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Scoping Memorandum

Date: 6 June 2017

To: Sean Sheldrake, Lori Cora, Stephanie Ebright – USEPA Region 10 and the Portland Harbor Pre-Remedial Design Group

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Subject: Overview of Proposed AOC Scope Pre-Remedial Design Investigation Studies – *For Discussion Purposes*
Geosyntec Project Number: PNG-0767

This scoping memorandum, prepared by Geosyntec Consultants, Inc. (Geosyntec) and AECOM Technical Services (AECOM), provides a conceptual overview of studies proposed for pre-remedial design at the Portland Harbor Superfund Site (PHSS or Site) located in Portland, Oregon. The strategy and scope of work is sponsored by a group of nine industrial parties called the Pre-Remedial Design (Pre-RD) Group. In the ROD, the selected remedy, Alternative F Modified (Alt F Mod) identified 396 acres of active remediation within the Site that extends from river mile (RM) 1.9 to 11.8 of the Lower Willamette River. The ROD also described a post-ROD sampling effort to delineate and better refine the sediment management area (SMA) footprints, refine the Conceptual Site Model (CSM), and support remedial design.

The proposed pre-remedial design investigation studies described in this memo are intended to meet these objectives and to support the allocation of the ROD. This Pre-RD scope of work focuses on site-wide studies that will re-baseline the river and assess current conditions, support the refinement of SMA footprints for allocation, support an initial discussion of Institutional Controls (ICs), and reduce the uncertainty and risk associated with implementation of the active remedy components. The scope does not include SMA-specific design-level sampling, nor source control evaluations, which could be conducted during later remedial design.

PROJECT GOALS

The synoptic data collected during this study (sediment, fish tissue, surface water) will be used to re-establish baseline conditions as of 2018, revisit the active remedial footprint (for remedy and allocation), and refine the conceptual site model (CSM). The upstream background concentrations will be used to evaluate remedy effectiveness targets. This proposed sampling program provides the best balance of (i) near-term initiation of field work; (ii) prioritizing field data collection of studies that provide informative updates to the Site baseline; and (iii) supporting the PCI allocation team's need to reduce remedy uncertainty.

The Pre-RD group proposes to conduct a comprehensive 2018 synoptic sampling program of surface sediment, fish tissue, surface water, select sediment cores, upstream porewater, and bathymetry/fish tracking studies. These proposed investigation activities are focused on achieving the following five goals:

1. Refine the active remedial footprints with new data to support allocation by reducing the uncertainty in remedy scope (specify depths, extent, and remedial technologies within SMA footprints);
2. Define the current baseline conditions by collecting synoptic 2017/2018 surface sediment, fish tissue, and surface water data;
3. Evaluate recovery trends (surface weighted average sediment concentrations [SWACs], points, trends, human health risk) to refine the remedial footprint for allocation, estimate recovery rates, and establish a point of reference for future long-term monitoring;
4. Refine the background/upstream dataset with new synoptic data to evaluate current conditions, and establish a benchmark for evaluating future recovery potential and progress towards remedial action objectives (RAOs); and
5. Evaluate calibration of the food web model (FWM) using new 2018 data to validate model predictions.

Table 1 lists the data that will be collected to achieve these goals. The 2018/2018 data will be used to determine current SWACs, human health risks, and background concentrations associated with both upstream and Site conditions.

The schedule includes time for development of focused work plans in 2017 for completing field investigation activities (planning and execution), data analysis, and reporting in two years (Figure 1). It is anticipated that the Pre-RD sampling and analysis activities will commence following a scoping meeting with United States Environmental Protection Agency (EPA) in June 2017 and completion of Administrative Order on Consent (AOC) negotiations (expected in mid-2017). The goal is to complete the AOC Pre-RD scope of work in two years, by June 2019.

PRE-DESIGN INVESTIGATION FIELD STUDIES

To achieve the goals listed above, the scope of work includes the following eight investigation field studies:

- Bathymetry survey;
- Surface sediment grab sampling (site-wide and upriver);
- Fish tissue sampling (site-wide and upriver);
- Surface water sampling (site-wide and upriver);
- Subsurface sediment coring;
- Fish acoustic tracking pilot study, with potential expansion to full study;
- Camera survey of anglers; and
- Porewater sampling in upstream areas.

In addition, although not currently part of our proposed AOC scope of work, we would like to engage EPA in discussions regarding a follow-up approach for composited/gridded surface sediment sampling of the Site to establish baseline for long-term monitoring and remedy performance evaluations.

All investigation field work will be completed by end of 2018. An interpretive data report(s) will be completed by second quarter 2019 (June 2019). Each study is briefly summarized below. Many of the field data will serve multiple data use objectives (DUOs), as shown in Table 2. Table 3 presents a summary of the Pre-RD investigation studies including media, sample counts, and analyses. Figure 1 presents the proposed project schedule.

Bathymetry Survey

A bank-to-bank, site-wide bathymetry survey is proposed to assess changes in elevation/sedimentation over the past 15 years and to evaluate mudline elevations relative to the remedial technology assignment requirements (per the ROD decision tree). The site-wide multi-beam bathymetry survey will be supplemented with lead-line measurements along the shoreline banks and difficult-to-access areas for better coverage than provided by multi-beam alone. Results may also serve as a line of evidence relative to the evaluation of riverbank slope conditions, natural recovery, and bed stability (e.g., erosional vs. depositional areas). The last bank-to-bank survey was performed in 2002. The new bathymetry data will also be used to help identify target areas for surface sediment sampling, refine the elevation clearances for capping and dredging, and adjust the dredge volumes (to reduce uncertainty for allocation associated with the extent of the active remedial footprint and remedial technologies assigned to them). The anticipated schedule for the bathymetry survey is the third quarter of 2017.

Surface Sediment Sampling

Many of the surface sediment data are over 10 years old. The goals of new surface sediment data collection include: re-baseline the river to establish current conditions and SWACs, refine the active remedial SMA footprints, and evaluate natural recovery trends. Because Portland Harbor is part of a dynamic river system, current concentrations for focused constituents of concern (COCs) are expected to be different than the data set used in EPA's RI. The focused COCs include polychlorinated biphenyls (PCBs), dioxins/furans, DDx, and polycyclic aromatic hydrocarbons (PAHs). The scope includes synoptic surface sediment sampling (0 to 30 centimeters [cm]), as well as fish tissue and surface water samples (discussed below), to provide an empirical and statistically valid[1] dataset for re-baselining the river and evaluating the CSM.

