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86-e32

Segment No. 25-00-02

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DEPARTMENT OF ECOLOGY
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MEMORANDUM

February 5, 1986

To: Tom Eaton, Southwest Regional Office

Through: Bill Yake BY

From: Dale Norton D.N.

Subject: Results of Priority Pollutant Analyses on Water, Sediment, and Clam Samples Collected in lower Budd Inlet near McFarland Cascade, Olympia, WA. August 14, 1985

ABSTRACT

Samples of water, sediment, and clams from lower Budd Inlet were analyzed to further define the extent of creosote and pentachlorophenol contamination previously documented in the vicinity of McFarland Cascade's Olympia pole-treating facility. Priority pollutant polynuclear aromatic hydrocarbons (PNAs), dibenzofuran and pentachlorophenol were detected at low levels in water from the West Bay drain. Priority pollutant PNAs were detected in all sediment samples from West Bay. The concentrations of low molecular weight PNAs and dibenzofuran in one intertidal sediment sample from West Bay appeared to be high enough to adversely affect marine life. Clams from East Bay contained PNA concentrations in the range of values seen in Eagle Harbor (Bainbridge Island, Puget Sound). Total PNA concentrations in West Bay clams were about an order of magnitude lower and fall into the lower range of concentrations reported in clams from other urban embayments in Puget Sound. PNAs, dibenzofuran and pentachlorophenol were not detected in clams from Priest Point Park.

INTRODUCTION

Substantial creosote and pentachlorophenol contamination of ground water at McFarland Cascade's Olympia pole-treating facility was first documented in 1983 (Applied Geotechnology, 1984). A subsequent investigation by the Washington State Department of Ecology (Ecology) in February 1985 confirmed the presence of creosote and pentachlorophenol in ground water at the site, and determined that contamination extended to marine discharges and intertidal sediments in the vicinity of the facility (Johnson, 1985). In response to your request for additional sampling to further define the extent of contamination, Art Johnson and I conducted an additional survey on August 14, 1985. The objectives of this survey were to: (1) measure pollutant loadings from the West Bay storm drain, (2) prepare a schematic of its drainage system, (3) re-sample sediments adjacent to the West Bay drain to clarify the extent of creosote contamination in this area, and (4) determine contaminant levels in clams near the McFarland Cascade facility, West Bay drain, and Priest Point Park (the nearest public beach).

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METHODS

Sampling

Fiqure 1 indicates the locations where samples were collected. Water samples from the West Bay drain were collected as grabs using the following containers: one-gallon qlass jars with teflon-lined lids (priority pollutant acid/base-neutral compounds); 40 mL glass vials with teffon septums (priority pollutant purgable orqanics); one-liter polyethylene bottles (pH, specific conductivity, tota? suspended solids); and eight-ounce glass jars with teflon-lined lids with 2 mL H_2SO_4 added as a preservative (total organic carbon). Flow was a single instantaneous measurement taken with a Marsh-McBirney magnetic flow meter. Temperature was measured with a precision thermometer.

Three sediment samples were collected in the vicinity of the West Bay storm drain. Two were located in the intertidal zone approximately ten feet below the drain outfall. The third was taken subtidally approximately 75 feet from the outfall at a depth of 34 feet MLLW. Intertidal sediments were collected by hand with 1.5-inch ID stainless steel core tubes. Subtidal sediment was collected using a 0.02 m^2 petite ponar grab sampler. In both instances, the top 2 cm layer was removed, placed in a two-gallon stainless steel beaker and homogenized by stirring with stainless steel spoons. In the case of intertidal sediments, several cores were composited from each station. A single grab was collected subtidally. Sample containers were eight-ounce glass jars with teflon-lined lids (priority pollutant acid/base-neutrals and purgable organics, total organic carbon, and percent solids).

Clam samples were dug with a shovel. Information on samples collected at each location are shown in Table 1.

Table 1. Data on clams collected by Ecology from lower Budd Inlet on August 14, 1985.

Location	Sample Number	Species† (Number)	Total Shucked Sample Weight (grams)	Size Range (mm)
Priest Point Park	338030	Native Littleneck (24)	216	38-71
" " "		Manila (7)		
East Bay	338031	Soft Shell (11)	215	48-100
West Bay	338032	Native Littleneck (27)	228	43-70
" "	338037	" " (27)	227	35-64

†Native Littleneck = Protothaca staminea
Manila = Tapes japonica
Soft Shell = Mya arenaria

