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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

by

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INTRODUCTION

This is a collection of data summaries on priority pollutants in point-source discharges and surface sediments in Commencement Bay waterways and the Old Tacoma-Ruston shoreline. They were compiled during 1983 by the WDOE Water Quality Investigations Section to assist in planning work for the Commencement Bay nearshore/tideflats investigations (Superfund). Most of these data were collected between 1979 and 1982 and reported by WDOE, EPA, NOAA, and Battelle. Also included were unpublished data from WDOE point-source sampling and a series of sediment collections made by EPA and WDOE. Water column data were reviewed for these summaries, but not tabulated. Data on sediments deeper than the limit for dredging (taken to be 60 feet) and biological data were not, in general, reviewed. Data on organic compounds not classified as priority pollutants were also not reviewed.

The data were summarized by waterway in the six parts listed below. Each was originally issued separately as the data were compiled and reviewed.* In the interest of putting together a useful package in a timely fashion, an outline format was used.

Part 1.	Hylebos Waterway	April 1983
Part 2.	City Waterway	May 1983
Part 3.	Blair Waterway	July 1983
Part 4.	Sitcum Waterway	July 1983
Part 5.	Milwaukee, Puyallup, St. Paul, Middle Waterways and S.W. Shore Commencement Bay	October 1983
Part 6.	Summary	December 1983

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. <u>The importance of consistent sampling techniques and analytical methods in future Commencement Bay investigations cannot be over-emphasized</u>.

The methods employed in obtaining most of the data compiled here are described in the reports cited. The WDOE point source data on discharges other than ASARCO, St. Regis, Tacoma Central STP, U.S. Oil, Reichhold, Pennwalt, Sound Refining, and Hooker/Occidental (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.

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*The final versions of these reports supercede Parts 1-6 issued separately, since they contain changes in the original text and/or data.

The WDOE point-source samples were collected in one-gallon glass jars (base/neutrals, acid extractables, pesticides, and PCBs), 40 mL screw-top glass vials with teflon septa (volatiles), and 2-1/2 or 5-gallon polyethylene cubitainers (metals and conventional water quality parameters*). Sample bottles were cleaned according to EPA priority pollutant protocol. Laboratory and field blanks were analyzed with the point-source samples to check for 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.

Analysis was done 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.

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 in a transect along the lower beach, usually below or near a point-source discharge, and pooled. After mixing with a glass or stainless steel rod, subsamples were placed in glass (organics analysis) or plastic (metals analysis) containers and analyzed as described above. A third portion of the sample was sent to the EPA Newport laboratory for amphipod bioassay. (The results of bioassay tests are 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.

*The data on conventionals are available on request.

PART 1. HYLEBOS WATERWAY

PART 1. HYLEBOS WATERWAY
(4/83; revised 1/84)

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 10) proposed a method for determining annual loads to Hylebos sediments. Because of sediment disturbances from dredging, the sedimentation rate used was that measured in a core from Commencement Bay close to, but outside, Hylebos Waterway. This rate may be different from that in the waterway. Based on Riley's method, the following loads have been estimated; they are compared with point-source loads to the waterway documented by WDOE surveys: — Table 2, Table 5, Table 10

Pollutant	Load to Sediment (kg/yr)	Load to Sediment (lbs/day)	Pt. Source Loads Measured by WDOE (lbs/day) Wet Weather	Pt. Source Loads Measured by WDOE (lbs/day) Dry Weather	Ratio of Dry Weather 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 has been accounted for in the source sampling. Because of the wide variance in ratios between documented source loads and accumulation rates in the sediments, it appears likely that significant sources of specific priority pollutants have not yet been identified.

Refer to Data in:

3. EPA amphipod bioassays conducted by Swartz (reference 11) indicate zones of high mortality are associated with sediments near Hooker (Occidental), Sound Refining, Pennwalt, Kaiser Ditch, and Hylebos Creek. Similar bioassays done at the University of Washington (reference 9) suggest that anoxia, particle size, and other factors (in the absence of toxics) may influence mortality in this test. Therefore, it is not clear what the relation is between amphipod mortality and toxicants in waterway sediment.

   Chapman's (reference 1) NOAA-sponsored assessment of sediment toxicity in Puget Sound, using both lethal and sublethal bioassays, ranked Hylebos sediments, along with those in Blair, as the third most toxic of the sites studied. (City Waterway and Elliot Bay near Denny Way CSO ranked first and second.) Additional in-depth study was recommended for Hylebos Waterway.

General Considerations for Future 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.

2. There is a need for criteria which establish what amounts of contaminants in sediment represent a hazard to marine life and public health.

Metals - Observations

1. EPA and WDOE point-source data show the highest concentrations of As, Cr, and Hg were in seeps and drains at the Pennwalt facility. The maximum concentrations measured were 12,000 μg/L As, 1,870 μg/L Cr, and 16.2 μg/L Hg. Samples from four seeps at other points along the Hylebos shoreline, including one at Hooker (Occidental), also had elevated concentrations of various metals. — Table 1

2. High metals concentrations are apparently not characteristic of NPDES-permitted effluents from Pennwalt, Hooker (Occidental), or Sound Refining.

3. Metals loads calculated for most discharges were much less than one pound per day. The largest loads were from Hooker (Occidental) and Pennwalt effluents and in Hylebos Creek and Kaiser Ditch--largely by virtue of the volume of these discharges rather than metals concentrations. The maximum load measured was 30.5 lbs/day Ni in the Hooker (Occidental) effluent. — Table 2, Table 3

Refer to Data in:

4. 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).

5. Log sort yards which have used ASARCO slag for ballast are potential significant sources of As, Cu, Zn and other metals to the Hylebos. These loads have not been quantified. Most yards have agreed to comply with a WDOE request to use other materials for ballast.

6. There are no metals data on runoff or nearshore sediment from General Metals.

7. EPA data (reference 12) showed Hylebos bottom waters had higher Pb, Cd, Cu, Se, Cr, and Ni concentrations than surface waters. The reverse was true for As, Zn, and Mn. There is some evidence that Cu and As 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)

8. Some data show water column concentrations of Cu are above EPA criteria for protection of marine life (references 3, 4, 12, and 13). Substantial point-source Cu loads have not been found. 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 Joe Cummins at the EPA Manchester laboratory (references 3 and 4) have not shown Hylebos waters to be acutely toxic.

9. EPA water samples (reference 12 and 13) taken along the Pennwalt shoreline below the seeps and drains mentioned above, had As, Hg, Pb, and Zn concentrations above EPA criteria.

10. No core data exist for metals in Hylebos sediments. This is required to determine depositional history of metals.

Metals - Considerations for Future Work

1. Quantify metals loads from log sort yards which have used ASARCO slag for ballast.

2. Sample runoff and nearshore sediment at General Metals.

3. The WDOE Southwest Regional Office should pursue the metals issue with Pennwalt.

	Refer to Data in:
4. Obtain better data on Cu in the water column and assess the applicability of the EPA criteria.	
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. 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 were the major organic priority pollutants isolated in EPA water column samples (reference 12). Concentrations were highest off Hooker (Occidental) and decreased toward the head of the waterway. Surface waters contained larger concentrations of volatiles than bottom waters. EPA aquatic life criteria were not exceeded; EPA human health criteria (cancer risk) for seafood consumption from these waters were sometimes exceeded. Battelle water samples collected by Riley (reference 10) for NOAA also showed 1,1,1-trichloroethane at relatively high concentrations near Hooker (Occidental).	Figure 4
2. Volatiles have been detected in intertidal sediments close to sources. They generally were not found in subtidal sediments; trace amounts of chloroform were detected in only 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 Hylebos Waterway are volatiles from Hooker (Occidental) 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 (Occidental) 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 the chlorine stripper. Bromoform has been detected throughout the waterway but in concentrations much lower than the volatiles mentioned above (reference 10). Peak concentrations of 2 to 4 μg/L were detected near Pennwalt (references 3 and 10).	Table 5 Table 6
6. Based on EPA and WDOE surveys, discharges other than Hooker (Occidental) and Pennwalt are probably not significant sources of halogenated organic priority pollutants.	

HYLEBOS WATERWAY

Refer to Data in:

Volatiles - Considerations for Future Work

1. Develop criteria for chloroform in marine water.

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

3. Because there are a variety of volatiles and other organic pollutants in Hooker's (Occidental) groundwater and effluent, an effort to assess the combined effects of these compounds should be undertaken. Bioassays of groundwater, effluent, nearshore sediment, and 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.

Base/Neutrals - Observations

1. Base/neutral compounds have been detected infrequently in most discharges to Hylebos Waterway. The greatest variety of compounds and highest concentrations were in seeps from Pennwalt and Hooker (Occidental), Kaiser Ditch, and in one of three samples from Morningside drain. With the exception of Pennwalt, concentrations measured for individual base/neutrals have been 20 μg/L or less. Table 4

   A major constituent in Pennwalt seeps is hexachloroethane--concentrations ranged from 21.3 to 478 μg/L in the four samples taken. Chlorinated benzenes, including hexachlorobenzene (HCB) were primarily associated with Hooker discharges and the single Morningside drain sample mentioned above. A trace of HCB was detected in Sound Refining's process effluent.

   Hexachlorobutadiene (HCBD) has been detected only in the above-mentioned seeps and in the Hooker (Occidental) process effluent. As much as 9 μg/L was measured in Pennwalt seeps. The Hooker (Occidental) effluent had .2 μg/L.

2. Riley (reference 10) measured up to 18 ng/L (pptr) of HCBD and 252 ng/L of trichlorobutadienes (not EPA priority pollutants) in the Hylebos water column. The HCBD concentrations did not exceed EPA criteria. Suspended matter samples contained up to 6256 μg/Kg (dry) total chlorinated butadienes. Further examination of these compounds with respect to impacts to pelagic organisms and human health effects was recommended.

HYLEBOS WATERWAY

		Refer to Data in:
3.	Chlorinated butadienes (CBD) and HCB have been detected in Hylebos sediments. CBD concentrations peak near Hooker (Occidental). HCB data also suggest a peak near Hooker (Occidental), but data for HCB in Hylebos sediments are limited.	Table 8 Table 9 Table 10
4.	Kaiser Ditch is the only Hylebos discharge in which PAH compounds have been detected frequently. A sediment sample from the mouth of the ditch contained PAH compound at concentrations 10 to 20 times higher than other Hylebos sediment samples. Settling basins at Kaiser Aluminum are the probable source of these compounds.	Table 4b Table 8
5.	PAH concentrations in water have generally been below detection limits.	
6.	A range of PAH compounds has been detected in waterway suspended matter (reference 10) and sediment.	Table 8 Talbe 9
7.	Concentrations of PAH 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
8.	Substantial concentrations of unidentified chlorinated organics occur in the Hooker (Occidental) effluent (reference 16). Pentachloropropene, a mutagen, may be one of the unknowns (reference 17).	
9.	One Morningside drain water sample contained 4-bromophenylether, nitrobenzene, 2-chloronaphthalene, and dichlorobenzene--all at low concentrations. The first three compounds have not been detected in other discharges to the waterway.	Table 4a

Base/Neutrals - Considerations for Future Work

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

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

3. 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.

Refer to Data in:

4. 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 10) detected polychlorinated biphenyls (PCBs) in water column samples in the waterway. Cl_1-biphenyls ranged from .022 - .316 μg/L; Cl_2-biphenyls ranged from .001 - .268 μg/L; and Cl_3-Cl_5-biphenyls ranged from <.001 - .025 μg/L. Up to 4,950 μg/Kg (dry) Cl_1-Cl_3-biphenyls were measured in suspended matter.

2. The EPA criteria document indicates that acute toxicity to marine life only occurs at PCB concentrations above 10 μg/L. PCB concentrations measured by Riley exceed EPA's 24-hour criterion (0.3 μg/L) for protection of marine organisms against chronic effects. Riley also recommended further examination of PCBs with respect to human health effects and impacts on pelagic organisms.

3. PCBs are 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.

PCBs - Considerations for Future Work

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

Acid Extractables - Observations

1. Only about half the point-source samples collected in Hylebos Waterway have been analyzed for acid extractables. — Table 4

2. The largest phenol concentration measured in Hylebos discharges was 190 μg/L in the Lincoln Avenue drain. Low concentrations of chlorinated phenols were also detected in Sound Refining effluent, Morningside drain, Kaiser Ditch, and Pennwalt discharges. — Table 4

3. Acid extractables have not been detected in the few water column samples analyzed for these compounds (references 3 and 4).

4. Traces of phenol and pentachlorophenol have been detected in a few Hylebos sediment samples. — Table 8, Table 9, Table 10

HYLEBOS WATERWAY

Refer to Data in:

Acid Extractables - Considerations for Future Work

1. Investigate source(s) of phenol in Lincoln Avenue drain.

2. Available data indicate phenolics are probably not a significant problem in Hylebos Waterway.

Pesticides - Observations

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

2. Pesticides have generally not been detected in Hylebos water column samples.

3. The following pesticides have been detected with some regularity in subtidal Hylebos sediments: DDT and metabolites, aldrin, and α-BHC. Les Williams (Tetra Tech, Bellevue) has pointed out that aldrin levels in Hylebos sediments may represent a hazard to marine life. QA/QC for these data have not been re-examined. — Table 9

4. 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

Pesticides - Considerations for Future Work

1. Efforts should be made to curtail discharge of DDT from the Pennwalt property.

2. QA/QC for the data on aldrin in sediment should be re-examined.

Addendum

The table below contains data on Hylebos Waterway sediment samples overlooked in preparing the data summary for Part 1. The detection of aldrin in these samples is noteworthy. Samples 1302 and 1303 are subsamples of the grabs for which EPA-Newport laboratory analyses are reported in Table 9b. Concentrations are mg/Kg, dry.

Addendum - continued.

Location	Subtidal Off Sound Refining	Subtidal Off Lincoln Avenue	Subtidal Off Pennwalt	South and Intertidal Near 11th St. Bridge
Original Agency Code	A-8	A-9	49	18
Agency Responsible for Analysis	EPA-Con.	EPA-Con.	EPA-Con.	EPA-Con.
Latitude (47°)	16'36"	16'25"	16'10"	16'38"
Longitude (122°)	23'22"	22'44"	22'22"	23'41"
Year Collected	1981	1981	1981	1981
Percent solids	66	48		
Volatiles				
toluene	--	T	--	--
Base/Neutrals				
acenapthene	a	a	T	--
hexachloroethane	a	a	.44	--
fluoranthene	a	a	1.9	T
naphthalene	a	a	.36	
benzo(a)anthracene/chrysene	a	a	2.1	T
benzo(a)pyrene	a	a	1.5	T
3,4-benzofluoranthene/ benzo(k)fluoranthene	a	a	2.3	T
anthracene/phenanthrene	a	a	1.1	T
fluorene	a	a	T	--
pyrene	a	a	1.5	T
bis(2-ethylhexyl) phthalate	a	a	--	T
Acid Compounds	a	a	--	--
Pesticides and PCBs				
aldrin	.031	.025	.078	.04
α-BHC	.022	--	--	--
γ-BHC (Lindane)	.021	--	--	--
PCB-1254	--	.44	--	--

-- = Not detected.
a = Not detected, but detection limits high.
T = Trace amount.

HYLEBOS WATERWAY

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PART 2. CITY WATERWAY

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PART 2. CITY WATERWAY
(5/83)

Refer to Data in:

General Observations

1. Relatively few samples have been collected in City Waterway. There is a lack of data on concentrations of priority pollutants in subsurface sediments and limited water column data.

2. Review of the data available on Commencement Bay sediments suggests City Waterway has relatively high concentrations of Pb, Cd, PAH, PAE (phthalate acid esters), DDT, and PCB.

3. Chapman's toxicity survey (reference 1) of Puget Sound sediments ranked City Waterway as the second most toxic site tested.

General Considerations for Future Work

1. At present, there is insufficient data to compare rates of accumulation of metals and organics in the sediment with source loadings. As noted for Hylebos Waterway, major missing pieces of information include the sedimentation rate and the flux of chemicals between City Waterway and Commencement Bay. Most storm drains to the waterway have not been sampled. As these data become available, an effort should be made to calculate a mass balance for contaminants of concern in the waterway.

Metals - Observations

1. The 15th Street storm drain had the highest metals concentrations among the four point sources sampled. Only one sample has been collected from this discharge. — Table 11

2. The largest metal loads measured were 32 lbs/day Pb; 16 lbs/day Zn; and 5.3 lbs/day Cu from the west drain at the head of City Waterway (Nalley Valley). — Table 12

3. Water column samples collected by Dames and Moore (reference 2) in October and December of 1980 indicated City Waterway had higher Cu and Zn concentrations than other waterways. Surface waters had higher concentrations than mid-depth or bottom waters. The highest Cu concentration measured, 9 μg/L, was intermediate between EPA's 24-hour average criterion of 4 μg/L and not-to-exceed criterion of 23 μg/L.

4. Sediment metal concentrations were highest in the inner portion of the waterway and declined near the waterway's entrance. High concentrations of Pb and Cd were observed. — Figure 10, Table 16

Metals - Considerations for Future Work

1. More point source, water column, and bottom sediment data need to be collected. Field observations indicate the quantity and quality of

Refer to Data in:

water in drains to the waterway are highly variable. This should be taken into account during sampling. Sediment samples should include cores to determine vertical stratification of metals.

2. It should be determined if metals are reaching the waterway due to ongoing or past practices at American Plating Company, Fick Foundry, and Martinac Shipbuilding Corporation.

Organics - Observations

1. The few organic priority pollutants detected in discharges to City Waterway were largely restricted to the west drain at the head of the waterway (1 of 2 samples only) and the 15th Street drain. Chloroform, naphthalene, and cyanide were present in both discharges. The west drain also contained butylbenzyl phthalate, toluene, and traces of trichloroethylene and tetrachloroethylene. Phenol was found in the 15th Street drain. All concentrations were less than 10 μg/L. — Table 13

2. Organic priority pollutant loads calculated from WODE data are small. — Table 14

3. No data quantifying organic pollutant concentrations in water column samples from the waterway are available. Dames and Moore (reference 2) was unable to detect PCBs in 3 water samples (0.2 μg/L detection limit).

4. Volatiles were not detected in the three sediment samples that have been analyzed for these constituents. — Table 16, Table 17

5. Relatively high concentrations of PAH, PAE, and PCB have been measured in some waterway sediments. PAH and PCB were highest at NOAA station 5-09031 north of the 11th Street bridge. — Table 16, Table 17

6. The WDOE Southwest Regional Office has found that groundwater beneath tank farms on the east shore of the waterway is grossly contaminated with petroleum. Petroleum can be seen seeping into the waterway along the tank farm shoreline. A sample of groundwater from a monitoring well at "D" Street collected May 18, 1982 contained the following concentrations of aromatic hydrocarbons:

	"Water Fraction" (EPA #23543)	"Oil Fraction" (EPA #23544)
benzene (μg/L)	3,400	No sample
ethylbenzene (μg/L)	7,000	" "
toluene (μg/L)	46,000	" "
naphthalene (μg/L)	46,000	142,000
anthracene/phenanthrene (μg/L)	130	400
fluorene (μg/L)	n.d.	100

n.d. = none detected

(Large numbers of substituted benzene and naphthalene compounds detected in both fractions but not quantified.)

	Refer to Data in:
7. A high concentration of HCBD, .236 mg/Kg (dry) has been reported by the EPA Newport laboratory in a sediment sample taken at the mouth of the waterway.	Table 16 Table 17

Organics - Considerations for Future Work

1. As noted for metals, more point-source and sediment data are needed. Water column data are particularly sparse.

2. It should be determined if petroleum in the groundwater beneath City Waterway tank farms has contaminated the waterway. If possible, the load of PAH and related compounds to the waterway in seepage from this source should be estimated.

CITY WATERWAY

REFERENCES

1. Chapman, P.M., *et al.*, 1982. Survey of Biological Effects of Toxicants upon Puget Sound Biota. I. Broad-scale Toxicity Survey. NOAA Technical Memorandum OMPA-25.

2. Dames and Moore, 1981. Commencement Bay Studies, Volume V, Water Quality. For U.S. Army Corps of Engineers, Seattle District.

3. Malins, D.C., *et al.*, 1980. Chemical Contaminants and Biological Abnormalities in Central and Southern Puget Sound. NOAA Technical Memorandum OMPA-2.

4. Malins, D.C., *et al.*, 1982. Chemical Contaminants and Abnormalities in Fish and Invertebrates from Puget Sound. NOAA Technical Memorandum OMPA-19.

5. NOAA, 1981. Unpubl. data. Concentrations of Aromatic Hydrocarbons and Metals found in Sediments from Central Puget Sound.

6. USEPA, 1982. Unpubl. sediment data. Letter from D.W. Schults, USEPA Marine Science Center, Newport, Oregon, to Art Johnson, WDOE.

PART 3. BLAIR WATERWAY

PART 3. BLAIR WATERWAY
(7/83)

Refer to Data in:

General Observations

1. A preliminary comparison of Blair Waterway sediment priority pollutant data with the data available on sediment in other Commencement Bay waterways indicates Blair is substantially less contaminated than Hylebos, City, or Sitcum waterways. Nevertheless, as noted in Part 1, Chapman (reference 3) ranked Blair Waterway along with Hylebos Waterway as the third most toxic site tested in Puget Sound (behind City Waterway and Elliot Bay near the Denny Way CSO). Blair was included among those areas recommended for additional in-depth study.

General Considerations For Future Work

1. A substantial body of data exists on contaminants in water, suspended matter, sediment, and point-source discharges in Blair Waterway. Among the major missing pieces of information are the sedimentation rate, depositional history of metals in the sediment, and flux of contaminants between the waterway and Commencement Bay.

2. Four sites in Blair Waterway worthy of further examination as potential sources or "hot spots" for metallic and/or organic priority pollutants are: Murray Pacific and West Coast Orient (Portac) log sort yards (metals); Lincoln Avenue south drain (metals and organics); north shoreline between 11th Street and Lincoln Avenue (volatiles); and sediment near 11th Street bridge (polyaromatic hydrocarbons).

Metals - Observations

1. Extremely high concentrations of As, Cu, Pb, Sb, and Zn have been measured in runoff from the Murray Pacific log sort yard. The source of these metals is thought to be ASARCO slag used as ballast. Runoff from the other sort yard on Blair, West Coast Orient (Portac), has not been sampled. This yard also used ASARCO slag. Log sort yards in the Tacoma tideflats area recently agreed to comply with a request from WDOE to use other materials for ballast. — Table 18

2. Lincoln Avenue drain on Blair's south shore (and adjacent to Murray Pacific) had an arsenic concentration of 850 μg/L in a sample collected during wet-weather conditions (3/28/82). Dry-weather arsenic concentrations were much lower. — Table 18

3. Other discharges where elevated metals concentrations have been observed are two seeps at the mouth of the waterway near the Zidell shipyard. — Table 18

Refer to Data in:

4. The largest metals loads to Blair Waterway measured during WDOE surveys were from the south shore Lincoln Avenue drain -- 19, 3.8, 2.2, and 1.1 pounds per day of As, Zn, Pb, and Cu, respectively. Metals loads from log sort yards have not been quantified.

5. Dames & Moore and EPA (references 4, 11) water column data for Blair Waterway show metals were generally within EPA criteria for the protection of marine life, except Cu and Se in the EPA samples which exceeded maximum recommended values. Samples from the EPA control station at Browns Point also exceeded the Cu and Se criteria.

6. Metals concentrations in Blair surface sediments are not high relative to other waterways (i.e., Sitcum, City, and Hylebos). — Table 24, Table 25

7. There is a peak in metals concentrations in subtidal sediments in the central part of Blair Waterway. The south shore Lincoln Avenue discharge and runoff from the Murray Pacific yard are possible sources. Lincoln Avenue drain has high metals concentrations in sediments at Milwaukee Street and at the drain's mouth on the waterway south shore. — Table 25, Table 24

8. Amphipod bioassays conducted by Swartz (reference 10) showed lowest survival in samples of sediment from the central part of the waterway. This pattern was not observed in two other sediment bioassay investigations (references 3, 8).

Metals - Considerations for Future Work

1. Metals loads from the two sort yards on Blair Waterway should be quantified. The relationship between metals in sort yard runoff and waterway sediments should be assessed.

2. Metals in the Lincoln Avenue south drain also appear to be a problem warranting further study.

3. Data on metals stratification in Blair Waterway sediments should be obtained from core samples.

Volatiles - Observations

1. Detection of volatiles in point-source discharges to Blair Waterway has been largely restricted to the north and south Lincoln Avenue drains. Detection frequencies have been highest in the south drain. Seven compounds (chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-trans-dichloroethylene, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene) have been detected in two or more of the four samples collected by EPA and WDOE from in the south drain. Concentrations were generally less than 10 μg/L. — Table 20

	Refer to Data in:
2. Based on WDOE Class II inspections and receiving environment surveys (references 1, 2, 14, 15), the two major NPDES dischargers to Blair Waterway (Reichhold Chemicals and U.S. Oil) are not significant sources of volatiles. However, a number of volatiles have been detected in the Reichhold storm drain system. With sufficient runoff, this drain overflows into the Lincoln Avenue north drain. Spills at the Lillyblad plant, a solvent recycler, have been documented by WDOE inspectors as a source of volatiles to Lincoln Avenue south drain.	Table 21
3. The largest point-source loads measured for individual volatile compounds were about 0.1 lb/day.	Table 22
4. EPA (reference 11) has collected grab samples of surface and bottom waters from eight sites in Blair Waterway. Most samples did not contain detectable concentrations of volatiles. Chlorodibromomethane, 1,1,1-trichloroethane, trichloroethylene, and methylene chloride were detected at 1 μg/L or less in two or three of these samples, depending on the compound in question.	
5. Riley (reference 9), using more sensitive methods, was able to quantify a number of volatiles (methylene chloride, haloforms, chlorinated ethanes, chlorinated ethylenes, benzene, and toluene) in surface waters at four sites along Blair's north shore between 11th Street and Lincoln Avenue. The compound present in the largest concentrations, up to 33.5 μg/L, was 1,1,1-trichloroethane.	
6. Volatiles concentrations were not in excess of EPA criteria for protection of marine life in the above-mentioned water column samples.	
7. Both the EPA and Riley surveys indicate Blair Waterway has lower concentrations of volatiles in the water column than Hylebos Waterway.	
8. Volatiles have not been detected in Blair Waterway sediment. A sample from within the Lincoln Avenue north drain had .006 mg/Kg toluene and .003 mg/Kg 1,1-dichloroethane.	Table 24 Table 25

Volatiles - Considerations for Future Work

1. In light of the relatively large concentrations of volatiles measured by Riley, a survey of volatiles in seeps and drains on Blair's north shore between Lincoln Avenue and 11th Street should be conducted. Additional samples for volatiles analysis should also be collected from the Lincoln Avenue south shore drain.

BLAIR WATERWAY

Refer to Data in:

Base/Neutrals and PCBs - Observations

1. The highest detection frequencies for base/neutral compounds in discharges to Blair Waterway have been in samples from the Lincoln Avenue south drain. 1,2-dichlorobenzene was the only compound routinely detected (three of four samples). All concentrations measured have been less than 10 µg/L. PCBs have not been detected in point-source samples. — Table 20

2. As was the case for volatiles, WDOE-measured loads of base/neutrals to the waterway have been small (i.e., 0.1 lb/day or less for individual compounds). — Table 22

3. EPA (reference 11) did not detect base/neutrals or PCBs in water column samples.

4. Riley (reference 9) measured the following concentration ranges for selected base/neutrals and PCBs in the water column:

Cl_3-butadiene-1	<2 - 124 ng/L (pptr)
Cl_3-butadiene-2	<2 - 54 "
hexachlorobutadiene	<1 - 4 "
Cl_1-biphenyls	34 - 154 "
Cl_2-"	<3 - 106 "
Cl_3-"	<1 - 24 "
Cl_4-"	<1 - 1 "
Cl_5-"	<1 - <2 "
Total Cl_1-Cl_5-biphenyls	34 - 212 "

Hexachlorobutadiene (HCBD) did not exceed the 32 µg/L EPA considers acutely toxic to marine life; EPA has no chronic HCBD criteria. All of the total selected chlorinated biphenyl concentrations measured exceeded EPA's suggested 0.030 µg/L 24-hour average criteria recommended as protective of marine life. There are no criteria for the lower chlorinated butadienes. PAH were not measured in Riley's water samples.

5. Riley (reference 9) also measured the following concentration ranges for selected base/neutral compounds and PCBs in suspended matter:

Cl_3-butadiene-1	<10 - 295 µg/Kg, dry
Cl_3-butadiene-2	10 - 186 "
hexachlorobutadiene	<1 - 21 "
Cl_1-biphenyl	<6 - 61 "
Cl_2-"	<3 - 253 "
Cl_3-"	4 - 133 "
Cl_4-"	<2 - 494 "
Cl_5-"	<1 - 152 "
Total Cl_1 - Cl_5 biphenyls	6 - 779 "
Total polyaromatic hydrocarbons*	2,637 - 19,207 "

*18 compounds

	Refer to Data in:
6. The concentrations of HCBD and chlorinated biphenyls measured by Riley in Blair suspended matter are similar to concentrations in the Blair subtidal sediments.	
7. EPA and WDOE surveys have not detected butadienes or chlorinated biphenyls in point-source discharges. Naphthalene and fluorene are the only polyaromatic hydrocarbons that have been detected -- although infrequently.	Table 20 Table 21
8. Blair sediment concentrations of HCBD are low relative to Hylebos Waterway.	Table 24 Table 25
9. PAH concentrations in sediment are lowest in the first mile of Blair Waterway (as measured from the head) and increase substantially seaward of this point. Whether this indicates the location of predominant sources or is related to the relatively recent (1964-1966) excavation of the inner waterway is not known.	Table 25
10. Riley (reference 9) found extremely high concentrations of naphthalenes (2.4 mg/Kg naphthalene, 3.4 mg/Kg 2-methyl naphthalene) in a sediment core near the 11th Street bridge. Recent analyses done by Laucks Testing Laboratories for the Port of Tacoma (unpublished data) confirm that high PAH concentrations exist in sediments from this part of Blair Waterway. In general, however, PAH concentrations are lower in Blair than in other waterways such as Hylebos and City.	
11. A large concentration of bis(2-ethylhexyl) phthalate, 22.0 mg/Kg dry, was reported in a sediment sample at the mouth of the Lincoln Avenue south drain.	Table 24

Base/Neutrals and PCBs - Considerations for Future Work

1. In light of the substantial concentrations of chlorinated butadienes and chlorinated biphenyls measured in the water column, additional work should be aimed at determing the sources, fate, and effects of these compounds in Blair Waterway.

2. Based on available data, the Lincoln Avenue south drain is the only point-source discharge where additional monitoring for base/neutrals appears warranted.

Acid Extractables - Observations

1. Detection of acid extractables in discharges to Blair has been limited to the detection of pentachlorophenol in the north and south Lincoln Avenue drains.	Table 20

	Refer to Data in:
2. Reichhold Chemicals' storm drain effluent is a potential source of phenols in the Lincoln Avenue north drain. Phenol, 2-chlorophenol, 2,4-dichlorophenol, 2,4,6-trichlorophenol, and pentachlorophenol have been identified in this effluent (reference 14).	Table 21
3. Acid extractables have not been detected in Blair Waterway sediments.	Table 24 Table 25

Acid Extractables - Considerations for Future Work

1. The Lincoln Avenue north drain is the only point-source discharge where additional monitoring for acid extractables appears warranted.

Pesticides - Observations

1. Detection of pesticides in discharges to Blair has been limited to traces of aldrin and α-BHC in one sample from the Lincoln Avenue south drain. Aldrin was not confirmed by GC/MS.	Table 20 Table 21
2. Riley (reference 9) did not detect pesticides in water column suspended matter.	
3. NOAA measured DDT compounds at low concentrations in sediment samples from the two sites sampled in Blair. DDT was not at detectable levels in samples analyzed by other investigators.	Table 24 Table 25

Pesticides - Considerations for Future Work

1. Pesticides do not appear to be a problem in Blair Waterway.

BLAIR WATERWAY

REFERENCES

1. Bernhardt, J., 1982a. Assessment of Surface Water Quality in the Vicinity of Reichhold Chemicals, Inc., Tacoma, Washington, WDOE memorandum to Frank Monahan.

2. Bernhardt, J., 1982b. U.S. Oil and Refining Company Receiving Water Survey, May 5, 1981. WDOE memorandum to Fred Fenske.

3. Chapman, P.M., et al., 1982. Survey of Biological Effects of Toxicants upon Puget Sound Biota. I. Broad-scale Toxicity Survey. NOAA Tech. Memo. OMPA-25.

