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A SUMMARY OF PRIORITY POLLUTANT DATA FOR POINT SOURCES AND SEDIMENT IN INNER COMMENCEMENT BAY: A PRELIMINARY ASSESSMENT OF DATA AND CONSIDERATIONS FOR FUTURE WORK

PART 1. HYLEBOS WATERWAY

by

Art Johnson, Bill Yake, and Dale Norton

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Washington State Department of Ecology
Water Quality Investigations Section
Olympia WA 98504

INTRODUCTION

This document is a compilation and review of data on priority pollutant concentrations in point source discharges and surface sediments in Commencement Bay and adjacent waterways collected between 1979 and 1982 and reported by WDOE, EPA, and NOAA. Also presented here are hitherto unpublished data from WDOE point source sampling and a series of sediment collections made by EPA and WDOE. Water column data were also reviewed for this report, but only to a limited extent and not tabulated. Pollutant concentrations in biota and biological responses to water and sediment samples were not, in general, reviewed.

This information was gathered with the aim of providing direction for the next phase of work in the Commencement Bay near-shore marine environment. In the interest of putting together a useful package in a timely fashion, an outline format is used.

The report is arranged by waterway in the six parts listed below; each to be issued in separate installments as the data are compiled and reviewed. The first installment, Hylebos Waterway, is included with these introductory remarks.

	Subject	Anticipated Completion Date (1983)
Part 1.	Hylebos Waterway	Completed
Part 2.	City Waterway	May 6
Part 3.	Blair Waterway	May 20
Part 4.	Sitcum Waterway	May 27
Part 5.	Milwaukee, Puyallup, St. Paul, Middle Waterway and S.W. Shore Commencement Bay	June 10
Part 6.	Summary	mid-July

SAMPLING AND ANALYTICAL METHODS

The results presented here are from studies conducted by a number of investigators and should be compared with caution because of the variable collection, extraction, and analytical methods employed. Even a casual review of the data will reveal that detection limits vary between laboratories and that certain compounds are regularly reported in some studies and rarely reported in others. The importance of consistent sampling techniques and analytical methods in future Commencement Bay investigations cannot be over-emphasized.

The methods employed in obtaining most of the data compiled here are described in the reports cited at the end of each data package. The WDOE point source data on discharges other than ASARCO, St. Regis, Tacoma Central STP, U.S. Oil, Reichhold, Pennwalt, Sound Refining, and Hooker (which are documented in WDOE "Class II" reports) and the data on sediment samples collected by EPA and WDOE on 5/13/81, 7/31/81, and 8/03-04/81 are being reported for the first time. The procedures used in obtaining these new data are briefly described below.

The point source samples were collected in one-gallon glass jars (base/neutral extractables, acid extractables, pesticides, and PCBs), 40 ml screw-top glass vials with teflon septums (volatiles), and 2-1/2 or 5-gallon polyethylene cubitainers (trace metals and conventional water quality parameters*). Sample bottles were cleaned according to EPA priority pollutant protocol. Laboratory and field blanks were included in conjunction with the point source samples as a check against sample contamination. All samples were composites, typically collected over a 2 - 6 hour period. Rising tides precluded long compositing periods at a number of discharges. Flows were measured with a magnetic flowmeter or bucket and stopwatch.

The analytical plan included sample analysis at several different laboratories. Organics analysis was done by EPA contract laboratories. Trace metals were analyzed at the WDOE Tumwater laboratory. Joe Blazevich, EPA Region X laboratory at Manchester, reviewed the organic priority pollutant data reported by the contract laboratories prior to inclusion in this report.

The intertidal sediment samples taken by WDOE on 7/30-31/81 were collected by hand using a stainless steel "cookie cutter" measuring 9 cm in diameter and 2.5 cm deep. Several samples were taken along a transect of the lower beach, usually below or near a point source discharge, and pooled. After mixing with a glass rod, subsamples were placed in glass (organics analysis) or plastic (trace metal analysis) containers and analyzed as described above. A third portion of the sample was sent to the EPA Newport laboratory for bioassay using amphipods as the test organism. (The results of bioassay tests were reported by R.C. Swartz in the Marine Pollution Bulletin Vol. 13, No. 10, pp. 359-364, 1982.)

The subtidal sediments collected by EPA and WDOE on 5/13/81 and 8/03-04/81 were taken with a Van Veen grab modified with rubber flaps to reduce loss of surface fines during retrieval. Subsamples of the top 2 cm were taken by core and analyzed as described above, except that a few samples were analyzed by the EPA Newport laboratory for a limited number of priority pollutants only.

*These data are available on request.

PART 1. HYLEBOS WATERWAY

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HYLEBOS WATERWAY

Refer to Data in:

General Observations

1. Subtidal surface sediments (generally from the dredged portion of the waterway) display more chemical homogeniety than intertidal or source-related sediments. For many priority pollutants, it appears that there is a continuity of concentrations (gradients) in the medium-distance scale (tenths of miles to several miles). The nature of concentrations in sediments has been described as "patchy". This may be largely a function of sampling locations being too far apart to detect gradients, and analytical methods which vary between laboratories and from year to year in the same laboratory. — Figure 6, Figure 7, Table 8, Table 9, Table 10

2. Riley (reference 8) proposed a method for determining annual loads to Hylebos sediments. Based on this method, the following loads have been estimated; they are compared with point-source loads to the Hylebos Waterway documented by WDOE surveys: — Table 2, Table 5, Table 10

Compound	Loading to Sediment (Kg/yr)	Loading to Sediment (lbs/day)	Pt. Source Load from WDOE Studies (lbs/day) High-Flow Survey	Pt. Source Load from WDOE Studies (lbs/day) Low-Flow Survey	Ratio of Low-flow Loads to Sediment Loads
PAH	15.4	.093		.27	2.9
PCBs	0.41	.0025			0
HCBD	0.10	.0006		.026	43
B(a)P	1.4	.0086			0
As	100	.61	16	5.2	8.5
Cd	1.7	.010	1.1	1.1	110
Cu	272	1.6	2.0	1.6	1.0
Hg	0.7	.004	.07	.007	1.8
Pb	232	1.4	1.2	.17	.12
Zn	320	1.9	9.6	.98	.51

Performing an overall mass balance on priority pollutants would require estimating all sinks (primarily sedimentation and advection) and sources (point, atmospheric, and incoming tidal waters from Commencement Bay). It is not currently possible to obtain reasonable estimates for advection, atmospheric input, and loads from incoming tidal waters. Thus it is not possible to accurately estimate how much of the total load to the Hylebos we have accounted for in the source sampling. Because of the wide variance in ratios between documented source loads and accumulation ratios in the sediments, it appears likely that significant sources of specific priority pollutants have not yet been identified.

Refer to
Data in:

3. EPA sediment bioassays using amphipods indicate zones of high mortality are associated with Hooker, Sound Refining, Pennwalt, Kaiser Ditch, and Hylebos Creek. However, recent experiments at the University of Washington indicate that anoxia, particle size, and other factors (in the absence of toxics) have an important influence on mortalities in this type of bioassay. Results of amphipod assays conducted in the Hylebos and elsewhere in Commencement Bay are thus cast into some doubt.

General Considerations for Further Work

1. To adequately estimate quantities, sources, and sinks of "toxic" chemicals in the Hylebos, it will be necessary to perform improved mass balances for these compounds. While this will probably involve obtaining improved estimates of sedimentation rates, the primary missing information is quantification of the flux of these chemicals between Hylebos Waterway and Commencement Bay. Both hydraulic exchange and suspended solids transport need to be quantified.

Metals - Observations

1. Based on WDOE results, point-source trace metal loads are not large. Based on comparisons with accumulation rates of metals in Hylebos sediments, source loads documented by WDOE studies appear to account for a substantial portion of the total load for certain metals (Cd, possibly As), while they appear to account for only a fraction of the loads for other metals (Cu, Pb, Zn). — Table 2

2. Copper was the only metal found in the water column above EPA criteria for protection of marine life (references 2,3,9,10). Substantial point-source copper loads have not been identified. Copper concentrations measured in seawater at "control" sites (Clam Bay) have also exceeded EPA criteria. These are total rather than dissolved concentrations. Oyster larvae bioassays run by the EPA Manchester laboratory have not shown these waters to be acutely toxic. Much of this copper is probably complexed with organic or inorganic ligands, thereby reducing its toxicity.

3. Surface waters have higher Pb, Cd, Cu, Se, Cr, and Ni concentrations than bottom waters. The reverse is true for As, Zn, and Mn. There is some evidence that copper and arsenic concentrations in the surface waters increase toward the head of the waterway. Surface sediment concentrations show a similar pattern: As, Cd, Cr, Cu, Hg, and Zn concentrations display gradients with concentrations highest near the head of the waterway, lowest near the mouth. — Figure 2, Figure 3, Figure 7

4. Sort yards using ASARCO slag as ballast are a potential significant source of metals. The metals loads from log sort yards have not been quantified in the Hylebos Waterway drainage.

	Refer to Data in:
5. Hylebos Creek appears to be a significant source of documented arsenic loads. Based on EPA data, the creek may also be a significant source of mercury loading.	Table 3
6. Hooker and Pennwalt effluents appear to be relatively significant sources of nickel, chromium, and arsenic. Pennwalt seeps and sewers have the highest concentrations of arsenic and chromium measured in waterway point sources.	Table 1 Table 3
7. Total source loads to Hylebos Waterway cannot be accurately estimated at present due largely to lack of information regarding pollutant flux between Commencement Bay and the Hylebos.	
8. No core data exist for metals stratification in Hylebos sediments. This is required to determine depositional history of metals.	

Metals - Considerations for Future Work

1. Develop criteria for "problem" sediments (biological/chemical).
2. Assess applicability of copper (water column) criteria to Hylebos Waterway and endemic marine organisms.
3. Quantify metal loadings from those sort yards using ASARCO slag as ballast.
4. Study Hylebos Creek to determine/quantify metal sources.
5. Determine stratification of metals in undisturbed sediment cores to provide depositional history of metals. This and other information should be used to improve estimates of sedimentation rates along the length of the Hylebos Waterway.
6. Southwest Regional Office (WDOE) should pursue the metals issue with Hooker and Pennwalt.
7. Investigate the use of metals ratios in sediments as a possible tool in identifying sources.

Volatiles - Observations

1. Chloroform, trichloroethylene, tetrachloroethylene, and 1,2(trans)dichloroethylene are the major organic priority pollutants isolated in EPA water column samples (reference 9). Concentrations are highest off Hooker and decrease toward the head of the waterway. Surface waters contain larger concentrations of volatiles than bottom waters. EPA aquatic life criteria are not violated; EPA human health criteria (cancer risk) for seafood consumption from these waters are sometimes violated. Water samples collected by Riley (reference 8) also show 1,1,1-trichloroethane at relatively high concentrations near Hooker.	Figure 4

		Refer to Data in:
2.	Volatiles were found in intertidal sediments close to sources. They generally were not found in subtidal sediments. Trace amounts of chloroform were detected in 2 of 20 samples and trichloroethylene in 1 of 20 samples.	Table 8 Table 9
3.	Based on WDOE measurements, the major organic priority pollutant loads to the water are volatiles from Hooker and Pennwalt. The following loads and relative contributions to the total waterway load were measured: bromoform 19.8 lbs/day (Pennwalt effluent = 94%); chloroform 9.3 lbs/day (Hooker groundwater = 67%); trichloroethylene 2.4 lbs/day (Hooker groundwater = 92%); tetrachloroethylene 1.0 lb/day (Hooker groundwater = 52%, Hooker effluent = 47%); and chlorodibromomethane 0.75 lb/day (Pennwalt effluent = 83%).	Table 5 Table 6
4.	Hooker appeared to be the major source of chloroform and the chlorinated ethylenes.	Table 5 Table 6
5.	Pennwalt appeared to be the major source of bromoform. Bromoform was present mainly in Pennwalt effluent, possibly due to discharge from chlorine stripper. Bromoform has been detected throughout the waterway in concentrations substantially lower than the volatiles listed above (reference 8). Peak concentrations of 2 to 4 ug/L were detected near Pennwalt (references 2,8).	Table 5 Table 6
6.	Based on EPA and WDOE surveys, discharges other than Hooker and Pennwalt are probably not significant sources of halogenated organic priority pollutants.	

Volatiles - Considerations for Future Work

1. Develop criteria for chloroform in marine water.

2. Pursue groundwater, surface water, effluent, and sediment monitoring at Hooker for 1,2-trans-dichloroethylene.

3. Because there are a variety of volatile and other organic pollutants in Hooker's groundwater and effluent, an effort to assess the synergistic effect of these compounds should be undertaken. Bioassays of groundwater, effluent, nearshore sediment, and immediate receiving waters should be conducted to determine the hazard to marine life. Specific consideration should be given to tests which estimate the potential mutagenic and carcinogenic characteristics of these discharges and immediate receiving environment media.

4. Because substantial bromoform loads from Pennwalt may coincide with operational changes, additional sampling may be warranted to determine if this load is continuous. Additional immediate receiving water sampling for volatiles, including bromoform, near Pennwalt may also be warranted.