Several stratified/random/equal allocation methods of statistical analysis were used to estimate the appropriate sample size within the Site needed to satisfy the DUOs described above. A summary of the geostatistical analysis, approach, and findings is summarized in Attachment A. Previous analyses (Wolf, 2015a; Wolf, 2015b; Toll et al., 2015) found that the river is spatially and chemically stratified into four river segments, each about 2 to 3 miles long. These four segments include: RM 1.9 to 5 (Segment 4); 5 to 7.5 (Segment 3); 7.5 to 9 (Segment 2); and 9 to 11.8 (Segment 1). Based on physical and chemical signatures, Swan Island Lagoon may be separated as a fifth segment. A key use of the new data (along with the fish tracking results and determination of smallmouth bass [SMB] home ranges) will be to confirm the representativeness of these segment delineations, then estimate SWACs site-wide, within each segment, and potentially at smaller spatial scales.

Site Area. As detailed in Attachment A, the sample count was determined by considering the number of discrete surface sediment samples needed in each segment to statistically detect

[1] This pertains to the number and location of proposed sediment samples. Details regarding sampling collection methodology, analysis, and associated quality control are expected to be developed in accordance with EPA guidance and standard operating procedures (SOPs) aligned as practicable with past EPA-approved sampling investigations.

differences ($p<.05$) between 2004 SWACs and current SWAC estimates with 95% confidence. An estimated 300 to 500 discrete surface sediment samples are needed to yield a statistically-robust new data set for calculating SWACs. We expect this new dataset to replace older RI/FS data for the purposes of refining the SMA footprints and technology selections.

Upstream/Background. An additional 30 to 40 discrete samples will be collected from upstream background areas with grain size and organic carbon content similar to the Site. A minimum of 30 samples are needed for statistical purposes.

Adjustments to the sample count and analytical program may be necessary after further discussions with EPA. Surface sediment grab samples will be collected as discrete samples from 0- to 30-cm depth using the RI data collection protocols. Samples will be analyzed for focused COCs (PCBs, dioxins/furans, DDx, PAHs) as well as total organic carbon (TOC), and grain size. The anticipated schedule for the surface sediment sampling is the beginning of the fourth quarter of 2017 through the first quarter of 2018.

Fish Tissue Sampling

The primary objectives of the fish tissue chemistry study include collecting the data needed to:

- Characterize current levels of selected COCs in resident fish tissue (SMB) on a site-wide basis and smaller spatial scale (pending results of the fish tracking study);
- Characterize upriver background concentrations in resident fish tissue (SMB);
- Update statistically-based evaluations of PCB trends in fish tissue; and
- Evaluate the bioaccumulation model used to relate sediment and tissue concentrations (input new SWACs, fish tissue, and surface water concentrations into the model).

The proposed study includes collection of synoptic SMB data to re-baseline resident fish tissue concentrations in the river, evaluate monitored natural recovery (MNR) trends, refine or recalibrate the FWM, and update human health fish consumption risks. The scope includes 95 whole body discrete samples, plus 10 upstream background discrete fish tissue samples, which is consistent with the 2012 SMB sample design (Figure 2). The sample design targets 20 to 30 samples in each of the four segments (described previously), including 5 samples in Swan Island Lagoon. A statistical analysis of the 2012 SMB data indicates that replicating the 2012 program sample size would allow detections of statistically significant ($p<.05$) trends for PCBs in SMB. A summary of the statistical power analysis performed for fish tissue sample size is provided in Attachment B.

Analytes will include PCBs and a subset for dioxins/furans and DDx (assume 33% of total sample size based on the more localized contribution of these contaminants to Site risk). Collection methods will include hook and line with electroshock back-up if needed. The anticipated schedule for the fish tissue sampling is summer of 2018.

Surface Water Sampling

The objective of surface water sampling is to re-baseline river conditions with synoptic data (sediment, fish tissue, surface water), evaluate surface water current conditions and trends, and provide current 2018 input data for the FWM to calculate current risks. Surface water data will be collected using a peristaltic pump, consistent with RI/FS approaches and methods. Surface water will be collected from 9 transect locations over three sampling rounds (high flow, low flow, and storm) with five transects located within the Site – one from each of the four main channel river segments, one in Swan Island lagoon – plus two transects at the boundary conditions, and two upstream transects. The proposed transects are located at approximately RM 1.8, Multnomah channel entrance near RM 3, RM 4, RM 7, Swan Island Lagoon, RM 8.8, RM 11.6, RM 16.2, and RM 26, to characterize the flow and quality of surface water passing through the river's cross section at each location. These locations were targeted to provide spatial coverage and physical changes in the river dynamics.

Three vertically-averaged composite samples will be collected per transect (similar to the RI/FS approach), except Swan Island Lagoon will have one composite sample.[2] Each sample will be analyzed for suspended solids in the water column (total suspended solids [TSS]), particle size distribution, and chemical testing for PCBs, DDx, PAHs, and dioxins/furans (total and dissolved). The anticipated schedule for the surface water sampling will start in the winter 2017 through summer 2018. The RI sampling events previously targeted November, March, and July for sampling. A total of 50 water samples (25 total and 25 dissolved) will be analyzed per event, for a total of 150 samples.

The synoptic TSS and particle size distribution data could be used in the future for hydrodynamic and sediment transport (STM) model refinement and calibration (these data are needed based on our review). The chemistry data would be needed, and could be used, for future fate and transport model refinement.

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[2] Vertically-integrated sample collected from 0.3 meters below the water surface to within 1 meter of the river bottom by lowering and raising the sample tube intake while pumping water at a pre-determined rate. The Round 2A RI study composited the three samples into one transect-composite sample. We propose three samples per transect for testing.

Subsurface Sediment Coring

Subsurface sediment sampling will be conducted in targeted areas within or along the boundaries of SMAs that have limited data coverage to refine the active footprint boundaries of the Alt F Mod SMA footprints. The goal of this study is to refine the horizontal and vertical extent of contamination at concentrations greater than the RALs at depth, to confirm the CSM, and to refine the dredge volumes. A total of 50 to 90 core locations are proposed based on visual distribution of subsurface contamination, using 250- to 300-foot distance as a general guide to the next nearest coring location. In some cases, stations will be reoccupied to determine the vertical extent of contamination where previous cores did not "tag bottom" and in other cases, a new core will be collected in an active footprint area where none previously existed.

Cores will be collected using a vibracore and visually logged using American Society of Testing Materials (ASTM) and RI procedures, then subsampled into 2-foot increments unless stratigraphy indicates otherwise. Proposed coring locations may be adjusted after the SMA footprints have been revised based on 2018 surface sediment sampling results. Subsurface sediment samples will be analyzed for focused COCs, or a subset of selected COCs and depths depending on the SMA.

