUL, PTW and RAL Change Summary

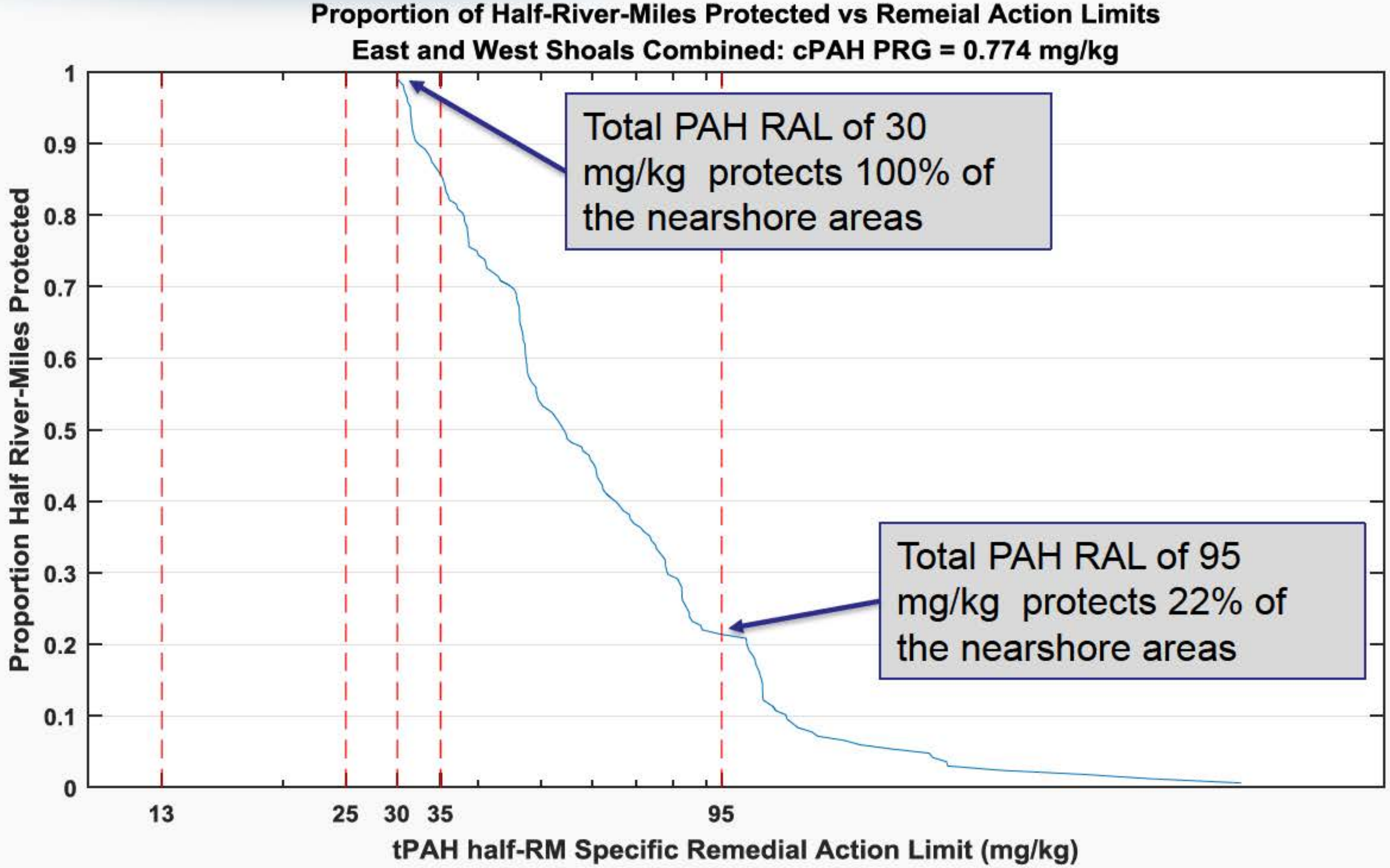
Scenario	Application Area	ROD Value	Updated Value
Direct Contact cPAH Beach Sediment CUL (RAO 1)	Beach Areas	12 µg/kg	85 µg/kg
Direct Contact cPAH In-Water Sediment CUL (RAO 1)	Nearshore sediment (excluding beach areas)	Not Included	774 µg/kg
Clam Consumption cPAH Tissue Target Level (RAO 2)	Site-Wide	7.1 µg/kg	51.6 µg/kg
Clam Consumption cPAH Sediment CUL (RAO 2)	Site-Wide	3,950 µg/kg	107,600 µg/kg
Benthic Risk total PAH Sediment CUL (RAO 5)	Site-Wide	23,000 µg/kg	23,000 µg/kg *
Highly Toxic cPAH PTW Threshold	Site-Wide	106,000 µg/kg	774,000 µg/kg
Nearshore total PAH RAL	Nearshore Sediment (Outside the Navigation Channel)	13,000 µg/kg	30,000 µg/kg
Navigation Channel total PAH RAL	Navigation Channel Sediment	170,000 µg/kg	170,000 µg/kg *