Refer to Data in:

Base Neutrals - Observations

1. Riley (reference 8) measured up to 252 ug/L chlorinated budadienes (CBD's) - 4 ug/L hexachlorobutadiene (HCBD) - in water and 1,677 ug/Kg (dry) CBD's in suspended matter. Further examination of these compounds with respect to human health effects and impacts to pelagic organisms was recommended. HCBD concentrations in the water column did not exceed EPA criteria. There are no criteria for the Cl_1-Cl_5 CBD's.

2. Detection of hexachlorobutadiene in point discharges has been restricted to samples of Hooker effluent and groundwater and to Pennwalt seeps. Recent research by Battelle N.W. on sediment cores throughout Puget Sound indicates that the CBD's are only detected in recent sediments (past 5 - 10 years) (Crecelius, personal communication). — Table 4

3. CBD's, HCBD, and hexachlorobenzene (HCB) have been detected in Hylebos sediments. CBD concentrations peak near Hooker. HCB data also suggest a peak near Hooker, but data for HCB's in Hylebos sediments are sparse. — Table 8, Table 9, Table 10

4. No sediment criteria exist for CBD's, HCBD, or HCB.

5. Significant concentrations of unidentified chlorinated organics occur in Hooker effluent (references 9,13). Pentachloropropene, a mutagen, may be one of the unknowns (reference 1).

6. One of three water samples from Morningside drain at Hylebos Boat Haven contained 4-bromophenyl ether, nitrobenzene, 2-chloronaphthalene, and dichlorobenzene isomers -- all at low concentrations. The first three compounds have not been detected in other discharges to the waterway. — Table 4a

7. Polyaromatic hydrocarbon (PAH) concentrations in water have generally been below detection limits.

8. A range of PAH compounds has been detected in suspended matter and sediment (references 4,5,8).

9. Concentrations of PAH compounds in Hylebos surface sediments appear to be higher at the head of the waterway, decreasing toward the mouth. There are also indications that 4- and 5-ring PAH compounds are comparatively higher at the head of the waterway, while 2- and 3-ring PAH are more prevalent near the mouth. — Figure 6

10. PAH compounds were detected only sporadically in sampling of sources to the Hylebos. — Table 4

11. Kaiser Ditch is one of the few discharges where PAH compounds were frequently detected. In addition, a sediment sample from the mouth of the Kaiser ditch contained PAH compounds at concentrations 10 to 20 times higher than any other sediment sample in the Hylebos area. Recent information from Kaiser Aluminum indicates that old settling basins at the facility are a potential source of elevated PAH at the Kaiser Ditch mouth. — Table 4, Table 8

12. No PAH criteria exist for sediments.

Refer to
Data in:

Base Neutrals - Considerations for Future Work

1. Testing procedures, standards, and criteria for chlorinated propenes and chlorinated butadienes are needed.

2. Monitoring at Hooker should be modified to include quantification of concentrations and loads of hexachlorobenzene, chlorinated butadienes, and chlorinated propenes (groundwater, effluent, sediments, water column).

3. Sediment criteria for CBD's, HCBD, HCB, chlorinated propenes, and PAH are required.

4. PAH compounds in Kaiser Ditch need further study. Information is required on the longitudinal and vertical distribution of PAH in the sediment, partitioning of PAH between water and suspended matter, PAH loading to Hylebos Waterway, and fate of PAH after entering the waterway. Bioassays of Kaiser Ditch water, suspended matter, sediment, and PAH extracted from these media should be undertaken and should assess mutagenicity and carcinogenicity as well as acute toxicity.

5. In general, the low PAH loading from identified sources and ubiquitous nature of potential sources indicate that it may be difficult to identify and quantify PAH loads from other sources. The "spill task" outlined in the Superfund cooperative agreement may provide some additional information on PAH sources.

PCBs - Observations

1. Riley (reference 8) detected polychlorinated biphenyls (PCBs) in water column samples in the waterway. Cl_1-biphenyls ranged from .022 - .317 ug/L; Cl_2-biphenyls ranged from .001 - .268 ug/L, and Cl_3-Cl_5-biphenyls ranged from <.001 - .025 ug/L. Up to 4,950 ug/Kg (dry) Cl_1-Cl_3-biphenyls was measured in suspended matter.

2. Although the EPA criteria document indicates that acute toxicity to marine life only occurs at concentrations above 10 ug/L, concentrations given above do exceed EPA's 24-hour criterion (.03 ug/L) for protection of marine organisms against chronic effects. Riley (reference 8) recommended further examination of these compounds with respect to human health effects and impacts on pelagic organisms.

3. PCBs are generally detected in Hylebos sediments at concentrations ranging up to 1.5 mg/Kg dry weight. No clear pattern of distribution is discernible from the available sediment data. Table 8 Table 9 Table 10

4. Although Riley's work suggests PCBs are currently entering the waterway, sources have not been identified.

5. There are no criteria for PCBs in sediment.

Refer to Data in:

PCBs - Considerations for Future Work

1. Sediment criteria for PCBs should be developed.

2. The issue of historical versus ongoing sources should be addressed and the need for further investigation assessed.

Pesticides - Observations

1. Pesticides have not generally been detected in water column samples from the waterway.

2. The following pesticides are detected with some regularity in subtidal Hylebos sediments: DDT and metabolites, aldrin, and α-BHC. — Table 9

3. Sediment concentrations of aldrin appear to be higher near the mouth of the waterway; data for α-BHC and DDT are not adequate to determine distribution patterns although two source-related sediment samples near Pennwalt had relatively high DDT concentrations. — Table 8, Table 9

4. Although documented source loads for pesticides are generally very low, the following sources were documented: Pennwalt (seeps and sewers) - DDT and metabolites, aldrin, BHC; Hooker (seep near old solvent plant) - DDT and metabolites; Lincoln Avenue drain - α-BHC. — Table 4, Table 5

Pesticides - Considerations for Future Work

1. Sediment criteria for pesticides (aldrin, DDT and metabolites, and α-BHC) need to be developed.

2. Documented loads of pesticides are very low (and appear to account for a relatively small percentage of total loads to the waterway), ubiquitous, and probably intermittent. Based on available data, no recommendations for reductions in pesticide loading to the Hylebos can be made.

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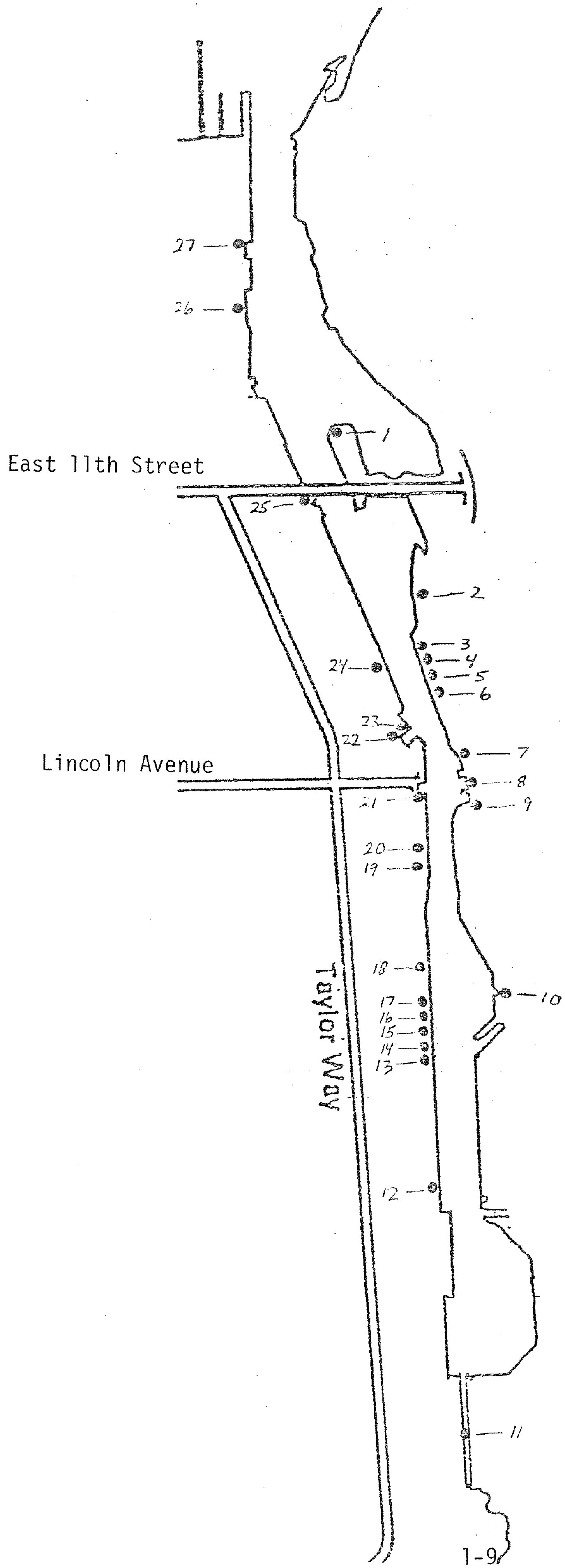

Figure 1. Hylebos Waterway: point source samples.

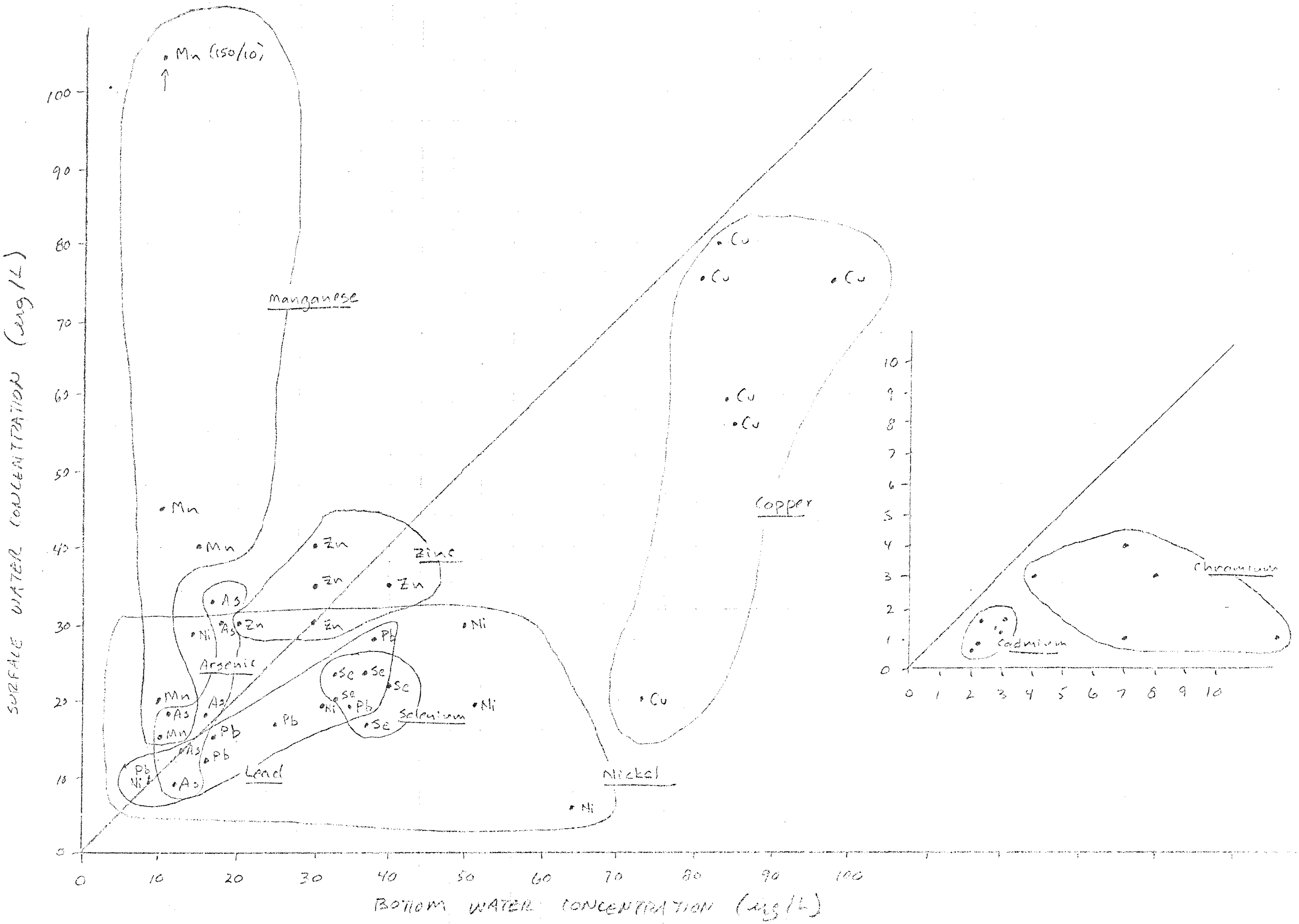

Figure 2. Hylebos Waterway: Surface water vs. bottom water concentrations of trace metals (total metal). (Data from USEPA 1980. Commencement Bay/Port of Tacoma Field Survey, June 3, 1980).

