Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Remedial Investigation

DATA REPORT:

SUBSURFACE SEDIMENT SAMPLING FOR CHEMICAL ANALYSES

FINAL

For submittal to

The US Environmental Protection Agency
Region 10
Seattle, WA

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, WA

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Acronyms

Acronym	Definition
ACG	analytical concentration goal
AES	atomic emission spectrometry
AET	apparent effects threshold
ARI	Analytical Resources, Inc.
ASTM	American Society for Testing and Materials
Axys	Axys Analytical Services, Ltd.
BEHP	bis(2-ethylhexyl) phthalate
BHC	benzene hexachloride (also known as hexachlorocyclohexane)
CCV	continuing calibration verification
CSL	cleanup screening level
CVAA	cold vapor atomic absorption
%D	percent difference
DBT	dibutyltin
DMMP	Dredged Material Management Program
dw	dry weight
ECD	electron capture detection
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
FPD	flame photometric detection
FS	feasibility study
GC/MS	gas chromatography / mass spectrometry
GPC	gel permeation chromatography
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
HpCDD	heptachlorodibenzo-*p*-dioxin
HpCDF	heptachlorodibenzofuran
HR	high resolution
HxCDD	hexachlorodibenzo-*p*-dioxin
HxCDF	hexachlorodibenzofuran
ICP	inductively coupled plasma
ID	identification
LAET	lowest apparent effects threshold
2LAET	second lowest apparent effects threshold
LCS	laboratory control sample
LDC	Laboratory Data Consultants, Inc.
LDW	Lower Duwamish Waterway

Acronym	Definition
LPAH	low-molecular-weight polycyclic aromatic hydrocarbon
MBT	monobutyltin
MDL	method detection limit
ML	maximum level
MLLW	mean lower low water
MS	matrix spike
MSD	matrix spike duplicate
na	not applicable
NAD83	North American Datum of 1983
nd	not detected
OC	organic carbon
OCDD	octachlorodibenzo-*p*-dioxin
OCDF	octachlorodibenzofuran
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pcf	pounds per cubic foot
PeCDD	pentachlorodibenzo-*p*-dioxin
PeCDF	pentachlorodibenzofuran
PID	photoionization detector
PQL	practical quantitation limit
PSEP	Puget Sound Estuary Program
PST	Pacific Standard Time
QAPP	quality assurance project plan
QC	quality control
RI	remedial investigation
RL	reporting limit
RPD	relative percent difference
%RSD	percent relative standard deviation
SDG	sample delivery group
SIM	selected ion monitoring
SL	screening level
SMS	Washington State Sediment Management Standards
SQS	sediment quality standard
SRM	standard reference material
SU	standard unit
SVOC	semivolatile organic compound
T-117	Terminal 117
TBT	tributyltin

Acronym	Definition
TCDD	tetrachlorodibenzo-*p*-dioxin
TCDF	tetrachlorodibenzofuran
TEQ	toxic equivalent
TOC	total organic carbon
VOC	volatile organic compound
Windward	Windward Environmental LLC

1.0 Introduction

This data report presents the results of chemical analyses conducted on subsurface sediment samples collected as part of the Phase 2 remedial investigation (RI) for the Lower Duwamish Waterway (LDW). The subsurface sediment quality assurance project plan (QAPP) (Windward 2006) presented the design for the sampling and analysis of subsurface sediment, including details on project organization, field data collection, laboratory analyses, and data management. As described in the Phase 2 RI work plan (Windward 2004), the subsurface sediment data will be used in combination with Phase 1 subsurface sediment data to determine the nature and extent of chemical contamination at depth and to support the feasibility study (FS). In addition, risk implications of contamination at depth will be discussed in an appendix to the Phase 2 RI.

Subsurface sediment core samples were collected at 56 locations in the LDW during the subsurface sediment sampling event in February 2006. Cores from each location were evaluated for stratigraphy and lithology, and were then subsectioned into 0.5-, 1- or 2-ft-depth intervals according to the QAPP (Windward 2006). At a subset of stations selected in consultation with the US Environmental Protection Agency (EPA) and the Washington Department of Ecology (Ecology), the upper 6 ft section of the core was split vertically, and one half was sectioned into 0.5-ft intervals and archived, while the other half of the core was sectioned into 1- or 2-ft intervals for chemical analysis. Some of the archived samples were later selected for chemical analysis, in consultation with EPA and Ecology, following review of analytical results of the 1- and 2-ft intervals. Chemical analyses were conducted on a total of 276 subsurface sediment samples. Geotechnical analyses were conducted on a subset of these samples. Geotechnical data will be used in the feasibility study to evaluate sediment bed properties and remedial alternatives.

The remainder of this report is organized into the following sections:

- Section 2 – Subsurface sediment collection methods
- Section 3 – Laboratory methods
- Section 4 – Results
- Section 5 – References

The text of this report is supported by the following appendices:

- Appendix A – Data tables
- Appendix B – Sediment core logs
- Appendix C – Data management
- Appendix D – Data validation reports

- Appendix E – Raw analytical laboratory data
- Appendix F – Field forms and summary tables
- Appendix G – Chain-of-custody forms
- Appendix H – Photographs of sediment cores

Appendices D through H, which consist of detailed validation reports and scanned original field and laboratory documents, plus an album of photographs of the subsurface sediment cores, may be viewed online at http://www.ldwg.org/rifs_docs.htm.[1] These materials are also on a compact disk provided in every hard copy of the data report.

2.0 Subsurface Sediment Collection Methods

This section describes the methods used for subsurface sediment sampling, including the sample identification (ID) scheme, sample locations, sediment core collection and processing methods, and field deviations from the QAPP (Windward 2006). Copies of field notebooks and forms filled out during the subsurface sediment core sampling effort (i.e., sediment core collection forms, sediment core processing logs, and protocol modification forms) are presented in Appendix F. Copies of completed chain-of-custody forms used to track sample custody are presented in Appendix G.

2.1 Sample Identification Scheme

Each subsurface sediment core sampling location was assigned a unique alphanumeric ID number. The first three characters of the location ID were "LDW" to identify the LDW project area. The next two characters were "SC" to indicate the type of sample collected (i.e., sediment core), followed by a number identifying the specific location within the LDW. If two cores were collected for analysis at one location, the location ID was followed by "a" and "b." For example, the two cores collected at location LDW-SC49 were identified as LDW-SC49a and LDW-SC49b.

The sample ID was similar to the location ID but also included a numerical suffix to indicate the depth horizon of the sample. For example, the sample from the upper 2-ft (60-cm) section of the core collected at location LDW-SC1 was identified as LDW-SC1-0-2; the 2-to-4-ft (60-to-120-cm) section of sediment from the same core was identified as LDW-SC1-2-4. These sample intervals represent recovered depths from the core as measured in the laboratory during core processing. *In situ* depths were calculated after core processing, as described in Section 2.4.2. Samples collected at

[1] The links to these resources are found in the Data Report section of that Web page under the heading Task 10: Results of Phase 2 fieldwork.

0.5-ft intervals were similarly identified. For example, the sample collected from the upper 0.5-ft section of the core at location LDW-SC1 was identified as LDW-SC1-0-0.5. Field replicates were identified using location numbers starting with 201. Rinsate blanks were assigned the first five characters of the location ID, followed by “RB” and a consecutive number beginning with “1.” For example, the first rinsate blank was identified as LDW-SC-RB1.

2.2 SAMPLING LOCATIONS

Subsurface sediment cores were collected from 56 sampling locations between February 6 and 24, 2006, as presented in Table 2-1. This table also presents the mudline depth at which each core was collected relative to mean lower low water (MLLW), the depth below mudline to which the core penetrated, and the volume of sediment recovered in the core. The target sampling locations from the QAPP, along with the actual sampling locations, are shown on Figure 2-1. The rationale for selecting subsurface sediment sampling locations is presented in Section 3.11 of the QAPP (Windward 2006).

Table 2-1. LDW subsurface sediment sampling locations

Location	Collection Date	Collection Time (PST)	Processing Date	Target Location[a]		Actual Location[a]		Distance from Target (m)	Depth to Mudline Above (+) or Below (-) MLLW (ft)	Penetration Depth (ft)	Recovery (%)
				X	Y	X	Y				
LDW-SC1	02.08.2006	1206	02.09.2006	1266326	211298	1266315	211282	5.9	-15.7	6.6	91
LDW-SC2	02.09.2006	0909	02.09.2006	1267028	211197	1267032	211196	1.3	-23.7	13.1	100
LDW-SC3	02.09.2006	1018	02.09.2006	1266433	210663	1266432	210649	4.4	-49.3	10.2	83
LDW-SC4	02.08.2006	1455	02.09.2006	1266960	210600	1266932	210598	8.5	-34.0	9.0	85
LDW-SC5	02.09.2006	1415	02.10.2006	1266034	210529	1266048	210543	6.0	-10.4	7.3	85
LDW-SC6	02.09.2006	1220	02.10.2006	1266290	209832	1266285	209838	2.4	-33.0	11.0	77
LDW-SC7	02.10.2006	0907	02.10.2006	1266852	209602	1266850	209606	1.4	-27.1	11.0	79
LDW-SC8	02.10.2006	1045	02.10.2006	1266611	209587	1266614	209589	1.1	-39.1	14.6	68
LDW-SC9	02.13.2006	1031	02.13.2006	1266864	208920	1266865	208920	0.3	-31.6	12.9	66
LDW-SC10	02.10.2006	0946	02.10.2006	1267170	208772	1267168	208777	1.6	-17.3	10.6	83
LDW-SC11	02.13.2006	0934	02.13.2006	1265896	208303	1265909	208291	5.4	-5.1	5.9	85
LDW-SC12	02.16.2006	1055	02.16.2006	1266577	208216	1266578	208218	0.7	-7.5	9.6	91
LDW-SC13	02.13.2006	1121	02.13.2006	1267583	207102	1267585	207097	1.7	-10.7	12.5	79
LDW-SC14	02.13.2006	0834	02.13.2006	1267397	207052	1267399	207054	0.9	-36.8	12.6	92
LDW-SC15	02.16.2006	0851	02.17.2006	1267815	206823	1267822	206822	2.2	-27.9	12.7	80
LDW-SC16	02.13.2006	1431	02.14.2006	1267971	206669	1267960	206670	3.5	-24.6	13.5	80
LDW-SC17	02.23.2006	1530	02.24.2006	1268449	206550	1268446	206551	1.0	-15.1	13.0	66
LDW-SC18	02.16.2006	0953	02.17.2006	1267932	206332	1267927	206334	1.6	-19.4	11.8	91
LDW-SC19[b]	02.24.2006	1355	02.24.2006	1267011	206189	1266968	206222	16.5	-25.3	13.0	92
LDW-SC20	02.15.2006	0849	02.15.2006	1267737	206172	1267735	206178	1.9	-33.9	12.6	79
LDW-SC21	02.14.2006	1330	02.15.2006	1267487	206170	1267488	206168	0.6	-28.5	12.7	89
LDW-SC22	02.13.2006	1520	02.14.2006	1268190	205909	1268174	205908	4.9	-3.4	9.3	83
LDW-SC23	02.16.2006	1156	02.17.2006	1268230	205416	1268229	205418	0.7	-18.7	12.4	86
LDW-SC24	02.17.2006	1119	02.17.2006	1267866	205106	1267861	205130	7.3	-20.4	12.2	97

Table 2-1. LDW subsurface sediment sampling locations, cont.

Location	Collection Date	Collection Time (PST)	Processing Date	Target Location[a] X	Target Location[a] Y	Actual Location[a] X	Actual Location[a] Y	Distance from Target (m)	Depth to Mudline Above (+) or Below (-) MLLW (ft)	Penetration Depth (ft)	Recovery (%)
LDW-SC25	02.17.2006	1245	02.18.2006	1267957	204752	1267979	204751	6.8	-15.2	10.3	88
LDW-SC26[b]	02.22.2006	1126	02.22.2006	1268100	204472	1268157	204480	17.5	-26.0	14.6	84
LDW-SC27	02.14.2006	0837	02.14.2006	1268520	204435	1268519	204443	2.5	-10.5	11.2	85
LDW-SC28[b]	02.24.2006	1500	02.25.2006	1268204	204204	1268253	204225	16.1	-30.6	13.0	92
LDW-SC29	02.21.2006	0818	02.21.2006	1268032	204056	1268061	204054	8.9	-4.2	6.1	59
LDW-SC30	02.14.2006	1059	02.14.2006	1268801	203593	1268784	203576	7.3	-12.2	6.9	86
LDW-SC31	02.16.2006	1345	02.17.2006	1268937	203090	1268935	203092	0.8	-31.7	7.5	79
LDW-SC32	02.10.2006	1243	02.11.2006	1269349	202951	1269345	202959	2.7	-17.2	12.7	88
LDW-SC33	02.10.2006	1415	02.11.2006	1269293	202059	1269267	202053	8.1	-14.7	13.1	78
LDW-SC34	02.17.2006	0936	02.18.2006	1268808	201999	1268831	202016	8.7	-14.5	12.2	76
LDW-SC35	02.14.2006	1505	02.15.2006	1269266	201575	1269260	201604	9.0	-13.8	10.2	81
LDW-SC36	02.15.2006	1131	02.16.2006	1269991	201491	1269990	201489	0.7	-12.3	12.3	83
LDW-SC37	02.22.2006	1228	02.22.2006	1270688	201421	1270691	201436	4.7	-11.4	8.6	80
LDW-SC38a	02.20.2006	0919	02.21.2006	1269737	200931	1269747	200937	3.6	4.2	4.5	69
LDW-SC38b[c]	02.20.2006	0955	02.21.2006	1269737	200931	1269744	200959	8.8	3.4	5.6	68
LDW-SC39	02.15.2006	1353	02.16.2006	1270032	200660	1270056	200657	7.2	-5.0	12.4	74
LDW-SC40	02.23.2006	1030	02.24.2006	1270298	200339	1270303	200332	2.5	-1.0	13.0	77
LDW-SC41	02.20.2006	1044	02.21.2006	1271170	200294	1271171	200294	0.3	-6.5	11.6	66
LDW-SC42	02.08.2006	0942	02.08.2006	1271362	199902	1271361	199898	1.3	-11.9	15.9	79
LDW-SC43	02.22.2006	1450	02.23.2006	1271865	199304	1271846	199289	7.4	-6.8	15.9	62
LDW-SC44	02.21.2006	1004	02.21.2006	1272232	198952	1272231	198926	7.8	-2.1	11.7	50
LDW-SC45	02.20.2006	1456	02.21.2006	1272643	198616	1272647	198588	3.7	-13.5	7.7	84
LDW-SC46	02.24.2006	1100	02.24.2006	1272117	198577	1272121	198579	1.4	-7.6	13.0	86
LDW-SC47	02.23.2006	1130	02.23.2006	1273340	197422	1273347	197447	8.0	-0.4	13.0	79

Table 2-1. LDW subsurface sediment sampling locations, cont.

Location	Collection Date	Collection Time (PST)	Processing Date	Target Location[a] X	Target Location[a] Y	Actual Location[a] X	Actual Location[a] Y	Distance from Target (m)	Depth to Mudline Above (+) or Below (-) MLLW (ft)	Penetration Depth (ft)	Recovery (%)
LDW-SC48	02.08.2006	0846	02.08.2006	1274534	196653	1274533	196659	2.0	-22.3	6.7	86
LDW-SC49a	02.06.2006	1244	02.06.2002	1275489	195853	1275477	195851	3.6	-19.8	14.0	81
LDW-SC49b[d]	02.22.2006	1021	02.22.2006	1275489	195853	1275498	195853	2.9	-18.2	15.4	77
LDW-SC50	02.24.2006	0828	02.24.2006	1276045	194871	1276043	194865	1.9	-4.0	13.0	75
LDW-SC51	02.22.2006	0758	02.22.2006	1276134	194727	1276135	194728	0.4	0.8	10.6	58
LDW-SC52	02.07.2006	1435	02.08.2006	1276295	194178	1276280	194160	7.1	1.3	10.3	57
LDW-SC53	02.06.2006	1520	02.07.2006	1277460	192936	1277459	192928	2.5	-12.6	13.6	82
LDW-SC54	02.23.2006	0920	02.23.2006	1276342	192179	1276355	192181	4.1	-0.2	13.0	78
LDW-SC55	02.06.2006	0902	02.06.2006	1278267	190387	1278268	190390	1.0	1.6	11.3	55
LDW-SC56	02.07.2006	0958	02.07.2006	1277573	189993	1277575	190022	8.9	1.0	10.7	52
LDW-SC201[e]	02.10.2006	1453	02.11.2006	1269293	202059	1269268	202052	7.9	-14.6	13.6	87
LDW-SC202[f]	02.15.2006	1255	02.16.2006	1269991	201491	1269986	201491	1.6	-12.2	12.5	81
LDW-SC203[g]	02.17.2006	1023	02.18.2006	1268808	201999	1268832	202013	8.5	-16.6	12.1	73

[a] Coordinates given in NAD83 horizontal datum; X-Y coordinates in Washington State Plane N (US survey ft).

[b] These three locations could not be sampled within 10 m of the targeted location, as specified in the QAPP (Windward 2006), for reasons presented in Table 2-3.

[c] A sample was collected from the 3-to-3.3-ft interval of this second core at location LDW-SC38 because the first core, which extended to 3 ft, appeared to contain a sheen in the bottom interval. This deeper sample from the second core was analyzed to determine if contamination was present at a depth below 3 ft.

[d] A second core was collected and analyzed for volatile organic compounds (VOCs) at location LDW-SC49 because of an elevated photoionization detection (PID) reading in the 10-to-11-ft interval of the first core.

[e] Field replicate of LDW-SC33.

[f] Field replicate of LDW-SC36.

[g] Field replicate of LDW-SC34.

LDW – Lower Duwamish Waterway

MLLW – mean lower low water

PST – Pacific Standard Time

2.3 Sample Collection Methods

Subsurface sediment cores were collected to a target depth of 10 ft (3 m) below the mudline or until refusal, whichever was reached first. Sediment cores were collected by MCS Environmental, Inc., using a diver-assisted impact core sampler called the MudMole™ deployed from a 30-ft pontoon research vessel. The bottom of each core tube was fitted with a hinged core catcher to minimize the loss of sediment during extraction. In some cases, the core catcher did not retain sediment in the core during extraction, so the diver inserted a screw cap at the bottom of the core before it was brought to the surface.

At each target sampling location, the MudMole™ was lowered to the sediment surface using a winch. The core tube was then driven into the sediment with an air hammer. At approximately 2-ft intervals, the operator suspended the driving operation, and a diver measured the penetration depth of the core tube and internal recovery of the core (total core length minus the empty space within the core). These measurements were recorded on field logs, which are included in Appendix F. After driving the core to 10 ft or refusal, the air hammer was turned off. The final set of penetration and recovery measurements was made, the actual sampling position was recorded, and the core was extracted. Once the sediment core was on board the sampling vessel, the core catcher end was inspected for signs of sediment loss during retrieval. In addition, an on-deck measurement from the top of the core tube to the surface of the sediment within the core tube was taken to account for any movement or loss of sediment in the core tube as the core catcher closed during extraction.

The penetration and recovery data and the on-deck top-of-sediment measurement were entered into a spreadsheet program to generate a bore log for each core. Each bore log included a graph of penetration versus recovery that was used to identify the *in situ* depth of different sediment horizons, as described in Section 2.4.2. Bore logs are presented in Appendix F.

Overlying water was siphoned out of the core tube on deck; and the cores were capped, taped, and labeled with the station ID and "top" and "bottom." The core tubes were stored at a slight angle to prevent loss of material out the top and sealed to minimize moisture loss during transport. Cores were transported to the field processing laboratory at Terminal 117 (T-117) on the west side of the LDW at River Mile 3.6 for subsequent processing. If the core tube was driven to a depth greater than 10 ft, material from this depth was also processed and archived. If core acceptance criteria from the QAPP (Windward 2006), or modified acceptance criteria (described in Section 2.5), were not achieved on the first drive, then multiple cores were driven to try to meet the acceptance criteria. Rationale for acceptance of cores that did not meet acceptance criteria are presented in Section 2.5.

At eight locations, Marine Sampling Systems used a vibratory core sampler (i.e., vibracorer) to collect sediment cores from the research vessel *Nancy Anne*. Six of these locations (LDW-SC17, LDW-SC28, LDW-SC40, LDW-SC47, LDW-SC50, and LDW-SC54) were resampled with the vibracorer because the MudMole™ sampler was not able to penetrate layers of sand or gravel to depths of 10 ft below the mudline, as specified in the QAPP (Windward 2006). The vibracorer was successful in collecting cores to a depth of 13 ft at all six of these locations. The vibracorer was also used to collect sediment at two locations (DW-SC19 and LDW-SC46) that were inaccessible during the MudMole™ sampling because of the presence of barges. Penetration and recovery measurements were not taken during driving but were measured once at the end of driving.

2.4 SUBSURFACE SEDIMENT CORE PROCESSING

This section describes the processing and sectioning of core tubes at the field laboratory, the calculation of *in situ* depths from measured depths in the field, and the generation of core logs.

2.4.1 Core processing and sectioning

Subsurface sediment core tubes were handled and processed at the field processing laboratory located at T-117. Core tubes were stored in a semi-vertical position in the laboratory and were processed within 72 hours of receipt. Core processing involved three steps: 1) cutting, 2) observing and logging, and 3) sectioning and sampling.

Each core tube was cut lengthwise with a circular saw to expose the sediment. Care was taken not to spill turbid water from the top of the tube. A thin film of sediment that had been in direct contact with the side of the core was removed from the exposed sediment surface prior to logging the core. The sediment profile was visually logged for major and minor contacts (i.e., regions in the core where sediment characteristics changed noticeably). The cores were logged using American Society for Testing and Materials (ASTM) visual classification method D-2488 (ASTM 2001b). A tape measure was affixed to the sidewalls of the tube to measure the length of the sediment core based on recovered depths. Photographs of the sediment core were taken. Finally, each core was sub-sectioned according to either Method A or Method B, as described in Section 3.1 of the QAPP (Windward 2006). Method A cores were sub-sectioned into 1- or 2-ft sampling intervals unless stratigraphic boundaries were observed. If stratigraphic boundaries were observed, the samples were collected from intervals from within the same stratigraphic units rather than at the fixed 1- or 2-ft intervals. The sectioning decision for each core was made by the field geologist in consultation with EPA oversight personnel, if present, at the time the core was sectioned. Sections from core depths of less than 4 ft were sent to the laboratory for analysis; samples from core depths of greater than 4 ft were archived. Decisions as to whether the deeper intervals would be analyzed were made based on the unvalidated results of chemical analyses in the upper intervals and in consultation with EPA and Ecology. This process is described in more detail in Section 3.0.

Method B from the QAPP (Windward 2006) was used for a subset of cores. The uppermost 6 ft section of each of these cores was split in half vertically. One half of this core was sub-sectioned into 2-ft sampling intervals, and the other half was sub-sectioned into 0.5-ft sampling intervals. Table 3-4 in the QAPP (Windward 2006) lists the locations of the 19 cores processed using Method B.

If necessary, sampling intervals were adjusted to maintain consistency in color and grain size within each sample or based on the presence of odor, sheen, or debris. Sediment descriptions were recorded on the sediment core processing logs. Sediment core processing logs and field notes from sediment processing are presented in Appendix F.

After each core was sectioned, a photoionization detector (PID) was used to measure volatile organic compounds (VOCs) in the air space immediately above the exposed sediment at various depths. In addition, if a heavy sheen was observed, the field geologist placed sediment in a plastic bag or jar for sheen testing and headspace PID readings. Torvane measurements were also taken in the field at approximately 2-ft intervals throughout the length of the core or where lithology was significantly different from the above unit to determine the sediment strength of that unit. Sediment strength, measured as shear stress, provides information about the geotechnical properties of sediment for engineering design purposes (e.g., slope and bed stability).

Geotechnical samples were collected by removing an intact portion of sediment from the 0-to-2- and 2-to-4-ft intervals of each core using a 1.5- or 2-in.-diameter tube. This tube was pushed into the sediment and sediment was removed from around the sidewalls of this tube. A metal plate was placed across the bottom to lift the tube out of the core, and plastic caps were placed over both ends of the tube. For the remaining analyses, sediment was transferred from designated sampling intervals within the core into stainless steel bowls, homogenized until uniform in color and texture, and placed into pre-cleaned labeled glass jars for laboratory analyses.[2] Material larger than approximately 1 in. in diameter (e.g., organisms, shell fragments, debris) was removed, if present, prior to placement in sample containers; removed materials were noted in the field logbooks. All sample containers were labeled on the outside (using indelible ink) with the sample identification number, time and date collected, and analyses to be performed.

[2] The samples collected at LDW-SC48b for VOC analyses were not homogenized to minimize the potential for volatilization.

2.4.2 Calculating *in situ* depths

The volume of sediment retained in the core tube during collection was typically less than 100% of the drive length, a common occurrence during sediment coring. Recovery of sediment in the core is dependent on the nature of the sediment, which is generally not uniform throughout the core, and frictional forces during driving. Lower recoveries in some samples were a result of: 1) sediment dewatering, 2) compaction of cohesionless and saturated sediments, 3) blockage during penetration that prevented material from entering the tube, or 4) sediment loss during recovery of the core tube through the water column. Because of these factors, the amount of material in the core tube during field processing (i.e., the recovered depth) usually does not reflect the actual depth below the mudline from which the sediment core was collected (referred to as the *in situ* depth). To calculate the *in situ* depths, incremental penetration and recovery information was collected during sampling with the MudMole™ , allowing for an accurate characterization of *in situ* conditions throughout the length of the core. Incremental penetration and recovery data were recorded by divers at approximately 1-to-2-ft intervals from inside and outside the core tube with a weighted tape measure. The data were used to generate a graph on the bore log to provide a record of the core tube penetration and sediment core recovery at regular intervals for each core. When the recovered sediment was less than 100% of the drive interval, these graphs were used to convert recovered depths recorded during field processing to corresponding *in situ* depths. Tables A-11 and A-12 in Appendix A present recovered depths compared to *in situ* depths for each of the samples.

Measurements to calculate recovery for cores obtained with the vibracorer were taken only once at the end of driving. The *in situ* depths for samples collected using the vibracorer were estimated based on the difference between recovered depth and the drive depth over the entire length of the core.

2.4.3 Generating core logs

Sediment core processing logs generated in the field, as described in Section 2.4.1, were converted into electronic logs using the software program LogPlot2005™. The sediment core processing logs included visual information as described in the QAPP (Windward 2006), such as sediment particle size and shape; density, color, and consistency; stratification, lenses, or layers; presence of debris, sheen, odor, or staining; condition of the core tube and catcher; and other distinguishing features. Data were transferred to LogPlot2005™ from both the drive logs documented on the boat and the sediment core processing logs recorded in the field laboratory. Cores were characterized according to the Unified Soil Classification System, consistent with current ASTM methods (ASTM 2001a). Sediment classification was based on ASTM D-2488 (ASTM 2001b), the visual-manual procedure for describing and identifying soils, which includes sediment description terminology (e.g., color, structure, density, moisture content), and a site-specific classification system used to denote sediment descriptions (see core log key in Appendix B). The final core logs generated in LogPlot2005™ are presented in Appendix B. Descriptions in the final core logs may differ slightly from the field logs presented in Appendix F as a result of post-field corrections made to the data. Examples of such corrections include a change to the recorded mudline elevations (ft MLLW) based on the tide charts and the addition or modification of sediment descriptions (e.g., change from loose to soft) to better match the formal ASTM guidelines. Grain size data and Atterberg limit results were also used to confirm or correct information presented in the core logs. Additions are shown in parentheses when inferred during post-field processing of the core logs.

2.5 FIELD DEVIATIONS FROM THE QAPP

Field deviations from the QAPP (Windward 2006) included modifications to sampling locations and core collection and processing methods. These field deviations did not affect the data quality. EPA and Ecology were consulted on deviations that involved a change in study design. The deviations were as follows:

- Upon consultation with EPA, core sample acceptance criteria were modified to facilitate the sampling process because of difficulties in obtaining acceptable cores after two collection attempts. The criteria were modified from a minimum 10-ft penetration depth and 75% on-deck recovery to either a minimum 10-ft penetration depth and 60% on-deck recovery after two collection attempts or a minimum 7-ft penetration depth and 75% on-deck recovery after two collection attempts. The cores at nine locations did not meet the modified acceptance criteria but were accepted for processing and analysis after consultation with EPA and Ecology. A list of the cores that did not meet the acceptance criteria, including the rationale for their acceptance, is presented in Table 2-2.
- Three sediment cores could not be collected at a distance ≤ 10 m from the target location. Table 2-3 presents the rationale for the decision to relocate and A vibracorer was used to collect sediment cores at locations LDW-SC17, LDW-SC28, LDW-SC40, LDW-SC47, LDW-SC50, and LDW-SC54 because the MudMole™ was not able to penetrate deeper layers of sand or gravel to obtain sediment cores that met sample acceptance criteria. The vibracorer was also used to collect sediment cores at locations LDW-SC19 and LDW-SC46 because those locations were blocked by barges when sampling was being conducted with the MudMole™. This collection method revision was made in consultation with EPA.
- Geotechnical samples were inadvertently not collected from location LDW-SC34 as specified in the QAPP (Windward 2006).
- At location LDW-SC36 (and field replicate LDW-SC202), only one geotechnical sample was collected from the 2-to-4-ft interval because the field geologist

confirmed that the sediment composition was the same for the 0-to-1-, 1-to-2-, and 2-to-4-ft intervals.

- Sediment cores that were not processed within 4 hours were not chilled on ice because air temperatures during the sampling event ranged from 23º to 44ºF (mean 35ºF). The cores that were not processed within 4 hours were those collected in the late afternoon; these cores were stored overnight in a locked box truck parked at T-117. Collection and processing dates for each sediment core are presented in Table 2-1.

Table 2-2. Subsurface cores accepted for analysis or archive that did not meet modified acceptance criteria

Sampling Location	Core Number	Penetration Depth (ft)	Recovery (%)	Rationale
LDW-SC1	1	6.3	87	The second core was accepted because the penetration depth was only slightly below the modified acceptance criteria.
	2	**6.6**	**91**	
LDW-SC11	**1**	**5.9**	**85**	The single core collected was accepted. Hard-packed substrate was observed in the lower portion of the core and it did not seem likely that the vibracorer would be able to penetrate this layer.
LDW-SC29	1	7.4	44	The first core was collected with the MudMole™. The second core was collected with the vibracorer and was accepted for analysis because it had a higher recovery.
	2	**6.1**	**59**	
LDW-SC30	1	4.4	68	The second core was accepted because the penetration depth was only slightly below the modified acceptance criteria.
	2	**6.9**	**86**	
LDW-SC38	**1**	**4.5**	**69**	Two cores were collected, and the first core was accepted.[a] It did not seem likely that additional attempts with the vibracorer would be successful in penetrating any deeper because scattered riprap, concrete, and wood debris were observed in the area.
	2	5.6	68	
LDW-SC44	1	1.0	0	The second core was accepted because the recovery was only slightly below the modified acceptance criteria, and winnowing[b] was observed in the third core.
	2	**11.7**	**50**	
	3	10.6	61	
LDW-SC48	1	5.8	99	The first core was rejected because it was bent. The second core was accepted because the penetration depth was only slightly below the modified acceptance criteria.
	2	**6.7**	**86**	
LDW-SC51	**1**	**10.6**	**58**	The first core was accepted because the recovery was only slightly below the modified acceptance criteria.
	2	7.0	60	
LDW-SC52	1	7.3	59	The third core was accepted because the recovery was only slightly below the modified acceptance criteria.
	2	6.0	70	
	3	**10.3**	**57**	

[a] Although the second core was deeper than the first, the decision to accept the first core was made based on a recovery of 76% as measured on deck, which was higher than the 68% recovery for the second core. The 76% recovery was later modified to 69% based on core measurements taken during core processing. One sample was collected and submitted for analysis at the 3-to-3.3-ft interval of the second core to characterize a deeper layer than was available in the first core because a sheen was present at the lowest interval in the first core.

[b] Some sediment was lost through the bottom of the core; sediment appeared to have a loss of fine material.

Bold identifies cores accepted for analysis.

Table 2-3. Actual sampling locations more than 10 m from their target locations

Sampling Location	Distance from Target (m)	Rationale[a]
LDW-SC19	16.5	Unable to collect sediment core at target location because it was located under a pier; core was collected at the nearest possible location to the northwest with acceptable penetration and recovery.
LDW-SC26	17.5	Unable to collect sediment core at target location because it was occupied by a barge during the sampling event; core was collected at the nearest possible location to the east, towards the navigation channel.
LDW-SC28	16.1	Unable to collect sediment core at target location because it was located under a dry-dock; core was collected to the northeast, towards the navigation channel to avoid hard substrate and sand and gravel-capped dredge area.

[a] Decisions about sampling locations presented in this table were made in consultation with EPA.

In addition to the cores specified in the QAPP (Windward 2006), a second core was collected at LDW-SC49. This second core (identified as LDW-SC49b) was collected for VOC analysis because of elevated PID readings in the first core (LDW-SC49a). Salinity and conductivity were also measured in the core from LDW-SC49b and in a second core from LDW-SC50 (identified as LDW-SC50b) to evaluate the relative mixing of groundwater and LDW water. In some of the cores that were collected as specified in the QAPP, additional samples that were not specified in the QAPP were collected from those cores. For example, if the core depth penetrated deeper than 10 ft, the sample interval below 10 ft was archived, although the QAPP did not specify how samples deeper than 10 ft would be processed. The additional cores and samples not specified in the QAPP and the rationale for their collection are presented in Table 2-4.

Table 2-4. Subsurface sediment samples in addition to those identified in the QAPP

Sampling Location	Sample Interval (ft)	Sample Status[a]	Rationale for Collection
LDW-SC2	10 – 10.7 10.7 – 12 12 – 13	10.7-to-12-ft interval was analyzed; other intervals were archived	Recovered length of core exceeded 10 ft.
LDW-SC11	3.4 – 4.1	analyzed	Sample was analyzed in addition to samples from the 0-to-0.8-, 0.8-to-2-, and 2-to-3.4-ft intervals because of a difference in stratigraphy.
LDW-SC14	10 – 11	analyzed	Recovered length of core exceeded 10 ft.
LDW-SC19	9 – 11.9	archived	Recovered length of core exceeded 10 ft; a sample was collected from the 7-to-9-ft interval in place of the 8-to-10-ft interval specified in the QAPP because of a difference in stratigraphy.
LDW-SC21	10 – 11.3	analyzed	Recovered length of core exceeded 10 ft.
LDW-SC26	11.1 – 12.1	analyzed	Recovered length of core exceeded 10 ft.

