APPENDIX D

SEDIMENT CHEMISTRY DATA

Excerpts from the

COMMENCEMENT BAY DAMAGE ASSESSMENT STUDIES

HYLEBOS WATERWAY DATA AND DATA ANALYSIS

REPORT

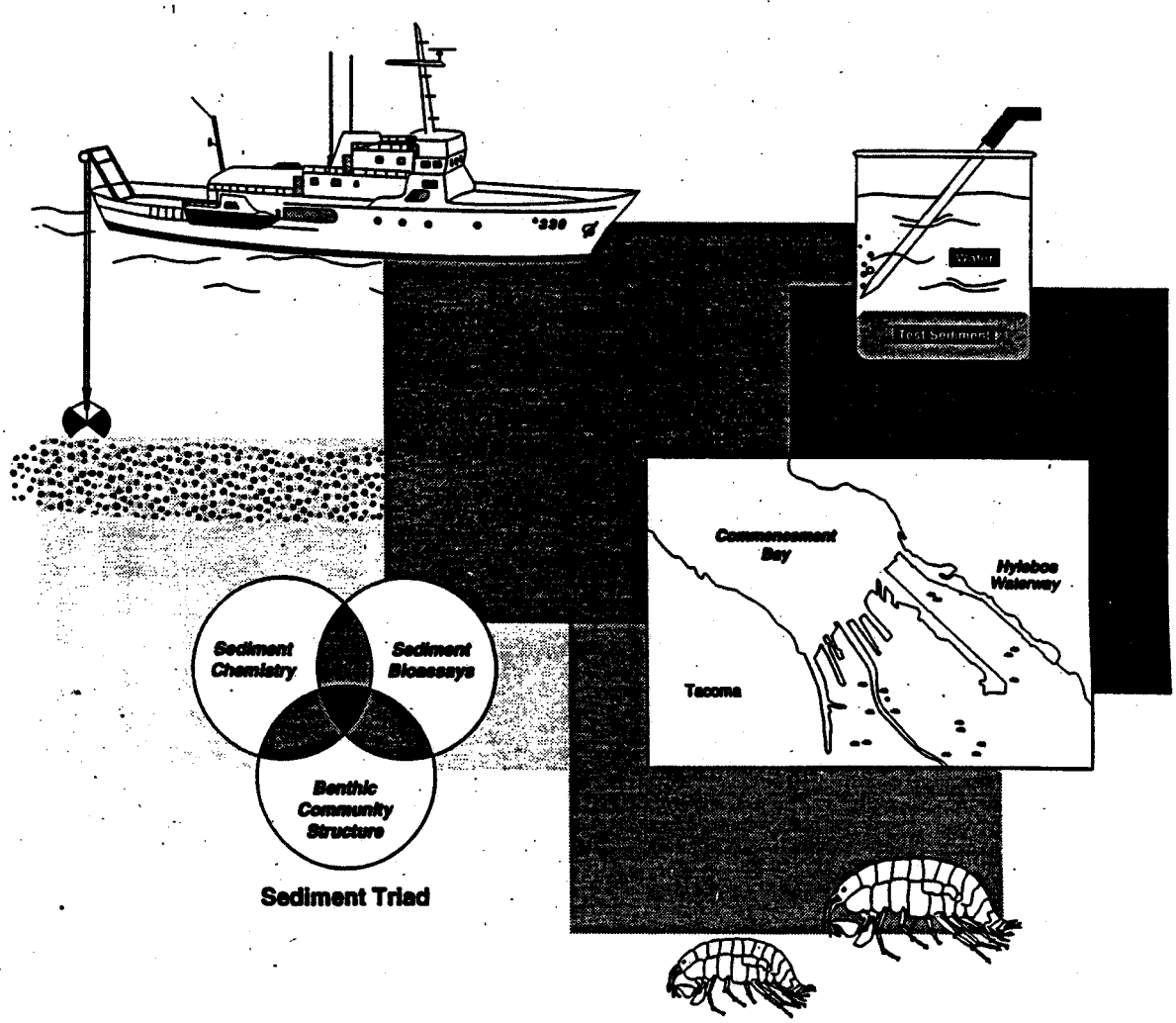
Reprinted with permission by Commencement Bay Natural Resource Trustees

Sediment Chemical Analyses (except volatile organic analyses)
conducted by
Northwest Fisheries Science Center