Fish Acoustic Tracking Study

An acoustic fish tracking study may be conducted to capture fine-scale temporal and spatial movement of SMB at the Site, pending pilot study results. A pilot study is planned for June 2017 and the study will provide data on the range and reception of fish tracking equipment in two different acoustic environments (more quiescent and more active). The results of the fish tracking pilot study will be used to assess the value of conducting a full-scale study.

If the pilot study provides valuable data, a full-scale study will be conducted over a one-year period to capture seasonal home range patterns. Using a more refined acoustic telemetry approach than the historical (2000-2003) radiotracking study, the results will re-evaluate where and to what extent SMB stay within the 1-mile exposure areas assumed in the FWM.

This study is being designed to use more refined technology and provide more robust data than the previous radiotelemetry study (Friesen 2005); we expect these results to replace previous findings if different. These results will be used to refine or recalibrate the FWM and reduce uncertainty about remedy effectiveness for fish tissue recovery. The anticipated schedule for the full-scale fish tracking study, if conducted, is fourth quarter 2017 through 2018. The work will be performed in collaboration with Karl Gustavson, EPA Office of Superfund Remediation and Technology Innovation (formerly United States Army Corps of Engineers [USACE]) and experienced staff from USACE Engineer Research and Development Center (ERDC).

Camera Survey of Anglers

A camera study is proposed to collect data on the location and frequency of people fishing along the river. The results will provide an empirical line of evidence on frequency and duration of angler trips over a year-long period that can be used to support the development of institutional controls (e.g., targeted locations and seasons for messaging).

The camera survey program will consist of photographic documentation of human activity using a network of cameras in the Site. The scope assumes installation of 12 stationary cameras at select locations that are known or suspected to be used by anglers or are popular points of access to the river based on prior studies and angler knowledge. Cameras will be pre-set to take photos at 30-minute intervals during daylight hours.

The survey will be conducted over a one-year period to account for seasonal variation in use. Photographs will be uploaded monthly to digital photographic software for visual review and tagging with descriptors (e.g., date, location, time, number of individuals), and stored in a project database. A similar camera study recently performed at the Berry's Creek Superfund Site in New Jersey provided data on human use of the Site for fishing, crabbing, boating, etc., and can help support the development of institutional controls.

The anticipated schedule for the camera survey is fourth quarter 2017 through 2018.

Porewater Sampling in Upstream Areas

The EPA conceptual sampling framework for pre-design sampling (17 March 2017) identified the collection of background (upstream) porewater samples as a baseline monitoring element. Background metals concentrations in porewater were not defined during the RI and the focus of a background porewater characterization would be naturally occurring metals. Background metals porewater concentrations should be developed and cleanup levels adjusted accordingly. The scope of the Pre-RD study is to place passive porewater samplers, or a similar device to collect porewater, at eight upstream locations co-located with bulk sediment grab stations. The samplers will be equilibrated for a 2- to 4-week period then retrieved. Porewater samples will be analyzed for freely-dissolved COC metals. Porewater results from passive samplers could be compared to laboratory-derived porewater samples from the upstream bulk sediment surface grab locations.

Gridded Composite Surface Sediment Sampling – for Long-term Monitoring

A composite sediment sampling approach is appropriate for evaluating future post-remedy long-term monitoring conditions. We would like to collaboratively explore a draft protocol with EPA for evaluating post-remedy SWACs and remedy effectiveness. A stratified random, gridded, composite sampling approach could be implemented later during remedial design under a separate AOC. A composite sampling program is not currently proposed as part of this AOC scope of work.

The gridded composite samples would establish baseline conditions for comparing with future post-remedy data and SWACs. As discrete samples, a monitoring dataset is subject to outliers, and a lot of variance. To minimize these effects, composite sampling would be incorporated into a future long-term sampling program. Project examples are presented in Attachment C. We propose that a similar approach be discussed for the Portland Harbor Superfund Site in collaboration with EPA.

DATA ANALYSES

Data collected from the AOC scope pre-design investigation field studies will be summarized and analyzed to meet several DUOs (see Table 2). Field work will be completed by the end of 2018; data analyses will be completed by the first quarter of 2019 and include the following elements:

- Evaluation of current sediment conditions and refinement of the active remedy footprint;
- Use of bathymetry data to refine the elevation requirements of the active remedy footprint, especially in the riverbank areas;
- Refinement of the CSM and understanding of current conditions;
- Refinement of sediment recovery curves based on empirical data trends (and confirm RALs);
- Re-calculation of site-wide and segment-wide surface sediment SWACs using new data, may also consider other spatial scales;
- Evaluation of fish tracking results to refine the extent and segmenting of the river (for calculation of SWACs) and assess fish home ranges used in the FWM;
- Update the trend analyses of validated 2017/2018 surface sediment, fish tissue, and surface water data;
- Assessment of new bathymetry for bed stability and fish/sediment data for monitored natural recovery potential;
- Evaluation of current (2017/2018) upstream background concentrations; and
- Use of new data to refine or recalibrate the FWM and update calculations of baseline fish consumption risks.

Deliverables will include data summary tables, data graphics such as box-and-whisker plots, maps depicting the spatial distribution of sediment chemistry for selected analytical parameters, a comparison of site conditions to the active Alt F Mod remedial footprint, trend analyses, and new SMA boundary maps. Draft deliverables will be provided to EPA at milestone endpoints of particular tasks. The 2017/2018 sampling program will be statistically robust to support calculation of site-wide SWACs and assess spatial patterns without reliance on older data. The older RI/FS data will only be used for trend analysis.

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LIST OF TABLES AND FIGURES

ATTACHMENTS

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Table 1. Project Goals for Pre-Remedial Investigation Design Scope of Work

#	Project Goals	Spatial Scale	Media	Questions to Answer
1	Obtain SMA baseline characterization data adequate to refine the remedial footprint for allocation purposes	SMA specific	Discrete sediment grabs (0 to 30 cm), bathymetry, sediment cores	• Have the active remedial footprints changed since the FS? Can we refine the footprints and reduce uncertainty? • Have the elevations changed since the FS, hence the footprint changes through the ROD technology decision tree? • What are the extent of footprints above RALs?
2	Establish current baseline conditions (SWACs, human health risk) to evaluate future remedy performance and progress towards RAOs	Site-wide, segments	Surface sediment, fish tissue (SMB), surface water	• What are concentrations of COCs prior to remedial activities? • Do results support refinement of the remedial footprint? • What are current baseline risks? • *Note: ideally, sediment composites would be used as baseline for long-term monitoring*
3	Evaluate recovery trends within the Site to estimate recovery rates and refine the remedial footprint	Site-wide, segments	Surface sediment, fish tissue (SMB), surface water	• Are Site conditions improving? • Are there improvements that lead to a different remedial footprint? • Can a recovery rate be calculated?
4	Update background dataset	Upstream RM 11.8 to 28	Surface sediment, fish tissue (SMB), surface water; porewater	• What are background concentrations of select COCs in sediment and fish tissue, and have they changed since the FS? • What are background concentrations of metals COCs in porewater? • How could new data inform future evaluation of remedy performance?
5	Update FWM calibration for evaluating progress towards RAOs	Site-wide, segments	Surface sediment, fish tissue (SMB), surface water, SMB home range	• Can we confirm relationships and assumptions used in the model? • How should fish tissue (SMB) data be evaluated for monitoring remedy effectiveness?

