



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION 10

1200 Sixth Avenue, Suite 900  
Seattle, WA 98101-3140

OFFICE OF  
ENVIRONMENTAL  
CLEANUP

August 26, 2015

**MEMORANDUM**

**SUBJECT:** Lower Duwamish Waterway Record of Decision Table and Figure Revisions

**FROM:** Alison Hiltner, Remedial Project Manager  
Office of Environmental Cleanup

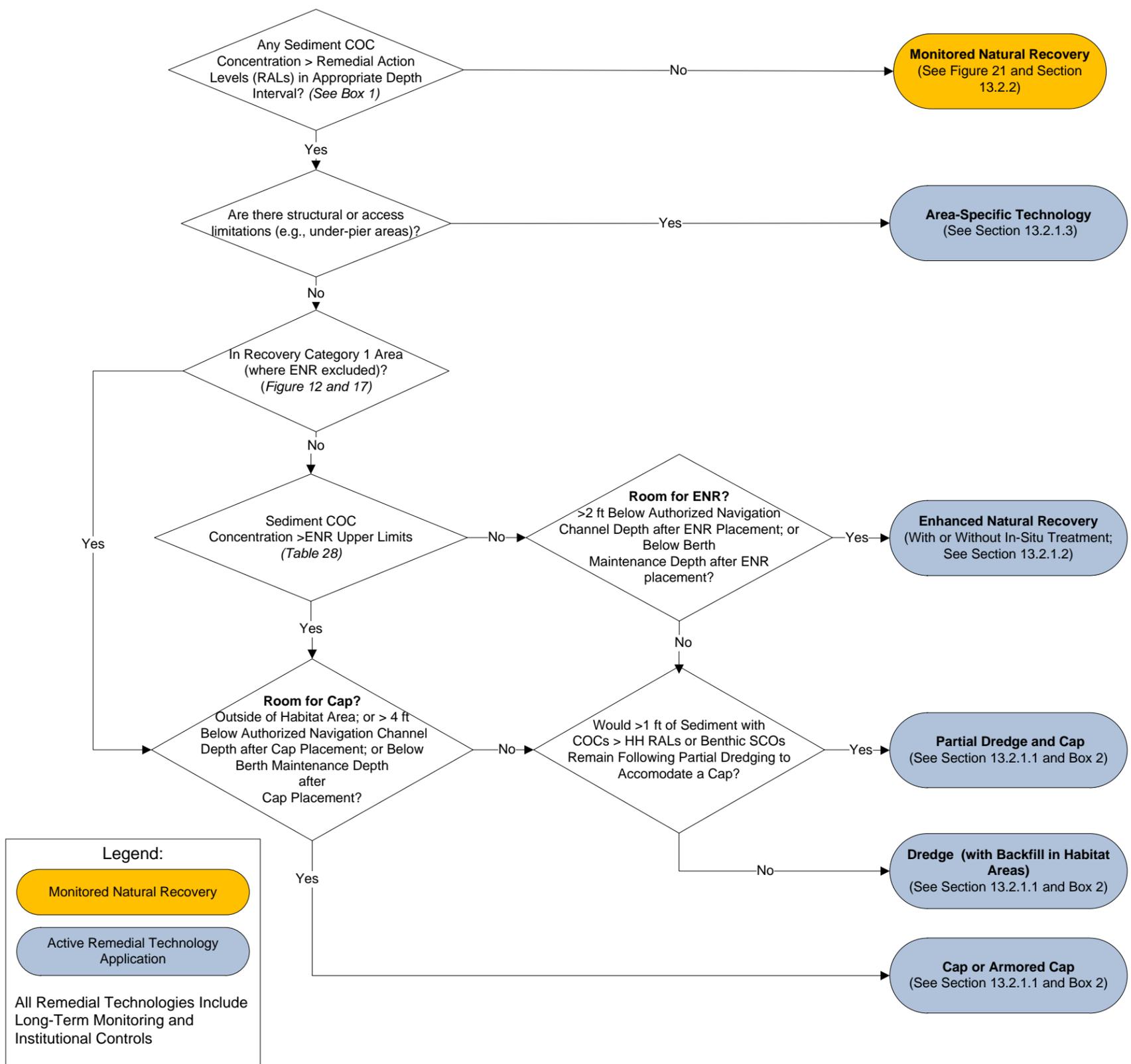
A handwritten signature in black ink, appearing to read "Alison Hiltner", written over the printed name in the "FROM" field.