4. Dames & Moore, 1981. Commencement Bay Studies, Volume V, Water Quality. for U.S. Army Corps of Engineers.

5. Malins, D.C., et al., 1980. Chemical Contaminants and Biological Abnormalities in Central and Southern Puget Sound. NOAA Tech. Memo. OMPA-19.

6. Malins, D.C., et al., 1982. Chemical Contaminants and Abnormalities in Fish and Invertebrates from Puget Sound. NOAA Tech. Memo. OMPA-19.

7. NOAA, 1981. Unpubl. data. Concentrations of Aromatic Hydrocarbons and Metals found in Sediments from Central Puget Sound.

8. Pierson, K.B., et al., 1982. Biological Testing of Solid Phase and Suspended Phase Dredged Material from Commencement Bay, Tacoma, Washington. Fisheries Research Institute, Univ. Wash., Seattle.

9. Riley, R.G., et al., 1981. Organic Pollutants in Waterways Adjacent to Commencement Bay (Puget Sound). NOAA Tech. Memo. OMPA-12.

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11. USEPAa, 1980. Commencement Bay/Port of Tacoma Field Survey - June 3, 1980.

12. USEPAb, 1980. Commencement Bay Waterways Survey - September 23-24, 1980.

13. USEPAc, 1982. Unpubl. sediment data. Letter from D.W. Schults, USEPA Marine Science Center, Newport, Oregon, to Art Johnson, WDOE.

14. Yake, B., 1981. Reichhold Chemicals Inc., Class II Inspection: 4/21/81. WDOE memorandum to Frank Monahan.

15. Yake, B., 1981. U.S. Oil and Refining Co., Class II Inspection of May 5 and 6, 1981. WDOE memorandum to Fred Fenske.

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PART 4. SITCUM WATERWAY

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PART 4. SITCUM WATERWAY
(7/38)

Refer to Data in:

General Observations

1. The major concern in Sitcum Waterway is high metals concentrations in the sediments. In spite of reported high concentrations, bioassays on Sitcum subtidal sediments by EPA, NOAA, and the University of Washington Fisheries Research Institute (references 1, 6, 7) have not shown acutely toxic effects. EPA has tested some intertidal sediments that elicited toxic responses (reference 7).

2. Sitcum Waterway water column samples have not been analyzed for organic priority pollutants. This is a substantial data gap.

3. Organic priority pollutants have not been measured in large concentrations in most samples of water and sediment. Limited data suggest further sampling for organics is warranted at four sites. These sites are identified below.

Metals - Observations

1. Only one sample from each of the two drains discharging to Sitcum Waterway has been analyzed for metals -- neither had high metals concentrations. As, Cu, Pb, and Zn were higher in the drain in the north corner of the waterway than in the south corner drain. Cu, Pb, and Zn in the north drain were above EPA chronic criteria for protection of marine life. — Table 27

2. Metals loads for the north corner drain were two orders of magnitude higher than the south drain. The maximum load measured for an individual metal was only .70 lb/day (Zn). — Table 28

3. Water column data on metals are limited to a sample collected by Dames & Moore (reference 2) in October 1980. Cu and Zn were measured at 3 and 10 μg/L, respectively, while As, Cd, Cr, and Pb were below detection limits. No metal exceeded EPA criteria.

4. Sitcum sediments are higher in As, Cu, Pb, and Zn than sediments in other Commencement Bay waterways. With the exception of As, the above same metals are roughly twice as high in sediments from the north side of the waterway than those from the south side. High Cu concentrations in sediment have also been reported in two samples off the south shoreline near the waterway entrance. — Table 30, Table 31

5. The highest concentrations of Cu, Pb, and Zn reported for Sitcum sediments were in an intertidal sample near the mouth of the north corner drain. 7,000, 19,000, and 3,200 mg/Kg (dry) of Cu, Pb, and Zn, respectively, were measured. — Table 30

Refer to Data in:

6. The source(s) of the metals in Sitcum sediments has not been identified. ASARCO slag used as rip-rap along the south shore and alumina and lead/zinc/copper concentrates unloaded at Pier 7 on the north side of the waterway are possible sources. Three samples of ore have been analyzed by WDOE as shown below. Metals concentrations differ widely among the samples. Sample #2 matches some of the Sitcum sediment data fairly well.

	Ore Sample #1	Ore Sample #2	Ore Sample #3
Collection Date	12/07/82	3/02/83	9/20/83
As		1,014 mg/Kg (dry)	
Cd	0.8 mg/Kg (dry)	38 "	<.01 mg/Kg (dry)
Cr	1.8 "	3.6 "	.02 "
Cu	27 "	6,900 "	<1 "
Hg		<.0002 "	
Ni	3.7 "	12 "	.83 "
Pb	190 "	6,300 "	2.7 "
Sb		2.0 "	
Zn	63 "	7,300 "	.02 "

7. No core data are avaliable on the vertical stratification of metals in Sitcum sediments.

Metals - Considerations for Future Work

1. The source(s) of metals in Sitcum sediments, whether historical or on-going, should be identified.

2. Sediment cores should be taken to determine metals stratification.

3. The materials handling procedures used at Pier 7 should be reviewed with the aim of reducing the spillage to the waterway that has been observed by WDOE inspectors.

4. Water column samples should be taken.

Volatiles - Observations

1. Of the two major point-source discharges to Sitcum Waterway, only the north corner drain has had detectable concentrations of volatiles. Chloroform, 1,1,1-trichloroethane, and tetrachloroethylene were detected in each of the two samples collected. 1,1,1-trichloroethane Table 27

Refer to Data in:

was present in the largest concentrations, 34 and 42 μg/L. Trichloroethylene and 1,1,2,2-tetrachloroethylene were detected in the first of these two samples. Detection limits were an order of magnitude higher for the second sample.

2. The higher of the two loads measured for 1,1,1-trichloroethane was .25 lb/day. — Table 28

3. Water column samples from Sitcum Waterway have not been analyzed for volatiles.

4. Volatiles have not been detected in intertidal or subtidal sediments collected within the waterway. — Table 30

5. A sediment sample collected by the Port of Tacoma (unpublished data) just outside the waterway entrance on February 26, 1981 and analyzed by Laucks Testing Laboratories, had 87 mg/Kg chloroform, 1.2 mg/Kg xylene, 1.5 mg/Kg dichlorobromomethane, and 210 mg/Kg toluene (dry-weight basis). The sample was a composite of the top four feet of a sediment core. Coordinates for the sample site are approximately 47°16'20" x 122°25'14", based on the sketch accompanying the raw data. These high concentrations of volatiles are unique among the analyses done to date on Commencement Bay sediments.

Volatiles - Considerations for Future Work

1. With the exception of the north corner drain, volatiles have not been shown to be a problem in Sitcum Waterway. Additional sediment samples (cores) should be collected outside the waterway entrance in the vicinity of the Port of Tacoma sample mentioned above to verify those measurements. The north corner drain should continue to be monitored for volatiles and efforts made to identify the source(s) of these compounds.

2. Water column samples should be taken.

Base/Neutrals - Observations

1. Base/neutral compounds have not been detected in either of the two drains to Sitcum Waterway. — Table 27

2. No data are available on base/neutrals in the water column of Sitcum Waterway.

3. Concentrations of hexachlorobutadiene in Sitcum sediments are low relative to findings for Hylebos, Blair, and City waterways sediments. — Table 30, Table 31

Refer to Data in:

4. One sediment sample near the mouth of Sitcum Waterway (station STS-9, Figure 17) had extremely high concentrations of PAH. Benzo(a)pyrene was the compound present in the highest concentrations, 230 mg/Kg. These are the highest PAH concentrations so far reported for Commencement Bay sediments. — Table 30

5. The concentration of PAH in the majority of Sitcum sediment samples are not elevated relative to sediment in other Commencement Bay waterways. — Table 30

Base/Neutrals - Considerations for Future Work

1. Sediments at station STS-9 should be sampled to verify this site as a PAH "hot spot" and determine the horizontal and vertical extent of contamination.

2. Water column samples are needed.

Acid Extractables - Observations

1. Phenol and pentachlorophenol are the only acid extractable compounds that have been detected in point-source discharges to Sitcum Waterway. Less than 10 μg/L of each was measured in one of the two north corner drain samples. — Table 27

2. Groundwater beneath phenolic waste ponds on Georgia Pacific property (formerly Pacific Resins and Chemicals) is contaminated with phenols. This material has been removed through a WDOE enforcement action. A two-year groundwater monitoring program has been initiated. This site, Certain-Teed, and other small industries within the Sitcum drainage basin are possible sources of phenols to the waterway.

3. No water column data are available on acid extractables.

4. Acid extractables have not often been detected in Sitcum sediments. Phenol and pentachlorophenol have been found in small concentrations in two and three samples, respectively, of the 10 samples that have been analyzed for this fraction. One subtidal sample (station STS-3, Figure 17) contained 2-chlorophenol, p-chloro-m-cresol, and 4-nitrophenol. 4-nitrophenol was present in large concentrations -- 2.3 mg/Kg. Phenol and pentachlorophenol were detected in an intertidal sample near the north corner drain. — Table 30

Acid Extractables - Considerations for Future Work

1. Additional samples should be collected at station STS-3 and analyzed for acid extractables.

Refer to Data in:

2. Because of the existence of sources of phenolic compounds within the Sitcum north corner drainage basin, this drain should continue to be monitored for these compounds.

3. Water column samples should be analyzed for acid extractables.

Pesticides and PCBs - Observations

1. Neither pesticides nor PCBs have been detected in discharges from the two Sitcum Waterway drains. Table 27

2. Dames & Moore (reference 2) could not detect PCBs in the single water sample they analyzed from the waterway (0.2 μg/L detection limit).

3. No data are available on pesticides in the water column.

4. The Dames & Moore water column sample mentioned above did not contain detectable concentrations of PCBs (0.2 μg/L detection limit).

5. High concentrations of pesticides and PCBs have not been observed in Sitcum sediments. Table 30

SITCUM WATERWAY

REFERENCES

1. Chapman, P.M., et al., 1982. Survey of Biological Effects of Toxicants upon Puget Sound Biota. I. Broad-scale Toxicity Survey. NOAA Tech. Memo. OMPA-25.

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3. Malins, D.C., et al., 1980. Chemical Contaminants and Biological Abnormalities in Central and Southern Puget Sound. NOAA Tech. Memo. OMPA-2.

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PART 5. MILWAUKEE, PUYALLUP, ST. PAUL, MIDDLE WATERWAYS AND S.W. SHORE COMMENCEMENT BAY

MILWAUKEE WATERWAY
(10/83)

Refer to Data in:

Observations

1. There are no known discharges to Milwaukee Waterway.

2. Water column data are limited to one sample each from the inner and outer waterway collected in October 1980 by Dames & Moore (reference 4). Cu was measured at 5 and 8 μg/L, Zn at 10 and 31 μg/L. As, Cd, Cr, and PCBs were below detection limits.

3. Only two sediment samples -- one intertidal, the other subtidal -- have been collected in the waterway. Neither sample had high metals concentrations. Trace amounts of PAH compounds were the only organic priority pollutants detected in the intertidal sample. The subtidal sample contained .0059 mg/Kg hexachlorobenzene, .0036 mg/Kg hexachlorobutadiene, up to 1.2 mg/Kg of individual PAH compounds, .037 mg/Kg ΣDDT, and .223 mg/Kg PCBs. These concentrations are typical of sediments in Commencement Bay waterways other than in the most contaminated areas; i.e., Hylebos and City waterways. Table 39

Considerations for Future Work

1. A few more sediment samples, preferably cores, should be collected in Milwaukee Waterway to confirm that it is not a major site of contamination.

PUYALLUP WATERWAY/RIVER
(10/83)

Refer to Data in:

Observations

1. USGS data on the Puyallup River at Puyallup (r.m. 5.7) and WDOE data on the river above the Tacoma Central STP (r.m. 1.7) indicate the river has low background concentrations of metals. Three river water samples have been collected immediately above the STP by WDOE and analyzed for organic priority pollutants. The only compound detected was 8 μg/L cyanide. Table 32 Table 36

2. The results of WDOE's most recent Class II surveys at the Tacoma Central STP have been reported by Yake (reference 20) who made the following observations: Table 36 Table 37

   a. "The wide range of priority pollutants found in Tacoma Central's wastewaters is generally typical of municipal wastewaters. Likewise, the concentrations reported are generally typical. The primary exception to this generalization appears to be the chlorinated phenols which are present in substantially higher concentrations than those observed in wastewaters from other municipalities."

   b. "Although metals concentrations at Tacoma Central do not appear to be unusually high when compared to wastewaters from other major cities throughout the country, they are elevated when compared to sludge concentrations at most other Washington towns and cities. This is particularly true for chromium, cadmium, nickel, and lead. Arsenic is probably also elevated; however, data are not available for arsenic concentrations in other Washington State wastewaters and sludges. Effluent mercury concentrations measured during the low-flow survey are well above EPA receiving water criteria."

   c. "Effluent loads for metals and several other priority pollutants (cyanide, tetrachloroethylene, and the chlorinated phenols) were substantially higher during the storm flow sampling period. Elevation of metals in wastewaters during storm flows in cities with combined sewer systems has been previously documented."

   d. "Many of the priority pollutants detected were only detected in one or two of the three [sampling] periods. Concentrations often varied substantially from one sampling period to another. Because a large portion of Tacoma's wastewater flow is from industrial sources, the potential for slug loads of specific pollutants from spills, upsets, or batch processes is substantial. A continuing program of wastewater analysis would provide a much more comprehensive and complete knowledge of pollutant concentrations and effluent loadings."

Refer to Data in:

e. "Concentrations of priority pollutants in the effluent are generally low enough that they would not exceed EPA in-stream criteria for the protection of aquatic and marine life after the effluent is fully mixed with the Puyallup River/Estuary. Possible exceptions to this generalization may be mercury, cadmium, and lead. Factors which may hinder ideal dilution include the absence of an effluent diffuser and effluent pooling caused when low river flow and high tidal conditions coincide."

f. "Based on data available, the primary treatment process employed at the Tacoma Central plant does not appear to be very effective in reducing priority pollutant concentrations in the wastewater stream. Available literature suggests that secondary treatment would be much more effective."

3. The Cleveland Street pump station effluent, about 1/3 mile upstream of the STP, was sampled once by WDOE during wet weather. Metals concentrations were slightly higher than in the Tacoma Central STP effluent sample collected during the same period. 1,2-dichlorobenzene and cyanide, 3.5 μg/L and 8 μg/L respectively, were the only organic priority pollutants detected. — Table 32, Table 36

4. The STP effluent appears to account for a large percentage of the priority pollutants load to Commencement Bay, as measured in WDOE point-source surveys. — Table 33, Table 37

5. During normal downstream flow, dilution generally reduces metal and organic priority pollutant concentrations in the Puyallup River to background or non-detectable levels. An increase in arsenic concentrations has been observed at the river mouth in some samples. This does not appear to be attributable to the STP effluent. — Table 32, Table 36

6. Riley (reference 14) analyzed samples of water and suspended matter collected in July 1979 from the mouth of the Puyallup River. Trichloroethylene and tetrachloroethylene were detected at <.1 μg/L. Chlorodibromomethane and bromoform were tentatively identified at <.1 and <.2 μg/L, respectively. Samples of Puyallup River suspended matter had low concentrations of metals and PAH. Analyses for chlorinated base/neutrals, acid extractables, or pesticides were not done.

7. WDOE receiving environment surveys at the Tacoma Central STP (reference 9) showed that with sufficiently large flood tide and low river flow, slack water conditions occur at the STP outfall site, causing pooling of the effluent. It was estimated that pooling equal or greater in magnitude to that observed during the survey would have been expected to occur on approximately 90 separate occasions during water year 1980.

Refer to Data in:

Water samples from within this effluent pool were the only river water samples collected during the WDOE surveys in which effluent organic priority pollutants were present at detectable concentrations and oyster larvae (*Crassostrea gigas*) and daphnid (*Daphnia pulex*) mortality or abnormality were observed during bioassays. Table 36

8. Priority pollutant analysis has been done on four samples of intertidal sediment and two samples of subtidal sediment from the lower Puyallup River. Sediment immediately below the STP outfall (station PI-2) had high concentrations of toluene and bis(2-ethylhexyl) phthalate, 7.9 and 3.1 mg/Kg, respectively. Sediment from within the old St. Regis bleach crib on the river's south bank had a relative high PAH concentration and was acutely toxic in EPA amphipod bioassays (reference 17). Hexachlorobutadiene has not been detected in Puyallup River sediments. Table 39

Considerations for Future Work

1. Concentrations of priority pollutants in the Puyallup River appear to be generally low. In order to accurately estimate priority pollutant loads in the river, extremely sensitive (low detection level) analytical methods would be required for most pollutants.

2. Sediment from the St. Regis bleach plant crib and portions of the Puyallup River reach adjacent to the Tacoma STP outfall are localized areas of concern because of elevated levels of contaminants and toxic effects on bioassay organisms.

ST. PAUL WATERWAY
(10/83)

Refer to Data in:

Observations

1. The three major discharges to St. Paul Waterway are from the St. Regis paper mill, log sort yard, and sawmill operations. The paper mill effluent is the largest industrial discharge to Commencement Bay.

2. A high concentration of Hg, 1.2 μg/L, was measured in the single sample WDOE has collected of the sawmill effluent. With this exception, metals concentrations in sawmill and log yard effluents were low (one sample each). — Table 32

3. A Cu concentration of 100 μg/L was measured in the St. Regis paper mill effluent during WDOE's most recent Class II inspection (reference 19). A net load of 30 lbs/day Cu, the largest metals load measured by WDOE for St. Paul Waterway, was calculated for this discharge. — Table 32, Table 33

4. Only a few organic priority pollutants, in trace amounts, were detected in the sawmill and log sort yard effluents. — Table 34

5. 1800 μg/L of chloroform was measured in the St. Regis paper mill effluent during the most recent WDOE Class II survey (reference 19). A chloroform load of 480 lbs/day was calculated for this discharge. This is the largest load of an organic priority pollutant known to occur in Commencement Bay. — Table 34, Table 35

   Receiving water samples (reference 8) collected during the Class II survey showed 420 μg/L chloroform in surface waters near the outfall and 8.1 μg/L chloroform in inner St. Paul Waterway. There are no EPA criteria for chloroform in marine waters. Some laboratory experiments (references 10, 16) have demonstrated adverse effects on aquatic organisms at chloroform concentrations as low or lower than 420 μg/L.

6. Oyster larvae (*C. gigas*) bioassays (references 8 and 19) on the paper mill effluent and receiving waters showed both to be acutely toxic.

7. Three sediment samples have been analyzed from St. Paul Waterway. Metals concentrations were not high relative to other Commencement Bay waterways. High naphthalene concentations (.72 - 3.0 mg/Kg) were characteristic of each St. Paul sediment sample. An extremely high phenol concentration of 91 mg/Kg was measured in the sample collected nearest the St. Regis outfall. 0.84 mg/Kg pentachlorophenol and traces of 2,4,6-trichlorophenol, chloroform, and toluene were also detected in this sample. Amphipod bioassays (reference 8) on the outfall and innermost waterway sediment samples showed both to be toxic. — Table 39

ST. PAUL WATERWAY

Refer to Data in:

Considerations for Future Work

1. The following concerns appear worth additional study:

   a. The persistence of chloroform in the waters off St. Regis, and its effect on salmonids and other pelagic organisms.

   b. Areal extent and degree of toxicity of sediments adjacent to St. Regis.

   c. Verification of high concentrations of phenol and naphthalene in St. Paul Waterway sediments.

   d. The quantification and environmental fate of chlorinated resin acids, guaicols, propenes, and other potentially toxic or mutagenic compounds which may be present in the St. Regis effluent.

MIDDLE WATERWAY
(10/83)

Refer to Data in:

Observations

1. The major discharge to Middle Waterway is the storm drain at the head of the waterway. WDOE has collected only one water sample here. Metals concentrations were low except for 990 μg/L of Zn. The flow rate from the drain, however, was only 0.01 MGD, resulting in a Zn load to the waterway of .08 lb/day. — Table 32, Table 33

   Detection limits for the organic priority pollutants analysis of this sample were high. Chloroform and cyanide were measured at <10 μg/L and 5 μg/L, respectively. — Table 34

2. Dames & Moore (reference 4) was unable to detect As, Cu, Cd, Cr, Pb, or PCBs in a water column sample collected in October 1980. Zn was measured at 9 μg/L.

3. One intertidal sample and one subtidal sample have been taken of Middle Waterway sediment. A third sample (subtidal) has also been taken outside the waterway entrance. The subtidal sample from within the waterway had high Cu, Hg, Pb, and Zn concentrations (486, 2.2, 230, and 353 mg/Kg, respectively) compared to the data on most other Commencement Bay sediments. High metals concentrations were not reported in the other two samples. — Table 39

4. Results of organic priority pollutant analyses of Middle Waterway sediments compare closely to the findings discussed earlier in this report for Milwaukee Waterway sediments.

Considerations for Future Work

1. The available data indicate Middle Waterway, like Milwaukee Waterway, is not a major site of contamination for the organic priority pollutants. More data are needed on metals in the sediments and in the drain at the head of the waterway.

S.W. SHORE COMMENCEMENT BAY
(10/83)

Observations	Refer to Data in:
1. Relatively few samples have been collected in this part of Commencement Bay.	
2. Metals data on the Old Tacoma storm drain and Ruston STP effluent indicate these are not major sources of metals to the bay. Chloroform and cyanide, at <10 μg/L and 5 μg/L, respectively, were the only compounds detected in the storm drain. A variety of organic priority pollutants was detected in the Ruston STP effluent. The types and concentrations of compounds found are not unusual for municipal wastewaters.	Table 32
3. There is little usable data on intertidal or nearshore sediments between City Waterway and the ASARCO smelter. One intertidal sample near the Ruston outfall has been analyzed for priority pollutants. All concentrations were low; however, weak acid digestion was used for the metals analyses and detection limits were high for the base/neutral and volatiles analyses.	Table 39
4. Extremely high concentrations of As, Cu, and Zn (2000 - 8900 μg/L) were measured in ASARCO's south and middle outfalls during WDOE's most recent Class II inspection (reference 7). Concentrations were one to two orders of magnitude lower in the north outfall. Considerable dilution (up to 1649:1 for Cu) would be required to bring these effluent metals concentrations within EPA criteria for protection of marine life.	Table 32
The ASARCO discharges constitute the largest known point-source metals loads to Commencement Bay. These loading data have not been corrected for the concentrations of metals in the intake water.	Table 33
5. Although several investigators report metals concentrations for ASARCO receiving waters, a comprehensive study has not been performed. Tatomer (reference 18) reported up to 42.6 μg/L Cu in surface water samples collected adjacent to the smelter in 1972. More recently, Battelle researchers (references 6 and 15) measured Cu in surface water samples from seven sites in Commencement Bay along the ASARCO shoreline (sampled August 19, 1982) and two sites in the yacht basin behind the slag pile (sampled January-September 1982). Copper (total Cu, unfiltered samples) ranged from 0.1 to 7.0 μg/L in the seven bay samples. Variable concentations of Cu -- some extremely high -- were found within the yacht basin. The results from nine samples are reported; eight from the basin entrance and one at the far end of the basin. Cu concentrations ranged from 3 to 1200 μg/L at the entrance. The median Cu concentration was 28 μg/L. 4 μg/L Cu was measured in the single sample from within the basin. Zn, Cd, Hg, and Ag were one to two orders of magnitude above concentrations measured at the study's control station (Sequim Bay) in the six basin samples analyzed for these metals.	

Refer to Data in:

One other source of data on the nearshore receiving waters is from samples taken by Dames & Moore (reference 4). These data, however, were collected during a strike at ASARCO, so metals loads were at a minimum. A composite of surface, middle, and bottom waters taken in October had 5 μg/L Cu. A discrete surface sample collected in December had no detectable Cu. As was not detected in the Dames & Moore samples.

Carpenter (reference 1) conducted a comprehensive survey of As in Puget Sound waters. He found uniform As concentrations everywhere in the Sound except "within a few kilometers of the smelter". Fifty surface water samples north of the smelter in the channel between the mainland and Vashon Island averaged 2.2 μg/L As compared to 1.5 to 1.7 μg/L As at stations north of Seattle.

6. Data on metals in ASARCO nearshore sediments are limited to a single WDOE intertidal sample which had high As, Zn, and Cu concentrations -- 280, 300, and 900 mg/Kg, respectively. Table 39

There are considerable data available on metals in Commencement Bay deepwater sediments, but this is outside the area addressed in this report. Those samples nearest ASARCO were collected at depths of about 60 meters by Crecelius (reference 3) and Malins (references 11, 12). Crecelius analyzed three samples and found 980 to 10,000 mg/Kg As and similar amounts of Sb. He did not analyze for other priority pollutant metals. Malins does not report As data for the NOAA station nearest ASARCO (station number 10-09036). 126 mg/Kg Cu and 140 mg/Kg Zn were measured in samples he collected at this site in 1979.

7. EPA (reference 5) and WDOE (reference 7) analyses on tissue from demersal fish and from mussels indicate specimens collected near ASARCO have higher metals concentrations than those in other parts of Commencement Bay and Puget Sound.

8. Organic priority pollutant analyses have been conducted on the south outfall only. One sample, a grab, was collected by the WDOE S.W. region on August 15, 1982 and analyzed for base/neutrals at the EPA Manchester laboratory. 7.2 μg/L bis(2-ethylhexyl) phthalate was detected.

9. The toxicity of the ASARCO receiving environment to marine life has not been closely investigated. Chapman (reference 2) recently conducted bioassays on two sediment samples collected off the ASARCO facility. His report states that the metals in these samples are "probably refractory and not toxic".

S.W. SHORE COMMENCEMENT BAY

Refer to
Data in:

Considerations for Future Work

1. More study is required at ASARCO. The slag processing operation next to the smelter should be included in future survey work. Among the types of studies suggested are:

    a. Determine net metals loads for ASARCO discharges.

    b. Measure metals concentrations in the receiving waters and assess their toxicity.

    c. Determine the availability of metals in sediments near ASARCO to marine organisms. Determine if these sediments are toxic.

    d. Analyze ASARCO discharges for organic priority pollutants.

MILWAUKEE, PUYALLUP, ST. PAUL, MIDDLE WATERWAYS
AND S.W. SHORE COMMENCEMENT BAY

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PART 6. SUMMARY

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PART 6. SUMMARY
(12/83)

1. Point Source Data

EPA and WDOE data on 60 individual discharges to Commencement Bay have been reviewed. The data base consists of over 100 samples collected between September 1979 and April 1982.

Some of the important limitations inherent in these data may not have been sufficiently emphasized in preceding parts of this report. Although concentrations and flow data for municipal and industrial discharges are considered to be reasonably accurate, the data on storm drains and natural drainages are subject to the vagaries of precipitation, upstream uses, and tidal effects. In many cases, only one or two samples have been collected from a given discharge. For many discharges, only dry-weather data are available. In addition, analytical methods for some compounds, PAH for example, have not always been sufficiently sensitive to detect or quantify them in water. In light of these and other considerations, EPA and WDOE are continuing to monitor those discharges where large numbers and/or high concentrations of contaminants have been found. Perhaps the most important caution in interpreting these data is the fact that the relative importance of other sources of contaminants such as aerial fallout, release from sediments, spills, advection, etc., has not been determined. Keeping these limitations in mind, the following observations were made.

Metals concentrations in most discharges were not large. In general, higher concentrations appeared to be associated with wet weather rather than dry weather. Especially high metals concentrations were found in seeps to Hylebos Waterway, Pennwalt seeps and drains, log sort yard runoff, the Lincoln Avenue south drain to Blair Waterway, the 15th Street storm drain to City Waterway, and ASARCO's south and middle outfalls.

Metals loads representative of dry weather have been calculated from the WDOE data and summarized in Table 40*. The largest total loads were for As, Cu, and Zn --390, 313, and 220 pounds/day, respectively. ASARCO discharges contributed most of the loads for these metals (64 percent to 95 percent depending on the metal in question) as well as 80 percent of the total Cd load of 12 pounds/day. The St. Regis paper mill effluent was only 10 percent of the overall Cu load, but constituted the largest load of Cu to an individual waterway (St. Paul) by a substantial margin. The largest Cr and Ni loads, 16 and 31 pounds/day, respectively, were to Hylebos Waterway and accounted for 66 percent and 76 percent of the total. Hooker (Occidental) was the major source of Cr and Ni loads. The Tacoma Central STP was the major Hg source based on its load of .087 pound/day. It also contributed 36 percent and 21 percent of the total Pb and Zn loads. The remaining waterways (Blair, Sitcum, St. Paul, Middle, Milwaukee, and City) as well as the Old Tacoma storm drain and Ruston STP had small metals loads.

*Because of its very large flow and low metals concentrations, loads for the Puyallup River were not included in Table 40. These data have been calculated and are in Part 5.

SUMMARY

Relatively few organic priority pollutants were detected in most discharges, as shown in Table 41. Overall detection frequencies for the major compound groups, in descending order of frequency were volatiles > acid extractables > base/neutrals > pesticides > PCBs. Cyanide, an inorganic compound, was routinely detected (i.e., 64 percent of samples). The individual compounds most frequently detected were chloroform (54 percent), trichloroethylene (37 percent), tetrachloroethylene (31 percent), phenol (26 percent), naphthalene (24 percent), chlorodibromomethane (20 percent), bis(2-ethylhexyl) phthalate (20 percent), pentachlorophenol (19 percent), and anthracene/phenanthrene (18 percent). Interlaboratory differences in detection limits make it difficult to determine if organics concentrations tended to be higher in wet weather, as was noted for metals.

Most of the sampling effort has been concentrated on Hylebos Waterway discharges. The greatest variety of compounds was detected here. Chemicals such as trichlorofluoromethane, bromoform, carbon tetrachloride, chloroethane, 1,1-dichloroethylene, several PAH, hexachlorobutadiene, 2-chloronaphthalene, nitrobenzene, 4-bromophenylether, and aldrin were detected only in Hylebos discharges. Detection of pesticides was largely restricted to Pennwalt and Hooker (Occidental) discharges to the Hylebos.

Only a few additional compounds were detected outside Hylebos Waterway or at greater frequencies. For example, the highest detection frequency and widest array of phenolic compounds were found in the Tacoma Central STP effluent. Chlorobenzene and 1,2-dichloroethane were detected only in Blair Waterway. PCBs were not detected in any of the EPA or WDOE Commencement Bay point-source samples.

Table 42 summarizes the WDOE data on organic priority pollutants loads. Loads greater than one pound/day were calculated for chloroform (492 pounds), bromoform (19.8 pounds), phenol (4.9 pounds), trichloroethylene (3.8 pounds), bis(2-ethylhexyl) phthalate (3.4 pounds), naphthalene (2.1 pounds), dichlorobromomethane (1.9 pounds), butylbenzyl phthalate (1.9 pounds), tetrachloroethylene (1.7 pounds), di-n-octyl phthalate (1.4 pounds), toluene (1.1 pounds), and 2-chlorophenol (1.1 pounds). A cyanide load of 3.1 pounds/day was also calculated.

The total calculated load for many compounds was contributed entirely by discharges to Hylebos Waterway. The total chloroform, dichlorobromomethane, and toluene loads were overwhelmingly due to the St. Regis effluent (St. Paul Waterway). Effluents from the Tacoma Central and Ruston STPs contributed most of the dichlorobenzenes and phthalates loads, with the former contributing 96 to 100 percent of the loads for five of the six phenols detected. Pentachlorophenol loads came primarily from the north Lincoln Avenue drain into Blair Waterway. For some compounds of concern in Commencement Bay such as PAH and hexachlorobutadiene, extremely low loads were measured. As mentioned above, PCBs were not detected in point sources.

2. Water Column Data

The data available from EPA, Battelle, Dames & Moore, and WDOE surveys suggest that, outside the immediate vicinity of discharges, the waters of Commencement Bay and adjacent waterways do not have especially high metals concentrations. Most metals measurements have been at levels not considered harmful to aquatic life. However, the receiving waters near ASARCO, Pennwalt, Tacoma Central STP, and log sort yards on Blair and Hylebos waterways have a potential for adverse effects on marine life because of elevated metals, especially arsenic, copper, zinc, lead, mercury, and cadmium. There are data indicating copper may be at levels harmful to marine life in Hylebos Waterway.

