Appendix C. Implications of Incorporating Round 3 Surface Sediment Data in Risk Assessments

List of Maps

These maps are included in the Appendix Maps folio.

C.1 Introduction

As part of the remedial investigation (RI), three rounds of surface sediment sampling were conducted in the Lower Duwamish Waterway (LDW) (Windward 2007).[1] Results from the first two rounds (conducted in 2005) were included in the baseline surface sediment dataset used in the ecological risk assessment (ERA) (Appendix A) and human health risk assessment (HHRA) (Appendix B). Prior to Round 3, the baseline dataset included a total of 1,446 surface sediment samples collected from 1,329 discrete locations throughout the LDW (Map C.1-1). Round 3 included the collection of 47 additional surface sediment samples from 44 discrete locations (Map C.1-1). Round 3 was conducted in October 2006 and results were not available for inclusion in the risk assessments because the sampling event was conducted after the draft HHRA and ERA had been submitted to the US Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) in August 2006 and September 2006, respectively. As stated in the quality assurance project plan (QAPP) for the Round 3 sampling (Windward 2006), the HHRA and ERA would not include Round 3 data, but instead, ramifications of the new data with respect to risk conclusions would be discussed in an appendix to the RI. The purpose of this appendix is to evaluate whether the conclusions of the risk assessments would have been different if Round 3 surface sediment data had been included in the baseline datasets.

In this appendix the various surface sediment datasets are defined as follows:

- The surface sediment data used in the HHRA and ERA represent baseline conditions in the LDW prior to remedial activities at the Duwamish/Diagonal early action area and the Boeing Developmental Center south storm drain associated with the Norfolk early action area (Appendix E defines criteria for inclusion of data in baseline dataset)
- The Round 3 dataset contains surface sediment data collected during Round 3
- The combined baseline/Round 3 dataset includes surface sediment data used in the risk assessments as well as Round 3 data.[2] The combined baseline/Round 3 dataset is equivalent to the RI baseline dataset, which is the dataset used to describe the nature and extent of contamination in Section 4 of the RI.

[1] RI Appendix E provides criteria for including surface sediment data in the RI baseline dataset including details regarding incorporation of Round 3 data.

[2] In addition to adding the Round 3 surface sediment data to the risk assessment datasets, a few other minor revisions were made. For example, Round 3 surface sediment data replaced data from older sampling events if the samples were collected within 10 ft.

C.2 Use of Sediment Chemistry in Risk Assessments

In the ERA, surface sediment data were used as a component of the exposure assessment for each receptor of concern (ROC), except crabs.[3] Sediment data were used in various ways for each ROC, as presented in Table C.2-1. For the benthic invertebrate community, sediment chemical concentrations at each location were compared to one of the following: 1) available chemical criteria of the Washington State Sediment Management Standards (SMS) (Washington Administrative Code [WAC] 173-204), 2) toxicologically based Dredged Material Management Program (DMMP) guidelines, or 3) toxicity reference values (TRVs) from the scientific literature. In addition, surface sediment data were used to estimate the tributyltin (TBT) concentrations in benthic invertebrate tissue using a significant regression relationship between TBT concentrations in sediment and co-located tissue; this estimated tissue concentration was compared to a TRV in the ERA.

Table C.2-1. Use of surface sediment data in the risk assessments for each receptor

RECEPTOR	EXPOSURE PATHWAY	DATA USED	STATISTIC USED
Benthic invertebrate community	direct contact	LDW-wide	sediment concentrations at each location were compared to sediment criteria, guidelines, or TRVs
	direct contact	LDW-wide	UCL[a] tissue TBT concentration based on regression relationship between sediment and co-located tissue
Juvenile chinook salmon	ingestion of benthic invertebrate tissue	intertidal	UCL[a] tissue arsenic concentration based on regression relationship between sediment and co-located tissue
English sole	incidental ingestion (1% of diet)	LDW-wide	UCL[b] sediment concentration for the LDW-wide dataset
	ingestion of benthic invertebrate tissue	LDW-wide	UCL[a] tissue arsenic concentration based on regression relationship between sediment and co-located tissue arsenic concentrations
Pacific staghorn sculpin	incidental ingestion (1% of diet)	LDW-wide; four modeling areas	UCL[b] sediment concentration for the LDW-wide dataset and for each modeling area
	ingestion of benthic invertebrate tissue	LDW-wide; four modeling areas	UCL[a] tissue arsenic concentration based on regression relationship between sediment and co-located tissue arsenic concentrations
Spotted sandpiper	incidental ingestion (18% of diet)	six sandpiper exposure scenarios[c]	UCL[b] sediment concentration for each exposure scenario
	ingestion of benthic invertebrate tissue	six sandpiper exposure scenarios[c]	UCL[a] tissue PCB and arsenic concentrations based on regression relationships between sediment and co-

[3] Risk estimates for crabs did not include a sediment pathway because a critical tissue-residue approach was used instead.

RECEPTOR	EXPOSURE PATHWAY	DATA USED	STATISTIC USED
			located tissue concentrations of either PCBs or arsenic
Great blue heron	incidental ingestion (2% of diet)	intertidal	UCL[b] sediment concentration for the intertidal dataset
Osprey	incidental ingestion (2% of diet)	intertidal	UCL[b] sediment concentration for the intertidal dataset
River otter	incidental ingestion (1% of diet)	LDW-wide	UCL[b] sediment concentration for the LDW-wide dataset
Harbor seal	incidental ingestion (1% of diet)	LDW-wide	UCL[b] sediment concentration for the LDW-wide dataset
Humans	incidental ingestion and dermal absorption	LDW-wide (netfishing scenario); eight beach play areas; three clamming scenarios	UCL[b] sediment concentration for each scenario

[a] Co-located benthic invertebrate tissue and sediment data were used to determine UCLs, as discussed n the ERA (Appendix A, Attachment 11).

[b] ProUCL (EPA 2004, 2007) was used to determine specific methods for deriving UCLs, as discussed in the ERA (Appendix A, Attachment 11) and the HHRA (Appendix B, Section B.3).

[c] Within each of the three exposure areas, two foraging scenarios were evaluated: one in which spotted sandpipers forage in only high-quality habitat, and another in which they forage in both high- and poor-quality habitats.

LDW – Lower Duwamish Waterway

TRV – toxicity reference value

UCL – 95% upper confidence limit on the mean

For English sole, Pacific staghorn sculpin, and all wildlife ROCs, the exposure assessment included incidental sediment ingestion as a component of the diet. In addition, sediment data were used to estimate polychlorinated biphenyl (PCB) and arsenic concentrations in benthic invertebrate tissue based on significant regression relationships between concentrations in sediment and tissue. Dietary exposures based on benthic invertebrate tissue concentrations derived from regression models were used to evaluate risk to juvenile chinook salmon, English sole, and Pacific staghorn sculpin from arsenic and to spotted sandpiper from PCBs and arsenic.

For humans, risk estimates were based on exposure to sediment through incidental ingestion and dermal absorption.

C.3 Risk Implications

This section describes the implications of Round 3 surface sediment data on risk conclusions for the benthic invertebrate community, fish, wildlife, and humans. The following evaluations were conducted:

- For the benthic invertebrate community, the Round 3 surface sediment data were compared to SMS criteria, DMMP guidelines, or TRVs from the scientific literature.
- For fish, wildlife, and humans, mean COPC concentrations using Round 3 surface sediment data for ERA or HHRA exposure scenarios were compared to mean COPC concentrations used in the ERA and HHRA.

These comparisons were made to determine if the inclusion of the Round 3 samples would have resulted in a change of the HQ from > 1.0 to < 1.0 or vice versa. If the HQ could have changed for a particular dataset, then 95% upper confidence limits on the mean (UCLs) were recalculated using the RI baseline dataset.

C.3.1 BENTHIC INVERTEBRATE COMMUNITY

Risks to the benthic invertebrate community were evaluated in the ERA by comparing surface sediment chemical concentrations at each location to the sediment quality standards (SQS) and cleanup screening levels (CSL) of the SMS. Three chemicals of potential concern (COPCs) identified in the ERA did not have an SQS or CSL: nickel, total DDTs (dichlorodiphenyltrichloroethane), and total chlordane. Nickel concentrations were compared to the toxicologically based DMMP guidelines for nickel. Because the DMMP guidelines for total DDTs and total chlordane were not toxicologically based, concentrations of these chemicals in sediment were compared to TRVs selected from the scientific literature.