**TO:** Lower Duwamish Waterway site file

The Lower Duwamish Waterway Group identified a few minor errors contained within 3 tables and a figure in the Record of Decision (ROD) for the Lower Duwamish Waterway Superfund Site (November 2014). These errors were brought to the attention of the EPA in a March 5, 2015 e-mail from Anne Fitzpatrick of AECOM and a May 18, 2015 email from Kathy Godtfredsen of Windward Environmental. To address these errors, this memorandum includes revisions to Figure 20 and Tables 1, 4, and 17 of the Record of Decision. The attachment provides revised Figure 20 and redlined and non-redlined versions of revised Tables 1, 4, and 17.

These revisions do not affect the final remedy. As such, they do not require an Explanation of Significant Differences or other amendment. This correction memorandum will be added to the site file. Corrected tables and Figure 20 are also included as an attachment.

Attachment



Box 1. Subtidal Sediments (-4 ft MLLW and Deeper)							
Remedial Action Levels (RALs) and Depth Interval for Application of RAL							
Contaminant	Units	Recovery Category 1 Areas		Recovery Category 2 and 3 Areas		Shoaled Areas of the Federal Channel	Risk Reduction Associated with RALs
		4 in (10 cm) depth interval	2 ft (60 cm) depth interval	4 in (10 cm) depth interval	2 ft (60 cm) depth interval-applied only at potential tug scour areas; See Footnote 2 and Figure 16	See Footnote 3. To a depth of 2 ft below the authorized depth for waterway reach <sup>f</sup>	
PCBs (Total)	mg/kg-OC	12	12	12	195	12	Human Health <sup>a,b,c</sup>
cPAH	µg TEQ/kg-dw	1000	1000	1000	--	1000	
Dioxins/Furans	ng TEQ/kg-dw	25	25	25	--	25	
Arsenic (Total)	mg/kg-dw	57	57	57	--	57	
39 SMS COCs	Varies by COC	SCO (see Table 27)	SCO	2xSCO (see Table 27)	--	SCO (see Table 27)	Ecological <sup>d,e</sup>

**Notes**

- The average concentrations in depth interval (e.g., vertically composited samples) are compared to RALs.
- Potential Tug Scour Areas are Subtidal Elevations Potentially Susceptible to Propellor Wash (North of the 1st Avenue South bridge located at approximately RM 2 in Water Depths from -4 to -24 ft MLLW, and South of the 1st Avenue S Bridge, in Water Depths from -4 to -18 ft MLLW).
- Shoaled areas are those areas in federal navigation channel with sediment accumulation above the authorized depth including a 2 ft over-dredge depth; see Table 28. For areas in the navigation channel that are not shoaled, Recovery Categories 1 or 2 & 3 RALs apply. Authorized depths are: (1) from RM 0 to 2, 30 ft below MLLW (from Harbor Island to the First Avenue South Bridge); (2) from RM 2 to RM 2.8, 20 ft below MLLW (from the First Avenue South Bridge to Slip 4); and (3) from 15 ft below MLLW from RM 2.8 to 4.7 (Slip 4 to the Upper Turning Basin).
- Human Health RALs (and RAO 3 PRGs (Benthic SCOs) in Category 1 areas) must be met immediately following construction.

<sup>a</sup> RAO 1 - Human health seafood consumption  
<sup>b</sup> RAO 2 - Human health direct contact includes beach play, clamming, and netfishing  
<sup>c</sup> RAO 4 - Ecological protection for river otter (addressed by meeting human health PCB RAL)  
<sup>d</sup> RAO 3 - Ecological protection of benthic community  
<sup>e</sup> There are 41 SMS COCs, but PCB and arsenic are principally RAO 1 COCs. SMS Also lists toxicity test-out criteria using bioassays. Test-out is not allowed for PCBs or arsenic.  
<sup>f</sup> Depth intervals to determine compliance will be determined during Remedial Design.