February 1996

Commencement Bay Damage Assessment Studies

Hylebos Waterway Data and Data Analysis Report



Prepared by:

ENVIRONMENT CONSULTANTS
200 West Mercer Street
Suite 403
Seattle, Washington 98119

Prepared for:

Commencement Bay Natural Resource Trustees

The National Oceanic and Atmospheric Administration of the U.S. Department of Commerce; the U.S. Department of the Interior, including the U.S. Fish and Wildlife Service; the Washington Department of Ecology, Washington Department of Fish and Wildlife, and Washington Department of Natural Resources; the Puyallup Tribe of Indians; and the Muckleshoot Indian Tribe

SEDIMENT CHEMISTRY

ERRATUM

There is an error in Tables 3-4 and 3-6, in reporting how the organotin analyses were conducted. Organotin analsyes were determined by solvent extraction and GC analysis rather than acid-digestion.

3.2.1.1 Trace Element Method Comparison

Total-to-strong acid ratios calculated for the trace elements analyzed in this study are presented in Appendix C. For most trace elements the concentrations generated by the total acid method were higher than that generated by the strong acid method by a factor of about 1.2, as shown below:

Average of total to strong acid ratios:

- Antimony — 5.85
- Arsenic — 0.82
- Cadmium — 1.07
- Chromium — 1.14
- Copper — 1.09
- Lead — 1.32
- Mercury — 0.85
- Nickel — 1.49
- Silver — 0.75
- Zinc — 1.17

As measured by total acid digestion, arsenic concentrations exceeded the SQS at three stations and exceeded the SQO at three stations; zinc concentrations exceeded the SQS at two stations and exceeded the SQO at two stations (Table 3-6). In comparison, as measured by strong acid digestion, arsenic and zinc concentrations exceeded SQS at one station and the SQO at one station (Table 3-7). These data indicate that for most elements analyzed, both methods yield comparable results.

3.2.2 Organic Compounds: Comparison to Criteria

Table 3-8 summarizes the concentrations of organic compounds in surface sediments collected from the Hylebos Waterway. All polycyclic aromatic hydrocarbons (PAHs) on the analyte list were detected at all 28 of Hylebos Waterway stations, but none of the concentrations exceeded SQS. However, the concentrations of anthracene and phenanthrene exceeded their SQO. There was at least one exceedance of SQO for each of the high molecular weight PAHs (HPAHs), but no exceedances of SQS. All exceedances occurred in Segments 1 and 2 (Figure 3-1). All HPAH compounds were detected at Station DAC-HY-24 (Segment 1) at concentrations exceeding the SQO.

All of the measured phenols except 2-methylphenol were detected at all of the Hylebos Waterway stations. Only pentachlorophenol exceeded the SQS and SQO, at one station in Segment 5 (DAC-HY-09).

Concentrations of 1,4-dichlorobenzene exceeded the SQS at two stations, and concentrations of 1,2,4-trichlorobenzene exceeded the SQS at 15 stations and the SQO at 4 stations (Figure 3-1). The concentration of neither 1,3- nor 1,2-dichlorobenzene exceeded SQS or SQO at any station.

Hexachlorobutadiene was detected at all 28 Hylebos Waterway stations. Concentrations exceeded both the SQS and SQO at five stations in Segments 5 and 6 (DAC-HY-06 through -10). With the exception of Station DAC-HY-17, the concentration of hexachlorobutadiene exceeded the SQO at all stations in Segments 2 through 6 (Figure 3-1).

Concentrations of bis(2-ethylhexyl)phthalate exceeded the SQS at Station DAC-HY-09, and the SQO at Station DAC-HY-24 (Figure 3-1). Concentrations of butylbenzylphthalate exceeded the SQS at Station DAC-HY-23 in Segment 2 (Figure 3-1). No other phthalates exceeded SQS or SQO concentrations.

All pesticides, except for aldrin, were detected at most of the Hylebos Waterway stations. Concentrations of hexachlorobenzene exceeded the SQS at 21 of 28 stations, and the SQO at 12 of 28 stations. The exceedances of the SQS occurred at every station mouthward of and including Station DAC-HY-21, which is midway in Segment 2 (Figure 3-1). Sediments from all stations in Segment 5 contained hexachlorobenzene at concentrations exceeding the SQO. The remaining exceedances occurred at various stations throughout the Hylebos Waterway.