Sampling Location	Sample Interval (ft)	Sample Status[a]	Rationale for Collection
LDW-SC28	9.1 – 12 12 – 12.6	9.1-to-12-ft interval was archived; 12-to-12.6-ft interval was analyzed	Recovered length of core exceeded 10 ft; a sample was collected from the 7.5-to-9-ft interval in place of the 8-to-10-ft interval specified in the QAPP because of a difference in stratigraphy.
LDW-SC32	10 – 11	archived	Recovered length of core exceeded 10 ft.
LDW-SC33	9.5 – 10	archived	There was a difference in stratigraphy.
LDW-SC38b	3 – 3.3	analyzed	Sample was analyzed because it was deeper than the samples collected from the other core at this location, and there was a difference in stratigraphy.
LDW-SC42	10 – 12	archived	Recovered length of core exceeded 10 ft.
LDW-SC46	10 – 11.2	archived	Recovered length of core exceeded 10 ft.
LDW-SC47	3 – 4	analyzed	Sample was analyzed in addition to samples from the 0-to-1-, 1-to-2-, and 2-to-3-ft intervals because of a difference in stratigraphy.
LDW-SC49a	10 – 11	archived	Recovered length of core exceeded 10 ft.
LDW-SC49b	1-ft intervals to 12 ft	analyzed	Elevated PID readings were obtained in the first core collected from LDW-SC49a, so unhomogenized samples from this separate core were collected for VOC analyses.
LDW-SC49b	2-ft intervals to 12 ft[a]	analyzed for salinity and conductivity only[b]	Information on salinity and conductivity of porewater was collected to evaluate the relative mixing of groundwater and LDW water.
LDW-SC50b	2-ft intervals to 4 ft[a]	analyzed for salinity and conductivity only[b]	Information on salinity and conductivity of porewater was collected to evaluate the relative mixing of groundwater and LDW water.
LDW-SC201	10 – 11.8	archived	Recovered length of core exceeded 10 ft.

[a] The process for determining which chemicals would be analyzed and the list of analytes is presented in Section 3.1.

[b] Samples for salinity and conductivity analyses were collected by centrifuging the sediment to extract the porewater.

PCB – polychlorinated biphenyl

PID – photoionization detection

SVOC – semivolatile organic compound

VOC – volatile organic compound

3.0 Laboratory Methods

This section describes the methods used to select samples for chemical analysis, the methods used to chemically analyze sediment samples, and any deviations in laboratory methods from the QAPP (Windward 2006).

3.1 Samples Selected for Analysis

All samples collected from the 0-to-1-, 1-to-2-, 0-to-2-, and 2-to-4-ft intervals were analyzed for metals, polychlorinated biphenyl (PCB) Aroclors, semivolatile organic compounds (SVOCs), and conventional parameters, and a subset was analyzed for butyltins, pesticides, and dioxins and furans, as specified in the QAPP (Windward 2006). Following this first round, two additional rounds of chemical analyses were conducted. The second round of analyses was conducted on a subset of archived samples collected from depths greater than 4 ft. A meeting was held with EPA and Ecology to review preliminary data and decide which archived samples should be analyzed in the second round. Archived samples were considered for analysis to characterize chemistry at depth if unvalidated data from the samples previously specified for analysis showed detected chemical concentrations exceeding either Washington State Sediment Management Standards (SMS) criteria (i.e., sediment quality standards [SQS] or cleanup screening levels [CSL]) or Dredged Material Management Program (DMMP) guidelines (i.e., screening levels [SL] or maximum levels [ML]), or if concentrations of chemicals without criteria or guidelines (i.e., dioxins and furans, tributyltin) were elevated. In addition, field observations of visual sheen, odor, or non-native material (as presented in Appendix F-6) were reviewed to decide whether additional analyses were warranted and which chemicals should be analyzed. For example, the sample from the 4-to-6-ft interval in the core from location LDW-SC41 was analyzed for both PCBs and SVOCs, although the only SMS exceedances were for PCBs in the 2-to-4-ft sample interval. This sample was analyzed for SVOCs because a sheen had been observed in the 4-to-6-ft interval during field processing. The third round of analyses was conducted on a subset of archived samples collected from > 6 ft if unvalidated data from the second round indicated that further characterization was necessary based on SMS exceedances at depth. Decisions on analyses to be conducted in the third round were made in consultation with EPA and Ecology.

In some cases, all intervals were not selected for analysis (i.e., some depth intervals were skipped at particular locations). For example, there may have been a location with SMS exceedances in the 4-to-6-ft sample interval, but only the 8-to-10-ft interval was analyzed in the second round (skipping the 6-to-8-ft interval). This approach was used to limit the number of additional analyses needed, and such decisions were made in consultation with EPA and Ecology based on lithology descriptions. If estimates about the depth of contamination are needed for locations with skipped intervals, chemical concentrations in the skipped interval(s) will be assumed to be similar to those in the interval above it.

Table 3-1 presents the target analytes for each sediment core interval analyzed and also indicates which sediment core intervals were archived without any analyses being conducted. Footnotes in Table 3-1 indicate samples that were analyzed during the second and third rounds.

Table 3-1. Chemical and geotechnical analyses or archival of subsurface sediment samples collected at 1- and 2-ft intervals

Sampling Location	Sample Interval (ft)[a]	Mercury	Other Metals	SVOCs	PCBs	Butyltins	Pesticides	Grain Size	Dioxins and Furans	Geotechnical[b]	Archived
LDW-SC1	0 – 2	X	X	X	X	X		X		X	
	2 – 4	X	X	X	X	X		X		X	
	4 – 6[c]				X						
LDW-SC2	0 – 2	X	X	X	X		X	X			
	2 – 4	X	X	X	X		X	X		X	
	4 – 6[c]		X	X	X						
	6 – 8										X
	8 – 10										X
	10 – 10.7										X
	10.7 – 12[c]		X	X	X						
	12 – 13										X
LDW-SC3	0 – 2	X	X	X	X	X		X		X	
	2 – 4	X	X	X	X	X		X		X	
	4 – 6										X
	6 – 8										X
LDW-SC4	0 – 1	X	X	X	X	X		X		X	
	1 – 2	X	X	X	X	X		X		X	
	2 – 4	X	X	X	X	X		X			
	4 – 6[c]				X						
	6 – 7.7										X
LDW-SC5	0 – 1	X	X	X	X			X		X	
	1 – 2.2	X	X	X	X			X			
	2.2 – 4	X	X	X	X			X		X	
	4 – 6.2										X
LDW-SC6	0 – 2	X	X	X	X			X		X	
	2 – 4.5	X	X	X	X			X		X	
	4.5 – 6										X
	6 – 8[c]	X	X	X	X						
	8 – 8.5										X
LDW-SC7	0 – 1	X	X	X	X	X	X	X		X	
	1 – 1.7	X	X	X	X	X	X	X			
	1.7 – 4	X	X	X	X	X	X	X		X	
	4 – 6.5										X
	6.5 – 8										X
	8 – 8.7										X

Table 3-1. Analyses conducted on subsurface sediment samples collected at 1- and 2-ft intervals, cont.

Sampling Location	Sample Interval (ft)[a]	Mercury	Other Metals	SVOCs	PCBs	Butyltins	Pesticides	Grain Size	Dioxins and Furans	Geotechnical[b]	Archived
LDW-SC8	0 – 1	X	X	X	X		X	X		X	
	1 – 2	X	X	X	X		X	X			
	2 – 4	X	X	X	X		X	X		X	
	4 – 6[c]	X	X	X	X						
	6 – 8[c]			X	X						
	8 – 10[d]	X	X	X	X						
LDW-SC9	0 – 1	X	X	X	X		X	X		X	
	1 – 2.6	X	X	X	X		X	X		X	
	2.6 – 4	X	X	X	X		X	X			
	4 – 6.4										X
	6.4 – 8.5										X
LDW-SC10	0 – 1	X	X	X	X		X	X		X	
	1 – 2	X	X	X	X		X	X			
	2 – 4	X	X	X	X		X	X		X	
	4 – 5[c]	X		X	X						
	5 – 6										X
	6 – 8[d]				X						
LDW-SC11	0 – 0.8	X	X	X	X			X			
	0.8 – 2	X	X	X	X			X		X	
	2 – 3.4	X	X	X	X			X			
	3.4 – 4.1	X	X	X	X			X			
	4.1 – 5										X
LDW-SC12	0 – 2	X	X	X	X	X		X		X	
	2 – 4	X	X	X	X	X		X		X	
	4 – 6.6[c]	X			X						
	6.6 – 8.7[d]	X			X						
LDW-SC13	0 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 6										X
	6 – 8										X
	8 – 9.5										X
LDW-SC14	0 – 1.4	X	X	X	X	X	X	X		X	
	1.4 – 2	X	X	X	X	X	X	X			
	2 – 4.1	X	X	X	X	X	X	X		X	
	4.1 – 6[c]	X		X	X						
	6 – 8.6[d]	X			X						
	8.6 – 10										X
	10 – 11[d]	X			X						

Table 3-1. Analyses conducted on subsurface sediment samples collected at 1- and 2-ft intervals, cont.

Sampling Location	Sample Interval (ft)[a]	Mercury	Other Metals	SVOCs	PCBs	Butyltins	Pesticides	Grain Size	Dioxins and Furans	Geotechnical[b]	Archived
LDW-SC15	0 – 1	X	X	X	X	X		X		X	
	1 – 2	X	X	X	X	X		X			
	2 – 4	X	X	X	X	X		X		X	
	4 – 6[c]				X	X					
	6 – 8										X
	8 – 10[d]				X						
LDW-SC16	0 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 6[c]	X	X	X	X						
	6 – 8										X
	8 – 10[c]	X	X	X	X						
	10 – 10.8										X
LDW-SC17	0 – 1	X	X	X	X			X			
	1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 6										X
	6 – 8.6[c]	X	X	X	X						
LDW-SC18	0 – 1	X	X	X	X			X			
	1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 6										X
	6 – 8										X
	8 – 10.7										X
LDW-SC19	0 – 1	X	X	X	X			X	X		
	1 – 2	X	X	X	X			X	X		
	2 – 4	X	X	X	X			X	X	X	
	4 – 6[c]				X						
	6 – 7[d]				X						
	7 – 9										X
	9 – 11.9[d]				X						
LDW-SC20	0 – 2	X	X	X	X	X	X	X	X	X	
	2 – 4	X	X	X	X	X	X	X	X	X	
	4 – 6[c]				X				X		
	6 – 8										X
	8 – 10[d]				X				X		

Table 3-1. Analyses conducted on subsurface sediment samples collected at 1- and 2-ft intervals, cont.

Sampling Location	Sample Interval (ft)[a]	Mercury	Other Metals	SVOCs	PCBs	Butyltins	Pesticides	Grain Size	Dioxins and Furans	Geotechnical[b]	Archived
LDW-SC21	0 – 1	X	X	X	X			X			
	1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 6.2[c]				X						
	6.2 – 8										X
	8 – 10										X
	10 – 11.3[d]				X						
LDW-SC22	0 – 1.1	X	X	X	X			X		X	
	1.1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X			
	4 – 6										X
	6 – 7.7										X
LDW-SC23	0 – 2	X	X	X	X	X	X	X		X	
	2 – 4	X	X	X	X	X	X	X		X	
	4 – 6[c]			X	X	X					
	6 – 8[d]				X						
	8 – 10.2[c]				X						
LDW-SC24	0 – 1	X	X	X	X			X		X	
	1 – 2	X	X	X	X			X			
	2 – 4	X	X	X	X			X		X	
	4 – 6										X
	6 – 8										X
	8 – 10										X
LDW-SC25	0 – 1	X	X	X	X	X		X			
	1 – 2	X	X	X	X	X		X		X	
	2 – 4	X	X	X	X	X		X		X	
	4 – 6[c]		X		X	X					
	6 – 8										X
	8 – 9.1[c]		X		X	X					
LDW-SC26	0 – 1	X	X	X	X	X		X	X		
	1 – 2	X	X	X	X	X		X	X	X	
	2 – 4	X	X	X	X	X		X	X	X	
	4 – 6										X
	6 – 8[c]	X	X	X	X	X			X		
	8 – 11.1										X
	11.1 – 12.1[c]		X		X						

Table 3-1. Analyses conducted on subsurface sediment samples collected at 1- and 2-ft intervals, cont.

Sampling Location	Sample Interval (ft)[a]	Mercury	Other Metals	SVOCs	PCBs	Butyltins	Pesticides	Grain Size	Dioxins and Furans	Geotechnical[b]	Archived
LDW-SC27	0 – 2	X	X	X	X			X		X	
	2 – 4.5	X	X	X	X			X		X	X
	4.5 – 6										X
	6 – 7.8										X
	7.8 – 9.5										X
LDW-SC28	0 – 1	X	X	X	X	X		X	X		
	1 – 2	X	X	X	X	X		X	X	X	
	2 – 4	X	X	X	X	X		X	X	X	
	4 – 5.5										X
	5.5 – 7.5[c]	X	X	X	X	X					
	7.5 – 9										X
	9 – 12										X
	12 – 12.6[d]	X	X	X	X	X					
LDW-SC29	0 – 1	X	X	X	X			X	X	X	
	1 – 2	X	X	X	X			X	X		
	2 – 3.6	X	X	X	X			X	X		
LDW-SC30	0 – 2.5	X	X	X	X			X		X	
	2.5 – 4	X	X	X	X			X		X	
	4 – 5.9										X
LDW-SC31	0 – 1	X	X	X	X	X	X	X		X	
	1 – 2.8	X	X	X	X	X	X	X		X	
	2.8 – 4	X	X	X	X	X	X	X			
	4 – 5.9										X
LDW-SC32	0 – 1	X	X	X	X			X			
	1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 5.2										X
	5.2 – 8[c]			X	X						
	8 – 10										X
	10 – 11										X
LDW-SC33	0 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 6[c]		X	X	X						
	6 – 8										X
	8 – 10[d]			X	X						
	9.5 – 10										X

Table 3-1. Analyses conducted on subsurface sediment samples collected at 1- and 2-ft intervals, cont.

Sampling Location	Sample Interval (ft)[a]	Mercury	Other Metals	SVOCs	PCBs	Butyltins	Pesticides	Grain Size	Dioxins and Furans	Geotechnical[b]	Archived
LDW-SC201[e]	0 – 1.5	X	X	X	X			X			
	1.5 – 4	X	X	X	X			X			
	4 – 6[c]			X	X						
	6 – 8										X
	8 – 10[d]			X	X						
	10 – 11.8										X
LDW-SC34	0 – 1	X	X	X	X		X	X			
	1 – 2	X	X	X	X		X	X			
	2 – 4	X	X	X	X		X	X			
	4 – 6										X
	6 – 8										X
	8 – 9.3										X
LDW-SC203[e]	0 – 1	X	X	X	X		X	X			
	1 – 2	X	X	X	X		X	X		X	
	2 – 4	X	X	X	X		X	X		X	
	4 – 6[c]			X	X						
	6 – 8										X
	8 – 8.8										X
LDW-SC35	0 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 4.9										X
	4.9 – 6										X
	6 – 8										X
LDW-SC36	0 – 1	X	X	X	X	X		X			
	1 – 2	X	X	X	X	X		X			
	2 – 4	X	X	X	X	X		X		X	
	4 – 6										X
	6 – 8										X
	8 – 10										X
LDW-SC202[e]	0 – 1	X	X	X	X	X		X			
	1 – 2	X	X	X	X	X		X			
	2 – 4	X	X	X	X	X		X		X	
	4 – 6										X
	6 – 8										X
	8 – 10.1										X

Table 3-1. Analyses conducted on subsurface sediment samples collected at 1- and 2-ft intervals, cont.

Sampling Location	Sample Interval (ft)[a]	Mercury	Other Metals	SVOCs	PCBs	Butyltins	Pesticides	Grain Size	Dioxins and Furans	Geotechnical[b]	Archived
LDW-SC37	0 – 1	X	X	X	X			X		X	
	1 – 2	X	X	X	X			X			
	2 – 4	X	X	X	X			X		X	
	4 – 5.3										X
	5.3 – 6.9[c]		X	X	X						
LDW-SC38a	0 – 1	X	X	X	X			X		X	
	1 – 2	X	X	X	X			X			
	2 – 3	X	X	X	X			X			
LDW-SC38b	3 – 3.3	X	X	X	X			X			
LDW-SC39	0 – 1	X	X	X	X	X	X	X	X		
	1 – 2	X	X	X	X	X	X	X	X	X	
	2 – 4	X	X	X	X	X	X	X	X	X	
	4 – 6[c]				X						
	6 – 8.5										X
	8.5 – 9.2										X
LDW-SC40	0 – 1.3	X	X	X	X		X	X	X		
	1.3 – 2	X	X	X	X		X	X	X	X	
	2 – 4	X	X	X	X		X	X	X	X	
	4 – 6										X
	6 – 8										X
	8 – 10										X
LDW-SC41	0 – 1	X	X	X	X			X	X		
	1 – 2	X	X	X	X			X	X	X	
	2 – 4	X	X	X	X			X	X	X	
	4 – 6[c]			X	X						
	6 – 7.9[d]				X						
LDW-SC42	0 – 1	X	X	X	X			X		X	
	1 – 2	X	X	X	X			X			
	2 – 4	X	X	X	X			X		X	
	4 – 6										X
	6 – 8										X
	8 – 10										X
	10 – 12										X
LDW-SC43	0 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 6										X
	6 – 9										X
	9 – 9.8										X

Table 3-1. Analyses conducted on subsurface sediment samples collected at 1- and 2-ft intervals, cont.

Sampling Location	Sample Interval (ft)[a]	Mercury	Other Metals	SVOCs	PCBs	Butyltins	Pesticides	Grain Size	Dioxins and Furans	Geotechnical[b]	Archived
LDW-SC44	0 – 2	X	X	X	X			X		X	
	2 – 3.2	X	X	X	X			X		X	
	3.2 – 4	X	X	X	X			X			
	4 – 5.8										X
LDW-SC45	0 – 1	X	X	X	X			X			
	1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 5										X
	5 – 6[c]				X						
LDW-SC46	0 – 1	X	X	X	X			X			
	1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 6.8[c]				X						
	6.8 – 8										X
	8 – 10										X
	10 – 11.2										X
LDW-SC47	0 – 1	X	X	X	X			X			
	1 – 2	X	X	X	X			X		X	
	2 – 3	X	X	X	X			X		X	
	3 – 4	X	X	X	X			X			
	4 – 6										X
	6 – 8										X
	8 – 10										X
LDW-SC48	0 – 1	X	X	X	X			X		X	
	1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X			
	4 – 5.6										X
LDW-SC49a[f]	0 – 1	X	X	X	X			X		X	
	1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 6[c]				X						
	6 – 8[d]				X						
	8 – 10[d]				X						
	10 – 11										X
LDW-SC50a[g]	0 – 1	X	X	X	X			X			
	1 – 2	X	X	X	X			X		X	
	2 – 2.8	X	X	X	X			X		X	
	2.8 – 4	X	X	X	X			X			

Table 3-1. Analyses conducted on subsurface sediment samples collected at 1- and 2-ft intervals, cont.

Sampling Location	Sample Interval (ft)[a]	Mercury	Other Metals	SVOCs	PCBs	Butyltins	Pesticides	Grain Size	Dioxins and Furans	Geotechnical[b]	Archived
	4 – 6										X
	6 – 8										X
	8 – 9.8										X
LDW-SC51	0 – 2	X	X	X	X			X		X	
	2 – 3.8	X	X	X	X			X		X	
	3.8 – 5.8[c]				X						
LDW-SC52	0 – 1	X	X	X	X			X			
	1 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X		X	
	4 – 4.9										X
LDW-SC53	0 – 2	X	X	X	X		X	X		X	
	2 – 4	X	X	X	X		X	X		X	
	4 – 6										X
	6 – 8										X
	8 – 10										X
LDW-SC54	0 – 2	X	X	X	X		X	X		X	
	2 – 4	X	X	X	X		X	X		X	
	4 – 5.5										X
	5.5 – 8										X
	8 – 10										X
LDW-SC55	0 – 1	X	X	X	X			X		X	
	1 – 2	X	X	X	X			X		X	
	2 – 3	X	X	X	X			X		X	
	3 – 4										X
	4 – 6										X
LDW-SC56	0 – 2	X	X	X	X			X		X	
	2 – 4	X	X	X	X			X			
	4 – 5.6										X
Total number		**177**	**178**	**185**	**214**	**50**	**40**	**162**	**26**	**108**	**107**

a Sample intervals presented in this table are based on recovered depths. All samples that were not archived were analyzed for total organic carbon (TOC) and total solids in addition to the analytes specified in the table.

b Geotechnical parameters included bulk density, Atterberg limits, and specific gravity.

c These sample intervals were analyzed during the second round of testing.

d These sample intervals were analyzed during the third round of testing.

e This location is a field replicate of the location directly preceding it in this table.

f A second core was collected at this location (LDW-SC49b), and VOCs were analyzed in samples collected at 1-ft intervals to a depth of 12 ft. Salinity and conductivity were also analyzed in porewater extracted from samples collected from this core at 2-ft intervals to a depth of 12 ft.

Table 3-1. Analyses conducted on subsurface sediment samples collected at 1- and 2-ft intervals, cont.

[g] Salinity and conductivity were also analyzed in porewater extracted from samples collected at the 0-to-2- and 2-to-4-ft intervals from second core at this location (LDW-SC50b).

PCB – polychlorinated biphenyl

SVOC – semivolatile organic compound

TOC – total organic carbon

At 19 locations, samples were collected and archived at 0.5-ft intervals according to Method B, as specified in Table 3-4 the QAPP (Windward 2006). Method B samples were collected to meet two objectives: 1) to provide additional information for the evaluation of sediment deposition in depositional areas with isolated SQS exceedances, and 2) to further evaluate the physical conceptual site model for sediment stability by obtaining finer vertical resolution of chemical profiles in depositional areas expected to have subsurface SMS criteria exceedances. The determination of which archived samples to analyze was made in consultation with EPA and Ecology based on an evaluation of unvalidated data from the 0-to-2- and 2-to-4-ft samples, as well as surface sediment data previously collected at these locations. Samples from 9 of the original 19 Method B cores were selected for analysis; 62 samples from the 0.5-ft intervals of these 9 cores were selected (Table 3-2). A core was selected for analysis of 0.5-ft interval samples if preliminary chemistry data for the initial core from that location indicated an increase in SQS exceedance factors with increasing depth, or for other reasons as indicated in Table 3-2.

Table 3-2. Chemical analyses of Method B subsurface sediment samples collected at 0.5-ft intervals

Sampling Location	Sample Interval (ft)[a]	Mercury	Lead	SVOCs	PCBs	Rationale
LDW-SC1	0 – 0.5	X		X	X	gradient in PCB concentration with depth; BEHP and mercury SQS exceedances in 0-2 ft sample; near a storm drain
	0.5 – 1	X		X	X	
	1 – 1.5	X		X	X	
	1.5 – 2	X		X	X	
LDW-SC6	0 – 0.5				X	gradient in PCB concentration with depth
	0.5 – 1				X	
	1 – 1.5				X	
	1.5 – 2				X	
	2 – 2.5				X	
	2.5 – 3				X	
	3 – 3.5				X	
	3.5 – 4				X	
	4 – 4.5				X	

Sampling Location	Sample Interval (ft)[a]	Mercury	Lead	SVOCs	PCBs	Rationale
LDW-SC12	0 – 0.5				X	gradient in PCB concentration with depth
	0.5 – 1				X	
	1 – 1.5				X	
	1.5 – 2				X	
	2 – 2.5				X	
	2.5 – 3				X	
	3 – 3.5				X	
	3.5 – 4				X	
LDW-SC13	0 – 0.5				X	minimal gradient in PCB concentrations, but location was near the historical PCB spill in Slip 1 and additional data were collected to help interpret the radionuclide data collected a geochronology core location Sg-3 (Windward and QEA 2005)
	0.5 – 1				X	
	1 – 1.5				X	
	1.5 – 2				X	
	2 – 2.5				X	
	2.5 – 3				X	
	3 – 3.5				X	
LDW-SC23	0 – 0.5			X		gradient in BEHP and PAH concentrations with depth
	0.5 – 1			X		
	1 – 1.5			X		
	1.5 – 2			X		
	2 – 2.5			X		
	2.5 – 3			X		
	3 – 3.5			X		
	3.5 – 4			X		
LDW-SC27	0 – 0.5				X	gradient in PCB concentration with depth
	0.5 – 1				X	
	1 – 1.5				X	
	1.5 – 2				X	
	2 – 2.5				X	
	2.5 – 3				X	
	3 – 3.5				X	
	3.5 – 4				X	
	4 – 4.5				X	
LDW-SC33	0 – 0.5		X		X	gradient in PCB and lead concentrations with depth
	0.5 – 1		X		X	
	1 – 1.5		X		X	
	1.5 – 2		X		X	
	2 – 2.5		X		X	
	2.5 – 3		X		X	

Sampling Location	Sample Interval (ft)[a]	Mercury	Lead	SVOCs	PCBs	Rationale
LDW-SC44	0 – 0.5				X	additional data collected to help interpret the radionuclide data collected at geochronology core location Sg-7 (Windward and QEA 2005)
	0.5 – 1				X	
	1 – 1.5				X	
	1.5 – 2				X	
	2 – 2.5				X	
	2.5 – 3				X	
	3 – 3.5				X	
LDW-SC51	0 – 0.5			X		additional data collected to determine if there was an ongoing source or if scour was occurring at this location near a private outfall and near the Isaacson storm drain/emergency overflow outfall
	0.5 – 1			X		
	1 – 1.5			X		
	1.5 – 2			X		
Total number of analyses		**4**	**6**	**16**	**50**	

[a] Samples were also collected at 0.5-ft intervals at the following ten locations but were not selected for analysis: LDW-SC2, LDW-SC3, LDW-SC16, LDW-SC20, LDW-SC30, LDW-SC35, LDW-SC43, LDW-SC53, LDW-SC54, and LDW-SC56. Half-foot samples were collected to a depth of 6 ft, but only sample intervals that were analyzed are shown in this table. Sample intervals not shown in this table were archived. All samples shown in this table were also analyzed for TOC and total solids. Samples were not analyzed for grain size because they had been previously frozen, which would affect grain size results.

BEHP – bis(2-ethylhexyl) phthalate

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

SQS – sediment quality standard

SVOC – semivolatile organic compound

TOC – total organic carbon

3.2 Methods for Chemical Analyses

All chemical analyses of the sediment samples were conducted at Analytical Resources, Inc. (ARI), except for the dioxin/furan analyses, which were conducted at Axys Analytical Services, Ltd. (Axys). Table 3-3 presents the analytical methods and sample handling requirements. Cleanup methods used to remove matrix interferences are presented in Table 3-4.

Table 3-3. Methods used to analyze subsurface sediment samples

Analyte	Method	Reference	Maximum Sample Holding Time[a]	Preservative
PCBs as Aroclors	GC/ECD	EPA 8082	14 days to extract, 40 days to analyze[b, c]	cool/4°C
Dioxins and furans	HRGC/HRMS	EPA 1613B	1 year to extract, 40 days to analyze	freeze/-20°C
Organochlorine pesticides[d]	GC/ECD	EPA 8081A	14 days to extract, 40 days to analyze[b, c]	cool/4°C

ANALYTE	METHOD	REFERENCE	MAXIMUM SAMPLE HOLDING TIME[a]	PRESERVATIVE
SVOCs (including PAHs)[e]	GC/MS	EPA 8270D	14 days to extract, 40 days to analyze[b, c]	cool/4°C
Selected SVOCs[f]	GC/MS	EPA 8270-SIM	14 days to extract, 40 days to analyze[b, c]	cool/4°C
Mercury	CVAA	EPA 7471A	28 days[g]	cool/4°C
Other metals[h]	ICP-AES	EPA 6010B	6 months[b]	cool/4°C[i]
TBT, DBT, MBT (as ions)	GC/MS	EPA 8270-SIM	14 days to extract, 40 days to analyze[c]	cool/4°C
VOCs	GC/MS	EPA 8260B	14 days to analyze	4°C
Grain size	sieve/ hydrometer	PSEP (1986)	none	none
TOC	combustion	Plumb (1981)	28 days	cool/4°C
Total solids	oven-dried	EPA 160.3	7 days[g]	cool/4°C
Atterberg limits	sieve	ASTM D4318	none	none
Specific gravity	pycnometer	ASTM D854	none	none
Bulk density	volumetric/ gravimetric	ASTM D2937	none	none
Conductivity[j]	conductivity meter	EPA 120.1	none	none
Salinity[k]	n/a	SM 2520-B	none	none

a All sample extracts will be archived frozen at the laboratory until the Windward project manager authorizes their disposal.

b Sediment may be frozen, with a maximum holding time of 1 year.

c Aqueous rinsate blanks have a maximum holding time of 7 days to extract and 40 days to analyze.

d Target pesticides include 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, 2,4'-DDT, 2,4'-DDE, 2,4'-DDD, aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC, oxychlordane, alpha- and gamma-chlordane, cis- and trans-nonachlor, dieldrin, endosulfan, endosulfan sulfate, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor, mirex, and toxaphene.

e Target PAHs include: anthracene, pyrene, dibenzofuran, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, fluoranthene, benzo(k)fluoranthene, acenaphthylene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, benz(a)anthracene, acenaphthene, phenanthrene, fluorene, 1-methylnaphthalene, naphthalene, 2-methylnaphthalene.

f Selected SVOCs for SIM include: 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 2,4-dimethylphenol, 2-methylphenol, benzoic acid, benzyl alcohol, butyl benzyl phthalate, hexachlorobenzene, hexachlorobutadiene, n-nitrosodimethylamine, n-nitrosodiphenylamine, n-nitroso-di-n-propylamine, and pentachlorophenol. Dibenzo(a,h)anthracene and dimethyl phthalate were added to the SIM analyte list for the analysis of archived samples, and benzoic acid was moved to the full-scan analyte list for reasons discussed in Section 3.3. Chemicals analyzed using SIM were not included in the EPA Method 8270D analyte list.

g Sediment may be frozen, with a maximum holding time of 6 months.

h Other metals included arsenic, antimony, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc.

i Aqueous rinsate blanks were preserved with nitric acid.

j Conductivity was analyzed in porewater samples extracted from sediment by centrifuge.

k Salinity values were calculated using temperature and conductivity results.

AES – atomic emission spectrometry
ASTM – American Society for Testing and Materials
CVAA – cold vapor atomic absorption
DBT – dibutyltin
ECD – electron capture detection
EPA – US Environmental Protection Agency
FPD – flame photometric detection
GC/MS – gas chromatography/mass spectrometry
HR – high resolution
ICP – inductively coupled plasma
MBT – monobutyltin
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PSEP – Puget Sound Estuary Program
SIM – selected ion monitoring
SVOC – semivolatile organic compound
TBT – tributyltin
TOC – total organic carbon
VOC – volatile organic compound

Table 3-4. Cleanup methods used in chemical analyses

Analyte	Method	Reference
PCBs as Aroclors	sulfur cleanup	EPA 3660B
	sulfuric acid cleanup	EPA 3665A
Organochlorine pesticides	Florisil® cleanup	EPA 3620
SVOCs and Selected SVOCs by SIM	GPC cleanup	EPA 3640A
TBT, DBT, MBT (as ions)	alumina cleanup	EPA 3610B

DBT – dibutyltin
EPA – US Environmental Protection Agency
GPC – gel permeation chromatography
MBT – monobutyltin
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SIM – selected ion monitoring
SVOC – semivolatile organic compound
TBT – tributyltin

3.3 Laboratory Deviations from the QAPP

This section discusses laboratory deviations from the QAPP (Windward 2006). ARI and Axys followed the methods and procedures described in the QAPP, with the following exceptions:

- The holding time for mercury analysis was extended to 6 months for frozen archived sediment samples. This decision was made in consultation with EPA, following Puget Sound Estuary Program (PSEP) protocols (PSEP 1997).
- The analyte lists for the SVOC full-scan and selected ion monitoring (SIM) methods were modified for the analysis of archived samples to alleviate analytical difficulties encountered in the first round of analyses at ARI. Specifically, dibenzo(a,h)anthracene was analyzed using the SIM method for all of the archived sediments, dimethyl phthalate was analyzed using the SIM

method for the first group of archived sediment samples, and benzoic acid was analyzed using the full-scan method for all of the archived sediment samples.

- Although not requested, ARI also analyzed samples LDW-SC20-0-2 and LDW-SC20-2-4 for organochlorine pesticides. No pesticides were detected in these two samples.

4.0 Results

This section summarizes the results of chemical and geotechnical analyses conducted on subsurface sediment samples collected in the LDW (Sections 4.1 and 4.2, respectively). The results of the data validation, conducted by Laboratory Data Consultants, Inc. (LDC), are discussed in Section 4.3.

4.1 LDW Subsurface Sediment Chemistry Results

The results of the chemical analyses are summarized by analyte group in Section 4.1.1 and by location in Section 4.1.2. Data tables containing all chemical results by sample ID are presented in Appendix A.

A detailed discussion of the approach used to average laboratory replicates is presented in Appendix C. Methods for calculating concentrations for total PCBs, total polycyclic aromatic hydrocarbons (PAHs), total DDTs, and total chlordane are also presented in Appendix C. The number of significant figures shown for each concentration in all results tables in this section was specified by the analytical laboratory, as described in Appendix C. There was no additional manipulation of significant figures. Raw laboratory data are presented in Appendix E.

4.1.1 Summary of results by analyte group

This section presents summaries of chemical results for the following groups of analytes in samples from the 1- and 2-ft intervals collected using both Methods A and B: metals, butyltins, SVOCs, PCBs, pesticides, dioxins/furans, VOCs, and conventional parameters (i.e., grain size, total organic carbon [TOC], and total solids). As described in the QAPP (Windward 2006), Method A involved collecting samples at 0-to-1-, 1-to-2-, and 2-to-4-ft intervals; and Method B involved collecting samples at 0-to-2- and 2-to-4-ft intervals in one vertical half of the core and at 0.5-ft intervals from 0 to 6 ft in the other vertical half of the core. Chemical results for samples collected at 0.5-ft intervals using Method B are presented in Section 4.1.2.2.

For the purpose of summarizing and displaying results in this section, each of the analyzed samples was placed into one of five interval categories (0 to 1 ft, 0 to 2 ft, 1 to 2 ft, 2 to 4 ft, and > 4 ft). The list of actual recovered sample intervals, *in situ* sample intervals, and the interval category assigned for each analyzed sample are presented in Table A-11 in Appendix A.

Tables in this section include comparisons of detected chemical concentrations in subsurface sediment to SMS criteria or to DMMP guidelines for chemicals not included in the SMS. Some of the SMS criteria are based on organic carbon (OC)-normalized concentrations. If the TOC content of a sediment sample is < 0.5%, then Ecology guidance does not recommend OC-normalization (Ecology 1995). In addition, OC-normalization is not considered appropriate if the TOC is > 4% (LDWG 2006) In these cases, the dry weight concentration was compared to the lowest apparent effects threshold (LAET) and second lowest apparent effects threshold (2LAET) (PTI 1988), which are analogous to the SQS and the CSL, respectively. A total of 24 samples had TOC concentrations < 0.5% and 4 samples had TOC concentration >4.0%. Appendix A contains detailed tables containing results for each location in comparison to SMS, DMMP, or apparent effects threshold (AET) values.

Figures 4-1a through 4-1d show exceedances of SMS criteria and DMMP guidelines by any chemical at subsurface sample locations. Figure 4-2 shows exceedances of SMS criteria by major chemical group, and Figure 4-3 shows exceedances of DMMP guidelines by major chemical group for those chemicals that do not have SMS criteria.