Notes:
(1) Data collected for each project goal may serve multiple data use objectives (DUOs).
(2) This scope of work proposes to collect discrete surface sediment samples because of multiple DUOs. Ideally, the baseline sediment dataset to be used as a starting point for comparing future long-term, monitoring data, would be based on a stratified random, composite sampling approach.
(3) COCs = chemicals of concern; FWM = food web model; FS = feasibility study; RAL = remedial action level; ROD = Record of Decision; SWAC = surface weighted average concentrations; SMB = small mouth bass

Table 2. Data Use Objectives for Pre-RD Investigation Studies

Proposed Scope Item			Data Use Objective (DUO)									
#	**Task**	**Purpose**	**CSM**	**Update SWAC**	**Recovery Trend**	**Model Calibration**	**Risk Update**	**Institutional Controls**	**Active Footprint/ RAL**	**Remedial Technology**	**Allocation**	**Future Compliance**
Pre-Design Field Investigation Studies												
1	Site-wide bathymetry survey	footprint	X		X	X			X	X	X	
2	Surface sediment sampling (discrete)	recovery/bkgrd	X	X	X	X	X		X	X	X	X
2	Fish tissue sampling	recovery/bkgrd	X		X	X	X	X				X
4	Surface water sampling	recovery/bkgrd	X		X	X	X					
5	Sediment cores	footprint	X		X				X	X	X	X
6	Fish acoustic tracking study (USACE)	fish home range	X	X		X	X					X
7	Camera survey of anglers	risk/IC	X				X	X				
8	Porewater sampling	bkgrd	X				X		X	X	X	X
Technical Analyses / Reporting												
A	Focused work plan for AOC	scope	X									
B	Evaluate current conditions and recovery trends	footprint/ recovery	X	X	X	X	X		X	X	X	X
C	Evaluate background levels	recovery	X		X		X					
D	Refine active footprint	footprint	X	X					X	X	X	X
E	Refine food web model and human health consumption risks	recovery/risk	X	X	X	X	X	X	X		X	X
G	Data Interpretation Report	footprint/ recovery/bkgrd/ risk	X	X	X	X	X	X	X	X	X	X

Table 3. Summary of Pre-RD Study Media, Sample Counts, Analyses

Media	Location	Approximate Sample Count	Analyses
Surface Sediment	Site	300 to 500 (discrete grabs)	Focused-COCs (PCBs, dioxins, DDx, PAHs), plus TOC, grain size
	Upstream	30 to 40	
Fish Tissue (SMB)	Site	95 (whole body)	PCBs and a subset for dioxins/furans, DDx
	Upstream	10 (whole body)	
Surface water	Site / Upstream	9 transects, 3 vertically-composited samples/ per transect 75 samples (total) 75 samples (dissolved)	Total and dissolved for focused-COCs plus grain size, TSS
Sediment Cores	Site	50 to 90 cores 2 to 8 samples/ per core	Focused-COCs (PCBs, dioxins, DDx, PAHs) plus TOC, grain size
Porewater	Upstream	8 samples	Dissolved metals

Notes:

(1) Total sample counts will be increased for QA/QC samples (5 to 10%).

(2) The proposed surface water transects are located at approximately RM 1.8, Multnomah channel entrance near RM 3, RM 4, RM 7, Swan Island Lagoon, RM 8.8, RM 11.6, RM 16.2, and RM 26. Swan Island Lagoon transect may be composited into one sample for chemical testing per event.

(3) The four Site segments include: RM 1.9 to 5 (Segment 4); 5 to 7.5 (Segment 3); 7.5 to 9 (Segment 2); and 9 to 11.8 (Segment 1). Based on physical and chemical signatures, Swan Island Lagoon may be separated into a fifth segment.

(4) Sampling and analysis methods capable of low-level concentration detection may be included for selected surface water transects.

(5) PCBs = PCB congeners; SMB = smallmouth bass; TOC = total organic carbon; TSS = total suspended solids

Figure 1 – Proposed Project Schedule – Draft

	Project Task	2017 Q1	2017 Q2	2017 Q3	2017 Q4	2018 Q1	2018 Q2	2018 Q3	2018 Q4	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4
EPA ROD / Post-ROD Overview Schedule																	
1	*ROD Date*																
2	*Next Phase Negotiations*																
4	*Consent Decree(CD) for Pre-Design Studies*																
5	*Pre-Design AOC - Statement of Work*																
6	*Conduct Pre-Design Studies (see below)*																
7	*Present Data for ROD considerations, and interim agreements*																
Pre-Design Study																	
5	***Scoping / Meetings***																
	Work plan/CSM scope evaluation & planning																
6A	***Field Collection /Lab Analysis***																
	Site-wide bathymetry survey																
	Fish Acoustic Tracking Study																
	Camera Survey of Anglers																
	Surface sediment sampling																
	Surface water sampling																
	Tissue sampling (2018 summer/early fall, 6 wks)																
	Sediment Coring																
	Porewater sampling upstream																
6B	***Data Evaluation***																
	Technology decision tree - steep slopes, NAPL, PTW																
	Data analysis (new SWACs, re-baseline current footprint)																
	Data analysis (MNR trends - bedded sediment)																
	Data analysis (MNR trends-tissue)																
	Foodweb modeling																
	Upstream Background evaluation (sediment, tissue, SW)																
7	***Deliverables***																
	Data Report - surface sediment																
	Data Report - tissue and surface water																
	Data Interpretation Report - active footprint, sediment trends/background																
	Data Interpretation Report - human health risks, tissue trends/background																