Concentrations of p,p'-DDE exceeded the SQO at three stations, and concentrations of p,p'-DDD exceeded the SQO at two stations. All five exceedances occurred in Segment 1 (Figure 3-1). p,p'-DDT was detected at nearly all Hylebos Waterway stations, but none of the measured concentrations exceeded the SQO criterion. There are no SQS criteria for DDT or its metabolites. No SQS or SQO criteria exist for the other pesticides. The only comparison criteria available are the PSDDA screening guidelines; there were no exceedances of these concentrations for other pesticides.

PCBs were detected in all sediment samples from the Hylebos Waterway. Total PCBs were determined by measuring the concentrations of 17 chlorobiphenyl congeners, summing the concentrations, and multiplying by 2, as specified in NOAA (1995). The concentration of total PCBs determined in this manner exceeded the SQS at 19 of the 28 Hylebøs Waterway stations, but did not exceed the SQO at any station (Figure 3-1). Segment 1 was the only segment that had no samples with total PCB concentrations exceeding the SQS.

Trichloroethene was the only VOC detected in any sample. It was measured in sediments from one station, but the SQO was not exceeded. Currently no SQS concentrations exist for VOCs.

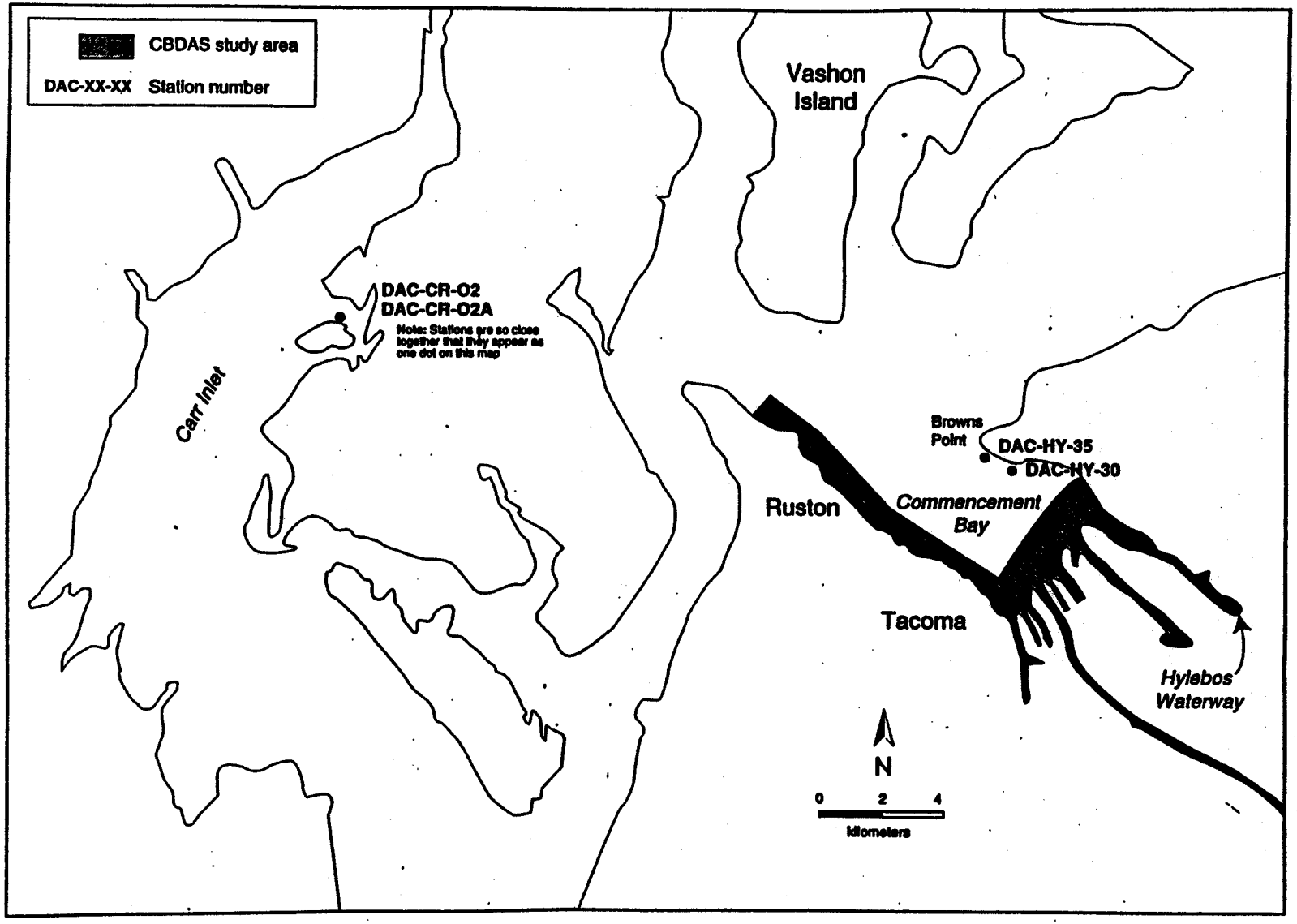


Figure 1-1. South and southcentral Puget Sound; locations of the CBDAS, the Hylebos Waterway, and reference stations in Carr Inlet and Commencement Bay.

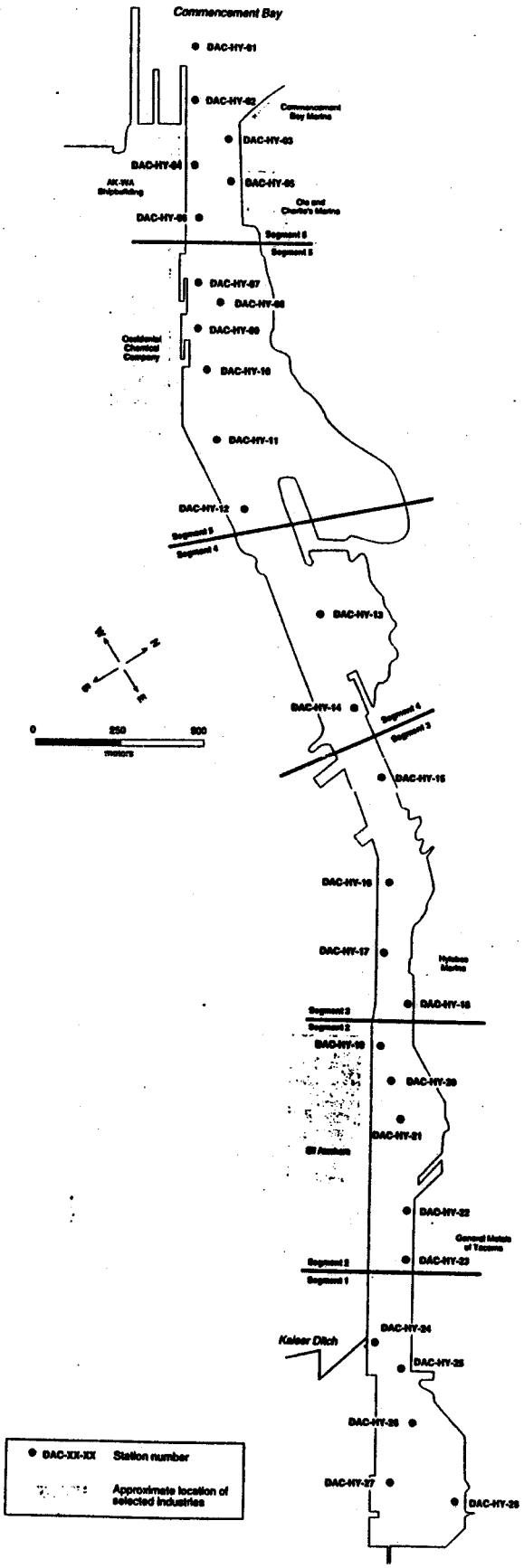


Figure 2-1. Approximate station locations and locations of selected industries in Hylebos Waterway.