Concentrations of all COPCs in surface sediment samples at each Round 3 location were compared to the SMS criteria (SQS and CSL) or, in the case of nickel, to DMMP guidelines; no comparisons were made to TRVs for total DDTs or total chlordane because none of the samples collected during Round 3 were analyzed for pesticides. The sampling locations targeted for Round 3 surface sediment sampling were selected in part to improve the spatial coverage in areas of the LDW with SMS exceedances. Consequently, in Round 3, surface sediments at 20 of the 44 locations had detected COPC concentrations that exceeded the SQS, and eight of those also exceeded the CSL; none of the locations had concentrations of nickel that exceeded DMMP guidelines (Table C.3-1; Map C.1-1). Concentrations of PCBs exceeded the SQS or CSL at 17 of the 20 locations with SMS exceedances. Other chemicals with exceedances of the SQS or CSL were: 1) arsenic at one location, 2) mercury at six locations, 3) individual polycyclic aromatic hydrocarbon (PAH) compounds at five locations, 4) both bis(2-ethylhexyl)

phthalate (BEHP) and butyl benzyl phthalate at two locations, and 5) both benzoic acid and benzyl alcohol at one location.[4]

Table C.3-1. COPCs with detected concentrations in Round 3 surface sediment samples exceeding SMS criteria

COPC	No. of Locations with Detected Concentrations	
	> SQS and ≤ CSL	> CSL
Metals		
Arsenic		1
Mercury	2	4
PAHs		
Benzo(a)anthracene		1
Benzo(a)pyrene		1
Benzo(g,h,i)perylene	1	1
Total benzofluoranthenes		1
Chrysene	2	1
Dibenzo(a,h)anthracene	1	
Fluoranthene	2	2
Indeno(1,2,3-cd)pyrene	1	1
Phenanthrene	1	
Pyrene	1	1
Total HPAH	2	1
Phthalates		
Bis(2-ethylhexyl) phthalate	1	1
Butyl benzyl phthalate	2	
Other SVOCs		
Benzoic acid		1
Benzyl alcohol		1
PCBs		
Total PCBs	16	1

COPC – chemical of potential concern
CSL – cleanup screening level
HPAH – high-molecular-weight polycyclic aromatic hydrocarbons
ML – maximum level
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SL – screening level
SMS – Washington State Sediment Management Standards
SQS – sediment quality standard
SVOC – semivolatile organic compound

[4] Arsenic and PCB exceedances of SQS or CSL are presented in Figures 4-3 and 4-5 of the Round 3 surface sediment data report, respectively (Windward 2007).

In the ERA, point locations of sediment samples with chemical exceedances of SMS were spatially interpolated using Thiessen polygons to estimate the degree and areal extent of potential adverse effects on benthic invertebrate communities. On the basis of this analysis, the ERA concluded that no adverse effects to benthic invertebrate communities in intertidal and subtidal sediments were expected in approximately 74% of the LDW area (i.e., the area in which detected chemical concentrations were less than or equal to the SQS, or were not detected). There was a higher likelihood for adverse effects in approximately 7% of the LDW area, which was designated as having chemical concentrations in excess of the CSL. The remaining 19% of the LDW area had chemical concentrations or biological effects between the SQS and the CSL, indicating that risks to benthic invertebrate communities were considered less certain in these areas than in the areas with concentrations greater than one or more CSL values. This spatial analysis was repeated using the Round 3 data, and results were compared. Incorporation of the Round 3 data did not result in sizeable differences among areas in any of these three SMS categories for all chemicals (Table C.3-2). Eight additional point locations were identified as representing a higher likelihood of adverse effects on the benthic invertebrate community (i.e., exceeding the CSL); however, no additional COCs were identified for the benthic invertebrate community, and area estimates remained approximately the same.

Table C.3-2. Areas of the LDW with SQS or CSL exceedances as calculated using Thiessen polygons

SMS Category	Percent Area within Each SMS Category	
	ERA Dataset	RI Baseline Dataset[a]
> CSL, detected	6.7	7.1
> SQS and ≤ CSL, detected	19.4	20.0
Either all detected and non-detected concentrations < SQS or only non-detected concentrations > SQS or CSL	73.9	72.9

[a] The RI baseline dataset includes ERA data plus Round 3 data.

CSL – cleanup screening level
ERA – ecological risk assessment
LDW – Lower Duwamish Waterway
RI – remedial investigation
SMS – Washington State Sediment Management Standards
SQS – sediment quality standard

The ERA also used TBT concentrations in sediment to estimate TBT concentrations in benthic invertebrate tissue based on a significant regression relationship between sediment and co-located tissue concentrations. When the maximum sediment TBT concentration of 3.0 mg/kg dw was used to estimate the tissue TBT concentration, the LOAEL-based HQ was 0.26, indicating low risk to benthic invertebrates. The three sediment samples analyzed for TBT during Round 3 had concentrations of 0.016, 0.055, and 0.073 mg/kg dw, all much lower than the maximum concentration used in the ERA. Thus, Round 3 data would not have changed risk conclusions for the exposure of the benthic invertebrate community to TBT.

C.3.2 FISH

Surface sediment data were used to estimate exposures of English sole and Pacific staghorn sculpin to arsenic, cadmium, copper, and vanadium through the incidental ingestion of sediment as 1% of the diet (Table C.3-3). In addition, arsenic concentrations in benthic invertebrate tissue were estimated using regression relationships between sediment and tissue concentrations. These estimated benthic invertebrate tissue concentrations were used to estimate dietary exposures of juvenile chinook salmon, English sole, and Pacific staghorn sculpin through the diet. Round 3 sediment samples were collected for the four COPCs in all of the fish exposure areas used in the ERA (Table C.3-3; Map C.3-1).

Table C.3-3. Surface sediment data used to assess exposure of fish in the ERA

RECEPTOR	AREA	COPCS
English sole	LDW-wide	arsenic, cadmium, copper, vanadium
Pacific staghorn sculpin	LDW-wide; four modeling areas	arsenic, cadmium, copper, vanadium
Juvenile chinook salmon	intertidal	arsenic

ERA – ecological risk assessment
COPC – chemical of potential concern
LDW – Lower Duwamish Waterway

Summary statistics (i.e., number of samples, detection frequency, minimum, maximum, and mean) were calculated for arsenic, cadmium, copper, and vanadium in sediment separately for the ERA datasets and for the Round 3 datasets for each exposure scenario for fish (i.e., LDW-wide for all three fish ROCs in addition to four modeling areas for Pacific staghorn sculpin) (Table 1 in Attachment 1). The exposure point concentrations (EPCs) used in the ERA were the UCLs rather than the mean concentrations. However, rather than recalculate the UCLs for each dataset, this appendix compares the mean concentrations for the Round 3 datasets to the mean concentrations in the ERA dataset as a preliminary step to determine if risk conclusions could have changed based on the new data (Table 1 in Attachment 1).

For arsenic, the mean Round 3 surface sediment concentrations in each of the specific exposure scenarios were lower than the corresponding mean concentrations used in the ERA for those same exposure scenarios. Because the LOAEL-based HQs for arsenic were < 1.0 (indicating low risk to fish), HQs would not have been > 1.0 if Round 3 data had been available to estimate dietary exposure through incidental ingestion of sediment in the ERA. In addition, for arsenic, a regression relationship between co-located sediment and benthic invertebrate tissue concentrations was used to estimate UCL tissue concentrations for use as EPCs in the ERA. The same regression relationship would be used with Round 3 data because there were no new co-located data. Using the lower mean arsenic sediment concentrations from the Round 3 dataset in the regression equation would result in a lower estimated UCL arsenic concentration in benthic invertebrate tissue than using the mean concentrations in sediment from the dataset.

Therefore, because LOAEL HQs were all < 1.0 based on the ERA dataset, and Round 3 concentrations for arsenic were generally lower than in the ERA dataset, risk conclusions would not have changed based on inclusion of Round 3 data.

For cadmium, copper, and vanadium, there were a total of 18 fish exposure scenarios (i.e., six scenarios for each COPC). For the 11 fish exposure scenarios with LOAEL-based HQs < 1.0 (indicating low risk to fish) in the ERA, the mean concentrations for scenarios using Round 3 data were lower than the mean concentrations for the ERA scenarios, indicating that risk conclusions would not have changed (i.e., LOAEL-based HQs would not have increased to > 1.0). There were five scenarios in the ERA with LOAEL-based HQs ≥ 1.0 (suggesting some risk to fish): two scenarios for cadmium and three scenarios for vanadium (Table C.3-4). With one exception, HQs would not have decreased to < 1.0 even if the lowest COPC concentration in the exposure area from either the ERA dataset or the Round 3 dataset had been used. The HQs did not change substantially because they are driven by concentrations in prey, which constitute 99% of the fish diet. Thus risk conclusions would not have changed for these scenarios based on inclusion of Round 3 data. In the one scenario that would have changed, the cadmium LOAEL-based HQ for Pacific staghorn sculpin in Area M3 would have decreased to 0.9 if the lowest COPC concentration had been used. Therefore, the UCL was calculated for cadmium in Area M3 using the RI baseline dataset. The use of this UCL in risk calculations for Pacific staghorn sculpin did not change the LOAEL-based HQ (i.e., the HQ would still have been > 1.0). These results indicate that risk conclusions for fish would not have changed if Round 3 data had been incorporated into the ERA dataset.

Table C.3-4. Comparison of ERA and Round 3 surface sediment datasets for fish

Scenario				ERA Dataset		Round 3 Dataset	
ROC	COPC	Area	LOAEL HQ	Detection Frequency	Calculated Mean (mg/kg dw)	Detection Frequency	Calculated Mean (mg/kg dw)
English sole	cadmium	LDW-wide	**1.2**	565/797	1.0	22/44	0.35
	vanadium	LDW-wide	**1.2**	556/556	59	44/44	51
Pacific staghorn sculpin	cadmium	M3	**1.0**	180/239	2.3	1/4	0.29
	vanadium	M2	**1.2**	132/132	59	10/10	51
		M3	**1.2**	182/182	58	4/4	58

COPC – chemical of potential concern
dw – dry weight
ERA – ecological risk assessment
HQ – hazard quotient
LDW – Lower Duwamish Waterway
LOAEL – lowest-observed-adverse-effect level
ROC – receptor of concern
Bold identifies LOAEL-based HQs ≥1.0.