ROD Jan 17, 2017

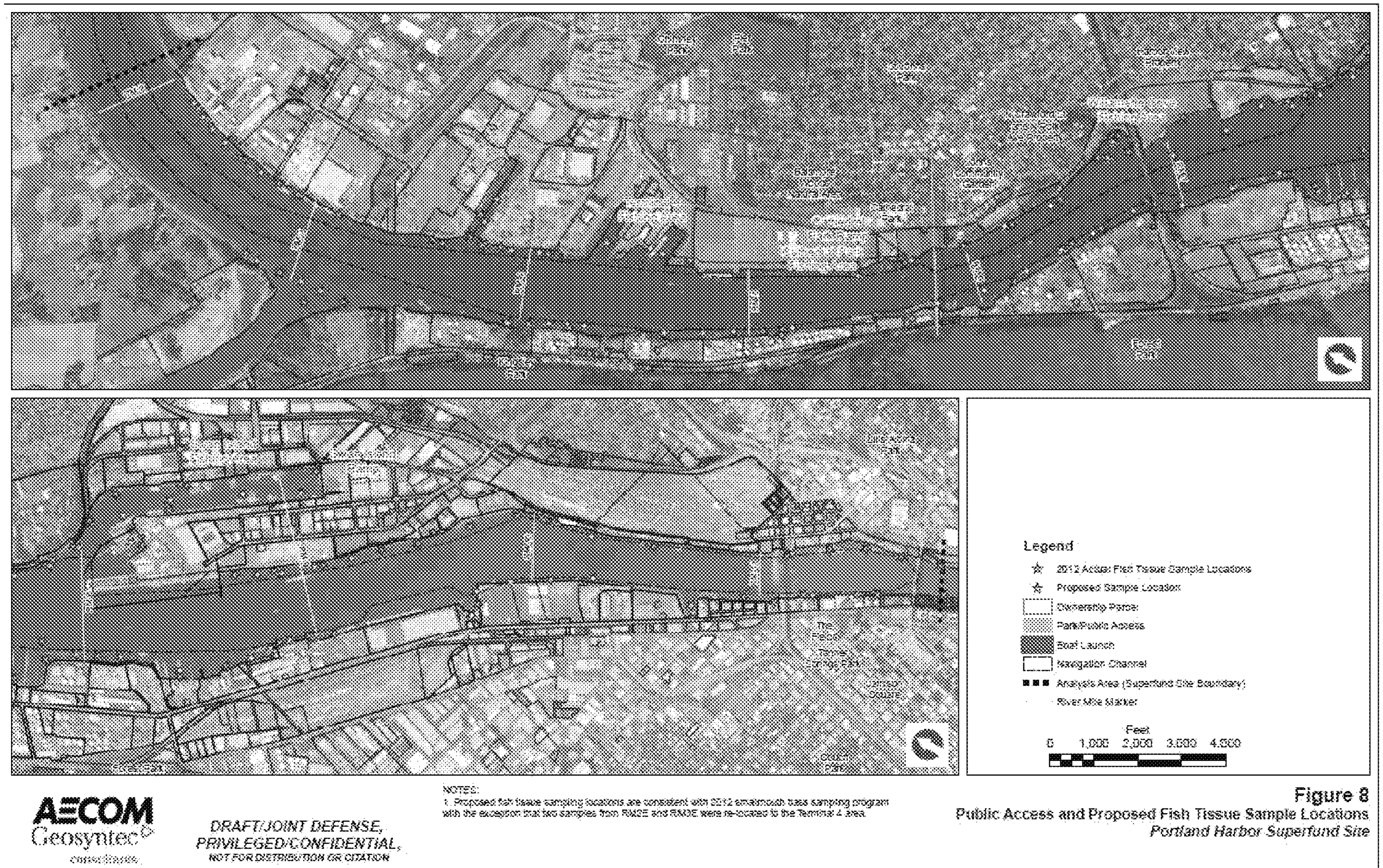
GOAL: Complete AOC Scope by Q2 2019

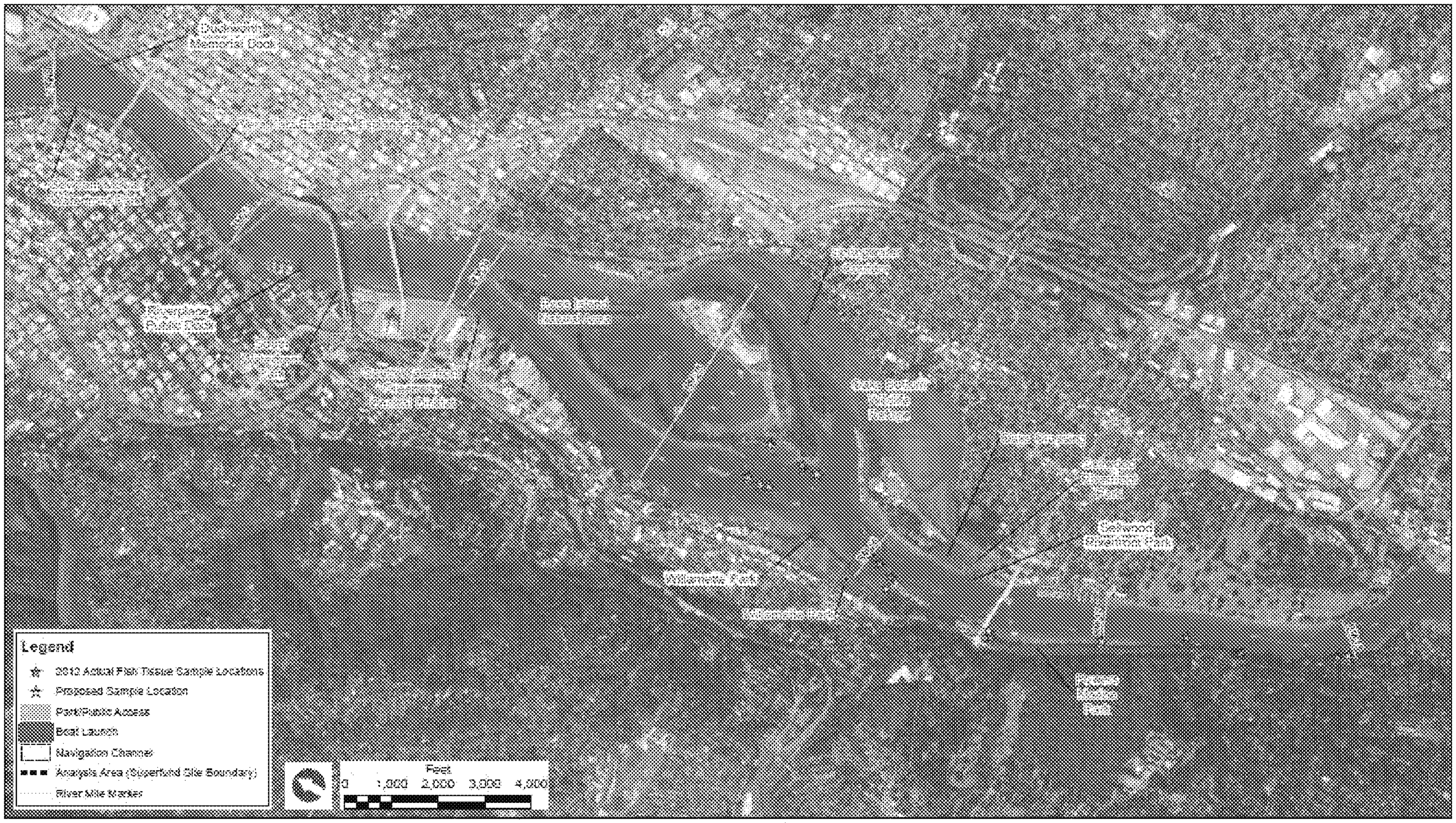
GOAL: Complete fieldwork by end of 2018 and analysis by Q1 2019