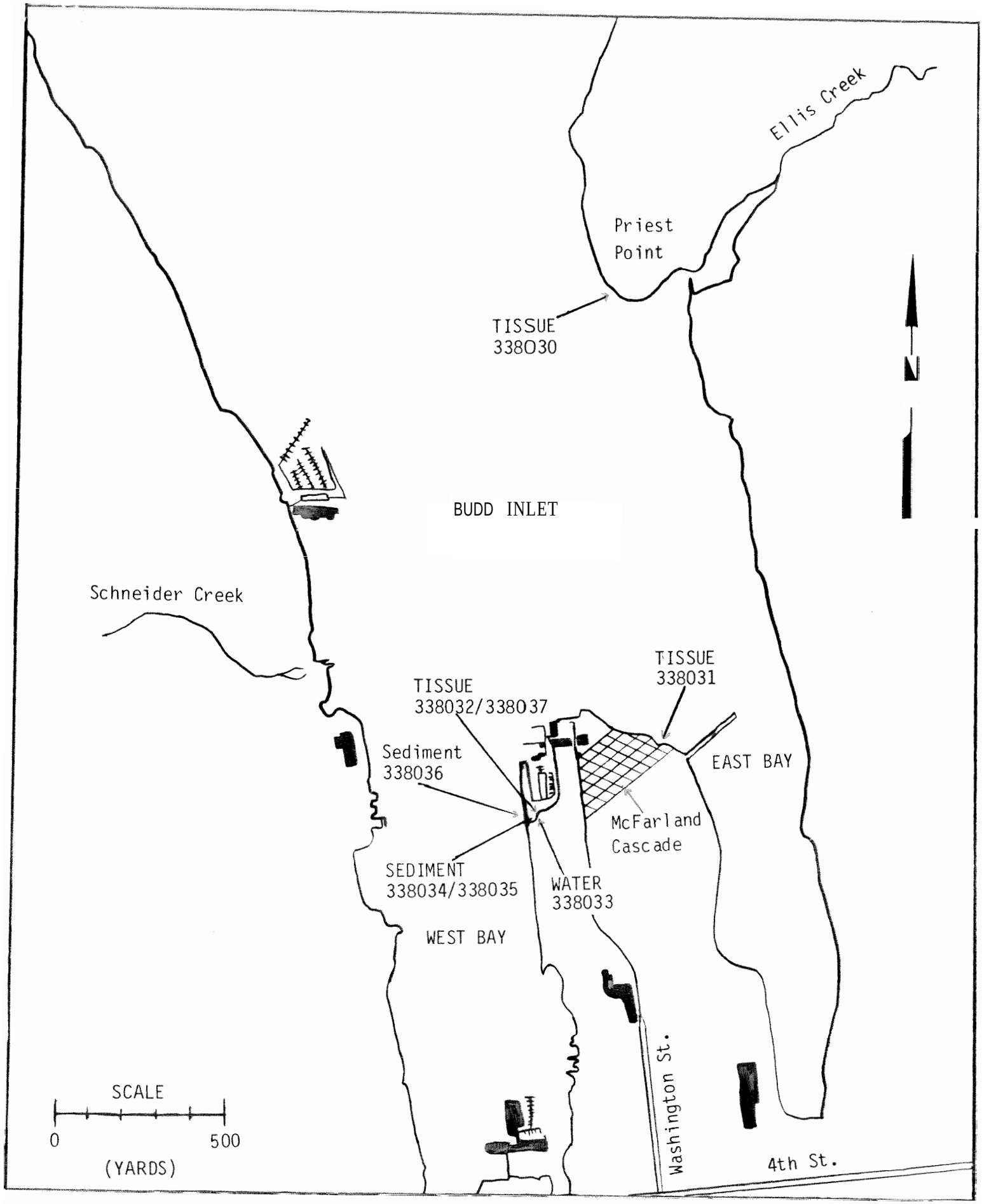

Figure 1. Locations of samples collected by Ecology in the vicinity of McFarland Cascade, Olympia, WA. August 14, 1985. (See Figure 3 for more detail on sampling sites in West Bay.)

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Only undamaged clams were saved for analysis. These were first rinsed in seawater on-site and then allowed to depurate for three hours in five-gallon plastic buckets filled with on-site seawater. The clams were wrapped in solvent-rinsed foil, placed in plastic bags, frozen overnight, then dissected the following day at the EPA/Ecology Manchester laboratory. For each sample, all soft tissues were removed, composited, and homogenized in a Waring blender. They were then placed in glass jars with teflon-lined lids and refrigerated pending analysis.

Containers for priority pollutant organics were cleaned with sequential rinses of detergent, tap water, HN03, de-ionized water, nanograde methylene chloride, then oven-dried. All sampling equipment, mixing beakers, spoons, dissection instruments, and blenders were cleaned by the following procedure: washed with detergent, rinsed with de-ionized water, nanograde methylene chloride, nanograde acetone, and dried for at least 10 minutes at 100°C. Solvent-rinsed foil was prepared by rinsing the foil with nanograde methylene chloride and nanograde acetone followed by oven-drying. All samples were placed on ice after collection. Ecology chain-of-custody procedures were followed.

Analyses

Sample analyses were conducted at the EPA/Ecology Manchester laboratory except for total organic carbon in water and sediment which was done by Laucks Testing Laboratories, Inc., Seattle.

Priority pollutant organics were analyzed by gas chromatography/mass spectrometry (GC/MS) following EPA Method 625 (acid/base-neutrals). Priority pollutant purgables data are not reported since maximum sample holding times were exceeded prior to analysis.

In order to quantify polynuclear aromatic hydrocarbons (PNAs) at low levels in sediment and tissue, special cleanup steps were necessary. The major steps used in the extraction and analysis are shown below in Figure 2.

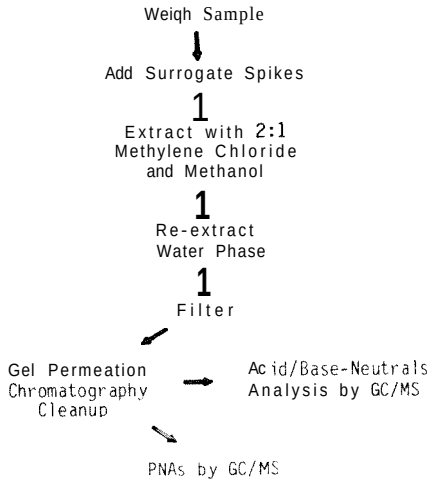

Figure 2. EPA/Ecology Manchester laboratory analytical scheme for low-level PNA determinations in sediment and tissue.