C.3.3 WILDLIFE

The exposure assessment for wildlife in the ERA evaluated exposure of the five wildlife ROCs to various COPCs through the incidental ingestion of sediment (Table C.3-5) as a component of the diet. During the Round 3 sampling event, surface sediment samples were collected from all areas included in wildlife exposure scenarios (i.e., LDW-wide, intertidal, and six sandpiper exposure areas) (Maps C.1-1 and C.3-2). Therefore, risk estimates for these areas were evaluated for potential changes in risk conclusions. Risk estimates for total DDTs and PCB TEQs would not have been affected by Round 3 data because samples were not analyzed for organochlorine pesticides or PCB congeners during Round 3.

Table C.3-5. Surface sediment wildlife exposure scenarios used in the ERA

ROC	AREA	COPCS
Spotted sandpiper	six exposure areas	arsenic, cadmium, chromium, cobalt, copper, total DDTs,[a] lead, mercury, nickel, total PCBs, PCB TEQ,[a] selenium, vanadium, zinc
Great blue heron	Intertidal	chromium, lead, mercury, total PCBs, PCB TEQ[a]
Osprey	Intertidal	chromium, lead, mercury, total PCBs, PCB TEQ[a]
River otter	LDW-wide	arsenic, cobalt, mercury, selenium, total PCBs
Harbor seal	LDW-wide	mercury, total PCBs

[a] No new data from Round 3 were available for these COPCs.

COPC – chemical of potential concern
DDT – dichlorodiphenyltrichloroethane
ERA – ecological risk assessment
LDW – Lower Duwamish Waterway
PCB – polychlorinated biphenyl
TEQ – toxic equivalency factor

Summary statistics (i.e., number of samples, detection frequency, minimum, maximum, and mean) were calculated for each of the COPCs in the LDW-wide, intertidal, and six sandpiper exposure areas using the Round 3 data (Table 1 in Attachment 1). The EPCs used in the ERA were UCLs rather than the mean concentrations. However, rather than recalculate the UCLs for each dataset, this appendix compares the mean concentrations from the ERA datasets to the mean concentrations from the Round 3 datasets as a preliminary step to determine if risk conclusions could have changed based on these new data (Table 1 in Attachment 1).

For all but 19 of the 88 wildlife exposure scenarios (i.e., ROC/area/COPC combinations), the LOAEL-based HQ was < 1.0 (indicating low risk), and the mean Round 3 dataset concentration was lower than or equal to the mean ERA dataset concentration, indicating that risk conclusions would not have changed (i.e., HQs would not have increased to > 1.0). Among the remaining 19 scenarios (see Table C.3-6), there was a potential for risk conclusions to change based on this preliminary analysis because: 1) LOAEL-based HQs were ≥1.0, and the mean concentrations in the Round 3 dataset were lower than in the ERA dataset (i.e., HQs could have decreased to < 1.0), or

2) HQs were < 1.0, and the mean concentrations in the Round 3 dataset were higher than in the ERA dataset (i.e., HQs could have increased to ≥ 1.0).

For these 19 scenarios, EPCs and LOAEL-based HQs were recalculated using data from the RI baseline dataset (Table C.3-6). EPCs were calculated as in the ERA (i.e., as the UCL) for each RI baseline dataset, with the exception of the total PCB dataset.

The total PCB EPCs[5] in Table C.3-6 were not recalculated because it was estimated that risk conclusions would not have changed based on the following two analyses: 1) if the maximum surface sediment concentration in Area 1 high-quality foraging habitat (H) and Area 1 high- and poor-quality foraging habitat (H/P) from the RI baseline dataset (1.01 mg/kg dw) had been used as the EPC, the LOAEL-based HQ for spotted sandpiper in each of these areas would have increased only slightly (from 0.18 to 0.19, still indicating low risk), and 2) if the minimum detected LDW-wide surface sediment concentration from the RI baseline dataset (0.0016 mg/kg dw) had been used as the EPC, the LOAEL-based HQ for river otter (2.9, indicating some risk) would not have changed, because sediment is a very small component of the dietary exposure for river otter. The maximum concentration was used in the first analysis to determine if HQs could have increased to > 1.0, and the minimum concentration was used in the second analysis to determine whether HQs could have decreased to < 1.0.

For the remaining 16 scenarios in Table C.3-6, three LOAEL-based HQs would have changed slightly based on the revised EPCs: 1) the lead HQ for spotted sandpiper in Area 2 H/P would have decreased from 5.5 to 5.3, 2) the mercury HQ for spotted sandpiper in Area 1 H would have increased from 0.22 to 0.23, and 3) the vanadium HQ for spotted sandpiper in Area 2 H would have decreased from 1.4 to 1.3. None of these changes would have affected the risk conclusions for spotted sandpiper. The LOAEL-based HQs for all of the other sandpiper scenarios in Table C.3-6 were unchanged.

The LOAEL-based HQs for mercury in river otter and harbor seal were the same when calculated with either the ERA dataset or the RI baseline dataset.

[5] The PCB EPCs were calculated in the ERA as the UCL of the spatially weighted average concentration (SWAC) for each exposure area under consideration (see the ERA [Appendix A], Attachment 11).

Table C.3-6. Comparison of the ERA and RI baseline surface sediment datasets for wildlife

Scenario			ERA Dataset				RI Baseline Dataset			
ROC	COPC	Area	Detection Frequency	Calculated Mean (mg/kg dw)	EPC (mg/kg dw)	LOAEL HQ	Detection Frequency[a]	Calculated Mean (mg/kg dw)	EPC (mg/kg dw)	LOAEL HQ
Spotted sandpiper	chromium	Area 2 H/P	49/49	28	32	**1.8**	52/52	27	32	**1.8**
	copper	Area 3 H/P	150/150	200	730	**1.1**	152/152	200	720	**1.1**
	lead	Area 2 H/P	49/49	70	96	**5.5**	52/52	71	92	**5.3**
		Area 3 H/P	150/150	300	1,000	**1.5**	152/152	340	1,000	**1.5**
	mercury	Area 1 H	34/39	0.13	0.17	0.22	37/45	0.14	0.18	0.23
		Area 1 H/P	40/47	0.13	0.16	0.22	43/53	0.14	0.17	0.22
		Area 3 H	71/87	0.20	0.45	**1.0**	73/89	0.20	0.44	**1.0**
	nickel	Area 2 H/P	41/42	17	20	< 0.1	45/45	18	20	< 0.1
	vanadium	Area 1 H	25/25	50	53	**1.1**	31/31	50	53	**1.1**
		Area 1 H/P	28/28	49	52	**1.0**	34/34	49	52	**1.0**
		Area 2 H	22/22	53	58	**1.4**	24/24	52	57	**1.3**
		Area 2 H/P	38/38	52	55	**1.3**	41/41	52	55	**1.3**
		Area 3 H	70/70	55	57	**1.3**	72/72	55	57	**1.3**
		Area 3 H/P	106/106	57	59	**1.3**	108/108	57	59	**1.3**
	total PCBs	Area 1 H	52/56	0.15	0.34	0.18	56/62	0.16	nc[b]	nc[b]
		Area 1 H/P	74/81	0.14	0.33	0.18	78/87	0.15	nc[b]	nc[b]
River otter	mercury	LDW-wide	715/831	0.21	0.30	0.57	747/869	0.19	0.23	0.57
	total PCBs	LDW-wide	1,203/1,288	1.0	0.98	**2.9**	1,243/1,327	1.2	nc[b]	nc[b]
Harbor seal	mercury	LDW-wide	715/831	0.21	0.30	< 0.1	747/869	0.19	0.23	< 0.1

[a] The total number of samples within either the entire LDW or specific subareas did not always increase by the number of Round 3 samples within those areas because some Round 3 sampling locations were within 10 ft of earlier stations, and therefore the Round 3 data replaced earlier data for those locations. In addition, some other minor changes were made in the RI baseline dataset.

[b] The EPCs for PCBs were calculated as the UCL of the SWAC in the ERA. These EPCs were not recalculated for the RI baseline dataset; however, risk conclusions would not have changed using conservative assumptions, as described in the text.

COPC – chemical of potential concern

EPC – exposure point concentration

H – high-quality sandpiper foraging habitat

HQ – hazard quotient

H/P – high- and poor-quality sandpiper foraging habitat

LDW – Lower Duwamish Waterway

LOAEL – lowest-observed-adverse-effect level

nc – not calculated

ROC – receptor of concern

PCB – polychlorinated biphenyl

SWAC – spatially-weighted average concentration

Bold identifies LOAEL-based HQs ≥1.0.

C.3.4 HUMAN HEALTH

The HHRA evaluated the exposure of people to various COPCs through incidental ingestion and dermal absorption of chemicals from sediment (Table C.3-7). Surface sediment samples were collected from netfishing (LDW-wide), beach play, and clamming areas during the Round 3 sampling event (Maps C.1-1, C.3-3, and C.3-4). Four of the beach play areas were not sampled during Round 3 (beach play areas 2, 3, 6, and 7), so risk conclusions would not have changed for those areas. In addition, risk estimates for aluminum, barium, benzidine, total DDTs, dieldrin, iron, manganese, and toxaphene would not have changed based on Round 3 data because sediments were not analyzed for these chemicals during Round 3. Risk estimates for PCB TEQ would not have changed because samples were not analyzed for PCB congeners in Round 3.