4.1.1.1 Metals

Table 4-1 summarizes the results for the 178 subsurface sediment samples from 56 locations in the LDW that were analyzed for metals.[3] Data summaries include the number of detections, the range of detected concentrations, the mean of detected concentrations, and the range of reporting limits (RLs) for metals reported as non-detects. Data tables containing metals results for each sample, including field replicate samples, are presented in Appendix A. Table 4-1 also presents the numbers of samples with detected concentrations within the following three categories: 1) ≤ SQS / SL, 2) > SQS / SL and ≤ CSL / ML, and 3) > CSL / ML. Figures 4-2 and 4-3 show exceedances of metals SMS criteria and DMMP guidelines by sample interval for each of the subsurface locations. Neither SMS criteria nor DMMP guidelines are available for cobalt, molybdenum, selenium, thallium, or vanadium.

[3] 177 samples were analyzed for mercury only.

Table 4-1. Summary of metals results in LDW subsurface sediment samples

Analyte and SMS Criteria or DMMP Guidelines if Available	Assigned Sample Interval (ft)	Detection Frequency[b]	Detected Concentration (mg/kg dw)			Reporting Limit (mg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria and DMMP Guidelines		
			Min	Max	Mean[c]	Min	Max	≤ SQS/SL	> SQS/SL and ≤ CSL/ML	> CSL/ML
Antimony SL = 150 mg/kg dw ML = 200 mg/kg dw	0 – 1	3 / 39	20 J	30 J	30	6	10	3	0	0
	0 – 2	2 / 20	13 J	40 J	30	6	10	2	0	0
	1 – 2	3 / 39	16 J	40 J	30	6	10	3	0	0
	2 – 4	6 / 64	10 J	590 J	100	6	40	5	0	1
	> 4	7 / 16	8 J	280 J	70	6	10	6	0	1
Arsenic SQS = 57 mg/kg dw CSL = 93 mg/kg dw	0 – 1	37 / 39	7	707	50	6	6	33	0	4
	0 – 2	17 / 20	7	190	30	6	7	16	0	1
	1 – 2	35 / 39	7	281	40	6	6	30	2	3
	2 – 4	49 / 64	6	2,000	70	6	7	43	2	4
	> 4	14 / 16	8	1,890	200	6	6	8	2	4
Cadmium SQS = 5.1 mg/kg dw CSL = 6.7 mg/kg dw	0 – 1	23 / 39	0.3	4.5	1	0.2	0.9	23	0	0
	0 – 2	12 / 20	0.4	3.4	1	0.2	0.4	12	0	0
	1 – 2	21 / 39	0.3	7.6	1	0.2	0.4	19	1	1
	2 – 4	32 / 64	0.3	15	2	0.2	0.8	31	0	1
	> 4	11 / 16	0.6	20.4	4	0.2	0.3	10	0	1
Chromium SQS = 260 mg/kg dw CSL = 270 mg/kg dw	0 – 1	39 / 39	13.6	81.3	33	na	na	39	0	0
	0 – 2	20 / 20	11.4	74.3	38	na	na	20	0	0
	1 – 2	39 / 39	10.8	135	40	na	na	39	0	0
	2 – 4	64 / 64	8.1	386	35	na	na	63	0	1
	> 4	16 / 16	8.3	160	46	na	na	16	0	0
Cobalt	0 – 1	39 / 39	4.3	18	8.7	na	na	na	na	na
	0 – 2	20 / 20	4.3	12.2	8	na	na	na	na	na
	1 – 2	39 / 39	4.2	15.6	8.7	na	na	na	na	na
	2 – 4	64 / 64	3.2	100	9	na	na	na	na	na
	> 4	16 / 16	3.3	106	20	na	na	na	na	na

Table 4-1. Summary of metal results in LDW subsurface sediment samples, cont.

Analyte and SMS Criteria or DMMP Guidelines if Available	Assigned Sample Interval (ft)	Detection Frequency[b]	Detected Concentration (mg/kg dw)			Reporting Limit (mg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria and DMMP Guidelines		
			Min	Max	Mean[c]	Min	Max	≤ SQS/SL	> SQS/SL and ≤ CSL/ML	> CSL/ML
Copper SQS = 390 mg/kg dw CSL = 390 mg/kg dw	0 – 1	39 / 39	16.3	327	91	na	na	39	0	0
	0 – 2	20 / 20	11.1 J	190 J	71	na	na	20	0	0
	1 – 2	39 / 39	12.0	339	81	na	na	39	0	0
	2 – 4	64 / 64	7.6	2,940	100	na	na	61	0	3
	> 4	16 / 16	7.5	1,950	320	na	na	13	0	3
Lead SQS = 450 mg/kg dw CSL = 530 mg/kg dw	0 – 1	39 / 39	6 J	639	80	na	na	38	0	1
	0 – 2	19 / 20	3	772	100	3	3	17	0	2
	1 – 2	38 / 39	3	320	70	3	3	38	0	0
	2 – 4	53 / 64	3	3,520 J	200	2	3	50	0	3
	> 4	14 / 16	9	1,350	300	2	2	10	1	3
Mercury SQS = 0.41 mg/kg dw CSL = 0.59 mg/kg dw	0 – 1	37 / 39	0.05	0.71	0.3	0.05	0.05	30	4	3
	0 – 2	17 / 20	0.05	0.65	0.3	0.06	0.07	14	1	2
	1 – 2	32 / 39	0.06	1.28	0.3	0.04	0.06	25	5	2
	2 – 4	46 / 64	0.07	1.29	0.3	0.04	0.06	37	4	5
	> 4	12 / 15	0.17	4.34	0.93	0.05	0.05	3	1	8
Molybdenum	0 – 1	30 / 39	0.9	11	3	0.6	1	na	na	na
	0 – 2	14 / 20	0.6	9.1	3	0.6	1	na	na	na
	1 – 2	28 / 39	0.6	16	3	0.6	1	na	na	na
	2 – 4	37 / 64	0.7	113	5	0.6	1	na	na	na
	> 4	15 / 16	0.7	166	20	0.6	0.6	na	na	na

Table 4-1. Summary of metal results in LDW subsurface sediment samples, cont.

Analyte and SMS Criteria or DMMP Guidelines if Available	Assigned Sample Interval (ft)	Detection Frequency[b]	Detected Concentration (mg/kg dw)			Reporting Limit (mg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria and DMMP Guidelines		
			Min	Max	Mean[c]	Min	Max	≤ SQS/SL	> SQS/SL and ≤ CSL/ML	> CSL/ML
Nickel SL = 140 mg/kg dw ML = 370 mg/kg dw	0 – 1	39 / 39	9	36	20	na	na	39	0	0
	0 – 2	20 / 20	7 J	34	20	na	na	20	0	0
	1 – 2	39 / 39	8	49	20	na	na	39	0	0
	2 – 4	64 / 64	6	226	20	na	na	63	1	0
	> 4	16 / 16	5	69	20	na	na	16	0	0
Selenium	0 – 1	0 / 39	nd	nd	nd	6	20	na	na	na
	0 – 2	0 / 20	nd	nd	nd	6	20	na	na	na
	1 – 2	0 / 39	nd	nd	nd	6	10	na	na	na
	2 – 4	0 / 64	nd	nd	nd	6	40	na	na	na
	> 4	0 / 16	nd	nd	nd	6	40	na	na	na
Silver SQS = 6.1 mg/kg dw CSL = 6.1 mg/kg dw	0 – 1	8 / 39	0.5	3.0	1	0.4	1	8	0	0
	0 – 2	10 / 20	0.6	3.3	2	0.4	0.6	10	0	0
	1 – 2	11 / 39	0.5	7.5	2	0.4	0.7	10	0	1
	2 – 4	18 / 64	0.6	5	2	0.3	1	18	0	0
	> 4	10 / 16	0.5	4.3	2	0.4	1	10	0	0
Thallium	0 – 1	0 / 39	nd	nd	nd	6	20	na	na	na
	0 – 2	0 / 20	nd	nd	nd	6	20	na	na	na
	1 – 2	0 / 39	nd	nd	nd	6	10	na	na	na
	2 – 4	0 / 64	nd	nd	nd	6	40	na	na	na
	> 4	0 / 16	nd	nd	nd	6	40	na	na	na
Vanadium	0 – 1	39 / 39	41.8	85	63	na	na	na	na	na
	0 – 2	20 / 20	37	86.9	63	na	na	na	na	na
	1 – 2	39 / 39	39.6	84.9	63.3	na	na	na	na	na
	2 – 4	64 / 64	26	223	60	na	na	na	na	na
	> 4	16 / 16	37.2	112	64	na	na	na	na	na

Table 4-1. Summary of metal results in LDW subsurface sediment samples, cont.

Analyte and SMS Criteria or DMMP Guidelines if Available	Assigned Sample Interval (ft)	Detection Frequency[b]	Detected Concentration (mg/kg dw)			Reporting Limit (mg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria and DMMP Guidelines		
			Min	Max	Mean[c]	Min	Max	≤ SQS/SL	> SQS/SL and ≤ CSL/ML	> CSL/ML
Zinc SQS = 410 mg/kg dw CSL = 960 mg/kg dw	0 – 1	39 / 39	37.5 J	1,260	200	na	na	37	1	1
	0 – 2	20 / 20	22.9	748	170	na	na	19	1	0
	1 – 2	39 / 39	23.7 J	2,050	200	na	na	36	2	1
	2 – 4	64 / 64	16.2 J	4,720	300	na	na	59	3	2
	> 4	16 / 16	17.6	4,550	910	na	na	10	1	5

a RL range for non-detect samples.

b Number of samples with detected concentrations divided by the total number of samples analyzed.

c Reported mean concentrations are the average of the detected concentrations only; RLs were not included in the calculation of the mean concentration. Mean nickel concentrations were coincidentally 20 mg/kg dw at all sample intervals.

CSL – cleanup screening level

dw – dry weight

J – estimated concentration

na – not applicable

nd – not detected

SQS – sediment quality standard

DMMP – Dredged Material Management Program

ML – maximum level

SL – screening level

SMS – Sediment Management Standards

Six metals (chromium, cobalt, copper, nickel, vanadium, and zinc) were detected in all of the subsurface sediment samples. Selenium and thallium were not detected in any of the subsurface sediment samples. The remaining metals were detected at frequencies ranging from 8 to 97% in the various sample intervals.

For all detected metals except silver, the maximum concentration was detected in either the 2-to-4- or > 4-ft interval. For all metals except antimony, the highest mean concentration was detected in the > 4-ft interval. The highest mean antimony concentration was detected in the 2-to-4-ft interval. The mean nickel concentrations were the same for all sample intervals.

Of the 178 samples analyzed for metals, 32 had detected concentrations of metals greater than the SQS / SL but less than the CSL / ML, and 67 had detected concentrations of metals greater than the CSL / ML. Detected concentrations of nine metals were greater the CSL / ML: antimony (2 samples), arsenic (16 samples), cadmium (3 samples), chromium (1 sample), copper (6 samples), lead (9 samples), mercury (20 samples), silver (1 sample), and zinc (9 samples).

4.1.1.2 Butyltins

Table 4-2 summarizes the results for the 50 subsurface sediment samples from 15 locations in the LDW analyzed for butyltins. Data tables containing the butyltin results for each sample, including field replicate samples, are presented in Appendix A. Of the 50 samples analyzed, tributyltin was detected in 34 samples from 13 locations, dibutyltin was detected in 24 samples from 12 locations, and monobutyltin was detected in 13 samples from 8 locations. The highest butyltin concentrations were detected in samples collected at depths greater than 4 ft, with the two highest tributyltin concentrations detected at 6 to 8 ft (6,200 µg / kg dw at LDW-SC26) and at 5.5 to 7.5 ft (3,400 µg / kg dw at LDW-SC28).

Table 4-2. Summary of butyltin results in LDW subsurface sediment samples

Analyte	Assigned Sample Interval (ft)	Detection Frequency[b]	Detected Concentration (µg/kg dw)			Reporting Limit (µg/kg dw)[a]	
			Min	Max	Mean[c]	Min	Max
Monobutyltin as ion	0 – 1	3 / 11	6.1	12	9.7	3.9	4.0
	0 – 2	2 / 5	8.0	10	9.0	3.9	3.9
	1 – 2	4 / 11	4.5	13	7.4	3.8	4.1
	2 – 4	2 / 16	6.0	18	12	2.6	4.0
	> 4	2 / 7	9.1	46	28	3.8	7.9
Dibutyltin as ion	0 – 1	9 / 11	6.4	72	22	5.7	5.7
	0 – 2	3 / 5	12	34	20	5.5	5.6
	1 – 2	5 / 11	15	64	31	5.4	5.8
	2 – 4	4 / 16	25	150	73	3.7	5.7
	> 4	3 / 7	92	960	520	5.4	11

Analyte	Assigned Sample Interval (ft)	Detection Frequency[b]	Detected Concentration (µg/kg dw)			Reporting Limit (µg/kg dw)[a]	
			Min	Max	Mean[c]	Min	Max
Tributyltin as ion	0 – 1	11 / 11	5.5	220	92	na	na
	0 – 2	3 / 5	55	140	86	3.7	3.7
	1 – 2	7 / 11	21	350	120	3.6	3.9
	2 – 4	7 / 16	10	720	240	3.6	3.8
	> 4	6 / 7	4.8	6,200	1,800	3.6	3.6

[a] RL range for non-detect samples.

[b] Number of samples with detected concentrations divided by the total number of samples analyzed.

[c] Reported mean concentrations are the average of the detected concentrations only; RLs were not included in the calculation of the mean concentrations.

dw – dry weight

4.1.1.3 SVOCs

Table 4-3 summarizes results for 185 subsurface sediment samples from 56 locations in the LDW that were analyzed for SVOCs. Table 4-3 summarizes results for total low-molecular-weight PAHs (LPAHs), total high-molecular-weight PAHs (HPAHs), total PAHs, and 21 other detected SVOCs (excluding individual PAHs). Complete SVOC results for all samples, including the three field replicates, are presented in Appendix A. Table 4-3 also presents the numbers of samples with detected concentrations within the following three categories: 1) ≤ SQS / SL, 2) > SQS / SL and ≤ CSL / ML, and 3) > CSL / ML. TOC concentrations were less than 0.5% or greater than 4.0% in 22 of the 185 samples analyzed for SVOCs. For these samples, dry weight concentrations of the chemicals were compared to the LAET and 2LAET values. Figures 4-2 and 4-3 show exceedances of SVOC SMS criteria and DMMP guidelines by depth for the various subsurface locations.

Table 4-3. Summary results for SVOCs detected in LDW subsurface sediment samples

Analyte and SMS Criteria or DMMP Guidelines if Available	Assigned Sample Interval (ft)	Detection Frequency[c]	Detected Concentration (µg/kg dw)			Reporting Limit (µg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria and DMMP Guidelines[b]		
			Min	Max	Mean[d]	Min	Max	≤ SQS/SL	> SQS/SL and ≤ CSL/ML	> CSL/ML
Total HPAH	0 – 1	38 / 39	122 J	34,700	4,200	nc	nc	37	0	1
	0 – 2	19 / 20	92 J	11,800	3,200	nc	nc	19	0	0
SQS = 960 mg/kg OC	1 – 2	36 / 39	13 J	40,000	4,300	nc	nc	35	1	0
CSL = 5,300 mg/kg OC LAET = 12,000 µg/kg dw	2 – 4	50 / 64	9.9 J	47,000	4,200	nc	nc	47	2	1
2LAET = 17,000 µg/kg dw	> 4	21 / 23	60 J	38,000 J	7,000	nc	nc	19	2	0
Total LPAH	0 – 1	37 / 39	12 J	2,100 J	420	nc	nc	37	0	0
	0 – 2	18 / 20	15 J	1,700 J	430	nc	nc	18	0	0
SQS = 370 mg/kg OC	1 – 2	34 / 39	24 J	7,500	700	nc	nc	33	1	0
CSL = 780 mg/kg OC LAET = 5,200 µg/kg dw	2 – 4	43 / 64	20	27,000 J	1,400	nc	nc	41	1	1
2LAET = 13,000 µg/kg dw	> 4	20 / 23	46 J	9,800	1,700	nc	nc	19	1	0
Total PAH[e]	0 – 1	39 / 39	24	36,200	4,500	nc	nc	na	na	na
	0 – 2	19 / 20	92 J	12,200 J	3,600	nc	nc	na	na	na
	1 – 2	36 / 39	13 J	42,600 J	4,900	nc	nc	na	na	na
	2 – 4	50 / 64	9.9 J	57,000 J	5,400	nc	nc	na	na	na
	> 4	21 / 23	60 J	46,000 J	8,600	nc	nc	na	na	na
Bis(2-ethylhexyl) phthalate	0 – 1	35 / 39	22	1,800	470	27	510	29	4	2
	0 – 2	18 / 20	12 J	1,800	420	42	530	16	0	2
SQS = 47 mg/kg OC	1 – 2	25 / 39	13 J	3,900	680	19	400	20	2	3
CSL = 78 mg/kg OC LAET = 1,300 µg/kg dw	2 – 4	37 / 64	13 J	3,900	660	19	280	30	3	4
2LAET = 1,900 µg/kg dw	> 4	15 / 23	56 J	3,800	900	61	66	10	3	2
Butyl benzyl phthalate	0 – 1	32 / 39	5.9	610	75	5.9	20	28	4	0
	0 – 2	12 / 20	11	71	34	5.8	38	12	0	0
SQS = 4.9 mg/kg OC	1 – 2	24 / 39	14	400	66	5.8	36	21	3	0
CSL = 64 mg/kg OC LAET = 63 µg/kg dw	2 – 4	29 / 64	5.8 J	180	40	5.8	42	26	3	0
2LAET = 900 µg/kg dw	> 4	10 / 23	12 J	48	27	6.1	36	10	0	0

Table 4-3. Summary results for SVOCs detected in LDW subsurface sediment samples, cont.

Analyte and SMS Criteria or DMMP Guidelines if Available	Assigned Sample Interval (ft)	Detection Frequency[c]	Detected Concentration (µg/kg dw)			Reporting Limit (µg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria and DMMP Guidelines[b]		
			Min	Max	Mean[d]	Min	Max	≤ SQS/SL	> SQS/SL and ≤ CSL/ML	> CSL/ML
Dimethyl phthalate	0 – 1	3 / 39	13 J	1,700	600	20	110	3	0	0
SQS = 53 mg/kg OC	0 – 2	1 / 20	9.9 J	9.9 J	9.9	19	99	1	0	0
CSL = 53 mg/kg OC	1 – 2	1 / 39	16 J	16 J	16	19	130	1	0	0
LAET = 71 µg/kg dw	2 – 4	2 / 64	49 J	8,800	4,400	19	140	1	0	1
2LAET = 160 µg/kg dw	> 4	5 / 23	16	210	67	6.5	62	5	0	0
Di-n-butyl phthalate	0 – 1	10 / 39	10 J	200	45	20	160	10	0	0
SQS = 220 mg/kg OC	0 – 2	4 / 20	16 J	47	33	20	180	4	0	0
CSL = 1,700 mg/kg OC	1 – 2	7 / 39	11 J	140	42	19	180	7	0	0
LAET = 1,400 µg/kg dw	2 – 4	15 / 64	10 J	94	31	19	140	15	0	0
2LAET = 5,100 µg/kg dw	> 4	3 / 23	31 J	67	47	61	66	3	0	0
Di-n-octyl phthalate	0 – 1	1 / 39	25	25	25	20	160	1	0	0
SQS = 58 mg/kg OC	0 – 2	0 / 20	nd	nd	nc	19	99	0	0	0
CSL = 4,500 mg/kg OC	1 – 2	2 / 39	79 J	220	150	19	110	2	0	0
LAET = 6,200 µg/kg dw	2 – 4	3 / 64	14 J	110	63	19	140	3	0	0
no 2LAET value	> 4	2 / 23	56 J	57 J	57	61	66	2	0	0
1,2,4-Trichlorobenzene	0 – 1	5 / 39	3.6 J	18 J	8.5	5.8	22	4	1	0
SQS = 0.81 mg/kg OC	0 – 2	4 / 20	4.8 J	6.5 J	5.8	5.8	12	4	0	0
CSL = 1.8 mg/kg OC	1 – 2	7 / 39	4.1 J	22 J	9.1	5.8	20	6	1	0
LAET = 31 µg/kg dw	2 – 4	4 / 64	4.1 J	110 J	41	5.8	22	2	0	2
2LAET = 51 µg/kg dw	> 4	5 / 23	9.8	18	13	6.1	6.6	5	0	0
1,2-Dichlorobenzene	0 – 1	3 / 39	4.2 J	17	9.3	5.8	20	3	0	0
SQS = 2.3 mg/kg OC	0 – 2	2 / 20	4.2 J	4.8 J	4.5	5.8	12	2	0	0
CSL = 2.3 mg/kg OC	1 – 2	5 / 39	2.9 J	9.6	5.7	5.8	20	5	0	0
LAET = 35 µg/kg dw	2 – 4	8 / 64	3.6 J	150	27	5.8	42	7	0	1
2LAET = 50 µg/kg dw	> 4	6 / 23	10	160	46	6.1	6.6	4	0	2

Table 4-3. **Summary results for SVOCs detected in LDW subsurface sediment samples, cont.**

Analyte and SMS Criteria or DMMP Guidelines if Available	Assigned Sample Interval (ft)	Detection Frequency[c]	Detected Concentration (µg/kg dw)			Reporting Limit (µg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria and DMMP Guidelines[b]		
			Min	Max	Mean[d]	Min	Max	≤ SQS/SL	> SQS/SL and ≤ CSL/ML	> CSL/ML
1,3-Dichlorobenzene	0 – 1	0 / 39	nd	nd	nd	20	160	0	0	0
	0 – 2	0 / 20	nd	nd	nd	19	99	0	0	0
SL = 170 µg/kg dw	1 – 2	0 / 39	nd	nd	nd	19	130	0	0	0
no ML value	2 – 4	0 / 64	nd	nd	nd	19	140	0	0	0
	> 4	3 / 23	6.5	12	8.6	6.5	62	3	0	0
1,4-Dichlorobenzene	0 – 1	14 / 39	3.0 J	18	7.1	5.8	20	14	0	0
	0 – 2	2 / 20	4.2 J	5.4 J	4.8	5.8	12	2	0	0
SQS = 3.1 mg/kg OC	1 – 2	9 / 39	3.5 J	9.2	5.5	5.8	20	9	0	0
CSL = 9 mg/kg OC LAET = 110 µg/kg dw	2 – 4	12 / 64	3.0 J	38	10	5.8	42	12	0	0
2LAET = 120 µg/kg dw	> 4	12 / 23	3.9 J	31	10	6.1	6.6	12	0	0
2,4-Dimethylphenol	0 – 1	2 / 39	25 J	27 J	26	5.8	18	2	0	0
	0 – 2	0 / 20	nd	nd	nd	5.8	19	0	0	0
SQS = 29 µg/kg dw	1 – 2	3 / 39	9.5 J	14 J	12	5.8	20	3	0	0
CSL = 29 µg/kg dw	2 – 4	5 / 64	6.3 J	46	16	5.8	42	4	0	1
	> 4	11 / 23	3.7 J	24 J	11	6.5	6.6	11	0	0
2-Methylphenol	0 – 1	10 / 39	3.0 J	160	22	5.8	20	9	0	1
	0 – 2	4 / 20	3.0 J	7.1	4.8	5.8	12	4	0	0
SQS = 63 µg/kg dw	1 – 2	4 / 39	9.3 J	16 J	13	5.8	20	4	0	0
CSL = 63 µg/kg dw	2 – 4	7 / 64	4.2 J	10	6.2	5.8	42	7	0	0
	> 4	4 / 23	5.9 J	12	7.8	6.1	6.6	4	0	0
4-Chloroaniline	0 – 1	1 / 39	47 J	47 J	47	98	780	na	na	na
	0 – 2	0 / 20	nd	nd	nd	97	490	na	na	na
	1 – 2	0 / 39	nd	nd	nd	97	650	na	na	na
	2 – 4	0 / 64	nd	nd	nd	96	700	na	na	na
	> 4	0 / 23	nd	nd	nd	300	330	na	na	na

Table 4-3. Summary results for SVOCs detected in LDW subsurface sediment samples, cont.

Analyte and SMS Criteria or DMMP Guidelines if Available	Assigned Sample Interval (ft)	Detection Frequency[c]	Detected Concentration (µg/kg dw)			Reporting Limit (µg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria and DMMP Guidelines[b]		
			Min	Max	Mean[d]	Min	Max	≤ SQS/SL	> SQS/SL and ≤ CSL/ML	> CSL/ML
4-Methylphenol[f] SQS = 670 µg/kg dw CSL = 670 µg/kg dw	0 – 1	2 / 39	17 J	42 J	30	20	160	2	0	0
	0 – 2	1 / 20	13 J	13 J	13	19	99	1	0	0
	1 – 2	2 / 39	16 J	24	20	19	130	2	0	0
	2 – 4	3 / 64	23	110 J	58	19	140	3	0	0
	> 4	3 / 23	37 J	48 J	42	61	66	3	0	0
Benzoic acid SQS = 650 µg/kg dw CSL = 650 µg/kg dw	0 – 1	29 / 39	52 J	750 J	210	59	200	28	0	1
	0 – 2	13 / 20	58 J	330	160	58	290	13	0	0
	1 – 2	24 / 39	48 J	540 J	150	59	200	24	0	0
	2 – 4	39 / 64	35 J	3,000 J	200	58	280	38	0	1
	> 4	1 / 23	320 J	320 J	320	580	620	1	0	0
Benzyl alcohol SQS = 57 µg/kg dw CSL = 73 µg/kg dw	0 – 1	10 / 39	18 J	200	78	29	100	5	1	4
	0 – 2	3 / 20	18 J	44	27	29	59	3	0	0
	1 – 2	7 / 39	19 J	210	61	29	99	5	1	1
	2 – 4	7 / 64	20 J	34 J	24	29	210	7	0	0
	> 4	1 / 23	52	52	52	31	38	1	0	0
Hexachlorobenzene SQS = 0.38 mg/kg OC CSL = 2.3 mg/kg OC LAET = 22 µg/kg dw 2LAET = 70 µg/kg dw	0 – 1	1 / 39	5.9	5.9	5.9	0.98	12	1	0	0
	0 – 2	0 / 20	nd	nd	nd	0.98	6.8	0	0	0
	1 – 2	1 / 39	10	10	10	0.98	12	0	1	0
	2 – 4	0 / 64	nd	nd	nd	0.96	42	0	0	0
	> 4	1 / 23	4.6 J	4.6 J	4.6	6.1	6.6	1	0	0
Hexachlorobutadiene SQS = 3.9 mg/kg OC CSL = 6.2 mg/kg OC LAET = 11 µg/kg dw 2LAET = 120 µg/kg dw	0 – 1	0 / 39	nd	nd	nd	0.98	12	0	0	0
	0 – 2	0 / 20	nd	nd	nd	0.98	6.8	0	0	0
	1 – 2	0 / 39	nd	nd	nd	0.98	12	0	0	0
	2 – 4	0 / 64	nd	nd	nd	0.96	42	0	0	0
	> 4	1 / 23	5.9 J	5.9 J	5.9	6.1	6.6	1	0	0

Table 4-3. Summary results for SVOCs detected in LDW subsurface sediment samples, cont.

Analyte and SMS Criteria or DMMP Guidelines if Available	Assigned Sample Interval (ft)	Detection Frequency[c]	Detected Concentration (µg/kg dw)			Reporting Limit (µg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria and DMMP Guidelines[b]		
			Min	Max	Mean[d]	Min	Max	≤ SQS/SL	> SQS/SL and ≤ CSL/ML	> CSL/ML
n-Nitroso-di-n-propylamine	0 – 1	3 / 39	30	320	130	29	100	na	na	na
	0 – 2	1 / 20	32	32	32	29	59	na	na	na
	1 – 2	2 / 39	21 J	70	46	29	99	na	na	na
	2 – 4	1 / 64	41	41	41	29	210	na	na	na
	> 4	0 / 23	nd	nd	nd	30	69	na	na	na
Pentachlorophenol SQS = 360 µg/kg dw CSL = 690 µg/kg dw	0 – 1	13 / 39	16 J	89 J	35	29	100	13	0	0
	0 – 2	2 / 20	18 J	730	370	29	59	1	0	1
	1 – 2	9 / 39	17 J	120 J	39	29	99	9	0	0
	2 – 4	10 / 64	18 J	190	62	29	99	10	0	0
	> 4	15 / 23	19 J	800	120	30	33	13	1	1
Phenol SQS = 420 µg/kg dw CSL = 1,200 µg/kg dw	0 – 1	14 / 39	14 J	210	94	20	160	14	0	0
	0 – 2	3 / 20	21	40	31	19	99	3	0	0
	1 – 2	10 / 39	15 J	150	60	19	130	10	0	0
	2 – 4	18 / 64	13 J	110	40	19	140	18	0	0
	> 4	0 / 23	nd	nd	nd	61	73	0	0	0

a RL range for non-detect samples.

b For samples with TOC concentrations outside the range for OC-normalization, comparisons were made to LAET and 2LAET.

c Number of samples with detected concentrations divided by the total number of samples analyzed.

d Reported mean concentrations are the average of the detected concentrations only; RLs were not included in the calculation of the mean concentrations.

e The following individual PAHs were also detected: 2-methylnaphthalene, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, fluoranthene, fluorine, indeno(1,2,3,-c,d)pyrene, naphthalene, phenanthrene, and pyrene. Results for these individual PAHs are presented in Appendix A.

f Coelutes with 3-methylphenol.

CSL – cleanup screening level

DMMP – Dredged Material Management Program

dw – dry weight

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

Table 4-3. Summary results for SVOCs detected in LDW subsurface sediment samples, cont.

J – estimated concentration

LAET – lowest apparent effects threshold

2LAET – second lowest apparent effects threshold

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

ML – maximum level

na – not applicable

nc – not calculated

nd – not detected

OC – organic carbon

SL – screening level

SMS – Sediment Management Standards

SQS – sediment quality standard

SVOC – semivolatile organic compound

Individual PAH compounds were frequently detected; 165 of the 185 samples analyzed for PAHs had at least one detected PAH compound. The highest concentration of total PAHs (57,000 µg/kg dw) was detected in the sample collected from 2 to 4 ft at location LDW-SC37. The detected concentrations of total HPAHs exceeded the SQS but not the CSL in five samples and exceeded the CSL in two samples. The detected concentrations of the LPAHs exceeded the SQS but not the CSL in three samples and exceeded the CSL in one sample. The highest concentrations of total HPAHs, total LPAHs, and total PAHs were all detected in samples 2 to 4 ft deep; the highest mean concentrations were all detected in samples greater than 4 ft deep.

Five of the six phthalates analyzed were detected in at least one sample; diethyl phthalate was not detected in any samples. Bis(2-ethylhexyl) phthalate (BEHP), the most frequently detected phthalate compound, was detected in 130 of 185 samples. The maximum concentration of BEHP was 3,900 µg/kg dw, detected in a sample collected from 2 to 4 ft at location LDW-SC10, and the same concentration was also detected in a sample collected from 1 to 2 ft at LDW-SC34. Detected concentrations of butyl benzyl phthalate and BEHP exceeded the SQS but not the CSL in 10 and 12 samples, respectively. Detected concentrations of dimethyl phthalate and BEHP exceeded the CSL in 1 and 13 samples, respectively.

Sixteen other SVOCs were detected at the following frequencies: 1,2,4-trichlorobenzene (25/185), 1,2-dichlorobenzene (24/185), 1,3-dichlorobenzene (3/185), 1,4-dichlorobenzene (49/185), 2-dimethylphenol (21/185), 2-methylphenol (29/185), 4-chloroaniline (1/185), 4-methylphenol (11/185), benzoic acid (106/185), benzyl alcohol (28/185), hexachlorobenzene (3/185), hexachlorobutadiene (1/185), n-nitroso-di-n-propylamine (7/185), pentachlorophenol (49/185), and phenol (45/185). The following SVOCs (followed by number of samples with exceedances) were detected at concentrations exceeding the SQS but not the CSL: 1,2,4-trichlorobenzene (2), benzyl alcohol (2), hexachlorobenzene (1), and pentachlorophenol (1). The following SVOCs (followed by number of samples with exceedances) were detected at concentrations exceeding the CSL: 1,2,4-trichlorobenzene (2), 1,2-dichlorobenzene (3), 2,4-dimethylphenol (1), 2-methylphenol (1), benzoic acid (2), benzyl alcohol (5), and pentachlorophenol (2).

4.1.1.4 PCB Aroclors

Table 4-4 summarizes the results for 214 subsurface sediment samples collected from 56 locations in the LDW that were analyzed for PCB Aroclors. Results are presented for both individual Aroclors and total PCBs. Data tables containing PCB Aroclor and total PCB results for all samples, including field duplicates, are presented in Appendix A.

Table 4-4 also presents the numbers of samples with detected total PCB concentrations within the following three categories: 1) ≤ SQS, 2) > SQS and ≤ CSL, and 3) > CSL.

TOC concentrations were less than 0.5% or > 4.0% in 28 of the 214 samples analyzed for PCBs; for these samples, the dry weight concentrations of PCBs were compared to the LAET and 2LAET values. Figures 4-2 and 4-3 show exceedances of PCB SMS criteria for each of the subsurface locations by depth.

Table 4-4. Summary of results for PCBs in LDW subsurface sediment samples

Analyte and SMS Criteria for Total PCBs	Assigned Sample Interval (ft)	Detection Frequency[c]	Detected Concentration (µg/kg dw)			Reporting Limit (µg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria[b]		
			Min	Max	Mean[d]	Min	Max	≤ SQS	> SQS and ≤ CSL	> CSL
Aroclor-1016	0 – 1	0 / 39	nd	nd	nd	3.9	570	na	na	na
	0 – 2	0 / 20	nd	nd	nd	3.9	350	na	na	na
	1 – 2	0 / 39	nd	nd	nd	3.8	400	na	na	na
	2 – 4	0 / 64	nd	nd	nd	3.8	900	na	na	na
	> 4	0 / 52	nd	nd	nd	3.8	310	na	na	na
Aroclor-1221	0 – 1	0 / 39	nd	nd	nd	3.9	570	na	na	na
	0 – 2	0 / 20	nd	nd	nd	3.9	350	na	na	na
	1 – 2	0 / 39	nd	nd	nd	3.8	400	na	na	na
	2 – 4	0 / 64	nd	nd	nd	3.8	900	na	na	na
	> 4	0 / 52	nd	nd	nd	3.8	310	na	na	na
Aroclor-1232	0 – 1	0 / 39	nd	nd	nd	3.9	570	na	na	na
	0 – 2	0 / 20	nd	nd	nd	3.9	350	na	na	na
	1 – 2	0 / 39	nd	nd	nd	3.8	400	na	na	na
	2 – 4	0 / 64	nd	nd	nd	3.8	900	na	na	na
	> 4	0 / 52	nd	nd	nd	3.8	310	na	na	na
Aroclor-1242	0 – 1	6 / 39	5.2	260	69	3.9	570	na	na	na
	0 – 2	5 / 20	13	1,500	560	3.9	190	na	na	na
	1 – 2	6 / 39	16	810	220	3.8	400	na	na	na
	2 – 4	10 / 64	13	1,100	270	3.8	900	na	na	na
	> 4	18 / 52	21	900	300	3.8	310	na	na	na
Aroclor-1248	0 – 1	28 / 39	5.1	1,600	210	3.9	570	na	na	na
	0 – 2	8 / 20	36	1,200	350	3.9	350	na	na	na
	1 – 2	22 / 39	5.0	820	190	3.8	330	na	na	na
	2 – 4	26 / 64	14 J	2,100	320	3.8	390	na	na	na
	> 4	5 / 52	39	710	290	3.8	310	na	na	na

Table 4-4. Summary of results for PCBs detected in LDW subsurface sediment samples, cont.