Notes:
AOC = administrative order on consent; CD = consent decree; RD = remedial design

= plan & model prep/ reporting
= field work, analysis, data validation
= uncertainty schedule lag

Figure 2 – Proposed Fish Tissue Locations in the Site (2A) and Upstream (2B)





NOTES:

AECOM Geosyntec consultants

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Figure 9
Public Access and Proposed Fish Tissue Sample Locations RM 13 to 18
Portland Harbor Superfund Site

ATTACHMENT A

Sample Plan Objectives and Geostatistical Approach for Sampling of Surface Sediment Portland Harbor Superfund Site, Pre-Remedial Investigation Design Re-Baseline Study

Prepared by Geosyntec

This attachment details a proposed approach for identifying a re-baselining sampling approach for 2018 surface sediment and a geostatistical analysis of discrete surface sediment samples.

DATA OBJECTIVES

The 2018 baseline sediment sampling program has five primary objectives for collection of surface sediment samples at discrete locations within the Site (river miles 1.9 to 11.8):

- **Objective 1: Natural Recovery.** A key objective is to assess natural recovery between the period of 2004 to 2018, and to quantify the rate of natural recovery. There are several robust and statistically-valid approaches for evaluating the data needed to evaluate natural recovery, and these are likely to be fully utilized following data collection in 2018. The simplest approach would be to compare site-wide and segment-by-segment surface weighted average sediment concentrations (SWAC) estimates and 95% Confidence Intervals (SWACs) for 2004 and 2018, looking for statistically significant differences at a level of at least $p<.05$. Additionally, stations sampled in both 2004 and 2018 could also serve as the basis by which to conduct paired evaluations or univariate and multivariate regression procedures with temporal and/or spatial data (GSI Environmental, Inc., 2014; Kleinfelder, 2015; Geosyntec Consultants, Inc., 2016; Newfields, 2016).[3]
- **Objective 2: SMA Delineation.** Delineating the sediment management areas (SMAs) is also a key objective of the 2018 data. The 2018 sampling plan will provide an optimized dataset for significantly refining the current SMAs. This will enable initial remedial design calculations and allow for the planning of additional high-resolution delineation of SMAs that will be needed for engineering purposes during remedial design.
- **Objective 3: Risk Evaluation.** Similar to Objective 1, a key use of the 2018 data will be to compare risk levels in 2018 to 2004. For example, it is anticipated that 2004 SWAC and 2018 SWAC estimates (or upper 95% confidence limits on the SWACs) on a site-wide and segment-by-segment basis would be input into risk assessment algorithms to evaluate the

[3] To achieve this objective, the sampling program may include some stratified sampling based on chemical distributions and spatial considerations such as erosional, stable, and depositional areas identified as part of the RI/FS.

expected decrease in risk that has likely occurred since 2004. The 2018 risk estimates may also be compared to background risk levels.

- **Objective 4: Remedy Success.** Data collected in 2018 will serve as a robust and precise baseline measurement for comparison of future post-remedy data to the remedy goals (or asymptote of a curve). In addition to comparing post-remedy sediment data to risk-based and remedial criteria, the post-remedy results must be able to be demonstrated to be significantly lower than the baseline 2018 results. Again, there are several approaches to the use of this data, but the simplest approach would be to compare site-wide and segment-by-segment SWAC estimates, or smaller stratified scales from actively remediated areas, or composite samples, and 95% Confidence Intervals (SWACs) developed in 2018 to those developed in post-remedy events at levels of significance of $p<.05$ or better.
- **Objective 5: Background Comparisons.** In addition to the sampling plan for the Site, discrete samples of surface sediment will be collected from background areas upstream of river mile 11.8 to provide a robust measure of concentrations of focused COCs in upstream areas. Future comparisons of SWACs on a site-wide and segment-by-segment basis would be made to statistics developed from the background dataset developed in 2018.

SAMPLE PLAN DEVELOPMENT

The basis for sampling within the Site boundaries (river miles 1.9 to 11.8) was devised according to the following steps:

- **Step 1: Initial Sample Count.** A variability reduction analysis was applied to evaluate the variability of the site-wide and segment-wide SWAC using the 2004 data set for total PCBs. This approach found that approximately 100 to 200 samples could be removed from the 2004 data without significantly increasing the variability of the SWAC estimate. Based on this analysis, an initial sample size of 200 was identified.
- **Step 2: Initial Sample Distribution.** In Step 2, the 200 samples identified in Step 1 were distributed among the Site and assigned discrete locations. 80 samples were placed at stations previously-sampled in 2004 (reoccupied sample stations). An even distribution among low and high areas of chemical concentrations was obtained by selecting locations among four groups of samples indicating concentrations of total PCBs (in 2004): the lowest quartile (0 to 25^{th} percentile), lower-middle quartile (25^{th} to 50^{th} percentile), upper-middle quartile (50^{th} to 75^{th} percentile), and highest quartile (75^{th} to 100^{th} percentile). Additionally, proposed locations were placed with even distribution among the entire reach, achieving a relatively uniform sampling density.

- **Step 3: Additional SMA Sample Delineation.** Recognizing that increased sampling density will be required to identify and delineate SMAs for preliminary design purposes, an increased sampling density was applied in bounding areas identified in the Alt F Mod footprint. Sample placement simultaneously considered (i) higher sampling densities in hotspot areas with higher variance/low certainty;[4] (ii) reoccupation of select 2004 sample locations not already identified in Step 2; (iii) relatively even sample spacing to ensure compact Thiessen polygons; and (iv) potential chemical concentration gradients (for all the focused COCs), and (v) physical and hydrodynamic features. Based on the various assumptions and considerations, this Step added approximately 100 to 300 samples to the design.