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Low-level analysis for PNA compounds in sediment and tissue followed EPA Method 610 except GC/MS was employed to detect and quantify individual PNAs instead of gas chromatography/flame ionization detection (GC/FID).

A number of organic compounds other than those on EPA's priority pollutant/hazardous substance list were tentatively identified in all media by computer-match with the Manchester laboratory spectrum library. Dick Huntamer (Ecology) did the acid/base-neutrals analyses.

Methods used for the analysis of conventional parameters are summarized as follows:

- pH was measured with a Corning pH/ion analyzer model #155.
- Specific conductivity was determined with a Beckman model #RC20 conductivity bridge.
- Total suspended solids and percent solids followed Methods 160.2 and 160.3, respectively, in Methods for Chemical Analysis of Water and Wastes (EPA, 1979).
- Total organic carbon (TOC) in water was determined by Method 505A in Standard Methods for the Examination of Water and Wastewater (APHA, 1985).
- Laucks Testing Laboratories measured TOC in sediment by CO_2 generation on combustion (Laucks, 1985).
- Percent lipids in tissue was determined by extracting a tissue subsample three times in petroleum ether. The extract was subsequently dried and the lipid content determined gravimetrically as described in Manual of Analytical Methods for the Analysis of Pesticides in Humans and Environmental Samples (EPA, 1980).

Transport and transfer blanks (laboratory numbers 338038 and 338039) were analyzed for priority pollutant organics. Blank water was prepared at the EPA/Ecology Manchester laboratory by passing de-ionized water through activated carbon filters. All compounds analyzed were below detection limits in these blanks.

Spike recovery data for priority pollutant organics analyses are summarized in Appendix 1. In general, spike recoveries were within quality assurance limits specified in Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act (EPA, 1984), except for hexachlorobutadiene in water (sample number 338033YJ). The data reported here have not been corrected for spike recoveries.

Organics concentrations in sediment are reported on a dry-weight basis. Tissue values are expressed as wet weight.

RESULTS AND DISCUSSION

The results of conventionals and priority pollutant organics analyses of water and sediments are summarized in Table 2. For comparison, West Bay results for the February 13, 1985, survey (Johnson, 1985) are included in Table 2.

Water

Eleven organic compounds, mainly priority pollutant PNAs, were detected in water from the West Bay drain. The total priority pollutant PMA concentration was 56 ug/L, of which 48 ug/L (or 85 percent) was low molecular weight PNAs†. Concentrations of individual low molecular weight PNAs detected were as follows: acenaphthene 32 ug/L; acenaphthylene 1.2 ug/L; fluorene 9.3 ug/L; and phenanthrene 5.5 ug/L. Five high molecular weight PNAs were detected, each at less than 2 ug/L. The abundance of low molecular weight PNAs is not surprising since these compounds predominate in creosote and are much more water soluble than high molecular weight PNA. Two other compounds, dibenzofuran and pentachlorophenol, were also detected in the West Bay drain at 12 ug/L and 11 ug/L, respectively.

The previous sample collected by Ecology on February 13, 1985, from the West Bay drain had substantially higher PNA concentrations (390 ug/L total PNAs), again primarily low molecular weight compounds. Higher concentrations of dibenzofuran (54 ug/L) and pentachlorophenol (17 ug/L) were also detected in this sample. Suspended solids concentrations in August and February were 16 mg/L and 29 mg/L, respectively. Judging from its high specific conductivity of 15,500 umohs/cm, the August sample from the drain represented primarily tidal waters. This could account for some of the differences seen in organics and suspended solids concentrations between the two samplings.

Pollutant loads from the West Bay drain are given in Table 3. In general, these loads are an order of magnitude lower than those measured in February. An exception is the August pentachlorophenol load which is approximately one-third of that seen in February.

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†In this report, low molecular weight PNAs are the 2- and 3-ring compounds acenaphthene, acenaphthylene, naphthalene, fluorene, anthracene, and phenanthrene; high molecular weight PNAs are the 4-, 5-, and 6-ring compounds fluoranthene, benzo(a)anthracene, chrysene, pyrene, benzo(b) and/or benzo(k) fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene.

Table 2. Summary of water and sediment data collected by Ecology in West Bay lower Budd Inlet, WA., February 13 and August 14, 1985 (water - ug/L; sediment - ug/Kg dry weight).