Analyte and SMS Criteria for Total PCBs	Assigned Sample Interval (ft)	Detection Frequency[c]	Detected Concentration (µg/kg dw)			Reporting Limit (µg/kg dw)[a]		No. of Detected Exceedances of SMS Criteria[b]		
			Min	Max	Mean[d]	Min	Max	≤ SQS	> SQS and ≤ CSL	> CSL
Aroclor-1254	0 – 1	39 / 39	5.7	2,400	320	na	na	na	na	na
	0 – 2	18 / 20	6.8	1,900	510	4.0	4.0	na	na	na
	1 – 2	31 / 39	8.5 J	1,100	270	3.8	19	na	na	na
	2 – 4	41 / 64	2.7 J	2,700	440	3.8	110	na	na	na
	> 4	33 / 52	4.5 J	2,600	530	3.8	40	na	na	na
Aroclor-1260	0 – 1	36 / 39	7.8	870	170	31	110	na	na	na
	0 – 2	17 / 20	6.1	840	310	4.0	120	na	na	na
	1 – 2	29 / 39	5.6	1,100	180	3.8	210	na	na	na
	2 – 4	42 / 64	7.8 J	5,400	350	3.8	4.0	na	na	na
	> 4	37 / 52	18 J	2,000	320	3.8	4.0	na	na	na
Total PCBs	0 – 1	39 / 39	13.5	4,500	650	nc	nc	15	19	5
	0 – 2	18 / 20	12.9	3,400	1,100	nc	nc	5	6	7
SQS = 12 mg/kg OC	1 – 2	32 / 39	19.6	2,700	600	nc	nc	12	12	8
CSL = 65 mg/kg OC LAET = 130 µg/kg dw	2 – 4	44 / 64	2.7 J	9,800	1,000	nc	nc	16	19	9
2LAET = 1,000 µg/kg dw	> 4	38 / 52	4.5 J	5,500	950	nc	nc	10	20	8

a RL range for non-detect samples.

b For samples with TOC concentrations outside the range for OC-normalization, comparisons were made to LAET and 2LAET.

c Number of samples with detected concentrations divided by the total number of samples analyzed.

d Reported mean concentrations are the average of the detected concentrations only; RLs were not included in the calculation of the mean concentrations.

CSL – cleanup screening level
dw – dry weight
na – not applicable
nc – not calculated
nd – not detected
J – estimated concentration

LAET – lowest apparent effects threshold
2LAET – second lowest apparent effects threshold
PCB – polychlorinated biphenyl
SMS – Sediment Management Standards
SQS – sediment quality standard

Four of the seven different Aroclors were detected in at least one sediment sample. The most frequently detected Aroclors were 1254 and 1260 (detected in 162 and 161 of the 214 samples, respectively), consistent with surface sediment data. In 43 samples, no PCB Aroclors were detected. The maximum concentration of total PCBs (9,800 µg/kg dw) was detected at location LDW-SC17 in the 2-to-4-ft interval. Total PCBs exceeded the SQS but not the CSL in 76 of the 214 samples and exceeded the CSL in 37 of the 214 samples.

4.1.1.5 Organochlorine pesticides

Chemical analyses were conducted for organochlorine pesticides in 40 subsurface sediment samples collected from 15 locations in the LDW. Only one pesticide, delta-hexachlorocyclohexane (delta-BHC), was detected. This pesticide was detected in cores collected from two locations, LDW-SC23 and LDW-SC34, at concentrations ranging from 7.0 to 1,100 ug/kg dw (Table 4-5). Delta-BHC was also detected in samples from the field replicate core associated with LDW-SC34. There are no SMS criteria for pesticides, and there are no DMMP guidelines for delta-BHC. Some of the reporting limits for pesticides exceeded the DMMP guidelines for pesticides (Figure 4-3). These reporting limits were elevated because of analytical interference in the quantification of organochlorine pesticides from the presence of PCBs.

Table 4-5. Results for delta-BHC in LDW subsurface sediment samples

Sampling Location	Assigned Sample Interval (ft)	Concentration (µg/kg dw)
LDW-SC23	0 – 2	1,100
	2 – 4	8.3
LDW-SC34	0 – 1	7.0
	1 – 2	19
	2 – 4	0.96 U
LDW-SC203 (replicate of LDW-SC34)	0 – 1	23
	1 – 2	60
	2 – 4	29

BHC – benzene hexachloride

dw – dry weight

LDW – Lower Duwamish Waterway

U – not detected at reporting limit presented

4.1.1.6 Dioxins and furans

Chemical analyses were conducted for dioxins and furans in 26 subsurface sediment samples collected from eight locations in the LDW. Dioxins and furans were detected in all of the samples analyzed. Toxic equivalents (TEQs) of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) were calculated using mammalian toxic equivalency factors for dioxin and furan congeners from Van den Berg et al.(Van den Berg et al. 2006). These TEQs were calculated using half the RL as the selected value for undetected congeners.

Results for 2,3,7,8-TCDD TEQs are presented in Table 4-6. TEQs ranged from 0.147 to 194 ng/kg dw. The highest concentration (194 ng/kg dw) was detected at the 4-to-6-ft interval in the core from location LDW-SC20. Data tables containing dioxin and furan results for individual congeners for all samples are presented in Appendix A.

Table 4-6. Summary of 2,3,7,8-TCDD TEQ results in LDW subsurface sediment samples

Sampling Location	Assigned Sample Interval (ft)	TEQ (ng/kg dw)
LDW-SC19	0 – 1	22.8 J
	1 – 2	20.1 J
	2 – 4	20.5 J
LDW-SC20	0 – 2	38.7 J
	2 – 4	27.1 J
	4 – 6	194 J
	8 – 10	5.60 J
LDW-SC26	0 – 1	15.9 J
	1 – 2	13.1 J
	2 – 4	22.4 J
	6 – 8	136 J
LDW-SC28	0 – 1	19.9 J
	1 – 2	14.8
	2 – 4	18.5 J
LDW-SC29	0 – 1	54.1 J
	1 – 2	1.03 J
	2 – 4	0.147 J
LDW-SC39	0 – 1	7.91 J
	1 – 2	12.4 J
	2 – 4	13.1 J
LDW-SC40	0 – 1	6.71 J
	1 – 2	0.485 J
	2 – 4	0.355 J
LDW-SC41	0 – 1	13.8
	1 – 2	12.5 J
	2 – 4	14.0 J

dw – dry weight

J – estimated concentration

LDW – Lower Duwamish Waterway

TCDD – tetrachlorodibenzo-*p*-dioxin

TEQ – toxic equivalent

4.1.1.7 VOCs

In the sediment core collected from LDW-SC49a, elevated PID readings of 500 units were obtained at the 10.5-ft depth of the core during field processing, although PID readings taken at 0.5 ft, 3 ft, 4.5 ft, and 8 ft were within the ambient background level of 5 units or less. As a result, a second sediment core (LDW-SC49b) was collected from the same location so that unhomogenized samples could be analyzed for VOCs. Samples were collected at 1-ft intervals throughout the 12-ft core and analyzed for VOCs. Twenty-two VOCs were detected in these samples, with the highest concentrations generally at depths from 9 to 12 ft (Table 4-7). The VOCs detected at the highest concentrations were cis-1,2-dichloroethene (200,000 µg/kg dw at 10 to 11 ft and 140,000 µg/kg dw at 11 to 12 ft) and vinyl chloride (60,000 µg/kg dw at 11 to 12 ft and 47,000 µg/kg dw at 10 to 11 ft). Hexachlorobutadiene exceeded the AET but not the 2LAET in the sample collected from the 9-to-10-ft interval. The ML was exceeded for ethylbenzene and total xylenes in the samples collected in the 9-to-10- and 10-to-11-ft intervals. The SL was exceeded but not the ML for these two chemicals in the 11-to-12-ft interval. The complete results for the VOC analyses are presented in Table A-4 of Appendix A. VOCs were not detected in the upper sample intervals, with the exception of acetone and methyl ethyl ketone, which were detected at relatively low concentrations. Although acetone and methyl ethyl ketone are common laboratory contaminants, these chemicals were not detected in any method blank associated with the reported results.

Table 4-7. Results for VOCs detected in subsurface sediment samples collected at LDW-SC49b

Analyte and AETs or DMMP Guidelines if Available	Sample Interval (ft)[a]											
	0–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	10–11	11–12
1,1-Dichloroethene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	1.7 U	320	120
1,2,4-Trimethylbenzene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	420	580 J	14 J
1,3,5-Trimethylbenzene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9	180	350 J	11 J
Acetone	59	40	41	38	94	100	120	190	440	550	640	630
Benzene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	4.4	12	41	62	38
Carbon disulfide	2.0 U	4.0	6.3	3.0	1.7 U	2.2	1.6 U	2.8	5.3	1.9	10	3.0
cis-1,2-Dichloroethene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	2.2	8.1	16	46	200,000	140,000
p-Cymene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	4.5	100	130 J	4.1 J
Dichloromethane	4.0 U	3.3 U	3.7 U	3.1 U	3.3 U	3.3 U	3.3 U	3.8 U	3.7 U	3.4 U	3.2 U	3.0
Ethylbenzene SL = 10 µg/kg dw ML = 50 µg/kg dw	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	**<u>240</u>**	**<u>360 J</u>**	**27**
Hexachlorobutadiene LAET = 3.9 µg/kg dw 2LAET= 6.2 µg/kg dw	9.9 U	8.3 U	9.2 U	7.8 U	8.3 U	8.3 U	8.2 U	9.5 U	9.5 U	**13**	8.1 UJ	7.4 UJ
Isopropylbenzene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	72	87 J	3.9 J
Methyl ethyl ketone	21	13	12	12	28	26	30	49	100	100	8.1 U	7.4 U
Methyl isobutyl ketone	9.9 U	8.3 U	9.2 U	7.8 U	8.3 U	8.3 U	8.2 U	9.5 U	9.4 U	8.4 U	8.1 U	7.8
Naphthalene LAET= 99 µg/kg dw 2LAET = 170 µg/kg dw	9.9 U	8.3 U	9.2 U	7.8 U	8.3 U	8.3 U	8.2 U	9.5 U	9.5 U	18	26 J	7.4 UJ
n-Butylbenzene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 UJ	58	78 J	1.5 UJ
n-Propylbenzene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	68	100 J	1.8 J
sec-Butylbenzene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	57	57 J	1.5 UJ

Analyte and AETs or DMMP Guidelines if Available	Sample Interval (ft)[a]											
	0–1	**1–2**	**2–3**	**3–4**	**4–5**	**5–6**	**6–7**	**7–8**	**8–9**	**9–10**	**10–11**	**11–12**
tert-Butylbenzene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	6.1	8.0 UJ	1.5 UJ
Toluene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.8	2.0	40	2,500	8,300	2,300
trans-1,2-Dichloroethene	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	22	1,700 J	980 J
Trichloroethene SL = 160 µg/kg dw ML = 1,600 µg/kg dw	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	1.7 U	12	6.5
Vinyl chloride	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	5.6 U	29	44	450	47,000	60,000
Xylene (ortho)	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	490	610 J	31
Xylene (meta and para)	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	1,200	4,700	74 J
Total Xylenes (calculated) SL = 40 µg/kg dw ML = 160 µg/kg dw	2.0 U	1.7 U	1.8 U	1.6 U	1.7 U	1.7 U	1.6 U	1.9 U	1.9 U	<u>**1,700**</u>	<u>**5,300 J**</u>	**105** J

[a] Sample intervals presented in this table are based on recovered depths.

AET – apparent effects threshold

DMMP – Dredged Material Management Program

dw – dry weight

LAET – lowest apparent effects threshold

2LAET – second lowest apparent effects threshold

ML – maximum level

SL – screening level

J – estimated concentration

U – not detected at reporting limit shown

UJ – not detected at estimated reporting limit shown

Concentration in **bold** indicates SQS/SL exceedance.

Concentration in <u>**bold underline**</u> indicates CSL/ML exceedance.

4.1.1.8 Grain size, TOC, and total solids

Table 4-8 summarizes grain size, TOC, and total solids results for subsurface sediment samples collected from 56 locations in the LDW. Samples from depth intervals greater than 4 ft were not analyzed for grain size because these intervals were analyzed in samples that had been previously frozen, which would affect grain size results. Samples from LDW-SC49b (core collected only for the analysis of VOCs) were not analyzed for grain size or TOC. Data tables containing results for each sample, including field replicates, are presented in Appendix A.

Table 4-8. Summary of grain size, TOC, and total solids results in LDW subsurface sediment samples

Analyte	Assigned Sample Interval (ft)	Number of Samples	Unit	Min	Max	Mean
Grain size						
Gravel	0 – 1	39	% dw	0.1	30.9	5
	0 – 2	20	% dw	0.1	29.7	6
	1 – 2	39	% dw	0.1	44.4	4
	2 – 4	64	% dw	0.1	40.6	5
Sand	0 – 1	39	% dw	10.8	89.2	38
	0 – 2	20	% dw	2.8	94.4	35
	1 – 2	39	% dw	5.8	97.4	37
	2 – 4	64	% dw	3.4	99.2	48
Silt	0 – 1	39	% dw	7.8	66.1	42
	0 – 2	20	% dw	3.4	82.8	46
	1 – 2	39	% dw	1.1	69.1	45
	2 – 4	64	% dw	0.5	84.7	40
Clay	0 – 1	39	% dw	2.7	31.1	15
	0 – 2	20	% dw	1.3	26.3	15
	1 – 2	39	% dw	0.7	31.9	10
	2 – 4	64	% dw	0.6	39.9	10
Fines (sum of silt and clay fractions)	0 – 1	39	% dw	10.5	88.3	57
	0 – 2	20	% dw	4.7	97.2	61
	1 – 2	39	% dw	1.8	94.0	59
	2 – 4	64	% dw	1.2	96.5	48

Analyte	Assigned Sample Interval (ft)	Number of Samples	Unit	Min	Max	Mean
Conventional parameters						
TOC	0 – 1	39	% dw	0.630	4.23	1.95
	0 – 2	20	% dw	0.541	3.46	1.91
	1 – 2	39	% dw	0.304	3.93	1.70
	2 – 4	64	% dw	0.074	6.88	1.7
	> 4	52	% dw	0.092	3.24	1.5
Total solids[a]	0 – 1	39	% ww	42.60	76.60	57.78
	0 – 2	20	% ww	46.38	80.20	60.86
	1 – 2	39	% ww	37.40	82.60	60.35
	2 – 4	64	% ww	38.50	85.10	65.26
	> 4	52	% ww	47.60	83.40	64.24

[a] Samples from LDW-SC49b were analyzed for total solids, but those results are not included in this table because samples were collected at 1-ft intervals. Results for totals solids in LDW-SC49b are presented in Table A-4 in Appendix A.

dw – dry weight

LDW – Lower Duwamish Waterway

TOC – total organic carbon

ww – wet weight

Percent fines in subsurface sediment samples ranged from 1.2 to 97.2%, with mean concentrations in the various depth intervals ranging from 48 to 61%. The highest percent fines concentration was 97.2% in a sample collected at the 0-to-2-ft interval at location LDW-SC53. TOC ranged from 0.074 to 6.88%, with mean concentrations in depth intervals ranging from 1.5 to 1.95%. Twenty-four samples had TOC contents of less than 0.5%, and 4 samples had TOC contents higher than 4.0%. The highest TOC concentration was 6.88% in a sample collected at the 2-to-4-ft interval at location LDW-SC45. Total solids ranged from 37.40 to 85.10%. The mean total solids exhibited a fairly narrow range (57.78 to 65.26%).

4.1.2 Summary of results by location

This section summarizes the analytical results for each location. Results for the 1-ft and 2-ft core intervals (from both Method A and B cores) are discussed first in Section 4.1.2.1. Results for the 0.5-ft core intervals from the Method B cores are then presented and compared to results for the associated 2-ft intervals from those cores in Section 4.1.2.2. A discussion of analytical variability at the three locations where field duplicates were collected is presented in Section 4.1.2.3.

4.1.2.1 1- and 2-ft core interval results

Table 4-9 summarizes the detected concentrations of chemicals that exceeded SMS criteria or DMMP guidelines for each location. Of the 56 locations, 44 had at least one sample with an exceedance of an SMS criterion or DMMP guideline. No exceedances were detected at 12 locations (LDW-SC3, LDW-SC18, LDW-SC22, LDW-SC29, LDW-SC30, LDW-SC36, LDW-SC42, LDW-SC43, LDW-SC48, LDW-SC53, LDW-SC54, and LDW-SC55). The locations with the highest number of chemical exceedances were LDW-SC17 (46 exceedances), LDW-SC37 (36 exceedances, LDW-SC26 (29 exceedances), LDW-SC28 (16 exceedances), and LDW-SC8 (15 exceedances).

As discussed in Section 3.1, three rounds of analyses were conducted to characterize sediment at depth. Samples at each location were analyzed as necessary until a depth interval was reached with no exceedances of SMS criteria or DMMP guidelines; the remaining deeper samples, if any, were archived. As shown in Table 4-9, there were seven cores in which there was an exceedance in the deepest core sample collected (LDW-SC8, LDW-SC10, LDW-SC17, LDW-SC26, LDW-SC28, LDW-SC41, and LDW-SC49). In these cores, it is not possible to determine whether there are exceedances below the depth of the core.

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location

Sample Interval (ft) Recovered Depth	Sample Interval (ft) In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines CSL/ML	AET Substitution[b]
LDW-SC1								
0 – 2	0 – 2.1	SMS chemicals	mercury	0.61	mg/kg dw	1.5	1.0	no
			bis(2-ethylhexyl) phthalate	86	mg/kg OC	1.8	1.1	no
			total PCBs	160	mg/kg OC	13	2.5	no
2 – 4	2.1 – 4.1	SMS chemicals	total PCBs	28	mg/kg OC	2.3	0.43	no
4 – 6	4.1 – 6.6	PCBs	ne	ne	ne	ne	ne	yes
LDW-SC2								
0 – 2	0 – 2.4	SMS chemicals and pesticides	arsenic	190	mg/kg dw	3.3	2.0	no
			lead	569	mg/kg dw	1.3	1.1	no
			zinc	748	mg/kg dw	1.8	0.78	no
			bis(2-ethylhexyl) phthalate	100	mg/kg OC	2.1	1.3	no
			total PCBs	150	mg/kg OC	13	2.3	no
2 – 4	2.4 – 4.1	SMS chemicals and pesticides	arsenic	210	mg/kg dw	3.7	2.3	no
			lead	1,050	mg/kg dw	2.3	2.0	no
			zinc	604	mg/kg dw	1.5	0.63	no
			bis(2-ethylhexyl) phthalate	1,800	µg/kg dw	1.4	0.95	yes
			total PCBs	2,900	µg/kg dw	22	2.9	yes
4 – 6	4.1 – 6	SMS chemicals (excluding mercury)	arsenic	270	mg/kg dw	4.7	2.9	no
			lead	1,210	mg/kg dw	2.7	2.3	no
			zinc	1,430	mg/kg dw	3.5	1.5	no
			total PCBs	209	µg/kg dw	1.6	0.21	yes
6 – 8	6 – 8	archived						
8 – 10	8 – 10	archived						
10 – 10.7	10 – 10.7	archived						
10.7 – 12	10.7 – 12	SMS chemicals (excluding mercury)	ne	ne	ne	ne	ne	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
12 – 13	12 – 13.1	archived						
LDW-SC3								
0 – 2	0 – 2.1	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.1 – 4.1	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 6	4.1 – 6.5	archived						
6 – 8	6.5 – 9.1	archived						
LDW-SC4								
0 – 1	0 – 1.1	SMS chemicals	mercury	0.53 J	mg/kg dw	1.3	0.90	no
1 – 2	1.1 – 2.2	SMS chemicals	arsenic	63	mg/kg dw	1.1	0.68	no
			mercury	0.43 J	mg/kg dw	1.0	0.73	no
			total PCBs	25	mg/kg OC	2.1	0.38	no
2 – 4	2.2 – 4.2	SMS chemicals	2,4-dimethylphenol	46	µg/kg dw	1.6	1.6	no
			total PCBs	35	mg/kg OC	2.9	0.54	no
4 – 6	4.2 – 6.1	PCBs	ne	ne	ne	ne	ne	no
6 – 7.7	6.1 – 9.0	archived						
LDW-SC5								
0 – 1	0 – 1.1	SMS chemicals	total PCBs	30	mg/kg OC	2.5	0.46	no
1 – 2.2	1.1 – 2.4	SMS chemicals	mercury	0.51	mg/kg dw	1.2	0.86	no
2.2 – 4	2.4 – 4.3	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 6.2	4.3 – 6.8	archived						
LDW-SC6								
0 – 2	0 – 2.2	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4.5	2.2 – 4.8	SMS chemicals	mercury	0.44	mg/kg dw	1.1	0.75	no
			bis(2-ethylhexyl) phthalate	67	mg/kg OC	1.4	0.86	no
			total PCBs	99	mg/kg OC	8.3	1.5	no
4.5 – 6	4.8 – 6.2	archived						
6 – 8	6.2 – 9.9	SMS chemicals	ne	ne	ne	ne	ne	no
8 – 8.5	9.9 – 11	archived						

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
LDW-SC7								
0 – 1	0 – 1	SMS chemicals and pesticides	mercury	0.47	mg/kg dw	1.1	0.80	no
			bis(2-ethylhexyl) phthalate	59	mg/kg OC	1.3	0.76	no
			total PCBs	64	mg/kg OC	5.3	0.98	no
1 – 1.7	1 – 1.8	SMS chemicals and pesticides	total PCBs	150 J	mg/kg OC	13	2.3	no
1.7 – 4	1.8 – 4.7	SMS chemicals and pesticides	ne	ne	ne	ne	ne	yes
4 – 6.5	4.7 – 6.9	archived						
6.5 – 8	6.9 – 8.8	archived						
8 – 8.7	8.8 - 11	archived						
LDW-SC8								
0 – 1	0 – 1.4	SMS chemicals and pesticides	total PCBs	15	mg/kg OC	1.3	0.23	no
1 – 2	1.4 – 2.4	SMS chemicals and pesticides	mercury	0.48	mg/kg dw	1.2	0.81	no
			total PCBs	90	mg/kg OC	7.5	1.4	no
2 – 4	2.4 – 4.4	SMS chemicals and pesticides	mercury	0.45	mg/kg dw	1.1	0.76	no
			bis(2-ethylhexyl) phthalate	110	mg/kg OC	2.3	1.4	no
			total PCBs	210	mg/kg OC	18	3.2	no
4 – 6	4.4 – 7.9	SMS chemicals	arsenic	62	mg/kg dw	1.1	0.67	no
			mercury	0.77	mg/kg dw	1.9	1.3	no
			zinc	527	mg/kg dw	1.3	0.55	no
			bis(2-ethylhexyl) phthalate	140	mg/kg OC	3.0	1.8	no
			total PCBs	350	mg/kg OC	29	5.4	no
6 – 8	7.9 – 11.4	SVOCs and PCBs	bis(2-ethylhexyl) phthalate	71	mg/kg OC	1.5	0.91	no
			total PCBs	190	mg/kg OC	16	2.9	no
8 – 10	11.4 – 14.6	SMS chemicals	mercury	0.89	mg/kg dw	2.2	1.5	no
			total PCBs	28	mg/kg OC	2.3	0.43	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	*In Situ* Depth					SQS/SL	CSL/ML	
LDW-SC9								
0 – 1	0 – 1.3	SMS chemicals and pesticides	mercury	0.42	mg/kg dw	1.0	0.71	no
			bis(2-ethylhexyl) phthalate	100	mg/kg OC	2.1	1.3	no
			1,2,4-trichlorobenzene	1.1 J	mg/kg OC	1.4	0.61	no
			benzyl alcohol	140 J	µg/kg dw	2.5	1.9	no
			total PCBs	220	mg/kg OC	18	3.4	no
1 – 2.6	1.3 – 2.6	SMS chemicals and pesticides	cadmium	5.9	mg/kg dw	1.2	0.88	no
			mercury	1.28	mg/kg dw	3.1	2.2	no
			silver	7.5	mg/kg dw	1.2	1.2	no
			bis(2-ethylhexyl) phthalate	49 J	mg/kg OC	1.0	0.63	no
			1,2,4-trichlorobenzene	0.89 J	mg/kg OC	1.1	0.49	no
			total PCBs	110	mg/kg OC	9.2	1.7	no
2.6 – 4	2.6 – 3.7	SMS chemicals and pesticides	ne	ne	ne	ne	ne	no
4 – 6.4	3.7 – 7.8	archived						
6.4 – 8.5	7.8 – 12.9	archived						
LDW-SC10								
0 – 1	0 – 1.1	SMS chemicals and pesticides	bis(2-ethylhexyl) phthalate	65	mg/kg OC	1.4	0.83	no
			total PCBs	14 J	mg/kg OC	1.2	0.22	no
1 – 2	1.1 – 2	SMS chemicals and pesticides	bis(2-ethylhexyl) phthalate	130	mg/kg OC	2.8	1.7	no
			butyl benzyl phthalate	7.2	mg/kg OC	1.5	0.11	no
			total PCBs	13	mg/kg OC	1.1	0.20	no
2 – 4	2 – 4.1	SMS chemicals and pesticides	mercury	0.74	mg/kg dw	1.8	1.3	no
			bis(2-ethylhexyl) phthalate	130	mg/kg OC	2.8	1.7	no
			butyl benzyl phthalate	6.1	mg/kg OC	1.2	0.095	no
			total PCBs	38	mg/kg OC	3.2	0.58	no
4 – 5	4.1 – 5.2	SVOCs, PCBs, and mercury	total PCBs	39	mg/kg OC	3.3	0.60	no
5 – 6	5.2 - 6	archived						

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft) Recovered Depth	Sample Interval (ft) In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines CSL/ML	AET Substitution[b]
6 – 8	6 – 8.8	PCBs	total PCBs	35	mg/kg OC	2.9	0.54	no
LDW-SC11								
0 – 0.8	0 – 0.9	SMS chemicals	lead	639	mg/kg dw	1.4	1.2	no
			mercury	0.64	mg/kg dw	1.6	1.1	no
			zinc	482	mg/kg dw	1.2	0.50	no
			benzo(a)anthracene	3,600	µg/kg dw	2.8	2.3	yes
			benzo(a)pyrene	3,100	µg/kg dw	1.9	1.0	yes
			total benzofluoranthenes	7,600	µg/kg dw	2.4	2.1	yes
			chrysene	4,300	µg/kg dw	3.1	1.5	yes
			fluoranthene	8,100	µg/kg dw	4.8	3.2	yes
			indeno(1,2,3-cd)pyrene	670	µg/kg dw	1.1	0.97	yes
			pyrene	6,700	µg/kg dw	2.6	2.0	yes
			total HPAH	34,700	µg/kg dw	2.9	2.0	yes
			total PCBs	3,000	µg/kg dw	23	3.0	yes
0.8 – 2	0.9 – 2.3	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 3.4	2.3 – 4.1	SMS chemicals	ne	ne	ne	ne	ne	yes
3.4 – 4.1	4.1 – 4.9	SMS chemicals	ne	ne	ne	ne	ne	yes
4.1 – 5	4.9 – 5.9	archived						
LDW-SC12								
0 – 2	0 – 2	SMS chemicals	total PCBs	18	mg/kg OC	1.5	0.28	no
2 – 4	2 – 4.1	SMS chemicals	mercury	0.45	mg/kg dw	1.1	0.76	no
			total PCBs	160	mg/kg OC	13	2.5	no
4 – 6.6	4.1 – 6.9	mercury and PCBs	mercury	0.74	mg/kg dw	1.8	1.3	no
			total PCBs	22	mg/kg OC	1.8	0.34	no
6.6 – 8.7	6.9 – 9.6	mercury and PCBs	ne	ne	ne	ne	ne	no
LDW-SC13								
0 – 2	0 – 2.1	SMS chemicals	total PCBs	14	mg/kg OC	1.2	0.22	no
2 – 4	2.1 – 4.2	SMS chemicals	ne	ne	ne	ne	ne	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
4 – 6	4.2 – 7.1	archived						
6 – 8	7.1 – 9.8	archived						
8 – 9.5	9.8 – 11.8	archived						
LDW-SC14								
0 – 1.4	0 – 1.4	SMS chemicals and pesticides	mercury	0.71	mg/kg dw	1.7	1.2	no
			bis(2-ethylhexyl) phthalate	70	mg/kg OC	1.5	0.90	no
			butyl benzyl phthalate	5.8	mg/kg OC	1.2	0.091	no
			total PCBs	260	mg/kg OC	22	4.0	no
1.4 – 2	1.4 – 2	SMS chemicals and pesticides	mercury	0.51	mg/kg dw	1.2	0.86	no
			total PCBs	130	mg/kg OC	11	2.0	no
2 – 4.1	2 – 4.1	SMS chemicals and pesticides	mercury	0.7	mg/kg dw	1.7	1.2	no
			butyl benzyl phthalate	6.4	mg/kg OC	1.3	0.10	no
			total PCBs	90	mg/kg OC	7.5	1.4	no
4.1 – 6	4.1 – 5.8	SVOCs, PCBs, and mercury	mercury	0.68	mg/kg dw	1.7	1.2	no
			total PCBs	23	mg/kg OC	1.9	0.35	no
6 – 8.6	5.8 – 8.8	mercury and PCBs	mercury	0.42	mg/kg dw	1.0	0.71	no
8.6 – 10	8.8 – 10.1	archived						
10 – 11	10.1 – 11.2	mercury and PCBs	ne	ne	ne	ne	ne	yes
LDW-SC15								
0 – 1	0 – 1.2	SMS chemicals	total PCBs	15	mg/kg OC	1.3	0.23	no
1 – 2	1.2 – 2	SMS chemicals	total PCBs	17 J	mg/kg OC	1.4	0.26	no
2 – 4	2 – 4.1	SMS chemicals	total PCBs	31	mg/kg OC	2.6	0.48	no
4 – 6	4.1 – 7.1	PCBs	total PCBs	89	mg/kg OC	7.4	1.4	no
6 – 8	7.1 – 9.5	archived						
8 – 10	9.5 – 12.4	PCBs	ne	ne	ne	ne	ne	yes
LDW-SC16								
0 – 2	0 – 2.2	SMS chemicals	fluoranthene	230	mg/kg OC	1.4	0.19	no
			total PCBs	16 J	mg/kg OC	1.3	0.25	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft) Recovered Depth	Sample Interval (ft) In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines CSL/ML	AET Substitution[b]
2 – 4	2.2 – 4.1	SMS chemicals	mercury	0.85	mg/kg dw	2.1	1.4	no
			zinc	428	mg/kg dw	1.0	0.45	no
			bis(2-ethylhexyl) phthalate	100	mg/kg OC	2.1	1.3	no
			total PCBs	180	mg/kg OC	15	2.8	no
4 – 6	4.1 – 6.1	SMS chemicals	mercury	0.98	mg/kg dw	2.4	1.7	no
			fluoranthene	220	mg/kg OC	1.4	0.18	no
			total HPAH	980	mg/kg OC	1.0	0.18	no
			bis(2-ethylhexyl) phthalate	71	mg/kg OC	1.5	0.91	no
			total PCBs	150	mg/kg OC	13	2.3	no
6 – 8	6.1 – 9.6	archived						
8 – 10	9.6 – 11.3	SMS chemicals	ne	ne	ne	ne	ne	no
10 – 10.8	11.3 – 13.5	archived						
LDW-SC17								
0 – 1	0 – 1.5	SMS chemicals	arsenic	110	mg/kg dw	1.9	1.2	no
			mercury	0.5	mg/kg dw	1.2	0.85	no
			zinc	1,260	mg/kg dw	3.1	1.3	no
			benzyl alcohol	140	µg/kg dw	2.5	1.9	no
			total PCBs	40	mg/kg OC	3.3	0.62	no
1 – 2	1.5 – 3	SMS chemicals	arsenic	170	mg/kg dw	3.0	1.8	no
			cadmium	7.6	mg/kg dw	1.5	1.1	no
			mercury	0.6	mg/kg dw	1.5	1.0	no
			zinc	2,050	mg/kg dw	5.0	2.1	no
			fluoranthene	170	mg/kg OC	1.1	0.14	no
			total PCBs	32	mg/kg OC	2.7	0.49	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
2 – 4	3 – 6	SMS chemicals	arsenic	60	mg/kg dw	1.1	0.65	no
			cadmium	15	mg/kg dw	2.9	2.2	no
			chromium	386	mg/kg dw	1.5	1.4	no
			lead	1,740	mg/kg dw	3.9	3.3	no
			mercury	1.29	mg/kg dw	3.1	2.2	no
			nickel	226	mg/kg dw	1.6	0.61	no
			zinc	3,840	mg/kg dw	9.4	4.0	no
			2-methylnaphthalene	4,500	µg/kg dw	6.7	3.2	yes
			acenaphthene	4,600	µg/kg dw	9.2	6.3	yes
			anthracene	1,900	µg/kg dw	2.0	0.43	yes
			benzo(a)anthracene	1,500	µg/kg dw	1.2	0.94	yes
			chrysene	1,800	µg/kg dw	1.3	0.64	yes
			dibenzofuran	1,700	µg/kg dw	3.1	2.4	yes
			fluoranthene	7,400	µg/kg dw	4.4	3.0	yes
			fluorene	4,300	µg/kg dw	8.0	4.3	yes
			naphthalene	3,400	µg/kg dw	1.6	1.4	yes
			phenanthrene	13,000	µg/kg dw	8.7	2.4	yes
			pyrene	5,700	µg/kg dw	2.2	1.7	yes
			total HPAH	20,400 J	µg/kg dw	1.7	1.2	yes
			total LPAH	27,000 J	µg/kg dw	5.2	2.1	yes
			bis(2-ethylhexyl) phthalate	2,300	µg/kg dw	1.8	1.2	yes
			1,2,4-trichlorobenzene	110 J	µg/kg dw	3.5	2.2	yes
			benzoic acid	3,000 J	µg/kg dw	4.6	4.6	no
			total PCBs	9,800	µg/kg dw	75	9.8	yes
4 – 6	6 – 9.1	archived						