<sup>g</sup> Caps were assumed to be 3 ft for cost estimating purposes; cap thicknesses will be evaluated by EPA during Remedial Design in accordance with EPA and USACE (1998)

Box 2. Habitat Areas (see Section 13.2.1.1)
Elevations of intertidal habitat areas are assumed to be unaffected by addition of 6-9" materials (i.e., ENR)
Cap, dredge and backfill, or partial dredge and cap to pre-construction grade; finish with suitable habitat layer.

Revised Figure 20. Subtidal Areas – Remedial Technology Application

**Revised Table 1. Statistical Summaries for Baseline Human Health COC Concentrations in Sediment**

Data Type/Contaminant	Summary Statistics for Sediment in the LDW (RM 0 to 5.0)				Total Number of Sediment Samples in FS Baseline Dataset	
	Minimum Detect	Calculated Mean	Maximum Detect	Spatially-Weighted Average Concentration (SWAC)	Total	With Detected Values
<b>Surface Sediment</b>						
PCBs (µg/kg dw)	2.2	1,136	<del>220,000</del> 223,000 <sup>a</sup>	346	1,392 (1,390) <sup>a</sup>	1,309
Arsenic (mg/kg dw)	1.2	17	1,100	15.6	918	857
cPAHs (µg TEQ/kg dw) <sup>b</sup>	9.7	459	11,000	388	893	852
Dioxins/Furans (ng TEQ / kg dw) <sup>c</sup>	0.25	42	2,100	25.6	123	119
<b>Subsurface Sediment</b>						
PCBs (µg/kg dw)	0.52	1,953	890,000	n/a	1,504	1131
Arsenic (mg/kg dw)	1.2	29	2,000	n/a	531	453
cPAHs (µg TEQ/kg dw) <sup>b</sup>	1.2	373	7,000	n/a	542	449
Dioxins/Furans (ng TEQ / kg dw) <sup>c</sup>	0.15	17	194	n/a	64	64

Source: FS baseline surface and subsurface sediment dataset dated April 28, 2010 (surface) and May 14, 2010 (subsurface). This summary is based on data used for the Feasibility Study (see Section 5.3); however, for the human health and ecological risk assessments the RI dataset was used..

- This table excludes two PCB samples, both collected at the inlet at RM 2.2. They were considered anomalous samples and statistical outliers and were not included in calculated mean and SWAC; their detected concentrations were 230,000 and 2,900,000 µg/kg. If the outliers were included, the mean would be 3,400 µg/kg dw and the SWAC would be 1,300 µg/kg dw.
- The cPAH TEQs were calculated using compound-specific potency equivalency factors.
- The dioxin/furan TEQs were calculated using World Health Organization's mammalian toxic equivalent factors.

**Revised Table 4. Summary of PCB, Arsenic, cPAH, and Dioxin/Furan Data for Natural Background Concentrations in Fish and Shellfish Tissue**

Species	Natural Background Fish and Shellfish Tissue Data			
	Detected Samples / Total Samples	Range of Detected Concentrations	Mean	95 <sup>th</sup> Percentile Upper Confidence Limit on the Mean (UCL95)
<b>PCBs (<math>\mu\text{g}/\text{kg ww}</math>)</b>				
English sole, rock sole (fillet)	158 / <del>238</del> 242	1.3 – 75.4	11	12
Dungeness crab (edible meat)	17 / 17	0.43 – 1.9	<del>0.87</del> 0.86	1.1
Dungeness crab (whole body)	15 / 15	3.0 – 16	7.1	9.1
Butter clam, geoduck, horse clam, littleneck clam (whole body)	24 / 70	0.09 – 1.4	0.3	0.42
<b>Inorganic arsenic (<math>\text{mg}/\text{kg ww}</math>)</b>				
Eastern softshell clams (whole body) <sup>a,b</sup>	6 / 6	0.047 / 0.112	0.064	0.09
<b>cPAH TEQ (<math>\mu\text{g}/\text{kg ww}</math>)</b>				
Butter clam, geoduck, littleneck clam (whole body) <sup>a</sup>	3 / 11	<del>0.069 – 0.17</del>	<del>0.088</del>	0.12
<b>Dioxin/furan TEQ (<math>\text{ng}/\text{kg ww}</math>)</b>				
Starry flounder, rock sole (whole body) <sup>c</sup>	7 / 7	<del>0.17 – 0.92</del> 0.15 – 0.42	0.28	0.35
Dungeness crab (edible meat)	27 / 27	0.027 – 1.4	0.57	0.53
Dungeness crab (whole body)	25 / 25	0.089 – 5.1	0.81	2.0
Butter clam, geoduck, horse clam, littleneck clam (whole body)	43 / 43	0.011 – 1.6	0.34 <sup>d</sup>	0.71