	WATER		SEDIMENT			
Location	West Bay Drain		Intertidal			Subtidal
Date Collected	2/13/85	8/14/85	2/13/85	8/14/85	8/14/85	8/14/85
Sample Number	079013	338033	079023	338035	338034	338036
Conventionals						
Time	1835	1130	--	--	--	--
Flow (cfs)	0.33	0.19	--	--	--	--
Temperature (°C)	9.1	15.6	--	--	--	--
pH (S.U.)	7.5	8.5	--	--	--	--
Sp. Cond. (umhos/cm)	877	15,500	--	--	--	--
Total Susp. Solids (mg/L)	29	16	--	--	--	--
Total Organic Carbon (%)	--	22	4.2	1.8	2.5	4.3
Percent Solids	--	--	70.2	70.3	56.6	26.7
Priority Pollutant PNA						
Acenaphthene	150	32	100u	20u	2,000	140
Acenaphthylene	6.1	1.2	100u	20u	200u	50u
Naphthalene	8.1	1u	100u	94	170	39J
Fluorene	65	9.3	100u	20u	730	69
Anthracene	18	1u	100u	20u	1,200	50u
Phenanthrene	65	5.5	100u	120	2,000	630
Fluoranthene	36	1.9	220	330	6,300	1,300
Benzo(a)anthracene	6.8	1u	100u	20u	1,600	390J
Chrysene	6.6	1u	100u	20u	2,000	540J
Pyrene	30	1.3	660	630	4,200	980
Benzo(b)fluoranthene and/or benzo(h)fluoranthene	3	2u	100u	330J	1,500	50u
Benzo(a)pyrene	2u	1u	100u	20u	810	50u
Dibenzo(a,h)anthracene	2u	1.8J	100u	20u	200u	50u
Indeno(1,2,3-cd)pyrene	2u	1.6	100u	20u	200u	50u
Benzo(g,h,i)perylene	2u	1.2	100u	20u	200u	50u
total 2-3-ring	310	48	--	210	6,100	880
total 4,5,6-ring	82	7.8	880	1,300	16,000	3,200
total PNA	/390/	56	880	1,500	23,000	4,100
Other Compounds						
Dibenzofuran	54	12	100u	20u	880	50u
Pentachlorophenol	17	11	100u	20u	200u	50u
2-methylnaphthalene	4.2	1u	100u	20u	200u	50u

-- = Not analyzed.
u = Not detected at detection limit shown.
J = Estimated concentration.

/—/ = Exceeds EPA criterion (acute toxicity) for the protection of saltwater aquatic life (EPA, 1980b).

Table 3. Pollutant loads to lower Budd Inlet from West Bay drain measured by Ecology February 13 and August 14, 1985.

Date Collected	Sample Number	Constituent	Load (lbs/day)
2/13/85	079013	Low molecular weight PNA	0.54
		High molecular weight PNA	0.15
		Dibenzofuran	0.096
		Pentachlorophenol	0.03
		Total suspended solids	52
8/14/85	338033	Low molecular weight PNA	0.049
		High molecular weight PNA	0.0078
		Dibenzofuran	0.012
		Pentachlorophenol	0.011
		Total suspended solids	16

West Bay drain is the major stormwater discharge point for runoff from the portion of the Port of Olympia shown in Figure 3. This drain also receives stormwater collected along Capitol Way in downtown Olympia. Contaminated ground water beneath the McFarland Cascade facility is in communication with this drainage system (Johnson, 1985).

Sediments

Priority pollutant PNAs were detected in all sediment samples from West Bay. As was the case in the February survey, pentachlorophenol was not detected in West Bay sediments.

The highest PNA levels (23,000 ug/Kg dry weight total PNAs, sample no. 338034) were found intertidally just southwest of the West Bay drain. Individual pollutant concentrations in this sample ranged from 170 ug/Kg naphthalene to 6,300 ug/Kg fluoranthene, Dibenzofuran was also detected in this sample at 880 ug/Kg.

PNA concentrations in an adjacent sediment sample taken northwest of the drain were approximately an order of magnitude lower (1,500 ug/Kg total PNAs, sample no. 338035) than those seen on the southwest side of the drain. This is similar to the results of the previous sample (880 ug/Kg total PNAs, sample no. 079023) collected by Ecology at this location in February (Johnson, 1985).

Subtidally, concentrations of individual PNAs ranged from 39 ug/Kg naphthalene to 1,300 ug/Kg fluoranthene. Total PNAs in this sample (4,100 ug/Kg, sample no. 338036) were also an order of magnitude lower than in intertidal sediment southwest of West Bay drain.