* No Change Proposed

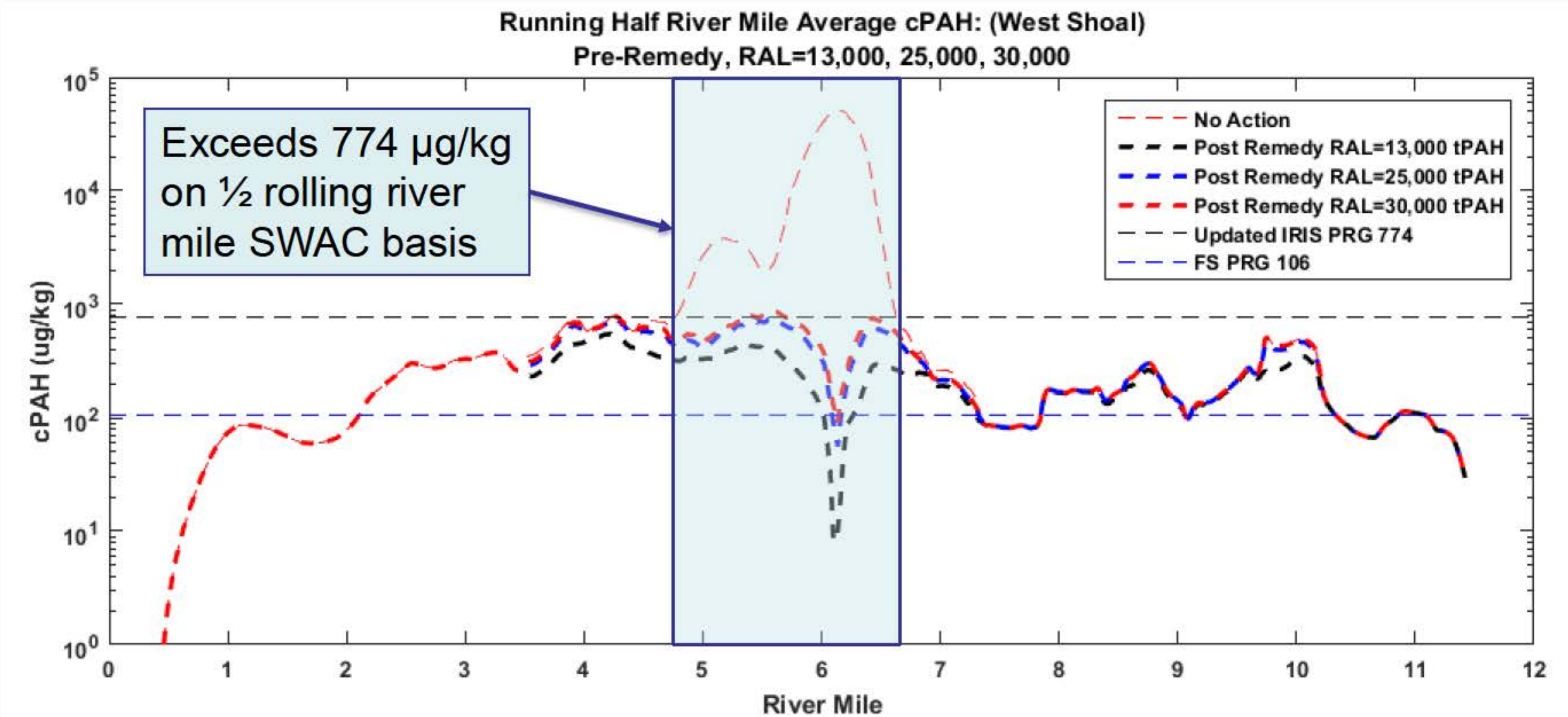
RAL Change Evaluation Summary

Criteria	Retain Nearshore RAL (13,000 µg/kg)	Adjust Nearshore RAL (30,000 µg/kg)	Retain Nav. Channel RAL (170,000 µg/kg)	Adjust Nav. Channel RAL (230,000 µg/kg)
Protective (Achieves RAOs)	Yes	Yes	Yes	No
Remediates areas not posing risk	Yes	Minimal	No	No
Achieves ARARs (WQS)	Potentially	Unknown	Potentially	Unknown
Ease of Implementation	Easy	Moderate	Easy	Moderate
PRP Acceptance	No	Yes	Potentially	Yes
State Acceptance	No	Yes	Yes	No