Figure 3. Hylebos Waterway: Concentrations of copper and arsenic in surface waters and bottom waters, June 3, 1980. (Data from: USEPA, 1980. Commencement Bay/Port of Tacoma Field Survey, June 3, 1980.)

Figure 4. Hylebos Waterway: Concentrations of chlorinated ethylenes and chloroform in surface waters, June 3, 1980. (Data from: USEPA, 1980. Commencement Bay/Port of Tacoma Field Survey, June 3, 1980.)

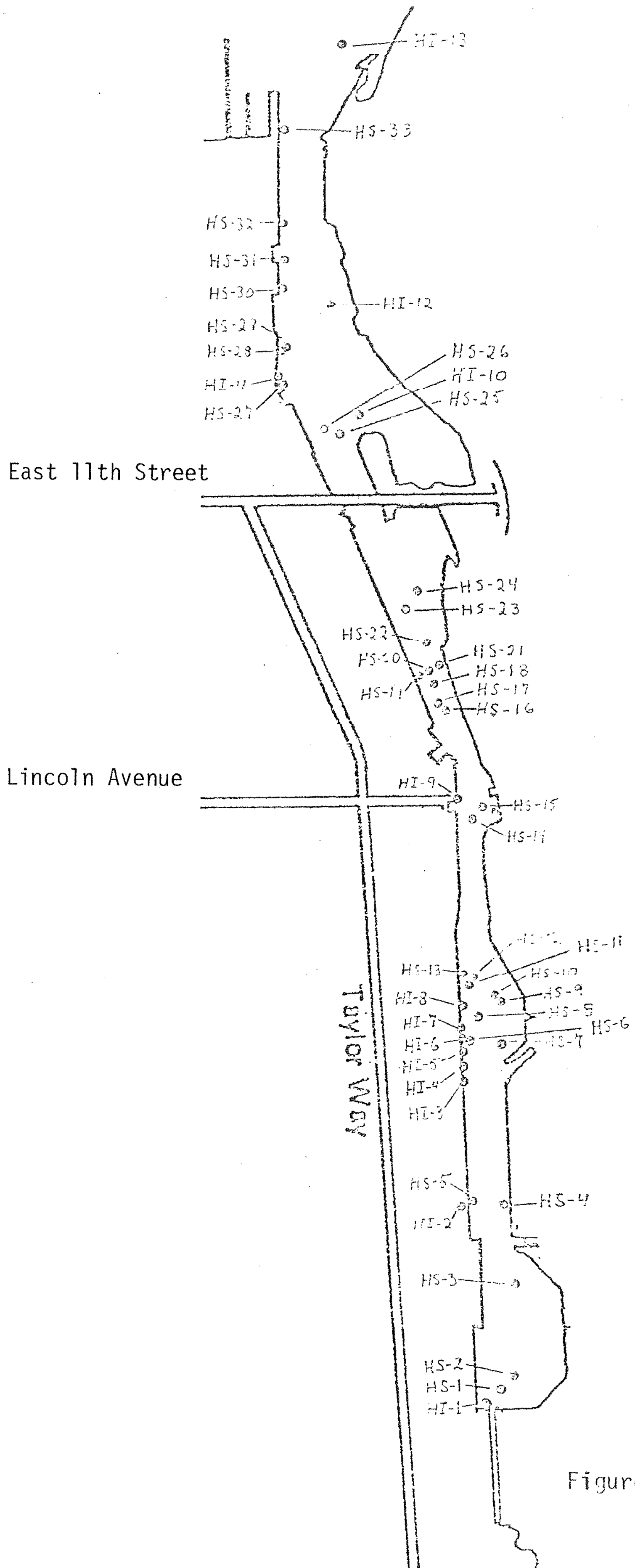

Figure 5 Hylebos Waterway: sediment samples.

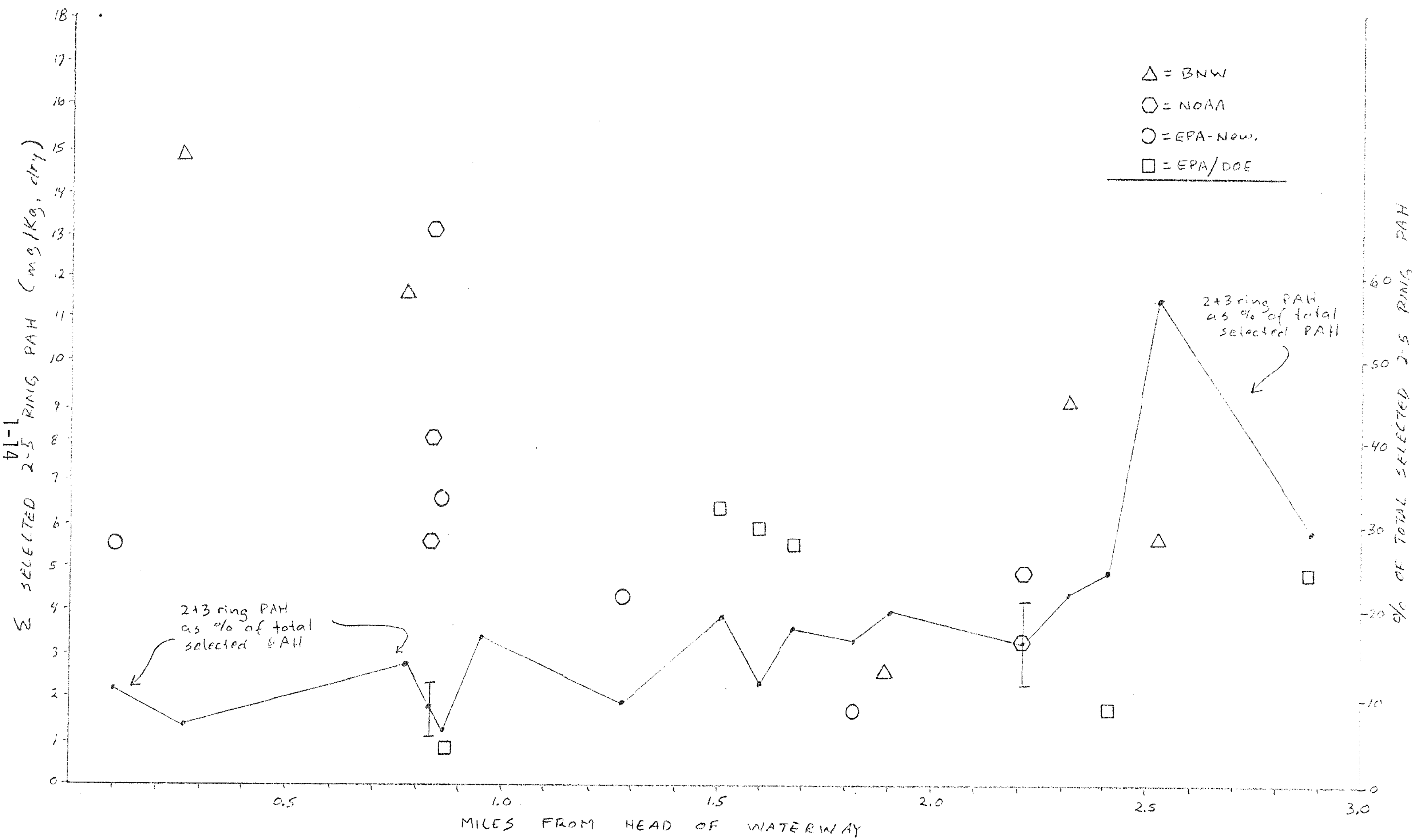

Figure 6. Hylebcs Waterway: Selected* PAH compounds in subtidal sediments.

*naphthalene, phenanthrene, anthracene, fluorene, pyrene, chrysene, benzo(a)anthracene, fluoranthene

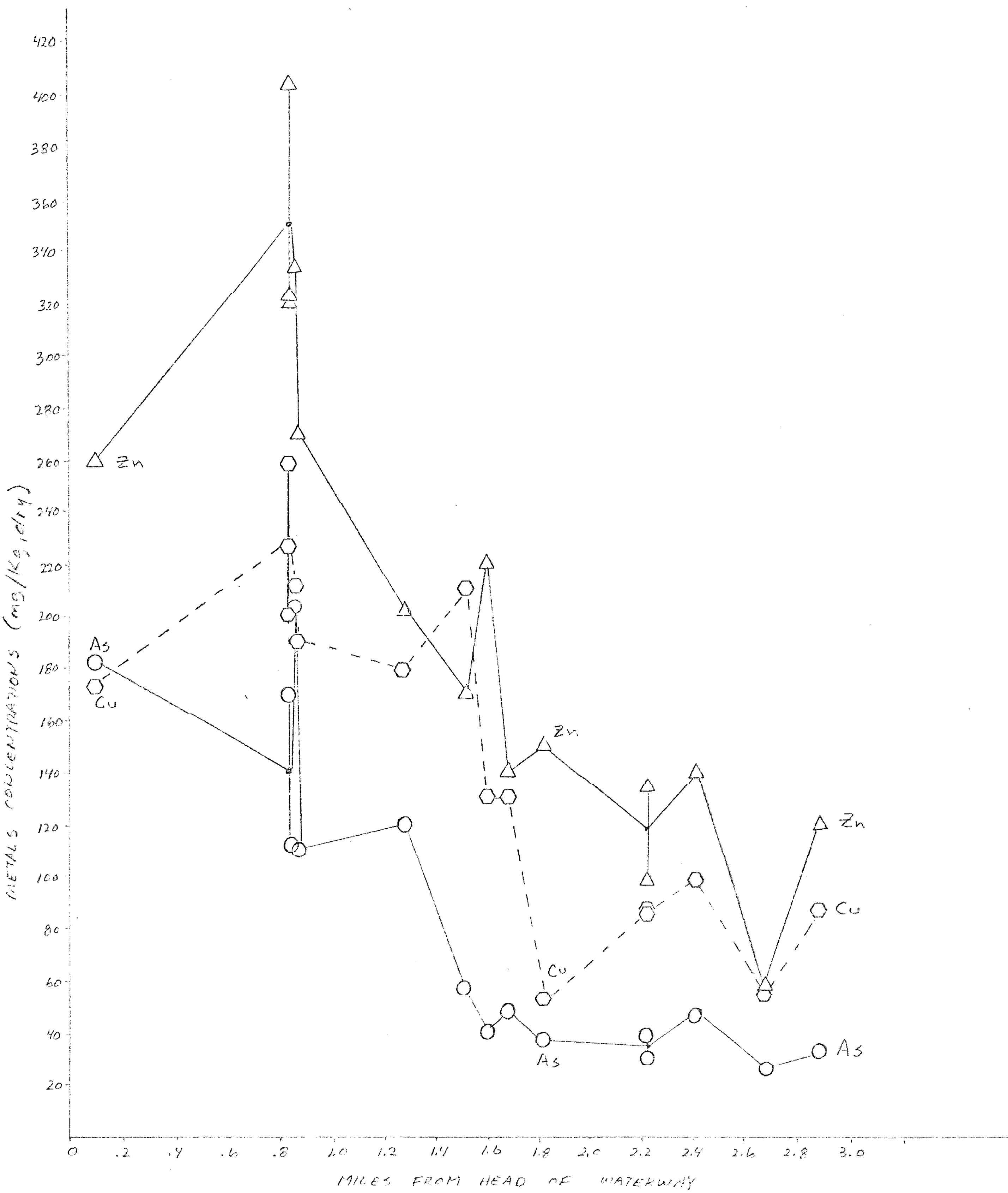

Figure 7. Hylebos Waterway: Concentrations of selected metals in subtidal sediments.

Table 1. Hylebos Waterway: Trace Metal Concentrations in Point Source Discharges (μg/L total metal).