Table C.3-7. Surface sediment exposure scenarios used in the HHRA

SCENARIO	AREA	COPCS
Netfishing CT and RME	LDW-wide	aluminum,[a] antimony, arsenic, barium,[a] benzidine,[a] cadmium, carcinogenic PAHs, chromium, copper, total DDTs,[a] dieldrin,[a] dioxin/furan TEQ, iron,[a] lead, manganese,[a] n-nitrosodimethylamine,[b] total PCBs, PCB TEQ,[a] thallium, toxaphene,[a] vanadium
Beach play RME	eight beach play areas[c]	4,6-dinitro-o-cresol, aluminum,[a] antimony, arsenic, barium,[a] benzidine,[a] bis(2-chloroethyl)ether,[b] cadmium, carcinogenic PAHs, chromium, copper, total DDTs,[a] dieldrin,[a] dioxin/furan TEQ,[d] iron,[a] lead, manganese,[a] mercury, molybdenum, n-nitrosodimethylamine,[b] n-nitroso-di-n-propylamine,[b] total PCBs, PCB TEQ,[a] silver, thallium, toxaphene,[a] vanadium, zinc
Clamming	shoreline access only (7 days/year) boat and shoreline access (tribal clamming RME and tribal clamming of 120 and 183 days/year, respectively)	

[a] Round 3 sediment samples were not analyzed for these COPCs.

[b] These chemicals were not evaluated in this appendix (and are not included in Attachment 1) because they were not detected in any Round 3 samples or in any samples in the HHRA dataset.

[c] Round 3 sediment samples were not collected in beach play areas 2, 3, 6, or 7.

[d] Dioxin/furan sediment data were not collected in any beach play or clamming areas in Round 3.

COPC – chemical of potential concern
DDT – dichlorodiphenyltrichloroethane
LDW – Lower Duwamish Waterway
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
TEQ – toxic equivalency factor

Summary statistics (i.e., number of samples, detection frequency, minimum, maximum, and mean) were calculated for each of the COPCs in each area using the Round 3 data (Table 1 in Attachment 1). The EPCs used in the HHRA were UCLs rather than the mean concentrations. However, rather than recalculate the UCLs for each dataset, the mean concentrations from the HHRA dataset were compared to the mean concentrations from the Round 3 dataset as a preliminary step to determine if risk conclusions could have changed based on the new data (Table 1 in Attachment 1).

Non-cancer HQs presented in the HHRA were ≤ 0.1 for all scenarios that could have been affected by Round 3 data (Table 1 in Attachment 1). The Round 3 data likely would not have increased any of these HQs to > 1.0 because: 1) the HQs were much lower than 1.0 and the number of Round 3 samples was small compared to the number of samples in the HHRA datasets, and 2) mean concentrations were lower for 64 of the 88 chemicals analyzed in Round 3 compared to the mean concentrations in the HHRA datasets. In the RI baseline dataset, Round 3 samples comprised less than 10% of the total number of surface sediment samples in any scenario, with the exception of beach play Area 1, which included one new sample from Round 3 compared to five samples in the HHRA dataset. All HQs in beach play Area 1 were ≤ 0.02 for COPCs with higher mean concentrations in Round 3; therefore it is unlikely that any of the concentrations of chemicals in the one Round 3 sample in this area would have been sufficiently high to have increased the HQ to 1 or greater. For the 24 chemicals in the Round 3 dataset with higher mean concentrations than those in the HHRA dataset, most concentrations were only slightly higher; thus, inclusion of Round 3 data would not have resulted in substantially different EPCs if the datasets had been combined. For example, zinc in beach play Area 5 had one of the largest differences in mean concentrations, with 92 mg/kg dw in the HHRA dataset compared to 250 mg/kg in the Round 3 dataset. The zinc UCL in the HHRA dataset was 110 mg/kg dw compared to 120 mg/kg dw in the RI baseline dataset, both resulting in HQs < 1.0.

Risk estimates for lead were calculated in the HHRA using the Integrated Exposure Uptake Biokinetic (IEUBK) model for children (EPA 1994) and the Adult Lead Model (ALM) for adults (EPA 2003).[9] Based on the HHRA dataset, estimated risks from exposure to lead using these models were less than unacceptable risk levels for both children and adults for all scenarios**.** Risk estimates would not have increased for children or adults from lead exposure in beach play areas by incorporating Round 3 data. The highest calculated mean lead concentration in the Round 3 dataset for any HHRA scenario (70 mg/kg dw lead in beach play Area 5) was lower than the calculated mean of 150 mg/kg dw in the area with the highest EPC value used to calculate lead blood levels in the HHRA (beach play area 2). For the clamming and netfishing scenarios, the mean lead concentrations in the Round 3 dataset were lower than the mean sediment lead concentrations used in the HHRA.

Excess cancer risks were calculated for arsenic, carcinogenic PAHs (cPAHs), dioxins/furans, and total PCBs in the HHRA. For these chemicals, there was a potential for the risk conclusions to change for the following reasons: 1) excess cancer risks were greater than the 1×10^{-6} threshold in the HHRA, and the mean concentrations in the Round 3 dataset were lower than those in the HHRA dataset (i.e., excess cancer risk could have decreased to $< 1 \times 10^{-6}$ if Round 3 data were included), or 2) excess cancer

[9] Risk estimates for lead were expressed as the probability of exceeding a threshold blood lead concentration (10 µg/dL in children for exposure of children or 10 µg/dL in the fetus for exposure of a pregnant mother) rather than as an excess cancer risk estimate or hazard quotient, as used for other COPCs.

risks were < 1×10^{-6} in the HHRA, and the mean concentrations in the Round 3 dataset were higher than those in the HHRA dataset (i.e., excess cancer risk could have increased to greater than the threshold if Round 3 data were included). Therefore, EPCs and excess cancer risks for these COPCs were recalculated for the human health scenarios using the RI baseline dataset (Table C.3-8).[10]

As shown in Table C.3-8, some of the excess cancer risk estimates changed slightly using the RI baseline dataset compared to the HHRA dataset, but none of the risk conclusions would have changed.

[10] In the HHRA, EPCs were calculated as the UCL on the mean for each of the sediment areas over which the exposure could potentially occur.

Table C.3-8. Comparison of the HHRA and RI baseline surface sediment datasets for human health scenarios

Scenario	HHRA Dataset				RI Baseline Dataset			
	Detection Frequency	Calc'd Mean (mg/kg dw)	EPC (mg/kg dw)	Excess Cancer Risk	Detection Frequency[a]	Calc'd Mean (mg/kg dw)	EPC (mg/kg dw)	Excess Cancer Risk
Arsenic								
Beach play RME – Area 1	4/4	6.5	15[b]	**5×10^{-6}**	5/5	6.2	15[b]	**5×10^{-6}**
Beach play RME – Area 4	10/10	8.2	11	**4×10^{-6}**	11/11	7.8	10	**3×10^{-6}**
Beach play RME – Area 5	22/22	8.1	8.9	**3×10^{-6}**	23/23	8.5	9.5	**3×10^{-6}**
Beach play RME – Area 8	11/11	8.7	10	**3×10^{-6}**	13/13	8.4	9.8	**3×10^{-6}**
Clamming – 7 days/year	100/103	8.8	9.5	3×10^{-7}	110/113	8.9	9.5	3×10^{-7}
Tribal clamming RME – 120 days/year	254/275	18	27	**2×10^{-5}**	264/285	18	27	**2×10^{-5}**
Tribal clamming – 183 days/year				**3×10^{-5}**				**3×10^{-5}**
Netfishing – RME	755/817	17	21	**6×10^{-6}**	794/852	17	21	**6×10^{-6}**
Netfishing – CT	755/817	17	21	1×10^{-6}	794/852	17	21	1×10^{-6}
Carcinogenic PAHs								
Beach play RME – Area 1	3/4	0.33	1.2[b]	**1×10^{-5}**	3/5	0.26	1.2[b]	**1×10^{-5}**
Beach play RME – Area 4	9/10	0.20	0.73	**8×10^{-6}**	10/11	0.20	0.67	**8×10^{-6}**
Beach play RME – Area 5	22/22	0.21	0.41	**5×10^{-6}**	23/23	0.28	0.55	**6×10^{-6}**
Beach play RME – Area 8	11/11	0.23	0.32	**4×10^{-6}**	12/13	0.20	0.40	**5×10^{-6}**
Clamming – 7 days/year	97/103	0.27	0.48	1×10^{-7}	105/113	0.32	0.57	1×10^{-7}
Tribal clamming RME – 120 days/year	255/264	0.48	0.77	**5×10^{-6}**	263/274	0.49	0.78	**5×10^{-6}**
Tribal clamming – 183 days/year				**8×10^{-6}**				**8×10^{-6}**
Netfishing – RME	749/793	0.45	0.57	**2×10^{-6}**	780/828	0.46	0.57	**2×10^{-6}**
Netfishing – CT	749/793	0.45	0.57	2×10^{-7}	780/828	0.46	0.57	2×10^{-7}