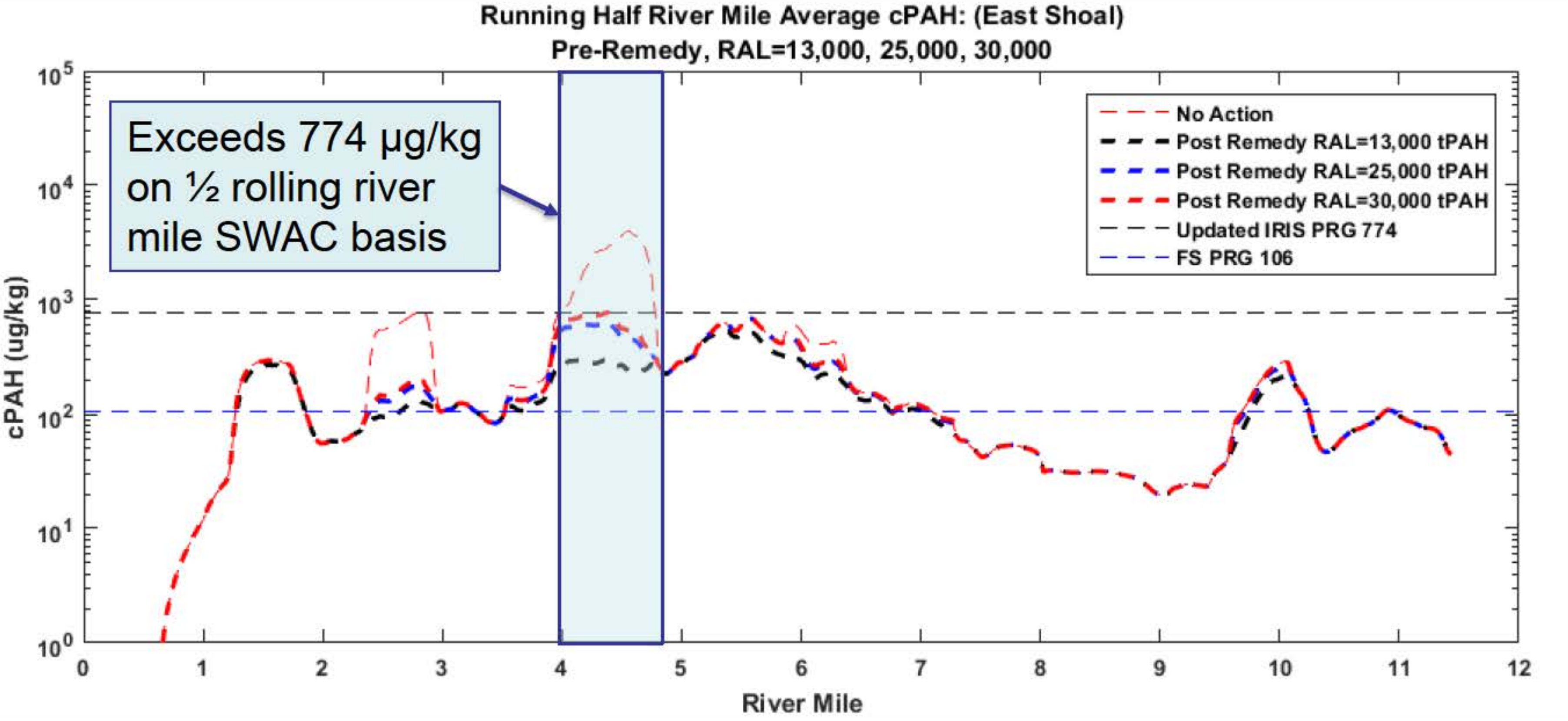
Backup Slides for Discussion



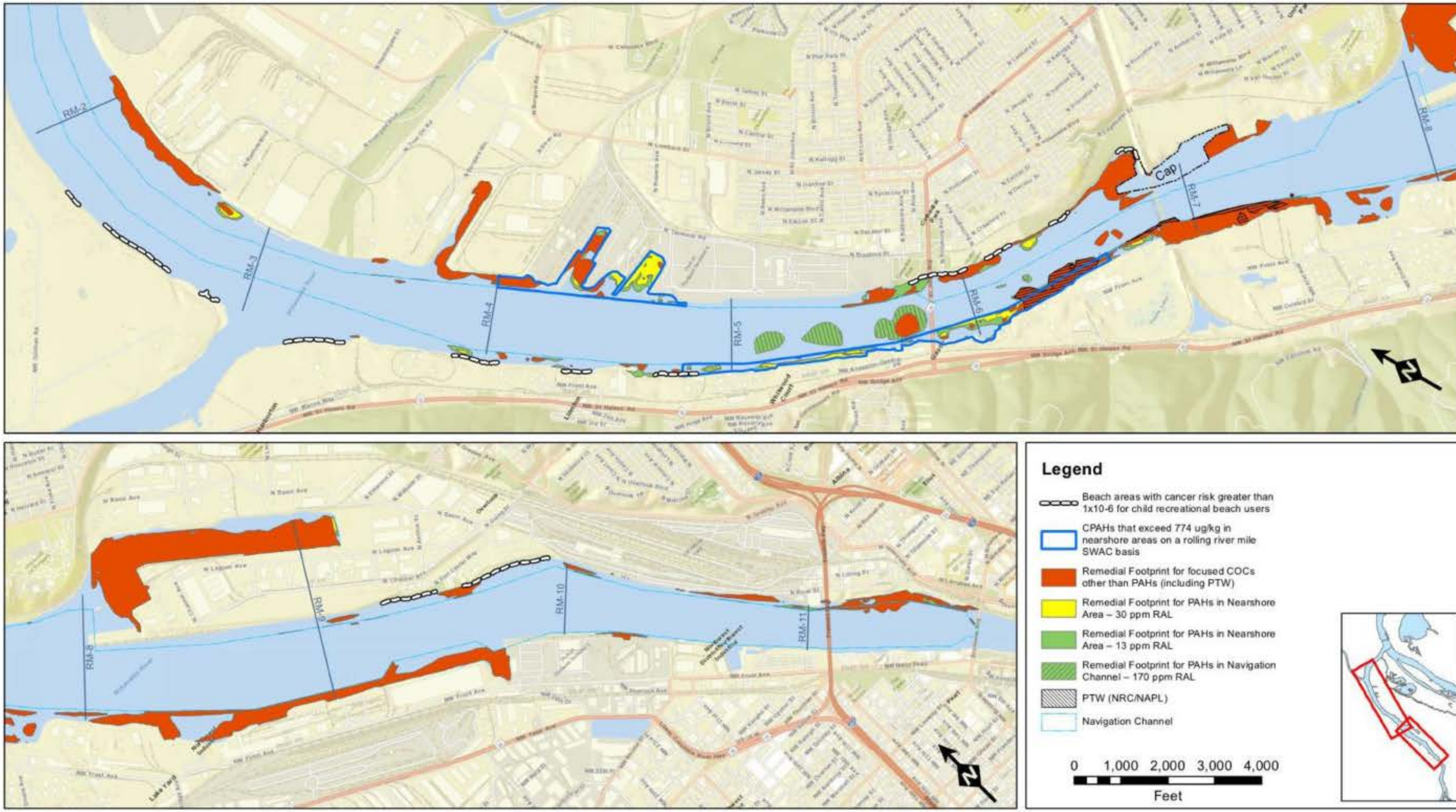
Proportion of Half-River-Miles Protected vs Remeial Action Limits
East and West Shoals Combined: cPAH PRG = 0.774 mg/kg
Proportion Half River-Miles Protected
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
13
25
30
35
95
tPAH half-RM Specific Remedial Action Limit (mg/kg)
Total PAH RAL of 30 mg/kg protects 100% of the nearshore areas
Total PAH RAL of 95 mg/kg protects 22% of the nearshore areas