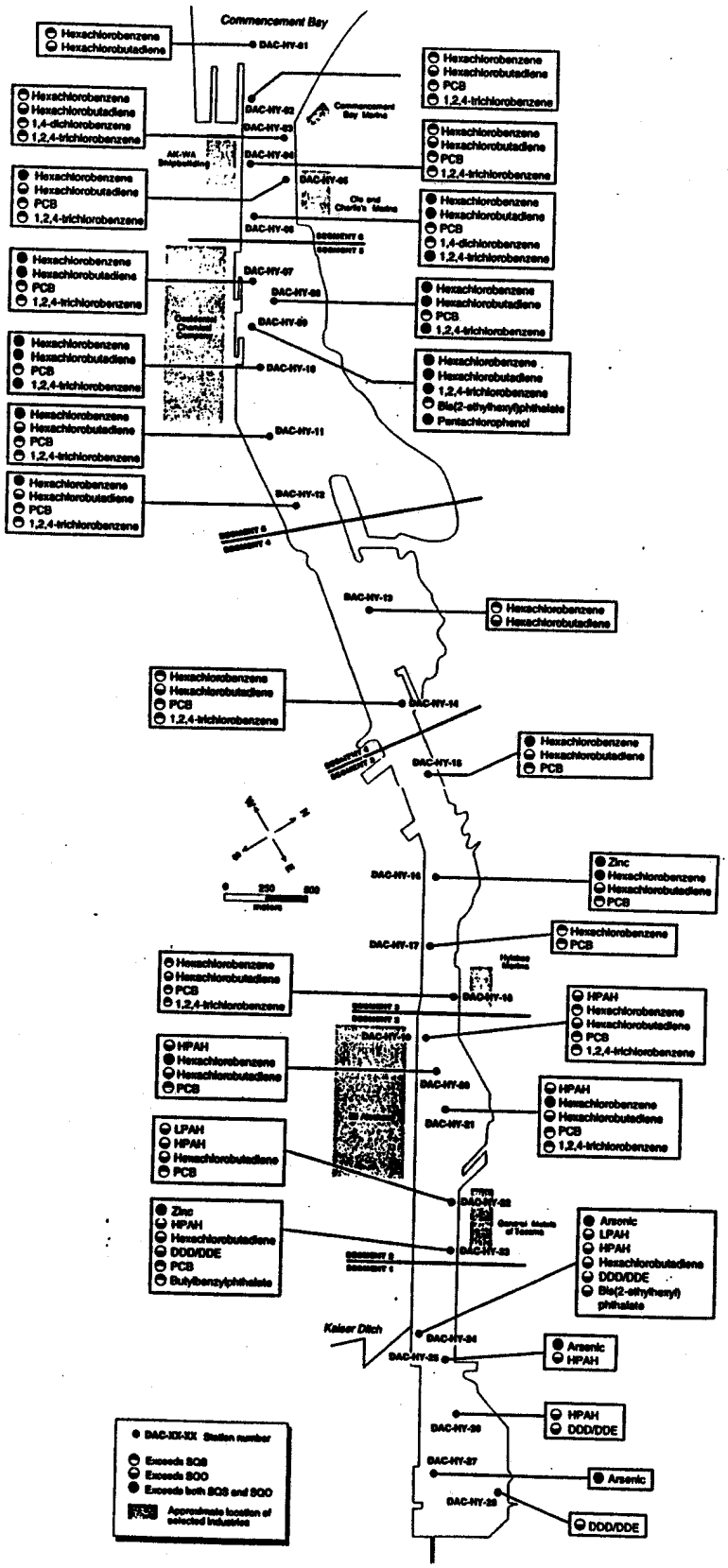


Figure 3-1. Contaminants of concern that exceeded SQS and/or SQO concentrations at Hylebos Waterway stations.

TABLE 3-4. CONCENTRATIONS OF TRACE ELEMENTS AND ORGANOTIN COMPOUNDS MEASURED IN SURFACE SEDIMENTS FROM REFERENCE STATIONS IN CARR INLET AND COMMENCEMENT BAY, DETERMINED BY THE TOTAL ACID DIGESTION METHOD

	Carr Inlet Stations		Commencement Bay Stations			
Parameter	DAC-CR-02	DAC-CR-02A	DAC-HY-30	DAC-HY-35	SQS	SQO
Trace Elements (mg/kg DW)						
Antimony	1.22U	1.22U	1.22U	1.22U	na	150
Arsenic	3.06	1.87	6.41	6.61	57	57
Cadmium	0.348	0.180	0.295	0.217	5.1	5.1
Chromium	61.4	45.8	27.7	20.9	260	na
Copper	16.0	9.80	71.4	52.1	390	390
Lead	10.4	8.49	28.7	40.9	450	450
Mercury	0.038UJ	0.024UJ	0.251UJ	0.169UJ	0.41	0.59
Nickel	33.9	27.5	26.1	24.6	na	140
Silver	0.076	0.043	0.240	0.217	6.1	6.1
Zinc	17.2	15.7U	75.5	64.6	410	410
Organotin Compounds (μg/kg DW)						
Monobutyltin	5.75U	7.26U	10.5U	7.14U	na	na
Dibutyltin	5.75U	7.26U	19.9	7.14U	na	na
Tributyltin	5.75U	7.26U	25.5	7.14U	na	na
Tetrabutyltin	5.75U	7.26U	10.5U	7.14U	na	na