Most of the water column data on organic priority pollutants are from Blair and Hylebos waterways. Concentrations of PCBs, chlorinated butadienes, chlorinated ethylenes, and haloforms are higher here than reported for most other marine waters. PCBs exceed certain of the EPA criteria for protection of marine life. No PCB sources have been identified. Low concentrations of hexachlorobutadiene have been measured in Hooker and Pennwalt discharges. Hooker (Occidental) is the major known source of chloroform and chlorinated ethylenes to Hylebos Waterway. Pennwalt is the major known bromoform source. Blair water column data suggest an as yet unidentified source of volatiles may exist somewhere along the middle of the north shoreline.

Organic priority pollutant concentrations in the water column are also of potential concern in St. Paul Waterway off St. Regis (chloroform) and in the Puyallup River at the Central STP outfall (a variety of compounds).

3. Sediment Data

Priority pollutant data from 115 samples of surface sediment collected by NOAA, Battelle, EPA, and WDOE in Commencement Bay waterways and the Ruston shoreline were reviewed. Most samples were from Hylebos, Blair, and Sitcum waterways -- 46, 26, and 14 samples, respectively.

The subtidal sediment data have been summarized in Table 43 by showing maximum and median pollutant concentrations.

As is now well known, Sitcum Waterway sediments have the highest concentrations of As, Cu, Pb, and Zn; the latter three metals possibly derived from spilled ore. Sediment(s) in City and Hylebos waterways have the second and third highest levels of metals in sediment. Horizontal gradients in metal concentrations are evident in Hylebos, Blair, Sitcum, and City waterways. There are no core data for metals.

Volatiles generally were not detected in subtidal sediment except for trace amounts in a few Hylebos and St. Paul waterways samples. Sediment-associated volatiles have been detected most frequently in the Hylebos intertidal zone -- 6 of 13 samples had one or more compound(s) detected. Each of these 6 samples was either a Pennwalt- or Hooker (Occidental)-related sediment.

SUMMARY

Acid extractables, like volatiles, were rarely detected in most waterway sediments. Three sediment samples adjacent to St. Regis had phenol concentrations of 1.2, 1.6, and 91 mg/Kg. Chlorinated phenols have been detected in two samples -- one near the St. Regis outfall and one in Sitcum Waterway. 2.3 mg/Kg of 4-nitrophenol was also detected in the Sitcum sample.

DDT and metabolites are the only pesticides routinely detected in most waterways. Especially high concentrations -- up to 3.6 mg/Kg ΣDDT -- occur in Pennwalt intertidal sediments. Pennwalt seeps and drains constitute the major known discharge of DDT compounds to Commencement Bay.

With the exception of trace amounts in a single Sitcum sediment sample, aldrin has been detected only in Hylebos Waterway sediments and deepwater sediments on the northeast side of Commencement Bay between the Hylebos and Browns Point. The highest concentrations are off Hooker (Occidental). Aldrin has been detected in one discharge -- the east sewer at Pennwalt.

The predominant organic priority pollutants in Commencement Bay waterways sediment are the base/neutrals hexachlorobenzene (HCB), hexachlorobutadiene (HCBD), PAH, and phthalates, and PCBs. Up to 1.3 mg/Kg HCB, 3.3 mg/Kg HCBD, and 1.7 mg/Kg PCBs have been measured in Hylebos surface sediments. The median concentrations of HCB and HCBD in Hylebos subtidal sediment are an order of magnitude above the medians for other waterways. PAH and phthalates appear to be highest in City Waterway.

A gradient of decreasing PAH in surface subtidal sediments moving from the head of Hylebos Waterway toward its mouth was observed and may be partly associated with Kaiser Aluminum sludge beds on upper Kaiser ditch. In contrast, PAH in Blair Waterway sediments are lowest in the innermost waterway; both high and low concentrations are reported from samples seaward of Lincoln Avenue. A source material for PAH has not been found in Blair. There are not sufficient data on City Waterway sediments to determine if a PAH concentration gradient exists.

No gradients in HCB, HCBD, or PCB concentrations were apparent in the subtidal surface sediment data on the Hylebos or other waterways. Variations in the detection limits achieved by different laboratories make identification of gradients difficult. The highest HCB and HCBD concentrations are near Hooker (Occidental). Seven Hylebos sediment samples have had high PCB concentrations, around 1 mg/Kg, but these were collected at stations scattered throughout the waterway.

Core data on Hylebos sediment show up to 77 mg/Kg chlorinated butadienes, 7 mg/Kg PCBs, and 105 mg/Kg aromatic hydrocarbons in subsurface layers. The lower chlorinated butadienes (tri, tetra, penta) have been found at higher concentrations than hexachlorobutadiene in both surface and subsurface sediment samples. EPA does not include the lower chlorinated butadienes among the priority pollutants.

4. Major Considerations for Future Work

For each of the Commencement Bay waterways previously discussed in Parts 1 - 5 of this report, an attempt was made to point out data gaps and survey needs. The following considerations were among the most important of these:

a. Develop sediment criteria for protection of marine life.

b. Mass balance contaminants of concern in Hylebos, Blair, and City waterways.

c. Collect more water column data in Sitcum, St. Paul, and City waterways.

d. Collect more sediment data, including cores, in Sitcum, Milwaukee, St. Paul, Middle, and City waterways.

e. Conduct receiving environment surveys at Hooker (Occidental), ASARCO, and St. Regis -- include objectives outlined in Parts 1 and 5.

f. Re-examine data on aldrin in Hylebos and nearby Commencement Bay sediments.

g. Identify the source(s) of elevated volatiles found in the Blair water column.

h. Measure metals concentrations and loads to waterways from log sort yards where ASARCO slag was used for ballast.

i. Evaluate the Kaiser ditch system as a source of PAH to Hylebos Waterway.

j. Determine the significance to pelagic marine life of observed levels of haloforms, chlorinated aliphatics, chlorinated butadienes, and polychlorinated biphenyls in the Blair and Hylebos water columns.

k. Analyze sediment, water, and biota for potentially toxic chemicals not included among EPA's priority pollutants.

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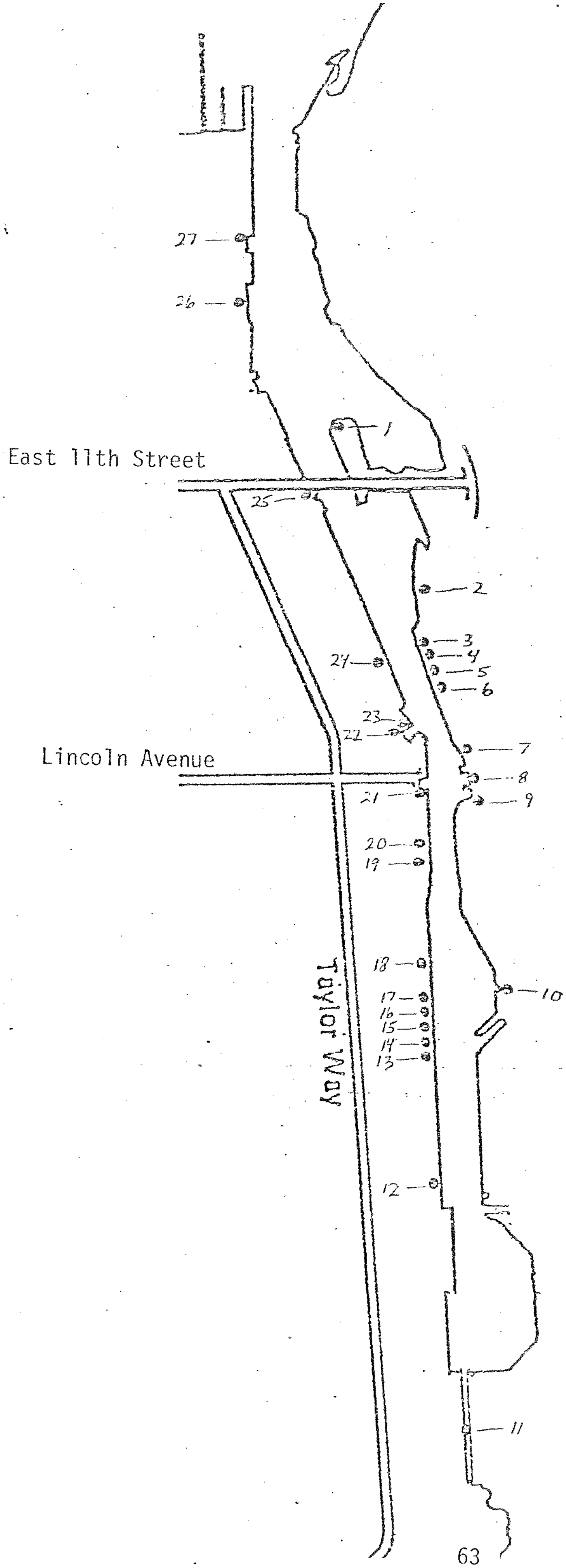

Figure 1. Hylebos Waterway: point source samples.

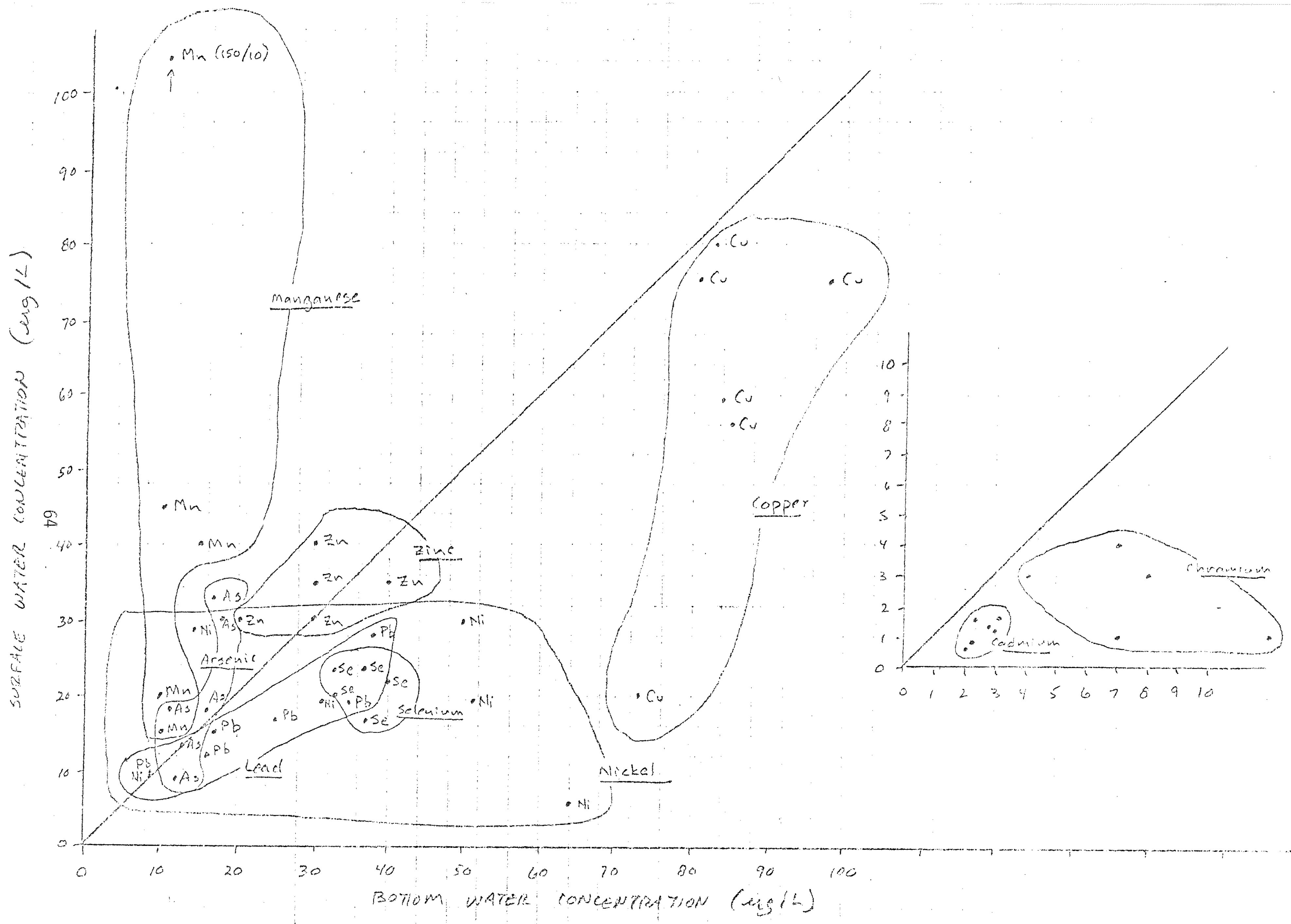

Figure 2. Hylebos Waterway: Surface water vs. bottom water concentrations of trace metals (total metal). (Data from USEPA 1980. Commencement Bay/Port of Tacoma Field Survey, June 3, 1980).

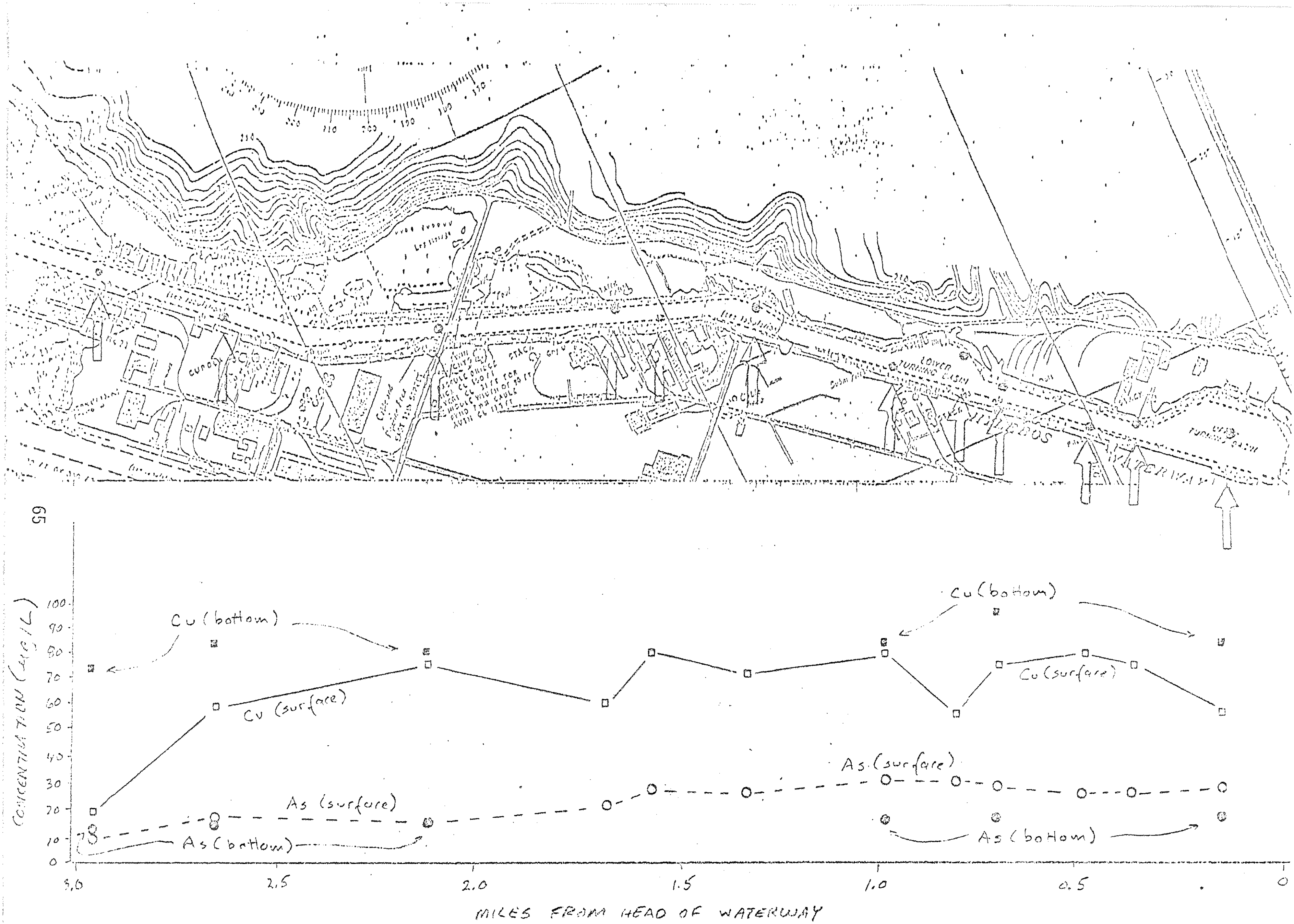

Figure 3. Hylebos Waterway: Concentrations of copper and arsenic in surface waters and bottom waters, June 3, 1980. (Data from: USEPA, 1980. Commencement Bay/Port of Tacoma Field Survey, June 3, 1980.)

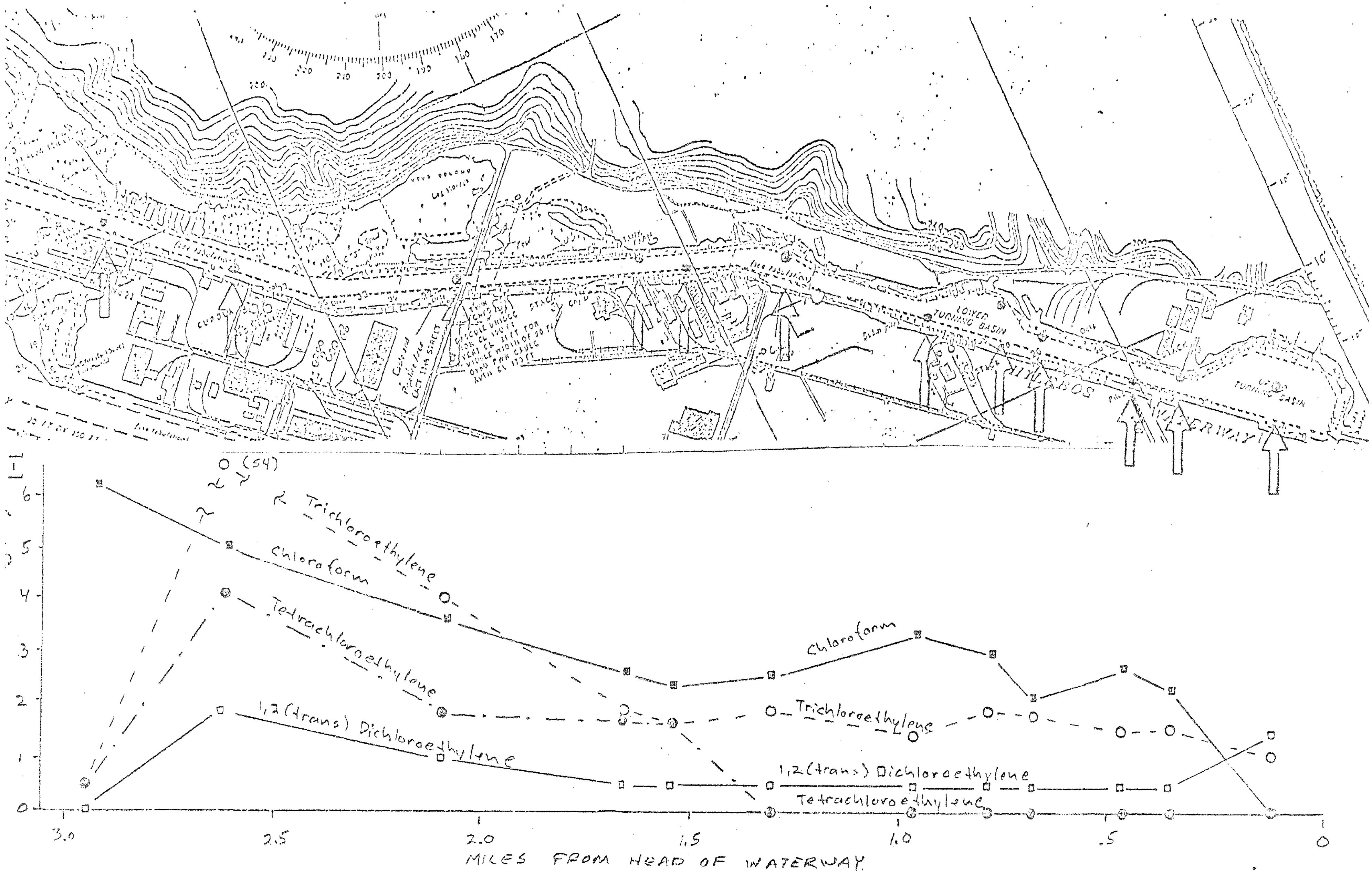

Figure 4. Hylebos Waterway: Concentrations of chlorinated ethylenes and chloroform in surface waters, June 3, 1980. (Data from: USEPA, 1980. Commencement Bay/Port of Tacoma Field Survey, June 3, 1980.)

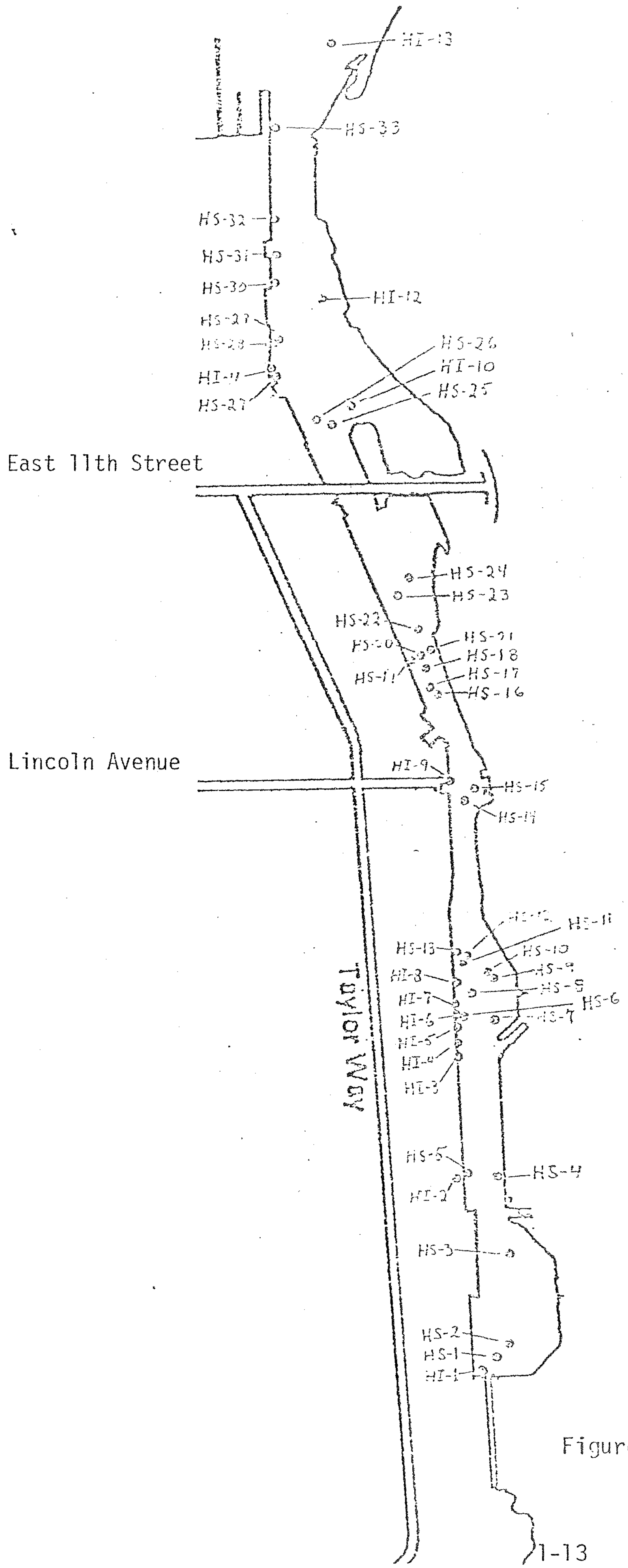

Figure 5 Hylebos Waterway: sediment samples.

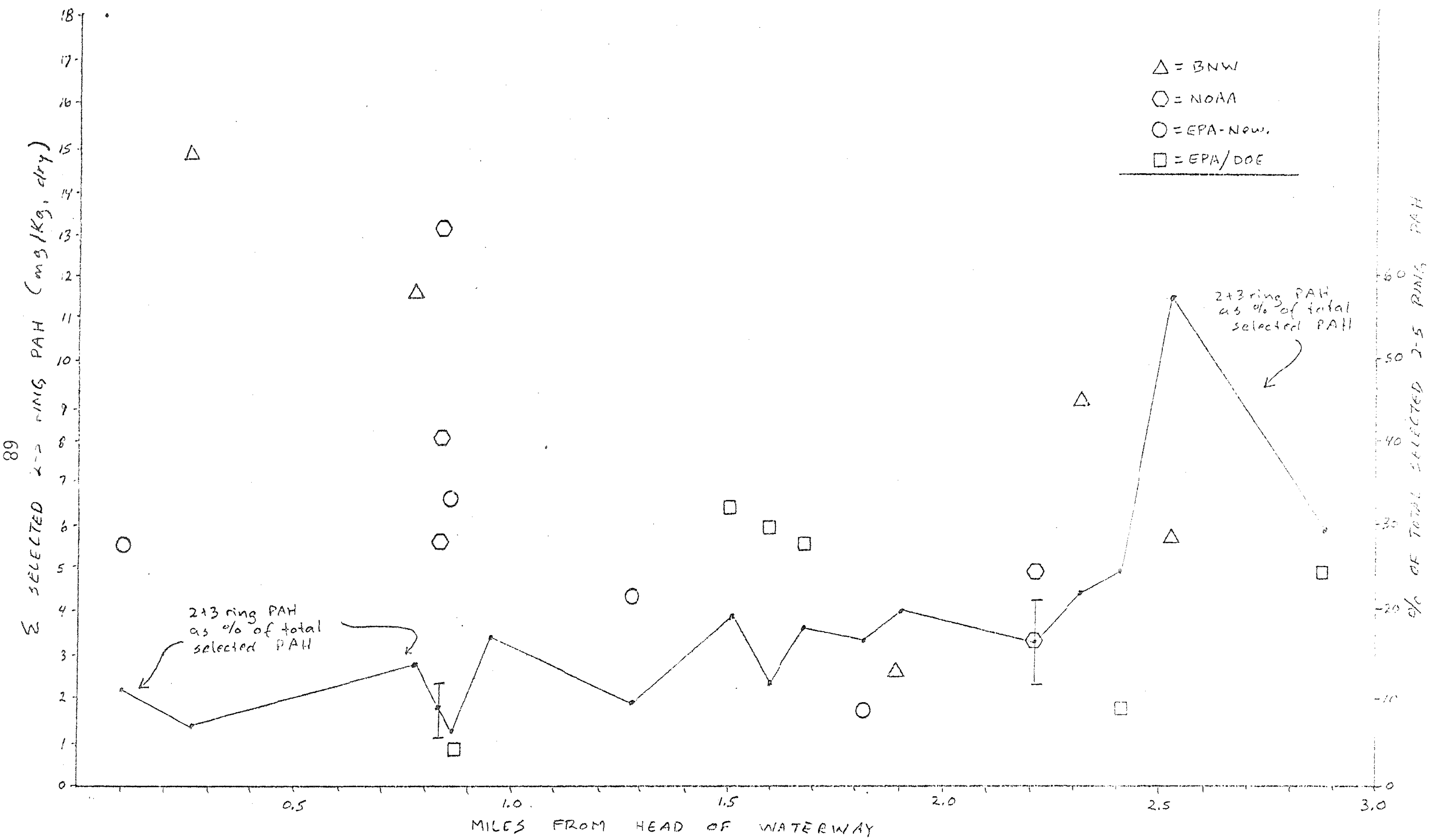

Figure 6. Hylebos Waterway: Selected* PAH compcunds in subtidal sediments.

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

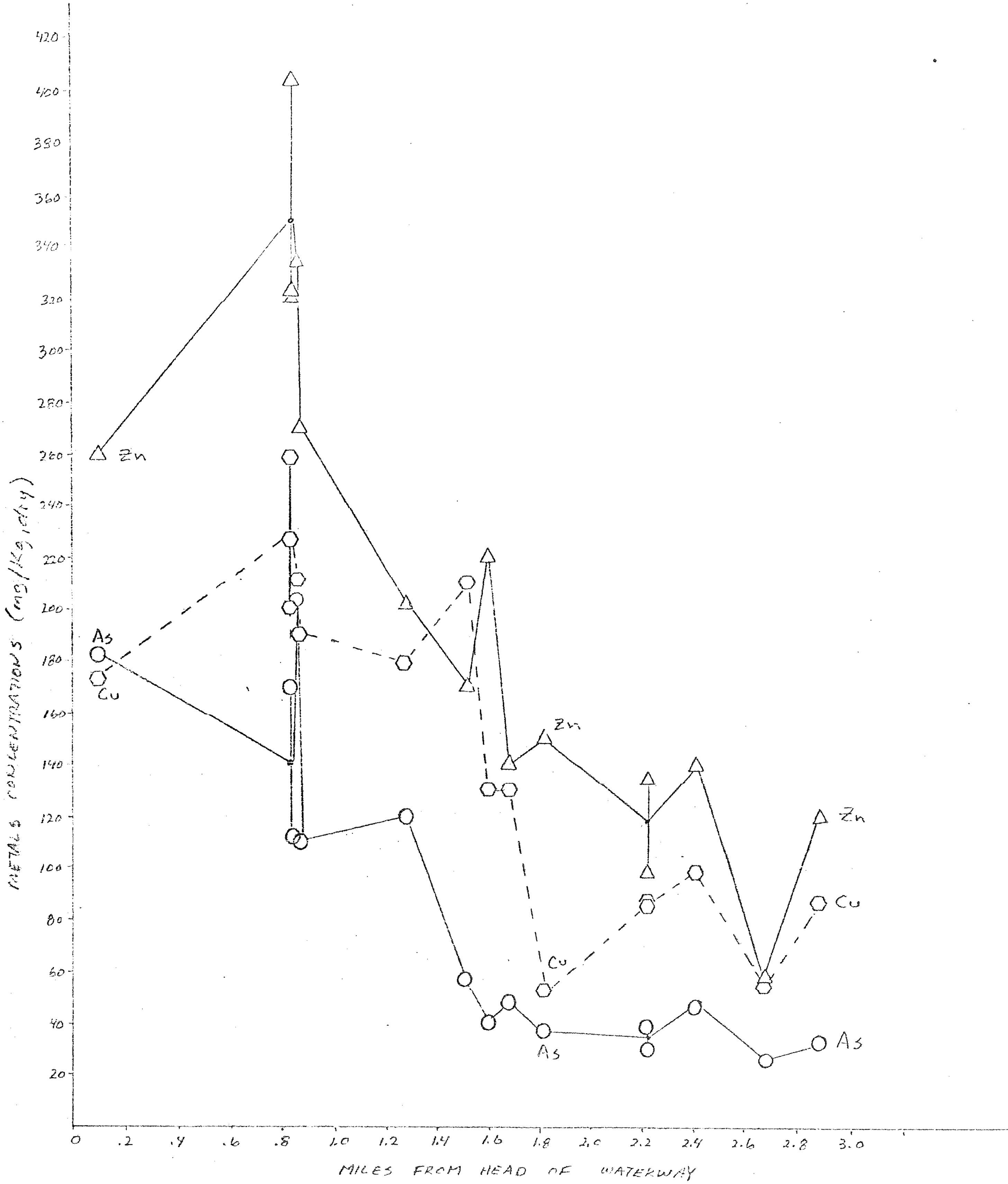

Figure 7. Hylebos Waterway: Concentrations of selected metals in subtidal sediments.