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft) Recovered Depth	Sample Interval (ft) In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines CSL/ML	AET Substitution[b]
6 – 8.6	9.1 – 13	SMS chemicals	arsenic	76	mg/kg dw	1.3	0.82	no
			cadmium	20.4	mg/kg dw	4.0	3.0	no
			lead	470	mg/kg dw	1.0	0.89	no
			mercury	0.75	mg/kg dw	1.8	1.3	no
			zinc	4,550	mg/kg dw	11	4.7	no
			acenaphthene	37	mg/kg OC	2.3	0.65	no
			dibenzofuran	22	mg/kg OC	1.5	0.38	no
			fluoranthene	220	mg/kg OC	1.4	0.18	no
			fluorene	43	mg/kg OC	1.9	0.54	no
			phenanthrene	130	mg/kg OC	1.3	0.27	no
			total PCBs	59	mg/kg OC	4.9	0.91	no
LDW-SC18								
0 – 1	0 – 1.4	SMS chemicals	ne	ne	ne	ne	ne	no
1 – 2	1.4 – 2.5	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.5 – 4.3	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 6	4.3 – 6.5	archived						
6 – 8	6.5 – 8.5	archived						
8 – 10.7	8.5 – 11.8	archived						
LDW-SC19								
0 – 1	0 – 1.1	SMS chemicals	ne	ne	ne	ne	ne	no
1 – 2	1.1 – 2.1	SMS chemicals	total PCBs	14	mg/kg OC	1.2	0.22	no
2 – 4	2.1 – 4.3	SMS chemicals	total PCBs	16	mg/kg OC	1.3	0.25	no
4 – 6	4.3 – 6.4	PCBs	total PCBs	35	mg/kg OC	2.9	0.54	no
6 – 7	6.4 – 7.53	PCBs	total PCBs	160	mg/kg OC	13	2.5	no
7 – 9	7.53 – 9.68	archived						
9 – 11.9	9.68 – 13	PCBs	ne	ne	ne	ne	ne	yes
LDW-SC20								
0 – 2	0 – 2	SMS chemicals and	mercury	0.65	mg/kg dw	1.6	1.1	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
		pesticides	total PCBs	210	mg/kg OC	18	3.2	no
2 – 4	2 – 4	SMS chemicals and pesticides	total PCBs	40	mg/kg OC	3.3	0.62	no
4 – 6	4 – 6.9	PCBs	total PCBs	18	mg/kg OC	1.5	0.28	no
6 – 8	6.9 – 9.4	archived						
8 – 10	9.4 – 12.6	PCBs	ne	ne	ne	ne	ne	no
LDW-SC21								
0 – 1	0 – 1.1	SMS chemicals	total PCBs	13	mg/kg OC	1.1	0.20	no
1 – 2	1.1 – 2.1	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.1 – 4	SMS chemicals	total PCBs	23 J	mg/kg OC	1.9	0.35	no
4 – 6.2	4 – 6.5	PCBs	total PCBs	87	mg/kg OC	7.3	1.3	no
6.2 – 8	6.5 – 8	archived						
8 – 10	8 – 10.4	archived						
10 – 11.3	10.4 – 12.7	PCBs	ne	ne	ne	ne	ne	no
LDW-SC22								
0 – 1.1	0 – 1.3	SMS chemicals	ne	ne	ne	ne	ne	no
1.1 – 2	1.3 – 2.2	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.2 – 4.2	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 6	4.2 – 6.1	archived						
6 – 7.7	6.1 – 9.3	archived						
LDW-SC23								
0 – 2	0 – 2.1	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.1 – 4.8	SMS chemicals and pesticides	benzo(a)anthracene	150	mg/kg OC	1.4	0.56	no
			benzo(a)pyrene	120	mg/kg OC	1.2	0.57	no
			total benzofluoranthenes	280	mg/kg OC	1.2	0.62	no
			chrysene	340	mg/kg OC	3.1	0.74	no
			fluoranthene	350 J	mg/kg OC	2.2	0.29	no
			total HPAH	1,500 J	mg/kg OC	1.6	0.28	no
			bis(2-ethylhexyl) phthalate	75	mg/kg OC	1.6	0.96	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft) Recovered Depth	Sample Interval (ft) In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines CSL/ML	AET Substitution[b]
4 – 6	4.8 – 6.4	SVOCs and PCBs	total PCBs	60	mg/kg OC	5.0	0.92	no
6 – 8	6.4 – 7.7	PCBs	total PCBs	18	mg/kg OC	1.5	0.28	no
8 – 10.2	7.7 – 11.9	PCBs	ne	ne	ne	ne	ne	no
LDW-SC24								
0 – 1	0 – 1.3	SMS chemicals	total PCBs	14	mg/kg OC	1.2	0.22	no
1 – 2	1.3 – 2.3	SMS chemicals	ne	ne	ne	ne	ne	yes
2 – 4	2.3 – 4.2	SMS chemicals	ne	ne	ne	ne	ne	yes
4 – 6	4.2 – 6.2	archived						
6 – 8	6.2 – 7.8	archived						
8 – 10	7.8 - 10	archived						
LDW-SC25								
0 – 1	0 – 1.5	SMS chemicals	total PCBs	16	mg/kg OC	1.3	0.25	no
1 – 2	1.5 – 2.4	SMS chemicals	arsenic	91	mg/kg dw	1.6	0.98	no
			zinc	503	mg/kg dw	1.2	0.52	no
			total PCBs	24	mg/kg OC	2.0	0.37	no
2 – 4	2.4 – 4.4	SMS chemicals	arsenic	170	mg/kg dw	3.0	1.8	no
			copper	541	mg/kg dw	1.4	1.4	no
			zinc	750	mg/kg dw	1.8	0.78	no
			total PCBs	25	mg/kg OC	2.1	0.38	no
4 – 6	4.4 – 6.6	metals (excluding mercury) and PCBs	arsenic	250	mg/kg dw	4.4	2.7	no
			copper	663	mg/kg dw	1.7	1.7	no
			zinc	1,420	mg/kg dw	3.5	1.5	no
			total PCBs	49 J	mg/kg OC	4.1	0.75	no
6 – 8	6.6 – 9.3	archived						
8 – 9.1	9.3 – 10.3	metals (excluding mercury) and PCBs	ne	ne	ne	ne	ne	yes
LDW-SC26								
0 – 1	0 – 1.2	SMS chemicals	total PCBs	20	mg/kg OC	1.7	0.31	no
1 – 2	1.2 – 2.3	SMS chemicals	ne	ne	ne	ne	ne	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
2 – 4	2.3 – 4.2	SMS chemicals	arsenic	67	mg/kg dw	1.2	0.72	no
			copper	544	mg/kg dw	1.4	1.4	no
			mercury	0.69 J	mg/kg dw	1.7	1.2	no
			total PCBs	15	mg/kg OC	1.3	0.23	no
4 – 6	4.2 – 6.6	archived						
6 – 8	6.6 – 8.9	SMS chemicals	antimony	280 J	mg/kg dw	1.9	1.4	no
			arsenic	1,890	mg/kg dw	33	20	no
			copper	1,950	mg/kg dw	5.0	5.0	no
			lead	1,350	mg/kg dw	3.0	2.5	no
			mercury	4.34	mg/kg dw	11	7.4	no
			zinc	3,700	mg/kg dw	9.0	3.9	no
			acenaphthene	48	mg/kg OC	3.0	0.84	no
			benzo(a)anthracene	200	mg/kg OC	1.8	0.74	no
			benzo(a)pyrene	150	mg/kg OC	1.5	0.71	no
			benzo(g,h,i)perylene	53	mg/kg OC	1.7	0.68	no
			total benzofluoranthenes	280	mg/kg OC	1.2	0.62	no
			chrysene	210	mg/kg OC	1.9	0.46	no
			dibenzo(a,h)anthracene	21 J	mg/kg OC	1.8	0.64	no
			dibenzofuran	19	mg/kg OC	1.3	0.33	no
			fluoranthene	530	mg/kg OC	3.3	0.44	no
			indeno(1,2,3-cd)pyrene	53	mg/kg OC	1.6	0.60	no
			phenanthrene	300	mg/kg OC	3.0	0.63	no
			total HPAH	2,000 J	mg/kg OC	2.1	0.38	no
			total LPAH	450 J	mg/kg OC	1.2	0.58	no
			bis(2-ethylhexyl) phthalate	200	mg/kg OC	4.3	2.6	no
			1,2-dichlorobenzene	3.9	mg/kg OC	1.7	1.7	no
			pentachlorophenol	800	µg/kg dw	2.2	1.2	no
			total PCBs	120	mg/kg OC	10	1.8	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft) Recovered Depth	Sample Interval (ft) In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines CSL/ML	AET Substitution[b]
8 – 11.1	8.9 – 12.9	archived						
11.1 – 12.1	12.9 – 14.6	metals (excluding mercury) PCBs	total PCBs	15	mg/kg OC	1.3	0.23	no
LDW-SC27								
0 – 2	0 – 2	SMS chemicals	mercury	0.52	mg/kg dw	1.3	0.88	no
			total PCBs	150	mg/kg OC	13	2.3	no
2 – 4.5	2 – 4.6	SMS chemicals	ne	ne	ne	ne	ne	no
4.5 – 6	4.6 – 6.6	archived						
6 – 7.8	6.6 – 9.1	archived						
7.8 – 9.5	9.1 – 11.2	archived						
LDW-SC28								
0 – 1	0 – 1	SMS chemicals	arsenic	114	mg/kg dw	2.0	1.2	no
			benzyl alcohol	110	µg/kg dw	1.9	1.5	no
			total PCBs	17	mg/kg OC	1.4	0.26	no
1 – 2	1 – 2.1	SMS chemicals	total PCBs	17 J	mg/kg OC	1.4	0.26	no
2 – 4	2.1 – 4.2	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 5.5	4.2 – 5.8	archived						
5.5 – 7.5	5.8 – 7.86	SMS chemicals	arsenic	760	mg/kg dw	13	8.2	no
			copper	1,480	mg/kg dw	3.8	3.8	no
			lead	583	mg/kg dw	1.3	1.1	no
			mercury	0.72	mg/kg dw	1.8	1.2	no
			zinc	1,880	mg/kg dw	4.6	2.0	no
			fluoranthene	250	mg/kg OC	1.6	0.21	no
			phenanthrene	110	mg/kg OC	1.1	0.23	no
			bis(2-ethylhexyl) phthalate	62	mg/kg OC	1.3	0.79	no
			1,2-dichlorobenzene	9.9	mg/kg OC	4.3	4.3	no
			pentachlorophenol	410	µg/kg dw	1.1	0.59	no
			total PCBs	200	mg/kg OC	17	3.1	no
7.5 – 9	7.86 – 9.5	archived						

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
9 – 12	9.5 – 12.6	archived						
12 – 12.6	12.6 – 13	SMS chemicals	total PCBs	41	mg/kg OC	3.4	0.63	no
LDW-SC29								
0 – 1	0 – 1	SMS chemicals	ne	ne	ne	ne	ne	no
1 – 2	1 – 2.1	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 3.6	2.1 – 6.1	SMS chemicals	ne	ne	ne	ne	ne	yes
LDW-SC30								
0 – 2.5	0 – 2.7	SMS chemicals	ne	ne	ne	ne	ne	no
2.5 – 4	2.7 – 4.2	SMS chemicals	ne	ne	ne	ne	ne	yes
4 – 5.9	4.2 – 6.9	archived						
LDW-SC31								
0 – 1	0 – 1.4	SMS chemicals and pesticides	total PCBs	15	mg/kg OC	1.3	0.23	no
1 – 2.8	1.4 – 3	SMS chemicals and pesticides	total PCBs	15	mg/kg OC	1.3	0.23	no
2.8 – 4	3 – 4.2	SMS chemicals and pesticides	ne	ne	ne	ne	ne	yes
4 – 5.9	4.2 – 7.5	archived						
LDW-SC32								
0 – 1	0 – 1.2	SMS chemicals	total PCBs	56	mg/kg OC	4.7	0.86	no
1 – 2	1.2 – 2.4	SMS chemicals	acenaphthene	120	mg/kg OC	7.5	2.1	no
			dibenzofuran	100	mg/kg OC	6.7	1.7	no
			fluoranthene	220	mg/kg OC	1.4	0.18	no
			fluorene	160	mg/kg OC	7.0	2.0	no
			phenanthrene	320	mg/kg OC	3.2	0.67	no
			total LPAH	650	mg/kg OC	1.8	0.83	no
			bis(2-ethylhexyl) phthalate	56	mg/kg OC	1.2	0.72	no
			total PCBs	150	mg/kg OC	13	2.3	no
2 – 4	2.4 – 4.3	SMS chemicals	acenaphthene	20	mg/kg OC	1.3	0.35	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
			total PCBs	170	mg/kg OC	14	2.6	no
4 – 5.2	4.3 – 5.8	archived						
5.2 – 8	5.8 – 8	SVOCs and PCBs	ne	ne	ne	ne	ne	no
8 – 10	8 - 10	archived						
10 – 11	10 – 11.2	archived						
LDW-SC33								
0 – 2	0 – 2.3	SMS chemicals	pentachlorophenol	730	µg/kg dw	2.0	1.1	no
			total PCBs	93	mg/kg OC	7.8	1.4	no
2 – 4	2.3 – 4.2	SMS chemicals	total PCBs	26	mg/kg OC	2.2	0.40	no
4 – 6	4.2 – 7	SMS chemicals (excluding mercury)	acenaphthene	48	mg/kg OC	3.0	0.84	no
			dibenzofuran	18	mg/kg OC	1.2	0.31	no
			fluorene	30	mg/kg OC	1.3	0.38	no
			total PCBs	13	mg/kg OC	1.1	0.20	no
6 – 8	7 – 8.4	archived						
8 – 10	8.4 – 11.2	SVOCs and PCBs	ne	ne	ne	ne	ne	no
9.5 – 10	10.5 - 11.2	archived						
LDW-SC201								
0 – 1.5	0 – 1.7	SMS chemicals	lead	772	mg/kg dw	1.7	1.5	no
			total PCBs	77	mg/kg OC	6.4	1.2	no
1.5 – 4	1.7 – 4	SMS chemicals	total PCBs	40 J	mg/kg OC	3.3	0.62	no
4 – 6	4 – 7	SVOCs and PCBs	acenaphthene	33	mg/kg OC	2.1	0.58	no
			fluoranthene	230	mg/kg OC	1.4	0.19	no
			fluorene	24	mg/kg OC	1.0	0.30	no
			total PCBs	16	mg/kg OC	1.3	0.25	no
6 – 8	7 – 8	archived						
8 – 10	8 – 10.4	SVOCs and PCBs	ne	ne	ne	ne	ne	no
10 – 11.8	10.4 – 13.6	archived						
LDW-SC34								

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
0 – 1	0 – 1.4	SMS chemicals and pesticides	butyl benzyl phthalate	15	mg/kg OC	3.1	0.23	no
1 – 2	1.4 – 2.5	SMS chemicals and pesticides	bis(2-ethylhexyl) phthalate	130	mg/kg OC	2.8	1.7	no
			butyl benzyl phthalate	13	mg/kg OC	2.7	0.20	no
			benzyl alcohol	210	µg/kg dw	3.7	2.9	no
2 – 4	2.5 – 4.7	SMS chemicals and pesticides	ne	ne	ne	ne	ne	no
4 – 6	4.7 – 6.6	archived						
6 – 8	6.6 – 9.6	archived						
8 – 9.3	9.6 – 12.2	archived						
LDW-SC203								
0 – 1	0 – 1.6	SMS chemicals and pesticides	bis(2-ethylhexyl) phthalate	55	mg/kg OC	1.2	0.71	no
			butyl benzyl phthalate	12	mg/kg OC	2.4	0.19	no
			benzyl alcohol	66	µg/kg dw	1.2	0.90	no
1 – 2	1.6 – 2.3	SMS chemicals and pesticides	bis(2-ethylhexyl) phthalate	89	mg/kg OC	1.9	1.1	no
			butyl benzyl phthalate	14	mg/kg OC	2.9	0.22	no
2 – 4	2.3 – 4.1	SMS chemicals and pesticides	butyl benzyl phthalate	5.4	mg/kg OC	1.1	0.084	no
			dimethyl phthalate	340	mg/kg OC	6.4	6.4	no
4 – 6	4.1 – 6.4	SVOCs and PCBs	ne	ne	ne	ne	ne	no
6 – 8	6.4 – 9.2	archived						
8 – 8.8	9.2 – 12.1	archived						
LDW-SC35								
0 – 2	0 – 1.8	SMS chemicals	total PCBs	20 J	mg/kg OC	1.7	0.31	no
2 – 4	1.8 – 3.8	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 4.9	3.8 – 5.2	archived						
4.9 – 6	5.2 – 6.6	archived						
6 – 8	6.6 - 10	archived						
LDW-SC36								
0 – 1	0 – 1	SMS chemicals	ne	ne	ne	ne	ne	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft) Recovered Depth	Sample Interval (ft) In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines CSL/ML	AET Substitution[b]
1 – 2	1 – 2.2	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.2 – 4.6	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 6	4.6 – 7	archived						
6 – 8	7 – 9.3	archived						
8 – 10	9.3 - 12	archived						
LDW-SC202								
0 – 1	0 – 1	SMS chemicals	ne	ne	ne	ne	ne	no
1 – 2	1 – 2.3	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.3 – 5.2	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 6	5.2 – 7	archived						
6 – 8	7 – 9.3	archived						
8 – 10.1	9.3 – 12.3	archived						
LDW-SC37								
0 – 1	0 – 1.7	SMS chemicals	arsenic	150	mg/kg dw	2.6	1.6	no
			total PCBs	20	mg/kg OC	1.7	0.31	no
1 – 2	1.7 – 2.6	SMS chemicals	arsenic	121	mg/kg dw	2.1	1.3	no
			mercury	0.45 J	mg/kg dw	1.1	0.76	no
			zinc	490	mg/kg dw	1.2	0.51	no
			benzo(a)anthracene	120	mg/kg OC	1.1	0.44	no
			benzo(a)pyrene	200	mg/kg OC	2.0	0.95	no
			benzo(g,h,i)perylene	37	mg/kg OC	1.2	0.47	no
			total benzofluoranthenes	380	mg/kg OC	1.7	0.84	no
			chrysene	180	mg/kg OC	1.6	0.39	no
			dibenzo(a,h)anthracene	13	mg/kg OC	1.1	0.39	no
			fluoranthene	170	mg/kg OC	1.1	0.14	no
			Indeno(1,2,3-cd)pyrene	56	mg/kg OC	1.6	0.64	no
			total HPAH	1,500	mg/kg OC	1.6	0.28	no
			total PCBs	36 J	mg/kg OC	3.0	0.55	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft) Recovered Depth	In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	CSL/ML	AET Substitution[b]
2 – 4	2.6 – 4.6	SMS chemicals	antimony	590 J	mg/kg dw	3.9	3.0	no
			arsenic	2,000	mg/kg dw	35	22	no
			copper	2,940	mg/kg dw	7.5	7.5	no
			lead	3,520 J	mg/kg dw	7.8	6.6	no
			zinc	4,720	mg/kg dw	12	4.9	no
			acenaphthene	28	mg/kg OC	1.8	0.49	no
			benzo(a)anthracene	200	mg/kg OC	1.8	0.74	no
			benzo(a)pyrene	180	mg/kg OC	1.8	0.86	no
			benzo(g,h,i)perylene	37	mg/kg OC	1.2	0.47	no
			total benzofluoranthenes	410	mg/kg OC	1.8	0.91	no
			chrysene	220	mg/kg OC	2.0	0.48	no
			dibenzofuran	25	mg/kg OC	1.7	0.43	no
			fluoranthene	580	mg/kg OC	3.6	0.48	no
			fluorene	33	mg/kg OC	1.4	0.42	no
			indeno(1,2,3-cd)pyrene	54	mg/kg OC	1.6	0.61	no
			phenanthrene	330	mg/kg OC	3.3	0.69	no
			total HPAH	2,100	mg/kg OC	2.2	0.40	no
			total LPAH	470 J	mg/kg OC	1.3	0.60	no
			1,2,4-trichlorobenzene	2.1	mg/kg OC	2.6	1.2	no
			1,2-dichlorobenzene	6.7	mg/kg OC	2.9	2.9	no
			total PCBs	25	mg/kg OC	2.1	0.38	no
4 – 5.3	4.6 – 6.3	archived						
5.3 – 6.9	6.3 – 8.6	SMS chemicals (excluding mercury)	ne	ne	ne	ne	ne	no
LDW-SC38a								
0 – 1	0 – 1.2	SMS chemicals	total PCBs	23	mg/kg OC	1.9	0.35	no
1 – 2	1.2 – 2.5	SMS chemicals	total PCBs	52	mg/kg OC	4.3	0.80	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
2 – 3	2.5 – 3.8	SMS chemicals	mercury	0.45	mg/kg dw	1.1	0.76	no
			acenaphthene	54 J	mg/kg OC	3.4	0.95	no
			dibenzofuran	17 J	mg/kg OC	1.1	0.29	no
			total PCBs	230	mg/kg OC	19	3.5	no
LDW-SC38b								
3 – 3.3	3.8 – 4.59	SMS chemicals	ne	ne	ne	ne	ne	no
LDW-SC39								
0 – 1	0 – 2	SMS chemicals and pesticides	total PCBs	20	mg/kg OC	1.7	0.31	no
1 – 2	2 – 3.3	SMS chemicals and pesticides	total PCBs	70	mg/kg OC	5.8	1.1	no
2 – 4	3.3 – 4.3	SMS chemicals and pesticides	total PCBs	14	mg/kg OC	1.2	0.22	no
4 – 6	4.3 – 6.8	PCBs	ne	ne	ne	ne	ne	no
6 – 8.5	6.8 – 10.3	archived						
8.5 – 9.2	10.3 – 12.4	archived						
LDW-SC40								
0 – 1.3	0 – 1.7	SMS chemicals and pesticides	total PCBs	21 J	mg/kg OC	1.8	0.32	no
1.3 – 2	1.7 – 2.6	SMS chemicals and pesticides	ne	ne	ne	ne	ne	yes
2 – 4	2.6 – 5.2	SMS chemicals and pesticides	ne	ne	ne	ne	ne	yes
4 – 6	5.2 – 7.8	archived						
6 – 8	7.8 -10.4	archived						
8 – 10	10.4 - 13	archived						
LDW-SC41								
0 – 1	0 – 1.2	SMS chemicals	total PCBs	15 J	mg/kg OC	1.3	0.23	no
1 – 2	1.2 – 2.2	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.2 – 4.1	SMS chemicals	ne	ne	ne	ne	ne	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
4 – 6	4.1 – 6.7	SVOCs and PCBs	total PCBs	27	mg/kg OC	2.3	0.42	no
6 – 7.9	6.7 – 11.6	PCBs	total PCBs	14	mg/kg OC	1.2	0.22	no
LDW-SC42								
0 – 1	0 – 1.3	SMS chemicals	ne	ne	ne	ne	ne	no
1 – 2	1.3 – 2.4	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.4 – 4	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 6	4 – 6.2	archived						
6 – 8	6.2 – 8.7	archived						
8 – 10	8.7 – 11.6	archived						
10 – 12	11.6 – 14.7	archived						
LDW-SC43								
0 – 2	0 – 2.4	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	2.4 – 5.1	SMS chemicals	ne	ne	ne	ne	ne	yes
4 – 6	5.1 – 7.6	archived						
6 – 9	7.6 – 11.9	archived						
9 – 9.8	11.9 – 15.9	archived						
LDW-SC44								
0 – 2	0 – 2.9	SMS chemicals	total PCBs	32	mg/kg OC	2.7	0.49	no
2 – 3.2	2.9 – 4.8	SMS chemicals	total PCBs	24	mg/kg OC	2.0	0.37	no
3.2 – 4	4.8 – 6.7	SMS chemicals	ne	ne	ne	ne	ne	no
4 – 5.8	6.7 – 11.7	archived						
LDW-SC45								
0 – 1	0 – 1	SMS chemicals	total PCBs	16 J	mg/kg OC	1.3	0.25	no
1 – 2	1 – 2.1	SMS chemicals	total PCBs	19	mg/kg OC	1.6	0.29	no
2 – 4	2.1 – 4.5	SMS chemicals	total PCBs	570	µg/kg dw	4.4	0.57	yes
4 – 5	4.5 – 5.5	archived						
5 – 6	5.5 – 6.9	PCBs	ne	ne	ne	ne	ne	yes

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft) Recovered Depth	In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	CSL/ML	AET Substitution[b]
LDW-SC46								
0 – 1	0 – 1.2	SMS chemicals	fluoranthene	220	mg/kg OC	1.4	0.18	no
1 – 2	1.2 – 2.3	SMS chemicals	fluoranthene	200	mg/kg OC	1.3	0.17	no
			benzyl alcohol	64 J	µg/kg dw	1.1	0.88	no
			hexachlorobenzene	0.70	mg/kg OC	1.8	0.30	no
			total PCBs	13 J	mg/kg OC	1.1	0.20	no
2 – 4	2.3 – 4.6	SMS chemicals	total PCBs	14	mg/kg OC	1.2	0.22	no
4 – 6.8	4.6 – 7.9	PCBs	ne	ne	ne	ne	ne	no
6.8 – 8	7.9 – 9.3	archived						
8 – 10	9.3 – 11.6	archived						
10 – 11.2	11.6 - 13	archived						
LDW-SC47								
0 – 1	0 – 1.3	SMS chemicals	ne	ne	ne	ne	ne	no
1 – 2	1.3 – 2.5	SMS chemicals	total PCBs	110	mg/kg OC	9.2	1.7	no
2 – 3	2.5 – 3.8	SMS chemicals	total PCBs	30 J	mg/kg OC	2.5	0.46	no
3 – 4	3.8 – 5.1	SMS chemicals	ne	ne	ne	ne	ne	yes
4 – 6	5.1 – 7.6	archived						
6 – 8	7.6 – 10.1	archived						
8 – 10	10.1 – 12.6	archived						
LDW-SC48								
0 – 1	0 – 1.1	SMS chemicals	ne	ne	ne	ne	ne	no
1 – 2	1.1 – 2.2	SMS chemicals	ne	ne	ne	ne	ne	yes
2 – 4	2.2 – 4.2	SMS chemicals	ne	ne	ne	ne	ne	yes
4 – 5.6	4.2 – 6.1	archived						
LDW-SC49a								
0 – 1	0 – 1.4	SMS chemicals	benzoic acid	750 J	µg/kg dw	1.2	1.2	no
			benzyl alcohol	200	µg/kg dw	3.5	2.7	no
1 – 2	1.4 – 2.5	SMS chemicals	ne	ne	ne	ne	ne	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft) Recovered Depth	Sample Interval (ft) In Situ Depth	Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines SQS/SL	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines CSL/ML	AET Substitution[b]
2 – 4	2.5 – 4.6	SMS chemicals	total PCBs	20	mg/kg OC	1.7	0.31	no
4 – 6	4.6 – 6.8	PCBs	total PCBs	38	mg/kg OC	3.2	0.58	no
6 – 8	6.8 – 9	PCBs	total PCBs	30	mg/kg OC	2.5	0.46	no
8 – 10	9 – 11.7	PCBs	ne	ne	ne	ne	ne	no
10 – 11	11.7 – 12.8	archived						
LDW-SC49b								
0 – 1	0 – 1.2	VOCs	ne	ne	ne	ne	ne	yes
1 – 2	1.2 – 2.6	VOCs	ne	ne	ne	ne	ne	yes
2 – 3	2.6 – 3.5	VOCs	ne	ne	ne	ne	ne	yes
3 – 4	3.5 – 4.5	VOCs	ne	ne	ne	ne	ne	yes
4 – 5	4.5 – 5.5	VOCs	ne	ne	ne	ne	ne	yes
5 – 6	5.5 – 6.5	VOCs	ne	ne	ne	ne	ne	yes
6 – 7	6.5 – 7.1	VOCs	ne	ne	ne	ne	ne	yes
7 – 8	7.1 – 8	VOCs	ne	ne	ne	ne	ne	yes
8 – 9	8 – 9.4	VOCs	ne	ne	ne	ne	ne	yes
9 – 10	9.4 – 10.7	VOCs	ethylbenzene	240	mg/kg dw	10	50	yes
			hexachlorobutadiene	13	mg/kg dw	11	120	yes
			total xylenes	1,700	mg/kg dw	40	160	yes
10 – 11	10.7 – 12.8	VOCs	ethylbenzene	360 J	mg/kg dw	10	50	yes
			total xylenes	5,300 J	mg/kg dw	40	160	yes
11 – 12	12.8 – 15.4	VOCs	ethylbenzene	27	mg/kg dw	10	50	yes
			total xylenes	105 J	mg/kg dw	40	160	yes
LDW-SC50a								
0 – 1	0 – 1.2	SMS chemicals	arsenic	707	mg/kg dw	12	7.6	no
			bis(2-ethylhexyl) phthalate	110	mg/kg OC	2.3	1.4	no
			total PCBs	81	mg/kg OC	6.8	1.2	no
1 – 2	1.2 – 2.7	SMS chemicals	arsenic	281	mg/kg dw	4.9	3.0	no
			total PCBs	96	mg/kg OC	8.0	1.5	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	In Situ Depth					SQS/SL	CSL/ML	
2 – 2.8	2.7 – 3.7	SMS chemicals	arsenic	161	mg/kg dw	2.8	1.7	no
2.8 – 4	3.7 – 5.3	SMS chemicals	ne	ne	ne	ne	ne	yes
4 – 6	5.3 – 8	archived						
6 – 8	8 – 10.7	archived						
8 – 9.8	10.7 - 13	archived						
LDW-SC51								
0 – 2	0 – 2.7	SMS chemicals	acenaphthene	26	mg/kg OC	1.6	0.46	no
			dibenzofuran	16	mg/kg OC	1.1	0.28	no
			total PCBs	88	mg/kg OC	7.3	1.4	no
2 – 3.8	2.7 – 5	SMS chemicals	total PCBs	40	mg/kg OC	3.3	0.62	no
3.8 – 5.8	5 – 10.6	PCBs	ne	ne	ne	ne	ne	no
LDW-SC52								
0 – 1	0 – 1.5	SMS chemicals	mercury	0.67	mg/kg dw	1.6	1.1	no
			butyl benzyl phthalate	26	mg/kg OC	5.3	0.41	no
			2-methylphenol	160	µg/kg dw	2.5	2.5	no
			total PCBs	130 J	mg/kg OC	11	2.0	no
1 – 2	1.5 – 3	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 4	3 – 6.2	SMS chemicals	ne	ne	ne	ne	ne	yes
4 – 4.9	6.2 – 7.8	archived						
LDW-SC53								
0 – 2	0 – 2.8	SMS chemicals and pesticides	ne	ne	ne	ne	ne	no
2 – 4	2.8 – 5.1	SMS chemicals and pesticides	ne	ne	ne	ne	ne	no
4 – 6	5.1 – 7.5	archived						
6 – 8	7.5 – 9.9	archived						
8 – 10	9.9 – 12.2	archived						
LDW-SC54								
0 – 2	0 – 2.4	SMS chemicals and	ne	ne	ne	ne	ne	no

Table 4-9. Summary of results for chemicals with detected concentrations exceeding SMS criteria or DMMP guidelines by sampling location, cont.

Sample Interval (ft)		Chemicals Analyzed[a]	Analyte	Concentration	Unit	Ratio of Detected Concentration to SMS Criteria or DMMP Guidelines		AET Substitution[b]
Recovered Depth	*In Situ* Depth					SQS/SL	CSL/ML	
		pesticides						
2 – 4	2.4 – 4.8	SMS chemicals and pesticides	ne	ne	ne	ne	ne	no
4 – 5.5	4.8 – 6.6	archived						
5.5 – 8	6.6 – 9.6	archived						
8 – 10	9.6 - 12	archived						
LDW-SC55								
0 – 1	0 – 1.3	SMS chemicals	ne	ne	ne	ne	ne	no
1 – 2	1.3 – 2.7	SMS chemicals	ne	ne	ne	ne	ne	no
2 – 3	2.7 – 4	SMS chemicals	ne	ne	ne	ne	ne	no
3 – 4	4 – 5.5	archived						
4 – 6	5.5 – 9.3	archived						
LDW-SC56								
0 – 2	0 – 2.4	SMS chemicals	total PCBs	20	mg/kg OC	1.7	0.31	no
2 – 4	2.4 – 5.8	SMS chemicals	ne	ne	ne	ne	ne	yes
4 – 5.6	5.8 – 8.4	archived						

[a] SMS chemical analyses include metals, mercury, SVOCs, and PCBs.

[b] This column indicates whether AETs were substituted for SMS criteria if TOC was <0.5% or >4.0%.

AET – apparent effects threshold

CSL – cleanup screening level

DMMP – Dredged Material Management Program

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

ne – no exceedance

PCB – polychlorinated biphenyl

SMS – Sediment Management Standards

SVOC – semivolatile organic compound

4.1.2.2 0.5-ft cores

Nineteen cores were processed according to Method B procedures, as described in the QAPP (Windward 2006). Specifically, the top 6 ft of each Method B core was divided vertically in half. One vertical half of this core was sub-sectioned into 2-ft sampling intervals, and the other vertical half was sub-sectioned into 0.5-ft sampling intervals. Samples from the 0-to-2- and 2-to-4-ft intervals were analyzed, and samples from all of the 0.5-ft intervals were archived. The determination of which archived 0.5-ft samples to analyze was made in consultation with EPA and Ecology based on an evaluation of unvalidated data from the 0-to-2- and 2-to-4-ft samples, as well as surface sediment data previously collected at these locations. The 62 samples selected for analyses from nine locations are listed in Table 3-2. Samples were selected for specific chemical analyses if data from a particular location indicated an increase in SMS exceedance factors with depth that would warrant finer vertical resolution or for other reasons as indicated in Table 3-2. Samples from seven of the locations were analyzed for PCB Aroclors, samples from three of the locations were analyzed for SVOCs, and samples from one location each were analyzed for mercury and lead. The targeted SVOCs of concern were phthalates at LDW-SC1, PAHs at LDW-SC51, and both phthalates and PAHs at LDW-SC23.

Figures 4-4a and 4-4b show results for the targeted chemicals in the 0.5-ft intervals compared to the corresponding results for that chemical in the 2-ft intervals from the same cores. Exceedances of the SMS criteria by the targeted chemicals are also presented in Figures 4-4a and 4-4b. The locations and the subsurface intervals at which the greatest total PCB concentrations occurred were as follows: LDW-SC1 at 1 to 1.5 ft, LDW-SC6 at 4 to 4.5 ft, LDW-SC12 at 2 to 2.5 ft, LDW-SC27 at 1 to 1.5 ft, and LDW-SC33 at 1.5 to 2 ft. At two locations, chemical concentrations were greatest at the shallowest intervals: total PCBs in the 0-to-0.5-ft interval at LDW-SC13 and total HPAHs in the 0-to-0.5-ft interval at LDW-SC51.

4.1.2.3 Field replicate results

Field replicate samples were collected and analyzed to evaluate spatial variability in the field. At least one field replicate sample was analyzed for each group of 20 samples for each type of analyte. Each field replicate sample was collected from a separate sediment core collected from a location as close as possible to the original core. The locations at which field replicate cores were collected, as listed in Table 2-1, are LDW-SC33, LDW-SC34, and LDW-SC36. These locations were selected in the field based on both the ease with which an additional acceptable core could be collected and the analyte group to be analyzed at that location.