Discharge	Date Sampled	Time Sampled	In-vesti-gator	Sample No.	Sta-tion No.	Flow (MGD)	As	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Zn
Surface Runoff West of 11th Street	9/23/80	0853	EPA	38200	1		16	.7	3	17	.14	25	30	<2	100
Surface Runoff East of 11th Street	9/23/80	0915	EPA	38201	2		82	.3	5	37	.07	23	28	<2	150
Sound Refining															
West Drain	9/21/80	1230	EPA	30319	3		74	.5	2	14	.21	22	10	<2	<20
"	6/30/81		WDOE		"	.071	<16	3	<10	27	.33	<50	<1		<5
Drain #004	6/30/81	1015-1420	WDOE		4	.0039	<16	<2	<10	<1	.42	<50	4		72
Final Effluent	6/3/80	1600	EPA	22307	5	(.072)	3	1.5	11	16	.83	17	21	2	90
"	6/30/81	0945-1420	WDOE		"	.0529	22	<2	<10	3	.50	<50	<1		40
Drain #003	6/30/81		WDOE		6	.001	37	<2	<10	10	.54	<50	8		175
West Drain opposite Lincoln Avenue	4/28/82	1410-1615	WDOE		7	.060	89	<2	<10	<10	.26	<20	<20		<5
Seepage opposite Lincoln Avenue	9/23/80	0935	EPA	38202	8		262	34	115	1,240	1.4	435	1,720	<2	11,800
East Drain opposite Lincoln Avenue	4/28/82	1335-1650	WDOE		9	.050	12	<2	<10	<10	<.2	<20	<20		15
Morningside Drain	9/23/80	0930	EPA	38300	10		14	.7	4	15	.07	17	24	<2	200
"	8/17/81	1130-1410	WDOE		"	(.13)	7	<5	<10	20	.24	<10	40		170
"	3/29/82	1125-1540	WDOE		"	.78	20	<2	<10	10	<.2	<20	<20		100
Hylebos Creek	6/3/80	1350	EPA	22313	11		51	.1	1	6	2.0	15	10	2	45
"	8/17/81	1240-1430	WDOE		"	4.06	<5	<5	<10	<10	<.2	<10	<50		10
"	3/29/82	1200-1600	WDOE		"	31.74	36	<2	<10	<10	.23	<20	<20		29
Kaiser Ditch	6/3/80	1545	EPA	22306	12	(1.5)	18	.2	2	23	1.1	12	13	2	25
"	9/23/80	0958	EPA	38203	"		65	3.2	10	64	.21	66	26	<2	100
"	9/23/80	1140	EPA	38308	"		12	.4	1	15	.21	8	30	<2	60
"	8/17/81	1100-1415	WDOE		"	2.81	<5	<5	<10	<10	.24	<10	<50		<5
"	3/29/82	1215-1520	WDOE		"	1.81	88	<5	<10	30	.53	80	70		55
Pennwalt															
East Property Line Ditch	9/23/80	1153	EPA	38210	13		545	<.2	24	19	.91	12	10	3	30
"	6/2/81	1115-1455	WDOE		"	.0014	470	0.5	400	37	.98	112	50		40
East Seep	6/3/80	1150	EPA	22305	14	(.002)	180	1.6	464	46	11.7	100	35	56	35
"	9/23/80	1118	EPA	38207	"		62	<.2	700	11	3.6	12	43	7	230
"	6/2/81	1100-1450	WDOE		"	.0014	36	.6	1,870	15	5.8	147	87		40
West Seep	9/23/80	1138	EPA	38209	15		5,505	<.2	1,850	31	16.2	18	105	62	80
"	6/2/81	1020-1515	WDOE		"	(.001)	5,000	1.9	1,530	90	3.4	82	95		400
East Sewer	6/2/81	1015-1525	WDOE		16	.0289	1,920	1.1	7	18	.6	<3	6		<20
West Sewer	6/3/80	1140	EPA	22303	17	(.003)	7,500	.5	3	50	1.1	93	12	127	60
"	6/3/81	1000-1600	WDOE		"	.0074	12,000	.3	7	29	.38	6	8		20
Final Effluent	6/3/80	1125	EPA	22302	18	(13)	33	3.2	9	74	.3	35	13	2	30
"	6/2-3/81	1230-1230	WDOE		"	12.4	60	10.4	9	79	.3	15	32		30
Seep near U.S. Gypsum	9/23/80	1150	EPA	38310	19		2,100	<.2	230	1,637	.35	179	920	515	17,200
U.S. Gypsum Heated Discharge	9/23/80	1115	EPA	38307	20		30	.8	<1	6	.21	7	4	<2	60
Lincoln Avenue Drain	4/28/82	1410-1630	WDOE		21	.029	37	<2	<10	<10	<.2	<20	<20		21
Buffelin Cooling Water	6/3/80	1530	EPA	22301	22	(.007)	15	.1	1	6	.38	13	13	2	20
Seep near Buffelin	9/23/80	1110	EPA	38302	23		112	.5	320	341	.63	179	70	7	1,350
Drainage opposite Sound Refining	9/23/80	1100	EPA	38305	24		130	.4	210	372	1.6	179	130	20	1,780
Drainage at East end 11th Street Bridge	4/28/82	1300-1635	WDOE		25	.040	31	<2	<10	20	.75	<20	<20		11
Hooker															
Final Effluent	6/3/80	1040	EPA	22300	26	(15)	9	3.3	8	74	.38	20	219	2	10
"	9/25 26/79	1100-1100	WDOE		"	15.5	<30		130	5		250	2	<50	16
Effluent Plume	9/23/80	1045	EPA	38304	"		106	1.1	1	5	.14	15	68	9	<20
Seep near old Solvent Plant	9/23/80	1015	EPA	38303	27		105	1.2	320	533	5.3	373	630	6	1,550

( ) = Estimated

Table 2. Hylebos Waterway: Trace Metal Loads Based on WDOE Data Collected September 1979 - April 1982 (pounds/day).

Discharge	Date Sampled	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Sound Refining:									
West Drain	6/30/81	--	.0018	--	.016	.0002	--	--	--
Drain #004	6/30-7/1/81	--	--	--	--	.00001	--	.00001	.0023
Process Effluent	6/30-7/1/81	.0097	--	--	.0013	.0002	--	--	.018
Drain #003	6/30/81	.0003	--	--	.00008	.00001	--	.00007	.001
West Drain opposite Lincoln Avenue	4/28/82	.045	--	--	--	.0001	--	--	--
East Drain opposite Lincoln Avenue	4/28/82	.0050	--	--	--	--	--	--	.0063
Morningside Drain	8/17/81	(.0076)	--	--	(.022)	(.0003)	--	(.043)	(.18)
"	3/29/82	.13	--	--	.065	--	--	--	.65
Hylebos Creek	8/17/81	--	--	--	--	--	--	--	.34
"	3/29/82	9.5	--	--	--	.061	--	--	7.7
Kaiser Ditch	8/17/81	--	--	--	--	.0056	--	--	--
"	3/29/82	1.3	--	--	.45	.0080	1.2	1.1	.83
Pennwalt:									
East Property Line Ditch	6/2/81	.0055	.00001	.0047	.0004	.00001	.0013	.0006	.0005
East Seep	6/2/81	.0004	.00001	.0218	.0002	.0001	.0017	.0010	.0005
West Seep	6/2/81	(.042)	(.00002)	(.013)	(.0008)	(.00003)	(.0007)	(.0008)	(.0033)
East Sewer	6/2/81	.45	.0003	.0017	.0043	.0001	--	.0014	--
West Sewer	6/2/81	.74	.00002	.0004	.0018	.00002	.0004	.0005	.0012
Process Effluent[1]	6/2-3/81	3.9	1.1	0.10	1.5	0	.75	.12	.40
Lincoln Avenue Drain	4/28/82	.0089	--	--	--	--	--	--	.0051
Drainage at East end 11th Street Bridge	4/28/82	.010	--	--	.0066	.0003	--	--	.026
Hooker:									
Process Effluent[1]	9/25-26/79	--	--	16	Neg.[2]	--	30.5	Neg.	Neg.
Sum of loads to Hylebos Waterway[3]		5.2	1.1	16	1.6	.0070	31	.17	.98
Sum of loads to Hylebos Waterway[4]		16	1.1	16	2.0	.070	32	1.2	9.6

( ) = Calculated using an estimated flow

[1]Net load; corrected for amount of constituent present in saltwater intake

[2]Negative load; i.e., less metal in final effluent than saltwater intake

[3]Calculated using August data for Morningside Drain, Hylebos Creek, and Kaiser Ditch

[4]Calculated using March data for Morninigside Drain, Hylebos Creek, and Kaiser Ditch

Table 3. Hylebos Waterway: Relative Trace Metal Contributions from Major Point Source Discharges.

Metal	Major Discharge	Load (pounds/day)
Nickel	Hooker process effluent	30.5*
	Kaiser Ditch (3/29/82)	1.2
	Pennwalt process effluent	.75
Chromium	Hooker process effluent	16
	Pennwalt process effluent	.10
Arsenic	Hylebos Creek (3/29/82)	9.5
	Pennwalt process effluent	3.9
	Kaiser Ditch (3/29/82)	1.3
	Pennwalt west sewer	.74
	Pennwalt east sewer	.46
	Morningside drain (3/29/82)	.13
Zinc	Hylebos Creek (3/29/82)	7.7
	Kaiser Ditch (3/29/82)	.83
	Morningside drain (3/29/82)	.65
	Pennwalt process effluent	.40
	Hylebos Creek (8/17/81)	.34
	Morningside drain (8/17/81)	(.18)
Copper	Pennwalt process effluent	1.5
	Kaiser Ditch (3/29/82)	.45
Cadmium	Pennwalt process effluent	1.1
Lead	Kaiser Ditch (3/29/82)	1.1
	Pennwalt process effluent	.12
Mercury	Hylebos Creek (3/29/82)	.061
	Kaiser Ditch (3/29/82)	.0080
	Kaiser Ditch (8/17/81)	.0056

* = Based on single set of analyses by Can-Test. Possible anomoly; should be verified by resampling.
( ) - Based on estimated flow.

Table 4a. Hylebos Waterway: Organic Priority Pollutant Concentrations in North Shore Discharges, Including Hylebos Creek (μg/L).

Discharge	Surface Runoff West of 11th St.	Surface Runoff East of 11th St.	Sound Refining: West Drain	Sound Refining: Drain #004	Sound Refining: Process Effluent		West Drain opposite Lincoln Avenue	Seepage opposite Lincoln Avenue	East Drain opposite Lincoln Avenue	Morningside Drain at Hylebos Boat Haven			Hylebos Creek		
Date Sampled	9/23/80	9/23/80	9/24/80	6/30/81	6/3/80	6/30/81	4/28/82	9/23/80	4/28/82	9/23/80	8/17/81	3/29/82	6/3/80	8/17/81	3/29/82
Time Sampled	0853	0915	1230	1015-1420	1600	0945-1420	1410-1615	0935	1335-1650	0930	1130-1410	1125-1540	1350	1240-1430	1200-1600
Investigator	EPA	EPA	EPA	WDOE	EPA	WDOE	WDOE	EPA	WDOE	EPA	WDOE	WDOE	EPA	WDOE	WDOE
Sample Number	38200	38201	38319	14J-5	22307	14J-4	J0483	38202	J0482	38300	33750	J1341	22312	33753	J1340
Station Number	1	2	3	4	5		7	8	9	10			11		
Flow (MGD)				.0039	(.072)	.0529	.060		.050		(.13)	.78		4.06	31.74
Volatiles															
chloroform	6.8	--	--	1.7	--	--	a	--	a	--	--	a	--	--	a
trichlorofluoromethane	--	--	--	--	--	--	a	--	a	--	--	a	--	--	a
1,2-trans-dichloroethylene	--	--	--	--	--	--	a	--	a	--	--	a	--	--	a
1,1,1-trichloroethane	--	--	1.1	--	1.8	T	a	--	a	--	--	a	--	3	a
trichloroethylene	3.3	2.0	--	--	--	--	a	--	a	--	--	a	--	--	a
benzene	--	--	--	--	2500	--	a	2.0	a	--	--	a	22	2	a
Base/Neutrals															
naphthalene	--	--	--	--	--	--	a	4.9	a	--	11	a	--	.6	a
acenaphthene	--	--	--	--	--	--	a	--	a	--	2	a	--	--	a
acenaphthylene	--	--	--	--	--	--	a	--	a	--	7	a	--	--	a
anthracene/phenanthrene	--	T	T	--	--	--	a	--	a	--	5	a	--	--	a
fluorene	T	--	--	--	--	--	a	--	a	--	6	a	--	--	a
pyrene	--	--	--	--	--	--	a	--	a	--	6	a	--	--	a
fluoranthene	T	--	--	--	--	--	a	--	a	--	--	a	--	--	a
1,2-dichlorobenzene	--	--	--	--	--	--	a	--	a	--	20	a	--	--	a
1,3-dichlorobenzene	--	--	--	--	--	--	a	--	a	--	19	a	--	--	a
1,4-dichlorobenzene	--	--	--	--	--	--	a	--	a	--	20	a	--	--	a
hexachlorobenzene	--	--	--	--	T	--	a	--	a	--	5	a	--	--	a
2-chloronaphthalene				--		--	a		a		5	a		--	a
bis(2-ethylhexyl) phthalate				--		--	a		a		--	a		--	a
dimethyl phthalate				--		--	a		a		2	a		--	a
diethyl phthalate				--		--	a		a		9	a		--	a
nitrobenzene				--		--	a		a		8	a		--	a
4-bromophenyl ether				--		--	a		a		10	a		--	a
Acid Extractables															
phenol				--		2.3	a		a		--	a		--	a
2-chlorophenol				--		--	a		a		11	a		--	a
pentachlorophenol				--		63	a		a		--	a		--	a
Pesticides				--		--	--		--		--	--		--	--
Miscellaneous															
cyanide				--		50	--		--		--	<5		--	<5

( ) = Estimated
-- = Not detected
a = Not detected, but detection limit high relative to other analyses
T = Trace; value is greater than the limit of detection but less than the limit of quantification (1 μg/L in most cases)

Table 5b. Hylebos Waterway: Organic Priority Pollutant Concentrations in South Shore Discharges - Kaiser Ditch and Pennwalt (µg/L).