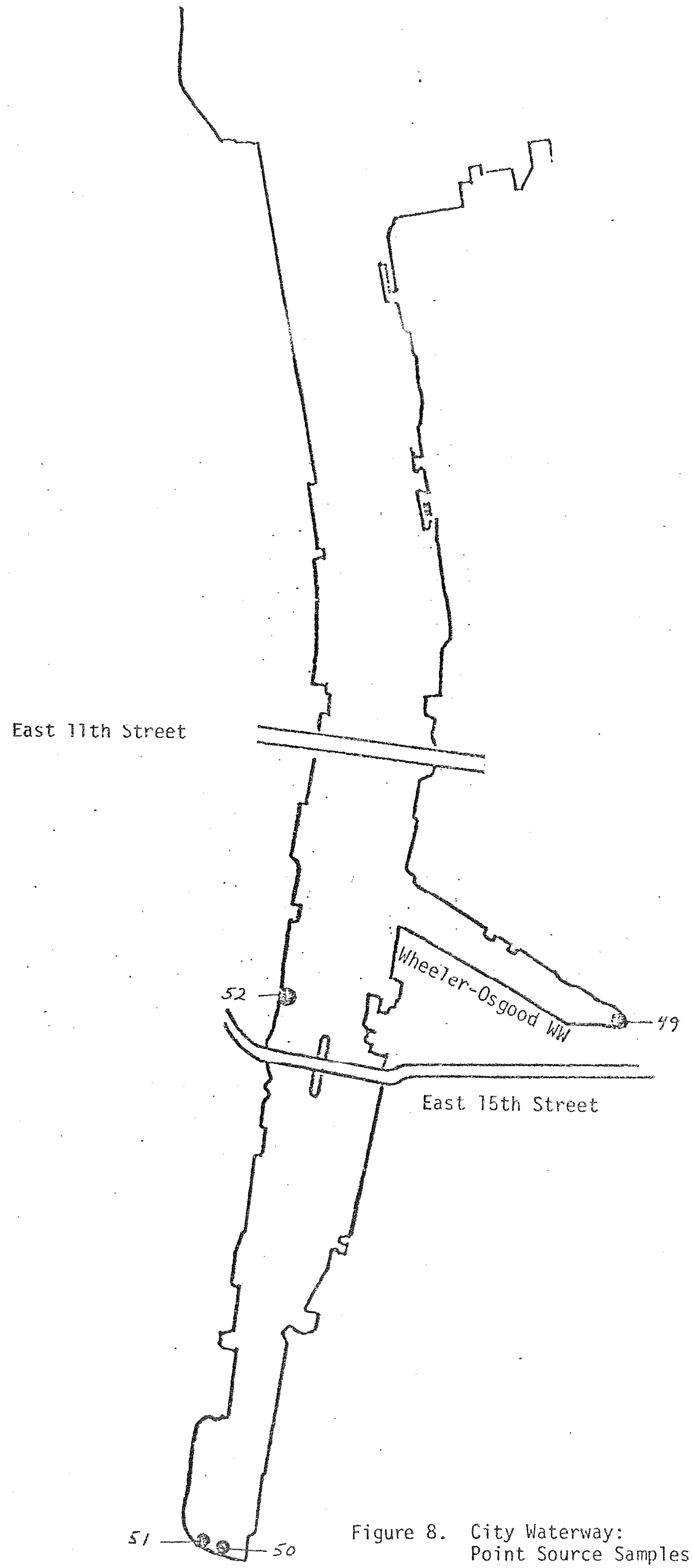

Figure 8. City Waterway: Point Source Samples.

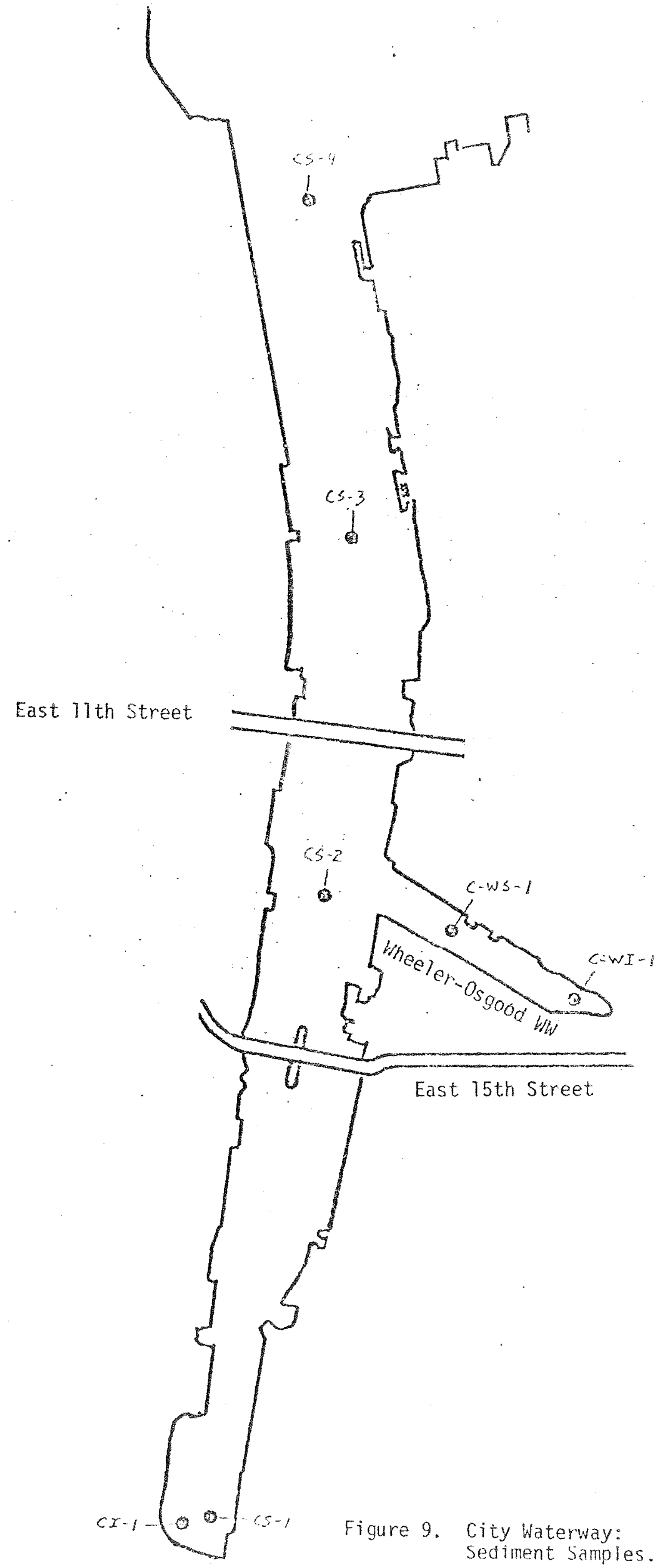

Figure 9. City Waterway: Sediment Samples.

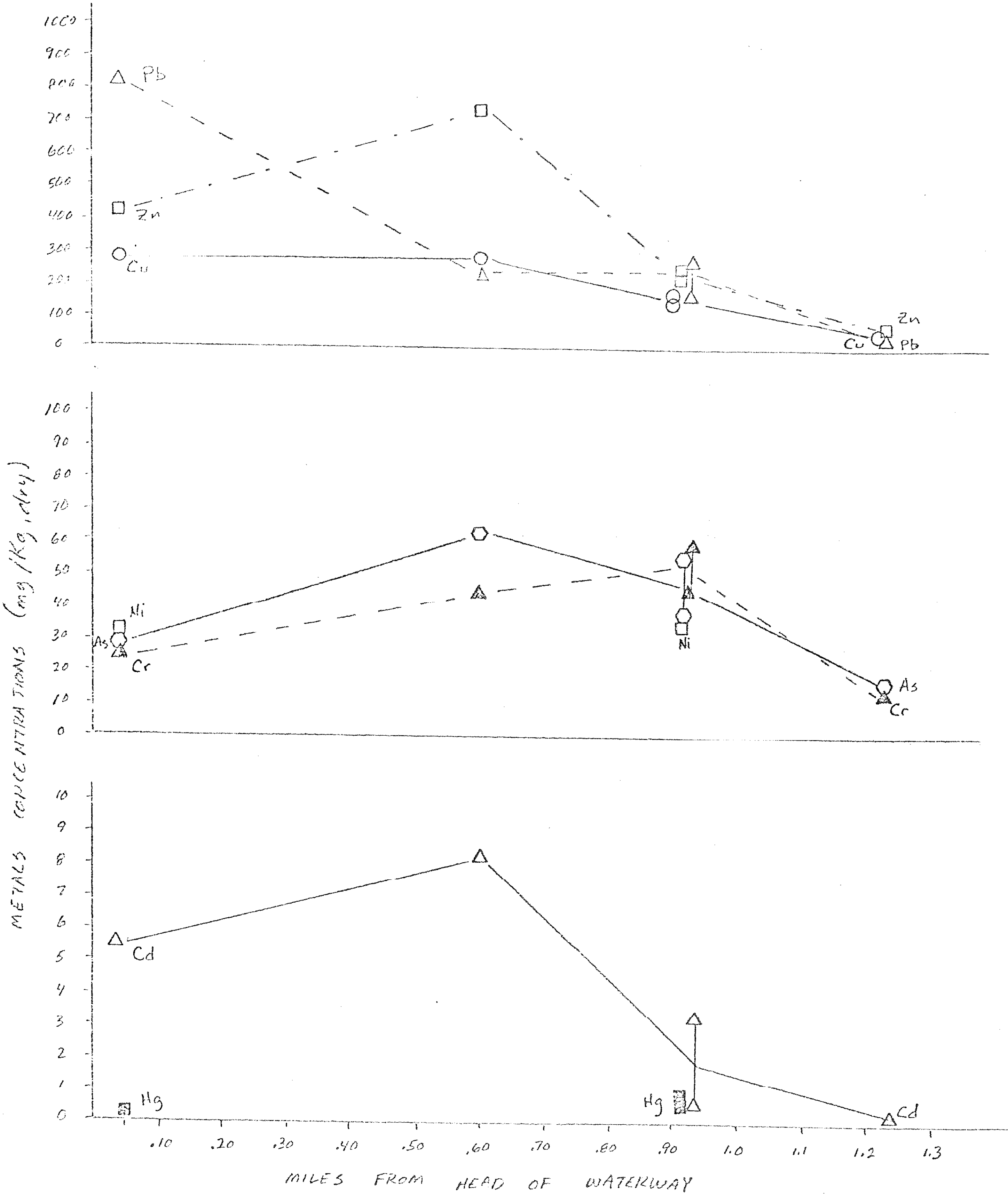

Figure 10. City Waterway: Concentrations of metals in subtidal sediments.

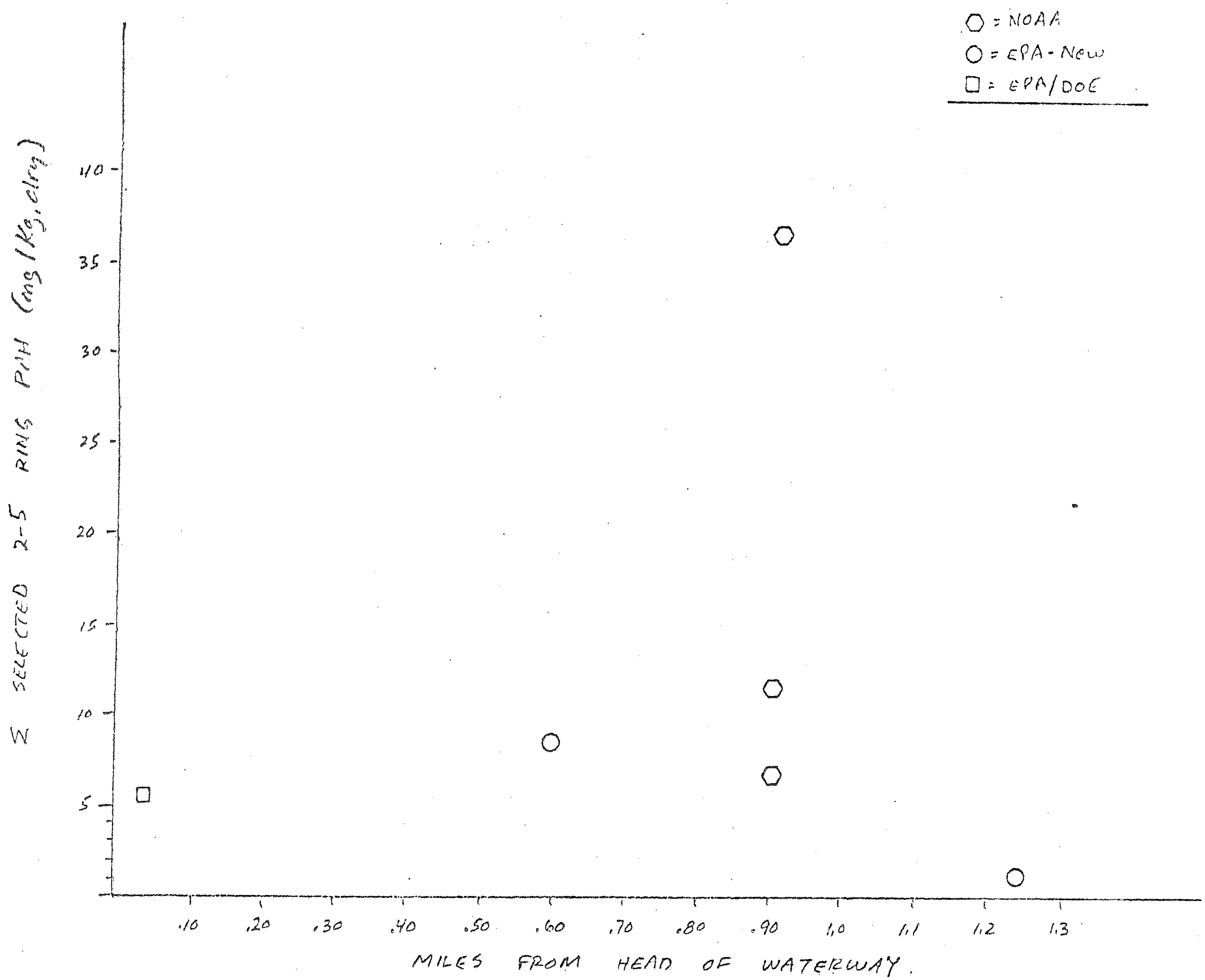

Figure 11. Sum of selected* PAH compounds in subtidal sediments.

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

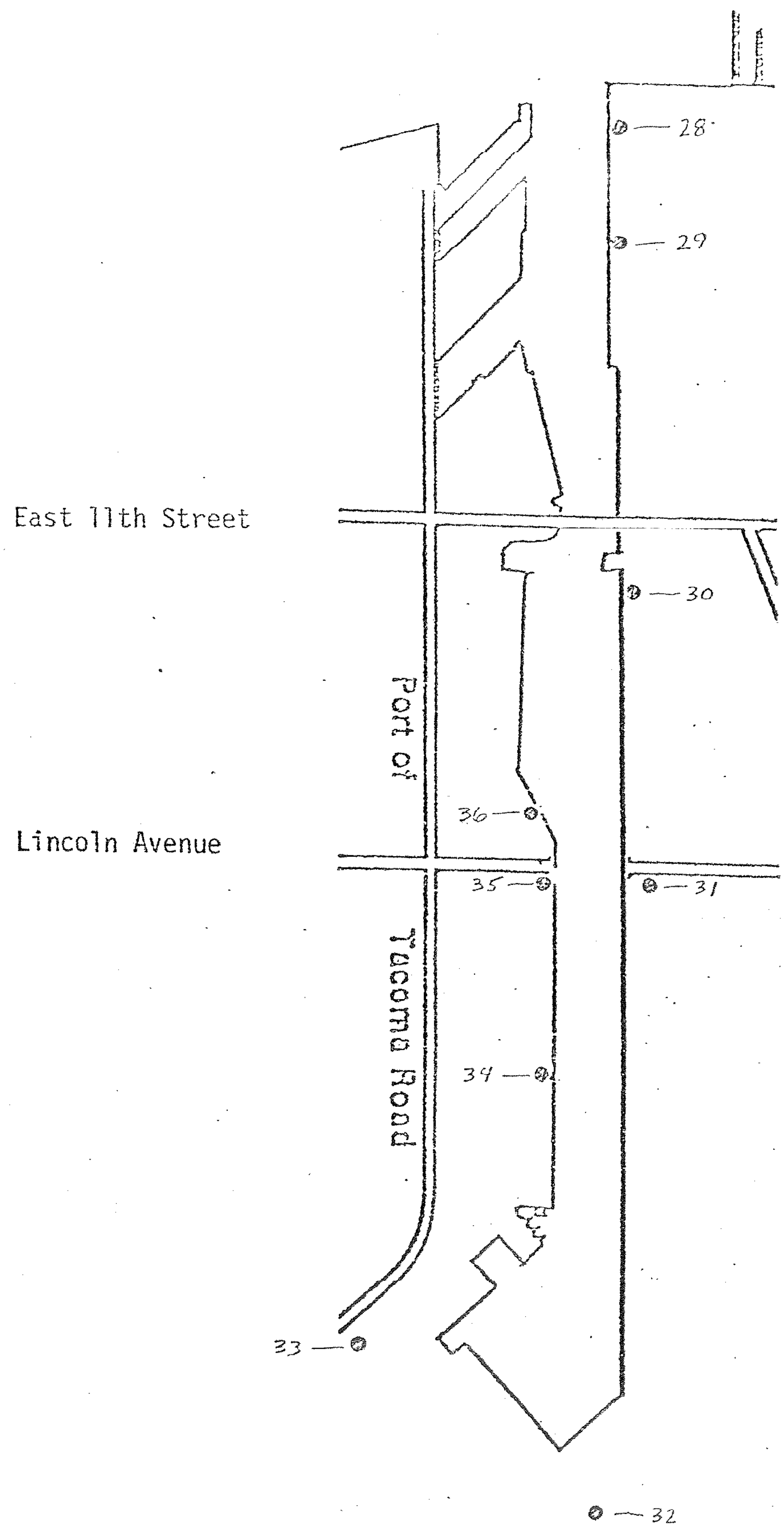

Figure 12. Blair Waterway: point source samples.

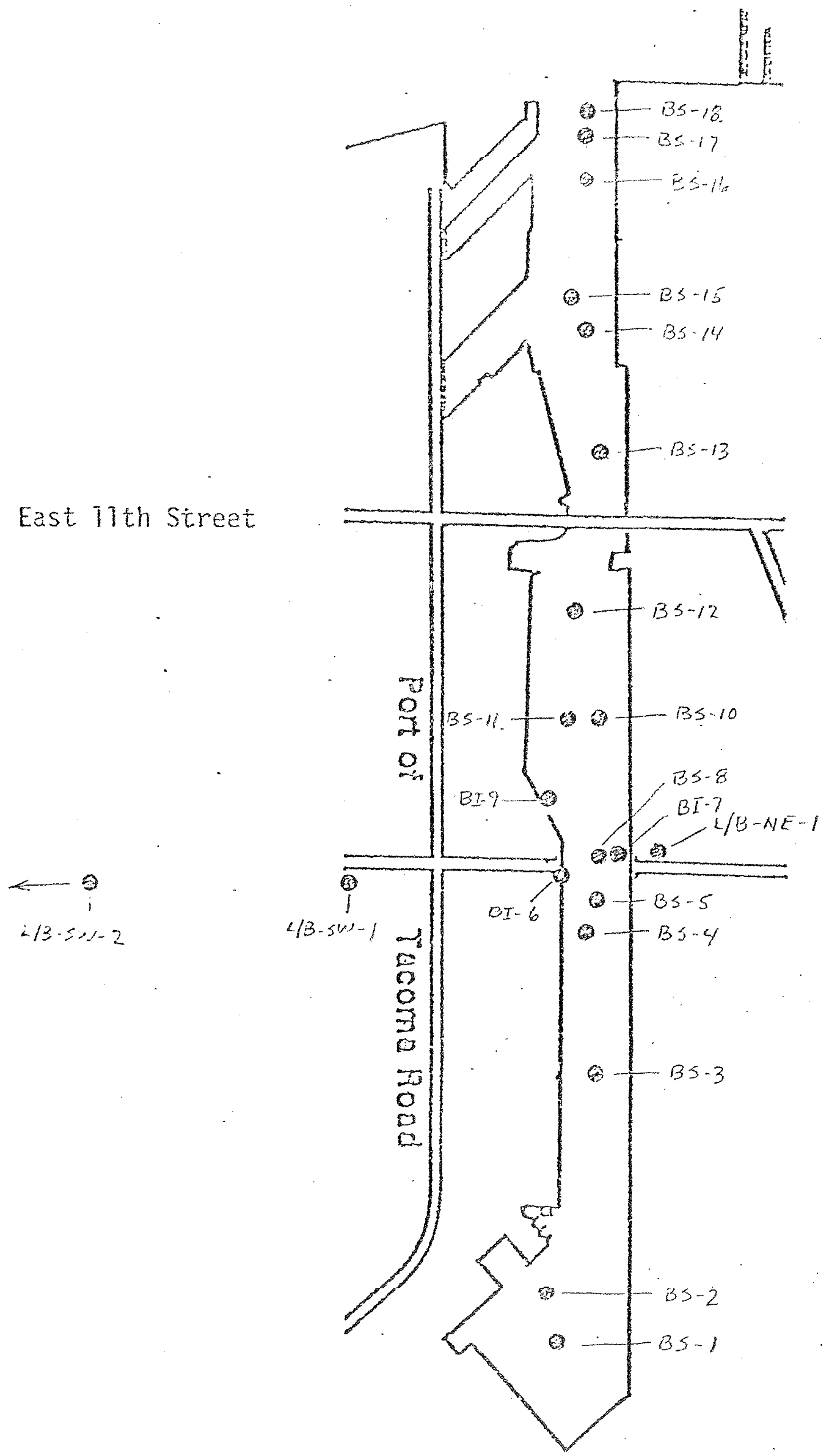

Figure 13. Blair Waterway: sediment samples.

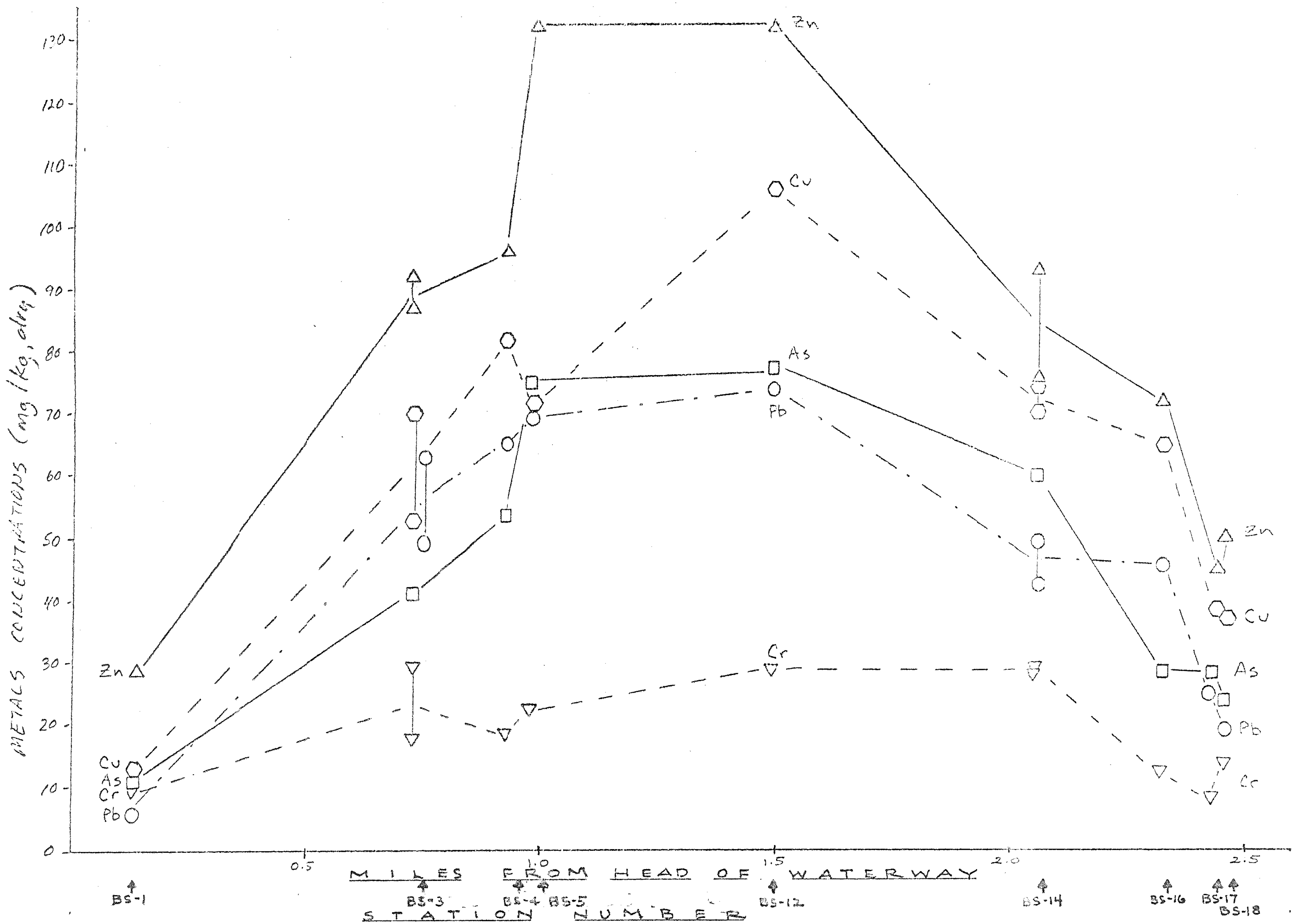

Figure 14. Blair Waterway: concentrations of selected metals in subtidal sediments.

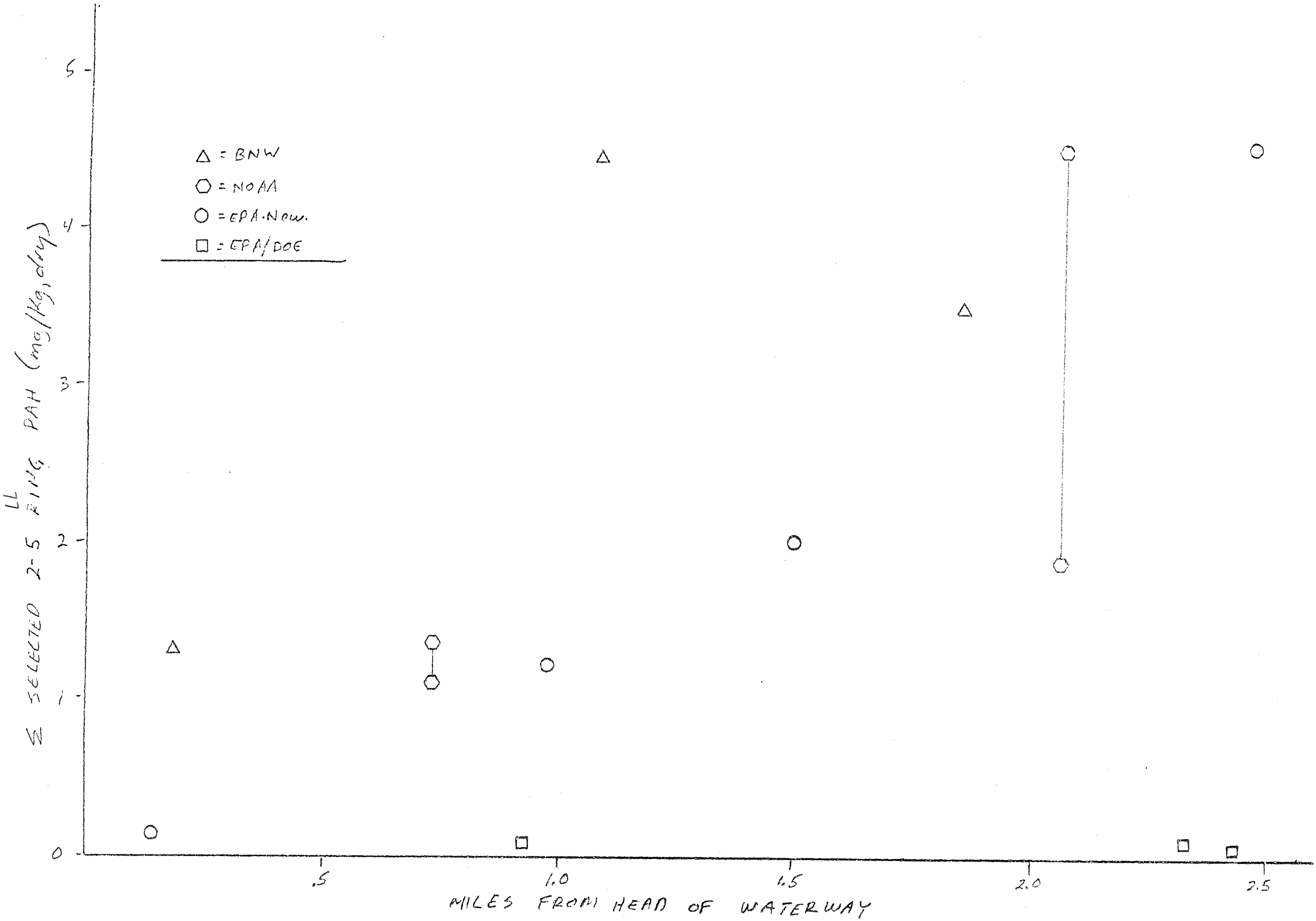

Figure 15. Blair Waterway: selected* PAH compounds in subtidal sediments.

*napthalene, phenanthrene, anthracene, fluorene, pyrene, chrysene, benzo(a)anthracene, fluoroanthene.

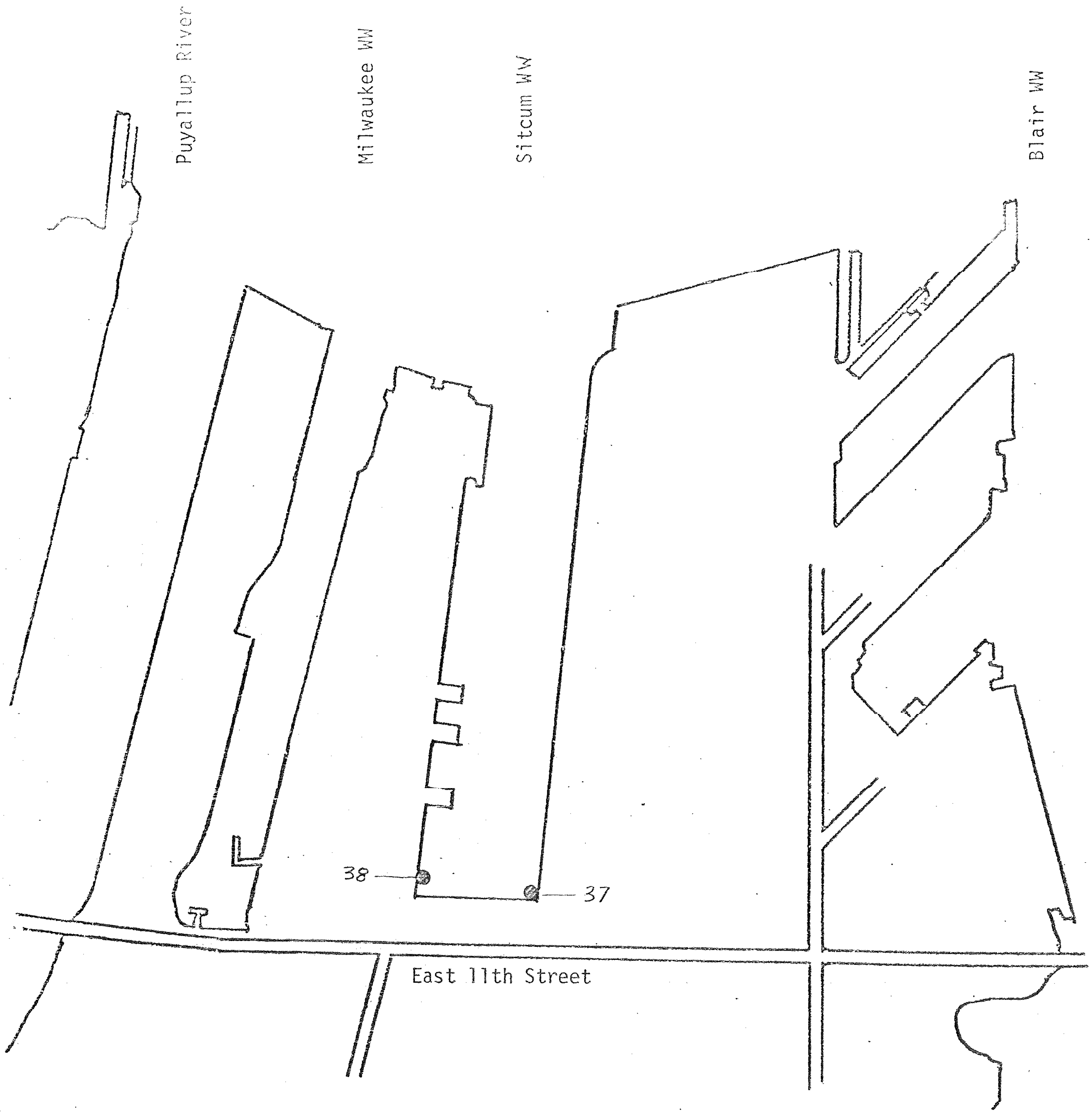

Figure 16. Sitcum Waterway: point source samples.