Scenario	HHRA Dataset				RI Baseline Dataset			
	Detection Frequency	Calc'd Mean (mg/kg dw)	EPC (mg/kg dw)	Excess Cancer Risk	Detection Frequency[a]	Calc'd Mean (mg/kg dw)	EPC (mg/kg dw)	Excess Cancer Risk
Dioxin/furan TEQ[c]								
Netfishing – RME	43/43	1.0×10^{-4}	6.10×10^{-4}	**2×10^{-5}**	47/47	9.3×10^{-5}	5.60×10^{-4}	**2×10^{-5}**
Netfishing – CT	43/43	1.0×10^{-4}	6.10×10^{-4}	**4×10^{-6}**	47/47	9.3×10^{-5}	5.60×10^{-4}	**4×10^{-6}**
Total PCBs								
Beach play RME – Area 1	3/5	0.029	0.12[b]	7×10^{-8}	4/6	0.026	0.062[b]	4×10^{-8}
Beach play RME – Area 4	12/12	2.8	11	**6×10^{-6}**	13/13	2.6	9.3	**5×10^{-6}**
Beach play RME – Area 5	31/32	0.10	0.19	1×10^{-7}	32/33	0.11	0.20	1×10^{-7}
Beach play RME – Area 8	12/18	0.056	0.23	1×10^{-7}	14/20	0.058	0.11	6×10^{-8}
Clamming – 7 days/year	142/161	0.43	1.5	9×10^{-8}	151/171	0.42	1.5	9×10^{-8}
Tribal clamming RME – 120 days/year	415/440	2.0	4.0	8×10^{-6}	424/450	2.0	3.9	**8×10^{-6}**
Tribal clamming – 183 days/year				**1×10^{-5}**				**1×10^{-5}**
Netfishing – RME	1,205/1,291	1.0	2.5	**2×10^{-6}**	1,243/1,327	1.2	2.4	**2×10^{-6}**
Netfishing – CT	1,205/1,291	1.0	2.5	3×10^{-7}	1,243/1,327	1.2	2.4	3×10^{-7}

[a] The total number of samples within either the entire LDW or specific subareas did not always increase by the number of Round 3 samples within those areas because some Round 3 sampling locations were within 10 ft of earlier stations, and therefore the Round 3 data replaced earlier data for those locations. In addition, some other minor changes were made in the RI baseline dataset.

[b] The EPC was equal to the maximum detected concentration if there were ≤ 5 samples with detected concentrations.

[c] No dioxin/furan data were collected in clamming areas or beach play areas during Round 3.

CT – central tendency
EPC – exposure point concentration
HHRA – human health risk assessment
HQ – hazard quotient
PAH – polycyclic aromatic hydrocarbon
RME – reasonable maximum exposure
TEQ – toxic equivalent

Bold text identifies excess cancer risks > 1×10^{-6}.

C.4 Summary

Incorporation of the Round 3 surface sediment data into the ERA and HHRA datasets would have had a minimal effect on risk conclusions for benthic invertebrates, and would not have affected risk conclusions for the remaining ROCs, as discussed below.

- **Benthic invertebrate community**. Twenty of the 44 Round 3 surface sediment locations had COPC concentrations exceeding the SQS and eight of those also exceeded the CSL. Based on the use of Thiessen polygons to estimate the areal extent of potential effects, the LDW areas with either an SQS or CSL exceedance would not have increased by more than 1%. TBT concentrations in Round 3 surface sediment samples were lower than the maximum concentration used in the ERA to estimate a benthic invertebrate tissue concentration, which resulted in a LOAEL-based HQ of 0.26. Thus, Round 3 surface sediment data would not have changed risk conclusions for the benthic invertebrate community as a result of exposure to TBT.
- **Fish.** The mean COPC concentrations in the Round 3 surface sediment datasets were lower than the mean concentrations in the ERA dataset, indicating that risk conclusions would not have changed (i.e., LOAEL-based HQs would not have increased to > 1.0) for all but five fish ROC/COPC/area scenarios. For those five scenarios, risk conclusions would not have changed based on conservative assumptions or recalculation of EPCs and HQs.
- **Wildlife.** For 69 of the 88 wildlife exposure scenarios, the mean COPC concentrations in the Round 3 surface sediment dataset were lower than or equal to the mean COPC concentrations in the ERA dataset, indicating that risk conclusions would not have changed (i.e., HQs would not have increased to > 1.0). In the remaining 19 scenarios, there were three LOAEL-based HQs that would have changed slightly if Round 3 surface sediment data had been combined with the ERA dataset: 1) the lead HQ for spotted sandpiper in Area 2 H/P would have decreased from 5.5 to 5.3, 2) the mercury HQ for spotted sandpiper in Area 1 H would have increased from 0.22 to 0.23, and 3) the vanadium HQ for spotted sandpiper in Area 2 H would have decreased from 1.4 to 1.3. None of these changes would have affected risk conclusions.
- **Humans—non-cancer hazards.** For non-cancer hazard scenarios, the mean COPC concentrations in the Round 3 surface sediment dataset were not compared to mean COPC concentrations in the HHRA dataset. HQs for these scenarios in the HHRA were all very low (i.e., ≤ 0.1). Instead, it was assumed that HQs would not have increased if Round 3 surface sediment data had been included because the number of Round 3 samples was small compared to those in the HHRA datasets. For lead risks, which were calculated using the IEUBK and ALM models, the mean lead concentrations in the relevant Round 3 surface

sediment dataset were lower than those in the HHRA dataset for the same scenarios, indicating that risk conclusions would not have changed.

- **Humans—excess cancer risks.** Some of the excess cancer risk estimates would have changed slightly if Round 3 surface sediment data had been combined with the HHRA dataset, but none of the risk conclusions would have changed.

C.5 References

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Attachment 1. Comparison of surface sediment data used in the risk assessments with Round 3 surface sediment data

For each HHRA or ERA exposure scenario (other than for the benthic invertebrate community) where there were new Round 3 surface sediment data, and therefore, the potential for a difference in risk conclusions, this attachment consists of a table comparing the surface sediment data used in the risk assessments with the Round 3 surface sediment data (Table 1). For each of those scenarios, Table 1 reports the detection frequencies and the minimum, maximum, and calculated mean concentrations for both the surface sediment datasets used in the risk assessments and the Round 3 surface sediment dataset. The risk estimates for each scenario reported in the risk assessments (expressed as HQs for ecological risks or as either HQs [non-cancer] or excess cancer risks for human health risks) are also presented. See the text of Appendix C for a discussion of the potential effects of the Round 3 data on those risk estimates. Chemicals that were never detected in surface sediments in either the dataset used in the risk assessments or in the Round 3 dataset are not included.