Note: cPAH ½ rolling river mile SWAC was estimated assuming cleanup above total PAH RAL for each scenario



Note: cPAH ½ rolling river mile SWAC was estimated assuming cleanup above total PAH RAL for each scenario



Source Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User

Figure X-X. Selected Remedy Footprint comparison

Path: E:_Projects\Portland Harbor\GIS\MapDocuments\Post ROD Phase\PAH analysis\FigX-X_SMAs-based-on-PAHs-30ppm.mxd

Date: 1/2/2018

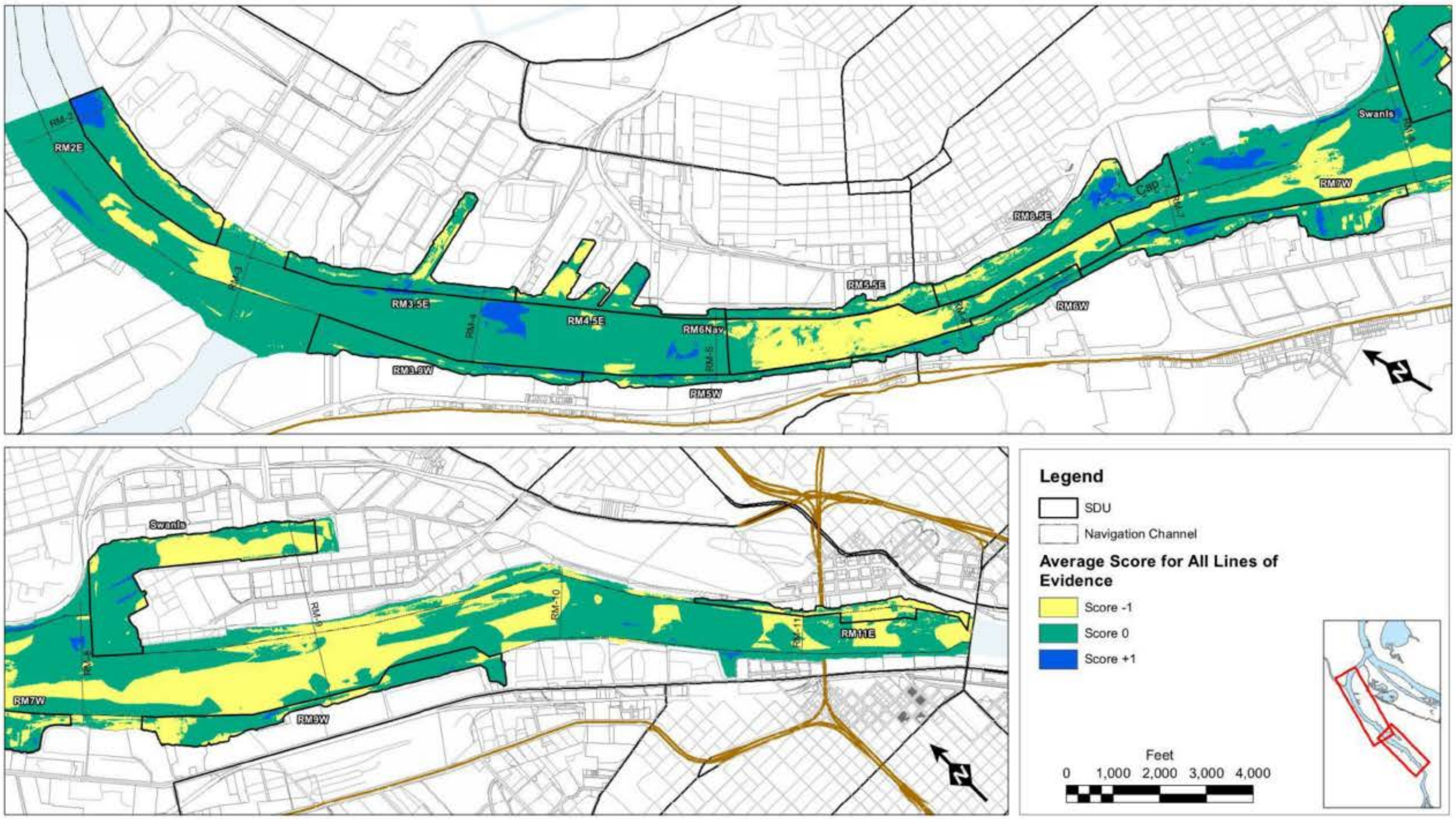


Figure D8-7. Average Score for Six Lines of Evidence

Path: E:_Projects\Portland Harbor\GIS\MapDocuments\FS Figures\Appendix D\FigureD8-x_MNR-Scoring.mxd, Created by: MLF