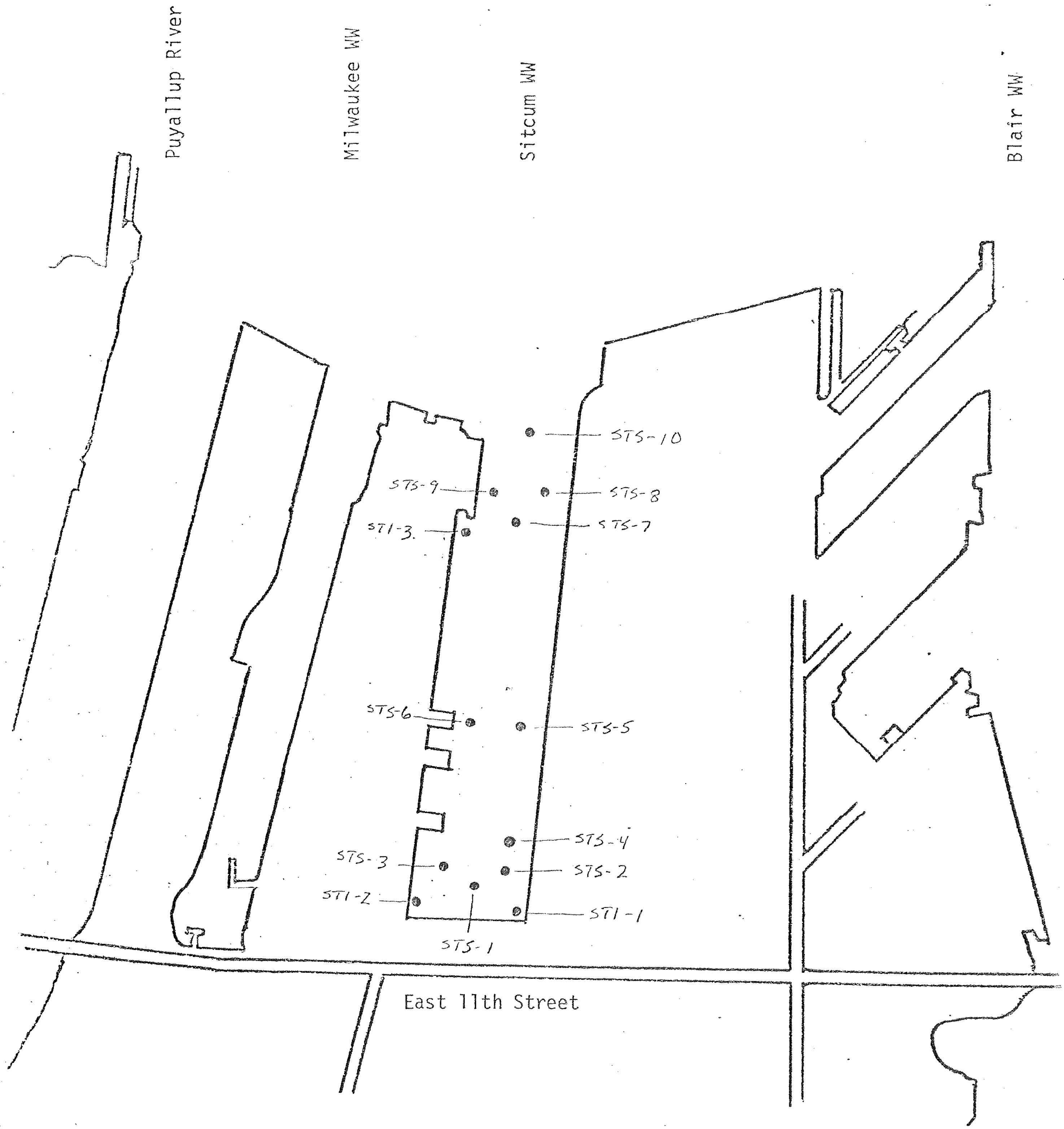

Figure 17. Sitcum Waterway: sediment samples.

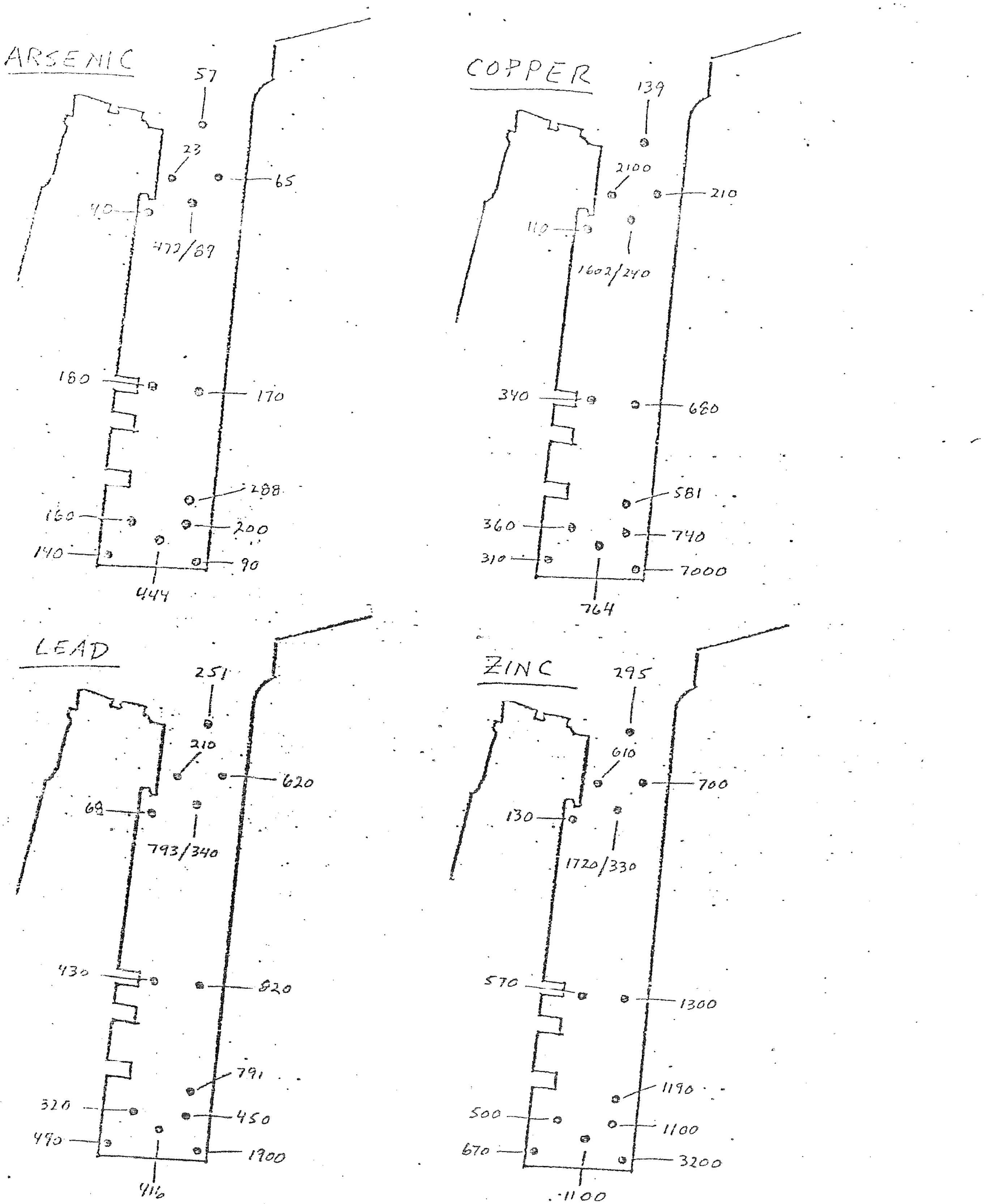

Figure 18. Sitcum Waterway: Concentrations of arsenic, copper, lead, and zinc in surface sediments (mg/Kg, dry).

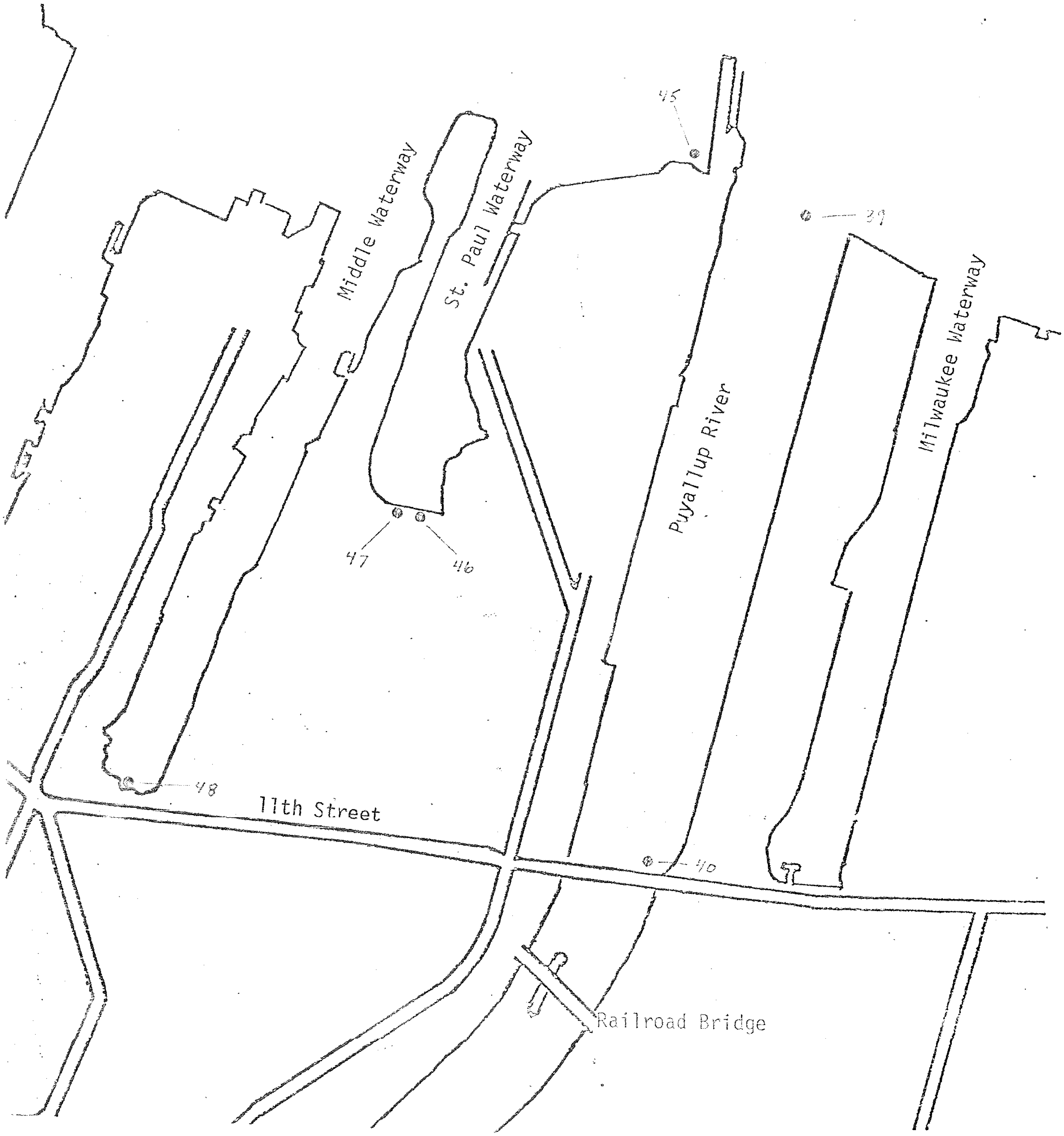

Figure 19a. Puyallup, St. Paul, and Middle Waterways: Point Source Samples.

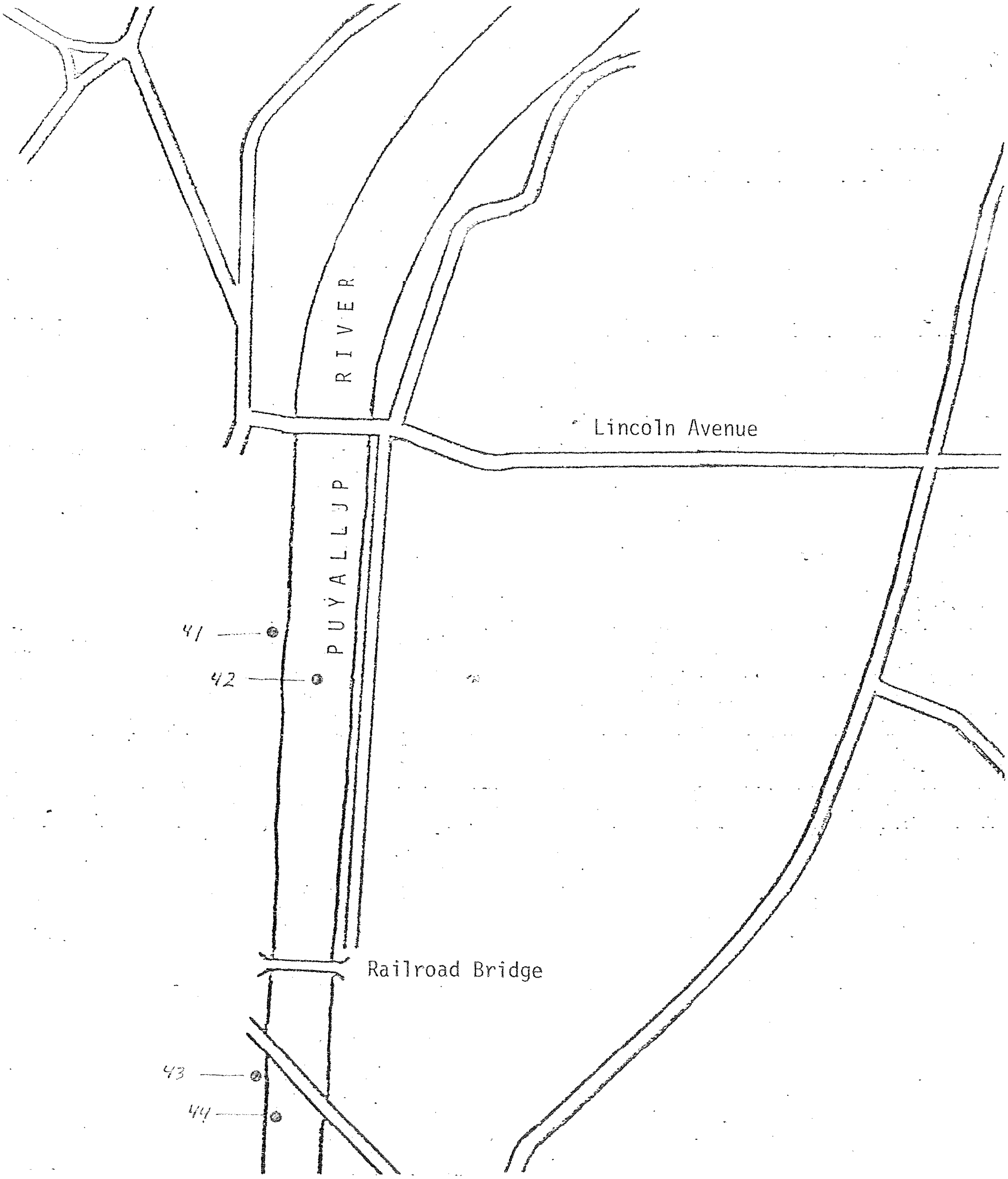

Figure 19b. Puyallup River: Point Source Samples.

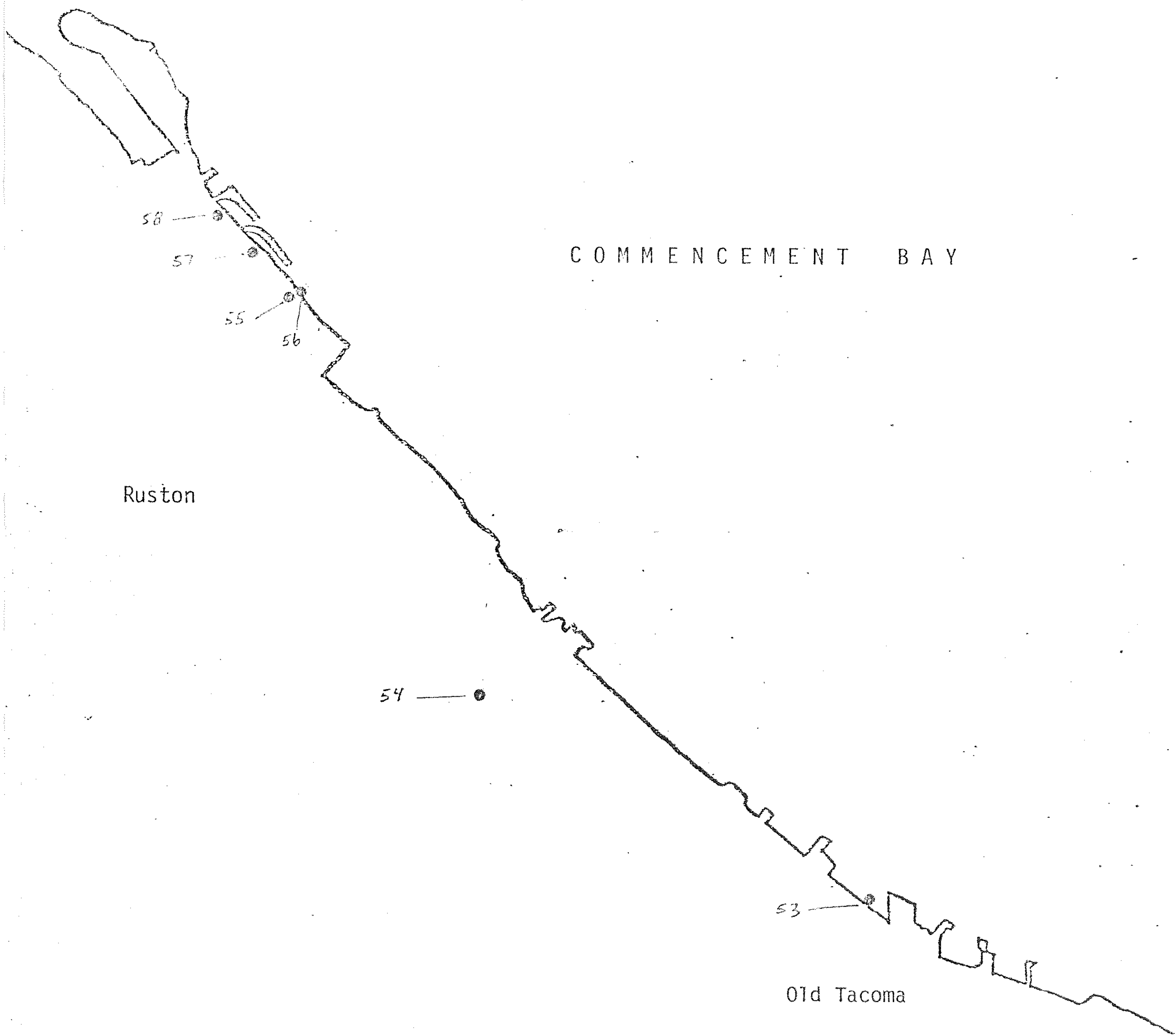

Figure 19c. S.W. Shore Commencement Bay: Point Source Samples.

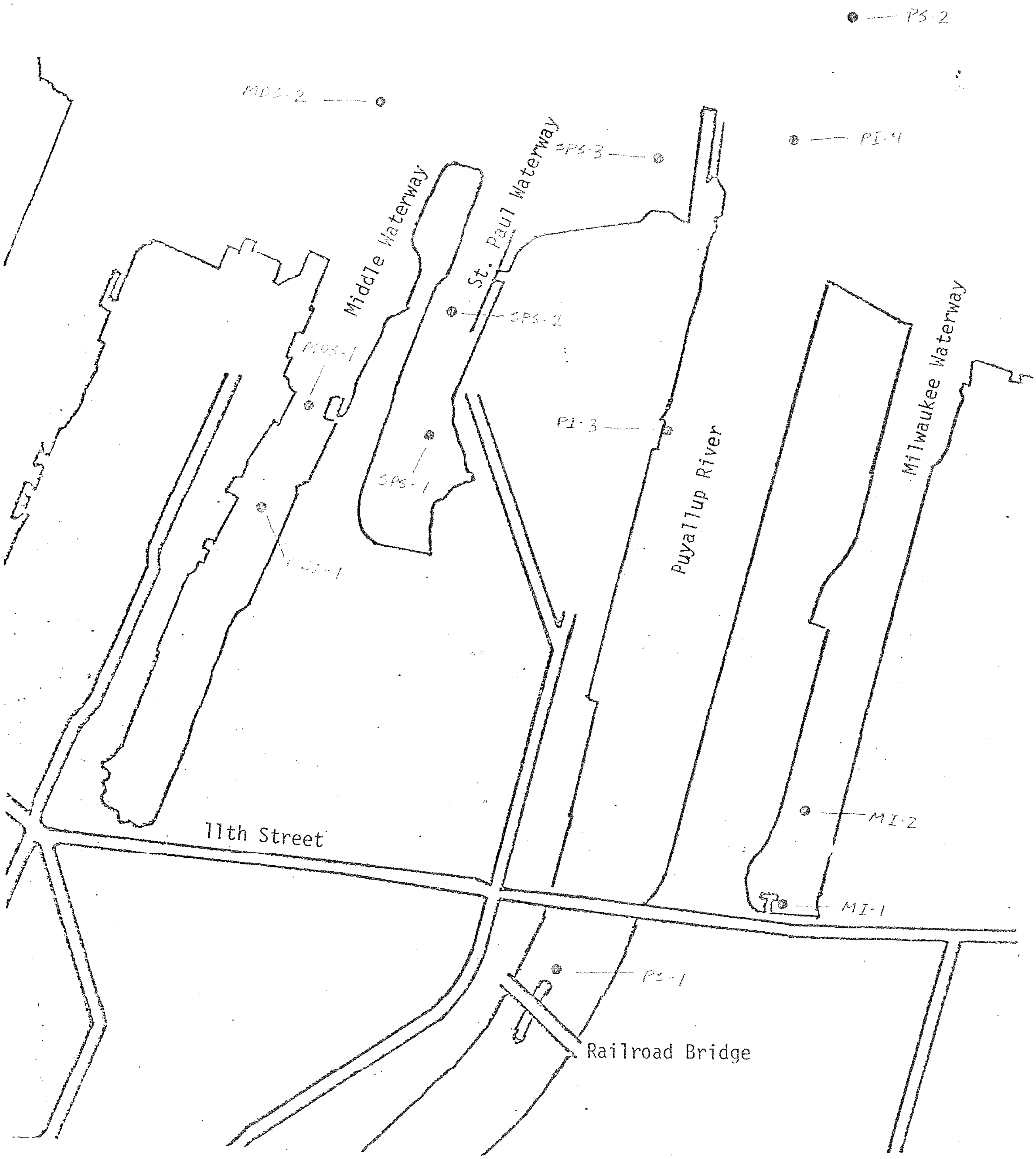

Figure 20a. Milwaukee, Puyallup, St. Paul, and Middle Waterways: Sediment Samples.

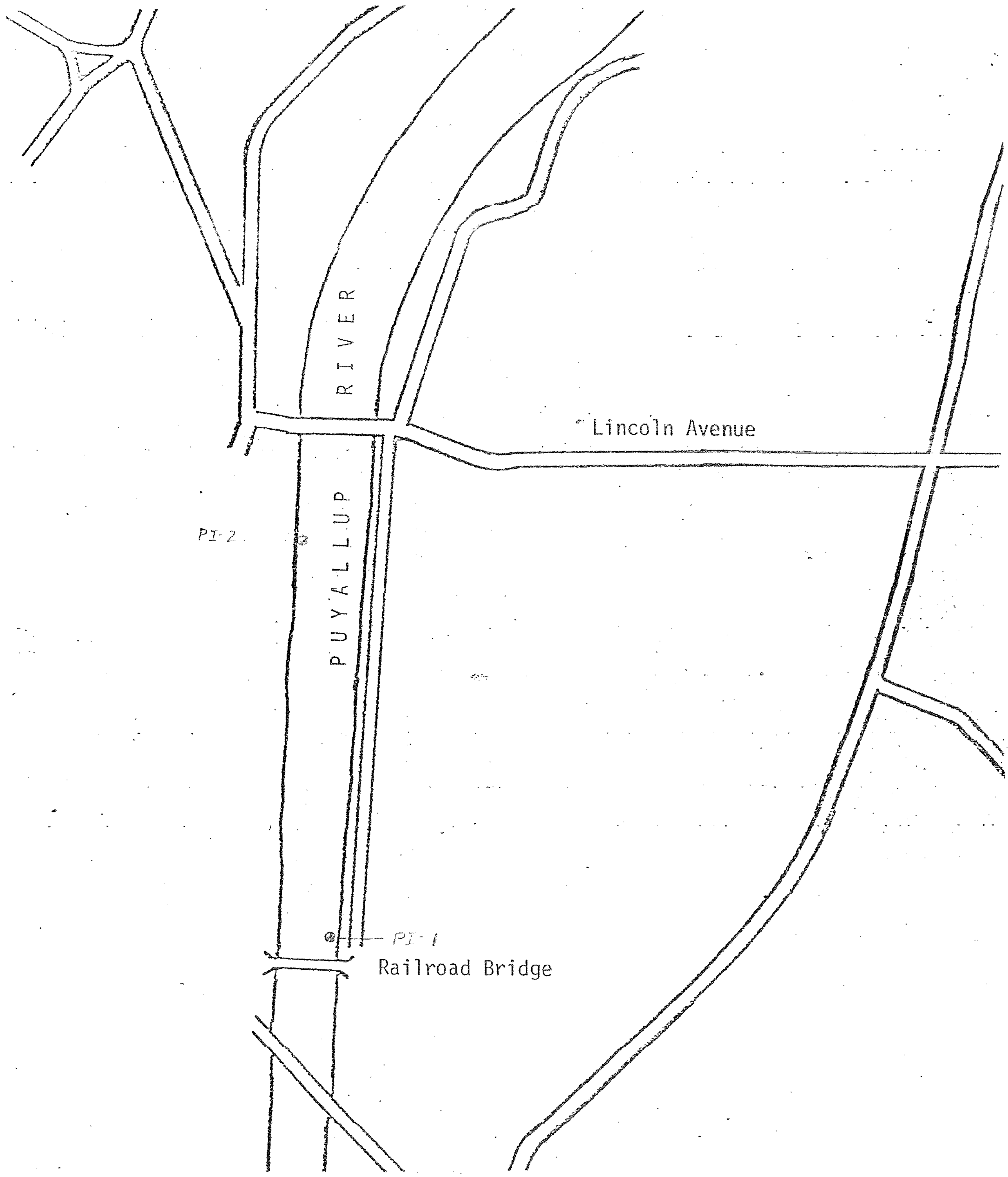

Figure 20b. Puyallup River: Sediment Samples.

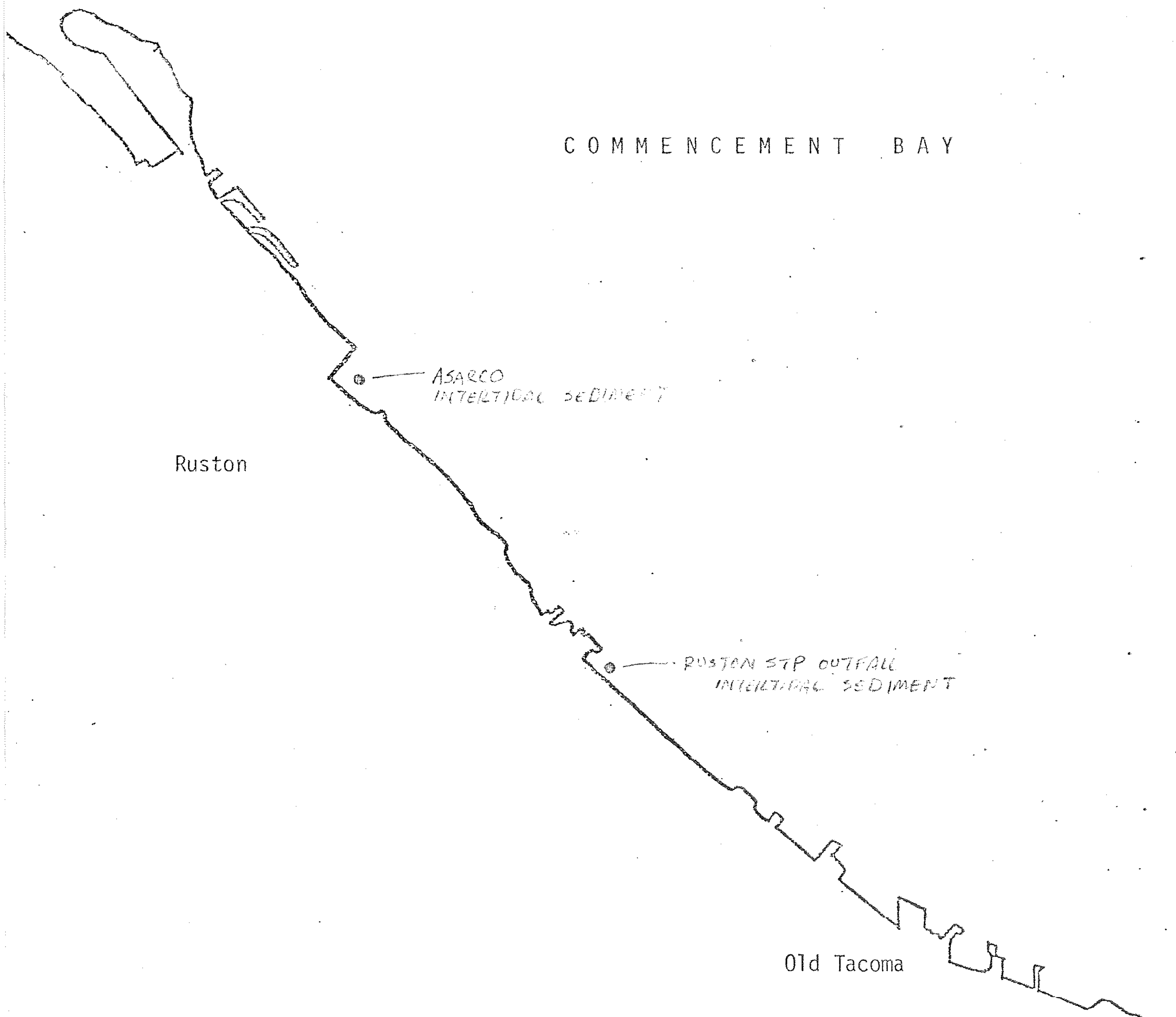

Figure 20c. S.W. Shore Commencement Bay: Sediment Samples.

Table 1. Metals Concentrations in Point Source Discharges (µg/L total metal)

Discharge	Date Sampled	Time Sampled	Investigator	Sample No.	Station 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	38319	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		77
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: Metals 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	.46	.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 Metals 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	Sound Refining: Process Effluent	West Drain opposite Lincoln Avenue	Seepage opposite Lincoln Avenue	East Drain opposite Lincoln Avenue	Morningside Drain at Hylebos Boat Haven	Morningside Drain at Hylebos Boat Haven	Morningside Drain at Hylebos Boat Haven	Hylebos Creek	Hylebos Creek	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	0953	0915	1230	1015-1420	1600	0945-1420	1410-1615	0935	1335-1650	0930	1130-1410	1125-1540	1350	1240-1430	1200-160[illegible]
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	J'340
Station Number	1	2	3	4	5		7	8	9		10			11	
Flow (MGD)				.0039	(.072)	.0529	.060		.050		(.13)	.78		4.06	3[illegible].74
Volatiles															
chloroform	6.8	--	--	1.7	--	--	a	--	a	--	--	a	--	--	a
trichlorofluoromethane	--	--	--	--	--	--	a	--	a	--	--	a	--	--	a
1,2-trans-dichloroethylene	--	--	--	--	--	--	a	--	a	--	--	a	--	3	a
1,1,1-trichloroethane	--	--	1.1	--	1.8	T	a	--	a	--	--	a	--	--	a
trichloroethylene	3.3	2.0	--	--	--	--	a	2.0	a	--	--	a	--	2	a
benzene	--	--	--	--	2500	--	a	--	a	--	--	a	22	--	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).