- Only clams are shown for inorganic arsenic and cPAH TEQ because most of the risk associated with these COCs was due to consumption of clams.
- Only clams collected from Dungeness Spit were selected by EPA for this category, as these were the only ones in the dataset likely unaffected by the atmospheric deposition of arsenic from the former Tacoma ASARCO smelter.
- There were insufficient data to derive a background value for pelagic fish (e.g., perch) for total PCBs, cPAHs, and dioxins/furans; there were insufficient data for benthic fish (e.g., English sole) fillets for dioxins/furans; **there were insufficient data for clams for cPAH TEQ.**
- This is a nonparametric mean, as there was no discernible distribution according to ProUCL v. 4.1.

**Revised Table 17. Surface Sediment Contaminant Concentrations from FS Dataset, with Comparison to SMS Chemical Criteria for Protection of Benthic Invertebrates**

Contaminant	Summary Statistics for Surface Sediments			Total Number of Surface Sediment Samples in FS Baseline Dataset					Exceedances Waterway Wide
	Minimum Detect	Maximum Detect	Mean <sup>a</sup>	Total Samples	Detection Frequency	>Benthic SCO, ≤Benthic CSL, detected <sup>b</sup>	>Benthic CSL, detected <sup>b</sup>	>Benthic SCO or Benthic CSL, detected <sup>b,c</sup>	>Benthic SCO
<i>Metals and TBT (mg/kg dw)</i>									
Arsenic	1.2	1,100	17	916	94%	5	9	14	1.53%
Cadmium	0.03	120	1.0	894	71%	2	12	14	1.57%
Chromium	4.80	1,680	42	906	100%	1	10	11	1.21%
Copper	5.0	12,000	106	908	100%	0	13	13	1.43%
Lead	2.0	23,000	139	908	100%	2	23	25	2.75%
Mercury	0.015	247	0.53	927	88%	20	30	50	5.39%
Nickel	5.0	910	28	836	100%	NA	NA	NA	—
Silver	0.018	270	1.0	875	61%	0	10	10	1.14%
Vanadium	15	150	59	589	100%	NA	NA	NA	—
Zinc	16	9,700	194	905	100%	26	19	45	4.97%
Tributyltin as ion	0.28	3,000	90	189	94%	NA	NA	NA	—
<i>PAHs (µg/kg dw)</i>									
2-Methylnaphalene	0.38	3,300	42	<del>882</del> 884	19%	1	4	5	0.57%
Acenaphthene	1.0	5,200	65	891	40%	16	4	20	2.24%
Anthracene	1.3	10,000	134	891	73%	2	0	2	0.22%
Benzo(a)anthracene	7.3	8,400	322	891	92%	10	6	16	1.80%
Benzo(a)pyrene	6.5	7,900	309	886	92%	7	5	12	1.35%
Benzo(g,h,i)perylene	6.1	3,800	165	891	86%	10	12	22	2.47%
Total benzofluoranthenes	6.6	17,000	732	885	94%	6	6	12	1.36%
Chrysene	12	7,700	474	891	95%	29	3	32	3.59%
Dibenzo(a,h)anthrecene	1.6	1,500	63	891	56%	18	6	24	2.69%
Dibenzofuran	1.0	4,200	54	889	31%	7	3	10	1.12%
Fluoranthene	18	24,000	889	891	97%	35	12	47	5.27%
Fluorene	0.68	6,800	78	891	48%	11	3	14	1.57%
Indeno(1,2,3-cd)pyrene	6.4	4,300	180	891	90%	16	13	29	3.25%
Naphthalene	3.0	5,300	49	882	21%	0	2	2	0.23%
Phenanthrene	7.1	28,000	429	891	93%	27	3	30	3.37%
Pyrene	19	16,000	723	891	97%	2	6	8	0.90%
Total HPAH	23	85,000	3,809	891	98%	25	6	31	3.48%