NOTES: None of the measured trace elements or organotin compounds exceeded the SQS or SQO concentrations at any of the reference stations. DW -Dry weight

na - Not applicable

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

TABLE 3-5. CONCENTRATIONS OF ORGANIC COMPOUNDS MEASURED IN SURFACE SEDIMENTS FROM REFERENCE STATIONS IN CARR INLET AND COMMENCEMENT BAY

Parameter	Carr Inlet Stations		Commencement Bay Stations		SQO	Carr Inlet Stations		Commencement Bay Stations		SQS
	DAC-CR-02 (µg/kg DW)	DAC-CR-02A (µg/kg DW)	DAC-HY-30 (µg/kg DW)	DAC-HY-35 (µg/kg DW)	(µg/kg DW)	DAC-CR-02 (µg/kg OC)	DAC-CR-02A (µg/kg OC)	DAC-HY-30 (µg/kg OC)	DAC-HY-35 (µg/kg OC)	(µg/kg OC)
Semivolatile Organic Compounds										
2-Methylnaphthalene	0.700 U	2.30	68.0	99.0	670	71.4 UJ	311	2,810	5,790	38,000
Acenaphthene	0.820 U	1.90 U	66.0	100	500	83.6 U	257 U	2,730	5,850	16,000
Acenaphthylene	0.480 U	1.10 U	12.0	23.0	1,300	48.9 U	149 U	496	1,350	66,000
Anthracene	0.420 U	1.40	190	230	960	42.8 U	189	7,850	13,500	220,000
Fluorene	0.660 U	1.50 U	82.0	110	540	67.3 U	203 U	3,390	6,430	23,000
Naphthalene	1.30	4.00	94.0	170	2,100	133	541	3,880	9,940	99,000
Phenanthrene	2.90	7.00	550 J	820	1,500	296	946	22,700 J	48,000	100,000
Total LPAHs	<6.58	<16.9	1,062 J	1,450	5,200	<671	<2,280	41,100 J	85,000	370,000
Benz(a)anthracene	0.570 U	3.50	240	340	1,600	58.1 U	473	9,920	19,900	110,000
Benzo(a)pyrene	0.550 U	3.50	260	250	1,600	56.1 U	473	10,700	14,600	99,000
Benzo(g,h,i)perylene	0.680 U	4.90	170	150	720	69.3 U	662	7,020	8,770	31,000
Chrysene	2.10	6.40	340	370	2,800	214	865	14,000	21,600	110,000
Dibenz(a,h)anthracene	0.720 U	1.10 U	43.0	34.0	230	73.4 U	149 U	1,780	1,990	12,000
Fluoranthene	6.10	15.0	670	780	2,500	622	2,030	27,700 J	45,600	160,000
Indeno(1,2,3-c,d)pyrene	0.720 U	3.70	180	140	690	73.4 U	500	7,440	8,190	34,000
Pyrene	4.90	12.0	750	890	3,300	499	1,620	31,000	52,000	1,000,000
Total benzofluoranthenes	1.10	12.0	530	460	3,600	112	1,620	21,900	26,900	230,000
Total HPAHs	<17.4	<62.1	3,183 J	3,410	17,000	<1,780	<8,390	132,000 J	200,000	960,000

TABLE 3-5. (CONTINUED)