Table 1. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
Antimony													
HHRA	beach play RME – Area 1	2/4	50%	0.21 J	1.05 J	0.38	1/1	100%	0.4 J	0.4 J	0.4	0.007	na
HHRA	beach play RME – Area 4	5/10	50%	0.7 J	6.0 J	2.1	0/1	0%	nd	nd	0.15	0.04	na
HHRA	beach play RME – Area 5	3/22	14%	0.26 J	5.0 J	1.7	0/1	0%	nd	nd	0.25	0.03	na
HHRA	beach play RME – Area 8	2/11	18%	1.72 J	7.0 J	2.7	0/2	0%	nd	nd	0.18	0.05	na
HHRA	clamming – 7 days/yr	24/89	27%	0.09 J	7.0 J	2.1	1/10	10%	0.4 J	0.4 J	0.22	0.00009	na
HHRA	tribal clamming RME[c]	52/159	33%	0.09 J	110 J	4.6	1/10	10%	0.4 J	0.4 J	0.22	0.008	na
	tribal clamming – 183 days/yr											0.05	na
HHRA	netfishing – RME	139/553	25%	0.09 J	122 J	4.2	2/44	5%	0.4 J	1.1 J	0.20	0.002	na
	netfishing – CT											0.0009	na
Arsenic													
HHRA	beach play RME – Area 1	4/4	100%	3.5	14.9	6.5	1/1	100%	5.1	5.1	5.1	0.1	5×10^{-6}
HHRA	beach play RME – Area 4	10/10	100%	2.7	17.3	8.2	1/1	100%	4.2	4.2	4.2	0.1	4×10^{-6}
HHRA	beach play RME – Area 5	22/22	100%	3.94	11.8	8.1	1/1	100%	16.9	16.9	16.9	0.09	3×10^{-6}
HHRA	beach play RME – Area 8	11/11	100%	5.8	15.6	8.7	2/2	100%	6.2	6.6	6.4	0.1	3×10^{-6}
HHRA	clamming – 7 days/yr	100/103	97%	2.7	20.7	8.8	10/10	100%	4.2	19.2	9.6	0.001	3×10^{-7}
HHRA	tribal clamming RME[c]	254/275	92%	1.2	1,100	18	10/10	100%	4.2	19.2	9.6	0.05	2×10^{-5}
	tribal clamming – 183 days/yr											0.3	3×10^{-5}
HHRA	netfishing – RME	755/817	92%	1.2	1,100	17	44/44	100%	4.0	123	13	0.02	6×10^{-6}
	netfishing – CT											0.008	1×10^{-6}
ERA	English sole – LDW-wide	754/814	93%	1.2	1,100	20	44/44	100%	4.0	123	13	0.8	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
	sculpin – LDW-wide											0.50	na
	River otter – LDW-wide											< 0.1	na
ERA	juvenile chinook salmon – intertidal	307/357	86%	1.2	1,100	16	13/13	100%	4.2	19.2	8.8	0.73	na
ERA	sandpiper – 1 H	37/39	95%	3.13	161	17	5/5	100%	5.1	19.2	11	0.12	na
ERA	sandpiper – 1 H/P	52/55	95%	1.2	161	15	5/5	100%	5.1	19.2	11	0.10	na
ERA	sandpiper – 2 H	23/25	92%	4.0	161	22	2/2	100%	4.2	7.6	5.9	0.13	na
ERA	sandpiper – 2 H/P	47/49	96%	1.2	161	15	3/3	100%	4.2	16.9	9.6	0.10	na
ERA	sandpiper – 3 H	80/87	92%	4.5	79.4	10	2/2	100%	6.2	6.6	6.4	< 0.1	na
ERA	sandpiper – 3 H/P	140/150	93%	4.5	1,100	20	2/2	100%	6.2	6.6	6.4	0.15	na
ERA	sculpin – Area M1	217/222	98%	1.55	725	19	24/24	100%	5.1	123	17	0.50	na
ERA	sculpin – Area M2	149/152	98%	1.2	807	22	10/10	100%	4.0	23.1	10	0.53	na
ERA	sculpin – Area M3	194/239	81%	2.5	1,100	18	4/4	100%	8.7	16.9	12	0.50	na
ERA	sculpin – Area M4	177/186	95%	1.5	51	11	6/6	100%	5.4	10.8	6.9	0.40	na
Cadmium													
HHRA	beach play RME – Area 1	2/4	50%	0.050	0.066	0.10	0/1	0%	nd	nd	0.15	0.0004	na
HHRA	beach play RME – Area 4	6/10	60%	0.12	2.0 J	0.52	1/1	100%	0.4	0.4	0.4	0.002	na
HHRA	beach play RME – Area 5	11/22	50%	0.060	0.4	0.19	1/1	100%	0.6	0.6	0.6	0.0007	na
HHRA	beach play RME – Area 8	5/11	45%	0.10 J	0.18	0.15	0/2	0%	nd	nd	0.18	0.0005	na
HHRA	clamming – 7 days/yr	65/103	63%	0.05	2.2	0.35	4/10	40%	0.4	0.7	0.32	0.00002	na
HHRA	tribal clamming RME[c]	179/268	67%	0.030 J	120	2.0	4/10	40%	0.4	0.7	0.32	0.003	na
	tribal clamming – 183 days/yr											0.02	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
HHRA	netfishing – RME	565/800	71%	0.030 J	120	1.0	22/44	50%	0.4	1.1	0.35	0.0005	na
	netfishing – CT											0.0002	na
ERA	English sole – LDW-wide	565/797	71%	0.030 J	120	1.0	22/44	50%	0.4	1.1	0.35	1.2	na
	sculpin – LDW-wide											0.76	na
ERA	sandpiper – 1 H	30/39	77%	0.050	1.0	0.36	2/5	40%	0.4	0.7	0.33	< 0.1	na
ERA	sandpiper – 1 H/P	43/55	78%	0.03	2	0.51	2/5	40%	0.4	0.7	0.33	< 0.1	na
ERA	sandpiper – 2 H	24/25	96%	0.070	2.7	0.84	1/2	50%	0.4	0.4	0.30	< 0.1	na
ERA	sandpiper – 2 H/P	38/49	78%	0.030 J	2.7	0.52	2/3	67%	0.4	0.6	0.40	< 0.1	na
ERA	sandpiper – 3 H	49/80	61%	0.068	5.2	0.52	0/2	0%	nd	nd	0.18	< 0.1	na
ERA	sandpiper – 3 H/P	98/143	69%	0.068	92	2.5	0/2	0%	nd	nd	0.18	< 0.1	na
ERA	sculpin – Area M1	190/217	88%	0.050	11.7	0.78	16/24	67%	0.4	1.1	0.42	0.98	na
ERA	sculpin – Area M2	128/152	84%	0.030	3	0.44	5/10	50%	0.4	0.6	0.32	0.60	na
ERA	sculpin – Area M3	180/239	75%	0.060	120	2.3	1/4	25%	0.6	0.6	0.29	1.0	na
ERA	sculpin – Area M4	66/177	37%	0.030	1	0.26	0/6	0%	nd	nd	0.16	0.64	na
Carcinogenic PAHs													
HHRA	beach play RME – Area 1	3/4	75%	0.023 J	1.20	0.33	0/1	0%	nd	nd	0.022	na	1×10^{-5}
HHRA	beach play RME – Area 4	9/10	90%	0.019	0.75 J	0.20	1/1	100%	0.12 J	0.12 J	0.12	na	8×10^{-6}
HHRA	beach play RME – Area 5	22/22	100%	0.015 J	1.00 J	0.21	1/1	100%	1.7 J	1.7 J	1.7	na	5×10^{-6}
HHRA	beach play RME – Area 8	11/11	100%	0.049	0.62	0.23	1/2	50%	0.10 J	0.10 J	0.061	na	4×10^{-6}
HHRA	clamming – 7 days/yr	97/103	94%	0.0097 J	3.0	0.27	8/10	80%	0.10 J	4.2	0.82	na	1×10^{-7}
HHRA	tribal clamming RME[c]	255/264	97%	0.0097 J	11	0.48	8/10	80%	0.10 J	4.2	0.82	na	5×10^{-6}
	tribal clamming – 183 days/yr											na	8×10^{-6}