Discharge	Kaiser Ditch					East Property Line Drain		Pennwalt East Seep			West Seep		East Sewer	West Sewer		Process Effluent	
Date Sampled	6/3/80	9/23/80	9/23/80	6/17/81	3/29/82	9/23/80	6/27/81	6/3/80	9/23/80	6/2/81	9/23/80	6/27/81	6/27/81	6/3/80	6/27/81	6/3/80	6/2-3/81
Time Sampled	1545	0958	1140	1100-1415	1216-1520	1153	1115-1455	1150	1118	1100-1450	1138	1020-1515	1015-1525	1140	1000-1500	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	13000	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	5	16	19	--	--	--	--	2.1	--
chloroethane	--	--	--	--	a	--	--	5	10	15	--	5	--	--	--	--	--
1,1-dichloroethane	--	--	--	--	a	--	--	--	1	3.8	--	--	--	--	3.1	--	--
1,2-trans-dichloroethylene	--	--	--	0.6	a	--	--	--	--	--	--	--	--	--	--	--	--
1,1-dichloroethylene	--	--	--	--	a	--	--	--	1	--	--	--	--	--	6.3	--	--
1,1,1-trichloroethane	--	--	--	--	a	--	--	2	4	4.8	--	--	--	--	210	--	--
trichloroethylene	--	1.9	1.9	5	a	2.4	17	30	1	--	10	4.7	--	--	T	1.4	--
tetrachloroethylene	--	1.3	--	--	a	1.8	--	4800	100	94	385	180	--	--	--	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	--	--	--	--	--	--	--	--
fluoranthene	T	--	.53	2	a	--	T	126	1	--	--	--	--	--	--	--	T
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				--	--		--	--	--	--		--	--	.06	--		--
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).

								Hooker			
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	Process Effluent		Effluent Plume	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 1604 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] 9/75-10/79	Hooker: Groundwater[2]	Sum of Loads to Hylebos Waterway[3]
Volatiles																					
chloroform	.00005	--	--	--	--	--	--	--	.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
Tetrachloroethylere	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	65	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	I	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
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 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		59	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

Table 11. City Waterway: Metals Concentrations in Point Source Discharges (μg/L, total metal).

Discharge	Date Sampled	Time Sampled	Investigator	Sample Number	Station No.	Flow (MGD)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Drain at Head of Wheeler-Osgood	7/28/81	0830-1200	WDOE	30113	49	.13	20	.6	4	40	.24	24	75	140
" " " " " "	3/29/82	1300-1530	WDOE	82-1388	49	.63	18	<2	<10	10	<.20	<20	80	80
East Drain at Head of Waterway	7/28/81	0850-1115	WDOE	3043	50	2.58	<1	<10	<2	<1	<.20	<1	<100	12
" " " " " "	2/16/82	1420-1800	WDOE	82-624	50	10.98	26	<5	<20	50	<.20	<5	59	80
West Drain at Head of Waterway	7/28/81	0850-1115	WDOE	3045	51	1.47	<1	10	<2	6	<.20	<1	<100	34
" " " " " "	2/16/82	1435-1800	WDOE	82-627	51	10.66	16	<5	<20	60	<.20	9	360	180
15th Street Drain	4/28/82	1300-1445	WDOE	82-2104	52	.14	150	6	20	420	.39	<20	650	370

Table 12. City Waterway: Metals Loads (pounds/day).

Discharge	Date Sampled	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Drain at Head of Wheeler-Osgood	7/28/81	.020	.0007	.0043	.043	.0003	.0026	.081	.15
" " " " " "	3/29/82	.0014	--	--	.053	--	--	.42	.42
East Drain at Head of Waterway	7/28/81	--	--	--	--	--	--	--	.26
" " " " " "	2/16/82	2.4	--	--	4.6	--	--	5.4	7.3
West Drain at Head of Waterway	7/28/81	--	.12	--	.074	--	--	--	.42
" " " " " "	2/16/82	1.4	--	--	5.3	--	.80	32	16
15th Street Drain	4/28/82	.18	.007	.023	.49	.0005	--	.76	.43

Table 13. City Waterway: Organic Priority Pollutant Concentrations in Point Source Discharges (µg/L).

Discharge	Drain at Head of Wheeler-Osgood		East Drain Head of Waterway		West Drain Head of Waterway		15th Street Drain
Date Sampled	7/28/81	3/29/82	7/28/81	2/16/82	7/28/81	2/16/82	4/28/82
Time Sampled	0830-1200	1300-1530	0850-1115	1420-1800	0850-1115	1435-1800	1300-1445
Investigator	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE
Sample Number	30113	J1343	30115	J0441	30117	J0442	J0478
Station Number	49		50		51		52
Flow (MGD)	.13	.63	2.58	10.98	1.47	10.66	.14
Volatiles							
chloroform	--	a	--	--	4.5	--	<10
trichloroethylene	--	a	T	--	T	--	a
tetrachloroethylene	--	a	--	--	T	--	a
toluene	--	a	--	--	1	--	a
Base/Neutrals							
naphthalene	--	a	--	--	.4	--	<10
anthracene/phenanthrene	--	15	--	--	--	--	a
butylbenzyl phthalate	--	a	--	--	6.1	--	a
Acid Extractables							
phenol	--	a	--	--	--	--	<10
Pesticides	--	--	--	--	--	--	--
Miscellaneous							
cyanide		5		<5		5	5

-- = 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 ug/L in most cases)

Table 14. City Waterway: Organic Priority Pollutant Loads (pounds/day).

Discharge	Drain at Head of Wheeler-Osgood		East Drain Head of Waterway		West Drain Head of Waterway		15th Street Drain
Date Sampled	7/28/81	3/29/82	7/28/81	2/16/82	7/28/81	2/16/82	4/28/82
Volatiles							
chloroform	--	--	--	--	.055	--	.0058*
trichloroethylene	--	--	.011*	--	.0061*	--	--
tetrachloroethylene	--	--	--	--	.0061*	--	--
toluene	--	--	--	--	.010	--	--
Base/Neutrals							
naphthalene	--	--	--	--	.0049*	--	.0058*
anthracene/phenanthrene	--	.079	--	--	--	--	--
butylbenzyl phthalate	--	--	--	--	.075	--	--
Acid Extractables							
phenol	--	--	--	--	--	--	.0058*
Pesticides	--	--	--	--	--	--	--
Miscellaneous							
cyanide		.026		.23*		.44	.0058

-- = Not detected
* = Calculated using 1/2 quantification limit

Table 15. City Waterway: Sediment Sites.

Station Code	Original Agency Code	Collector	Analysis By	Location Name	Latitude 47°	Longitude 122°	Date Collected
*CI-1	I-4	DOE	EPA/DOE[a]	Head of City Waterway	14' 32"	25' 52"	7/30/81
*C-WI-1	I-5	"	" "	Head of Wheeler-Osgood	15' 04"	25' 30"	7/30/81
†CS-1	2	EPA	" "	Head of City Waterway	14' 32"	25' 51"	8/03/81
CS-2	CII	"	EPA-New[b]	City Waterway off Wheeler-Osgood Entrance	15' 06"	25' 54"	5/13/81
†C-WS-1	CI	EPA	EPA-New	Wheeler-Osgood	15' 06"	25' 44"	5/13/81
CS-3	5-09031	NOAA	NOAA[c]	City Waterway North of 11th Street	15' 25"	26' 00"	1979
"	"	"	"	" " " " " "	15' 25"	26' 00"	1980
"	"	"	"	" " " " " "	15' 25"	26' 00"	1981
CS-4	A-I	EPA	EPA-New	City Waterway Entrance	15' 41"	26' 10"	5/13/81

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

[b]USEPA - Newport laboratory

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

*CI-1, C-WI-1 = intertidal samples
†CS-1, C-WS-1, etc. = subtidal samples

Table 16. City Waterway: Sediment[†] Priority Pollutant Concentrations (mg/Kg dry weight).

	Intertidal		Subtidal						
Station Code	CI-1	C-WI-1	CS-1	CS-2	C-WS-1	CS-3	CS-3	CS-3	CS-4
Agency Responsible for Analysis	EPA/DOE	EPA/DOE	EPA/DOE	EPA-New	EPA-New	NOAA	NOAA	NOAA	EPA-New
Original Agency Code	I-4	I-5	2	C-II	C-I	5-09031	5-09031	5-09031	A-I
Miles from Head of WW	.03	.02	.04	.60	.12	.92	.92	.92	1.23
Year Collected	1981	1981	1981	1981	1981	1979	1980	1981	1981
Percent Solids	53	41	37	42.3	28.0	41	42.1	44	68.6
Metals									
As	46	36	28	63	39		55	38	18
Cd	2.0	3.8	5.5	8.2	10.7	(9.09)	.50	3.2	.28
Cr	34	33	26	45.1	34.7	46.5	45.7	59	13.2
Cu	220	320	280	276	196	178	174	190	38
Hg	.35	.21	.34			1.03	.62	.97	
Ni	36	36	32			33.3			
Pb	600	290	820	225	149	269	174	270	25
Sb	6.2	14	5.0			44.0			
Zn	270	620	410	742	637	224	267	240	60
Volatiles	--	--	--						
Base/Neutrals									
hexachlorobenzene	--	--	--	--	--	.003	.0082	.0032	.057
hexachlorobutadiene	--	--	--	--	--	.002	.0058	.0032	.236
naphthalene	T	--	--	.372	.65	4.0	.58	.98	.143
acenaphthene	T	--	.2			.71	.10	.15	
acenaphthalene	T	--	--			.31	.10		
anthracene/phenanthrene	1.5	.26	1.7	1.278	4.881	7.0	.47	2.09	.192
fluorene	T	--	.24	.133	.375	.81	.18	.29	T
pyrene	2.1	T	1.3	6.02*	15.45*	10.0	1.8	3.9	.57*
chrysene/benzo(a)anthracene	1.3	--	.96	.985	7.431	8.5	2.67	2.29	.347
fluoranthene	2.2	.25	1.4			6.1	1.2	2.2	
benzo(a)pyrene	1.3	--	1.1			2.6	.65	.83	
benzo(k)fluoranthene/ 3,4-benzofluoranthene	1.1	--	1.1			6.6**	1.3**		
benzo(g,h,i)perylene	T	--	--						
ideno(1,2,3-cd)pyrene	T	--	--			1.3	.35		
dimethyl phthalate	--	--	--	.063	--				T
diethyl phthalate	--	--	--	--	--				.065
di-n-butyl pnthalate	--	--	T	.154	.357				.15
di-n-octyl pnthalate	--	--	.58	1.1	.357				1.7
bis(2-ethylhexyl) phthalate	2.6	1.4	9.6	7.7	9.08				.372
butylbenzyl phthalate	--	--	.86	.78	.857				.155
Acid Extractables									
phenol	--	T	--						
Pesticides and PCBs									
4,4'-DDD	--	--	--	--	--	.030	.030	.016	--
4,4'-DDE	--	--	--	--	T	.005	.0077	--	--
4,4'-DDT	--	--	--	T	T	.020	.003	.0094	--
total DDT forms	--	--	--	T	T	.077	.046	.025	--
PCB-1254	--	--		T	T				--
PCB-1260	--	.06		--	--				--
total PCBs	--	.06	.08	T	T	.381	.647	.292	--

† = All data represent samples obtained from the top 2-5 cm of sediment
-- = None detected
* = Pyrene + fluoranthene
** = Benzofluoranthenes
T = Trace amounts
( ) = Value questionable - included, but not used for any calculations

Table 17. Summary of City Waterway Sediment Priority Pollutant Data (mg/Kg, dry weight).

Constituent	Intertidal Sediments		Subtidal Sediments		
	Minimum	Maximum	Minimum	Maximum	Median
Metals*					
As	36	46	18	63	37
Cd	2.0	3.8	.28	10.7	4.4
Cr	33	34	13.2	59	35
Cu	220	320	38	280	190
Hg	.21	.35	.34	1.03	.80
Ni	36	36	32	33.3	33
Pb	290	600	25	820	225
Zn	270	620	60	742	267
Base/Neutrals					
hexachlorobenzene	--	--	--	.057	(.003)
hexachlorobutadiene	--	--	--	.236	(.0045)
naphthalene	--	T	--	4.0	.58
acenaphthene	--	T	.1	.71	.17
acenaphthalene	--	T	--	.31	(.2)
anthracene/phenanthrene	.26	1.5	.192	7.0	1.7
fluorene	--	T	T	.81	.24
pyrene	T	2.1	<.57	10	(2.8)
chrysene/benzo(a)anthracene	--	1.3	.347	8.5	2.3
fluoranthene	.25	2.2	1.2	6.1	1.8
benzo(a)pyrene	--	1.3	.65	2.6	1.0
benzo(k)fluoranthene/ 3,4-benzofluoranthene	--	1.1	1.1	6.6	1.3
benzo(g,h,i)perylene	--	T	--	--	I
ideno(1,2,3-cd)pyrene	--	T	--	1.3	(.35)
dimethyl phthalate	--	--	--	.063	--
diethyl phthalate	--	--	--	.085	--
di-n-butyl phthalate	--	--	T	.357	.15
di-n-octyl phthalate	--	--	.357	1.7	.8
bis(2-ethylhexyl) phthalate	1.4	2.6	.372	9.6	7
butylbenzl phthalate	--	--	.155	.86	.7
Acid Extractables					
phenol	--	T	--	--	I
Pesticides and PCBs					
4,4'-DDD	--	--	--	.030	(.025)
4,4'-DDE	--	--	--	.0077	(.005)
4,4'-DDT	--	--	--	.020	(.01)
total DDT forms	--	--	--	.077	(.046)
PCB-1254	--	--	--	T	--
PCB-1260	--	.06	--	--	--
total PCBs	--	.06	T	.647	(.3)

T = Trace amount
I = Insufficient data
-- = None detected
( ) = Estimated median
* = Strong acid digestion data only

Table 18. Blair Waterway: Metals Concentrations in Point Source Discharges (μg/L, total metal).

Discharge	Date Sampled	Time Sampled	Investigator	Sample Number	Station Number	Flow (MGD)	As	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Zn
Seepage at Zidell	9/24/80	1015	EPA	38311	28		66	<.2	170	397	1.5	193	100	<2	650
Seepage East of Zidell	9/24/80	1040	EPA	38312	29		36	<.2	58	136	.63	47	44	<2	220
Surface Drain at Domtar	9/24/80	1100	EPA	38314	30		10	<.2	3	19	.21	20	61	5	30
Lincoln Avenue Drain, North Shore	6/3/80	1645	EPA	22308	31		190	.6	4	85	.45	17	17	14	50
"	9/24/80	1115	EPA	38214	31		75	<.2	6	19	.35	21	25	<2	40
"	4/21/81	1210-1415	WDOE		31	.88	282	13.8	100	37	.28	135	134		228
"	3/29/82	1245-1500	WDOE		31		94	8	10	20	<.20	100	170		55
Wapato Creek	6/3/80	1405	EPA	22311	32		3	.1	4	8	.68	8	12	2	30
"	3/29/82	1115-1410	WDOE		32	2.02	66	<2	<10	30	.46	30	<20		43
Drain at West Corner, Turning Basin	6/3/80	1415	EPA	22310	33		6	.3	4	35	.68	38	10	2	60
	8/17/81	1130-1400	WDOE		33	.51	100	<5	<10	10	.32	<10	<50		15
"	3/29/82	1210-1420	WDOE		33	3.10	12	<2	<10	10	<.20	<20	<20		80
Murray Pacific Drainage	9/24/80	1145	EPA	38318	34		66,000	3.2	12	496	.49	221	640	189	1,780
Lincoln Avenue Drain, South Shore	6/3/80	1440	EPA	22309	35		75	.2	43	21	.45	22	35	8	85
"	9/24/80	1135	EPA	38317	35		60	<.2	12	14	.21	12	8	<2	40
"	5/5/81	1100-1400	WDOE		35	.90	46	<5	<10	7	<.2	<50	<14		50
"	3/29/82	1220-1530	WDOE		35	2.69	850	<2	<10	50	<.20	<20	100		170
Surface Runoff at Stauffer	9/24/80	1115	EPA	38315	36		36	<.2	4	19	.21	43	58	5	70

Table 19. Blair Waterway: Metals Loads Based on WDOE Data Collected April 1981 - March 1982 (pounds/day).

Discharge	Date Sampled	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Lincoln Avenue Drain, North Shore	4/21/81	2.1	0.10	0.74	0.27	0.0021	1.0	1.0	1.7
Wapato Creek	3/29/82	1.1	--	--	.51	.0078	.51	--	.73
Drain at West Corner of Turning Basin	8/17/81	.43	--	--	.043	.0014	--	--	.064
"	3/29/82	.31	--	--	.26	--	--	--	2.1
Lincoln Avenue Drain, South Shore	5/5/81	.35	--	--	.053	--	--	--	.38
"	3/29/82	19	--	--	1.1	--	--	2.2	3.8
Sum of loads to Blair Waterway[1]		4.0	0.1	0.74	0.88	.011	1.5	1.0	2.9
Sum of loads to Blair Waterway[2]		23	.10	.74	2.1	.0093	1.5	3.2	8.3

[1]Calculated using August Turning Basin Drain data and May south Lincoln Drain data (dry weather).

[2]Calculated using March data for Turning Basin and south Lincoln drain (wet weather).

Table 20. Blair Waterway: Organic Priority Pollutant Concentrations in Point Source Discharges (μg/L).

Discharge	Seepage at Zidell	Seepage E. of Zidell	Surface Drain at Dortar	Lincoln Avenue Drain, North Shore				Wapato Creek		Drain at West Corner of Turning Basin			Murray Pacific Drainage	Lincoln Avenue Drain, South Shore				[illegible]
Date Sampled	9/24/80	9/24/80	9/24/80	6/3/80	9/24/80	4/21/81	3/29/82	6/3/80	3/29/82	6/3/80	8/17/81	3/29/82	9/24/80	6/3/80	9/24/80	5/5/81	3/29/82	[illegible]
Time Sampled	1015	1040	1100	1645	1115	1210-1415	1245-1500	1405	1115-1410	1415	1130-1400	1210-1420	1145	1440	1135	1100-1400	1220-1530	1115
Investigator	EPA	EPA	EPA	EPA	EPA	WDOE	WDOE	EPA	WDOE	EPA	WDOE	WDOE	EPA	EPA	EPA	WDOE	WDOE	EPA
Sample Number	38311	38312	38314	22308	38214	18J-13/14	J1337	22311	J1335	22310	33761	J1336	38318	22309	38317	19751	J1334	38315
Station Number	28	29	30			31			32		33		34			35		36
Flow (MGD)						.88			2.02		.51	3.10				.90	2.69	
Volatiles																		
chloroform	--	--	--	1.8	--	--	a	--	<10	--	--	a	--	5.7	7.6	1.3	a	--
chlorodibromomethane	--	--	--	--	--	--	a	--	a	--	--	a	--	1.5	--	--	a	--
1,1-dichloroethane	--	--	--	--	--	--	a	--	a	--	--	a	--	--	3.4	1.1	a	--
1,2-dichloroethane	--	--	--	--	--	--	a	--	a	--	--	a	--	T	1.9	--	a	--
1,2-trans-dichloroethylene	--	--	--	--	--	8	<10	--	a	--	--	<10	--	T	1.4	0.7	a	--
1,1,1-trichloroethane	--	--	--	--	--	3	a	--	a	--	--	a	--	18	3.7	2.4	<10	--
trichloroethylene	--	--	--	T	--	--	<10	--	a	--	--	a	--	4.4	.5	--	a	--
1,1,2,2-tetrachloroethane	--	--	--	--	--	--	a	--	a	--	--	a	--	--	2.3	--	a	--
tetrachloroethylene	--	--	--	--	--	--	a	--	a	--	--	a	--	6	.6	--	a	--
toluene	--	--	--	--	--	3	a	--	a	--	--	a	--	--	.5	--	a	--
benzene	--	--	--	--	--	--	a	72	a	--	--	a	--	1260	--	--	a	--
Base Neutrals																		
naphthalene	--	2.9	--	--	--	--	a	--	a	--	0.3	a	--	--	--	--	a	--
fluorene	--	--	--	--	--	--	a	--	a	--	--	a	--	--	--	--	<10	--
hexachloroethane	--	--	--	--	--	--	a	--	a	--	--	a	--	T	--	--	a	--
chlorobenzene	--	--	--	--	--	--	a	--	a	--	--	a	--	--	7.1	--	a	--
1,2-dichlorobenzene	--	--	--	--	--	--	a	T	a	--	--	a	--	--	6	5.5	<10	--
1,4-dichlorobenzene	--	--	--	--	--	--	a	--	a	--	--	a	--	--	--	1.6	a	--
hexachlorobenzene	--	--	--	T	--	--	a	--	a	--	--	a	--	--	--	--	a	--
bis(2-ethylhexyl) phthalate						--	a		a		--	a			8	--	a	
diethyl phthalate						--	a		a		--	a			2	--	a	
Acid Extractables																		
pentachlorophenol						37	a		a		--	a			--	3.8	<10	
Pesticides																		
aldrin						--	--		--		--	--				T	--	
α-BHC						--	--		--		--	--				T	--	
Miscellaneous																		
cyanide						--	<5		8		--	8					10	

-- = 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 21. Blair Waterway: Priority Pollutants in Discharges to the Lincoln Avenue Drainages (μg/L).

	North Lincoln Drain to Blair		South Lincoln Drain to Blair	
Discharge	Reichhold Storm Drain Effluent		U.S. Oil Effluent	Sewer Discharge to Lincoln Drain Downstream of U.S. Oil Outfall
Date Sampled	4/21-22/81	3/29/82	5/5/81	5/5/81
Time Sampled	1415-1415	1230-1600	1020-1600	1215-1545
Flow (MGD)	no discharge	0.045	.238	.577
Metals				
As	<5	7	<16	<16
Cd	12	<5	<2	<2
Cr	130	<10	45	10
Cu	36	10	10	5
Hg	.4	0.76	.43	<.2
Ni	86	80	<10	<10
Pb		150	15	<14
Zn	85	200	125	70
*Mo	1,800			
Volatiles				
chloroform	2	--	--	3.9
chloroethylene	161	--	--	--
1,1-dichloroethane	--	--	--	2.0
1,2-trans-dichloroethylene	--	T	--	1.1
1,1,1-trichloroethane	8	T	--	6.0
trichloroethylene	232	66	--	--
tetrachloroethylene	422	--	--	2.2
toluene	3	--	--	1.1
dichlorofluoromethane	T	--	--	--
trichlorofluoromethane	320	10	--	--
Base/Neutrals				
1,4-dichlorobenzene	--		--	0.9
naphthalene	--		--	9.7
Acid Extractables				
phenol	28	220	--	--
2-chlorophenol	68	30	--	--
2,4-dichlorophenol	25	T	--	--
2,4,6-trichlorophenol	15	T	--	--
pentachlorophenol	182	26	--	3.0
*4-chlorophenol	T	--		
*2,3,4,6-tetrachlorophenol	T	--		
*2,4-bis(1,1-dimethyl ethyl) phenol	--	--		
*3-(1,1-dimethyl ethyl) phenol	T	--		
Pesticides				
aldrin	--		--	.4**
α-BHC	--		--	.1**
Miscellaneous				
cyanide	<5		--	--
*formaldehyde	.6; 19.7	38 mg/L		

-- = not detected
T = Trace; value is greater than the limit of detection but less than the limit of quantification
* = not a priority pollutant
** = value not confirmed by mass spectrophotometer

Table 22. Blair Waterway: Organic Priority Pollutant Loads Based on WDOE Data Collected April 1981 - March 1982 (pounds/day).

Discharge Date Sampled	Lincoln Avenue Drain, North Shore 4/21/81	Wapato Creek 3/28/82	Drain at West Corner of Turning Basin 8/17/81	 3/28/82	Lincoln Avenue Drain, South Shore 5/5/81	 3/29/82	Sum of Loads to Blair Waterway[1]
Volatiles							
chloroform	--	.084*	--	--	.0098	--	.094
1,1-dichloroethane	--	--	--	--	.0083	--	.0083
1,2-trans-dichloroethylene	.059	--	--	.13*	.0053	--	.064
1,1,1-trichloroethane	.022	--	--	--	.018	.11*	.040
toluene	.022	--	--	--	--	--	.022
Base/Neutrals							
napthalene	--	--	.0013		--	--	.0013
fluorene	--	--	--	--	--	.11*	--
1,2-dichlorobenzene	--	--	--	--	.041	.11*	.041
1,4-dichlorobenzene	--	--	--	--	.012	--	.012
Acid Extractables							
pentachlorophenol	.27	--	--	--	.029	.11*	.30
Pesticides							
aldrin	--	--	--	--	.0038*	--	.0038
α-BHC	--	--	--	--	.038*	--	.038
Miscellaneous							
cyanide	--	.13	--	.21		.22	.13

[1] Calculated using dry flow (August and May) data only for Turning Basin and South Lincoln drains
-- = Not detected
* = Calculated using 1/2 quantification limit

Table 23. Blair Waterway: Sediment Sites.

Station Code	Original Agency Code	Collector	Analysis By	Location Name	Latitude 47°	Longitude 122°	Date Collected
*BS-1	A-7	EPA[a]	EPA-New[b]	Blair Waterway at turning basin	15' 23"	22' 43"	5/13/81
BS-2	10	BNW[c]	BNW	Blair Waterway at turning basin	15' 25"	22' 49"	1980
BS-3	14-09040	NOAA[d]	NOAA	Blair Waterway	15' 45"	23' 10"	1979
BS-3	14-09040	NOAA	NOAA	Blair Waterway	15' 45"	23' 10"	1980
BS-4	17	EPA/DOE[e]	EPA/DOE[f]	Blair Waterway near Lincoln Avenue	15' 50"	23' 22"	8/03/81
BS-5	A-6	EPA	EPA-New	Blair Waterway near Lincoln Avenue	15' 54"	23' 25"	5/13/81
+BI-6		DOE	EPA/DOE	Blair Waterway at Lincoln Drain, south shore	15' 54"	23' 30"	5/05/81
BI-6	I-12	DOE	EPA-Con[g]	Blair Waterway at Lincoln Drain, south shore	15' 54"	23' 30"	7/30/81
LB-SW-1		DOE	DOE	Lincon Avenue Drain at U.S. Oil Outfall	15' 39"	23' 49"	5/05/81
LB-SW-2		DOE	DOE	Lincoln Avenue Drain near Milwaukee Road	15' 22"	24' 13"	5/05/81
LB-NE-1		DOE	EPA	Lincoln Drain N side of Blair	16' 00"	23' 24"	4/21/81
LB-NE-1	I-14	DOE	EPA-Con	Lincoln Drain N side of Blair	16' 00"	23' 24"	7/30/81
BI-7		DOE	EPA	Blair Waterway at Lincoln Drain, north shore	15' 59"	21' 25"	4/21/81
BI-7	I-13	DOE	EPA-Con	Blair Waterway at Lincoln Drain, north shore	15' 59"	23' 25"	7/30/81
BS-8	9	BNW	BNW	Blair Waterway near Lincoln Avenue	15' 58"	23' 26"	1980
BI-9		DOE	EPA/DOE	Blair Waterway at Stauffer Chemical	15' 57"	23' 38"	9/14/81
BS-10	16	EPA	EPA-Con	Blair Waterway between 11th St. & Lincoln Avenue	16' 06"	23' 40"	8/03/81
BS-11	15	EPA	EPA-Con	Blair Waterway between 11th St. & Lincoln Avenue	16' 04"	23' 43"	8/03/81
BS-12	L-1	EPA	EPA-New	Blair Waterway east of 11th Street	16' 11"	23' 25"	5/12/81
BS-13	8	BNW	BNW	Blair Waterway west of 11th Street	16' 26"	24' 11"	1980
BS-14	3-09029	NOAA	NOAA	Blair Waterway, east 11th St. Bridge	16' 32"	24' 24"	1979
BS-14	3-09029	NOAA	NOAA	Blair Waterway, east 11th St. Bridge	16' 32"	24' 24"	1981
BS-15	12	EPA	EPA-Con	Blair Waterway mid-channel off second slip	16' 32"	24' 28"	8/03/81
BS-16	10	EPA/DOE	EPA/DOE	Blair Waterway near entrance	16' 43"	24' 39"	8/03/81
BS-17	9	EPA/DOE	EPA/DOE	Blair Waterway at entrance	16' 47"	24' 46"	8/03/81
BS-18	A-5	EPA	EPA-New	Blair Waterway at entrance	16' 47"	24' 47"	5/13/81

[a]USEPA (Schwartz)

[b]USEPA - Newport laboratory

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

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

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

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

[g]USEPA - contract laboratory

*BS = Blair, Subtidal

+BI = Blair, Intertidal

Table 24. Blair Waterway: Intertidal (and source-related) Surface† Sediment Priority Pollutant Concentrations (mg/Kg dry weight).

Station Code	BI-6		L/B-SW-1	L/B-SW-2	L/B-NE-1		BI-7		BI-9
Agency Responsible for Analysis	EPA/DOE	EPA/Con	DOE	DOE	EPA	EPA-Con	EPA	EPA-Con	EPA/DOE
Original Agency Code		I-12				I-14		I-13	
Miles from Head of WW	1.03	1.03	1.03	1.03	1.05	1.06	1.06	1.06	1.15
Year Collected	1981	1981	1981	1981	1981	1981	1981	1981	1981
Percent Solids	44.9	61.3	67.5	27.3	36.3	44.8	36.3	73.1	61.3
Metals									
As	530	[15.0]	<5	890		[150.0]		[4.4]	
Cd	1.5	[<.2]	.68	6.3		[<.2]		[<.14]	.3
Cr	53	[3.3]	12	150		[<2]		[<1.4]	16
Cu	200	[15.0]	22	850		[25.0]		[<7]	37
Hg	.43	[<.03]	.14			[<.04]		[<.03]	<.1
Ni	24	[<7]	12	89		[<9]		[<6]	11
Pb	210	[11.0]	22	340		[56.0]		[<10]	21
Zn	400	[51.0]	150	740		[98.0]		[<19]	68
Volatiles									
toluene	--	--			.005	--	--	--	--
1,1-dichloroethane	--	--			.003	--	--	--	--
Base/Neutrals									
1,2-dichlorobenzene	.12	a			--	a	--	a	--
1,4-dichlorobenzene	.04	a			--	a	--	a	--
napthalene	--	a			--	a	--	a	.049
anthracene/phenanthrene	--	a			--	a	--	a	.39
pyrene	--	a			--	a	--	a	.49
chrysene/benzo(a)anthracene	--	a			--	a	--	a	.73
fluoranthene	--	a			--	a	--	a	.65
benzo(a)pyrene	--	a			--	a	--	a	.098
benzo(k)fluoranthene/ 3,4 benzofluoranthene	--	a			--	a	--	a	.65
benzo(g,h,i)perylene	--	a			--	a	--	a	.049
ideno(1,2,3-cd)pyrene	--	a			--	a	--	a	.049
diethyl phthalate	--	a			--	a	1.9	a	
butylbenzyl phthalate	--	a			--	a	--	a	2.5
di-n-octyl phthalate	--	a			--	a	--	a	1.6
bis(2-ethylhexyl) phthalate	22.0	a			5.7	a	1.5	a	--
Acid Extractables	--	a			--	a	--	a	--
Pesticides and PCBs									
α-BHC	T	--			--	--	--	--	--
γ-BHC (Lindane)	T	--			.0066	--	.0025	--	--
PCB-1248	--	--			--	.74	--	--	--
total PCBs	--	--			--	.74	--	--	--

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

Table [illegible]. Blair Waterway: Subtidal Surface† Sediment Priority Pollutant Concentrations (mg/Kg dry weight).