						Pennwalt											
Discharge	Kaiser Ditch					East Property Line Drain		East Seep			West Seep		East Sewer	West Sewer		Process Effluent	
Date Sampled	6/3/80	9/23/80	9/23/80	8/17/81	3/29/82	9/23/80	6/2/81	6/3/80	9/23/80	6/2/81	9/23/80	6/2/81	6/2/81	6/3/80	6/2/81	6/3/80	6/2-3/81
Time Sampled	1545	0958	1140	1100-1415	1215-1520	1153	1115-1455	1150	1118	1100-1450	1138	1020-15[illegible]	1015-1525	1140	1000-1600	1125	1230-1230
Investigator	EPA	EPA	EPA	WDOE	WDOE	EPA	WDOE	EPA	EPA	WDOE	EPA	WDOE	WDOE	EPA	WDOE	EPA	WDOE
Sample Number	22306	38203	38308	33759	01339	38210	13J-7	22305	38207	13J-8	38209	13J-9	13J-10	22303	13J-11	22302	13J-13
Station Number			12			13			14		15		16	17		18	
Flow (MGD)	(1.5)			2.81	1.81		.0014	(.002)		.0014		(.001)	.0289	(.003)	.0074	(12)	12.4
Volatiles																	
chloroform	15	7.7	7.8	12	a	120	160	1630	50,000	1300	1400	2300	2700	20	14	28	7.9
dichlorobromomethane	1.3	--	--	--	a	4.1	--	42	300	130	3.8	28	T	--	--	T	--
chlorodibromomethane	--	--	--	--	a	3.1	--	8	70	36	--	43	--	--	--	1.5	6.0
trichlorofluoromethane	--	--	--	--	a	--	--	--	--	--	--	--	--	--	--	--	1.2
bromoform	--	--	--	--	a	--	--	--	15	9.4	--	44	--	--	--	9.5	180
carbontetrachloride	--	--	--	--	a	--	--	70	6	16	19	--	--	--	--	2.1	--
chloroethane	--	--	--	--	a	--	--	5	10	15	--	5	--	--	--	--	--
1,1-dichloroethane	--	--	--	--	a	--	--	--	1	3.8	--	--	--	--	--	--	--
1,2-trans-dichloroethylene	--	--	--	0.6	a	--	--	--	--	--	--	--	--	--	3.1	--	--
1,1-dichloroethylene	--	--	--	--	a	--	--	--	1	--	--	--	--	--	--	--	--
1,1,1-trichloroethane	--	--	--	--	a	--	--	2	4	4.8	--	--	--	--	6.3	--	--
trichloroethylene	--	1.9	1.9	5	a	2.4	17	30	1	--	10	4.7	--	--	210	1.4	--
tetrachloroethylene	--	1.3	--	--	a	1.8	--	4800	100	94	385	180	--	--	T	3.3	--
1,1,2,2-tetrachloroethane	--	--	--	5.3	a	--	--	--	--	--	--	--	--	--	--	--	--
toluene	--	--	--	0.2	a	--	--	--	--	--	--	--	--	1	1.3	--	2.2
benzene	--	--	--	--	a	--	--	80	--	--	--	--	--	85	--	--	--
Base/Neutrals																	
naphthalene	--	--	T	--	a	--	--	8	3	--	--	T	--	--	--	--	--
acenaphthene	--	--	--	--	a	--	--	13	--	--	--	--	--	--	--	--	--
acenaphthylene	--	--	--	--	a	--	--	4	--	--	--	--	--	--	--	--	--
anthracene/phenanthrene	--	3.4	T	0.2	a	T	--	130	1	--	--	--	--	--	--	--	--
fluorene	--	--	T	--	a	--	--	20	--	--	--	--	--	--	--	--	--
pyrene	--	--	--	2	a	--	--	72	--	--	--	--	--	--	--	--	--
chrysene/benzo(a)anthracene	--	10	1.6	1	a	--	--	77	1	--	--	--	--	--	--	--	T
fluoroanthene	T	--	.53	2	a	--	T	126	1	--	--	--	--	--	--	--	--
benzo(a)pyrene	--	--	--	--	a	--	--	9	--	--	--	--	--	--	--	--	--
benzo(b)fluoranthene	--	--	--	--	a	--	--	18	--	--	--	--	--	--	--	--	--
hexachloroethane	--	--	--	--	a	--	--	225	170	26	21.3	478	--	--	--	--	--
hexachlorobutadiene	--	--	--	--	a	--	--	--	9	4.8	T	8.7	--	--	--	--	--
bis(2-ethylhexyl) phthalate				--	a		--	28	3	--		--	--	1	4.1		--
diethyl phthalate				--	a		--	--	--	--		--	--	--	T		--
Acid Extractables																	
phenol				8.4	a		4.0	--	--	--		--	--	--	--		--
2,4,6-trichlorophenol				--	a		2.3	4	16	--		--	--	--	--		--
Pesticides																	
aldrin				--	--		--	--	--	--		--	.26	--	--		--
α-BHC				--	--		--	.10	--	--		--	--	.25	--		--
β-BHC				--	--		--	--	--	--		--	--	.32	--		--
δ-BHC				--	--		--	--	--	--		--	--	.05	--		--
γ-BHC				--	--		--	.28	--	--		--	.58	.12	--		--
4,4'-DDT				--	--		--	1.91	.046	--		--	4.1	.30	.15		--
4,4'-DDE				--	--		--	.24	.019	--		--	.62	--	--		--
4,4'-DDD				--	--		--	--	.021	--		--	.27	--	--		--
Miscellaneous																	
cyanide				--	8		10			--		--	25		--		--

( ) = Estimated
-- = Not detected
a = Not detected, but detection limit high relative to other analyses
T = Trace; value is greater than the limit of detection but less than the limit of quantification (1 µg/L in most cases)

Table 4c. Hylebos Waterway: Organic Priority Pollutant Concentrations in South Shore Discharges - U.S. Gypsum to Hooker (µg/L).

Discharge	Seep near U.S. Gypsum	U.S. Gypsum Heated Discharge	Lincoln Avenue Drain	Buffelin Cooling Water	Seep near Buffelin	Shore Drainage opposite Sound Refining	Drainage at S. End 11th St. Bridge	Hooker: Process Effluent	Hooker: Process Effluent	Hooker: Effluent Plume	Hooker: Seep near Old Solvent Plant
Date Sampled	9/23/80	9/23/80	4/28/82	6/3/80	9/23/80	9/23/80	4/28/82	6/3/80	9/25-26/79	9/23/80	9/23/80
Time Sampled	1150	1115	1410-1630	1530	1110	1100	1300-1635	1040	1100-1100	1045	1015
Investigator	EPA	EPA	WDOE	EPA	EPA	EPA	WDOE	EPA	WDOE	EPA	EPA
Sample Number	38310	38307	J0480	22301	38306	38305	J0481	22300	--	38304	38303
Station Number	19	20	21	22	23	24	25	26		26	27
Flow (MGD)			.029	(.007)			.040	(15)	15.50		
Volatiles											
chloroform	--	8.4	<10	--	--	--	a	17	11	9.3	950
dichlorobromomethane	--	--	a	--	--	--	a	1.1	--	--	3.6
chlorodibromomethane	--	--	a	--	--	--	a	2.2	1	--	7.6
bromoform	--	--	a	--	--	--	a	1.7	9	--	--
chloroethane	--	--	a	--	--	--	a	--	--	--	5
1,2-dichloroethane	--	--	a	--	--	--	a	--	--	--	35
1,2-trans-dichloroethylene	--	--	a	--	3.7	--	a	--	--	3.8	130
1,1-dichloroethylene	--	--	a	--	--	--	a	--	--	--	5
1,1,1-trichloroethane	--	--	a	--	--	--	a	--	--	--	2
trichloroethylene	--	T	a	--	2.7	--	a	--	--	3.4	57
tetrachloroethylene	--	--	a	--	--	--	a	3.0	4	2.8	240
1,1,2,2-tetrachloroethane	--	--	a	--	--	--	a	--	--	--	1400
toluene	--	--	a	--	--	--	a	--	--	--	--
Base/Neutrals											
naphthalene	1.3	--	a	--	--	--	a	--	--	--	6.6
anthracene/phenanthrene	.64	--	a	--	--	--	a	--	--	--	T
fluorene	.62	--	a	--	--	--	a	--	--	--	--
pyrene	--	--	a	--	23	--	a	--	--	--	10
chrysene/benzo(a)anthracene	--	--	a	--	--	--	a	--	--	--	1
fluoranthene	--	--	a	--	--	--	a	--	--	T	7.3
hexachloroethane	--	--	a	--	--	--	a	--	--	--	3.4
hexachlorobutadiene	--	--	a	--	--	--	a	--	.2	--	1.9
1,2-dichlorobenzene	--	--	a	--	--	--	a	--	--	--	T
1,3-dichlorobenzene	--	--	a	--	--	--	a	--	--	--	T
1,4-dichlorobenzene	--	--	a	--	--	--	a	--	--	--	T
1,2,4-trichlorobenzene	--	--	a	--	--	--	a	--	--	--	6.9
hexachlorobenzene	--	--	a	--	--	--	a	T	.3	--	T
2-chloronaphthalene	--	--	a	--	--	--	a	--	--	--	4.5
bis(2-ethylhexyl) phthalate			a				a		--		20
di-n-butyl phthalate			a				a		--		1
Acid Extractables											
phenol			<10				a				1
pentachlorophenol			190				a				--
Pesticides											
α-BHC			.130				--				--
4,4'-DDT			--				--				.181
4,4'-DDE			--				--				.110
4,4'-DDD			--				--				.086
Miscellaneous											
cyanide			5				8				

( ) = Estimated
-- = Not detected
a = Not detected, but detection limit high relative to other analyses
T = Trace; value is greater than the limit of detection but less than the limit of quantification (1 µg/L in most cases)

Table 5. Hylebos Waterway: Organic Priority Pollutant Loads Based on WDOE Data Collected September 1979 - April 1982 (pounds/day).

Discharge / Date Sampled	Sound Refining Drain #004 6/30/81	Sound Refining Process Effluent 6/30/81	W. Drain opposite Lincoln Avenue 4/20/82	E. Drain opposite Lincoln Avenue 4/28/82	Morningside Drain at Hylebos Boat Haven 8/17/81	Morningside Drain at Hylebos Boat Haven 3/29/82	Hylebos Creek 8/17/81	Hylebos Creek 3/29/82	Kaiser Ditch 8/17/81	Kaiser Ditch 3/29/82	Pennwalt East Property Line Drain 6/2/81	Pennwalt East Seep 6/2/81	Pennwalt West Seep 6/2/81	Pennwalt East Sewer 6/2/81	Pennwalt West Sewer 6/2/81	Pennwalt Process Effluent[1] 6/2-3/81	Lincoln Avenue Drain 4/20/82	Drainage at E. End 11th St. Bridge 4/20/82	Hooker Process Effluent[1] 9/25-26/79	Hooker Groundwater[2]	Sum of Loads to Hylebos Waterway[3]
Volatiles																					
chloroform	.00006	--	--	--	--	--	--	--	.28	--	.0019	.15	(.019)	.65	.0009	.71	.0012*	--	1.3	6.2	9.3
dichlorobromomethane	--	--	--	--	--	--	--	--	--	--	--	.0015	(.0002)	.0001*	--	--	--	--	--		.0018
chlorodibromomethane	--	--	--	--	--	--	--	--	--	--	--	.0004	(.0004)	--	--	.62	--	--	.13		.75
trichlorofluoromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.12	--	--	--		.12
bromoform	--	--	--	--	--	--	--	--	--	--	--	.0001	(.0004)	--	--	18.6	--	--	1.2		19.8
carbontetrachloride	--	--	--	--	--	--	--	--	--	--	--	.0002	--	--	--	--	--	--	--		.0002
chloroethane	--	--	--	--	--	--	--	--	--	--	--	.0002	(.00004)	--	--	--	--	--	--		.0002
1,1-dichloroethane	--	--	--	--	--	--	--	--	--	--	--	.00004	--	--	.0002	--	--	--	--	**	.0002
1,2-trans-dichloroethylene	--	--	--	--	--	--	.10	--	.014	--	--	--	--	--	--	--	--	--	--	.27	.38
1,1-dichloroethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.0004	--	--	--	--	**	.0004
1,1,1-trichloroethane	--	.0002	--	--	--	--	--	--	--	--	--	.00006	--	--	.013	--	--	--	--	**	.013
trichloroethylene	--	--	--	--	--	--	.068	--	.12	--	.0002	--	(.00004)	--	.00003*	--	--	--	--	2.2	2.4
tetrachloroethylene	--	--	--	--	--	--	--	--	--	--	--	.0011	(.0015)	--	--	--	--	--	.49	.54	1.0
1,1,2,2-tetrachloroethane	--	--	--	--	--	--	--	--	.12	--	--	--	--	--	--	--	--	--	--	**	.12
toluene	--	--	--	--	--	--	--	--	.0047	--	--	--	--	--	.00008	.23	--	--	--	**	.23
Base/Neutrals																					
naphthalene	--	--	--	--	(.012)	--	.020	--	--	--	--	--	(.000004)*	--	--	--	--	--	--		.032
acenaphthene	--	--	--	--	(.0022)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.0022
acenaphthylene	--	--	--	--	(.0076)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.0076
anthracene/phenanthrene	--	--	--	--	(.0054)	--	--	--	.0047	--	--	--	--	--	--	--	--	--	--		.010
flourene	--	--	--	--	(.0065)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.0065
pyrene	--	--	--	--	(.0065)	--	--	--	.047	--	--	--	--	--	--	--	--	--	--		.054
chrysene/benzo(a)anthracene	--	--	--	--	--	--	--	--	.023	--	--	--	--	--	--	.052*	--	--	--		.075
fluoranthene	--	--	--	--	--	--	--	--	.047	--	.000006*	--	--	--	--	--	--	--	--		.047
hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	.0003	(.0040)	--	--	--	--	--	--	**	.0043
hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	.00006	(.00007)	--	--	--	--	--	.026	**	.026
1,2-dichlorobenzene	--	--	--	--	(.022)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.022
1,3-dichlorobenzene	--	--	--	--	(.021)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.021
1,4-dichlorobenzene	--	--	--	--	(.022)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.022
hexachlorobenzene	--	--	--	--	(.0054)	--	--	--	--	--	--	--	--	--	--	--	--	--	.039		.044
2-chloronaphthalene	--	--	--	--	(.0054)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.0054
bis(2-ethylhexyl) phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.0003	--	--	--	--		.0003
dimethyl phthalate	--	--	--	--	(.0022)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.0022
diethyl phthalate	--	--	--	--	(.098)	--	--	--	--	--	--	--	--	--	.00003*	--	--	--	--		.098
nitrobenzene	--	--	--	--	(.0086)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.0086
4-bromophenyl ether	--	--	--	--	(.011)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.011
Acid Extractables																					
phenol	--	.0010	--	--	--	--	--	--	.20	--	.00005	--	--	--	--	--	.0012*	--	--		.20
2-chlorophenol	--	--	--	--	(.012)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.012
2,4,6-trichlorophenol	--	--	--	--	--	--	--	--	--	--	.00003	--	--	--	--	--	--	--	--		.00003
pentachlorophenol	--	.028	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.046	--	--		.074
Pesticides																					
aldrin	--	--	--	--	--	--	--	--	--	--	--	--	--	.00006	--	--	--	--	--		.00006
α-BHC	--	--	--	--	--	--	--	--	--	--	--	--	--	--		--	.00003	--	--		.00003
γ-BHC	--	--	--	--	--	--	--	--	--	--	--	--	--	.0001	--	--	--	--	--		.0001
4,4'-DDT	--	--	--	--	--	--	--	--	--	--	--	--	--	.0010	.00001	--	--	--	--		.0010
4,4'-DDE	--	--	--	--	--	--	--	--	--	--	--	--	--	.0002	--	--	--	--	--		.0002
4,4'-DDD	--	--	--	--	--	--	--	--	--	--	--	--	--	.00007	--	--	--	--	--		.00007
Miscellaneous																					
cyanide	--	.022	--	--	--	.016*	--	.66*	--	.12	.0001	--	--	.0060	--	--	.0012	.0027	--		.032