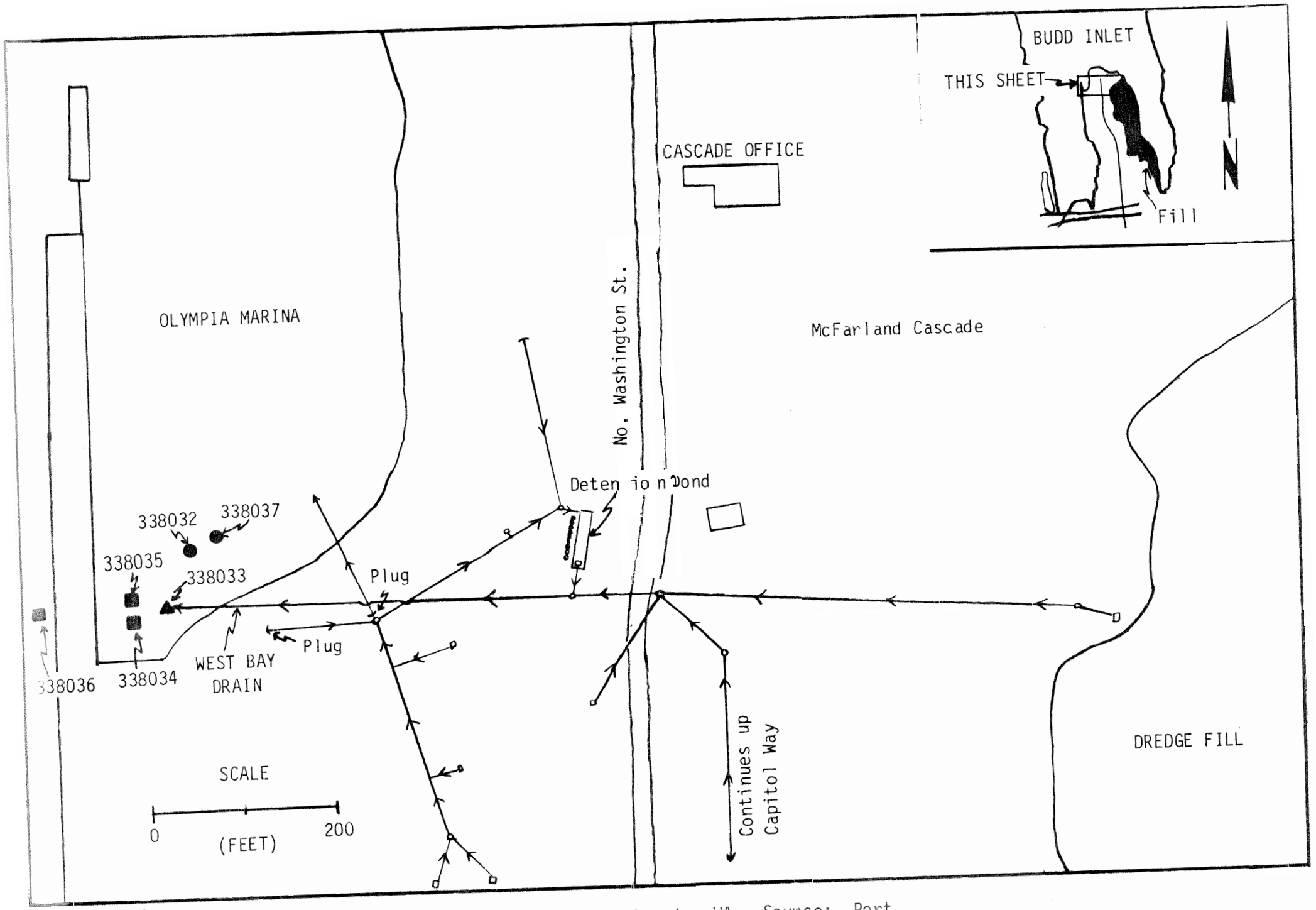

Figure 3. Schematic of West Bay drain, Port of Olympia, WA. Source: Port of Olympia Commission (sampling sites; ▲ = water; ■ = sediment ● = tissue).

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In all sediment samples analyzed from West Bay, high molecular weight PNA compounds predominated. High molecular weight PNAs, are strongly lipophylic and are hence characterized by a low solubility in water and a strong affinity for binding with particulate matter. Consequently, one of the primary removal processes for these compounds in the marine environment is through sedimentation (Lee, et al., 1978). In contrast, low molecular weight PNAs have a greater volatility and a higher solubility in water. Therefore, the predominance of high molecular weight PNAs in West Bay sediments is not unexpected.

The substantial variation in PNA concentrations seen in West Bay sediments does not appear to be a simple function of carbon content which suggests that their distribution is source-related. Considering the close proximity of a number of other potential hydrocarbon sources (marinas and creosoted pilings) in West Bay, it is difficult to fully explain the distribution of PNAs observed in the sediment samples. It is, however, likely that the West Bay drain is a major contributor of PNAs to nearby West Bay sediments.

In East Bay, sediments collected in February from a localized area near McFarland Cascade had particularly elevated concentrations (75,000 to 1,300,000 ug/Kg) of high molecular weight PNAs (Johnson, 1985). In contrast, the largest concentration (16,000 ug/Kg) of high molecular weight PNAs seen in West Bay sediments are approximately two orders of magnitude lower than the largest concentration in East Bay.

The levels of low molecular weight PNAs (6,100 ug/Kg) and dibenzofuran (880 ug/Kg) in the most contaminated West Bay sample (no. 338034) may be sufficient to have deleterious effects on marine life (Table 4). This conclusion is based on comparisons with "apparent effects thresholds" (AET) determined during Superfund investigations of the nearshore/tideflats area of Commencement Bay (Tetra Tech, 1985). These thresholds were developed by comparing biological response (as measured by amphipod and oyster larvae bioasays and abundance of infauna) to sediment chemistry,

Table 4. West Bay sediments: low molecular weight PNA and dibenzofuran data compared to apparent effects thresholds (ug/Kg dry weight).

Location	"Apparent Effects	INTERTIDAL		SUBTIDAL
Sample Number	Thresholds"†	338034	338035	338036
low molecular weight PNAs	5200	/6100/	1300	ND
dibenzofuran	540	/880/	ND	ND

†Tetra Tech, Inc., 1985. Commencement Bay Nearshore/Tideflats Remedial Investigation. Vol. 1 prepared for Wash. St. Dept. Ecology and USEPA.

/ / = Above threshold

ND = Not detected

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Tissue

The results of priority pollutant organics analysis of clam samples collected in lower Budd Inlet are summarized in Table 5. To place these results in perspective, organics concentrations reported for clams from Eagle Harbor and other areas of Puget Sound are also presented.

Priority pollutant PNAs, dibenzofuran and pentachlorphenol, were not detected in clam samples from Priest Point Park. This park, located approximately three-fourths mile north of the McFarland Cascade facility, is the nearest public beach to the facility.