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	Minimum Detect	Maximum Detect	Mean <sup>a</sup>	Total Samples	Detection Frequency	>Benthic SCO, ≤Benthic CSL, detected <sup>b</sup>	>Benthic CSL, detected <sup>b</sup>	>Benthic SCO or Benthic CSL, detected <sup>b,c</sup>	>Benthic SCO
Total LPAH	9.1	44,000	696	891	94%	4	3	7	0.79%
<b>Phthalates (µg/kg dw)</b>									
Bis(2-ethylhexyl) phthalate	5.4	17,000	590	886	79%	46	58	104	11.74%
Butyl benzyl phthalate	2.0	7,100	87	878	54%	80	10	90	10.25%
Dimethyl phthalate	2.0	440	25	878	21%	0	2	2	0.23%
<b>Chlorobenzenes (µg/kg dw)</b>									
1,2,4-Trichlorobenzene	1.6	940	19	871	1%	0	2	2	0.23%
1,2-Dichlorobenzene	1.3	670	19	871	2%	0	4	4	0.46%
1,4-Dichlorobenzene	1.5	1,600	23	871	6%	0	4	4	0.46%
Hexachlorobenzene	0.4	95	17	874	5%	4	2	6	0.69%
<b>Other SVOCs<sup>d</sup> and COCs (µg/kg dw)</b>									
2,4-Dimethylphenol	6.1	290	44	869	3%	0	25	25	2.88%
4-Methylphenol	4.8	4,600	44	883	13%	0	4	4	0.45%
Benzoic acid	54	4,500	238	876	13%	0	9	9	1.03%
Benzyl alcohol	8.2	670	49	867	3%	9	7	16	1.85%
Carbazole	3.2	4,200	82	775	55%	NA	NA	NA	
n-Nitrosodiphenylamine	6.5	230	27	871	3%	0	2	2	0.23%
Pentachlorophenol	14	14,000	122	840	4%	1	1	2	0.24%
Phenol	10	2,800	91	886	32%	19	6	25	2.82%
<b>Pesticides (µg/kg dw)</b>									
Total DDTs	0.72	77,000	462	216	40%	NA	NA	NA	—
Total chlordanes	0.20	230	268	216	13%	NA	NA	NA	—
Aldrin	0.01	1.6	27	216	2%	NA	NA	NA	—
Dieldrin	0.10	280	29	218	4%	NA	NA	NA	—
alpha-BHC	0.14	1.8	1.1	207	1%	NA	NA	NA	—
beta-BHC	0.09	13	1.2	207	2%	NA	NA	NA	—
gamma-BHC	0.05	8.6	27	216	6%	NA	NA	NA	
Heptachlor	0.12	5.2	27	216	3%	NA	NA	NA	
Heptachlor epoxide	0.47	4.9	2.8	207	2%	NA	NA	NA	
Toxaphene	340	6,300	111	205	1%	NA	NA	NA	

<b>Total PCBs (<math>\mu\text{g}/\text{kg dw}</math>)</b>									
Total PCBs <sup>e</sup>	2.2	223,000	1,136	1390	94%	336	179	515	37.05%

Source: LDWG (2012)

General: Contaminants identified as risk drivers for the benthic invertebrate community (RAO 3) are those with one or more surface sediment samples with exceedances of the SCO. Three additional contaminants (total DDTs, total chlordanes, and nickel) that do not have SMS criteria were also identified as COCs for the benthic community.

- a. Calculated mean concentration is the average of concentrations using one-half the reporting limit substitution for non-detected results.
- b. For non-polar organic compounds, comparisons to SCO and CSL were made using organic carbon-normalized concentrations. If total organic carbon (TOC) in the sample was <0.5% or >4%, dry weight concentrations were compared to the Apparent Effect Thresholds: (Lowest Apparent Effects Threshold) and Second Lowest Apparent Effects Threshold. Additional discussion can be found at [http://www.ecy.wa.gov/programs/tcp/smu/sed\\_pubs.htm#ApparentEffectsThreshold/](http://www.ecy.wa.gov/programs/tcp/smu/sed_pubs.htm#ApparentEffectsThreshold/). See also Section 15 (Key Terms).
- c. Sum of samples exceeding the SCO but not the CSL and samples exceeding the CSL.
- d. SVOCs — semi-volatile organic compounds
- e. Total PCB statistics and counts were generated with two outliers excluded (2,900,000 and 230,000  $\mu\text{g}/\text{kg dw}$  at RM 2.2).