[1] Net load; corrected for amount of constituent present in saltwater influent

[2] Source: Walker Wells, Inc., groundwater studies for Hooker

[3] Calculated using dry flow (August) data only for Morningside Drain, Hylebos Creek and Kaiser Ditch

( ) = Calculated using an estimated flow

* = Calculated using 1/2 quantification limit

** = Also present, but load not calculated

-- = Not detected

Table 6. Hylebos Waterway: Relative Organic Priority Pollutant Contributions from Major Point Source Discharges.

Chemical	Total Load to Hylebos Waterway (pounds/day)	Major Sources	Individual Load (pounds/day)	Percent of Total Load	Detection Frequency†
Bromoform	19.8	Pennwalt process effluent	18.6	94	2/2
		Hooker process effluent	1.2	6	2/2
Chloroform	9.3	Hooker groundwater	6.2	67	
		Hooker process effluent	1.3	14	2/2
		Pennwalt process effluent	.71	7.5	2/2
		Pennwalt east sewer	.65	7	1/1
		Kaiser ditch (8/17/81)	.28	3	4/5
		Pennwalt east seep	.15	1.5	3/3
Trichloroethylene	2.4	Hooker groundwater	2.2	92	
		Kaiser ditch (8/17/81)	.12	5	3/5
		Hylebos Creek (8/17/81)	.068	2.8	1/3
Tetrachloroethylene	1.0	Hooker groundwater	.54	52	
		Hooker process effluent	.49	47	2/2
Chlorodibromomethane	.75	Pennwalt process effluent	.62	83	2/2
		Hooker process effluent	.13	17	2/2
1,2-trans-dichloroethylene	.38	Hooker groundwater	.27	70	
		Hylebos Creek (8/17/81)	.10	26	1/3
		Kaiser ditch	.014	3.6	1/2
Toluene	.23	Pennwalt process effluent	.23	100	1/1
Phenol	.20	Kaiser ditch (8/17/81)	.20	100	1/2
Trichlorofluoromethane	.12	Pennwalt process effluent	.12	100	1/2
1,1,2,2-tetrachloroethane	.12	Kaiser ditch (8/17/81)	.12	100	1/5

†Fraction of total number of EPA and WDOE samples in which the chemical was detected (Tables 1a - 1c).

Table 7. Hylebos Waterway: Sediment Sites.

Station Code	Original Agency Code	Collector	Analysis By	Location Name	Latitude 47°	Longitude 122°	Date Collected
*HI-1	I-20	EPA/DOE[a]	EPA/DOE[b]	Hylebos Waterway at Hylebos Creek	15' 40"	21' 33"	7/31/81
+HS 1	58	EPA[c]	EPA-Con[d]	Hylebos Waterway off Hylebos Creek	15' 42"	21' 35"	8/04/81
HS-2	A-10	EPA	EPA-New[e]	Hylebos Waterway upper turning basin	15' 46"	21' 36"	5/13/81
HS-3	1	BNW[f]	BNW	Upper turning basin, Hylebos Waterway	15' 51"	21' 45"	1980
HS-4	53	EPA	EPA-Con	Hylebos Waterway off Kaiser Ditch, mid-channel	15' 57"	21' 59"	8/04/81
HS-5	54	EPA	EPA-Con	Hylebos Waterway at Kaiser Ditch	15' 56"	22' 02"	8/04/81
HI-2	I-19	EPA/DOE	EPA/DOE	Hylebos Waterway at Kaiser Ditch	15' 55"	22' 02"	7/31/81
HI-3		DOE	EPA/DOE	Pennwalt, east property line drain	16' 03"	22' 15"	6/02/81
HI-4		DOE	EPA/DOE	Pennwalt, east seep	16' 04"	22' 17"	6/02/81
HI-5		DOE	EPA/DOE	Pennwalt, west seep	16' 05"	22' 19"	6/02/81
HS-6	52	EPA	EPA/Con	Hylebos Waterway at Pennwalt south drain	16' 06"	22' 18"	8/04/81
HS-7	2	BNW	BNW	Lower turning basin, north side of channel	16' 09"	22' 14"	1980
HI-6		DOE	EPA/DOE	Pennwalt, east sewer	16' 06"	22' 19"	6/02/81
HI-7		DOE	EPA/DOE	Pennwalt, west sewer	16' 07"	22' 21"	6/02/81
HS-8	1-09027	NOAA[g]	NOAA	Hylebos Waterway, lower turning basin	16' 10"	22' 19"	1979
HS-8	1-09027	NOAA	NOAA	Hylebos Waterway, lower turning basin	16' 10"	22' 19"	6/05/80
HS-8	1-09027	NOAA	NOAA	Hylebos Waterway, lower turning basin	16' 10"	22' 19"	3/05/81
HS-9	H-1	EPA	EPA-New	Hylebos Waterway, lower turning basin	16' 12"	22' 19"	5/12/81
HS-10	48	EPA/DOE	EPA/DOE	Hylebos Waterway off Pennwalt mid-channel	16' 11"	22' 20"	8/04/81
HI-8		DOE	EPA/DOE	Pennwalt, near main effluent	16' 10"	22' 25"	6/02/81
HS-11	46	EPA	EPA-Con	Hylebos Waterway at north end of Pennwalt	16' 12"	22' 26"	8/04/81
HS-12	47	EPA	EPA-Con	Hylebos WW, off N. end of Pennwalt mid-channel	16' 13"	22' 25"	8/04/81
HS-13	3	BNW	BNW	Central Hylebos WW, S. side of channel	16' 12"	22' 27"	1980
HS-14	A-9	EPA	EPA-New	Hylebos Waterway near 11th Avenue	16' 25"	22' 44"	5/13/81
HS-15	45	EPA	EPA-Con	Hylebos Waterway at Lincoln Ave. NE side	16' 27"	22' 46"	8/04/81
HI-9	I-22	EPA	EPA-Con	Hylebos Waterway at Lincoln Avenue drain	16' 25"	22' 49"	7/31/81
HS-16		DOE	EPA/DOE	Sound Refining, east end	16' 31"	22' 59"	6/30/81
HS-17	40	EPA	EPA-Con	Hylebos Waterway near Sound Refinery mid-channel	16' 31"	23' 02"	8/04/81
HS-18		DOE	EPA/DOE	Sound Refining, near process effluent outfall	16' 33"	23' 05"	6/30/81
HS-19	38	EPA	EPA-Con	Hylebos Waterway off Sound Refinery, SW side	16' 32"	23' 08"	8/04/81
HS-20	37	EPA	EPA-Con	Hylebos Waterway off Sound Refinery, mid-channel	16' 33"	23' 07"	8/04/81
HS-21	39	EPA	EPA-Con	Hylebos Waterway at Sound Refinery	16' 34"	23' 07"	8/04/81
HS-22		DOE	EPA/DOE	Sound Refining, west end	16' 34"	23' 10"	6/30/81
HS-23	A-8	EPA	EPA-New	Hylebos Waterway near 11th Avenue	15' 36"	23' 22"	5/13/81
HS-24	4	BNW	BNW	Hylebos Waterway, north side subtidal flat	16' 38"	23' 22"	1980
HS-25	32	EPA	EPA-Con	Hylebos WW off PRI NW dock, mid-channel	16' 45"	23' 55"	8/04/81
HS-26	2-09028	NOAA	NOAA	Hylebos Waterway, east 11th St. Bridge	16' 44"	23' 49"	1979
HS-26	2-09028	NOAA	NOAA	Hylebos Waterway, east 11th St. Bridge	16' 44"	23' 49"	6/05/80
HS-26	2-09028	NOAA	NOAA	Hylebos Waterway, east 11th St. Bridge	16' 44"	23' 49"	3/05/81
HI-10	I-24	EPA	EPA-New	Hylebos Waterway opposite Navy dock	16' 47"	23' 49"	7/31/81
HI-10	I-24	EPA	EPA-Con	Hylebos Waterway opposite Navy dock	16' 47"	23' 49"	7/31/81
HS-27	5	BNW	BNW	Lower Hylebos Waterway, south side	16' 43"	23' 59"	1980
HI-11	I-17	EPA/DOE	EPA/DOE	Hylebos Waterway at Hooker seep	16' 43"	24' 00"	7/31/81
HS-28	31	EPA/DOE	EPA/DOE	Hylebos Waterway at Hooker dock No. 2	16' 46"	24' 03"	8/04/81
HS-29	30	EPA	EPA-Con	Hylebos WW off Hooker dock No. 2, mid-channel	16' 48"	24' 01"	8/04/81
HI-12	I-16	EPA/DOE	EPA/DOE	Hylebos Waterway opposite Hooker outfall	16' 53"	24' 03"	7/31/81
HS-30	6	BNW	BNW	Lower Hylebos Waterway, S. side of channel	16' 51"	24' 10"	1980
HS-31	28	EPA	EPA-Con	Hylebos WW off Hooker dock No. 1, mid-channel	16' 55"	24' 13"	8/04/81
HS-32	27	EPA/DOE	EPA/DOE	Hylebos Waterway off marina, mid-channel	16' 58"	24' 18"	8/03/81
HS-33	24	EPA/DOE	EPA/DOE	Entrance of Hylebos Waterway, SW side	17' 03"	24' 29"	8/03/81
HI-13	I-25	EPA	EPA-Con	Entrance to Hylebos Waterway, NE shore	17' 13"	24' 36"	7/31/81

[a] USEPA (Schwartz), WDOE (Johnson)

[b] USEPA - contract laboratory (organics), WDOE - Tumwater laboratory (metals)

[c] USEPA (Schwartz)

[d] USEPA contract laboratory

[e] USEPA - Newport laboratory

[f] Battelle NW (Riley, *et al.*) for NOAA, OMPA-12

[g] NOAA (Malins, *et al.*) OMPA-2, etc.

*HS = Hylebos, Subtidal

+HI = Hylebos, Intertidal

Table 8. Hylebos Waterway: Intertidal (and source-related) Surface+ Sediment Priority Pollutant Concentrations (mg/Kg dry weight).