Clams collected in East Bay near McFarland Cascade contained a number of priority pollutant PNAs, with the greatest fraction being high molecular weight compounds. Concentrations of individual compounds reported on a wet-weight basis ranged from 10 ug/Kg fluorene to 360 ug/Kg fluoranthene. The total PNA concentration of 1,100 ug/Kg in this sample is the highest found in clam tissue during the present survey.

The total PNA concentrations measured in West Bay clams (99 to 190 ug/Kg total PNAs) were approximately an order of magnitude lower than in East Bay clams. Concentrations of individual PNAs in West Bay clams ranged from 11 ug/Kg acenaphthene to 56 ug/Kg fluoranthene, with the greatest portion of the PNAs present being high molecular weight compounds. This seems to be in good agreement with what is known about sediment contamination in West Bay. Concentrations of individual PNAs in clams from West Bay were somewhat lower than levels seen in sediments.

In summary, it appears that total PNA concentrations in clams from East Bay near the McFarland Cascade facility in lower Budd Inlet are at the upper end of concentrations reported in urban areas of Puget Sound and in the range of values seen in Eagle Harbor. West Bay clams, however, have PNA concentrations which fall into the lower range of values reported from other urban embayments in Puget Sound.

There are several important points to keep in mind when comparing data on PNA levels in clams from the present survey to results obtained from other investigations. Differences in species analyzed, sample preparation, and analytical techniques can significantly affect reported PNA values. Based on information from the Eagle Harbor investigation (Yake, et al., 1984) it is clear that the NOAA laboratory has in the past been able to achieve consistently higher percent recoveries than the anchester laboratory in analyzing tissue samples. In addition, NOAA uses percent recovery data to adjust their final reported results, while the Manchester laboratory does not. It is probable, therefore, that Manchester PNA results are low with respect to those reported by NOAA in other areas of Puget Sound.

Seventeen additional compounds not found on EPAs list of priority pollutants/ hazardous substances were tentatively identified in water, sediment, and tissue samples collected during this survey (Table 6). The majority of these

Table 5. comparison of polynuclear aromatic hydrocarbon concentrations (PNA) in clams collected from lower Budd Inlet by Ecology August 14, 1985, to PNA concentrations in clams from other parts of Puget Sound (ug/Kg wet weight).

	LOWER BUDD INLET 1/				PUGET SOUND 2/								
Station	Priest Point	East Bay	West Bay		EAGLE HARBOR 3/ (NOAA)	(Ecology)	Case Inlet	Port Madison	Sinclair Inlet	Duwamish Waterway	Seattle Waterfront	Com. Bay Waterways	Hylebos Waterway
Sample Number	338030	338031	338037	338032									
Ancillary Measurements													
Percent Lipids	0.65	0.84	0.69	0.66	--	0.8-1.3	--	--	--	--	--	--	--
Percent Solids	17.9	15.3	15.2	13.8	16.5-18.0	14-18.3	7.3	18	15	16	14	14	16
Priority Pollutant PNAs													
Acenaphthene	10u	17	16	11J	5.4-130	2u-55	1.5u	16u	4.5	27	46u	--	--
Acenaphthylene	10u	20u	10u	10u	--	--	--	--	--	--	--	--	--
Naphthalene	10u	20u	28J	16	6.1-26	2u-6.6	0.7u	5.4u	4.5u	--	11u	13	13u
Fluorene	10u	10J	10u	10u	11-180	2u-82	0.7u	1.8u	1.5u	11	2.8u	8.4	8
Anthracene	10u	22	10u	10u	12-130	2u-67	0.7u	1.8u	6	21	5.6	18	18
Phenantht-ene	10u	120	39J	10u	73-740	14-480	--	--	12u	--	--	57	--
Fluoranthene	10u	360	56	40	200-970	26-560	0.7u	7.2	42	208	14	110	45
Benzo(a)anthracene	50u	77	10u	10u	35-210	2u-210	2.2u	3.6u	68	160	39	100	22
Chrysene	50u	110	10u	10u	120-360	2u-210	0.7u	3.6	54	102	11	69	26
Pyrene	50u	300	52	32	200-920	19-430	0.7u	11	--	157	71	180	45
Benzo(b)fluoranthene and/or Benzo(k)fluoranthene	10u	91	10u	10u	48-120	2u-120	2.9u	5.4u	36	37	34	28	14u
Benzo(a)pyrene	10u	10u	10u	10u	14-58	6u-45	0.7u	1.8u	18	37	14	35	3.2u
Dibenzo(a,h)anthracene	10u	10u	10u	10u	2.5-8.6	12u	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	10u	10u	10u	10u	6.3-11	12u	1.5u	1.8u	3u	5u	5.6u	1.4u	3.2u
Benzo(g,h,i)perylene	10u	10u	10u	10u	7.9-21	12u	--	--	--	--	--	--	--
total 2-3-ring	--	170	83	27	119-1210	16-690	--	--	11	60	5.6	96	30
total 4,5,6-ring	--	940	110	72	566-2680	45-1580	--	22	220	700	180	520	140
total	--	1,100	190	99	685-3880	61-2270	--	22	230	760	190	620	170
Other Compounds													
Dibenzofuran	10u	20u	20u	20u	3.5-120	2u-62	--	--	--	--	--	--	--
Pentachlorophenol	10u	20u	20u	20u	--	0.3-9.3	--	--	--	--	--	--	--

1/ Prototheca staminea, Tapes japonica, and Mya arenaria.

2/ All data except Eagle Harbor from Malins, et al. (1980). Macoma nasuta, M. carlottensis, and Acila castrensis.