The results of the comparison of data from the original cores and the field replicate cores are presented in Table A-1 in Appendix A. In general, the results for original and field replicate samples for location LDW-SC36 were similar. At locations LDW-SC33 and LDW-SC-34, there were some differences in results for metals, PAHs, PCBs, benzoic acid, and pentachlorophenol in original samples compared to field replicate samples, indicating some spatial heterogeneity in concentrations of these chemicals.

4.1.3 Comparison of non-detected results to analytical concentration goals and practical quantitation limits

This section compares RLs and method detection limits (MDLs) for non-detected results to site-specific analytical concentration goals (ACGs) (Windward 2005) and practical quantitation limits (PQLs) recommended for sediment analyses by Ecology (2003). Appendix C of the surface sediment QAPP (Windward 2005) documented the initial derivation of ACGs for evaluating risks to human health [4](based on both indirect exposure [e.g., seafood consumption] and direct exposure [e.g., dermal contact]), benthic invertebrates (based on SQS, or SL if an SQS was not available for a given chemical), and sandpiper (based on consumption of benthic invertebrates and sediment). The target detection limits for the subsurface sediment analyses, which were updated by the laboratories in 2005 and 2006, were identified in the subsurface QAPP (Windward 2006) and are presented in the tables in this section. Actual MDLs and RLs may differ from the target detection limits as a result of necessary analytical dilutions or the adjustment of extracted sample volumes for some samples based on pre-screen results. When sample extracts were diluted because the concentrations for one or more target analytes exceeded the upper end of the calibration curve, RLs from the original undiluted extract were reported for chemicals other than the target analytes that required dilution. The analytical laboratory performed the appropriate sample cleanups to achieve the lowest possible detection limits. The sample-specific RL is based on the lowest point of the calibration curve associated with each analysis, whereas the MDL is statistically derived following EPA methods. Both the RL and MDL will be elevated in cases where the sample extract required dilution. Detected concentrations between the MDL and RL were reported by the laboratories and flagged with a J-qualifier to indicate that the reported concentration was an estimate because it fell below the lowest point on the calibration curve.

Thirty-four chemicals had at least one sample-specific RL above the applicable ACG for human health – indirect exposure (Table 4-10). Eighteen of these chemicals were never detected. One or more MDLs for 26 of these 34 chemicals also exceeded ACGs. The minimum MDL reported in Table 4-10 was generally lower than the target MDL; many of the MDLs that were above the ACGs were for chemicals previously identified in the surface sediment QAPP (Windward 2005) as those that would likely represent analytical challenges. Six additional chemicals that were not anticipated in the surface sediment QAPP (benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate,

[4] The ACGs for human health that were presented in Table C-1 of the surface sediment QAPP have been updated. The correct human health ACGs are presented in Tables 4-10 and 4-11.

hexachlorobutadiene, hexachloroethane, endrin, and total chlordane) had RLs above the ACGs; however, all of the MDLs were lower than the ACGs for these chemicals, with the exception of total chlordane. MDLs for total chlordane were elevated because of analytical interferences; this chemical was not detected in any sample.

Table 4-10. Detected and non-detected results, RLs, and MDLs for sediment samples compared to human health ACGs associated with indirect exposure

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	Number of RLs > ACG	Range of MDLs for Non-Detected Results	Number of MDLs > ACG	Target MDL	Human Health – Indirect Exposure ACG
Metals and Trace Elements										
Arsenic	mg/kg dw	152	6 – 2,000	26	6 – 7	26	0.88 – 1.1	26	0.78	0.006
Cadmium	mg/kg dw	99	0.3 – 20.4	79	0.2 – 0.9	79	0.016 – 0.19	79	0.04	0.003
Chromium	mg/kg dw	178	8.1 – 386	0	na	0	na	0	0.09	100
Copper	mg/kg dw	178	7.5 – 2,940	0	na	0	na	0	0.06	1.3
Mercury	mg/kg dw	148	0.05 – 4.34	33	0.04 – 0.07	33	0.0025 – 0.0042	0	0.000003	0.016
Zinc	mg/kg dw	178	16.2 – 4,720	0	na	0	na	0	0.34	16
Organometals										
Tributyltin as ion	µg/kg dw	34	4.8 – 6,200	16	3.6 – 3.9	16	1.5 – 3.9	16	1.33	0.28
PAHs										
2-Methylnaphthalene	µg/kg dw	27	21 – 4,500	174	19 – 160	0	18 – 140	0	18.3	1,700
Acenaphthene	µg/kg dw	71	12 – 4,600	130	19 – 160	0	10 – 81	0	10.4	5.4×10^5
Anthracene	µg/kg dw	143	11 – 8,800	58	19 – 99	0	7.7 – 39	0	7.95	9.0×10^5
Benzo(a)anthracene	µg/kg dw	166	12 – 7,100	35	19 – 99	35	8.4 – 43	35	8.67	5.2
Benzo(a)pyrene	µg/kg dw	163	11 – 5,300	38	19 – 99	38	7.8 – 40	38	8.05	0.76
Benzo(b)fluoranthene	µg/kg dw	169	9.9 – 6,400	32	19 – 99	32	8.3 – 43	32	8.63	4.7
Benzo(k)fluoranthene	µg/kg dw	168	10 – 4,100	33	19 – 99	6	7.7 – 39	0	7.98	47
Chrysene	µg/kg dw	168	12 – 7,800	33	19 – 99	0	9.3 – 48	0	9.65	480
Dibenzofuran	µg/kg dw	40	20 – 1,700	161	19 – 160	0	16 – 130	0	17.1	560
Fluoranthene	µg/kg dw	175	12 – 24,000	26	19 – 66	0	8.3 – 28	0	8.57	2,100
Indeno(1,2,3-cd)pyrene	µg/kg dw	136	10 – 1,500	65	19 – 99	65	6 – 31	65	6.18	2.9
Naphthalene	µg/kg dw	58	12 – 3,400	155	7.4 – 160	0	0.17 – 91	0	11.7	4,500
Pyrene	µg/kg dw	180	9.9 – 14,000	21	19 – 66	0	9 – 31	0	9.38	8,900
Phthalates										
Bis(2-ethylhexyl)	µg/kg dw	145	12 – 3,900	56	19 – 530	10	11 – 36	0	11	120

Table 4-10. Detected and non-detected results, RLs, and MDLs for sediment samples compared to human health ACGs associated with indirect exposure, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	Number of RLs > ACG	Range of MDLs for Non-Detected Results	Number of MDLs > ACG	Target MDL	Human Health – Indirect Exposure ACG
phthalate										
Butyl benzyl phthalate	µg/kg dw	123	5.8 – 610	78	5.8 – 42	0	0.51 – 4	0	4	3.0×10^4
Dimethyl phthalate	µg/kg dw	12	9.9 – 8,800	189	6.5 – 140	0	1.7 – 66	0	9.38	1.4×10^6
Di-n-butyl phthalate	µg/kg dw	43	10 – 200	158	19 – 180	0	6.4 – 52	0	6.64	1.4×10^4
Di-n-octyl phthalate	µg/kg dw	8	14 – 220	193	19 – 160	0	9.8 – 79	0	10.2	3,000
Other SVOCs										
1,2-Dichlorobenzene	µg/kg dw	28	2.9 – 160	185	1.5 – 42	0	0.075 – 7.1	0	1.347	1.2×10^4
1,4-Dichlorobenzene	µg/kg dw	53	3.0 – 38	160	1.5 – 42	0	0.14 – 6.8	0	2.205	73
2,4,5-Trichlorophenol	µg/kg dw	0	nd	201	96 – 780	0	5.7 – 46	0	5.95	3.7×10^4
2,4-Dichlorophenol	µg/kg dw	0	nd	201	96 – 780	0	8 – 65	0	8.3	1,100
2-Chlorophenol	µg/kg dw	0	nd	201	19 – 160	0	8.7 – 70	0	9.02	1,800
4-Methylphenol	µg/kg dw	11	13 – 110	190	19 – 160	0	7 – 57	0	7.3	1,800
Hexachlorobutadiene	µg/kg dw	2	5.9 – 13	211	0.96 – 42	1	0.126 – 3.3	0	2.878	23
Hexachloroethane	µg/kg dw	0	nd	201	19 – 160	3	9.3 – 75	0	9.68	120
Phenol	µg/kg dw	45	13 – 210	156	19 – 400	0	12 – 95	0	12.2	2.1×10^5
PCBs										
Aroclor-1016	µg/kg dw	0	nd	264	3.8 – 900	179	0.38 – 160	85	0.397	6.1
Aroclor-1221	µg/kg dw	0	nd	264	3.8 – 900	264	0.38 – 160	264	0.397	0.21
Aroclor-1232	µg/kg dw	0	nd	264	3.8 – 900	264	0.38 – 160	264	0.397	0.21
Aroclor-1242	µg/kg dw	48	5.2 – 2,400	216	3.8 – 900	216	0.38 – 130	216	0.397	0.21
Aroclor-1248	µg/kg dw	95	5.0 – 2,100	169	3.8 – 1,200	169	0.38 – 160	169	0.397	0.21
Aroclor-1254	µg/kg dw	205	2.7 – 3,300	59	3.8 – 110	59	0.38 – 13	59	0.397	0.21
Aroclor-1260	µg/kg dw	206	5.6 – 5,400	58	3.8 – 210	58	0.38 – 12	58	0.397	0.21
Total PCBs	µg/kg dw	216	2.7 – 9,800	48	3.8 – 5.5	48	0.38 – 1.3	48	0.397	0.21
Pesticides										
2,4'-DDD	µg/kg dw	0	nd	40	1.9 – 29	18	0.832 – 12.6	2	0.037	8.3

Table 4-10. Detected and non-detected results, RLs, and MDLs for sediment samples compared to human health ACGs associated with indirect exposure, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	Number of RLs > ACG	Range of MDLs for Non-Detected Results	Number of MDLs > ACG	Target MDL	Human Health – Indirect Exposure ACG
2,4'-DDE	µg/kg dw	0	nd	40	1.9 – 100	26	0.857 – 13	19	0.033	2.6
2,4'-DDT	µg/kg dw	0	nd	40	1.9 – 29	40	1.06 – 16.1	40	0.091	0.92
4,4'-DDD	µg/kg dw	0	nd	40	1.9 – 39	20	0.091 – 1.38	0	0.095	8.3
4,4'-DDE	µg/kg dw	0	nd	40	1.9 – 90	25	0.12 – 1.81	0	0.125	2.6
4,4'-DDT	µg/kg dw	0	nd	40	1.9 – 160	40	0.19 – 2.89	18	0.199	0.92
Total DDTs	µg/kg dw	0	nd	40	1.9 – 160	40	1.06 – 16.1	40	0.199	0.92
Aldrin	µg/kg dw	0	nd	40	0.96 – 14	40	0.042 – 0.639	21	0.044	0.063
Dieldrin	µg/kg dw	0	nd	40	1.9 – 31	40	0.081 – 1.23	40	0.085	0.033
beta-BHC	µg/kg dw	0	nd	40	0.96 – 24	40	0.087 – 1.32	8	0.091	0.63
gamma-BHC	µg/kg dw	0	nd	40	0.96 – 14	40	0.086 – 1.31	3	0.09	0.83
alpha-Endosulfan	µg/kg dw	0	nd	40	0.96 – 14	0	0.06 – 0.914	0	0.063	500
beta-Endosulfan	µg/kg dw	0	nd	40	1.9 – 29	0	0.12 – 1.81	0	0.125	500
Endosulfan sulfate	µg/kg dw	0	nd	40	1.9 – 69	0	0.142 – 2.15	0	0.148	500
Endrin	µg/kg dw	0	nd	40	1.9 – 150	7	0.078 – 1.19	0	0.082	27
Heptachlor	µg/kg dw	0	nd	40	0.96 – 14	40	0.07 – 1.06	18	0.073	0.25
Methoxychlor	µg/kg dw	0	nd	40	9.6 – 140	0	1.07 – 16.3	0	1.12	440
Total chlordane	µg/kg dw	0	nd	40	1.9 – 100	40	0.922 – 14	21	1.12	1.7
Dioxins/Furans										
2,3,7,8-TCDD	ng/kg dw	24	0.0530 – 3.36	2	0.0440 – 0.0467	0	0.0467 – 0.0487	0	0.036	0.35
1,2,3,7,8-PeCDD	ng/kg dw	24	0.0640 – 10.5	2	0.0440 – 0.0471	0	0.0478 – 0.0487	0	0.069	0.35
1,2,3,4,7,8-HxCDD	ng/kg dw	24	0.106 – 11.2	2	0.0440 – 0.0471	0	0.0478 – 0.0487	0	0.095	0.7
1,2,3,6,7,8-HxCDD	ng/kg dw	25	0.120 – 184	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.114	3.5
1,2,3,7,8,9-HxCDD	ng/kg dw	25	0.0680 – 52.3	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.081	3.5
1,2,3,4,6,7,8-HpCDD	ng/kg dw	25	2.56 – 5,930	1	0.307 – 0.307	0	0.0478 – 0.0478	0	0.246	3.5
OCDD	ng/kg dw	26	2.92 – 62,000	0	na	0	na	0	2.39	3.5
2,3,7,8-TCDF	ng/kg dw	23	0.0740 – 6.09	3	0.0440 – 0.0471	0	0.0467 – 0.0487	0	0.025	3.5

Table 4-10. Detected and non-detected results, RLs, and MDLs for sediment samples compared to human health ACGs associated with indirect exposure, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	Number of RLs > ACG	Range of MDLs for Non-Detected Results	Number of MDLs > ACG	Target MDL	Human Health – Indirect Exposure ACG
1,2,3,7,8-PeCDF	ng/kg dw	23	0.0930 – 18.1	3	0.0440 – 0.0471	0	0.0467 – 0.0487	0	0.085	3.5
2,3,4,7,8-PeCDF	ng/kg dw	25	0.0640 – 61.8	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.101	3.5
1,2,3,4,7,8-HxCDF	ng/kg dw	25	0.176 – 467	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.101	3.5
1,2,3,6,7,8-HxCDF	ng/kg dw	24	0.135 – 76.0	2	0.0440 – 0.0471	0	0.0478 – 0.0487	0	0.078	7
1,2,3,7,8,9-HxCDF	ng/kg dw	19	0.113 – 8.02	7	0.0440 – 3.02	0	0.0440 – 3.02	0	0.076	35
2,3,4,6,7,8-HxCDF	ng/kg dw	24	0.146 – 28.2	2	0.0440 – 0.0471	0	0.0478 – 0.0487	0	0.056	35
1,2,3,4,6,7,8-HpCDF	ng/kg dw	25	0.743 – 2,490	1	0.0471 – 0.0471	0	0.0520 – 0.0520	0	0.129	35
1,2,3,4,7,8,9-HpCDF	ng/kg dw	25	0.106 – 299	1	0.0471 – 0.0471	0	0.0523 – 0.0523	0	0.134	3,500
OCDF	ng/kg dw	26	0.0875 – 13,500	0	na	0	na	0	0.15	3,500

ACG – analytical concentration goal
BHC – benzene hexachloride
dw – dry weight
HpCDD – heptachlorodibenzo-*p*-dioxin
HpCDF – heptachlorodibenzofuran
HxCDD – hexachlorodibenzo-*p*-dioxin
HxCDF – hexachlorodibenzofuran
MDL – method detection limit
na – not applicable
nd – not detected
OCDD – octachlorodibenzo-*p*-dioxin
OCDF – octachlorodibenzofuran
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PeCDD – pentachlorodibenzo-*p*-dioxin
PeCDF – pentachlorodibenzofuran
RL – reporting limit
SVOC – semivolatile organic compound
TCDD – tetrachlorodibenzo-*p*-dioxin
TCDF – tetrachlorodibenzofuran

For human health – direct exposure, 17 chemicals had one or more RLs that exceeded the applicable ACG (Table 4-11). The MDLs for these 17 chemicals were below the ACGs, with the exception of all MDLs for thallium and arsenic, most MDLs for n-nitrosodimethylamine, and MDLs in one to three individual samples for antimony, dibenzo(a,h)anthracene, and toxaphene. N-nitrosodimethylamine is known to be difficult to quantify in sediment.

Table 4-11. Detected and non-detected results, RLs, and MDLs for sediment samples compared to human health ACGs associated with direct exposure

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > ACG	Range of MDLs for Non-Detected Results	No. of MDLs > ACG	Target MDL	Human Health – Direct Exposure ACG
Metals and Trace Elements										
Antimony	mg/kg dw	21	8 – 590	157	6 – 40	157	0.76 – 5.6	1	0.77	3.1
Arsenic	mg/kg dw	152	6 – 2,000	26	6 – 7	26	0.88 – 1.1	26	0.78	0.39
Cadmium	mg/kg dw	99	0.3 – 20.4	79	0.2 – 0.9	0	0.016 – 0.19	0	0.04	3.7
Chromium	mg/kg dw	178	8.1 – 386	0	na	0	na	0	0.09	210
Cobalt	mg/kg dw	178	3.2 – 106	0	na	0	na	0	0.04	900
Copper	mg/kg dw	178	7.5 – 2,940	0	na	0	na	0	0.06	310
Lead	mg/kg dw	169	3 – 3,520	15	2 – 3	0	0.13 – 0.15	0	0.11	40
Mercury	mg/kg dw	148	0.05 – 4.34	33	0.04 – 0.07	0	0.0025 – 0.0042	0	0.000003	2.3
Molybdenum	mg/kg dw	124	0.6 – 166	54	0.6 – 1	0	0.068 – 0.15	0	0.06	39
Nickel	mg/kg dw	178	5 – 226	0	na	0	na	0	0.2	160
Selenium	mg/kg dw	0	nd	178	6 – 40	3	1.2 – 10	0	1.24	39
Silver	mg/kg dw	57	0.5 – 7.5	121	0.3 – 1	0	0.039 – 0.19	0	0.04	39
Thallium	mg/kg dw	0	nd	178	6 – 40	178	0.55 – 6.8	178	0.82	0.52
Vanadium	mg/kg dw	178	26 – 223	0	na	0	na	0	0.03	55
Zinc	mg/kg dw	178	16.2 – 4,720	0	na	0	na	0	0.34	2,300
Organometals										
Tributyltin as ion	µg/kg dw	34	4.8 – 6,200	16	3.6 – 3.9	0	1.5 – 3.9	0	1.33	1,800
PAHs										
2-Chloronaphthalene	µg/kg dw	0	nd	201	19 – 160	0	8.8 – 71	0	9.16	4.9×10^5
Acenaphthene	µg/kg dw	71	12 – 4,600	130	19 – 160	0	10 – 81	0	10.4	3.7×10^5
Anthracene	µg/kg dw	143	11 – 8,800	58	19 – 99	0	7.7 – 39	0	7.95	2.2×10^6
Benzo(a)anthracene	µg/kg dw	166	12 – 7,100	35	19 – 99	0	8.4 – 43	0	8.67	620
Benzo(a)pyrene	µg/kg dw	163	11 – 5,300	38	19 – 99	6	7.8 – 40	0	8.05	62
Benzo(b)fluoranthene	µg/kg dw	169	9.9 – 6,400	32	19 – 99	0	8.3 – 43	0	8.63	620

Table 4-11. Detected and non-detected results, RLs, and MDLs for sediment samples compared to human health ACGs associated with direct exposure, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > ACG	Range of MDLs for Non-Detected Results	No. of MDLs > ACG	Target MDL	Human Health – Direct Exposure ACG
Benzo(k)fluoranthene	µg/kg dw	168	10 – 4,100	33	19 – 99	0	7.7 – 39	0	7.98	6,200
Chrysene	µg/kg dw	168	12 – 7,800	33	19 – 99	0	9.3 – 48	0	9.65	6.2×10^4
Dibenzo(a,h)anthracene	µg/kg dw	77	3.7 – 400	124	6.6 – 160	14	2.8 – 66	1	8.47	62
Dibenzofuran	µg/kg dw	40	20 – 1,700	161	19 – 160	0	16 – 130	0	17.1	2.9×10^4
Fluoranthene	µg/kg dw	175	12 – 24,000	26	19 – 66	0	8.3 – 28	0	8.57	2.3×10^5
Fluorene	µg/kg dw	74	12 – 4,300	127	19 – 160	0	11 – 90	0	11.6	2.7×10^5
Indeno(1,2,3-cd)pyrene	µg/kg dw	136	10 – 1,500	65	19 – 99	0	6 – 31	0	6.18	620
Naphthalene	µg/kg dw	58	12 – 3,400	155	7.4 – 160	0	0.17 – 91	0	11.7	5,600
Pyrene	µg/kg dw	180	9.9 – 14,000	21	19 – 66	0	9 – 31	0	9.38	2.3×10^5
Phthalates										
Bis(2-ethylhexyl) phthalate	µg/kg dw	145	12 – 3,900	56	19 – 530	0	11 – 36	0	11	3.5×10^4
Butyl benzyl phthalate	µg/kg dw	123	5.8 – 610	78	5.8 – 42	0	0.51 – 4	0	4	1.2×10^6
Diethyl phthalate	µg/kg dw	0	nd	201	19 – 160	0	10 – 82	0	10.6	4.9×10^6
Dimethyl phthalate	µg/kg dw	12	9.9 – 8,800	189	6.5 – 140	0	1.7 – 66	0	9.38	1.0×10^8
Di-n-butyl phthalate	µg/kg dw	43	10 – 200	158	19 – 180	0	6.4 – 52	0	6.64	6.1×10^5
Di-n-octyl phthalate	µg/kg dw	8	14 – 220	193	19 – 160	0	9.8 – 79	0	10.2	2.4×10^5
Other SVOCs										
1,2,4-Trichlorobenzene	µg/kg dw	27	3.6 – 110	186	5.8 – 22	0	0.31 – 4.7	0	1.638	6.5×10^4
1,2-Dichlorobenzene	µg/kg dw	28	2.9 – 160	185	1.5 – 42	0	0.075 – 7.1	0	1.347	3.7×10^5
1,3-Dichlorobenzene	µg/kg dw	3	6.5 – 12	210	1.5 – 160	0	0.26 – 65	0	8.4	1,600
1,4-Dichlorobenzene	µg/kg dw	53	3 – 38	160	1.5 – 42	0	0.14 – 6.8	0	2.205	3,400
2,4,5-Trichlorophenol	µg/kg dw	0	nd	201	96 – 780	0	5.7 – 46	0	5.95	6.1×10^5
2,4,6-Trichlorophenol	µg/kg dw	0	nd	201	96 – 780	3	8.5 – 68	0	8.78	610
2,4-Dichlorophenol	µg/kg dw	0	nd	201	96 – 780	0	8 – 65	0	8.3	1.8×10^4
2,4-Dimethylphenol	µg/kg dw	22	3.7 – 46	179	5.8 – 42	0	3.5 – 36	0	3.856	1.2×10^5
2,4-Dinitrophenol	µg/kg dw	0	nd	201	190 – 1,600	0	28 – 230	0	29.4	1.2×10^4

Table 4-11. Detected and non-detected results, RLs, and MDLs for sediment samples compared to human health ACGs associated with direct exposure, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > ACG	Range of MDLs for Non-Detected Results	No. of MDLs > ACG	Target MDL	Human Health – Direct Exposure ACG
2,4-Dinitrotoluene	µg/kg dw	0	nd	201	96 – 780	0	9.9 – 80	0	10.3	1.2×10^4
2,6-Dinitrotoluene	µg/kg dw	0	nd	201	96 – 780	0	12 – 95	0	12.2	6,100
2-Chlorophenol	µg/kg dw	0	nd	201	19 – 160	0	8.7 – 70	0	9.02	6,300
2-Methylphenol	µg/kg dw	38	3 – 160	163	5.8 – 42	0	2 – 14	0	3.379	3.1×10^5
3,3'-Dichlorobenzidine	µg/kg dw	0	nd	201	96 – 780	0	46 – 370	0	47.4	1,100
4-Chloroaniline	µg/kg dw	1	47 – 47	200	96 – 780	0	39 – 310	0	39.9	2.4×10^4
4-Methylphenol	µg/kg dw	11	13 – 110	190	19 – 160	0	7 – 57	0	7.3	3.1×10^4
Aniline	µg/kg dw	0	33 – 36	201	19 – 160	0	9.3 – 75	0	9.64	8.5×10^4
Benzoic acid	µg/kg dw	106	35 – 3,000	95	58 – 620	0	30 – 290	0	52.723	1.0×10^8
Benzyl alcohol	µg/kg dw	29	18 – 210	172	29 – 210	0	13 – 97	0	15.547	1.8×10^6
bis(2-chloroethyl)ether	µg/kg dw	0	nd	201	19 – 160	0	11 – 93	0	11.9	210
bis(2-chloroisopropyl)ether	µg/kg dw	0	nd	201	19 – 160	0	12 – 93	0	12	2,900
Hexachlorobenzene	µg/kg dw	3	4.6 – 10	198	0.96 – 42	0	0.038 – 5.4	0	1.966	300
Hexachlorobutadiene	µg/kg dw	2	5.9 – 13	211	0.96 – 42	0	0.126 – 3.3	0	2.878	6,200
Hexachloroethane	µg/kg dw	0	nd	201	19 – 160	0	9.3 – 75	0	9.68	3.5×10^4
Isophorone	µg/kg dw	0	nd	201	19 – 160	0	11 – 86	0	11	5.1×10^5
Nitrobenzene	µg/kg dw	0	nd	201	19 – 160	0	10 – 82	0	10.5	2,000
n-Nitrosodimethylamine	µg/kg dw	0	nd	201	29 – 210	201	8.5 – 62	74	23.871	9.5
n-Nitroso-di-n-propylamine	µg/kg dw	7	21 – 320	194	29 – 210	7	2.4 – 23	0	2.68	69
n-Nitrosodiphenylamine	µg/kg dw	0	nd	201	5.8 – 7,300	0	0.46 – 3.3	0	3.054	9.9×10^4
Pentachlorophenol	µg/kg dw	50	14 – 800	151	29 – 100	0	9.5 – 33	0	13.126	3,000
Phenol	µg/kg dw	45	13 – 210	156	19 – 400	0	12 – 95	0	12.2	3.7×10^6
PCBs										
Aroclor-1016	µg/kg dw	0	nd	264	3.8 – 900	3	0.38 – 160	0	0.397	390
Aroclor-1221	µg/kg dw	0	nd	264	3.8 – 900	16	0.38 – 160	0	0.397	220
Aroclor-1232	µg/kg dw	0	nd	264	3.8 – 900	16	0.38 – 160	0	0.397	220

Table 4-11. Detected and non-detected results, RLs, and MDLs for sediment samples compared to human health ACGs associated with direct exposure, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > ACG	Range of MDLs for Non-Detected Results	No. of MDLs > ACG	Target MDL	Human Health – Direct Exposure ACG
Aroclor-1242	µg/kg dw	48	5.2 – 2,400	216	3.8 – 900	12	0.38 – 130	0	0.397	220
Aroclor-1248	µg/kg dw	95	5 – 2,100	169	3.8 – 1,200	13	0.38 – 160	0	0.397	220
Aroclor-1254	µg/kg dw	205	2.7 – 3,300	59	3.8 – 110	0	0.38 – 13	0	0.397	220
Aroclor-1260	µg/kg dw	206	5.6 – 5,400	58	3.8 – 210	0	0.38 – 12	0	0.397	220
Total PCBs	µg/kg dw	216	2.7 – 9,800	48	3.8 – 5.5	0	0.38 – 1.3	0	0.397	220
Pesticides										
2,4'-DDD	µg/kg dw	0	nd	40	1.9 – 29	0	0.832 – 12.6	0	0.037	2,400
2,4'-DDE	µg/kg dw	0	nd	40	1.9 – 100	0	0.857 – 13	0	0.033	1,700
2,4'-DDT	µg/kg dw	0	nd	40	1.9 – 29	0	1.06 – 16.1	0	0.091	1,700
4,4'-DDD	µg/kg dw	0	nd	40	1.9 – 39	0	0.091 – 1.38	0	0.095	2,400
4,4'-DDE	µg/kg dw	0	nd	40	1.9 – 90	0	0.12 – 1.81	0	0.125	1,700
4,4'-DDT	µg/kg dw	0	nd	40	1.9 – 160	0	0.19 – 2.89	0	0.199	1,700
Total DDTs	µg/kg dw	0	nd	40	1.9 – 160	0	1.06 – 16.1	0	0.199	1,700
Aldrin	µg/kg dw	0	nd	40	0.96 – 14	0	0.042 – 0.639	0	0.044	29
Dieldrin	µg/kg dw	0	nd	40	1.9 – 31	1	0.081 – 1.23	0	0.085	30
alpha-BHC	µg/kg dw	0	nd	40	0.96 – 14	0	0.049 – 0.74	0	0.051	90
beta-BHC	µg/kg dw	0	nd	40	0.96 – 24	0	0.087 – 1.32	0	0.091	320
gamma-BHC	µg/kg dw	0	nd	40	0.96 – 14	0	0.086 – 1.31	0	0.09	440
alpha-Endosulfan	µg/kg dw	0	nd	40	0.96 – 14	0	0.06 – 0.914	0	0.063	3.7×10^4
beta-Endosulfan	µg/kg dw	0	nd	40	1.9 – 29	0	0.12 – 1.81	0	0.125	3.7×10^4
Endosulfan sulfate	µg/kg dw	0	nd	40	1.9 – 69	0	0.142 – 2.15	0	0.148	3.7×10^4
Endrin	µg/kg dw	0	nd	40	1.9 – 150	0	0.078 – 1.19	0	0.082	1,800
Heptachlor	µg/kg dw	0	nd	40	0.96 – 14	0	0.07 – 1.06	0	0.073	110
Heptachlor epoxide	µg/kg dw	0	nd	40	0.96 – 120	6	0.052 – 0.784	0	0.054	53
Methoxychlor	µg/kg dw	0	nd	40	9.6 – 140	0	1.07 – 16.3	0	1.12	3.1×10^4
Mirex	µg/kg dw	0	nd	40	1.9 – 29	0	0.379 – 5.75	0	0.013	270

Table 4-11. Detected and non-detected results, RLs, and MDLs for sediment samples compared to human health ACGs associated with direct exposure, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > ACG	Range of MDLs for Non-Detected Results	No. of MDLs > ACG	Target MDL	Human Health – Direct Exposure ACG
Toxaphene	µg/kg dw	0	nd	40	96 – 1,400	18	45.9 – 697	3	2.96	440
Total chlordane	µg/kg dw	0	nd	40	1.9 – 100	0	0.922 – 14	0	1.12	1,600
Dioxins/Furans										
2,3,7,8-TCDD	ng/kg dw	24	0.053 – 3.36	2	0.044 – 0.0467	0	0.0467 – 0.0487	0	0.036	3.9
1,2,3,7,8-PeCDD	ng/kg dw	24	0.064 – 10.5	2	0.044 – 0.0471	0	0.0478 – 0.0487	0	0.069	3.9
1,2,3,4,7,8-HxCDD	ng/kg dw	24	0.106 – 11.2	2	0.044 – 0.0471	0	0.0478 – 0.0487	0	0.095	7.8
1,2,3,6,7,8-HxCDD	ng/kg dw	25	0.12 – 184	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.114	39
1,2,3,7,8,9-HxCDD	ng/kg dw	25	0.068 – 52.3	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.081	39
1,2,3,4,6,7,8-HpCDD	ng/kg dw	25	2.56 – 5,930	1	0.307 – 0.307	0	0.0478 – 0.0478	0	0.246	39
OCDD	ng/kg dw	26	2.92 – 62,000	0	na	0	na	0	2.39	39
2,3,7,8-TCDF	ng/kg dw	23	0.074 – 6.09	3	0.044 – 0.0471	0	0.0467 – 0.0487	0	0.025	39
1,2,3,7,8-PeCDF	ng/kg dw	23	0.093 – 18.1	3	0.044 – 0.0471	0	0.0467 – 0.0487	0	0.085	39
2,3,4,7,8-PeCDF	ng/kg dw	25	0.064 – 61.8	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.101	39
1,2,3,4,7,8-HxCDF	ng/kg dw	25	0.176 – 467	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.101	39
1,2,3,6,7,8-HxCDF	ng/kg dw	24	0.135 – 76	2	0.044 – 0.0471	0	0.0478 – 0.0487	0	0.078	78
1,2,3,7,8,9-HxCDF	ng/kg dw	19	0.113 – 8.02	7	0.044 – 3.02	0	0.044 – 3.02	0	0.076	390
2,3,4,6,7,8-HxCDF	ng/kg dw	24	0.146 – 28.2	2	0.044 – 0.0471	0	0.0478 – 0.0487	0	0.056	390
1,2,3,4,6,7,8-HpCDF	ng/kg dw	25	0.743 – 2,490	1	0.0471 – 0.0471	0	0.052 – 0.052	0	0.129	390
1,2,3,4,7,8,9-HpCDF	ng/kg dw	25	0.106 – 299	1	0.0471 – 0.0471	0	0.0523 – 0.0523	0	0.134	3.90×10^4
OCDF	ng/kg dw	26	0.0875 – 13,500	0	na	0	na	0	0.15	3.90×10^4

ACG – analytical concentration goal
BHC – benzene hexachloride
dw – dry weight
HpCDD – heptachlorodibenzo-*p*-dioxin
HpCDF – heptachlorodibenzofuran
HxCDD – hexachlorodibenzo-*p*-dioxin
HxCDF – hexachlorodibenzofuran
MDL – method detection limit
na – not applicable
nd – not detected
OCDD – octachlorodibenzo-*p*-dioxin
OCDF – octachlorodibenzofuran
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PeCDD – pentachlorodibenzo-*p*-dioxin
PeCDF – pentachlorodibenzofuran
RL – reporting limit
SVOC – semivolatile organic compound
TCDD – tetrachlorodibenzo-*p*-dioxin
TCDF – tetrachlorodibenzofuran

For benthic invertebrates, the ACG was either the SQS or the SL if an SQS was not available. For samples where OC-normalization was not appropriate (i.e., TOC < 0.5% or > 4.0 %), the applicable ACG was the LAET. As shown in Tables 4-12 and 4-13, 15 chemicals had RLs greater than their ACGs. Four of these 15 chemicals also had one or more MDLs greater than their respective ACG. Elevated RLs were not anticipated in the QAPP (Windward 2005) for three of the 15 chemicals with RLs greater than the ACGs. The MDLs for these three chemicals were less than the ACG for all results except for a single result for benzyl alcohol. The detection limits were elevated for these three chemicals because of analytical dilutions.

For sandpiper, there was a single chemical, selenium, that had one or more RLs above the lowest ACG. The range of RLs for selenium was 6 to 40 mg/kg dw compared to the ACG of 14.9 mg/kg dw. The MDLs for selenium ranged from 1.2 to 10 mg/kg dw, less than the ACG.

Table 4-14 compares RLs and MDLs to Ecology's PQLs. Twenty-four chemicals had at least one RL that exceeded the applicable PQLs. Nine of these 24 chemicals also had at least one MDL that exceeded the PQLs. These elevated MDLs and RLs resulted from analytical interferences and/or analytical dilutions needed for other chemicals present in the samples.