Parameter	Carr Inlet Stations		Commencement Bay Stations		SQO	Carr Inlet Stations		Commencement Bay Stations		SQS
	DAC-CR-02 (µg/kg DW)	DAC-CR-02A (µg/kg DW)	DAC-HY-30 (µg/kg DW)	DAC-HY-35 (µg/kg DW)	(µg/kg DW)	DAC-CR-02 (µg/kg OC)	DAC-CR-02A (µg/kg OC)	DAC-HY-30 (µg/kg OC)	DAC-HY-35 (µg/kg OC)	(µg/kg OC)
2-Methylphenol	2.00 U	1.90 U	4.60 U	4.50 U	63	na	na	na	na	na
2,4-Dimethylphenol	0.410	1.50	4.40	6.00	29	na	na	na	na	na
4-Methylphenol	3.90	4.00	25.0	32.0	670	na	na	na	na	na
Pentachlorophenol	0.760 J	0.700 J	13.0 J	7.80 J	360	na	na	na	na	na
Phenol	21.0	16.0 U	31.0	31.0	420	na	na	na	na	na
1,2-Dichlorobenzene	0.300 U	0.400 U	1.60	1.80	50	30.6 U	54 U	66.1	105	2,300
1,2,4-Trichlorobenzene	0.270 U	0.320 U	2.50	2.00	51	27.5 U	43.2 U	103	117	810
1,3-Dichlorobenzene	0.260 U	0.380 U	1.00	0.690	170	na	na	na	na	na
1,4-Dichlorobenzene	1.20 U	1.80 U	10.0	7.70 U	110	122 U	243 U	413	450 U	3,100
Hexachlorobutadiene	1.10 U	1.50 U	3.30	3.20	11	112 U	203 U	136	187	3,900
Di-n-octyl phthalate	0.190 U	0.350 U	7.80	1.80	6,200	19.4 U	47.3 U	322	105	58,000
Bis(2-ethylhexyl)phthalate	7.90 U	18.0 UJ	150 J	97.0 J	1,300	805 U	2,430 UJ	6,200 J	5,670 J	47,000
Butylbenzyl phthalate	0.970 UJ	1.90 U	13.0	5.70 UJ	900	98.9 UJ	257 U	537	333 UJ	4,900
Diethyl phthalate	2.10 UJ	2.50 U	3.20 UJ	2.70 UJ	200	214 UJ	338 U	132 UJ	158 UJ	61,000
Dimethyl phthalate	0.210 J	0.420 UJ	20.0	5.50 J	160	21.4 J	56.8 UJ	826	322 J	53,000
Di-n-butyl phthalate	2.70 UJ	5.40 UJ	11.0 UJ	6.80 UJ	1,400	275 UJ	730 UJ	455 UJ	398 UJ	220,000
Gamma-HCH (Lindane)	0.070	0.110 U	0.530	0.210	na	na	na	na	na	na
Hexachlorobenzene	0.110 U	0.180	4.60	4.30	22	11.2 U	24.3	190	251	380

TABLE 3-5. (CONTINUED)

Parameter	Carr Inlet Stations		Commencement Bay Stations			Carr Inlet Stations		Commencement Bay Stations		
	DAC-CR-02 (µg/kg DW)	DAC-CR-02A (µg/kg DW)	DAC-HY-30 (µg/kg DW)	DAC-HY-35 (µg/kg DW)	SQO (µg/kg DW)	DAC-CR-02 (µg/kg OC)	DAC-CR-02A (µg/kg OC)	DAC-HY-30 (µg/kg OC)	DAC-HY-35 (µg/kg OC)	SQS (µg/kg OC)
Aldrin	0.100	0.082 U	0.090 U	0.120 U	na	na	na	na	na	na
Alpha-chlordane	0.130	0.390	0.540	0.350	na	na	na	na	na	na
Gamma-chlordane	0.110	0.550	0.097 U	1.80	na	na	na	na	na	na
Chlordane	0.240	0.940	0.540	2.20	na	na	na	na	na	na
Dieldrin	0.054	0.086 U	0.570	0.340	na	na	na	na	na	na
Heptachlor	0.100	0.100 U	0.300	0.100	na	na	na	na	na	na
Chlorobiphenyl 10/209*	0.055 U	0.150	3.90	1.50	na	na	na	na	na	na
Chlorobiphenyl 3/18*	0.190 U	0.280 U	2.30	2.60	na	na	na	na	na	na
Chlorobiphenyl 3/28*	0.180 U	0.220 U	0.770 U	0.980 U	na	na	na	na	na	na
Chlorobiphenyl 4/44*	0.530 U	0.560 U	2.00 U	1.20 U	na	na	na	na	na	na
Chlorobiphenyl 4/52*	0.180	0.210	2.10	1.70	na	na	na	na	na	na
Chlorobiphenyl 4/66*	0.080 U	0.200	0.200 U	0.100 U	na	na	na	na	na	na
Chlorobiphenyl 5/101*	0.200 U	0.270	2.50	2.90	na	na	na	na	na	na
Chlorobiphenyl 5/105*	0.160	0.075 U	0.520	1.30	na	na	na	na	na	na
Chlorobiphenyl 5/118*	0.250	0.390	2.70	5.10	na	na	na	na	na	na
Chlorobiphenyl 6/128*	0.077	0.071 U	0.710	0.500	na	na	na	na	na	na
Chlorobiphenyl 6/138*	0.340 U	0.510 U	2.80	4.10	na	na	na	na	na	na
Chlorobiphenyl 6/153*	0.310 U	0.380	3.10	5.40	na	na	na	na	na	na
Chlorobiphenyl 7/170*	0.460 U	0.130 U	1.20	0.930	na	na	na	na	na	na
Chlorobiphenyl 7/180*	0.160	0.210	2.20	1.70	na	na	na	na	na	na
Chlorobiphenyl 7/187*	0.066 U	0.100	2.00	1.10	na	na	na	na	na	na
Chlorobiphenyl 8/195*	0.050 U	0.059	0.320	0.087	na	na	na	na	na	na
Chlorobiphenyl 9/206*	0.110	0.079	2.30	0.710	na	na	na	na	na	na