3/ Yake, B., J. Joy, and A. Johnson, 1984. "Chemical contaminants in clams and crabs from Eagle Harbor, Washington State, with emphasis on polynuclear aromatic hydrocarbons. Dept. of Ecology. 31 pp. Saxidomus giganteus, Prototheca starninea, and Tapes japonica.

( ) = Laboratory conducting analysis
u = Not detected at detection limit shown.
J = Estimated Value
-- = Not quantified

Table 6. Compounds tentatively identified in water, sediment, and tissue samples collected by Ecology August 14, 1985, in lower Budd Inlet, Olympia, WA. (water - ug/L; sediment ug/Kg dry weight; tissue - ug/Kg wet weight).

Media		Water	Sediment		Tissue
Location		West Bay Drain	West Bay Intertidal		East Bay
Sample Number		338033	338034	338035	338031
Compound	CAS† No.				
1-naphthalene - carboxylic acid	86-55-5	6J	--	--	--
1- methylnaphthalene	90-12-0	200J	--	--	--
1,2-dimethyl naphthalene	573-98-3	--	5700J	--	--
1,2,3 trimethyl-4-propenyl-(E)-naphthalene	26137-53-1	--	1200J	--	--
1,4-dihydro-1,4-methano-naphthalene-9-ol	4796-33-2	47J	--	--	--
1,2,3,4 tetrahydronaphthalene	119-64-2	12J	--	--	--
3,4,5,6 tetramethyl phenanthrene	7343-06-8	--	--	5900J	--
2,3-dihydro-IH inden-1-01	6351-10-6	110J	--	--	--
2,3-dihydro-1-methyl-1H indene and/or isomer	767-58-8	140J	--	--	--
4-methyl dibenzofuran	7320-53-8	--	4900J	--	--
2,6-dimethyl pyridine and/or isomer	108-48-5	240J	--	--	--
3-phenyl 2-propenal	104-55-2	150J	--	--	--
Benzo(b)thiophene	95-15-2	110J	--	--	--
Isoquinoline	119-65-3	63J	--	--	--
2-methyl quindine	91-63-4	33J	--	--	--
4-methyl oxine (E)-benzaldehyde	3717-15-5	11J	--	--	--
Chloro-tris (2-methyl propyl) stannane		--	--	--	860J

J = estimated concentration.
† = Chemical Abstracts Service (CAS) registry numbers.

compounds (primarily methylated aromatic hydrocarbons--especially naphthalenes) were detected in water from the West Bay drain. A number of methylated aromatic hydrocarbons were also seen in water from the West Bay drain during the February survey (Johnson 1985).

SUMMARY

The major findings of this survey are as follows:

1. Nine priority pollutant PNAs were quantified in water from the West Bay drain. Dibenzofuran and pentachlorophenol were also detected at low levels. In addition, 12 non-priority pollutant compounds were tentatively identified.

2. The West Bay drain appears to be a continuing source of PNAs, dibenzofuran, and pentachlorophenol, although contaminant loads to West Bay estimated in August 1985 were somewhat less than those measured in February 1985.

3. Total PNA concentrations in three West Bay sediments collected during this survey ranged from 1,500 to 23,000 ug/Kg. This compares to the 880 ug/Kg reported during the February collection.

4. Concentrations of low molecular weight PNAs (6,100 ug/Kg) and dibenzofuran (880 ug/Kg) detected in one intertidal sediment sample (no. 338034) from West Bay may be sufficient to adversely affect marine life.

5. Clams from East Bay near McFarland Cascade were found to contain high concentrations of priority pollutant PNA concentrations in the range of values seen in Eagle Harbor. Total PNA levels in West Bay clams are about an order of magnitude lower than concentrations in East Bay clams. PNA levels in clams from West Bay appear to fall in the lower range of values reported from other urban embayments in Puget Sound.

6. Priority pollutant PNAs, dibenzofuran and pentachlorophenol were not detected in clams from Priest Point Park.

DN:cp

Attachments

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Appendix 1. Surrogate and matrix spike recovery data (%) for water, sediment, and tissue samples collected August 14, 1985, by Ecology near McFarland Cascade, Olympia, WA.