Date: 5/23/2016

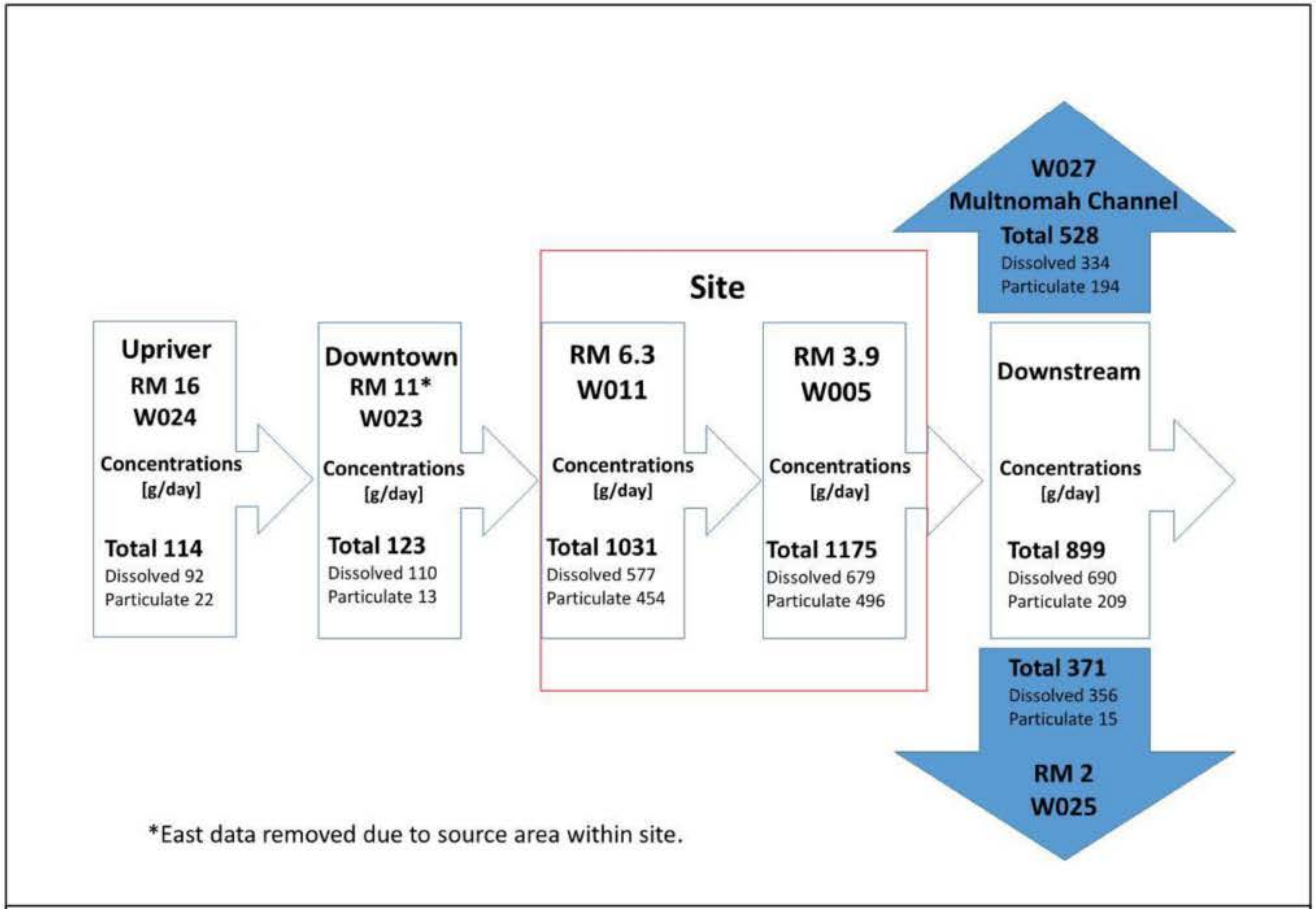


Figure 1.2-23a Portland Harbor Superfund Site PAH Loading Low Flow (Sept 2006) 8,730 cfs