Station Code	BS-1	BS-2	BS-3		BS-4	BS-5	BS-8	BS-10	BS-11	BS-12	BS-13	BS-14		BS-15	BS-16	BS-17	BS-18
Agency Responsible for Analysis	EPA-New	BNW	NOAA	NOAA	EPA/DOE	EPA-New	BNW	EPA-Con	EPA-Con	EPA-New	BNW	NOAA	NOAA	EPA-Con	EPA/DOE	EPA/DOE	EPA-New
Original Agency Code	A-7	10	14-09040	14-09040	17	A-6	9	16	15	L-1	8	14-09029	14-09029	12	10	9	A-5
Miles from Head of WW	.14	.18	.73	.73	.93	.99	1.07	1.29	1.30	1.50	1.85	2.06	2.06	2.09	2.33	2.44	2.47
Year Collected	1981	1980	1979	1980	1981	1981	1980	1981	1981	1981	1980	1979	1981	1981	1981	1981	1981
Percent Solids	74.9		56	51.7	49	50.4		56.3	49.4	50.6		59	47	[illegible]	58	65	69
Metals																	
As	11			46.4	53	75		[14.0]	[15.0]	77			60	[3.5]	28	28	24
Cd	.13		(6.02)	.657	.45	.34		[<.2]	[<.2]	.36		(5.45)	<.10	[.2]	.48	.34	.26
Cr	10.2		29.5	17.6	18	22.6		[25.0]	[3.60]	28		27.9	29	[illegible]	12	8.8	14.3
Cu	13		69.9	52.6	82	72		[44.0]	[49.0]	106		59.6	74	[19]	65	38	37
Hg			.157	<.077	.16			[<.04]	[<.04]			.132	.26	[<.04]	.14	<.1	
Ni			22.4		15			[9.2]	[18.0]			21.1		[6]	12	11	
Pb	6		49	62.9	65	69		[28.0]	[39.0]	74		42.5	49	[13.0]	46	25	19
Zn	28		92.2	87.0	96	132		[50.0]	[83]	132		75.4	93	[43.0]	72	45	50
Volatiles					--			--	--								
Base Neutrals																	
hexachlorobenzene	--		.002	.002	--	--		a	a	--		.003	.0023	a	--	--	--
hexachlorobutadiene	--	--	.002	.0025	--	.228	--	a	a	--	--	.006	.0044	a	--	--	--
naphthalene	--	.026	.060	.032	--	T	.154	a	a	.050	2.434	.440	.140	a	--	--	.313
acenaphthene			.010	.006	--			a	a			.090	.028	a	--	--	
acenaphthalene			.001	.0044	--			a	a			.030	.023	a	--	--	
anthracene/phenanthrene	--	.213	.17	.16	T	.147	.874	a	a	.39	.295	.80	.38	a	T	--	.557
fluorene	--	.019	.007	.020	--	.022	.111	a	a	.078	.094	.080	.042	a	--	--	.061
pyrene	.048*	.228	.190	.230	T	.540*	.553	a	a	.860*	.231	.870	.460	a	--	--	2.960*
chrysene/benzo(a)anthracene	.029	.493	.44	.69	--	.515	1.60	a	a	.582	.405	1.46	.53		--	--	.643
fluoranthene		.363	.230	.240	T		1.15	a	a		.036	.900	.370	a	--	--	
benzo(a)pyrene		.147	.060	.110	--		.159	a	a		.525	.190	.150	a	--	--	
benzo(k)fluoranthene/ 3,4-benzofluoranthene			.250	.360	T			a	a			.720	.550	a	--	--	
perylene		.081	.100	.300	--		.278				.221	.220	.098				
indeno(1,2,3-cd)pyrene			.070	.070	--			a	a			.180	.064	a	--	--	
diethyl phthalate	.092				--	--		a	a	--				a	--	--	--
bis(2-ethylhexyl) phthalate	.290				.38	1.725		a	a	1.07				a	.48	T	.578
butylbenzyl phthalate	--				--	.180		a	a	.079				a	--	--	--
di-n-butyl phthalate	.091				--	.107		a	a	--				a	--	--	.110
dimethyl phthalate	--				--	T		a	a	.009				a	--	--	--
di-n-octyl phthalate	--				--	--		a	a	T				a	--	--	.426
Acid Extractables					--			a	a					a	--	--	
Pesticides and PCBs																	
γ-chlordane			.003	--	--			--	--			.0001	.00017	--	--	--	
4,4'-DDD	--		.002	.0011	--	--		--	--	--		.006	.0014	--	--	--	--
4,4'-DDE	--		.0002	.0029	--	--		--	--	--		.001	.00042	--	--	--	--
4,4'-DDT	--		.002	.0029	--	--		--	--	--		.003	.0016	--	--	--	--
total DDT forms	--		.0053	.0098	--	--		--	--	--		.0134	.0034	--	--	--	--
PCB-1242	--				--	T		--	--	--				--	--	--	--
PCB-1248	T				--	--		--	--	--				--	--	--	--
total PCBs	T	.025	.035	.059	.03	T	.128	--	--	--	.021	.0223	.0541	--	--	--	--

† = All data represent samples obtained from the top 2-5 cm of sediment
* = Pyrene + fluoranthene
a = Not detected, but detection levels too high to be useful
T = Trace amount
-- = Not detected
[ ] = Weak acid digestion (0.1 N nitric acid w/5 wet g. of sediment)
( ) = Because it appears these data may be anomalous, they were not used for graphical or statistical interpretation

Table 26. Summary of Blair Waterway Sediment Priority Pollutant 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
Metals*					
As	<5	890	11	77	53
Cd	.3	6.3	<.10	.66	.34
Cr	12	150	8.8	29.5	18
Cu	22	850	13	106	70
Hg	<.1	.43	<.077	.26	.16
Ni	11	89	11	22.4	15
Pb	21	340	6	74	49
Zn	68	740	28	132	87
Volatiles					
toluene	--	.006	--	--	--
1,1-dichloroethane	--	.003	--	--	--
Base/Neutrals					
1,2-dichlorobenzene	--	.12	--	--	--
1,4-dichlorobenzene	--	.04	--	--	--
hexachlorobenzene	--	--	--	.003	(.0025)
hexachlorobutadiene	--	--	--	.228	(.003)
naphthalene	--	.049	--	2.434	.055
acenaphthene	--	--	--	.090	(.02)
acenaphthalene	--	--	--	.030	(.004)
anthracene/phenanthrene	--	.39	--	.874	.2
fluorene	--	--	--	.111	.05
pyrene	--	.49	--	.870	.23
chrysene/benzo(a)anthracene	--	.73	--	1.6	.47
fluoranthene	--	.65	--	1.15	.24
benzo(a)pyrene	--	.098	--	.525	.13
benzo(k)fluoranthene/ 3,4-benzo fluoranthene	--	.65	--	.72	.45
perylene	--	--	--	.30	.15
ideno(1,2,3-cd)pyrene	--	.049	--	.18	.07
diethyl phthalate	--	1.9	--	.092	--
bis(2-ethylhexyl) phthalate	--	22	T	1.725	.48
butylbenzyl phthalate	--	2.5	--	.18	--
di-n-butyl phthalate	--	--	--	.11	--
dimethyl phthalate	--	--	--	.009	--
di-n-octyl phthalate	--	1.6	--	.246	--
Pesticides and PCBs					
α-chlordane	--	--	--	.003	.00017
α-BHC	--	T	--	--	--
γ-BHC (Lindane)	--	.0066	--	--	--
4,4'-DDD	--	--	--	.006	.0017
4,4'-DDE	--	--	--	.0029	.0007
4,4'-DDT	--	--	--	.003	.0025
total DDT forms	--	--	--	.0134	.0075
PCB-1242	--	--	--	T	--
PCB-1248	--	.74	--	T	--
total PCBs	--	.74	--	.128	(.02)

* = Strong acid digestion data only
-- = None detected
T = Trace amount
( ) = Estimated median

Table 27. Sitcum Waterway: Metal and Organic Priority Pollutants in Point Source Discharges (ug/L).

Discharge	North Corner Drain		South Corner Drain	
Date Sampled	7/28/81	3/29/82	7/28/81	3/29/82
Time Sampled	0850-1040	1230-1600	0910-1100	1240-1600
Investigator	WDOE	WDOE	WDOE	WDOE
Sample Number	30108	J1344	30109	J1345
I.D. Number	37		38	
Flow (MGD)	(.15)	.72	(.020)	.086
Metals				
As		100		10
Cd		<2		<2
Cr		<10		<10
Cu		30		<10
Hg		<.20		<.20
Ni		<20		<20
Pb		70		20
Zn		180		39
Volatiles				
chloroform	3.8	<10	--	--
dichlorobromomethane	--	a	--	--
chlorodibromomethane	--	a	--	--
trichlorofluoromethane	--	a	--	--
1,1,1-trichloroethane	34	42	--	--
trichloroethylene	11	a	--	--
tetrachloroethylene	8.4	<10	--	--
1,1,2,2-tetrachloroethane	2.2	a	--	--
toluene	--	a	--	--
Base/Neutrals	--	--	--	--
Acid Extractables				
phenol	--	<10	--	--
pentachlorophenol	--	<10	--	--
Pesticides and PCBs	--	--	--	--
Miscellaneous				
cyanide		5		5

( ) = Estimated
-- = Not detected
a = Not detected, but detection limit high relative to other analyses

Table 28. Sitcum Waterway: Metal and Organic Priority Pollutant Loads Based on WDOE Data Collected July 1981 and March 1982 (pounds/day).

Discharge	North Corner Drain		South Corner Drain	
Date Sampled	7/28/81	3/29/82	7/28/81	3/29/82
Metals				
As		.60		.007
Cd		--		--
Cr		--		--
Cu		.18		--
Hg		--		--
Ni		--		--
Pb		.42		.014
Zn		1.1		.028
Volatiles				
chloroform	(.0048)	.030	--	--
dichlorobromomethane	--	--	--	--
chlorodibromomethane	--	--	--	--
trichlorofluoromethane	--	--	--	--
1,1,1-trichloroethane	(.043)	.25	--	--
trichloroethylene	(.014)	--	--	--
tetrachloroethylene	(.011)	.030*	--	--
1,1,2,2-tetrachloroethane	(.0028)	--	--	--
toluene	--	--	--	--
Base/Neutrals	--	--	--	--
Acid Extractables				
phenol	--	.030*	--	--
pentachlorophenol	--	.030*	--	--
Pesticides and PCBs	--	--	--	--
Miscellaneous				
cyanide		.030		.0036

( ) = Calculated using an estimated flow
-- = Not detected
* = Calculated using 1/2 quantification limit

Table 29. Sitcum Waterway: Sediment Sites.

Station Code	Original Agency Code	Collector	Analysis By	Location Name	Latitude (47°)	Longitude (122°)	Date Collected
STI-1	I-9	DOE	EPA/DOE	North Corner Sitcum Waterway	15' 58"	24' 38"	7/31/81
STI-2	I-10	DOE	"	South " " "	15' 54"	24' 45"	7/31/81
STI-3	I-11	DOE	"	South Side Sitcum Waterway Entrance	16' 14"	25' 07"	7/31/81
STS-1	15-09043	NOAA	NOAA	Head of Sitcum Waterway, Middle	15' 58"	24' 43"	1980
STS-2	8	EPA	EPA/DOE	" " " " , North Side	16' 00"	24' 42"	8/03/81
STS-3	7	"	"	" " " " , South Side	15' 58"	24' 46"	8/03/81
STS-4	SI	EPA	EPA-New	" " " " , North Side	15' 59"	24' 43"	5/12/81
STS-5	6	EPA	EPA/DOE	Middle of Sitcum Waterway, North Side	16' 06"	24' 50"	8/03/81
STS-6	5	EPA	EPA/DOE	" " " " , South Side	16' 04"	24' 55"	8/03/81
STS-7	4-09030	NOAA	NOAA	Inside Sitcum Waterway Entrance, Middle	16' 13"	25' 02"	1979;1981
STS-8	4	EPA	EPA/DOE	" " " " , North Side	16' 16"	25' 02"	8/03/81
STS-9	3	EPA	EPA/DOE	" " " " , South Side	16' 14"	25' 06"	8/03/81
STS-10	A-4	EPA	EPA-New	At Sitcum Waterway Entrance	16' 17"	25' 06"	5/13/81

Table 30. Sitcum Waterway: Sediment[†] Priority Pollutant Concentrations (mg/Kg, dry weight).

	Intertidal			Subtidal										
Station Code	STI-1	STI-2	STI-3	STS-1	STS-2	STS-3	STS-4	STS-5	STS-6	STS-7		STS-8	STS-9	STS-10
Agency Responsible for Analysis	EPA/DOE	EPA/DOE	EPA/DOE	NOAA	EPA/DOE	EPA/DOE	EPA-New	EPA/DOE	EPA/DOE	NOAA		EPA/DOE	EPA/DOE	EPA-New
Original Agency Code	I-9	I-10	I-11	15-09043	8	7	SI	6	5	4-09030		4	3	A-4
Miles from Head of Waterway	.01	.02	.40	.04	.05	.05	.08	.20	.20	.41		.45	.45	.51
Year Collected	1981	1981	1981	1980	1981	1981	1981	1981	1981	1979	1981	1981	1981	1981
Percent Solids	61	74	73	49.5	54	52	54.0	58	70	56	56	55	72	61.0
Metals														
As	90	140	40	444	200	160	238	170	180	472	89	65	23	57
Cd	6.8	1.6	.37	6.5	6.7	4.4	6.9	7.0	1.8	(16.2)	1.8	3.3	1.0	1.6
Cr	41	13	13	32.7	22	35	27.4	15	8.8	58.7	37	16	14	17.5
Cu	7000	310	110	764	740	360	531	680	340	1602	240	210	2100	139
Hg	.17	.11	<.1	.10	.79	.34		.63	.34	.492	.26	.27	.23	
Ni	51	22	11		20	21		16	9.8	36.1		16	13	
Pb	1900	490	68	416	450	320	791	820	430	793	340	620	210	251
Sb	5.6	4.1	3.8		6.2	5.6		7.2	4.5	(338)		7.0	5.0	
Zn	3200	670	130	1100	1100	500	1190	1300	570	1720	330	700	610	295
Volatiles	--	--	--	--	--	--		--	--			--	--	
Base/Neutrals														
hexachlorobenzene	--	--	--	.0083	--	--	--	--	--	.002	.0029	--	--	--
hexachlorobutadiene	--	--	--	.004	--	--	--	--	--	.002	.0022	--	--	--
naphthalene	--	--	--	.48	--	T	.170	--	--	.17	.410	--	.23	T
acenaphthene	--	--	--	.150	--	--		T	--	.10	.059	--	3.0	
acenaphthylene	--	--	--	.074	--	--		--	--	.02		--	--	
anthracene/phenanthrene	--	--	T	.352	.24	.56	.363	.64	.24	.49	.64	-	19	.205
fluorene	--	--	--	.14	--	--	.071	T	--	.080	.093	--	6	.025
pyrene	1.1	T	.5	.94	T	.5	2.090*	1.5	T	.32	.99	-	38	1.041*
chrysene/benzo(a) anthracene	.99	T	--	1.1	T	.27	.475	--	.3	.39	.62	.30	77	.456
fluoranthene	1.1	T	T	1.1	.24	.56		1.6	.34	.38	.83	.28	27	
benzo(a)pyrene	1.1	.25	T	.20	.3	--		1.2	.3	.070	.19	.38	230	
benzo(k)fluoranthene/ 3,4-benzofluoranthene	1.2	T	T	.530**	T	T		1.3	14	.20**		.42	94	
benzo(g,h,i)perylene	--	--	--		--	--		T	--			-	15	
ideno(1,2,3-cd)pyrene	T	--	--	.11	--	--		T	--	.060		-	11	
dimethyl phthalate	--	--	--		--	--	.009	--	--			--	--	--
diethyl phthalate	--	--	--		--	--	--	--	--			--	--	.093
di-n-octyl phthalate	--	--	--		--	--	T	--	--			--	--	.411
di-n-butyl phthalate	--	--	--		--	--	--	--	--			--	--	.164
butylbenzyl phthalate	--	--	--		--	--	.079	--	--			--	--	.080
bis(2-ethylhexyl) phthalate	.62	--	T		.28	.28	1.07	.2	.26			.26	--	.620
Acid Extractables														
phenol	.27	T	T	--	--	.38		--	--			--	--	
2-chlorophenol	--	--	--	--	--	.33		--	--			--	--	
pentachlorophenol	T	--	--	--	--	T		--	--			--	--	
p-chloro-m-cresol	--	--	--	--	--	.4		--	--			--	--	
4-nitrophenol	--	--	--	--	--	2.3		--	--			--	--	
Pesticides and PCBs														
aldrin	--	--	--	--	--	--		--	--	.002	--	--	--	
γ-BHC (Lindane)	--	--	--	.00038	--	--		--	--	--	--	--	--	
4,4'-DDD	--	--	--	.0073	--	--	--	--	--	.0009	.0032	--	--	--
4,4'-DDE	--	--	--	.0038	--	--	--	--	--	.0006	--	--	--	--
4,4'-DDT	--	--	--	.0066	--	--	--	--	--	.0003	.0023	--	--	--
total DDT forms	--	--	--	.023	--	--		--	--	.016	.0059	--	--	--
PCB-1260	--	--	--				--	--	--			--		--
total PCBs	.09	.04	T	.21	.06	.06	--	.03	--	--	.10	--	.12	--

† = All data represent samples obtained from the top 2-5 cm of sediment
-- = Not detected
* = Pyrene + fluoranthene
** = Benzofluoranthenes
T = Trace; value is greater than the limit of detection but less than the limit of quantification
( ) = Value questionable -- included, but not used in calculations

Table 31. Summary of Sitcum Waterway 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
Metals*					
As	40	140	23	472	170
Cd	.37	6.8	1.0	7.0	3.8
Cr	13	41	8.8	58.7	27.4
Cu	110	7,000	139	2,100	581
Hg	<0.1	.17	.10	.79	.34
Ni	11	51	9.8	35.1	16
Pb	68	1,900	210	793	450
Sb	3.8	5.6	4.5	7.2	5.8
Zn	130	3,200	295	1,720	700
Base/Neutrals					
hexachlorobenzene	--	--	--	.0083	(.003)
hexachlorobutadiene	--	--	--	.004	(.002)
naphthalene	--	--	--	.48	(.2)
acenaphthene	--	--	--	3.0	(.1)
acenaphthalene	--	--	--	.074	(.02)
anthracene/phenanthrene	--	T	T	19	.49
fluorene	--	--	--	6	.071
pyrene	T	1.1	T	38	1.0
chrysene/benzo(a)anthracene	--	.99	--	77	0.39
fluoranthene	T	1.1	.24	27	0.56
benzo(a)pyrene	T	1.1	--	230	0.30
benzo(k)fluoranthene/ 3,4-benzofluoranthene	T	1.2	T	94	0.85
benzo(g,h,i)perylene	--	--	--	15	--
ideno(1,2,3-cd)pyrene	--	T	--	11	(.08)
dimethyl phthalate	--	--	--	.009	--
diethyl phthalate	--	--	--	.093	--
di-n-octyl phthalate	--	--	--	.411	--
di-n-butyl phthalate	--	--	--	.164	--
butylbenzyl phthalate	--	--	--	.080	--
bis(2-ethylhexyl) phthalate	--	.62	--	1.07	.27
Acid Extractables					
phenol	--	.27	--	.38	--
2-chlorophenol	--	--	--	.33	--
pentachlorophenol	--	T	--	T	--
p-chloro-m-cresol	--	--	--	0.4	--
4-nitrophenol	--	--	--	2.3	--
Pesticides and PCBs					
aldrin	--	--	--	.002	--
γ-BHC (Lindane)	--	--	--	.00038	--
4,4'-DDD	--	--	--	.0073	(.003)
4,4'-DDE	--	--	--	.0038	(.001)
4,4'-DDT	--	--	--	.0066	(.002)
total DDT forms	--	--	--	.023	(.01)
PCB-1260	--	.04	--	--	--
total PCBs	--	.09	--	.21	.06

T = Trace amount
-- = None detected
( ) = Estimated median
* = Strong acid digestion data only

Table 32. Metals Concentrations in Discharges to the Puyallup River, St. Paul and Middle Waterways and S.W. Commencement Bay (μg/L, total metal).

Discharge	Date Sampled	Time Sampled	Investigator	Station No.	Flow (MGD)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Puyallup River													
Puyallup River at Puyallup[1]	Jan-May, 1978-1982		USGS		2,264	2	.8	7	9	.1	5	8	19
" " " "	July-Nov, 1978-1982		USGS		1,374	2	.5	8	15	.07	8	17	26
River above Pump Station	2/16/82	1300-1715	WDOE	44	12,210	<2	<5	<20	20	<.20	<5	4	35
Cleveland Street Pump Station	2/16/82	1300-1600	WDOE	43	51	32	<5	<20	220	<.20	9	200	22[illegible]
River above STP	7/28/81	0930-1400	WDOE	42	1,650	18	10	<2	10	.24	<1	<100	3[illegible]
" " "	8/25/81	0745-1030	WDOE	42	1,160	4	<5	<10	<10		<10	<20	26
Central STP Effluent	7/28/81	0900-1400	WDOE	41	(17)	<1	10	57	50	<.20	39	<100	15[illegible]
" " "	8/25-26/81	0940-0940	WDOE	41	16.5	12	2.0	76	53	.63	59	39	34[illegible]
" " "	2/16-17/82	1230-1230	WDOE	41	71.7	23	1	<10	50	<.20	170	80	13[illegible]
River Mouth	7/28/81	0800-1200	WDOE	40	1670	28	10	<2	9	<.20	<1	<100	15
" "	8/25/81	0630-0830	WDOE	39	1,170	11	<5	<10	20	<.20	<10	<20	15
" "	2/16/82	1400-1730	WDOE	40	12,330	5	<5	<20	20	<.20	8	4	50
St. Paul Waterway													
St. Regis Paper Co. Final Eff.	8/11-12/81	0930-0930	WDOE	45	32.2	16	<10	20	100	<.2	<50	<100	53
St. Regis Log Sort Yard Effluent	9/14/81	0930-1330	WDOE	46	.232	2	<1	<3	10	.21	11	6	65
St. Regis Sawmill Effluent	9/14/81	0930-1330	WDOE	47	.116	10	2	<3	10	1.2	<3	2	25
Middle Waterway													
Drain at Head of Waterway	4/28/82	1230-1500	WDOE	48	.010	25	2	<10	30	<.2	<20	<20	990
Southwest Shore Commencement Bay													
Old Tacoma Storm Drain	9/14/81	1030-1355	WDOE	53	.64	2	<1	5	<10	.43	<3	<2	20
" " " "	4/28/82	1415-1630	WDOE	53	1.18	5	2	<10	10	.26	<20	<20	62
Ruston STP Effluent	9/14/81	0955-1330	WDOE	54	4.8	32	<1	10	65	.36	<3	6	380
" " "	4/28/82	1545	WDOE	54	5.8*	21	5	<10	50	.39	<20	<20	250
ASARCO													
South Outfall (into disp. pond)	2/24-25/81	24 hr. comp	WDOE	55	4.32	8900	250	<20	6600		170	140	3500
Dispersion Pond Seepage	2/24/81	1115	WDOE	56		6100	150	~20	4500		190	70	2000
Middle Outfall	2/24-25/81	24 hr. comp	WDOE	57	1.02	5500	70	<10	3600		<50	270	2000
North Outfall	2/24-25/81	24 hr. comp	WDOE	58	.32	150	<5	21	700		<50	80	75

[1]USGS NASQAN station 12101500 (means for period indicated)

* = Average April flow 1979-1982

( ) = Estimated

Table 33. Metals Loads to the Puyallup River, St. Paul and Middle Waterways and S.W. Commencement Bay (pounds/day).

Discharge	Date Sampled	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Puyallup River									
Puyallup R. at Puyallup	Jan-May, 1978-1982	29	15	130	170	2	100	140	420
" " " "	July-Nov, 1978-1982	25	6	98	170	.8	76	150	290
River above Pump Station	2/16/82	--	--	--	2,000	--	--	410	3,600
Cleveland Street Pump Station	2/16/82	14	--	--	94	--	3.8	85	94
River above STP	7/28/81	250	140	--	140	3.3	--	--	410
" " "	8/25/81	39	--	--	--		--	--	270
Central STP Effluent	7/28/81	--	(1.4)	(8.1)	(7.1)	--	(5.5)	--	(21)
" " "	8/25-26/81	1.7	1.4	11	7.3	.087	8.1	5.4	47
" " "	2/16-17/82	14	0.6	--	30	--	102	48	78
River Mouth	7/28/81	390	140	--	130	--	--	--	210
" "	8/25/81	110	--	--	200	--	--	--	150
" "	2/16/82	510	--	--	2,100	--	820	410	5,100
St. Paul Waterway									
St. Regis Paper Co. Effluent	8/11-12/81	4.3	--	5.4	30	--	--	--	14
St. Regis Log Sort Yard Effluent	9/14/81	.0039	--	--	.019	.0004	.021	.012	.13
St. Regis Sawmill Effluent	9/14/81	.0097	.0019	--	.0097	.012	--	.0019	.024
Middle Waterway									
Drain at Head of Waterway	4/28/82	.0021	.0002	--	.0025	--	--	--	.080
Southwest Shore Commencement Bay									
Old Tacoma Storm Drain	9/14/81	.011	--	.027	--	.0023	--	--	.11
" " " "	4/28/82	.049	.020	--	.098	.0026	--	--	.61
Ruston STP Effluent	9/14/81	1.3	--	.40	2.6	.014	--	.24	15
" " "	4/28/82	(1.0)	(.24)	--	(2.4)	(.019)	--	--	(12)
ASARCO[a]									
South Outfall	2/24-25/81	320	9.0	--	238		6.1	5.0	126
Middle Outfall	2/24-25/81	47	.6	--	31		--	2.3	17
North Outfall	2/24-25/81	.4	--	.1	1.9		--	.2	.2

( ) = Calculated using an estimated flow
a = Gross metal loads, influent metals concentrations not measured
-- = Load not calculated for "less than" (<) concentrations

Table 34. Organic Priority Pollutant Concentrations in Discharges to St. Paul and Middle Waterways and S.W. Commencement Bay (ug/L).

	St. Paul Waterway			Middle Waterway	S.W. Shore Commencement Bay			
Discharge	Papermill Effluent	Log Sort Yard Effluent	Sawmill Effluent	Drain at Head of Waterway	Old Tacoma Storm Drain		Ruston STP Effluent	
Date Sampled	8/11-12/81	9/14/81	9/14/81	4/28/82	9/14/81	4/28/82	9/14/81	4/28/82
Time Sampled	0930-0930	0930-1330	0930-1330	1230-1500	1030-1355	1415-1630	0955-1330	1545-1600
Investigator	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE
Sample Number		35704	30705	J0479	35720	J0477	35700	J0476
Station Number	45	46	47	48	53		54	
Flow (MGD)	32.2	.232	.116	.010	.64	1.18	4.8	5.8*
Volatiles								
chloroform	1800	--	--	<10	--	<10	--	<10
dichlorobromomethane	7.0	--	--	a	--	a	--	<10
chlorodibromomethane	--	--	--	a	--	a	--	<10
trichlorofluoromethane	--	--	--	a	--	a	--	a
1,1,1-trichloroethane	--	--	--	a	--	a	--	a
trichloroethylene	--	--	--	a	--	a	--	a
tetrachloroethylene	--	--	--	a	--	a	9.7	<10
1,1,2,2-tetrachloroethane	--	2	--	a	--	a	--	a
toluene	3.0	--	--	a	--	a	--	<10
Base/Neutrals								
naphthalene	4.4	0.4	--	a	--	a	5	a
anthracene/phenanthrene	--	--	--	a	--	a	--	a
1,3-dichlorobenzene	--	--	--	a	--	a	2	a
butylbenzyl phthalate	--	--	4	a	--	a	44	a
di-n-octyl phthalate	--	--	--	a	--	a	27	a
Acid Extractables								
phenol	--	--	--	a	--	a	--	<10
pentachlorophenol	--	--	--	a	--	a	--	a
Pesticides								
γ-BHC	--	--	--	--	--	--	--	.040
Miscellaneous								
cyanide				5	--	5	12	88

* = Average April flow 1979-1982
-- = Not detected
a = Not detected, but detection limit high relative to other analyses

Table 35. Organic Priority Pollutant Loads to St. Paul and Middle Waterways and S.W. Commencement Bay (pounds/day).

Discharge	St. Paul Waterway	St. Paul Waterway – St. Regis	St. Paul Waterway – St. Regis	Middle Waterway	S.W. Shore Commencement Bay	S.W. Shore Commencement Bay	S.W. Shore Commencement Bay	S.W. Shore Commencement Bay
Discharge	Papermill Effluent	Log Sort Yard Effluent	Sawmill Effluent	Drain at Head of Waterway	Old Tacoma Storm Drain	Old Tacoma Storm Drain	Ruston STP	Ruston STP
Date Sampled	8/11-12/81	9/14/81	9/14/81	4/28/82	9/14/81	4/28/82	9/14/81	4/28/82
Volatiles								
chloroform	480	--	--	.0004*	--	.049*	--	(.24)*
dichlorobromomethane	1.9	--	--	--	--	--	--	(.24)*
chlorodibromomethane	--	--	--	--	--	--	--	(.24)*
trichlorofluoromethane	--	--	--	--	--	--	--	--
1,1,1-trichloroethane	--	--	--	--	--	--	--	--
trichloroethylene	--	--	--	--	--	--	--	--
tetrachloroethylene	--	--	--	--	--	--	.39	(.24)*
1,1,2,2-tetrachloroethane	--	.0039	--	--	--	--	--	--
toluene	.81	--	--	--	--	--	--	(.24)*
Base/Neutrals								
naphthalene	1.2	.0008	--	--	--	--	.20	--
anthracene/phenanthrene	--	--	--	--	--	--	--	--
1,3-dichlorobenzene	--	--	--	--	--	--	.080	--
butylbenzyl phthalate	--	--	.0039	--	--	--	1.8	--
di-n-octyl phthalate	--	--	--	--	--	--	1.1	--
Acid Extractables								
phenol	--	--	--	--	--	--	--	(.24)*
pentachlorophenol	--	--	--	--	--	--	--	--
Pesticides								
γ-BHC	--	--	--	--	--	--	--	(.0019)
Miscellaneous								
cyanide				.0004	--	.049	.48	(4.3)

( ) = Calculated using an estimated flow
* = Calculated using 1/2 quantification limit
-- = Not detected

Table 36. Organic Priority Pollutant Concentrations in the Puyallup River and Associated Discharges (µg/L).

Discharge	River above Pump Station	Cleveland Street Pump Station	River above Central STP		Central STP Effluent			River Mouth		
Date Sampled	2/16/82	2/16/82	7/28/81	8/25/81	7/28/81	8/25-26/81	2/16-17/82	7/28/81	8/25/81	2/16/82
Time Sampled	1300-1715	1300-1600	0930-1400	0745-1000	0900-1400	0940-0940	1230-1230	0800-1200	0630-0830	1400-1730
Investigator	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE	WDOE
Sample Number	J0438	J0439	[illegible]		30123	273-11	J0132	30119		J0440
Station Number	44	43	42			41		40	39	40
Flow (MGD)	12,210	51	1,650	1,160	(17)	16.5	71.7	1,650+	1,170	12,330
Volatiles										
chloroform	--	--	--	--	18	16	8	12	--	--
dichlorobromomethane	--	--	--	--	3.2	--	--	--	--	--
1,1-dichloroethane	--	--	--	--	--	1.1	--	--	--	--
1,1,1-trichloroethane	--	--	--	--	--	1.1	1	--	--	--
trichloroethylene	--	--	--	--	--	10	--	--	--	--
tetrachloroethylene	--	--	--	--	2.5	2.3	110	--	--	--
toluene	--	--	--	--	10	--	8	--	--	--
benzene	--	--	--	--	63	--	3	--	--	--
ethyl benzene	--	--	--	--	2	--	--	--	--	--
Base/Neutrals										
naphthalene	--	--	--	--	2.5	4.5	4.9	--	--	--
anthracene/phenanthrene	--	--	--	--	0.7	--	--	--	--	--
1,2-dichlorobenzene	--	3.5	--	--	--	5.6	--	--	--	--
1,3-dichlorobenzene	--	--	--	--	3.6	--	--	--	--	--
1,4-dichlorobenzene	--	--	--	--	--	3.3	--	--	--	--
bis(2-ethylhexyl) phthalate	--	--	--	--	17	25	--	--	--	--
butylbenzyl phthalate	--	--	--	--	21	--	--	--	--	--
di-n-octyl phthalate	--	--	--	--	--	2.1	--	--	--	--
Acid Extractables										
phenol	--	--	--	--	27	34	18			
2,4-dimethylphenol	--	--	--	--	5.1	3.9	--	--	--	--
2-chlorophenol	--	--	--	--	--	8.2	5.7	--	--	--
2,4-dichlorophenol	--	--	--	--	--	4.5	8.5	--	--	--
2,4,6-trichlorophenol	--	--	--	--	--	5.3	11	--	--	--
pentachlorophenol	--	--	--	--	<40	--	24	--	--	--
Pesticides										
Δ-BHC	--	--	--	--	--	--	0.1	--	--	--
Miscellaneous										
cyanide	8	8	--	--	--	18	85	5	--	5

( ) = Estimated
-- = Not detected

Table 37. Organic Priority Pollutants Loads to the Puyallup River from the Central STP and Cleveland Street Pump Station (pounds/day).