Station Code	HI-1	HI-2	HI-3	HI-4	HI-5	HI-6	HI-7	HI-8	HI-9	HI-10		HI-11	HI-12	HI-13
Agency Responsible for Analysis	EPA/DOE	EPA/DOE	EPA/DOE	EPA/DOE	EPA/DOE	EPA/DOE	EPA/DOE	EPA/DOE	EPA-Con	EPA/DOE	EPA-Con	EPA/DOE	EPA/DOE	EPA-Con
Original Agency Code	I-20	I-19							I-22		I-24	I-17	I-16	I-25
Miles from Head of WW	.00	.49	.71	.74	.77	.79	.82	.91	1.32		2.23	2.35	2.47	3.24
Year Collected	1981	1981	1981	1981	1981	1981	1981	1981	1981		1981	1981	1981	1981
Percent Solids	37	63	77	60	47	72	64	53	50.6	68	80.3	73	71	79
Metals														
As	150	41	66	87	560	690	270	240	[73]	31	[4.2]	<1	20	[3.5]
Cd	0.70	0.46	0.20	0.40	2.3	3.7	0.57	1.5	[<0.2]	0.24	[<.13]	1.2	0.25	[<.13]
Cr	26	16	9	40	28	13	23	37	[<2]	9.0	[<1.3]	2.9	8.0	[<1.2]
Cu	81	27	23	28	1400	1000	72	1400	[20]	37	[<6.2]	4.2	21	[<6.3]
Hg	0.18	<0.1	0.20	0.31	0.97	15	0.11	0.49	[<.04]	<0.1	[<.02]	<0.1	<0.1	[<.02]
Ni	21	19	8.7	11	28	85	27	25	[13]	8.3	[<5]	11	9.3	[<5]
Pb	66	20	21	22	300	310	84	610	[87]	17	[29]	6100	20	[15]
Zn	160	54	74	60	620	240	250	400	[120]	37	[19]	30	35	[18]
Volatiles														
chloroform	--	--	--	2.17	1.52	T	--	T	--	--	--	--	--	--
dichlorobromomethane	--	--	--	.18	7.6	--	--	--	--	--	--	--	--	--
chlorodibromomethane	--	--	--	T	--	--	--	--	--	--	--	--	.02	--
bromoform	--	--	--	T	--	--	--	--	--	--	--	--	--	--
1,1,1-trichloroethane	--	--	--	T	--	--	--	--	--	--	--	--	--	--
trichloroethylene	--	--	--	T	--	--	--	--	--	--	--	--	--	--
tetrachloroethylene	--	--	--	.74	.68	T	--	--	--	--	--	.27	--	--
toluene	--	--	--	--	--	--	--	T	--	--	--	--	--	--
Base/Neutrals														
hexachloroethane	--	--	--	--	--	--	--	--	a	--	--	2.6	--	a
1,2,4-trichlorobenzene		--	--	--	--	--	--	--	a	--	--	.38	--	a
hexachlorobenzene	--	--	--	--	--	--	--	--	a	--	--	.47	--	a
hexachlorobutadiene	--	--	--	T	--	--	--	--	a	--	--	.71	--	a
naphthalene	--	T	--	--	--	--	--	.34	a	--	--	.33	--	a
acenaphthene	--	.97	--	--	--	.32	--	--	a	--	--	--	--	a
acenaphthalene	--	--	--	--	--	--	--	--	a	--	--	--	--	a
anthracene/phenanthrene	--	49	.31	.18	.86	3.6	.20	1.37	a	--	--	T	--	a
fluorene	--	1.6	--	--	--	--	--	--	a	--	--	--	--	a
pyrene	T	95	.29	T	1.14	2.6	.24	1.52	a	--	--	T	--	a
chrysene/ benzo(a)anthracene	--	95	.47	T	2.1	3.5	.31	2.25	a	--	--	--	--	a
fluoranthene	T	110	0.4	.18	1.05	1.8	.25	1.76	a	--	--	T	--	a
dibenzo(a,h)anthracene	--	2.1	--	--	--	--	--	--	a	--	--	--	--	a
benzo(a)pyrene	T	24	--	--	1.14	2.8	--	1.13	a	--	--	--	--	a
benzo(k)fluoranthene/ 3,4-benzofluoranthene	--	32	--	--	1.8	2.4	.15	1.28	a	--	--	T	--	a
benzo(g,h,i)perylene	--	4.6	--		.40	--	--	--	a	--	--	--	--	a
ideno(1,2,3-cd)pyrene	--	4.8	--	--	.38	--	--	--	a	--	--	--	--	a
diethyl phthalate	--	--	--	--	T	--	--	--	a	--	--	--	--	a
bis(2-ethylhexyl) phthalate	--	--	--	--	--	--	--	--	a	--	--	--	--	a
butylbenzyl phthalate	--	--	--	--	--	--	--	--	a	--	--	--		a
Acid Extractables														
phenol	--	--	--	--	--	--	--	--	a	T	--	--	--	a
pentachlorophenol	--	--	--	--	--	--	--	--	a	--	--	T	--	a
Pesticides and PCBs														
aldrin	--	--	--	--	--	--	--	T	--	--	--	.95	.062	--
α-BHC	--	--	--	T	--	--	--	--	--	--	--	--	--	--
β-BHC	--	--	--	--	T	--	--	T	--	--	--	--	--	--
γ-BHC (Lindane)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDD	--	--	--	--	.57	.15		--	--	--	--	--	--	--
4,4'-DDE	--	--	--	--	T	.67	--	T	--	--	--	--	--	--
4,4'-DDT	--	--	--	--	3.0	.36	--	--	--	--	--	--	--	--
total DDT forms	--	--	--	--	3.6	1.18	--	T	--	--	--	--	--	--
PCB-1248	--	.98	--	--	--	--	--	--	--	--	--	--	--	--
PCB-1254	--	--	--	--	--	--	--	T	--	--	--	--	--	--
PCB-1260	--	--	--	--	--	--	.42	--	.17	--	--	--	--	--
total PCBs	--	.98	--	--	--	--	.42	T	.17	--	--	--	--	--

-- = Not detected
a = Not detected, but detection levels too high to be useful
T = Trace amounts
[ ] = Weak acid digestion (0.1 N nitric acid w/5 g. wet sediment)
+ = All data represent samples obtained from the top 2-5 cm. of sediment

Table 9a. Hylebos Waterway: Subtidal Surface† Sediment Priority Pollutant Concentrations (mg/Kg dry weight).

Station Code	HS-1	HS-2	HS-3	HS-4	HS-5	HS-6	HS-7	HS-8			HS-9	HS-10	HS-11
Agency Responsible for Analysis	EPA-Con	EPA-New	BNW	EPA-Con	EPA-Con	EPA-Con	BNW	NOAA			EPA-New	EPA/DOE	EPA-Con
Original Agency Code	58	A-10	1	53	54	52	2	1-09027			H-1	48	46
Miles from Head of Waterway	.05	.10	.26	.47	.49	.78	.78	.84			.86	.87	.94
Year Collected	1981	1981	1980	1981	1981	1981	1980	1979	1980	1981	1981	1981	1981
Percent Solids	56.5	37		43.0	36.1	8.9			27.7	36		38	42.5
Metals													
As	[20]	182		[42]	[6.1]	[56]			112	170	203	110	[31]
Cd	[0.42]	2.7		[<0.23]	[<0.28]	[<1.1]		(9.61)	3.0	1.2	3.2	1.6	[<.24]
Cr	[5.8]	30.9		[6.3]	[5.0]	[<11]		47.6	52	59	40.1	32	[5.9]
Cu	[19]	173		[<11]	[<14]	[<56]		259	227	200	211	190	[18.1]
Hg	[<.04]			[<.05]	[<.06]	[<0.22]		0.79	1.2	0.22		.47	[<.05]
Ni	[13]			[13]	[18]	[<45]		(64.4)				35	[9.4]
Pb	[37]	123		[79]	[64]	[<45]		154	164	170	197	160	[164]
Zn	[73]	259		[3500]	[116]	[84]		324	404	320	334	270	[134]
Volatiles													
chloroform	--			--	--	--						--	--
dichlorobromomethane	--			--	--	--						--	--
chlorodibromomethane	--			--	--	--						--	--
bromoform	--			--	--	--						--	--
1,1,1-trichloroethane	--			--	--	--						--	--
trichloroethylene	--			--	--	--						--	--
tetrachloroethylene	--			--	--	--						--	--
toluene	--			--	--	--						--	--
Base/Neutrals													
hexachloroethane	a			a	a	a						--	a
1,2,4-trichlorobenzene	a			a	a	a						--	a
hexachlorobenzene	a	T		a	a	a		.02	.05	.03	--	--	a
hexachlorobutadiene	a	--	--	a	a	a	.022	.09	.085	.095	--	--	a
naphthalene	a	.093	.035	a	a	a	.200	.10	.085	.12	.044	--	a
acenaphthene	a			a	a	a		.04	.02	.033		--	a
acenaphthalene	a			a	a	a		--	.013			--	a
anthracene/phenanthrene	a	.489	.989	a	a	a	1.406	.60	.21	1.44	.343	T	a
fluorene	a	.045	.072	a	a	a	.218	.04	.035	.095	.034	--	a
pyrene	a	3.55*	6.102	D	D	a	2.772	1.6	1.1	3.8	4.05*	T	a
chrysene/ benzo(a)anthracene	D	1.32	5.972	D	D	D	5.587	4.0	3.1	4.9	2.07	.79	D
fluoranthene	a		1.640	D	D	a	1.409	1.7	1.0	2.8		T	a
dibenzo(a,h)anthracene	D			a	a	a						--	a
benzo(a)pyrene	a		5.467	D	D	a	1.149	.50	.52	.87		.68	a
benzo(k)fluoranthene/ 3,4-benzofluoranthene	a			D	D	a		2.9	2.0	3.9		T	a
benzo(g,h,i)perylene	a			a	a	a						--	a
ideno(1,2,3-cd)pyrene	a			a	a	a		.43	.26	.33		--	a
diethyl phthalate	a	.092		a	a	a					--	--	a
bis(2-ethylhexyl) phthalate	a	1.72		a	a	a					1.76	--	a
butylbenzyl phthalate	a	--		a	a	a					.36	--	a
Acid Extractables													
phenol	a			a	a	a						--	a
pentachlorophenol	a			a	a	a						--	a
Pesticides and PCBs													
aldrin	--			--	--	--		--	I	I		--	--
α-BHC	--			--	--	--						--	--
β-BHC	--			--	--	--						--	--
γ-BHC (Lindane)	--			--	--	--		--	--	I		--	--
4,4'-DDD	--	--		--	--	--		.05	.031	I	--	--	--
4,4'-DDE	--	.224		--	--	--		.01	.030	I	--	--	--
4,4'-DDT	--	.645		--	--	--		.07	.018	I	--	--	--
total DDT forms	--	.869		--	--	--		.16	.085	I	--	--	--
PCB-1248	--	--		--	--	--					--	--	--
PCB-1254	--	T		--	--	--					.39	--	--
PCB-1260	--	--		--	--	--					--	--	--
total PCBs	--	T	.018	--	--	--	.203	1.15	.98	I	.39	.53	--

-- = Not detected
a = Not detected, but detection levels too high to be useful
D = Detected despite poor detection limits; not quantified
I = Not determined due to interference
( ) = Because it appears that these data may be anomolous, they were not used for graphical or statistical interpretation
* = Pyrene + fluoranthene
T = Trace amount
[ ] = Weak acid digestion (0.1 N nitric acid w/5 wet grams of sediment)
† = All data represent samples obtained from the top 2-5 cm. of sediment.

Table 9b. Hylebos Waterway: Subtidal Surface+ Sediment Priority Pollutant Concentrations (mg/Kg dry weight) - continued.