TABLE 3-5. (CONTINUED)

Parameter	Carr Inlet Stations		Commencement Bay Stations		SQO	Carr Inlet Stations		Commencement Bay Stations		SQS
	DAC-CR-02 (µg/kg DW)	DAC-CR-02A (µg/kg DW)	DAC-HY-30 (µg/kg DW)	DAC-HY-35 (µg/kg DW)	(µg/kg DW)	DAC-CR-02 (µg/kg OC)	DAC-CR-02A (µg/kg OC)	DAC-HY-30 (µg/kg OC)	DAC-HY-35 (µg/kg OC)	(µg/kg OC)
Total PCBs	6.00	8.00	64.0	63.0	1,000[b]	612	1,080	2,640	3,680	12,000
p,p'-DDD	0.140	0.180	1.30	1.70	16	na	na	na	na	na
p,p'-DDE	0.110	0.210	0.380	0.190	9	na	na	na	na	na
p,p'-DDT	0.057 U	0.140 U	0.210	0.200	34	na	na	na	na	na
Volatile Organic Compounds										
Trichloroethene	1.20 U	1.00 U	1.70 U	1.60 U	na	na	na	na	na	na
Tetrachloroethene	1.20 U	1.00 U	1.70 U	1.60 U	57	na	na	na	na	na
Ethylbenzene	1.20 U	1.00 U	1.70 U	1.60 U	10	na	na	na	na	na
Xylenes	2.40 U	2.00 U	3.30 U	3.20 U	40	na	na	na	na	na

NOTES: None of the measured concentrations of organic compounds exceeded the SQO or SQS concentrations at any of the reference stations.
DW - dry weight
OC - organic carbon normalized
U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

[a] PCB congeners reported as chlorobiphenyl A/B, where A = the number of chlorines and B = the typical BZ number.
[b] This table indicates the SQO for PCBs is 1,000 µg/kg. The ROD for the RI selected the human health-based PCB SQO of 150 µg/kg as the PCB decision criterion.

TABLE 3-6. CONCENTRATIONS OF TRACE ELEMENTS AND ORGANOTIN COMPOUNDS MEASURED IN SURFACE SEDIMENTS FROM HYLEBOS WATERWAY, DETERMINED BY THE TOTAL ACID DIGESTION METHOD

Parameter	No. Stations (Detections/Total)	Minimum Concentration	Median Concentration	Maximum Concentration	SQS	No. Stations Exceeding SQS	SQO	No. Stations Exceeding SQO
Trace Elements (mg/kg DW)								
Antimony	28/28	1.73	6.29	16.5	na	na	150	0
Arsenic	28/28	5.45	16.6	120	57	3	57	3
Cadmium	21/28	0.202	0.477	1.95	5.1	0	5.1	0
Chromium	28/28	28.7	33.6	91.7	260	0	na	na
Copper	28/28	53.6	117	230	390	0	390	0
Lead	28/28	23.4	73.8	207	450	0	450	0
Mercury	1/28	0.16	0.16	0.16	0.41	0	0.59	0
Nickel	28/28	24.8	33.6	43.7	na	na	140	0
Silver	28/28	0.095	0.29	0.398	6.1	0	6.1	0
Zinc	28/28	99.4	174	579	410	2	410	2
Organotin Compounds (µg/kg DW)								
Monobutyltin	0/28	<5.78	<9.26	<12.8	na	na	na	na
Dibutyltin	24/28	10.8	46.75	82.8	na	na	na	na
Tributyltin	28/28	14.9	134.5	238	na	na	na	na
Tetrabutyltin	0/28	<5.78	<9.26	<12.8	na	na	na	na

NOTES: DW - dry weight