Table 4-12. Detected and non-detected results, RLs, and MDLs for sediment samples compared to benthic invertebrate ACGs

Chemical	Unit	Number of Detected Results	Range of Detected Results	Number of Non-Detected Results	Range of Non-Detected Reporting Limits	Number of RLs > ACG	Range of Non-Detected MDLs	Number of MDLs > ACG	Target MDL	Benthic Invertebrate ACG[a]
Metals and trace elements										
Antimony	mg/kg dw	21	8 – 590	157	6 – 40	0	0.76 – 5.6	0	0.005	150
Arsenic	mg/kg dw	152	6 – 2,000	26	6 – 7	0	0.88 – 1.1	0	0.02	57
Cadmium	mg/kg dw	99	0.3 – 20.4	79	0.2 – 0.9	0	0.016 – 0.19	0	0.02	5.1
Chromium	mg/kg dw	178	8.1 – 386	0	na	0	na	0	0.09	260
Copper	mg/kg dw	178	7.5 – 2,940	0	na	0	na	0	0.04	390
Lead	mg/kg dw	169	3 – 3,520	15	2 – 3	0	0.13 – 0.15	0	0.12	450
Mercury	mg/kg dw	148	0.05 – 4.34	33	0.04 – 0.07	0	0.0025 – 0.0042	0	0.003	0.41
Nickel	mg/kg dw	178	5 – 226	0	na	0	na	0	0.38	140
Silver	mg/kg dw	57	0.5 – 7.5	121	0.3 – 1	0	0.039 – 0.19	0	0.03	6.1
Zinc	mg/kg dw	178	16.2 – 4,720	0	na	0	na	0	0.29	410
PAHs										
2-Methylnaphthalene	mg/kg OC	25	1 – 19	153	0.88 – 12	0	0.79 – 11	0	na[b]	38
Acenaphthene	mg/kg OC	67	0.49 – 160	111	0.88 – 12	0	0.44 – 6.3	0	na[b]	16
Acenaphthylene	mg/kg OC	43	0.52 – 10	135	0.88 – 12	0	0.41 – 5.7	0	na[b]	66
Anthracene	mg/kg OC	137	0.62 – 680	41	0.95 – 12	0	0.38 – 4.8	0	na[b]	220
Benzo(a)anthracene	mg/kg OC	160	0.62 – 550	18	0.95 – 10	0	0.41 – 4.5	0	na[b]	110
Benzo(a)pyrene	mg/kg OC	156	0.85 – 230	22	0.95 – 12	0	0.38 – 4.8	0	na[b]	99
Benzo(g,h,i)perylene	mg/kg OC	131	0.69 – 56	47	0.95 – 12	0	0.40 – 5.2	0	na[b]	31
Total benzofluoranthenes	mg/kg OC	162	1.2 – 490	16	0.95 – 10	0	0.41 – 4.5	0	na[b]	230
Chrysene	mg/kg OC	162	0.62 – 600	16	0.95 – 10	0	0.46 – 5.0	0	na[b]	110
Dibenzo(a,h)anthracene	mg/kg OC	74	0.58 – 21	104	0.87 – 9.5	0	0.36 – 4.0	0	na[b]	12
Dibenzofuran	mg/kg OC	37	1.3 – 100	141	0.88 – 12	0	0.75 – 10	0	na[b]	15
Fluoranthene	mg/kg OC	167	0.83 – 1,800	11	0.95 – 10	0	0.40 – 4.5	0	na[b]	160
Fluorene	mg/kg OC	71	0.76 – 160	107	0.88 – 12	0	0.49 – 7.0	0	na[b]	23
Indeno(1,2,3-cd)pyrene	mg/kg OC	131	0.63 – 72	47	0.95 – 12	0	0.29 – 3.7	0	na[b]	34

Table 4-12. Detected and non-detected results, RLs, and MDLs for sediment samples compared to benthic invertebrate ACGs, cont.

CHEMICAL	UNIT	NUMBER OF DETECTED RESULTS	RANGE OF DETECTED RESULTS	NUMBER OF NON-DETECTED RESULTS	RANGE OF NON-DETECTED REPORTING LIMITS	NUMBER OF RLS > ACG	RANGE OF NON-DETECTED MDLS	NUMBER OF MDLS > ACG	TARGET MDL	BENTHIC INVERTEBRATE ACG[a]
Naphthalene	mg/kg OC	53	0.57 – 87	125	0.88 – 12	0	0.53 – 7.0	0	na[b]	99
Phenanthrene	mg/kg OC	161	0.62 – 920	17	0.95 – 10	0	0.48 – 5.5	0	na[b]	100
Pyrene	mg/kg OC	170	1 – 1,100	8	0.95 – 9.1	0	0.44 – 4.3	0	na[b]	1,000
Total HPAH	mg/kg OC	170	1.9 – 4,900	8	0.95 – 9.1	0	0.46 – 4.4	0	na[b]	960
Total LPAH	mg/kg OC	161	0.62 – 1,900	17	0.95 – 10	0	0.57 – 6.1	0	na[b]	370
Phthalates										
Bis(2-ethylhexyl)phthalate	mg/kg OC	136	0.95 – 200	42	0.51 – 20	0	0.28 – 6.6	0	na[b]	47
Butyl benzyl phthalate	mg/kg OC	120	0.33 – 26	58	0.20 – 2.3	0	0.017 – 0.72	0	na[b]	4.9
Diethyl phthalate	mg/kg OC	0	nd	178	0.51 – 12	0	0.25 – 6.4	0	na[b]	61
Dimethyl phthalate	mg/kg OC	12	0.43 – 340	166	0.31 – 9.6	0	0.076 – 4.5	0	na[b]	53
Di-n-butyl phthalate	mg/kg OC	37	0.51 – 9	141	0.53 – 12	0	0.17 – 4.1	0	na[b]	220
Di-n-octyl phthalate	mg/kg OC	8	0.99 – 7.3	170	0.51 – 12	0	0.25 – 6.1	0	na[b]	58
Other SVOCs										
1,2,4-Trichlorobenzene	mg/kg OC	25	0.14 – 2.1	153	0.15 – 2.4	23	0.036 – 0.54	0	na[b]	0.81
1,2-Dichlorobenzene	mg/kg OC	27	0.15 – 9.9	151	0.15 – 2.4	1	0.025 – 0.40	0	na[b]	2.3
1,3-Dichlorobenzene	ug/kg dw	3	6.5 – 12	210	1.5 – 160	0	0.26 – 65	0	7.55	170
1,4-Dichlorobenzene	mg/kg OC	52	0.12 – 2	126	0.15 – 2.4	0	0.024 – 0.41	0	na[b]	3.1
2,4-Dimethylphenol	ug/kg dw	22	3.7 – 46	179	5.8 – 42	1	3.5 – 36	1	10.52	29
2-Methylphenol	ug/kg dw	38	3 – 160	163	5.8 – 42	0	2 – 14	0	13.8	63
4-Methylphenol	ug/kg dw	11	13 – 110	190	19 – 160	0	7 – 57	0	13.5	670
Benzoic acid	ug/kg dw	106	35 – 3,000	95	58 – 620	0	30 – 290	0	105	650
Benzyl alcohol	ug/kg dw	29	18 – 210	172	29 – 210	21	13 – 97	1	41	57
Hexachlorobenzene	mg/kg OC	3	0.23 – 0.7	175	0.032 – 1.2	62	0.0013 – 0.35	0	na[b]	0.38
Hexachlorobutadiene	mg/kg OC	1	0.3 – 0.3	177	0.032 – 1.2	0	0.0043 – 0.52	0	na[b]	3.9
Hexachloroethane	ug/kg dw	0	nd	201	19 – 160	0	9.3 – 75	0	7.98	1,400
N-Nitrosodiphenylamine	mg/kg OC	0	nd	178	0.26 – 80	13	0.012 – 0.55	0	na[b]	11
Pentachlorophenol	ug/kg dw	50	14 – 800	151	29 – 100	0	9.5 – 33	0	37.1	360
Phenol	ug/kg dw	45	13 – 210	156	19 – 400	0	12 – 95	0	9.47	420

Table 4-12. Detected and non-detected results, RLs, and MDLs for sediment samples compared to benthic invertebrate ACGs, cont.

Chemical	Unit	Number of Detected Results	Range of Detected Results	Number of Non-Detected Results	Range of Non-Detected Reporting Limits	Number of RLs > ACG	Range of Non-Detected MDLs	Number of MDLs > ACG	Target MDL	Benthic Invertebrate ACG[a]
Pesticides										
Total DDTs	ug/kg dw	0	nd	40	1.9 – 160	31	1.06 – 16.1	9	1.1	6.9
Aldrin	ug/kg dw	0	nd	40	0.96 – 14	1	0.042 – 0.639	0	0.054	10
Dieldrin	ug/kg dw	0	nd	40	1.9 – 31	9	0.081 – 1.23	0	0.049	10
gamma-BHC	ug/kg dw	0	nd	40	0.96 – 14	1	0.086 – 1.31	0	0.141	10
Heptachlor	ug/kg dw	0	nd	40	0.96 – 14	1	0.07 – 1.06	0	0.027	10
alpha-Chlordane	ug/kg dw	0	nd	40	0.96 – 14	1	0.055 – 0.842	0	0.058	10
Total chlordane	ug/kg dw	0	nd	40	1.9 – 100	14	0.922 – 14	1	0.964	10
Polychlorinated biphenyls										
Total PCBs	mg/kg OC	208	0.54 – 350	28	0.19 – 0.72	0	0.019 – 0.15	0	na[b]	12
Volatile organic compounds										
Ethylbenzene	ug/kg dw	3	27 – 360	9	1.6 – 2	0	0.65 – 0.81	0	na[c]	10
Tetrachloroethene	ug/kg dw	0	nd	12	1.5 – 2	0	0.63 – 0.84	0	na[c]	57
Trichloroethene	ug/kg dw	2	6.5 – 12	10	1.6 – 2	0	0.53 – 0.66	0	na[c]	160
Total xylenes	ug/kg dw	3	105 – 5,300	9	1.6 – 2	0	0.97 – 1.2	0	na[c]	40

a In Appendix C of the surface sediment QAPP (Windward 2005), the OC-normalized ACGs were converted to dry weight values for comparison to dry weight RLs and MDLs, using a lower-than-average OC content of 0.5%. In the comparison presented in this table, the RLs and MDLs were converted to OC-normalized values using sample-specific TOC contents for comparison to OC-normalized ACGs.

b The target MDLs presented in the subsurface QAPP are dry weight values.

c Target MDLs for these analytes were not presented in the subsurface QAPP.

ACG – analytical concentration goal
BHC – benzene hexachloride
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
MDL – method detection limit
na – not applicable
nd – not detected
OC – organic carbon
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
SVOC – semivolatile organic compound

Table 4-13. Detected and non-detected results, RLs, and MDLs for sediment samples compared to benthic invertebrate ACGs, for results where OC-normalization was not applicable

Chemical	Unit	Number of Detected Results	Range of Detected Results	Number of Non-Detected Results	Range of Non-Detected Reporting Limits	Number of RLs > ACG	Range of Non-Detected MDLs	Number of MDLs > ACG	Target MDL	Benthic Invertebrate ACG
PAHs										
2-Methylnaphthalene	ug/kg dw	2	62 – 4,500	21	19 – 110	0	18 – 98	0	7.21	670
Acenaphthene	ug/kg dw	4	55 – 4,600	19	19 – 110	0	10 – 56	0	9.36	500
Acenaphthylene	ug/kg dw	2	93 – 280	21	19 – 66	0	9 – 31	0	9.09	1,300
Anthracene	ug/kg dw	6	16 – 1,900	17	19 – 66	0	7.7 – 26	0	8.69	960
Benzo(a)anthracene	ug/kg dw	6	50 – 3,600	17	19 – 66	0	8.4 – 28	0	8.34	1,300
Benzo(a)pyrene	ug/kg dw	7	13 – 3,100	16	19 – 66	0	7.8 – 26	0	7.31	1,600
Benzo(g,h,i)perylene	ug/kg dw	5	12 – 520	18	19 – 66	0	8.2 – 28	0	8.04	670
Total Benzofluoranthenes	ug/kg dw	7	36 – 7,600	16	19 – 66	0	8.3 – 28	0	10.4	3,200
Chrysene	ug/kg dw	6	59 – 4,300	17	19 – 66	0	9.3 – 32	0	8.09	1,400
Dibenzo(a,h)anthracene	ug/kg dw	3	4.3 – 150	20	6.6 – 140	0	2.8 – 60	0	8.35	230
Dibenzofuran	ug/kg dw	3	58 – 1,700	20	19 – 110	0	16 – 92	0	7.95	540
Fluoranthene	ug/kg dw	8	14 – 8,100	15	19 – 20	0	8.3 – 8.5	0	8.49	1,700
Fluorene	ug/kg dw	3	62 – 4,300	20	19 – 110	0	11 – 62	0	9.17	540
Indeno(1,2,3-cd)pyrene	ug/kg dw	5	13 – 670	18	19 – 66	0	6 – 20	0	8.54	600
Naphthalene	ug/kg dw	5	18 – 3,400	30	7.4 – 110	0	0.17 – 63	0	7.53	2,100
Phenanthrene	ug/kg dw	7	30 – 13,000	16	19 – 20	0	9.9 – 10	0	8.63	1,500
Pyrene	ug/kg dw	10	9.9 – 6,700	13	19 – 20	0	9 – 9.3	0	8.72	2,600
Total HPAH	ug/kg dw	10	9.9 – 34,700	13	19 – 20	0	9.3 – 9.6	0	10.4	1.20×10^4
Total LPAH	ug/kg dw	7	46 – 27,000	16	19 – 20	0	11 – 12	0	9.36	5,200
Phthalates										
Bis(2-ethylhexyl)phthalate	ug/kg dw	9	13 – 2,300	14	19 – 62	0	11 – 34	0	10.8	1,300
Butyl benzyl phthalate	ug/kg dw	3	10 – 28	20	5.8 – 42	0	0.51 – 3.9	0	10.3	63

Table 4-13. Detected and non-detected results, RLs, and MDLs for sediment samples compared to benthic invertebrate ACGs, for results where OC-normalization was not applicable, cont.

Chemical	Unit	Number of Detected Results	Range of Detected Results	Number of Non-Detected Results	Range of Non-Detected Reporting Limits	Number of RLs > ACG	Range of Non-Detected MDLs	Number of MDLs > ACG	Target MDL	Benthic Invertebrate ACG
Diethyl phthalate	ug/kg dw	0	nd	23	19 – 140	0	10 – 75	0	135	200
Dimethyl phthalate	ug/kg dw	0	nd	23	6.6 – 140	2	1.7 – 66	0	12	71
Di-n-butyl phthalate	ug/kg dw	6	10 – 22	17	19 – 140	0	6.4 – 47	0	13.5	1,400
Di-n-octyl phthalate	ug/kg dw	0	nd	23	19 – 140	0	9.8 – 72	0	11.3	6,200
Other SVOCs										
1,2,4-Trichlorobenzene	ug/kg dw	2	4.5 – 110	33	5.8 – 22	0	0.31 – 1.6	0	5.88	31
1,2-Dichlorobenzene	ug/kg dw	1	12 – 12	34	1.5 – 42	1	0.075 – 7.1	0	8.76	35
1,4-Dichlorobenzene	ug/kg dw	1	5.6 – 5.6	34	1.5 – 42	0	0.14 – 6.8	0	7.55	110
Hexachlorobenzene	ug/kg dw	0	nd	23	0.96 – 42	1	0.038 – 5.4	0	8.16	22
Hexachlorobutadiene	ug/kg dw	1	13 – 13	34	0.96 – 42	1	0.126 – 3.3	0	10.52	11
N-Nitrosodiphenylamine	ug/kg dw	0	nd	23	5.8 – 7,300	5	0.46 – 3.3	0	13.8	28
Polychlorinated biphenyls										
Total PCBs	ug/kg dw	8	2.7 – 9,800	20	3.8 – 5.5	0	0.38 – 1.3	0	0.98	130

ACG – analytical concentration goal

dw – dry weight

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

MDL – method detection limit

na – not applicable

nd – not detected

PAH –polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

RL – reporting limit

SVOC – semivolatile organic compound

Table 4-14. Detected and non-detected results, RLs, and MDLs for sediment samples compared to Ecology PQLs

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > PQL	Range of MDLs Non-Detected Results	No. of MDLs > PQL	Target MDL	Ecology PQL
Metals and Trace Elements										
Antimony	mg/kg dw	21	8 – 590	157	6 – 40	0	0.76 – 5.6	0	0.77	50
Arsenic	mg/kg dw	152	6 – 2,000	26	6 – 7	0	0.88 – 1.1	0	0.78	19
Cadmium	mg/kg dw	99	0.3 – 20.4	79	0.2 – 0.9	0	0.016 – 0.19	0	0.04	1.7
Chromium	mg/kg dw	178	8.1 – 386	0	na	0	na	0	0.09	87
Copper	mg/kg dw	178	7.5 – 2,940	0	na	0	na	0	0.06	130
Lead	mg/kg dw	169	3 – 3,520	15	2 – 3	0	0.13 – 0.15	0	0.11	150
Mercury	mg/kg dw	148	0.05 – 4.34	33	0.04 – 0.07	0	0.0025 – 0.0042	0	0.000003	0.14
Nickel	mg/kg dw	178	5 – 226	0	na	0	na	0	0.2	47
Silver	mg/kg dw	57	0.5 – 7.5	121	0.3 – 1	0	0.039 – 0.19	0	0.04	2
Zinc	mg/kg dw	178	16.2 – 4,720	0	na	0	na	0	0.34	137
Organometals										
Monobutyltin as ion	µg/kg dw	13	4.5 - 46	37	2.6 - 7.9	3	2.1 - 4.3	0	4.51	5
Dibutyltin as ion	µg/kg dw	24	6.4 – 960	26	3.7 – 11	25	1.2 – 5.8	21	4.79	5
Tributyltin as ion	µg/kg dw	34	4.8 – 6,200	16	3.6 – 3.9	0	1.5 – 3.9	0	1.33	5
PAHs										
2-Methylnaphthalene	µg/kg dw	27	21 – 4,500	174	19 – 160	0	18 – 140	0	18.3	223
Acenaphthene	µg/kg dw	71	12 – 4,600	130	19 – 160	0	10 – 81	0	10.4	167
Acenaphthylene	µg/kg dw	45	10 – 280	156	19 – 160	0	9 – 73	0	9.38	433
Anthracene	µg/kg dw	143	11 – 8,800	58	19 – 99	0	7.7 – 39	0	7.95	320
Benzo(a)anthracene	µg/kg dw	166	12 – 7,100	35	19 – 99	0	8.4 – 43	0	8.67	433
Benzo(a)pyrene	µg/kg dw	163	11 – 5,300	38	19 – 99	0	7.8 – 40	0	8.05	533
Benzo(g,h,i)perylene	µg/kg dw	136	11 – 1,000	65	19 – 99	0	8.2 – 42	0	8.52	223
Chrysene	µg/kg dw	168	12 – 7,800	33	19 – 99	0	9.3 – 48	0	9.65	467

Table 4-14. Detected and non-detected results, RLs, and MDLs for sediment samples compared to Ecology PQLs, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > PQL	Range of MDLs Non-Detected Results	No. of MDLs > PQL	Target MDL	Ecology PQL
Dibenzo(a,h)anthracene	µg/kg dw	77	3.7 – 400	124	6.6 – 160	12	2.8 – 66	0	8.47	77
Dibenzofuran	µg/kg dw	40	20 – 1,700	161	19 – 160	0	16 – 130	0	17.1	180
Fluoranthene	µg/kg dw	175	12 – 24,000	26	19 – 66	0	8.3 – 28	0	8.57	567
Fluorene	µg/kg dw	74	12 – 4,300	127	19 – 160	0	11 – 90	0	11.6	180
Indeno(1,2,3-cd)pyrene	µg/kg dw	136	10 – 1,500	65	19 – 99	0	6 – 31	0	6.18	200
Naphthalene	µg/kg dw	58	12 – 3,400	155	7.4 – 160	0	0.17 – 91	0	11.7	700
Phenanthrene	µg/kg dw	168	10 – 13,000	33	19 – 99	0	9.9 – 51	0	10.3	500
Pyrene	µg/kg dw	180	9.9 – 14,000	21	19 – 66	0	9 – 31	0	9.38	867
Phthalates										
Bis(2-ethylhexyl) phthalate	µg/kg dw	145	12 – 3,900	56	19 – 530	2	11 – 36	0	11	433
Butyl benzyl phthalate	µg/kg dw	123	5.8 – 610	78	5.8 – 42	7	0.51 – 4	0	4	21
Diethyl phthalate	µg/kg dw	0	nd	201	19 – 160	19	10 – 82	3	10.6	67
Dimethyl phthalate	µg/kg dw	12	9.9 – 8,800	189	6.5 – 140	104	1.7 – 66	88	9.38	24
Di-n-butyl phthalate	µg/kg dw	43	10 – 200	158	19 – 180	0	6.4 – 52	0	6.64	467
Di-n-octyl phthalate	µg/kg dw	8	14 – 220	193	19 – 160	0	9.8 – 79	0	10.2	2,067
Other SVOCs										
1,2,4-Trichlorobenzene	µg/kg dw	27	3.6 – 110	186	5.8 – 22	0	0.31 – 4.7	0	1.638	31
1,2-Dichlorobenzene	µg/kg dw	28	2.9 – 160	185	1.5 – 42	1	0.075 – 7.1	0	1.347	35
1,3-Dichlorobenzene	µg/kg dw	3	6.5 – 12	210	1.5 – 160	92	0.26 – 65	2	8.4	57
1,4-Dichlorobenzene	µg/kg dw	53	3.0 – 38	160	1.5 – 42	1	0.14 – 6.8	0	2.205	37
2,4-Dimethylphenol	µg/kg dw	22	3.7 – 46	179	5.8 – 42	1	3.5 – 36	1	3.856	29
2-Methylphenol	µg/kg dw	38	3.0 – 160	163	5.8 – 42	0	2 – 14	0	3.379	63
4-Methylphenol	µg/kg dw	11	13 – 110	190	19 – 160	0	7 – 57	0	7.3	223
Benzoic acid	µg/kg dw	106	35 – 3,000	95	58 – 620	41	30 – 290	38	52.723	217
Benzyl alcohol	µg/kg dw	29	18 – 210	172	29 – 210	21	13 – 97	1	15.547	57

Table 4-14. Detected and non-detected results, RLs, and MDLs for sediment samples compared to Ecology PQLs, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > PQL	Range of MDLs Non-Detected Results	No. of MDLs > PQL	Target MDL	Ecology PQL
Hexachlorobenzene	µg/kg dw	3	4.6 – 10	198	0.96 – 42	1	0.038 – 5.4	0	1.966	22
Hexachlorobutadiene	µg/kg dw	2	5.9 – 13	211	0.96 – 42	13	0.126 – 3.3	0	2.878	11
Hexachloroethane	µg/kg dw	0	nd	201	19 – 160	111	9.3 – 75	16	9.68	47
n-Nitrosodiphenylamine	µg/kg dw	0	nd	201	5.8 – 7,300	90	0.46 – 3.3	0	3.054	28
Pentachlorophenol	µg/kg dw	50	14 – 800	151	29 – 100	0	9.5 – 33	0	13.126	120
Phenol	µg/kg dw	45	13 – 210	156	19 – 400	2	12 – 95	0	12.2	140
PCBs										
Total PCBs	µg/kg dw	216	2.7 – 9,800	48	3.8 – 5.5	0	0.38 – 1.3	0	0.397	6
Pesticides										
4,4'-DDD	µg/kg dw	0	nd	40	1.9 – 39	26	0.091 – 1.38	0	0.095	3.3
4,4'-DDE	µg/kg dw	0	nd	40	1.9 – 90	25	0.12 – 1.81	0	0.125	2.3
4,4'-DDT	µg/kg dw	0	nd	40	1.9 – 160	31	0.19 – 2.89	0	0.199	6.7
Total DDTs	µg/kg dw	0	nd	40	1.9 – 160	31	1.06 – 16.1	9	0.199	6.7
Aldrin	µg/kg dw	0	nd	40	0.96 – 14	22	0.042 – 0.639	0	0.044	1.7
Dieldrin	µg/kg dw	0	nd	40	1.9 – 31	24	0.081 – 1.23	0	0.085	2.3
gamma-BHC	µg/kg dw	0	nd	40	0.96 – 14	23	0.086 – 1.31	0	0.09	1.7
Heptachlor	µg/kg dw	0	nd	40	0.96 – 14	23	0.07 – 1.06	0	0.073	1.7
Total chlordane	µg/kg dw	0	nd	40	1.9 – 100	40	0.922 – 14	21	1.12	1.7
Dioxins/Furans										
2,3,7,8-TCDD	ng/kg dw	24	0.0530 – 3.36	2	0.0440 – 0.0467	0	0.0467 – 0.0487	0	0.036	10
1,2,3,7,8-PeCDD	ng/kg dw	24	0.0640 – 10.5	2	0.0440 – 0.0471	0	0.0478 – 0.0487	0	0.069	10
1,2,3,4,7,8-HxCDD	ng/kg dw	24	0.106 – 11.2	2	0.0440 – 0.0471	0	0.0478 – 0.0487	0	0.095	10
1,2,3,6,7,8-HxCDD	ng/kg dw	25	0.120 – 184	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.114	10
1,2,3,7,8,9-HxCDD	ng/kg dw	25	0.0680 – 52.3	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.081	10
1,2,3,4,6,7,8-HpCDD	ng/kg dw	25	2.56 – 5,930	1	0.307 – 0.307	0	0.0478 – 0.0478	0	0.246	10
OCDD	ng/kg dw	26	2.92 – 62,000	0	na	0	na	0	2.39	10

Table 4-14. Detected and non-detected results, RLs, and MDLs for sediment samples compared to Ecology PQLs, cont.

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > PQL	Range of MDLs Non-Detected Results	No. of MDLs > PQL	Target MDL	Ecology PQL
2,3,7,8-TCDF	ng/kg dw	23	0.0740 – 6.09	3	0.0440 – 0.0471	0	0.0467 – 0.0487	0	0.025	10
1,2,3,7,8-PeCDF	ng/kg dw	23	0.0930 – 18.1	3	0.0440 – 0.0471	0	0.0467 – 0.0487	0	0.085	10
2,3,4,7,8-PeCDF	ng/kg dw	25	0.0640 – 61.8	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.101	10
1,2,3,4,7,8-HxCDF	ng/kg dw	25	0.176 – 467	1	0.0471 – 0.0471	0	0.0478 – 0.0478	0	0.101	10
1,2,3,6,7,8-HxCDF	ng/kg dw	24	0.135 – 76.0	2	0.0440 – 0.0471	0	0.0478 – 0.0487	0	0.078	10
1,2,3,7,8,9-HxCDF	ng/kg dw	19	0.113 – 8.02	7	0.0440 – 3.02	0	0.0440 – 3.02	0	0.076	10
2,3,4,6,7,8-HxCDF	ng/kg dw	24	0.146 – 28.2	2	0.0440 – 0.0471	0	0.0478 – 0.0487	0	0.056	10
1,2,3,4,6,7,8-HpCDF	ng/kg dw	25	0.743 – 2,490	1	0.0471 – 0.0471	0	0.0520 – 0.0520	0	0.129	10
1,2,3,4,7,8,9-HpCDF	ng/kg dw	25	0.106 – 299	1	0.0471 – 0.0471	0	0.0523 – 0.0523	0	0.134	10
OCDF	ng/kg dw	26	0.0875 – 13,500	0	na	0	na	0	0.15	10

ACG – analytical concentration goal
BHC – benzene hexachloride
dw – dry weight
HpCDD – heptachlorodibenzo-*p*-dioxin
HpCDF – heptachlorodibenzofuran
HxCDD – hexachlorodibenzo-*p*-dioxin
HxCDF – hexachlorodibenzofuran
MDL – method detection limit
na – not applicable
nd – not detected
OCDD – octachlorodibenzo-*p*-dioxin
OCDF – octachlorodibenzofuran
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PeCDD – pentachlorodibenzo-*p*-dioxin
PeCDF – pentachlorodibenzofuran
PQL – practical quantitation limit
RL – reporting limit
SVOC – semivolatile organic compound
TCDD – tetrachlorodibenzo-*p*-dioxin
TCDF – tetrachlorodibenzofuran

4.2 PHYSICAL RESULTS

This section presents the lithology / stratigraphy descriptions and the geotechnical results. This information was collected to: 1) provide context for the nature and extent of chemical contamination, 2) support the FS; and 3) aid in the interpretation of historical changes or events. Sediment core logs are presented in Appendix B.

4.2.1 Lithology and stratigraphy

The physical attributes of sediment strata are referred to as lithology and stratigraphy. Lithology is the set of physical characteristics of the sediment consisting of the dominant soil type (e.g., sand or silt), grain size percentages, texture (e.g., fine or medium grain), sorting (e.g., well sorted or poorly sorted), shape, and the color and mineralogy of particles (Krumbein and Sloss 1963). Stratigraphy defines the individual sediment beds or groups of beds differentiated above or below by unity of color, texture, or gross appearance (Krumbein and Sloss 1963).

The lithology of each core was recorded in the field according to nomenclature described in ASTM D-2488 (ASTM 2001b) and a core log field key. Lithology descriptions were determined and recorded on the basis of visual differences observed in the sediment profile, including features such as density, consistency, moisture content, color, composition, grain size, organic matter content, or other notable characteristics.

Sediments were grouped into three stratigraphic units identified for the LDW based primarily on density, color, sediment type, texture, and marker bed horizons. Other information used to delineate these units included presence of anthropogenic matter, depth in waterway, proximity to shoreline features, and historical dredge events. A vertical stratigraphic profile was established by evaluating differences in the sediment lithologies described above, as well as differences or changes between sediment contacts, and correlating sediment horizons or marker beds among cores. Stratigraphic correlations were established among most cores. It should be noted that the interpretations of stratigraphy presented in this report are preliminary and are subject to change in the RI or FS reports as additional information is obtained. Based on this preliminary analysis, the three sediment stratigraphy units were identified as follows:

- **Recent –** This upper unit consisted of recent material dominated mostly by unconsolidated organic silt. This material was characterized by higher moisture content, finer texture, and higher visible organic matter compared to the underlying materials.
- **Upper Alluvium/Transition –** This middle unit consisted of mostly silty sand. The upper alluvium material was characterized by low organic matter, higher density, and higher percentage of sand compared to the upper unit. Some organic silt and woody layers were often present.

- **Lower Alluvium –** This lower unit was predominantly sand (95% and non-silty) with gradational sequences of sand and silty sand layers. The lower alluvium unit was typically demarcated by a sharp horizon at its upper interface.

In addition to the above three primary stratigraphic units, sediment was classified as "other" in a few cases in which the sediment matrix consisted of over 50% fill, woody, or anthropogenic material. Sediment descriptions and graphic keys on the core logs provide rationale for the classification of these units as "other."

The core logs (provided in Appendix B) detail the observations relating to lithology and stratigraphy for each core. The format for the sediment core logs, along with a key for sediment descriptions, is shown in Figures 4-5a and 5-5b. The logs depict four major types of information: 1) lithology profile based on recovered depths, using description categories based on ASTM nomenclature (ASTM 2001b); 2) sample interval based on recovered depths and selected analyses; 3) detailed sediment descriptions and comments; and 4) combined lithology and stratigraphy profile based on the information described above and organized according to *in situ* depths. The lithology and preliminary stratigraphy information for each core is presented on maps of the LDW on Figures 4-1a to 4-1d.

4.2.2 Geotechnical results

Results for the core samples that were analyzed for geotechnical parameters are summarized by depth interval in Table 4-15. The geotechnical tests performed on samples collected from the upper 4 ft included moisture content, specific gravity, Atterberg limits (i.e., liquid limit, plastic limit, plastic index) bulk density (dry and wet), and porosity. Detailed sample results are presented in Appendix A.

Table 4-15. Results for geotechnical parameters

Parameter	Sample Interval (ft)[a]	Number of Samples	Unit	Minimum	Maximum	Mean
Moisture	0 – 1	18	% dw	31.22	121.6	75.49
	0 – 2	18	% dw	23.17	132.1	71.25
	1 – 2	24	% dw	23.41	161.7	66.09
	2 – 4	48	% dw	19.85	127.0	63.37
Specific gravity	0 – 1	18	g/cc	2.56	2.69	2.64
	0 – 2	18	g/cc	2.57	2.73	2.66
	1 – 2	24	g/cc	2.37	2.71	2.64
	2 – 4	48	g/cc	2.06	2.80	2.64
Liquid limit[b]	0 – 1	14	% dw	37.8	77.3	61.2
	0 – 2	11	% dw	49.9	96.2	70.7
	1 – 2	15	% dw	52.9	95.4	65.7

Parameter	Sample Interval (ft)[a]	Number of Samples	Unit	Minimum	Maximum	Mean
	2 – 4	31	% dw	36.2	165	64.0
Plastic limit[b]	0 – 1	14	% dw	23.3	52.6	35.0
	0 – 2	11	% dw	27.4	60.2	38.2
	1 – 2	15	% dw	27.2	73.2	39.3
	2 – 4	31	% dw	25.6	63.4	37.1
Plasticity index[b]	0 – 1	14	% dw	12.7	41.6	26.2
	0 – 2	11	% dw	22.5	49.9	32.5
	1 – 2	15	% dw	13.8	45.4	26.4
	2 – 4	31	% dw	9.7	119	27
Bulk density (dry)	0 – 1	18	pcf	40.7	98.6	60.4
	0 – 2	18	pcf	37.9	97.5	62.9
	1 – 2	24	pcf	31.4	102.5	65.9
	2 – 4	48	pcf	36.2	112.5	67.2
Bulk density (wet)	0 – 1	18	pcf	88.9	131.5	102.0
	0 – 2	18	pcf	82.1	127.7	102.0
	1 – 2	24	pcf	77.5	129.5	103.7
	2 – 4	48	pcf	75.0	134.8	104.4
Porosity	0 – 1	18	SU	0.41	0.75	0.64
	0 – 2	18	SU	0.43	0.76	0.62
	1 – 2	24	SU	0.39	0.81	0.60
	2 – 4	48	SU	0.34	0.79	0.59

[a] Samples for geotechnical parameters were collected from intact portions of the sediment core at discrete depths rather than from the homogenized samples.

[b] Measured by Atterberg limits test.

dw – dry weight

g/cc – grams per cubic centimeter

pcf – pounds per cubic foot

SU – standard unit

Specific gravity, porosity, and wet bulk density did not vary notably with depth. The average specific gravity ranged from 2.64 to 2.66 g/cc. The average porosity of sediments ranged from 0.59 to 0.64 SU. The average wet bulk density ranged from 102 to 104.4 pcf.

Some geotechnical properties varied with depth. Average moisture content was 75% at the surface and decreased to 63% below 2 ft, which is consistent with the observations documented on the core log, which noted a decrease in water content with depth. The average dry bulk density increased with depth from 60.4 to 67.2 pcf.