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Dungeness crab (edible meat)	17 / 17	0.43 – 1.9	0.86	1.1
Dungeness crab (whole body)	15 / 15	3.0 – 16	7.1	9.1
Butter clam, geoduck, horse clam, littleneck clam (whole body)	24 / 70	0.09 – 1.4	0.3	0.42
<b>Inorganic arsenic (<math>\text{mg}/\text{kg ww}</math>)</b>				
Eastern softshell clams (whole body) <sup>a,b</sup>	6 / 6	0.047 / 0.112	0.064	0.09
<b>Dioxin/furan TEQ (<math>\text{ng}/\text{kg ww}</math>)</b>				
Starry flounder, rock sole (whole body) <sup>c</sup>	7 / 7	0.15 – 0.42	0.28	0.35
Dungeness crab (edible meat)	27 / 27	0.027 – 1.4	0.57	0.53
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Butter clam, geoduck, horse clam, littleneck clam (whole body)	43 / 43	0.011 – 1.6	0.34 <sup>d</sup>	0.71

- Only clams are shown for inorganic arsenic because most of the risk associated with these COCs was due to consumption of clams.
- Only clams collected from Dungeness Spit were selected by EPA for this category, as these were the only ones in the dataset likely unaffected by the atmospheric deposition of arsenic from the former Tacoma ASARCO smelter.
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<b>Metals and TBT (mg/kg dw)</b>									
Arsenic	1.2	1,100	17	916	94%	5	9	14	1.53%
Cadmium	0.03	120	1.0	894	71%	2	12	14	1.57%
Chromium	4.80	1,680	42	906	100%	1	10	11	1.21%
Copper	5.0	12,000	106	908	100%	0	13	13	1.43%
Lead	2.0	23,000	139	908	100%	2	23	25	2.75%
Mercury	0.015	247	0.53	927	88%	20	30	50	5.39%
Nickel	5.0	910	28	836	100%	NA	NA	NA	—
Silver	0.018	270	1.0	875	61%	0	10	10	1.14%
Vanadium	15	150	59	589	100%	NA	NA	NA	—
Zinc	16	9,700	194	905	100%	26	19	45	4.97%
Tributyltin as ion	0.28	3,000	90	189	94%	NA	NA	NA	—
<b>PAHs (µg/kg dw)</b>									
2-Methylnaphalene	0.38	3,300	42	882	19%	1	4	5	0.57%
Acenaphthene	1.0	5,200	65	891	40%	16	4	20	2.24%
Anthracene	1.3	10,000	134	891	73%	2	0	2	0.22%
Benzo(a)anthracene	7.3	8,400	322	891	92%	10	6	16	1.80%
Benzo(a)pyrene	6.5	7,900	309	886	92%	7	5	12	1.35%
Benzo(g,h,i)perylene	6.1	3,800	165	891	86%	10	12	22	2.47%
Total benzofluoranthenes	6.6	17,000	732	885	94%	6	6	12	1.36%
Chrysene	12	7,700	474	891	95%	29	3	32	3.59%
Dibenzo(a,h)anthrecene	1.6	1,500	63	891	56%	18	6	24	2.69%
Dibenzofuran	1.0	4,200	54	889	31%	7	3	10	1.12%
Fluoranthene	18	24,000	889	891	97%	35	12	47	5.27%
Fluorene	0.68	6,800	78	891	48%	11	3	14	1.57%
Indeno(1,2,3-cd)pyrene	6.4	4,300	180	891	90%	16	13	29	3.25%
Naphthalene	3.0	5,300	49	882	21%	0	2	2	0.23%
Phenanthrene	7.1	28,000	429	891	93%	27	3	30	3.37%
Pyrene	19	16,000	723	891	97%	2	6	8	0.90%
Total HPAH	23	85,000	3,809	891	98%	25	6	31	3.48%