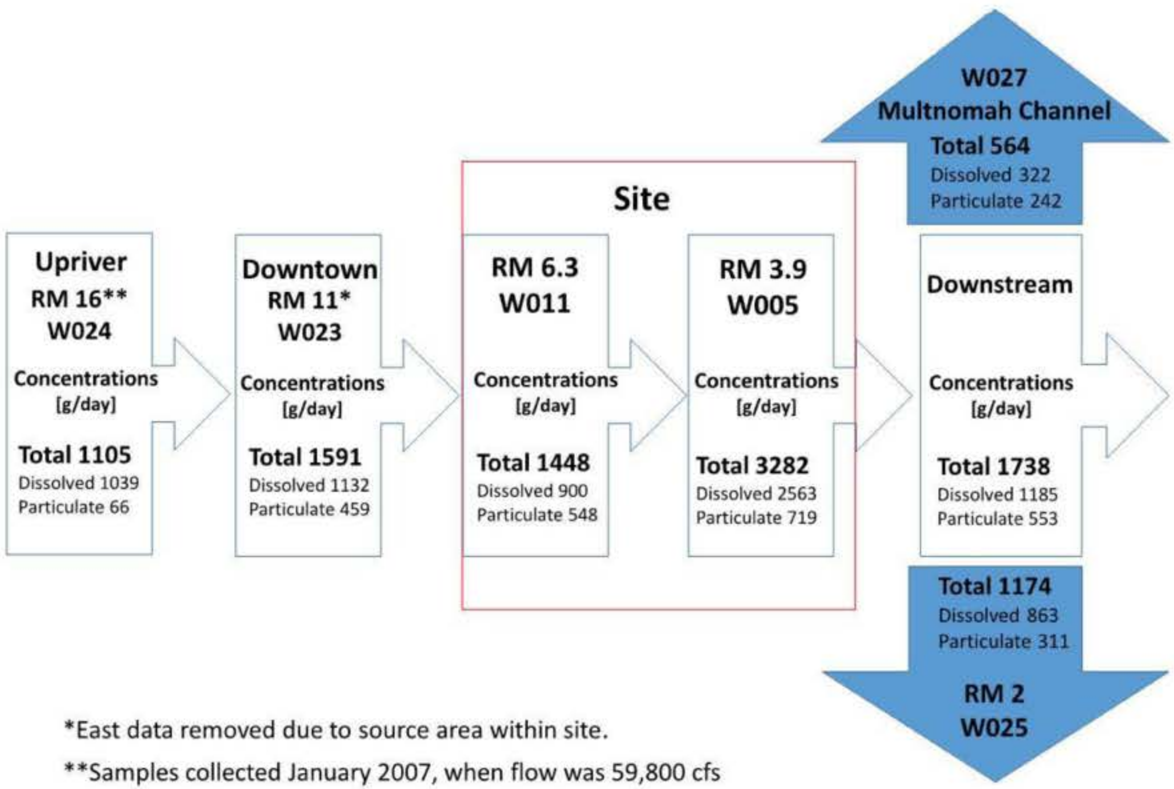


Figure 1.2-23c Portland Harbor Superfund Site PAH Loading High Flow (Feb-Mar 2007) 60,900 cfs

Remedial Footprint Area Summary

Scenario	Remedial Footprint (Acres)			Notes
	Current Remedy	Nearshore Total PAH RAL Change from 13 to 30 ppm	Remedial Footprint Change	
Total Remedial Area (All focused COCs)	364	340	24	Totals do not include 28 acres of ENR in Swan Island Lagoon
Contribution of PAHs to Remedial Area	66	42	24	Contribution of PAHs based on applicable RAL
Remedial Area below In-Water Sediment cPAH CUL (774 µg/kg)	18	3	15	Nearshore areas that do not pose risk based on comparison to revised in-water cPAH CUL
Navigation Channel NAPL/NRC PTW	6	6	0	No change in NAPL/NRC remedial footprint