Atterberg limits testing is a set of index tests (i.e., liquid limit, plastic limit, and plasticity index) performed on fine-grained silt/clay sediments to determine the relative behavior of sediments and their relation to moisture content. The liquid limit and plastic limit define the relative stages of behavior as sediment moves from a solid to a liquid state. The liquid limit marks the change of sediment from a viscous fluid to a plastic state, and the plastic limit is the point at which the sediment behaves as a solid. The average liquid limit was 61.2 to 70.7%, and the average plastic limit was 35.0 to 39.3%. Sediment samples exhibited medium to high plasticity, with the average plasticity index varying between 26.2 and 32.5% dw.

Table 4-16 provides an overall classification of the Atterberg limits results. The uppermost sample interval (0 to 1 ft) contained predominately organic clays (OH) and organic silts (OL), with 61% of the samples classified as organic. Organic content and plasticity decreased with depth, with higher percentages of non-plastic material or sand below the 2-ft depth.

Table 4-16. Results from Atterberg limits testing

Sample Interval (ft)	No. of Samples	Number of Samples by Atterberg Limits Classification						
		CH	CL	MH	ML	OH	OL	Non-Plastic
0– 1	18	1	1		1	9	2	4
0 – 2	18			2		8	1	7
1 – 2	24			4		11		9
2 – 4	48			5		22	4	17

CH – inorganic clays of high plasticity, fat clays

CL – inorganic clays of low to medium plasticity; gravelly clays, silty clays, sandy clays, lean clays

MH – inorganic silts, micaceous or diatomaceous fine sands or silt, elastic silts

ML – inorganic silts, very fine sands, rock flour, silty or clayey fine sands

OH – organic clays of medium plasticity

OL – organic silts and organic silt-clays of low plasticity

4.3 Chemical Data Validation Results

Independent validation of all chemical analysis results was conducted by LDC. The complete data validation reports for the three rounds of analyses are provided in Appendix D. The following sections summarize the results of the validation but do not list every sample affected by data qualification as a result of the data validation. Detailed information regarding every qualified sample is available in Appendix D.

4.3.1 Overall data quality

The subsurface sediment samples submitted to ARI for analysis were analyzed in 37 sample delivery groups (SDGs). LDC conducted full data validation (i.e., EPA Level 4) on seven complete ARI SDGs (JA36, JA64, JA90, JB00, JC17, JC42, and JC48) and full data validation on specific samples and analyses in nine other SDGs (JB80, JB90, JB98, JC21, JH57, JK31, JO76, JQ01, and JQ82) to meet the QAPP (Windward 2006) minimum requirement that 20% of samples undergo full validation. All sample results that were not selected for full validation underwent a summary validation. The summary validation included a review of all quality control (QC) summary forms submitted by ARI, including calibration, internal standard, and inductively coupled plasma (ICP) interference check sample summary forms. Table 4-17 identifies the numbers of samples analyzed in each SDG by ARI and Axys, the analyses performed, and the level of data validation (i.e., full or summary).

Table 4-17. Level of data validation performed for each SDG and numbers of samples in each SDG

SDG	Lab	Validation Level	Numbers of Sediment Samples Analyzed[a]											
			PCBs	SVOCs	Mercury	Other Metals	Butyltins	Pesticides	TOC and Total Solids	Grain Size	Geotech[b]	Dioxins and Furans	Salinity and Conductivity	VOCs
JA36	ARI	full	6	6	6	6	0	0	6	6	6	0	0	0
JA64	ARI	full	2	2	2	2	0	2	2	4	3	0	0	0
JA90	ARI	full	6	6	6	6	0	0	6	4	6[c]	0	0	0
JB00	ARI	full	2	2	2	2	2	0	2	2	2	0	0	0
JB01	ARI	summary	5	5	5	5	3	0	5	5	3	0	0	0
JE74	ARI	summary	0	0	0	0	0	2	0	0	0	0	0	0
JB20	ARI	summary	11	11	11	11	3	9	11	11	8	0	0	0
JB22	ARI	summary	4	4	4	4	0	0	4	4	2	0	0	0
JB30	ARI	summary	5	5	5	5	0	3	5	5	4	0	0	0
JB31	ARI	summary	10	10	10	10	3	3	10	10	5	0	0	0
JB46	ARI	summary	7	7	7	7	0	0	7	7	6	0	0	0
JB47	ARI	summary	2	2	2	2	0	0	2	2	2	0	0	0
JB64	ARI	summary	5	5	5	5	0	0	5	5	4	0	0	0
JB80	ARI	full/summary	2 (0 / 2)	2 (0 / 2)	2 (0 / 2)	2 (0 / 2)	2 (2 / 0)	0	2 (0 / 2)	2 (0 / 2)	2 (0 / 2)	0	0	0
JB82	ARI	summary	11	11	11	11	11	3	11	11	6	0	0	0
JB90	ARI	full/summary	7 (0 / 7)	7 (0 / 7)	7 (0 / 7)	7 (0 / 7)	2 (2 / 0)	0	7 (0 / 7)	5 (0 / 5)	2 (0 / 2)[c]	0	0	0
JB91	ARI	summary	2	2	2	2	2	2	2	2	2	0	0	0
JB96	ARI	summary	9	9	9	9	3	6	9	9	4	0	0	0
JB98	ARI	full/summary	12 (0 / 12)	12 (0 / 12)	12 (0 / 12)	12 (0 / 12)	6 (0 / 6)	3 (3 / 0)	12 (0 / 12)	12 (0 / 12)	8 (0 / 8)	0	0	0
JC05	ARI	summary	3	3	3	3	0	0	3	3	2	0	0	0
JC10	ARI	summary	7	7	7	7	0	0	7	7	3	0	0	0
JC17	ARI	full	0	0	0	0	0	0	0	0	0	0	8	0
JC21[d]	ARI	full/summary	8 (0 / 8)	8 (0 / 8)	8 (0 / 8)	8 (0 / 8)	3 (0 / 3)	0	20 (0 / 20)	8 (0 / 8)	6 (0 / 6)	0	0	12 (12 / 0)
JC32	ARI	summary	8	8	8	8	0	2	8	8	6	0	0	0

SDG	Lab	Validation Level	Numbers of Sediment Samples Analyzed[a]											
			PCBs	SVOCs	Mercury	Other Metals	Butyltins	Pesticides	TOC and Total Solids	Grain Size	Geotech[b]	Dioxins and Furans	Salinity and Conductivity	VOCs
JC42	ARI	full	13	13	13	13	0	3	13	13	8	0	0	0
JC48	ARI	full	3	3	3	3	3	0	3	3	2	0	0	0
JC95	ARI	summary	12	12	12	12	0	0	12	12	6	0	0	0
JE74	ARI	summary	0	0	0	0	0	2	0	0	0	0	0	0
JH57	ARI	full/summary	33 (17 / 16)	19 (7 / 12)	13 (1 / 12)	10 (1 / 9)	5 (1 / 4)	0	0	0	0	0	0	0
JK31	ARI	full/summary	0	0	0	0	0	0	33 (19 / 14)	0	0	0	0	0
JL31	ARI	summary	19	4	4	6[e]	0	0	19	0	0	0	0	0
JL32	ARI	summary	16	0	0	0	0	0	16	0	0	0	0	0
JL33	ARI	summary	8	8	0	0	0	0	16	0	0	0	0	0
JL34	ARI	summary	7	4	0	0	0	0	11	0	0	0	0	0
JO76	ARI	full/summary	18 (4 / 15)	4 (1 / 3)	5 (1 / 4)	3 (1 / 2)	2 (1 / 1)	0	18 (15 / 4)	0	0	0	0	0
JQ01	ARI	summary	1	0	0	0	0	0	1	0	0	0	0	0
JQ82	ARI	full/summary	0	0	0	0	0	0	0	0	6	0	0	0
WG18542	Axys	full	0	0	0	0	0	0	0	0	0	12	0	0
WG18542	Axys	full	0	0	0	0	0	0	0	0	0	11	0	0
WG19107	Axys	full	0	0	0	0	0	0	0	0	0	2	0	0
WG19595	Axys	full	0	0	0	0	0	0	0	0	0	1	0	0
Percentage of samples that underwent full validation			20%	20%	20%	20%	22%	20%	20%	21%	24 – 25%	100%	100%	100%

a The number of samples that underwent full or summary validation is indicated in parentheses (full/summary).

b Geotechnical parameters include specific gravity, porosity, moisture, bulk density (wet and dry), and Atterberg limits. The liquid limit, plastic limit, and plasticity index were also determined for samples that exhibited plastic Atterberg characteristics.

c Four samples were analyzed for Atterberg limits in these SDGs.

d Twelve samples were analyzed for TOC in JC21 and underwent summary data validation.

e Lead only; no other metals were analyzed on these six samples.

ARI – Analytical Resources, Inc.
Axys – Axys Analytical Services, Ltd.
PCB – polychlorinated biphenyl
SVOC – semivolatile organic compound
TOC – total organic carbon
SDG – sample delivery group

The subsurface sediment samples submitted to Axys for dioxin and furan analyses were analyzed in four SDGs (Table 4-17). LDC conducted full data validation on all of the dioxin and furan results.

The majority of the data did not require qualification, or were qualified with a J, indicating that they were estimated values. No data were rejected as a result of the data validation. Based on the information reviewed, the overall data quality was considered acceptable for use in the RI and the FS, as qualified. The results of the validation are summarized in the following subsections.

4.3.2 Sample transport and holding times

All analyses of the subsurface sediment samples were conducted within the maximum holding times. The chain-of-custody documents were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

4.3.3 Field blank results

Rinsate blanks were collected at a rate of one per week during sample collection and were submitted for each of the chemical analyses. Low concentrations of zinc and copper were detected in the rinsate blanks, ranging from 0.006 to 0.012 mg/L and 0.003 to 0.004 mg/L, respectively. Di-n-butylphthalate was detected in the rinsate blanks collected during the second and third weeks of sample collection, at a concentration below the laboratory RL but greater than the MDL (0.7 µg/L). No data were qualified as a result of these detections in the rinsate blanks. No other chemicals were detected in the rinsate blanks. A trip blank was not analyzed for VOCs.

4.3.4 Analytical results

This section presents the data validation results for each of the following groups of analytes: metals (including mercury), butyltins, SVOCs, SVOCs by SIM, PCBs as Aroclors and organochlorine pesticides, dioxins and furans, VOCs, and conventional and geotechnical parameters.

4.3.4.1 Metals (including mercury)

Calibration

An initial calibration was performed daily for all analyses, and all QC requirements were met. The frequency of analysis and all QC criteria for the initial calibration verification and continuing calibration verification (CCV) were also met for each analysis.

Blanks

Zinc was detected in three method blanks associated with SDGs JA36, JA64, and JH57, and copper was detected in two calibration blanks associated with SDGs JB96 and

JB98. No samples were qualified because these metals were either not detected or the sample concentrations were greater than five times the blank concentration.

Interference Check Sample Analysis

The frequency of analysis and QC criteria were met for interference check samples analyzed for metals, as applicable. These samples are not applicable to the mercury analyses.

Matrix Spike

All matrix spike (MS) results were within QC limits, with the following exceptions. The MS recoveries were below QC limits of 70 to 130% for zinc (56%) in SDGs JB90 and JB91 and for copper (64%) in SDGs JB01 and JB22. Associated samples were J- or UJ-qualified for these chemicals. MS recoveries of 194 and 354% for lead in the MS samples associated with SDGs JC21, JB90, and JB91 were elevated and the associated detected results were J-qualified.

Low percent recoveries were reported for all MS samples (ranging from 13 to 49%), resulting in J- or UJ-qualification of all detected and non-detected antimony results. The results were not rejected because the post-digestion spike recoveries for antimony were greater than 75%, although the systematic low recoveries may be indicative of an overall low bias in both the detected and non-detected results for this chemical.

Laboratory Duplicates

Laboratory duplicates were analyzed at the required frequency. All laboratory duplicate results met QC limits of ≤ 30% relative percent difference (RPD), with the exception of some laboratory duplicates for the analytes listed in Table 4-18. As a result of the high RPDs, the results in the SDGs associated with the laboratory duplicates were J- or UJ-qualified.

Table 4-18. Metals sample results qualified because of high laboratory duplicate RPD

Analyte	Number of Qualified Samples	RPD or Range of RPDs
Copper	18	35% – 67%
Lead	19	45% – 52%
Mercury	17	44% – 74%
Molybdenum	3	40%
Nickel	9	47%

RPD – relative percent difference

Laboratory Control Samples and Standard Reference Material

All percent recoveries for laboratory control samples (LCS) were within QC limits. Standard reference material (SRM) samples were analyzed at the required frequencies, and all results were within QC limits.

Sample Result Verification

All sample result verifications met validation criteria.

4.3.4.2 Butyltins

Calibration

Initial calibration was performed as required by the method. Calibration verifications were also performed at the required frequency, and all aspects of the calibration were within QC limits.

Blanks

No butyltin compounds were detected in the method blanks.

Surrogate Recovery

All surrogate recoveries were within QC limits.

Matrix Spike

MS/matrix spike duplicate (MSD) results were within QC limits in all undiluted samples, with the following exceptions. The MS percent recovery of 17% (QC limit of 20 to 130%) and RPD of 51% (QC limit of ≤ 50%) for monobutyltin in sample LDW-SC20-2-4 resulted in the UJ-qualification of the non-detected result in this sample. The MS recovery of 281% and the RPD of 65% for dibutyltin were biased high in sample LDW-SC28-0-1, resulting in the J-qualification of the detected result in this sample.

Laboratory Control Samples

All LCS results were within QC limits.

Internal Standards

All internal standard recoveries and retention times were within QC limits.

4.3.4.3 SVOCs (including PAHs)

Calibration

The initial calibration was conducted correctly and verified at the required frequencies. All response factors, system performance check compounds, and percent relative standard deviations (%RSDs) were adequate in the initial calibration, with the following exceptions. Five %RSDs, ranging from 39 to 73%, were outside QC limits for 2,4-dinitrophenol, affecting 18 SDGs. All associated results were non-detected and were UJ-qualified. In SDG JO76, 4,6-dinitro-o-cresol had a %RSD outside of QC limits at 35%, resulting in the UJ-qualification of four non-detected results.

All percent differences (%Ds) of the continuing calibration relative to the initial calibration were ≤ 25%, with the exception of some sample results for eight SVOCs (Table 4-19). As a result of the high %Ds, the results for these chemicals associated with the CCVs were J- or UJ-qualified.

Table 4-19. SVOC sample results J- or UJ-qualified because of CCV percent differences outside of QC limits

Analyte	Number of Qualified Samples	CCV Percent Difference(s) Out of QC Limits
2,4-Dinitrophenol	53	25 – 100%
3,3-Dichlorobenzidine	1	38%
4,6-Dinitro-o-cresol	86	27 – 57%
4-Chloroaniline	15	26%
4-Nitrophenol	38	28 – 30%
Hexachlorocyclopentadiene	46	34 – 54%
Indeno(1,2,3-cd)pyrene	17	27 – 30%
Pyrene	17	34 – 65%

CCV – continuing calibration verification

%D – percent difference

QC – quality control

SVOC – semivolatile organic compound

The %D of the initial calibration verification (second source standard) for hexachloro-cyclopentadiene in SDG JO76 was 28%, which was outside the QC limit of ≤ 25%. This chemical was not detected in the four associated samples and the results were UJ-qualified.

Blanks

SVOCs were detected in 14 method blanks. Sample concentrations were compared to concentrations detected in the method blanks. Detected concentrations that were less than 10 times the blank concentration for phthalates, which are common laboratory contaminants, or less than 5 times the blank concentration for other SVOCs were qualified as non-detected with elevated RLs, as shown in Table 4-20.

Table 4-20. SVOC sample results qualified because of method blank contamination

Analyte	Number of Qualified Samples	Lowest Modified Final Concentration (µg/kg dw)	Highest Modified Final Concentration (µg/kg dw)
Di-n-butylphthalate	30	20 U	180 U
Phenol	13	24 U	400 U

Analyte	Number of Qualified Samples	Lowest Modified Final Concentration (µg/kg dw)	Highest Modified Final Concentration (µg/kg dw)
Bis(2-ethylhexyl) phthalate	12	27 U	530 U
4-Methylphenol	1	25 U	25 U
Benzo(a)anthracene	1	64 U	64 U
Fluoranthene	1	54 U	54 U
Pyrene	1	35 U	35 U

dw – dry weight

SVOC – semivolatile organic compound

Surrogate Recovery

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries were within QC limits of 40 to 130%, with the exception of 10 samples, which exhibited low surrogate recoveries ranging from 28 to 39%. The results for chemicals associated with the surrogates in these samples were J- or UJ-qualified as estimated.

Matrix Spike

All MS / MSD results were within QC limits of 40 to 130%, with the following exceptions. An MSD percent recovery of 135% in LDW-SC42-2-4 and an MS percent recovery of 35% in LDW-SC-201-1.5-4 resulted in a J-qualification of the detected pyrene concentrations. The MS / MSD for sample LDW-SC6-2-4.5 exhibited low recoveries for chrysene, benzo(k)fluoranthene, phenanthrene, and phenol, resulting in J-qualification of the results for these detected chemicals. The RPD for benzo(g,h,i)perylene was 75%, outside the QC limit of 50% in the MS / MSD in SDG JO76. The associated detected result was J-qualified.

Laboratory Control Samples and Standard Reference Material

LCS results were reviewed, and percent recovery results were within QC limits of 40 to 130%, with the exception of some results for the analytes noted in Table 4-21. Both detected and non-detected results associated with low LCS recoveries were J- or UJ-qualified, as applicable. Only detected results were J-qualified for high LCS recoveries. Although the percent recoveries of aniline, 4-chloroaniline, 3,3’dichlorobenzidine, and 3-nitroaniline were as low as 0%, the data were qualified as estimated. The non-detect results were not rejected despite the low recoveries because the concentrations of these compounds were low in the LCS solution prior to extraction. The vendor of the LCS spiking solution indicated that the concentrations of these chemicals cannot be certified because of the instability of these compounds in solution. The laboratory assayed the spiking solution, and recoveries were between 40 and 56% of the expected concentration. These chemicals are not required spiked compounds, and therefore, no additional data were qualified or rejected. SRM samples were analyzed at required frequencies, and all results were within QC limits.

Table 4-21. SVOC sample results qualified because of LCS percent recoveries outside of QC limits

Analyte	Number of Qualified Samples	LCS Percent Recovery or Range of Recoveries
2,4-Dinitrophenol	3	28%
3,3-Dichlorobenzidine	162	0 – 30%
3-Nitroaniline	58	0 – 34%
4,6-Dinitro-o-cresol	9	39%
4-Chloroaniline	178	0 – 39%
4-Nitroaniline	20	19%
Aniline	167	0 – 23%
Dibenzo(a,h)anthracene	5	132%
Hexachlorocyclopentadiene	21	36 – 37%

LCS – laboratory control sample

QC – quality control

SVOC – semivolatile organic compound

Internal Standards

All internal standard areas and retention times were within QC limits, except for select internal standards in 15 samples. Consequently, all of the results for the chemicals associated with these specific internal standards were J- or UJ-qualified in the samples with low recovery (perylene-d12 in 10 samples). Detected concentrations were J-qualified as estimated in the samples with high internal standard recovery (di-n-octylphthalate-d4 in four samples, and both di-n-octylphthalate-d4 and chrysene-d12 in one sample).

Compound Quantification

All compound identification and quantification parameters were within validation criteria. When detected concentrations exceeded the calibration range of the instrument, extracts were diluted and reanalyzed to obtain results within the calibration range. Three results for aniline were Y-qualified by the laboratory as non-detect at elevated RLs ranging from 33 to 120 µg/kg dw. The Y-qualifier indicates that chromatographic interference in the sample prevented adequate resolution of the analyte at the standard RL, which is 20 µg/kg dw for this chemical. The Y-qualifier is mapped to a U-qualifier to indicate a non-detected result.

4.3.4.4 SVOCs by selected ion monitoring

Calibration

Initial and continuing calibrations were conducted as required by the method. The initial calibration %RSDs were less than or equal to the QC limit of 30% for all compounds, with the following exceptions. Eighteen detected benzoic acid results for

SDGs JC32, JC48, and JC95 were J-qualified based on an initial calibration %RSD of 32%.

All of the continuing calibration percent differences were less than 25%, with the exception of some results for the analytes noted in Table 4-22. Associated detected and non-detected results were J- or UJ-qualified, as applicable.

Table 4-22. SVOC SIM sample results qualified because of CCV percent differences outside of QC limits

Analyte	Number of Qualified Samples	CCV Percent Difference(s) Out of QC Limits
Benzoic acid	53	29 – 73%
Pentachlorophenol	5	43%
Benzyl alcohol	27	26 – 29%
1,2,4-Trichlorobenzene	77	26 – 74%
2,4-Dimethylphenol	62	30 – 89%
n-Nitrosodimethylamine	17	26 – 35%
2-Methylphenol	31	30 – 58%
Butyl benzyl phthalate	10	30%
n-Nitroso-di-n-propylamine	31	25 – 68%

CCV – continuing calibration verification

QC – quality control

SIM – selected ion monitoring

SVOC – semivolatile organic compound

Blanks

Two chemicals were detected in the method blanks. Sample concentrations were compared to the concentrations detected in the method blanks. Detected sample concentrations that were less than 5 times the blank concentration for benzoic acid, or less than 10 times the blank concentration for butyl benzyl phthalate, which is common laboratory contaminant, were qualified as non-detected with elevated RLs as a result of blank contamination. Five method blanks contained benzoic acid at concentrations ranging from 32 to 76 µg/kg dw, which resulted in the U-qualification of 31 samples with elevated RLs ranging from 63 to 430 µg/kg dw. One other method blank contained butyl benzyl phthalate at a concentration of 6 µg/kg dw, which resulted in the U-qualification of seven samples with elevated RLs ranging from 12 to 38 µg/kg dw.

Surrogate Recovery

All surrogate recoveries were above the QC limits of 40%, except for low percent recoveries of 30 and 38% for two surrogates in LDW-SC23-1.5-2. As a result, all of the detected or non-detected results for SVOC compounds associated with these surrogates were J- or UJ-qualified.

Matrix Spike

All MS / MSD results were within QC limits, with the following exceptions. The MS and MSD recoveries of 29 and 33%, respectively, associated with sample LDW-SC1-0.5-1 were below the lower limit of 40% for 1,2,4-trichlorobenzene. N-nitroso-di-n-propylamine recoveries of 0% were also below the lower limit because of matrix interference. These chemicals were not detected in the associated sample, and the results for both chemicals were UJ-qualified. A non-detected pentachlorophenol result in sample LDW-SC42-2-4 was UJ-qualified because of a high RPD (59%), and a detected pentachlorophenol result in LDW-SC25-2-4 was J-qualified because of a low MS recovery (37%).

Laboratory Control Samples and Standard Reference Materials

LCS results were reviewed and results were within QC limits of 40 to 130%, with the exception of some samples for the six SVOCs listed in Table 4-23. Detected results were J-qualified for high LCS recoveries. Detected and non-detected results associated with low LCS recoveries were J- or UJ-qualified, as applicable. SRM samples were analyzed at required frequencies and results were within QC limits.

Table 4-23. SVOC SIM sample results qualified because of LCS recoveries outside of QC limits

Analyte	Number of Qualified Samples	LCS Recovery or Range of LCS Recoveries
1,2,4-Trichlorobenzene	21	132 – 169%
Benzoic acid	18	137 – 446%
2,4-Dimethylphenol	49	1 – 138%
2-Methylphenol	11	138 – 154%
n-Nitroso-di-n-propylamine	10	29%
n-Nitrosodiphenylamine	20	14%

LCS – laboratory control sample

QC – quality control

SIM – selected ion monitoring

SVOC – semivolatile organic compound

Internal Standards

All internal standard areas and retention times were within QC limits, with the following exceptions. Sixteen samples had high internal standard recoveries outside of method acceptance criteria, resulting in the J-qualification of the associated detected results (chrysene-d12 in seven samples, both chrysene-d12 and perylene-d12 in six samples, both phenanthrene-d10 and chrysene-d12 in two samples, and perylene-d12 in one sample). In addition, six samples had low internal standard recoveries (naphthalene-d8 in four samples and acenapthene-d10 in two samples). Both detected and non-detected chemicals associated with these internal standards were J- or UJ-qualified.

Compound Quantification

All compound identification and quantification parameters were within validation criteria**.** When detected concentrations exceeded the calibration range of the instrument, extracts were diluted and reanalyzed to obtain results within the calibration range. Results for seven chemicals were Y-qualified by the laboratory as non-detect at elevated RLs, as presented in Table 4-24. The Y-qualifier indicates that chromatographic interference in the sample prevented adequate resolution of the analyte at the standard RLs. The Y-qualifier is mapped to a U-qualifier to indicate a non-detected result.

Table 4-24. SVOC SIM sample results reported at elevated RLs because of chromatographic interferences

Analyte	Number of Samples With Elevated RLs	Standard RL (µg/kg dw)	Elevated RL or Range of Elevated RLs (µg/kg dw)
1,2,4-Trichlorobenzene	2	6.7	22
2,4-Dimethylphenol	1	6.7	28
Benzyl alcohol	5	33	31 – 40
Butyl benzyl phthalate	1	6.7	36
Dimethyl phthalate	1	20	44
n-Nitroso-di-n-propylamine	1	33	69
n-Nitrosodiphenylamine	154	33	6.5 – 7,300

SVOC – semivolatile organic compound

SIM – selected ion monitoring

RL – reporting limit

dw – dry weight

4.3.4.5 PCBs (as Aroclors) and organochlorine pesticides

Calibration

Initial calibration and CCVs were conducted as required by the methods. The %RSDs were less than or equal to 20% for all compounds, and retention times of all compounds were within QC limits. The %D calculated for the CCVs were within QC limits of 15%, with the following exceptions. In the PCB analyses, three CCVs of 16% exceeded the %D QC limit (one for Aroclor 1016 and two for Aroclor 1260), resulting in the J- or UJ-qualification of associated non-detected and detected results for eight samples. In the pesticides analyses, %D calculated for the CCVs ranged from 18 to 25% and exceeded the %D QC limit, resulting in the UJ-qualification of non-detected results for four samples each for endrin ketone and 2,4'-DDT; three samples for

4,4’-DDD; and two samples each for endrin aldehyde, cis-nonachlor, dieldrin, and methoxychlor.

Blanks

No PCB Aroclors or pesticides were detected in any of the method blanks.

Surrogate Recovery

Surrogates were added to all samples and blanks as required by the method. Surrogate recoveries were within QC limits in all undiluted samples, with the following exceptions. In the PCB analysis, sample LDW-SC16-8-10 in SDG JH57 had a high surrogate recovery of 195%, which was outside of QC limits of 50 to 150%. The laboratory noted this high surrogate recovery as an acceptable outlier because of matrix interferences. The associated detected result for Aroclor 1260 was J-qualified. Thirteen other samples had low surrogate recoveries ranging from 32 to 48%, and associated detected and non-detected results were J- or UJ-qualified.

Internal Standards

The laboratory used internal standards for quantification in both methods EPA 8082 and EPA 8081A. All internal standard areas and retention times were within QC limits.

Matrix Spike

All MS/MSD results for PCBs were within QC limits for all undiluted samples, with one exception. The MS for LDW-SC201-1.5-4 had 175% recovery for Aroclor 1260 (QC limits of 50 to 150%), and the associated detected results in this sample were J-qualified. All MS/MSD results for pesticides were within QC limits.

Laboratory Control Samples and Standard Reference Material

The LCS results for PCBs were within the QC limits of 50 to 150% with the following exceptions. Two LCS recoveries for Aroclor 1016 were below QC limits at 49% and 43%; these were associated with one sample in SDG JO57 and seven samples in SDG JC42. These associated results were UJ-qualified.

For the pesticide analyses, a single LCS recovery for endrin aldehyde of 45% was outside of the QC limits of 50 to 150%, which resulted in UJ-qualification of two non-detected results. SRM samples were analyzed at the required frequencies and all results were within QC limits.

Compound Quantification

All pesticide and PCB compound identification and quantification parameters were within validation criteria. When detected concentrations exceeded the calibration range of the instrument, extracts were diluted and reanalyzed to obtain results within the calibration range.

In general, when more than one Aroclor is present in a sample, the potential exists for a high bias from the contribution of one Aroclor to another caused by common peaks or peaks that cannot be completely resolved. Analytical peaks are selected and Aroclor identification is made based on the best resolution possible for that particular sample. In this dataset, RLs for some PCB Aroclors were elevated in 53 samples because of chromatographic interferences and overlapping Aroclor patterns. Reported Aroclor concentrations were reported based on the individual Aroclors that provided the best match to the sample pattern.

Thirty-five samples exhibited an analytical response above standard RLs for select pesticides (Table 4-25). These tentatively identified results were Y-qualified by the laboratory as non-detect at elevated RLs. The Y-qualifier indicates that chromatographic interference from PCB congeners in the sample prevented adequate resolution of the analyte at the standard RLs. The Y-qualifier is mapped to a U-qualifier to indicate a non-detected result.

Table 4-25. Pesticide sample results reported at elevated RLs because of chromatographic interferences

Analyte	Number of Samples with Elevated RLs	Standard RL (µg/kg dw)	Elevated RL or Range of Elevated RLs (µg/kg dw)
2,4'-DDE	11	2.0	3.8 – 100
4,4'-DDD	8	2.0	3.4 – 39
4,4'-DDE	10	2.0	4.7 – 90
4,4'-DDT	32	2.0	3.2 – 160
Aldrin	1	1.0	2.6
alpha-Chlordane	3	1.0	1.6 – 9.2
beta-BHC	3	1.0	2 – 24
beta-Endosulfan	1	2.0	5.2
cis-Nonachlor	1	2.0	3.3
delta-BHC	3	1.0	1.1 – 2.2
Dieldrin	5	2.0	2.7 – 31
Endosulfan sulfate	15	2.0	3 – 69
Endrin	11	2.0	7.6 – 150
Endrin aldehyde	1	2.0	23
gamma-BHC	2	1.0	2.6 – 3.1
gamma-Chlordane	24	1.0	1.7 – 82
Heptachlor	3	1.0	1.6 – 10
Heptachlor epoxide	16	1.0	2.5 – 120
Oxychlordane	3	2.0	3.8 – 100

BHC – benzene hexachloride

dw – dry weight

RL – reporting limit

Fifteen samples had detected results for PCB Aroclors from the two analytical columns that exceeded the RPD QC limit of 40%. As a result, the detected Aroclors in the samples identified in Table 4-26 were J-qualified. The reported result was selected from the analytical column with the higher of the two values.

Table 4-26. Detected Aroclor results with dual-column RPD greater than QC limit

Sample ID	Parameter	RPD
LDW-SC2-4-6	Aroclor 1260	46
LDW-SC10-0-1	Aroclor 1242	41
LDW-SC12-2-2.5	Aroclor 1260	42
LDW-SC15-1-2	Aroclor 1260	46
LDW-SC21-2-4	Aroclor 1260	42
LDW-SC29-0-1	Aroclor 1248	50
	Aroclor 1260	52
LDW-SC33-1.5-2	Aroclor 1260	46
LDW-SC201-1.5-4	Aroclor 1242	43
LDW-SC37-1-2	Aroclor 1260	61
LDW-SC40-0-1.3	Aroclor 1254	52
LDW-SC41-4-6	Aroclor 1254	53
	Aroclor 1260	51
LDW-SC42-1-2	Aroclor 1260	43
LDW-SC44-.5-1	Aroclor 1260	46
LDW-SC45-5-6	Aroclor 1242	61
LDW-SC50-2-2.8	Aroclor 1248	46

ID – identification

QC – quality control

RPD – relative percent difference

4.3.4.6 Dioxins and furans

Calibration

All criteria for the initial and continuing calibration were met.

Blanks

Dioxins and furans were detected in all four method blanks. Sample concentrations were compared to the concentrations detected in the method blanks, and sample concentrations were either not detected or the detected concentrations were greater than five times the blank concentration, with the following exception. The detected concentrations of 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin (HpCDD) in LDW-SC40-2-4 and its laboratory duplicate were qualified as non-detected with elevated RLs of

0.309 and 0.307 ng/kg dw, respectively, because of the presence of this compound in the associated method blank.

Laboratory Duplicates

Duplicate sample analyses were reviewed, and the RPDs between the results were within QC limits for all samples.

Compound Identification and Quantification

All compound identification and quantification parameters were within validation criteria, with the following exceptions. Select results for individual dioxin and furan congeners in 11 samples did not meet the method ion abundance criteria and were K-qualified by the laboratory to indicate an estimated maximum possible concentration. All of the K-qualified results were mapped to a U-qualifier and regarded as non-detects.

Laboratory Control Samples and Standard Reference Material

LCS and SRM results were reviewed and all recoveries were within QC limits.

4.3.4.7 Total solids, grain size, total organic carbon, geotechnical methods, salinity, and conductivity

Calibration

All calibration criteria for each method were met.

Blanks

Method blanks were reviewed for each of the applicable analyses. Analytes were not detected in the method blanks at concentrations that required data qualification.

Laboratory Replicates

Laboratory replicate results were reviewed for total solids, grain size, TOC, salinity, and conductivity. All laboratory replicate results were within acceptance criteria.

Matrix Spike

MS results were reviewed for TOC analysis. Percent recoveries were within QC limits.

Laboratory Control Samples and Standard Reference Material

LCS and SRM results were reviewed for TOC analysis and salinity. SRM results were reviewed for TOC and conductivity. All LCS and SRM results were within QC limits.

Compound Quantification

Several sample results for the conventional and geotechnical analyses were verified by recalculation. All recalculated results were acceptable.

4.3.4.8 VOCs

This section presents data validation results for the 12 samples from sampling location LDW-SC49b that were analyzed for VOCs using EPA Method 8260B. ARI followed all requirements of the reference method and their standard operating procedure for this analysis.

Calibration

Initial calibration was performed as required by the method. Calibration verification samples were analyzed at the required frequency and all aspects of the calibration were within QC limits, with the following exceptions. The high CCV %D for bromomethane and chloroethane of 29 and 26%, respectively, were outside of the QC limit of 25%. All samples were non-detected for these chemicals and the results were UJ-qualified.

Blanks

No VOCs were detected in any of the method blanks associated with reported results. A trip blank was not analyzed for VOCs.

Surrogate Recovery

All surrogate recoveries were within QC limits.

Matrix Spike

Several chemicals had MS/MSD recoveries below the laboratory's established control limits, and one chemical had an MS/MSD recovery that was elevated above QC limits. The results for these chemicals were J- or UJ-qualified in the spiked sample, LDW-SC49V-11-12, because of matrix interferences.

Laboratory Control Samples

LCS results were reviewed, and all results were within the laboratory's QC limits.

Internal Standards

All internal standard areas and retention times were within QC limits, with the following exception. Recovery was low for one internal standard in three samples, and all chemical results associated with this internal standard were J- or UJ-qualified.

Compound Quantification

All compound quantitation requirements were within validation criteria, with the following exception. Two samples were diluted to obtain results within the calibration range of the instrument. The analytical dilution of these samples was prepared based on the chemicals of the highest detected concentration in the original analysis. As a result, some chemicals were diluted out of detection range. The results for these chemicals that were detected over calibration range in the original analysis were reported with J-qualification.

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