These three steps lead to a final sample design in the range of 300 to 500 samples within the Site. The sample count will produce a statistically valid surface sediment baseline dataset for calculating SWACs with the ability to detect significant differences between events with 95% confidence at $p<.05$.

ASSESSMENT APPROACH

A procedure for the quantitative evaluation of this sampling plan has been developed and indicates that the variation around the SWAC estimates is likely to be sufficient to enable the basic comparisons described above. For example, the 2004 PCB SWAC and the SWAC that would have been obtained in 2013-2016 (if the proposed sampling plan had been applied with the sample sizes noted) would be statistically distinct. Thus, assuming the natural recovery trend indicated in the 2013-2016 data, the future results that could be developed using the proposed sampling plan are likely to be able to indicate significant changes in SWACs since 2004 (e.g., the two SWACs are significantly different with 95% confidence at $p<.05$). However, statistically robust changes may still be concluded using less stringent hypothesis test statistics (e.g., lower confidence or power).

In addition, a power analysis (Champely, 2017) of the expected upstream sampling plan (40 additional discreet samples) indicates acceptable levels of precision for future comparisons of the Site to background conditions. It is expected that the sample plan itself, the approach for evaluating the sampling plan, and the sampling plan evaluation results will be presented in detail to EPA and stakeholders in subsequent communications.

[4] For reference, recent investigations at River Mile 11E Site used a sample density of 1 sample per every 100 to 200 feet.

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ATTACHMENT B
Power Analysis for Fish Tissue Sample Size
Portland Harbor Superfund Site, Pre-Remedial Investigation Design Re-Baseline Study
Prepared by AECOM

A statistical analysis was performed using the 2012 smallmouth bass (SMB) tissue data set for the Portland Harbor Superfund Site (Kennedy/Jenks Consultants, 2013) to estimate sample sizes for re-baselining fish tissue chemistry. Prior analyses of 2002, 2007, and 2012 data for polychlorinated biphenyls (PCBs) in SMB indicate fish tissue concentrations have declined over time. The primary focus of this analysis was to estimate the number of SMB samples needed to determine with statistical significance whether PCB concentrations have continued to decline since 2012. Comparison of historical and new means and 95% confidence intervals, as well as trend analysis, provide robust and statistically-valid approaches for evaluating the data to evaluate natural recovery, and are likely to be used following data collection in 2018.

An important aspect of monitoring design is power analysis, which was performed to estimate the difference that can be detected between the 2012 and re-baselining fish tissue data sets. This was illustrated by calculating the effect size (d) or the standardized difference between two means that could be detected (Cohen, 1988); and the minimum detectable difference (MDD) as a function of sample size and variance. The MDD is the difference between two means that must exist to detect a statistically significant effect/difference. The MDD is a commonly employed technique to indicate the potential significant difference at a given sample size in fish tissue monitoring (e.g., United States Environmental Protection Agency [EPA], 2000).

METHODS AND RESULTS

Two scenarios were evaluated: (i) assuming sample size equivalent to the 2012 smallmouth bass data set (n=83 Study Area, n= 9 upriver background); and (ii) assuming sample size equivalent to the targets set forth in the 2012 work plan (n=95 Study Area, n=10 upriver background) (Windward Environmental, 2012). The sample size calculations were performed considering two spatial scales: (i) site-wide; and (ii) four 2 to 3-mile segments.[5] Both spatial scales are relevant to evaluation of SMB in the risk assessment and bioaccumulation modeling.[6] Sample size estimation

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[5] The segmentation is based on prior analysis of the available data (Wolf, 2015).
[6] A spatial scale of 2 to 3 mile segments may better reflect the home range of SMB which ranges from 0.5 to 5.5 miles (Scott and Crossman, 1998). Based on a radio-tracking study of predator species in the Lower Willamette River, the median total distance traveled (upstream and downstream) by SMB was 4.3 kilometers (km) (2.7 miles), with 25th and 75th percentiles of 0.8 km and 8.0 km (Friesen, 2005).

to support statistical analysis of trend/natural recovery on an individual river mile (RM) basis is not a data use objective; large sample sizes would be needed to detect trends with adequate power. The power analysis was performed using the following assumptions:

- Confidence = 95% (alpha [α] = 0.05);
- Power = 80% (1-ß = 0.80); and
- PCB data lognormally distributed.

The assumption that PCB concentrations in the 2012 whole body SMB data set are lognormally distributed is based on distribution testing performed using @Risk v.6 (Palisades, 2012). Table 1 presents summary statistics for the 2012 SMB data set. PCB fish tissue concentrations were log (base 10) transformed for the power analyses. The assumptions of 95% confidence (α = 0.05) and power of 80% are used by convention to support statistically significant results (e.g., EPA, 2000). However, statistically robust changes may still be concluded using less stringent hypothesis test statistics (e.g., lower confidence or power).

The calculation of effect size (Cohen's d) was performed using the pwr package (Champely, 2017) in the R statistical computing (R Core Team, 2015). The calculation of the minimum detectable difference (MDD) as a function of the sample size and variance in the 2012 data was performed using the following formula and expressed as a percentage of the 2012 mean[7] (Harcum and Dressing, 2015):

MDD = √[(4σ2 (Z(1-(α/2)) + Z(1-β)) 2) ÷ N]

where:

N = total sample size (number of samples in 2012 and new baseline)
σ = standard deviation (assumed equal to 2012 sample populations)
Z(1-(α/2)) = 1.96
Z(1-ß) = 0.84
MDD = minimum detectable difference between 2012 and new baseline means

The effect size analysis indicates that replicating the 2012 sample sizes (actual or target sample sizes) will allow for moderate differences between the means to be detected on a site-wide basis

[7] While log transforming the data results in the power analysis being on the population geometric mean, results using the techniques described here are considered to be adequate practical approximations for the purpose of this analysis.

(Cohen's d of ~0.4). For the four segments, the 2012 sample sizes will allow for large differences between the means to be detected (Cohen's d of ~0.8).[8]

Results of the MDD analysis are summarized in Table 2 for the full Site (RM 2-12), each of the four segments, and the upriver background area. The MDD analysis was also performed excluding Segment 1 (RM 9-12), which has the highest mean and variance; eight of the ten highest 2012 PCB SMB samples were from Segment 1, which includes the RM11 area. Table 2 includes MDD results for combined Segments 2, 3, and 4 (RM 2-9).