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
HHRA	netfishing – RME	749/793	94%	0.0091 J	11	0.45	40/44	91%	0.045 J	4.2	0.50	na	2×10^{-6}
	netfishing – CT											na	2×10^{-7}
Chromium													
HHRA	beach play RME – Area 1	4/4	100%	9.10	20.8	15	1/1	100%	19.8	19.8	20	0.02	na
HHRA	beach play RME – Area 4	10/10	100%	12	122 J	34	1/1	100%	13.2	13.2	13	0.07	na
HHRA	beach play RME – Area 5	22/22	100%	12	61 J	23	1/1	100%	40	40	40	0.02	na
HHRA	beach play RME – Area 8	11/11	100%	15	26	21	2/2	100%	15.9	18.5	17	0.02	na
HHRA	clamming – 7 days/yr	103/103	100%	9.0	122 J	26	10/10	100%	13.2	40	23	0.0002	na
HHRA	tribal clamming RME[c]	275/275	100%	4.8	1,100 J	52	10/10	100%	13.2	40	23	0.01	na
	tribal clamming – 183 days/yr											0.07	na
HHRA	netfishing – RME	814/814	100%	4.8	1,100 J	40	44/44	100%	11.0	40	25	0.003	na
	netfishing – CT											0.002	na
ERA	great blue heron	357/357	100%	4.8	1,100 J	50	13/13	100%	12.5	40	21	< 0.1	na
	osprey											< 0.1	na
ERA	sandpiper – 1 H	39/39	100%	9.84	60.5	28	5/5	100%	18	37	25	0.28	na
ERA	sandpiper – 1 H/P	55/55	100%	4.8	60.5	27	5/5	100%	18	37	25	0.26	na
ERA	sandpiper – 2 H	25/25	100%	9.0	122 J	35	2/2	100%	13.2	19.6	16	0.80	na
ERA	sandpiper – 2 H/P	49/49	100%	4.8	122 J	28	3/3	100%	13.2	40	24	1.8	na
ERA	sandpiper – 3 H	87/87	100%	9.19	76 J	29	2/2	100%	15.9	18.5	17	0.32	na
ERA	sandpiper – 3 H/P	150/150	100%	9.19	1,100	67	2/2	100%	15.9	18.5	17	0.82	na
Cobalt													
ERA	river otter – LDW-wide	556/556	100%	2.82	140	9.5	44/44	100%	3.6	12	7.6	< 0.1	na
ERA	sandpiper – 1 H	25/25	100%	2.82	18.7	7.4	5/5	100%	3.6	8.1	6.0	< 0.1	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
ERA	sandpiper – 1 H/P	28/28	100%	2.82	18.7	7.1	5/5	100%	3.6	8.1	6.0	< 0.1	na
ERA	sandpiper – 2 H	22/22	100%	3.0	18.7	8.2	2/2	100%	4.1	5.4	4.8	< 0.1	na
ERA	sandpiper – 2 H/P	38/38	100%	3.0	18.7	7.3	3/3	100%	4.1	10.2	6.6	< 0.1	na
ERA	sandpiper – 3 H	70/70	100%	3.48	12	7.7	2/2	100%	5.9	6.4	6.2	< 0.1	na
ERA	sandpiper – 3 H/P	106/106	100%	3.48	37	9.2	2/2	100%	5.9	6.4	6.2	< 0.1	na
Copper													
HHRA	beach play RME – Area 1	4/4	100%	17.6	50.2	33	1/1	100%	27.7	27.7	28	0.003	na
HHRA	beach play RME – Area 4	10/10	100%	13.3	117	47	1/1	100%	19.0	19.0	19	0.005	na
HHRA	beach play RME – Area 5	22/22	100%	17.1	180	43	1/1	100%	100	100	100	0.005	na
HHRA	beach play RME – Area 8	11/11	100%	22	46.7	29	2/2	100%	17.9	26.9	22	0.002	na
HHRA	clamming – 7 days/yr	103/103	100%	7.9	180	44	10/10	100%	17.9	100	47	0.00003	na
HHRA	tribal clamming RME[c]	275/275	100%	5	12,000 J	180	10/10	100%	17.9	100	47	0.005	na
	tribal clamming – 183 days/yr											0.03	na
HHRA	netfishing – RME	817/817	100%	5	12,000 J	100	44/44	100%	14.5	137	59	0.001	na
	netfishing – CT											0.0005	na
ERA	English sole – LDW-wide	814/814	100%	5	12,000 J	110	44/44	100%	14.5	137	59	0.93	na
	sculpin – LDW-wide											0.56	na
ERA	sandpiper – 1 H	39/39	100%	7.90	365	74	5/5	100%	27.7	92	55	0.72	na
ERA	sandpiper – 1 H/P	55/55	100%	7.9	365	65	5/5	100%	27.7	92	55	0.72	na
ERA	sandpiper – 2 H	25/25	100%	16	365	87	2/2	100%	19.0	35.5	27	0.86	na
ERA	sandpiper – 2 H/P	49/49	100%	11.5	365	64	3/3	100%	19.0	100	52	0.83	na
ERA	sandpiper – 3 H	87/87	100%	17.2	290	45	2/2	100%	17.9	26.9	22	0.45	na
ERA	sandpiper – 3 H/P	150/150	100%	17.2	12,000	200	2/2	100%	17.9	26.9	22	1.1	na
ERA	sculpin – Area M1	222/222	100%	7.9	495	84	24/24	100%	27.7	137	72	0.65	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
ERA	sculpin – Area M2	152/152	100%	10	1420	100	10/10	100%	14.5	100	53	0.77	na
ERA	sculpin – Area M3	239/239	100%	14	12000	200	4/4	100%	30.1	100	58	0.45	na
ERA	sculpin – Area M4	186/186	100%	5	89.9	38	6/6	100%	16.5	32.2	22	0.48	na
Dioxin/furan TEQ													
HHRA	netfishing – RME	43/43	100%	1.10×10^{-6} J	0.00210 J	1.1×10^{-4}	5/5	100%	1.02×10^{-5} J	1.69×10^{-5} J	1.4×10^{-5}	na	2×10^{-5}
HHRA	netfishing – CT											na	4×10^{-6}
Lead													
HHRA	beach play RME – Area 1	4/4	100%	4	71	32	1/1	100%	40	40	40	bt[d]	na
HHRA	beach play RME – Area 4	10/10	100%	9	615	130	1/1	100%	16	16	16	bt[d]	na
HHRA	beach play RME – Area 5	22/22	100%	17	70 J	32	1/1	100%	70	70	70	bt[d]	na
HHRA	beach play RME – Area 8	11/11	100%	9.3	95	24	2/2	100%	15	26	21	bt[d]	na
HHRA	clamming – 7 days/yr	103/103	100%	4	615	53	10/10	100%	15	138	48	bt[d]	na
HHRA	tribal clamming RME[c]	275/275	100%	2	23,000	230	10/10	100%	15	138	48	bt[d]	na
	tribal clamming – 183 days/yr											bt[d]	na
HHRA	netfishing – RME	817/817	100%	2	23,000	100	44/44	100%	7	292	50	bt[d]	na
	netfishing – CT											bt[d]	na
ERA	great blue heron	357/357	100%	2	23000	190	13/13	100%	7	138	39	< 0.1	na
	osprey											< 0.1	na
ERA	sandpiper – 1 H	39/39	100%	7.94 J	400	70	5/5	100%	19	138	66	0.37	na
ERA	sandpiper – 1 H/P	55/55	100%	7.94 J	400	70	5/5	100%	19	138	66	0.37	na
ERA	sandpiper – 2 H	25/25	100%	8.2	615	110	2/2	100%	16	34	25	0.34	na
ERA	sandpiper – 2 H/P	49/49	100%	8.2	615	70	3/3	100%	16	70	40	5.5	na
ERA	sandpiper – 3 H	87/87	100%	6.3	533	50	2/2	100%	15	26	21	0.17	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
ERA	sandpiper – 3 H/P	150/150	100%	6.3	23,000	300	2/2	100%	15	26	21	1.5	na
Mercury													
HHRA	beach play RME – Area 1	3/4	75%	0.053	0.17	0.082	0/1	0%	nd	nd	0.030	0.005	na
HHRA	beach play RME – Area 4	8/10	80%	0.038	2.46	0.53	0/1	0%	nd	nd	0.030	0.05	na
HHRA	beach play RME – Area 5	14/22	64%	0.06	0.23	0.081	1/1	100%	0.28	0.28	0.28	0.003	na
HHRA	beach play RME – Area 8	8/11	73%	0.05	0.21	0.088	2/2	100%	0.070	0.080	0.075	0.003	na
HHRA	clamming – 7 days/yr	78/103	76%	0.025	2.46	0.15	7/10	70%	0.070	0.6	0.16	0.00005	na
HHRA	tribal clamming RME[c]	218/272	80%	0.021	4.6 J	0.18	7/10	70%	0.070	0.6	0.16	0.0009	na
	tribal clamming – 183 days/yr											0.006	na
ERA	great blue heron	278/356	78%	0.021	5.6	0.17	7/13	54%	0.060	0.6	0.13	< 0.1	na
	osprey											< 0.1	na
ERA	harbor seal – LDW-wide	715/831	86%	0.021	4.6 J	0.21	37/44	84%	0.060	1.8	0.28	< 0.1	na
	river otter – LDW-wide											0.57	na
ERA	sandpiper – 1 H	34/39	87%	0.025	0.63	0.13	3/5	60%	0.11	0.6	0.22	0.22	na
ERA	sandpiper – 1 H/P	40/47	85%	0.021	0.63	0.13	3/5	60%	0.11	0.6	0.22	0.22	na
ERA	sandpiper – 2 H	29/32	91%	0.03	2.46	0.30	0/2	0%	nd	nd	0.035	0.24	na
ERA	sandpiper – 2 H/P	41/49	84%	0.021	2.46	0.22	1/3	33%	0.28	0.28	0.12	0.21	na
ERA	sandpiper – 3 H	71/87	82%	0.030	4.6 J	0.20	2/2	100%	0.070	0.080	0.075	1.0	na
ERA	sandpiper – 3 H/P	124/149	83%	0.030	4.6	0.20	2/2	100%	0.070	0.080	0.075	0.99	na
Molybdenum													
HHRA	beach play RME – Area 1	4/4	100%	0.494 J	1.8	0.90	1/1	100%	0.5	0.5	0.5	0.001	na
HHRA	beach play RME – Area 4	7/7	100%	0.543 J	5.1	1.6	1/1	100%	0.3	0.3	0.3	0.002	na
HHRA	beach play RME – Area 5	15/15	100%	0.486 J	4	1.5	1/1	100%	2.1	2.1	2.1	0.001	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
HHRA	beach play RME – Area 8	6/6	100%	0.9	2	1.5	2/2	100%	0.4	0.5	0.45	0.001	na
HHRA	clamming – 7 days/yr	56/60	93%	0.399	5.8	1.5	10/10	100%	0.3	8.8	2.1	0.00001	na
HHRA	tribal clamming RME[c]	93/97	96%	0.390 J	49	2.7	10/10	100%	0.3	8.8	2.1	0.0003	na
	tribal clamming – 183 days/yr											0.002	na
Nickel													
ERA	sandpiper – 1 H	39/39	100%	6.0	37	19	5/5	100%	10	22.4	17	< 0.1	na
ERA	sandpiper – 1 H/P	47/48	98%	6.0	37	20	5/5	100%	10	22.4	17	< 0.1	na
ERA	sandpiper – 2 H	25/25	100%	8.9	39	19	2/2	100%	10.5	13.2	12	< 0.1	na
ERA	sandpiper – 2 H/P	41/42	98%	8.9	39	17	3/3	100%	10.5	35	20	< 0.1	na
ERA	sandpiper – 3 H	85/85	100%	7.66	52	20	2/2	100%	11.4	14.5	13	< 0.1	na
ERA	sandpiper – 3 H/P	141/141	100%	7.66	910	50	2/2	100%	11.4	14.5	13	0.11	na
Total PCBs													
HHRA	beach play RME – Area 1	3/5	60%	0.0031 J	0.119	0.029	1/1	100%	0.0084 J	0.0084 J	0.0084	0.02	7×10^{-8}
HHRA	beach play RME – Area 4	12/12	100%	0.011 J	23	2.8	1/1	100%	0.038	0.038	0.038	1	6×10^{-6}
HHRA	beach play RME – Area 5	31/32	97%	0.024 J	0.66	0.10	1/1	100%	0.30	0.30	0.30	0.04	1×10^{-7}
HHRA	beach play RME – Area 8	12/18	67%	0.0061 J	0.52	0.056	2/2	100%	0.060	0.088 J	0.074	0.04	1×10^{-7}
HHRA	clamming – 7 days/yr	142/161	88%	0.0022 J	23	0.43	9/10	90%	0.0084 J	1.01	0.21	0.005	9×10^{-8}
HHRA	tribal clamming RME[c]	415/440	94%	0.0022 J	110	2.0	9/10	90%	0.0084 J	1.01	0.21	0.05	2×10^{-6}
	tribal clamming – 183 days/yr											0.3	3×10^{-6}
HHRA	netfishing – RME	1205/1291	93%	0.0016 J	220	1.0	43/44	98%	0.0084 J	1.01	0.22	0.01	3×10^{-7}
	netfishing – CT											0.003	5×10^{-8}
ERA	great blue heron	509/552	92%	0.0022 J	220	2.3	12/13	92%	0.0084 J	1.01	0.16	0.12	na
	osprey											0.23	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
ERA	Harbor seal – LDW-wide	1203/1288	93%	0.0016 J	220	1.0	43/44	98%	0.0084 J	1.01	0.22	0.22	na
	river otter – LDW-wide											2.9	na
ERA	sandpiper – 1 H	52/56	93%	0.0026	0.81	0.15	4/5	80%	0.0084 J	1.01	0.29	0.18	na
ERA	sandpiper – 1 H/P	74/81	91%	0.0022 J	0.81	0.14	4/5	80%	0.0084 J	1.01	0.29	0.18	na
ERA	sandpiper – 2 H	49/50	98%	0.061	25	2.8	2/2	100%	0.038	0.097 J	0.068	0.71	na
ERA	sandpiper – 2 H/P	84/88	95%	0.0047	25	1.6	3/3	100%	0.038	0.30	0.15	0.46	na
ERA	sandpiper – 3 H	117/129	91%	0.0061 J	15	1.3	2/2	100%	0.060	0.088 J	0.074	0.32	na
ERA	sandpiper – 3 H/P	216/228	95%	0.0061 J	110	3.3	2/2	100%	0.060	0.088 J	0.074	0.41	na
Selenium													
ERA	river otter – LDW-wide	277/629	44%	0.2 J	28	4.3	0/44	0%	nd	nd	0.43	0.40	na
ERA	sandpiper – 1 H	12/28	43%	0.2 J	1	2.5	0/5	0%	nd	nd	0.46	0.39	na
ERA	sandpiper – 1 H/P	13/36	36%	0.2 J	10	0.71	0/5	0%	nd	nd	0.46	0.38	na
ERA	sandpiper – 2 H	12/22	55%	0.3	9	3.2	0/2	0%	nd	nd	0.40	0.55	na
ERA	sandpiper – 2 H/P	16/38	42%	0.3	9	3.3	0/3	0%	nd	nd	0.43	0.45	na
ERA	sandpiper – 3 H	22/60	37%	0.6 J	13	5.5	0/2	0%	nd	nd	0.40	0.50	na
ERA	sandpiper – 3 H/P	32/96	33%	0.6 J	20	5.9	0/2	0%	nd	nd	0.40	0.49	na
Silver													
HHRA	beach play RME – Area 1	1/4	25%	0.04	0.04	0.12	0/1	0%	nd	nd	0.15	0.0001	na
HHRA	beach play RME – Area 4	7/10	70%	0.083	1.7	0.49	0/1	0%	nd	nd	0.15	0.0004	na
HHRA	beach play RME – Area 5	9/22	41%	0.084	0.18	0.21	0/1	0%	nd	nd	0.25	0.00008	na
HHRA	beach play RME – Area 8	6/11	55%	0.06	0.13 J	0.18	0/2	0%	nd	nd	0.18	0.00006	na
HHRA	clamming – 7 days/yr	55/103	53%	0.04	5.7	0.35	0/10	0%	nd	nd	0.20	0.000003	na
HHRA	tribal clamming RME[c]	143/265	54%	0.02	270	2.1	0/10	0%	nd	nd	0.20	0.0005	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
	tribal clamming – 183 days/yr											0.003	na
Thallium													
HHRA	beach play RME – Area 1	1/4	25%	0.036	0.036	0.076	0/1	0%	nd	nd	0.15	0.006	na
HHRA	beach play RME – Area 4	6/10	60%	0.03	0.11 J	0.096	0/1	0%	nd	nd	0.15	0.003	na
HHRA	beach play RME – Area 5	9/22	41%	0.03	0.07	0.12	0/1	0%	nd	nd	0.25	0.002	na
HHRA	beach play RME – Area 8	6/11	55%	0.04	0.07	0.11	0/2	0%	nd	nd	0.18	0.002	na
HHRA	clamming – 7 days/yr	42/89	47%	0.010 J	0.18	1.1	0/10	0%	nd	nd	0.20	0.00003	na
HHRA	tribal clamming RME[c]	83/190	44%	0.010 J	30	2.7	0/10	0%	nd	nd	0.20	0.02	na
	tribal clamming – 183 days/yr											0.1	na
HHRA	netfishing – RME	325/638	51%	0.010 J	32 J	3.3	0/44	0%	nd	nd	0.18	0.007	na
	netfishing – CT											0.004	na
Vanadium													
HHRA	beach play RME – Area 1	4/4	100%	44.2	47.2	46	1/1	100%	43.6	43.6	44	0.1	na
HHRA	beach play RME – Area 4	10/10	100%	37.3	71	51	1/1	100%	36.3	36.3	36	0.2	na
HHRA	beach play RME – Area 5	22/22	100%	41.2	68.7	53	1/1	100%	67.6	67.6	68	0.1	na
HHRA	beach play RME – Area 8	11/11	100%	41	65.4	53	2/2	100%	40.7	49.9	45	0.2	na
HHRA	clamming – 7 days/yr	81/81	100%	15	71	51	10/10	100%	34.6	70.7	49	0.001	na
HHRA	tribal clamming RME[c]	192/192	100%	15	87	55	10/10	100%	34.6	70.7	49	0.02	na
	tribal clamming – 183 days/yr											0.1	na
HHRA	netfishing – RME	557/557	100%	15	150	59	44/44	100%	34.6	74	51	0.01	na
	netfishing – CT											0.006	na
ERA	English sole – LDW-wide	556/556	100%	15	150	59	44/44	100%	34.6	74	51	1.2	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
	sculpin – LDW-wide											0.79	na
ERA	sandpiper – 1 H	25/25	100%	34.8	72.6	50	5/5	100%	34.6	70.7	49	1.1	na
ERA	sandpiper – 1 H/P	28/28	100%	34.8	72.6	49	5/5	100%	34.6	70.7	49	1.0	na
ERA	sandpiper – 2 H	22/22	100%	15	72.6	53	2/2	100%	36.3	45.7	41	1.4	na
ERA	sandpiper – 2 H/P	38/38	100%	15	72.6	52	3/3	100%	36.3	67.6	50	1.3	na
ERA	sandpiper – 3 H	70/70	100%	27.9	83	55	2/2	100%	40.7	49.9	45	1.3	na
ERA	sandpiper – 3 H/P	106/106	100%	27.9	87	57	2/2	100%	40.7	49.9	45	1.3	na
ERA	sculpin – Area M1	128/128	100%	27.7	100	61	24/24	100%	34.6	74	52	0.86	na
ERA	sculpin – Area M2	132/132	100%	15	86	59	10/10	100%	35.0	71.9	51	1.2	na
ERA	sculpin – Area M3	182/182	100%	30	150	58	4/4	100%	49.5	67.6	58	1.2	na
ERA	sculpin – Area M4	100/100	100%	27.9	89.6	58	6/6	100%	38.2	54.1	44	0.65	na
Zinc													
HHRA	beach play RME – Area 1	4/4	100%	30.8	142 J	73	1/1	100%	98	98	98	0.001	na
HHRA	beach play RME – Area 4	10/10	100%	35.3	417	140	1/1	100%	57	57	57	0.002	na
HHRA	beach play RME – Area 5	22/22	100%	52.1	246 J	92	1/1	100%	250	250	250	0.001	na
HHRA	beach play RME – Area 8	11/11	100%	56	211	83	2/2	100%	51	76	64	0.001	na
HHRA	clamming – 7 days/yr	103/103	100%	28	480 J	110	10/10	100%	51	250	100	0.00001	na
HHRA	tribal clamming RME[c]	275/275	100%	16	9,700	270	10/10	100%	51	250	100	0.0006	na
	tribal clamming – 183 days/yr											0.004	na
ERA	sandpiper – 1 H	39/39	100%	31	607	150	5/5	100%	57	160	100	0.28	na
ERA	sandpiper – 1 H/P	54/55	98%	19.2	607	140	5/5	100%	57	160	100	0.27	na
ERA	sandpiper – 2 H	25/25	100%	28	607	190	2/2	100%	57	91	74	0.43	na
ERA	sandpiper – 2 H/P	48/49	98%	19.2	607	140	3/3	100%	57	250	130	0.52	na
ERA	sandpiper – 3 H	87/87	100%	35.6	343	110	2/2	100%	51	76	64	0.37	na