Discharge	Central STP			Cleveland Street Pump Station
Date Sampled	7/28/81	8/25-26/81	2/16-17/82	2/16/82
Volatiles				
chloroform	(2.6)	2.2	4.7	--
dichlorobromomethane	(.45)	--	--	--
1,1-dichloroethane	--	.15	--	--
1,1,1-trichloroethane	--	.15	.6	--
trichloroethylene	(.62)	1.4	--	--
tetrachloroethylene	(.37)	.32	66	--
toluene	(1.4)	--	4.7	--
benzene	(8.9)	--	1.8	--
ethylbenzene	(.28)	--	--	--
Base/Neutrals				
naphthalene	(.35)	.62	2.9	--
anthracene/phenanthrene	(.10)	--	--	--
1,2-dichlorobenzene	--	.45	--	1.5
1,3-dichlorobenzene	(.51)	--	--	--
1,4-dichlorobenzene	--	.77	--	--
bis(2-ethylhexyl) phthalate	(2.4)	3.4	--	--
di-n-octyl phthalate	--	.29	--	--
butylbenzyl phthalate	(3.0)	--	--	--
Acid Extractables				
phenol	(3.8)	4.7	11	--
2,4-dimethylphenol	(.72)	.54	--	--
2-chlorophenol	--	1.1	3.4	--
2,4-dichlorophenol	--	.62	5.0	--
2,4,6-trichlorophenol	--	.73	6.6	--
pentachlorophenol	(2.8)*	--	14	--
Pesticides				
Δ-BHC	--	--	.060	--
Miscellaneous				
cyanide	--	2.5	51	--

( ) = Calculated using an estimated flow
-- = Not detected
* = Calculated using 1/2 quantification limit

Table 38. Sediment Sites: Milwaukee, Puyallup, St. Paul, and Middle Waterways and the Ruston Shoreline.

Station Code	Original Agency Code	Collector	Analysis by	Location Name	Latitude (47°)	Longitude (122°)	Date Collected
			Milwaukee Waterway				
MI-1	I-8	DOE	EPA/DOE[b]	Head of Milwaukee Waterway	15' 45"	24' 53"	7/30/81
MS-1	16-09044	NOAA	NOAA[g]	"	15' 49"	24' 58"	1980
			Puyallup Waterway				
PI-1		DOE	EPA/DOE	Above Central STP	14' 55"	24' 18"	8/25/81
PI-2		DOE	EPA/DOE	Below "	14' 55"	24' 43"	8/25/81
PI-3	I-40	DOE	EPA/DOE	St. Regis Old Bleach Crib	15' 57"	25' 28"	8/11/81
PI-4		DOE	EPA/DOE	River Mouth	16' 15"	25' 35"	8/25/81
PS-1	17-09045	NOAA	NOAA	Below Railroad Bridge	15' 33"	25' 01"	1981
PS-2	A-3	EPA	EPA/New[c]	Off River Mouth	16' 22"	25' 44"	5/13/81
			St. Paul Waterway				
SPS-1	I-39	DOE	EPA/DOE	Inner St. Paul Waterway	15' 48"	25' 39"	8/11/81
SPS-2	18-09046	NOAA	NOAA	St. Paul Waterway Entrance	15' 53"	25' 46"	1980
SPS-3	I-38	DOE	EPA/DOE	St. Regis Outfall Boom	16' 07"	25' 42"	8/11/81
			Middle Waterway				
MDI-1	I-6	DOE	EPA/DOE	Middle Waterway off Building #21	15' 38"	25' 45"	7/30/81
MDS-1	19-09047	NOAA	NOAA	Middle Waterway Entrance	15' 44"	25' 49"	1980
MDS-2	A-2	EPA	EPA-New	Off Middle Waterway Entrance	15' 58"	26' 02"	5/13/81
			Ruston Shoreline				
Ruston STP	I-3	DOE	EPA-Con	Inshore of Ruston STP Outfall	17' 11"	29' 09"	7/31/81
ASARCO	I-2	DOE	DOE	Adjacent to ASARCO Property	17' 43"	29' 51"	7/31/81

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

[c]USEPA (Schwartz)

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

Table 39. Sediment Data: Milwaukee, Puyallup, St. Paul, and Middle Waterways and Ruston Shoreline (mg/Kg, dry weight).

	Milwaukee Waterway		Puyallup Waterway						St. Paul Waterway			Middle Waterway			Ruston Shoreline	
	Intertidal	Subtidal	Intertidal				Subtidal		Subtidal			Intertidal	Subtidal		Intertidal	
Station Code	MI-1	MS-1	PI-1	PI-2	PI-3	PI-4	PS-1	PS-2	SPS-1	SPS-2	SPS-3	MDI-1	MDS-1	MDS-2	Ruston STP	ASARCO
Agency Responsible for Analysis	EPA/DOE	NOAA	EPA/DOE	EPA/DOE	EPA/DOE	EPA/DOE	NOAA	EPA-New	EPA/DOE	NOAA	EPA/DOE	EPA/DOE	NOAA	EPA-New	EPA-Con	DOE
Original Agency Code	I-6	16-09044	P-4	P-3	I-40	P-2	10-09045	A-3	I-39	18-09045	I-38	I-6	19-09047	A-2	I-3	I-2
Miles from Head of Waterway	0.00	.11	2.03**	1.61**	.31**	0.00**	.88**		.11	.24	.46	.35	.46	.79		
Year Collected	1981	1980	1981	1981	1981	1981	1981	1981	1981	1980	1981	1981	1980	1981	1981	1981
Percent Solids	50	41.1	30.5	35.3	41.4	23.9	76	68.1	26.9	33.2	13.2	68	43.0	49.7	82.2	69
Metals																
As	37	29.2	9.4	8.0	23	5.4	1.6	16	40	9.0	21	22	70	37	[1.8]	280
Cd	.92	2.7	.19	.56	1.2	.17	<.10	.14	3	2.8	2.2	.44	3.6	.64	[<.1]	1.6
Cr	17	23.6	4.6	7.9	25	3.8	12	7.5	28	20.5	25	13	27.2	17.5	[1.7]	19
Cu	97	120	20	28	180	16	15	16	170	105	160	76	486	102	[<5]	900
Hg	.13	.10	.89	.28	.35	.090	.02		.47	.15	.080	.67	2.2		[<.02]	.04
Ni	14		9.7	12	41	8.1			22		25	10			[6.7]	39
Pb	120	109	5.8	12	100	3.4	<1.5	4	100	53.6	70	75	230	43	[2.6]	230
Sb	4.2											3.2				6.0
Zn	170	214	14	42	120	13	23	3	200	114	100	54	353	81	[85]	300
Volatiles																
chloroform	--		--	--	--	--			--		T	--			a	
toluene	--		--	7.9	T	--			--		T	--			a	
Base/Neutrals																
hexachlorobenzene	--	.0059	--	--	--	--	.00014	--	--	.019	--	--	.0048	--	a	
hexachlorobutadiene	--	.0036	--	--	--	--	--	--	--	.0062	--	--	.0029	--	a	
naphthalene	--	.420	--	--	2.1	--	.0079	.94	3.0	1.4	.72	--	.510	.536	a	
acenaphthene	--	.099	--	--	.29	--	.00047		T	.19	--	--	.140		a	
acenaphthylene	--	.075	--	--	--	--			--	.21	--	--	.083		a	
anthracene/phenanthrene	T	.380	--	--	1.1	--	.039	.053	.82	.941	.64	--	.530	.264	a	
fluorene	--	.120	--	--	.31	--	.0043	--	T	.27	--	--	.160	T	a	
pyrene	T	.99	--	--	1.09	--	.010	T	.97	.95	--	T	1.6	1.57*	a	
chrysene/benzo(a)anthracene	--	1.25	--	--	.29	--	.018	--	T	.77	--	--	1.2	.171	a	
fluoranthene	.25	1.2	--	--	1.35	--	.012	--	1.15	1.2	--	T	1.3		a	
dibenzo(a,h)anthracene	--		--	--	--	--			--		--	--			a	
benzo(a)pyrene	T	.24	--	--	--	--	.0046		--	.021	--	T	.26		a	
benzo(k)fluoranthene/ 3,4-benzofluoranthene	T	.61+	--	--	--	--			--	.081+	--	T	.54+		a	
benzo(g,h,i)perylene	--		--	--	--	--			--		--	--			a	
ideno(1,2,3-cd)pyrene	--	.150	--	--	--	--			--	.0091	--	--	.140		a	
di-methyl phthalate	--		--	--	--	--		--	--		--	--		--	a	
di-ethyl phthalate	--		--	--	--	--		--	--		--	--		--	a	
di-n-butyl phthalate	--		T	--	--	T		--	--		--	--		.163	a	
di-n-octyl phthalate	--		--	T	1.36	--		3.33	--		--	--		.372	a	
bis(2-ethylhexyl) phthalate	--		--	3.1	--	--		.38	--		--	T		.429	a	
butylbenzyl phthalate	--		--	--	--	--		--	--		--	--		--	a	
Acid Extractables																
phenol	--		T	.31	1.2	T			1.0		91	--			a	
2,4,6-trichlorophenol	--		--	--	--	--			--		T	--			a	
pentachlorophenol	--		--	--	--	--			--		.84	--			a	
Pesticides and PCBs																
4,4'-DDT	--	.015	--	--	--	--	.00002	--	--	.0028	--	--	--	--	--	
4,4'-DDE	--	.0033	--	--	--	--	.00002	--	--	.0027	--	--	.0005	--	--	
4,4'-DDD	--	.012	--	--	--	--	--	--	--	.0072	--	--	--	--	--	
Total DDT forms	--	.037	--	--	--	--	.00004	--	--	.017	--	--	.0013	--	--	
PCB-1242	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	
Total PCBs	--	.223	--	--	--	--	.00074	--	--	.25	--	--	.229	T	--	

** = River miles from mouth
[ ] = Weak acid digestion (.1 N HNO_3 with 5 wet grams sediment)
-- = Not detected
T = Trace, value is greater than the limit of detection but less than the limit of quantification
a = Not detected, but detection levels too high to be useful
* = Pyrene + fluoranthene
+ = Benzofluoranthenes

Table 40. Summary of WDOE data collected September 1979 to April 1982 on metals loads to Commencement Bay and adjacent waterways (pounds/day).

Metal	Hylebos Waterway Load	Hylebos Waterway % of Total CMB Load	Blair Waterway Load	Blair Waterway % of Total CMB Load	Sitcum Waterway Load	Sitcum Waterway % of Total CMB Load	Tacoma Central STP Load	Tacoma Central STP % of Total CMB Load	St. Paul Waterway Load	St. Paul Waterway % of Total CMB Load	Middle Waterway Load	Middle Waterway % of Total CMB Load	City Waterway Load	City Waterway % of Total CMB Load	Old Tacoma Storm Drain Load	Old Tacoma Storm Drain % of Total CMB Load	Ruston STP Load	Ruston STP % of Total CMB Load	ASARCO Load	ASARCO % of Total CMB Load	Sum of Loads
As	5.2	1.3	4.0	1.0	.7	.18	1.7	.44	4.4	1.1	.0021	<.1	.20	<.1	.011	<.1	1.3	.33	370	95	390
Cd	1.1	9.3	.1	.83	--		1.4	12	.0019	<.1	.0002	<.1	.13	1.1	--		--		9.6	80	12
Cr	16	76	.74	3.5	--		1.1	5.2	5.4	26	--		.030	.14	.027	.13	.40	1.9	.1	.48	21
Cu	1.6	.51	.88	.28	.18	<.1	7.3	2.3	30	9.6	.0025	<.1	.61	.19	--		2.6	.83	270	86	313
Hg	.007	5.4	.011	8.5	--		.087	67	.012	9.2	--		.0008	.62	.0023	1.8	.014	11			.13
Ni	31	66	1.5	3.2	--		8.1	17	.021	<.1	--		.0026	<.1	--		--		6.1	14	47
Pb	.17	1.1	1.0	6.3	.43	2.7	5.4	34	.014	<.1	--		.84	5.3	--		.24	1.5	7.5	47	16
Zn	.98	.45	2.9	1.3	1.1	.50	47	21	.14	6.4	.080	<.1	1.3	.59	.11	<.1	15	6.8	140	64	220

Note: Dry-weather data only used where possible. See Parts 1 - 5 of this report for details on loading calculations. There are no major discharges to Milwaukee Waterway.

-- = not detected

Table 41. Detection frequency (DF) of organic priority pollutants in WDOE and EPA samples from point source discharges to Commencement Bay and adjacent waterways, September 1979 - April 1982.

	Hylebos Waterway DF*	%	Blair Waterway DF	%	Sitcum Waterway DF	%	Tacoma Central STP DF	%	Puyallup River Mouth DF	%	St. Paul Waterway DF	%	Middle Waterway DF	%	City Waterway DF	%	Old Tacoma Storm Drain DF	%	Ruston STP DF	%	ASARCO South Outfall DF	%	Overall DF	%
Volatiles																								
chloroform	24/37	65	5/15	33	2/4	50	3/3	100	1/3	33	1/3	33	1/1	100	2/6	33	1/2	50	1/2	50			41/76	54
dichlorobromomethane	11/35	31	0/14	0	0/3	0	1/3	33	0/3	0	1/3	33	a		0/5	0	0/1	0	1/2	50			14/70	20
chlorodibromomethane	10/36	28	1/14	7	0/3	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	1/2	50			12/70	17
trichlorofluoromethane	1/36	3	0/14	0	0/3	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			1/69	1
bromoform	7/36	19	0/14	0	0/3	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			7/69	10
carbon tetrachloride	5/36	14	0/14	0	0/3	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			5/69	7
chloroethane	5/36	14	0/4	0	0/3	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			5/69	7
1,1-dichloroethane	3/35	8	2/14	14	0/3	0	1/3	33	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			6/69	9
1,2-trans-dichloroethylene	5/36	14	6/16	33	0/3	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			11/71	15
1,1-dichloroethylene	3/35	8	0/14	0	0/3	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			3/69	4
1,1,1-trichloroethane	8/36	22	5/15	33	2/4	50	2/3	67	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			17/71	24
trichloroethylene	18/36	50	4/15	27	1/3	33	1/3	33	0/3	0	0/3	0	a		2/5	40	0/1	0	0/1	0			26/70	37
tetrachloroethylene	12/36	33	2/14	14	2/4	50	3/3	100	0/3	0	0/3	0	a		1/5	20	0/1	0	2/2	100			22/71	31
1,1,2,2-tetrachloroethane	2/36	6	1/14	7	1/3	33	0/3	0	0/3	0	1/3	33	a		0/5	0	0/1	0	0/1	0			5/69	7
toluene	4/36	11	2/14	14	0/3	0	2/3	67	0/3	0	1/3	33	a		1/5	20	0/1	0	1/2	50			11/70	16
benzene	4/36	11	2/14	14	0/3	0	2/3	67	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			8/69	12
1,2-dichloroethane	0/36	0	2/14	14	0/3	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			2/69	3
ethylbenzene	0/36	0	0/14	0	0/3	0	1/3	33	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0			1/69	1
Base/Neutrals																								
naphthalene	9/36	25	2/14	14	0/4	0	3/3	100	0/3	0	2/3	67	a		2/6	33	0/1	0	1/1	100	0/1	0	17/72	24
acenaphthene	2/36	6	0/14	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	2/71	3
acenaphthylene	2/36	6	0/14	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	2/71	3
anthracene/phenanthrene	11/36	31	0/11	0	0/4	0	1/3	33	0/3	0	0/3	0	a		1/6	17	0/1	0	0/1	0	0/1	0	13/72	18
fluorene	5/36	14	1/15	7	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	6/72	8
pyrene	5/35	14	0/14	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	5/71	7
chrysene/benzo(a)anthracene	7/36	19	0/14	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	7/71	10
fluoranthene	9/36	25	0/14	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	9/71	13
benzo(a)pyrene	1/36	3	0/14	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	1/71	1
benzo(b)fluoranthene	1/36	3	0/14	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	1/71	1
hexachloroethane	6/35	17	1/14	7	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	7/71	10
hexachlorobutadiene	6/36	17	0/14	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	6/71	8
1,2-dichlorobenzene	2/36	6	4/15	27	0/4	0	1/3	33	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	7/72	10
1,3-dichlorobenzene	2/36	6	0/14	0	0/4	0	1/3	33	0/3	0	0/3	0	a		0/5	0	0/1	0	1/1	100	0/1	0	4/71	6
1,4-dichlorobenzene	2/36	6	1/14	7	0/4	0	1/3	33	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	4/71	6
hexachlorobenzene	5/36	14	1/14	7	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	6/71	8
2-chloronaphthalene	1/36	3	0/14	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	1/71	1
dimethyl phthalate	1/16	6	0/4	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	1/41	2
diethyl phthalate	2/16	13	1/4	25	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	3/41	7
di-n-butyl phthalate	1/16	6	0/4	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	1/41	2
di-n-octyl phthalate	0/16	0	0/4	0	0/4	0	1/3	33	0/3	0	0/3	0	a		0/5	0	0/1	0	1/1	100	0/1	0	2/41	5
butylbenzyl phthalate	0/16	0	0/4	0	0/4	0	1/3	33	0/3	0	1/3	33	a		1/5	20	0/1	0	1/1	100	0/1	0	4/41	10
bis(2-ethylhexyl) phthalate	4/16	25	1/4	25	0/4	0	2/3	67	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	1/1	100	8/41	20
nitrobenzene	1/16	6	0/4	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	1/41	2
4-bromophenyl ether	1/16	6	0/4	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	1/41	2
chlorobenzene	0/36	0	1/14	7	0/4	0	0/3	0	0/3	0	0/3	0	a		0/5	0	0/1	0	0/1	0	0/1	0	1/71	1

*Detection frequency = number of samples in which a compound is detected ÷ total number of samples analyzed for that compound.

[a] Detection limits high in single sample collected.

NOTE: Analyses employing poor detection limits not used in this tabulation.

Table 41 - continued.

	Hylebos Waterway DF*	%	Blair Waterway DF	%	Sitcum Waterway DF	%	Tacoma Central STP DF	%	Puyallup River Mouth DF	%	St. Paul Waterway DF	%	Middle Waterway DF	%	City Waterway DF	%	Old Tacoma Storm Drain DF	%	Ruston STP DF	%	ASARCO South Outfall DF	%	Overall DF	%
Acid Extractables																								
phenol	5/16	31	0/5	0	1/4	25	3/3	100	0/3	0	0/3	0	a		1/6	17	0/1	0	1/2	50			11/43	26
2,4-dimethyl phenol	0/16	0	0/5	0	0/4	0	2/3	67	0/3	0	0/3	0	a		0/6	0	0/1	0	0/1	0			2/42	5
2-chlorophenol	1/16	6	0/5	0	0/4	0	2/3	67	0/3	0	0/3	0	a		0/6	0	0/1	0	0/1	0			3/42	7
2,4-dichlorophenol	0/16	0	0/5	0	0/4	0	2/3	67	0/3	0	0/3	0	a		0/6	0	0/1	0	0/1	0			2/42	5
2,4,6-trichlorophenol	3/16	19	0/5	0	0/4	0	2/3	67	0/3	0	0/3	0	a		0/6	0	0/1	0	0/1	0			5/42	12
pentachlorophenol	2/16	13	3/5	60	1/4	25	2/3	67	0/3	0	0/3	0	a		0/6	0	0/1	0	0/1	0			8/42	19
Pesticides and PCBs																								
aldrin	1/22	5	1/7	14	0/4	0	0/3	0	0/3	0	0/3	0	a		0/7	0	0/2	0	0/2	0			2/53	4
α-BHC	3/22	14	1/7	14	0/4	0	0/3	0	0/3	0	0/3	0	a		0/7	0	0/2	0	0/2	0			4/53	6
β-BHC	1/22	5	0/7	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/7	0	0/2	0	0/2	0			1/53	2
δ-BHC	1/22	5	0/7	0	0/4	0	1/3	33	0/3	0	0/3	0	a		0/7	0	0/2	0	0/2	0			2/53	4
γ-BHC	3/22	14	0/7	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/7	0	0/2	0	1/2	50			4/53	6
4,4'-DDT	6/22	27	0/7	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/7	0	0/2	0	0/2	0			6/53	11
4,4'-DDE	4/22	18	0/7	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/7	0	0/2	0	0/2	0			4/53	6
4,4'-DDD	3/22	14	0/7	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/7	0	0/2	0	0/2	0			3/53	6
PCBs	0/22	0	0/7	0	0/4	0	0/3	0	0/3	0	0/3	0	a		0/7	0	0/2	0	0/2	0			0/53	0
Miscellaneous																								
cyanide	8/18	44	4/6	67	2/2	100	2/3	67	2/3	67					4/4	100	1/2	50	2/2	100			25/40	63

*Detection frequency = number of samples in which a compound is detected ÷ total number of samples analyzed for that compound.

[a]Detection limits high in single sample collected.

NOTE: Analyses employing poor detection limits not used in this tabulation.

Table 42. Summary of WDOE data collected September 1979 to April 1982 on organic priority pollutants loads to Commencement Bay and adjacent waterways (pounds/day).

	Hylebos Waterway		Blair Waterway		Sitcum Waterway		Tacoma Central STP		St. Paul Waterway		Middle Waterway		City Waterway		Old Tacoma Storm Drain		Ruston STP		
	Load	% of Total CMB Load	Load	% of Total CMB Load	Load	% of Total CMB Load	Load	% of Total CMB Load	Load	% of Total CMB Load	Load	% of Total CMB Load	Load	% of Total CMB Load	Load	% of Total CMB Load	Load	% of Total CMB Load	Sum of Loads
Volatiles																			
chloroform	9.3	1.9	.094	<.1	.0048	<.1	2.2	.4	480	98	.004	<.1	.061	<.1	--		--		492
dichlorobromomethane	.0018	<.1	--		--		--		1.9	100	--		--		--		--		1.9
chlorodibromomethane	.75	100	--		--		--		--		--		--		--		--		.75
trichlorofluoromethane	.12	100	--		--		--		--		--		--		--		--		.12
bromoform	19.8	100	--		--		--		--		--		--		--		--		19.8
carbon tetrachloride	.0002	100	--		--		--		--		--		--		--		--		.002
chloroethane	.0002	100	--		--		--		--		--		--		--		--		.002
1,1-dichloroethane	.0002	.1	.0083	5.2	--		.15	95	--		--		--		--		--		.16
1,2-trans-dichloroethylene	.38	86	.064	14	--		--		--		--		--		--		--		.44
1,1-dichloroethylene	.0004	100	--		--		--		--		--		--		--		--		.0004
1,1,1-trichloroethane	.013	5.2	.040	16	.043	18	.15	61	--		--		--		--		--		.25
trichloroethylene	2.4	63	--		.014	.4	1.4	37	--		--		.017	.4	--		--		3.8
tetrachloroethylene	1.0	58	--		.011	.6	.32	19	--		--		.0061	.4	--		.39	23	1.7
1,1,2,2-tetrachloroethane	.12	94	--		.0028	2.2	--		.0039	3.1	--		--		--		--		.13
toluene	.23	21	.022	2.1	--		--		.81	75	--		.010	.9	--		--		1.1
Base/Neutrals																			
naphthalene	.032	1.6	.0013	<.1	--		.62	30.0	1.2	58	--		.011	.5	--		.20	9.7	2.1
acenaphthene	.0022	100	--		--		--		--		--		--		--		--		.0022
acenaphthylene	.0076	100	--		--		--		--		--		--		--		--		.0076
anthracene/phenanthrene	.010	11.1	--		--		--		--		--		--		--		--		.010
fluorene	.0065	100	--		--		--		--		--		--		--		--		.0065
pyrene	.054	100	--		--		--		--		--		--		--		--		.054
chrysene/benzo(a)anthracene	.075	100	--		--		--		--		--		--		--		--		.075
fluoranthene	.047	100	--		--		--		--		--		--		--		--		.047
hexachloroethane	.0043	100	--		--		--		--		--		--		--		--		.0043
hexachlorobutadiene	.026	100	--		--		--		--		--		--		--		--		.026
1,2-dichlorobenzene	.022	4.3	.041	8.0	--		.45	88	--		--		--		--		--		.51
1,3-dichlorobenzene	.021	20	--		--		--		--		--		--		--		.080	80.0	.10
1,4-dichlorobenzene	.022	2.7	.012	1.5	--		.77	96	--		--		--		--		--		.80
hexachlorobenzene	.044	100	--		--		--		--		--		--		--		--		.044
2-chloronaphalene	.0054	100	--		--		--		--		--		--		--		--		.0054
dimethyl phthalate	.0022	100	--		--		--		--		--		--		--		--		.0022
diethyl phthalate	.098	100	--		--		--		--		--		--		--		--		.098
di-n-octyl phthalate	--		--		--		.29	21	--		--		--		--		1.1	80	1.4
butylbenzyl phthalate	--		--		--		--		.0039	.2	--		.075	4.0	--		1.8	96	1.9
bis(2-ethylhexyl) phthalate	.0003	<.1	--		--		3.4	100	--		--		--		--		--		3.4
nitrobenzene	.0086	100	--		--		--		--		--		--		--		--		.0086
4-bromophenyl ether	.011	100	--		--		--		--		--		--		--		--		.011
Acid Extractables																			
phenol	.20	4.1	--		--		4.7	96	--		--		.0058	.1	--		--		4.9
2,4-dimethylphenol	--		--		--		.54	100	--		--		--		--		--		.54
2-chlorophenol	.012	1.1	--		--		1.1	99	--		--		--		--		--		1.1
2,4-dichlorophenol	--		--		--		.62	100	--		--		--		--		--		.62
2,4,6-trichlorophenol	.00003	<.1	--		--		.73	100	--		--		--		--		--		.73
pentachlorophenol	.074	20	.30	80	--		--		--		--		--		--		--		.37
Pesticides																			
aldrin	.00006	<.1	.0038	100	--		--		--		--		--		--		--		.038
α-BHC	.00003	<.1	.038	100	--		--		--		--		--		--		--		.038
β-BHC	.0001	100	--		--		--		--		--		--		--		--		.0001
4,4'-DDT	.0010	100	--		--		--		--		--		--		--		--		.0010
4,4'-DDE	.0002	100	--		--		--		--		--		--		--		--		.0002
4,4'-DDD	.00007	100	--		--		--		--		--		--		--		--		.00007
Miscellaneous																			
cyanide	.032	1.0	.13	4.1	--		2.5	79	--		.0004	<.1	.0058	.2	--		.48	15	3.1

Note: Dry-weather data only used where possible. See Parts 1 - 5 of this report for details on loading calculations. There are no major discharges to Milwaukee Waterway. No simultaneous flow and organic priority pollutant data are available for ASARCO effluents.

-- = Not detected

Table 43. Summary of maximum and median concentrations of selected priority pollutants in subtidal surface sediments from Commencement Bay waterways (mg/Kg, dry weight).

Constituent	Hylebas Waterway Maximum	Hylebas Waterway Median	Blair Waterway Maximum	Blair Waterway Median	Sitcum Waterway Maximum	Sitcum Waterway Median	Milwaukee Waterway Maximum	Milwaukee Waterway Median	Puyallup River Maximum	Puyallup River Median	St. Paul Waterway Maximum	St. Paul Waterway Median	Middle Waterway Maximum	Middle Waterway Median	City Waterway Maximum	City Waterway Median	Southwest Shoreline Commencement Bay Maximum	Southwest Shoreline Commencement Bay Median
Metals																		
As	203	18	77	46.3	472	170		29.2*	16	(9)	40	21	70	(54)	63	37		I
Cd	3.2	0.99	.66	.34	7.0	3.8		2.7*	.14	(<.1)	3	2.8	3.6	(2.1)	10.7	4.4		I
Cr	59	29	29.5	18	58.7	22		23.6*	12	(10)	28	25	27.2	(22)	59	35		I
Cu	259	130	106	70	2100	581		120*	16	(16)	170	160	486	(290)	280	190		I
Hg	1.2	0.28	.26	.14	.79	.34		.10*		.02*	.41	.15	I	2.2*	1.03	.80		I
Ni	35	18	22.4	15	36.1	16					22	23			33.3	33		I
Pb	197	110	74	49	793	430		109*	4	(2)	100	70	230	(140)	820	225		I
Zn	404	170	132	87	1720	700		214*	23	(13)	200	114	353	(220)	742	267		I
Volatiles																		
chloroform	T	--	--	--	--	--		I		I	1	--	I	I	--	--		I
trichloroethylene	T	--	--	--	--	--		I		I	--	--	I	I	--	--		I
toluene	T	--	--	--	--	--		I		I	T	--	I	I	--	--		I
Base/Neutrals																		
hexachlorobenzene	1.3	(.06)	.003	(.0025)	.0083	(.003)		.0059*		.00014*	.019	(.019)	.0048	(.0048)	.057	(.003)		I
hexachlorobutadiene	3.3	(.05)	.228	(.003)	.004	(.002)		.0036*		--*	.0062	(.006)	.0029	(.0029)	.236	(.0045)		I
naphthalene	.55	.10	2.434	(.055)	.48	(.2)		.42*	.94	(.5)	3.0	1.4	.536	.51	4.0	.58		I
acenapthene	.069	(.05)	.090	(.02)	3.0	(.1)		.099*		.0005*	.19	(.19)	.140	(.14)	.71	.17		I
acenapthalene	.090	(.05)	.033	(.004)	.074	(.02)		.075*		I	.21	(.21)	.083	(.083)	.31	(.2)		I
anthracene/phenanthrene	2.69	.62	.874	.20	19	.49		.380*	.053	(.4)	.34	.82	.530	(.25)	7.0	1.7		I
fluorene	.48	(.08)	.111	.05	6	.071		.120*		.004*	.27	(.27)	.16	(.16)	.81	.24		I
pyrene	6.1	1.3	.870	.23	38	.0		.99*	.01	(.01)	.97	.95	1.6	(1.2)	10	(2.8)		I
chrysene/benzo(a)anthracene	6.0	2.0	1.6	.47	77	.39		1.25*		.018*	.77	(.77)	1.2	(.7)	8.5	2.3		I
fluoranthene	4.7	1.0	1.15	.24	27	.56		1.2*		.012*	1.2	1.15	1.3	(1.3)	6.1	1.8		I
benzo(a)pyrene	5.5	.68	.525	.13	230	.30		.24*		.0046*	.021	(.021)	.26	(.26)	2.6	1.0		I
benzo(k)fluoranthene/ 3,4-benzofluoranthene	2.9	1.3	.72	.45	94	.85		.61*		I	.081	(.081)	.54	(.54)	6.6	1.3		I
benzo(g,h,i)perylene	.34	(.1)	--	--	15	--		I		I	--	--	--	I	I	I		I
ideno(1,2,3-cd)pyrene	.43	.24	.18	.07	11	(.08)		.16*		I	.0091	(.0091)	.14	(.14)	1.3	(.35)		I
total PAH forms		7.5		1.9		4.1		5.4*		0.95*		(5.9)		(5.3)		12.4		I
diethyl phthalate	.094	.05	.092	--	.093	--		I		I	--	--	--	--	.005	--		I
bis(2-ethylhexyl) phthalate	1.76	.30	1.725	.48	1.07	.27		I		I	--	--	.429	(.4)	9.6	8.4		I
butylbenzyl phthalate	.36	(.1)	.18	--	.080	--		I		I	--	--	--	--	.86	.82		I
Acid Extractables																		
phenol	T	--	--	--	.38	--		I		I	91	(46)		I	I	I		I
2-chlorophenol	--	--	--	--	.33	--		I		I	--	--		I	I	I		I
2,4,6-trichlorophenol	--	--	--	--	--	--		I		I	T	--		I	I	I		I
p-chloro-m-cresol	--	--	--	--	.4	--		I		I	--	--		I	I	I		I
4-nitrophenol	--	--	--	--	2.3	--		I		I	--	--		I	I	I		I
pentachlorophenol	--	--	--	--	T	--		I		I	.84	(.4)		I	I	I		I
Pesticides and PCBs																		
aldrin	.82	(.02)	--	--	.002	--		I			--	--		I	--			I
α-BHC	.063	(.01)	--	--	--	--		I			--	--		I	I			I
γ-BHC	.04	--	--	--	.00038	--		I			--	--			I			
total DDT forms	.87	(.015)	.0134	.0075	.023	(.01)		.037*		.00004*	.017	(.017)	.0013	(.0013)	.077	(.045)		I
total PCBs	1.7	.2	.128	(.02)	.21	.06		.223*		.00074*	.25	(.25)	.229	(.23)	.647	(.3)		I

-- = None detected
* = One sample only
( ) = Estimated median (low number of detected concentrations)
I = Insufficient data
T = Trace amount