As shown in Table 2, sample sizes consistent with the 2012 program (actual or target) result in a MDD of about 30% on a site-wide basis. The MDD improves slightly (about 1%) when the 2012 target sample size is used (increase of 12 samples site-wide). When the area with high variance is removed (Segment 1), the MDD is about 23% for the remainder of the Site.

On a river segment basis, sample sizes of 20 to 23 result in MDDs of about 28% to 40% in Segments 2, 3, and 4. In Segment 1 (RM 9-12) where variance is highest, sample sizes of 22 to 28 result in a MDD of about 60%. For upriver background, a sample size of 9 to 10 results in an MDD of about 60%. For upriver background, the means for the 2002 (n=6 composite samples) and 2012 (n=9 discrete samples) SMB data sets are similar (170 micrograms per kilogram [µg/kg] and 230 µg/kg, respectively).

Based on prior trend analysis indicating a decline of about 4% per year (Nielsen, 2015), the maximum change that could be expected in the new baseline data would be approximately 24% in 2018 from the 2012 site-wide mean assuming a linear response (declines may become asymptotic over time as conditions reach equilibrium). Based on the MDD values calculated in this analysis, sample sizes consistent with the 2012 program should be sufficient to detect a change of this magnitude on a site-wide basis (excluding Segment 1/RM11 area) with a high degree of statistical significance.

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[8] The Cohen's d statistic is a standardized measure of the size of the effect that can be observed between two means, with smaller values indicating smaller differences can be observed. Per Cohen (1977): 0.2 = small effect; 0.5 = moderate effect; and 0.8 = large effect.

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Table 1
Summary Statistics for 2012 Smallmouth Bass Data Set
Portland Harbor Superfund Site
Pre-Remedial Design Baseline Study

		2012 SMB Data (a)					
Domain	River Miles	n	Minimum (ug/kg)	Maximum (ug/kg)	Mean (ug/kg)	SD (ug/kg)	CV
Site-wide	2-12	83	92.4	6470	648.7	1185.9	1.8
Segment 1	9-12	22	134	6470	1531.6	2057.7	1.3
Segment 2	7.5-9 & SIL	23	118	1060	331.3	203.7	0.6
Segment 3	5-7.5	19	92.4	440	225.1	85.4	0.4
Segment 4	2-5	19	148	1280	434.2	299.8	0.7
Upriver Background	15-18	9	50.7	634	234.0	187.5	0.8

Notes
(a) PCB wet weight data from 2012 Smallmouth Bass Tissue Study (whole body). Kennedy/Jenks 2013.
n = sample size
CV = coefficient of variation
SD = standard deviation
SMB = smallmouth bass

Table 2
Summary of Power Analysis for Smallmouth Bass Sample Size
Portland Harbor Superfund Site
Pre-Remedial Design Baseline Study

Domain	River Miles	2012 SMB Data (a)				Sample Size Equals 2012 Actual Catch		Sample Size Equals 2012 Targets			Increase in MDD due to attaining targets
		n	Mean log10 PCB (ug/kg)	SD log10PCB (ug/kg)	Geometric Mean (ug/kg)	MDD log PCB (ug/kg)	MDD (%)	n	MDD log PCB (ug/kg)	MDD (%)	
Site-wide	2-12	83	2.56	0.38	364	0.17	31.6%	95	0.16	30.7%	0.9%
Segments 2, 3 & 4 (b)	2-9	61	2.45	0.23	282	0.12	23.9%	67	0.12	23.4%	0.5%
Segment 1	9-12	22	2.87	0.52	745	0.44	63.5%	28	0.41	61.2%	2.4%
Segment 2	7.5-9 & SIL	23	2.46	0.22	290	0.18	33.8%	23	0.18	33.8%	0.0%
Segment 3	5-7.5	19	2.32	0.16	211	0.14	28.3%	21	0.14	27.6%	0.6%
Segment 4	2-5	19	2.56	0.27	359	0.24	42.8%	23	0.23	41.2%	1.6%
Upriver Background	15-18	9	2.26	0.33	180	0.44	63.8%	10	0.43	62.8%	1.0%

Notes
(a) PCB data from 2012 Smallmouth Bass Tissue Study. Kennedy/Jenks 2013.
(b) Site-wide domain after exclusion of Segment 1 (highest 2012 SMB PCB levels were observed in RM11 area).
Analyses performed using alpha of 0.05 and power of 0.80.
n = sample size
MDD = Minimum Detectable Difference
SD = standard deviation of the log base 10 transformed mean
SMB = smallmouth bass

ATTACHMENT C
Project Examples of Composite Sampling for Long-term Monitoring

Several recent sediment cleanup projects have designed a composite sampling approach for sediments to evaluate post-remedy long-term monitoring conditions, post-remedy SWACs, and remedy effectiveness. Project examples include:

- **PSNS Superfund Site, Bremerton, Washington**: The long-term monitoring program at the 400-acre shipyard area (Operable Unit B Marine) of the Puget Sound Naval Shipyard was modified after 10 years to a gridded, composite sampling approach. Starting in 2003, the area was monitored using a rectangular grid of 71 500-foot by 500-foot cells (sample size N=71). Three random grab surface sediment samples were collected for each grid cell and composited to yield one sample from each grid cell for analysis. All grid cells were given equal weight when computing sample statistics using an area-weighted geometric mean. Adoption of a vigorous mechanical compositing method for mixing was introduced to reduce large intra-sample variability. For the outer portion of the study area (the monitored natural remediation [MNR] area) a 1,500-foot by 1,500-foot composite sampling grid was developed and approved by EPA (Vita, 2007).
- **Fox River Superfund Site, Wisconsin:** Long-term monitoring is focusing on site-wide surface water and fish tissue trends, and surface sediment trends in MNR areas. Surface water samples are collected along transects and averaged over the cross-section of flow, in accordance with United States Geological Survey (USGS) "quarter point" sampling procedures. For MNR sediment sampling, a five-point composite sample is collected from each monitoring area (AnchorQEA et al., 2009; Foth, 2007; EPA, 2008).
- **Head of Hylebos Waterway Superfund Site, Washington**: The 2005 project cleanup goal was to dredge to a clean surface. The confirmation sampling approach divided the Site into 400 construction dredge management areas (CDMAs) sized to 5,000 square feet grids each. A total of four to six randomized discrete samples were collected within each CDMA and composited for testing. A surface weighting criteria was applied to verify whether the dredging had achieved a clean remediated sediment surface (Wolf and Parkinson, 2015). In 2012, the surface sediment sampling program replicated the same compositing approach used in 2004/2006 to establish current sediment chemical concentrations for future comparisons of long-term monitoring data, and to revise the Operations, Maintenance, and Monitoring Program (OMMP) for the Site (DOF, 2012).

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