Station Code	HS-12	HS-13	HS-14	HS-15	HS-16	HS-17	HS-18	HS-19	HS-20	HS-21	HS-22	HS-23	HS-24	HS-25
Agency Responsible for Analysis	EPA-Con	BNW	EPA-New	EPA-Con	EPA/DOE	EPA-Con	EPA/DOE	EPA-Con	EPA-Con	EPA-Con	EPA/DOE	EPA-New	BNW	EPA-Con
Original Agency Code	47	3	A-9	45		40		38	37	39		A-8	4	32
Miles from Head of Waterway	.94	.95	1.28	1.32	1.51	1.54	1.60	1.61	1.62	1.63	1.68	1.82	1.90	2.17
Year Collected	1981	1980	1981	1981	1981	1981	1981	1981	1981	1981	1981	1981	1980	1981
Percent Solids	40.9		48	48	41	47.3	53	56.5	48.8	50.8	53	66		60
Metals														
As	[39]		120	[13]	57	[17]	40	[8.5]	[15]	[31]	48	37		[7]
Cd	[<.24]		1.1	[.27]	0.99	[<.21]	0.73	[<.18]	[<.20]	[.37]	0:77	0.38		[<.16]
Cr	[12]		29.0	[4.4]	24	[4.2]	19	[3.0]	[5.3]	[6.3]	23	20.0		[<1.6]
Cu	[83]		179	[<10]	210	[5.3]	130	[<9]	[17]	[49]	130	53		[17]
Hg	[<.05]			[<.04]	0.38	[<.04]	0.33	[<.04]		[<.04]	0.26			[<.03]
Ni	[20]			[<8]	20	[<8.5]	18	[<7]	[15]	[<8]	17			[<7]
Pb	[152]		147	[48]	23	[93]	11	[21]	[120]	[59]	22	41		[43]
Zn	[220]		202	[77]	170	[89]	220	[71]	[90]	[89]	140	150		[98]
Volatiles														
chloroform	--			--	--	--	--	--	--	--	T			--
dichlorobromomethane	--			--	--	--	--	--	--	--	--			--
chlorodibromomethane	--			--	--	--	--	--	--	--	--			--
bromoform	--			--	--	--	--	--	--	--	--			--
1,1,1-trichloroethane	--			--	--	--	--	--	--	--	--			--
trichloroethylene	--			--	--	--	--	--	--	--	T			--
tetrachloroethylene	--			--	--	--	--	--	--	--	--			--
toluene	--			--	T	--	T	--	--	--	T			--
Base/Neutrals														
hexachloroethane	a			a	--	a	--	a	a	a	--			a
1,2,4-trichlorobenzene	a			a	--	a	--	a	a	a	--			a
hexachlorobenzene	a		.105	a	T	a	--	a	a	a	T	.052		a
hexachlorobutadiene	a	<.001	--	a	T	a	--	a	a	a	T		<.001	a
naphthalene	a	.284	.096	a	T	a	--	a	a	a	.23	.084	.116	a
acenaphthene	a			a	--	a	--	a	a	a	T			a
acenaphthalene	a			a	--	a	--	a	a	a	--			a
anthracene/phenanthrene	a	2.658	.285	a	1.2	a	.68	a	a	a	.76	.188	.388	a
fluorene	a	.369	.017	a	--	a	--	a	a	a	--	.027	.087	a
pyrene	a	3.578	2.28*	a	1.4	a	1.1	D	a	a	1.4	.84*	.451	a
chrysene/ benzo(a)anthracene	a	5.794	1.57	a	2.2	a	2.3	D	a	a	1.5	.51	.739	a
fluoranthene	a	4.724		a	1.6	a	1.8	D	a	a	1.7		.775	a
dibenzo(a,h)anthracene	a			a	--	a	--	a	a	a	--			a
benzo(a)pyrene	a	1.454		a	1.3	a	.99	a	a	a	.68		.147	a
benzo(k)fluoranthene/ 3,4-benzofluoranthene	a			a	1.4	a	1.4	a	a	a	.94			a
benzo(g,h,i)perylene	a			a	.34	a	.32	a	a	a	.24			a
ideno(1,2,3-cd)pyrene	a			a	T	a	.24	a	a	a	T			a
diethyl phthalate	a		.094	a	T	a	--	a	a	a	--	--		a
bis(2-ethylhexyl) phthalate	a		1.44	a	--	a	--	a	a	a	.62	.30		a
butylbenzyl phthalate	a		--	a	T	a	--	a	a	a	.23	--		a
Acid Extractables														
phenol	a			a	T	a	T	a	a	a	T			a
pentachlorophenol	a			a	--	a	--	a	a	a	--			a
Pesticides and PCBs														
aldrin	.02			.052	--	--	--	.034	--	.057	--			.03
α-BHC	--			.025	--	--	--	.034	--	.063	--			--
β-BHC	--			--	--	--	--	--	--	--	--			--
γ-BHC (Lindane)	--			--	--	--	--	--	--	.04	--			--
4,4'-DDD	--		--	--	--	--	--	--	--	--	--	--		--
4,4'-DDE				--	--	--	--	--	--	--	--	--		--
4,4'-DDT	--		.382	--	--	--	--	--	--	--	--	--		--
total DDT forms	--		.382	--	--	--	--	--	--	--	--	--		--
PCB-1248	--		--	--	--	--	--	--	--	--	--	--		--
PCB-1254	--		1.224	--	--	--	--	--	--	--	--	--		--
PCB-1260	0.64		--	.40	.27	--	.34	1.7	--	--	.34	--		.107
total PCBs	0.64	.196	1.224	.40	.27	--	.34	1.7	--	--	.34	--	.154	.107

-- = Not detected
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D = Detected despite poor detection limits; not quantified
I = Not determined due to interference
( ) = Because it appears that these data may be anomolous, they were not used for graphical or statistical interpretation
* = Pyrene + fluoranthene
T = Trace amount
[ ] = Weak acid digestion (0.1 N nitric acid w/5 wet grams of sediment)
+ = All data represent samples obtained from the top 2-5 cm. of sediment

Table 9c. Hylebos Waterway: Subtidal Surface[+] Sediment Priority Pollutant Concentrations (mg/Kg dry weight) - continued.

Station Code	HS-26			HS-27	HS-28	HS-29	HS-30	HS-31	HS-32	HS-33
Agency Responsible for Analysis	NOAA			BNW	EPA/DOE	EPA-Con	BNW	EPA-Con	EPA/DOE	EPA/DOE
Original Agency Code	2-09028			5	31	30	6	28	27	24
Miles from Head of Waterway	2.22			2.32	2.42	2.43	2.53	2.59	2.68	2.88
Year Collected	1979	1980	1981	1980	1981	1981	1980	1981	1981	1981
Percent Solids		56	56		50	43.6		57.5	60	56
Metals										
As		39	31		47	[10]		[5.9]	27	33
Cd	(6.8)	1.21	.38		0.85	[<.2]		[<.17]	.48	0.64
Cr	33.5	19.8	32		20	[<2]		[2.4]	11	16
Cu	84.8	86.0	88		99	[34]		[<8.7]	55	87
Hg	.428	0.25	0.28		0.26	[<.05]		[<.04]	.27	0.19
Ni	(41.9)				23	[<9]		[<7.0]	17	15
Pb	111	102	77		110	[67[		[35]	47	66
Zn	134	120	99		140	[99]		[56]	58	120
Volatiles										
chloroform					--	T		--	--	--
dichlorobromomethane					--	--		--	--	--
chlorodibromomethane					--	--		--	--	--
bromoform					--	--		--	--	--
1,1,1-trichloroethane					--	--		--	--	--
trichloroethylene					--	--		--	--	--
tetrachloroethylene					--	--		--	--	--
toluene					--	--		--	--	--
Base/Neutrals										
hexachloroethane					--	a		a	--	--
1,2,4-trichlorobenzene					--	a		a	--	--
hexachlorobenzene	(.06)	1.3	.15		--	a		a	----	--
hexachlorobutadiene	(.002)	3.3	.56	.007	--	a	.09	a	--	--
naphthalene	(2.6)	.21	.23	.48	--	a	.547	a	--	--
acenaphthene	(.31)	.069	.052		--	a		a	--	T
acenaphthalene	(.28)	.090			--	a		a	--	--
anthracene/phenanthrene	(8.0)	.36	.64	1.482	.42	a	2.686	a	T	1.4
fluorene	(.82)	.096	.084	.172	--	a	.482	a	--	T
pyrene	(6.7)	1.3	.87	3.412	T	a	.074	a	T	1.1
chrysene/ benzo(a)anthracene	(6.2)	1.9	.85	1.906	.60	a	1.269	a	T	1.0
fluoranthene	(6.4)	1.0	.75	1.490	.68	a	.060	a	--	1.3
dibenzo(a,h)anthracene					--	a		a	--	--
benzo(a)pyrene	(1.7)	.26	.19	1.683	.68	a	.251	a	--	1.0
benzo(k)fluoranthene/ 3,4-benzofluoranthene	(11.0)	.64	.71		T	a		a	T	1.2
benzo(g,h,i)perylene					--	a		a	--	T
ideno(1,2,3-cd)pyrene	(1.1)	.12	.076		--	a		a	--	T
diethyl phthalate					--	a		a	--	--
bis(2-ethylhexyl) phthalate					.42	a		a	T	.54
butylbenzyl phthalate					--	a		a	--	--
Acid Extractables										
phenol					--	a		a	--	--
pentachlorophenol					--	a		a	--	--
Pesticides and PCBs										
aldrin	--	I	I		.82	--		--	.17	.43
α-BHC					--	--		.043	--	--
β-BHC					--	--		--	--	--
γ-BHC (Lindane)	--	I	I		--	--		--	--	--
4,4'-DDD	.010	I	I		--	--		--	--	--
4,4'-DDE	.0002	I	I		--	--		--	--	--
4,4'-DDT	.003	I	I		--	--		--	--	--
total DDT forms	.015	I	I		--	--		--	--	--
PCB-1248					--	--		--	--	--
PCB-1254					--	--		--	--	--
PCB-1260					--	--		--	--	--
total PCBs	1.15	I	I	1.683	--	--	1.057	--	--	--

-- = Not detected
a = Not detected, but detection levels too high to be useful
D = Detected despite poor detection limits; not quantified
I = Not determined due to interference
( ) = Because it appears that these data may be anomolous, they were not used for graphical or statistical interpretation
* = Pyrene + fluoranthene
T = Trace amount
[ ] = Weak acid digestion (0.1 N nitric acid w/5 wet grams of sediment)
+ = All data represent samples obtained from the top 2-5 cm. of sediment

Table 10. Summary of Hylebos Sediment Priority Pollutants Data (mg/Kg dry weight).

Constituent	Intertidal (including source-related) Sediments Minimum	Intertidal (including source-related) Sediments Maximum	Subtidal Sediments Minimum	Subtidal Sediments Maximum	Subtidal Sediments Median	Estimated Load to Sediments+ (lbs/day)
Metals*						
As	<1	690	27	203	48	0.61
Cd	0.2	3.7	0.38	3.2	0.99	0.01
Cr	9	40	11	59	24	0.30
Cu	4.2	1400	53	259	130	1.6
Hg	<0.1	15	0.19	1.2	0.28	.004
Ni	9.3	86	15	35	18	.23
Pb	20	6100	11	197	111	1.4
Zn	35	620	58	404	150	1.9
Volatiles						
chloroform	--	2.17	--	T	--	--
dichlorobromomethane	--	7.6	--	--	--	--
chlorodibromomethane	--	0.2	--	--	--	--
bromoform	--	T	--	--	--	--
1,1,1-trichloroethane	--	T	--	--	--	--
trichloroethylene	--	T	--	T	--	--
tetrachloroethylene	--	.74	--	--	--	--
toluene	--	T	--	T	--	--
Base/Neutrals						
hexachloroethane	--	2.6	--	--	--	--
1,2,4-trichlorobenzene	--	0.38	--	--	--	--
hexachlorobenzene	--	0.47	--	1.3	(.06)	(.0008)
hexachlorobutadiene	--	0.71	--	3.3	(.05)	(.0006)
naphthalene	--	0.34	--	.55	.10	.0013
acenaphthene	--	0.97	--	.069	(.05)	(.0006)
acenaphthalene	--	--	--	.090	(.05)	(.0006)
anthracene/phenanthrene	--	49	T	2.69	.62	.0078
fluorene	--	1.6	--	.48	(.08)	(.001)
pyrene	--	95	T	6.1	1.3	.017
chrysene/ benzo(a)anthracene	--	95	T	6.0	2.0	.025
fluoranthene	--	110	--	4.7	1.0	.013
dibenzo(a,h)anthracene	--	2.1	--	T	--	--
benzo(a)pyrene	--	24	--	5.5	.68	.0086
benzo(k)fluoranthene/ 3,4-benzofluoranthene	--	32	T	2.9	1.3	.016
benzo(g,h,i)perylene	--	4.6	--	.34	(.1)	(.001)
ideno(1,2,3-cd)pyrene	--	4.8	--	.43	.24	.0030
diethyl phthalate	--	T	--	.094	.05	.0006
bis(2-ethylhexyl) phthalate		--	--	1.76	.30	.0038
butylbenzyl phthalate	--	--	--	.36	(.1)	(.001)
Acid Extractables						
phenol	--	T	--	T	--	--
pentachlorophenol	--	T	--	--	--	--
Pesticides and PCBs						
aldrin	--	.95	--	.82	(.02)	(.0003)
α-BHC	--	T	--	.063	(.01)	(.0001)
β-BHC	--	T	--	--	--	--
γ-BHC (Lindane)	--	--	--	.04	--	--
4,4'-DDD	--	.57	--	.05	(.005)	(.00006)
4,4'-DDE	--	.67	--	.22	(.005)	(.00006)
4,4'-DDT	--	3.0	--	.65	(.01)	(.0001)
total DDT forms	--	3.6	--	.87	(.015)	(.0002)
PCB-1248	--	.98	--	--	--	--
PCB-1254	--	T	--	1.2	(.05)	(.0006)
PCB-1260	--	.42	--	1.7	(.1)	(.001)
total PCBs	--	.98	--	1.7	.2	.0025

-- = None detected
T = Trace amount
( ) = Estimated median
* = Strong acid digestion data only
\+ = Sediment loading estimates based on following assumptions: median values equal mean values, sedimentation rate of .35 gr of dry solids per cm^2 per year, area of Hylebos Waterway equals 6×10^5 m^2