Contaminant	Summary Statistics for Surface Sediments			Total Number of Surface Sediment Samples in FS Baseline Dataset					Exceedances Waterway Wide
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Total LPAH	9.1	44,000	696	891	94%	4	3	7	0.79%
<b>Phthalates (µg/kg dw)</b>									
Bis(2-ethylhexyl) phthalate	5.4	17,000	590	886	79%	46	58	104	11.74%
Butyl benzyl phthalate	2.0	7,100	87	878	54%	80	10	90	10.25%
Dimethyl phthalate	2.0	440	25	878	21%	0	2	2	0.23%
<b>Chlorobenzenes (µg/kg dw)</b>									
1,2,4-Trichlorobenzene	1.6	940	19	871	1%	0	2	2	0.23%
1,2-Dichlorobenzene	1.3	670	19	871	2%	0	4	4	0.46%
1,4-Dichlorobenzene	1.5	1,600	23	871	6%	0	4	4	0.46%
Hexachlorobenzene	0.4	95	17	874	5%	4	2	6	0.69%
<b>Other SVOCs<sup>d</sup> and COCs (µg/kg dw)</b>									
2,4-Dimethylphenol	6.1	290	44	869	3%	0	25	25	2.88%
4-Methylphenol	4.8	4,600	44	883	13%	0	4	4	0.45%
Benzoic acid	54	4,500	238	876	13%	0	9	9	1.03%
Benzyl alcohol	8.2	670	49	867	3%	9	7	16	1.85%
Carbazole	3.2	4,200	82	775	55%	NA	NA	NA	
n-Nitrosodiphenylamine	6.5	230	27	871	3%	0	2	2	0.23%
Pentachlorophenol	14	14,000	122	840	4%	1	1	2	0.24%
Phenol	10	2,800	91	886	32%	19	6	25	2.82%
<b>Pesticides (µg/kg dw)</b>									
Total DDTs	0.72	77,000	462	216	40%	NA	NA	NA	—
Total chlordanes	0.20	230	268	216	13%	NA	NA	NA	—
Aldrin	0.01	1.6	27	216	2%	NA	NA	NA	—
Dieldrin	0.10	280	29	218	4%	NA	NA	NA	—
alpha-BHC	0.14	1.8	1.1	207	1%	NA	NA	NA	—
beta-BHC	0.09	13	1.2	207	2%	NA	NA	NA	—
gamma-BHC	0.05	8.6	27	216	6%	NA	NA	NA	
Heptachlor	0.12	5.2	27	216	3%	NA	NA	NA	
Heptachlor epoxide	0.47	4.9	2.8	207	2%	NA	NA	NA	
Toxaphene	340	6,300	111	205	1%	NA	NA	NA	

<b>Total PCBs (<math>\mu\text{g}/\text{kg dw}</math>)</b>									
Total PCBs <sup>e</sup>	2.2	223,000	1,136	1390	94%	336	179	515	37.05%

Source: LDWG (2012)

General: Contaminants identified as risk drivers for the benthic invertebrate community (RAO 3) are those with one or more surface sediment samples with exceedances of the SCO. Three additional contaminants (total DDTs, total chlordanes, and nickel) that do not have SMS criteria were also identified as COCs for the benthic community.

- a. Calculated mean concentration is the average of concentrations using one-half the reporting limit substitution for non-detected results.
- b. For non-polar organic compounds, comparisons to SCO and CSL were made using organic carbon-normalized concentrations. If total organic carbon (TOC) in the sample was <0.5% or >4%, dry weight concentrations were compared to the Apparent Effect Thresholds: (Lowest Apparent Effects Threshold) and Second Lowest Apparent Effects Threshold. Additional discussion can be found at [http://www.ecy.wa.gov/programs/tcp/smu/sed\\_pubs.htm#ApparentEffectsThreshold/](http://www.ecy.wa.gov/programs/tcp/smu/sed_pubs.htm#ApparentEffectsThreshold/). See also Section 15 (Key Terms).
- c. Sum of samples exceeding the SCO but not the CSL and samples exceeding the CSL.
- d. SVOCs — semi-volatile organic compounds
- e. Total PCB statistics and counts were generated with two outliers excluded (2,900,000 and 230,000  $\mu\text{g}/\text{kg dw}$  at RM 2.2).