Table 1, cont. Comparison of surface sediment data used in risk assessments with Round 3 surface sediment data by chemical

HHRA or ERA	Exposure Scenario	Surface Sediment Data Used in Risk Assessments					Round 3 Surface Sediment Data					HHRA or ERA Risk Estimate (Without Round 3 Data)	
		Detection Frequency		Concentration (mg/kg dw)			Detection Frequency		Concentration (mg/kg dw)				
		Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	Ratio	%	Minimum Detect	Maximum Detect	Calc'd Mean[a]	HQ[b]	Excess Cancer Risk
ERA	sandpiper – 3 H/P	150/150	100%	35.6	6,400	320	2/2	100%	51	76	64	0.50	na

[a] Calculated mean concentration is the average of detected concentrations and one-half the RL for non-detected results.

[b] ERA HQs are the LOAEL-based HQs. HQs with values less than 0.1 were reported as < 0.1 in the ERA. HHRA hazard quotients are for non-cancer risks.

[c] Tribal clamming RME risk estimates are calculated using an exposure frequency of 120 days per year.

[d] Human health risks from exposure to lead were determined using the IEUBK model for children and the ALM model for adults. The risk estimates for lead were expressed as the probability of exceeding a threshold blood lead concentration (10 µg/dL in children for exposure of children or 10 µg/dL in the fetus for exposure of a pregnant mother) rather than as an excess cancer risk estimate or hazard quotient, as used for other COPCs. Consequently, the risk estimates are shown as "below threshold (or bt)" rather than as a hazard quotient.

bt – below threshold

COPC – chemical of potential concern

ERA – ecological risk assessment

H – high-quality sandpiper foraging habitat

HHRA – human health risk assessment

H/P – high- and poor-quality sandpiper foraging habitat

HQ – hazard quotient

J – estimated concentration

na – not applicable

nd – not detected