Media	WATER				SEDIMENT										TISSUE											
Sample Number	338033	338033YJ	338038	338039	338034		338034Y		338034YJ		338035		338036		338030		338031		338031Y		338031YJ		338032		338037	
Analysis	Total	Total	Total	Total	Total	PNA	Total	PNA	Total	PNA	Total	PNA	Total	PNA	Total	PNA	Total	PNA	Total	PNA	Total	PNA	Total	PNA	Total	PNA
SURROGATE SPIKES																										
2-fluorophenol	74	--	57	54	55	--	--	--	--	--	93	--	31	--	59	--	70	--	--	--	--	--	80	--	62	--
D-5 phenol	61	--	35	33	46	--	--	--	--	--	93	--	27	--	59	--	69	--	--	--	--	--	80	--	47	--
D-5 nitrobenzene	100	--	78	74	23	--	--	--	--	--	69	--	20	--	52	--	49	--	--	--	--	--	54	--	38	--
2-fluorobiphenyl	44	--	29	25	48	48	--	47	--	38	61	38	28	17	71	46	64	62	--	55	--	41	44	30	47	40
D-14 terphenyl	98	--	75	81	60	66	--	50	--	60	60	58	39	66	52	48	54	65	--	48	--	52	53	41	54	56
D-12 benzo(a)pyr	103	--	72	80	53	52	--	46	--	55	68	54	30	27	91	111	61	58	--	51	--	45	39	30	51	42
MATRIX SPIKES																										
Acenaphthene	--	69	--	--	--	--	106	48	62	71	--	--	--	--	--	--	--	--	72	61	73	49	--	--	--	--
Acenaphthylene	--	66	--	--	--	--	68	64	62	71	--	--	--	--	--	--	--	--	77	69	76	57	--	--	--	--
Naphthalene	--	23	--	--	--	--	54	40	84	53	--	--	--	--	--	--	--	--	71	62	73	34	--	--	--	--
Fluorene	--	90	--	--	--	--	87	45	121	65	--	--	--	--	--	--	--	--	74	53	76	45	--	--	--	--
Anthracene	--	100	--	--	--	--	85	54	92	81	--	--	--	--	--	--	--	--	59	66	59	63	--	--	--	--
Phenanthrene	--	98	--	--	--	--	114	52	140	90	--	--	--	--	--	--	--	--	86	69	97	67	--	--	--	--
Fluoranthene	--	100	--	--	--	--	62	46	105	116	--	--	--	--	--	--	--	--	63	78	72	71	--	--	--	--
Benzo(a)anthracene	--	94	--	--	--	--	100	46	104	71	--	--	--	--	--	--	--	--	82	60	82	83	--	--	--	--
Chrysene	--	81	--	--	--	--	98	50	87	71	--	--	--	--	--	--	--	--	67	61	73	61	--	--	--	--
Pyrene	--	59	--	--	--	--	96	40	42	92	--	--	--	--	--	--	--	--	39	53	46	56	--	--	--	--
Benzo(b)fluoranthene/Benzo(k)fluoranthene	--	62	--	--	--	--	71	42	79	56	--	--	--	--	--	--	--	--	62	46	67	48	--	--	--	--
Benzo(a)pyrene	--	98	--	--	--	--	86	47	100	65	--	--	--	--	--	--	--	--	87	66	88	61	--	--	--	--
Dibenzo(a,h)anthracene	--	98	--	--	--	--	120	36	178	44	--	--	--	--	--	--	--	--	177	44	182	29	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	96	--	--	--	--	89	44	129	55	--	--	--	--	--	--	--	--	127	48	122	47	--	--	--	--
Benzo(g,h,i)perylene	--	67	--	--	--	--	61	46	87	59	--	--	--	--	--	--	--	--	81	48	79	44	--	--	--	--
2-methylnaphthalene	--	28	--	--	--	--	65	46	79	47	--	--	--	--	--	--	--	--	74	60	74	38	--	--	--	--
2-chloronaphthalene	--	39	--	--	--	--	64	51	78	59	--	--	--	--	--	--	--	--	79	67	80	50	--	--	--	--
Dibenzofuran	--	69	--	--	--	--	81	143	96	58	--	--	--	--	--	--	--	--	66	51	66	43	--	--	--	--
1,3-dichlorobenzene	--	12	--	--	--	--	35	--	8	--	--	--	--	--	--	--	--	--	63	--	69	--	--	--	--	--
1,4-dichlorobenzene	--	13	--	--	--	--	40	--	49	--	--	--	--	--	--	--	--	--	61	--	66	--	--	--	--	--
1,2-dichlorobenzene	--	15	--	--	--	--	42	--	53	--	--	--	--	--	--	--	--	--	61	--	67	--	--	--	--	--
1,2,4-trichlorobenz	--	12	--	--	--	--	43	--	40	--	--	--	--	--	--	--	--	--	60	--	62	--	--	--	--	--
Hexachlorobenzene	--	75	--	--	--	--	50	--	64	--	--	--	--	--	--	--	--	--	49	--	54	--	--	--	--	--
Nitrobenzene	--	63	--	--	--	--	53	--	70	--	--	--	--	--	--	--	--	--	63	--	72	--	--	--	--	--
2,6-dinitrotoluene	--	91	--	--	--	--	63	--	74	--	--	--	--	--	--	--	--	--	70	--	68	--	--	--	--	--
2,4-dinitrotoluene	--	98	--	--	--	--	64	--	82	--	--	--	--	--	--	--	--	--	62	--	62	--	--	--	--	--
Hexachlorobutadiene	--	(7)	--	--	--	--	47	--	57	--	--	--	--	--	--	--	--	--	54	--	54	--	--	--	--	--
Hexachlorocyclopentd	--	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenol	--	100	--	--	--	--	78	--	93	--	--	--	--	--	--	--	--	--	69	--	64	--	--	--	--	--
Pentachlorophenol	--	101	--	--	--	--	47	--	54	--	--	--	--	--	--	--	--	--	67	--	71	--	--	--	--	--
2-chlorophenol	--	94	--	--	--	--	74	--	86	--	--	--	--	--	--	--	--	--	73	--	71	--	--	--	--	--
2-methylphenol	--	111	--	--	--	--	83	--	96	--	--	--	--	--	--	--	--	--	82	--	77	--	--	--	--	--
4-methylphenol	--	121	--	--	--	--	81	--	103	--	--	--	--	--	--	--	--	--	98	--	82	--	--	--	--	--
2-nitrophenol	--	84	--	--	--	--	60	--	69	--	--	--	--	--	--	--	--	--	60	--	57	--	--	--	--	--
4-nitrophenol	--	89	--	--	--	--	64	--	--	--	--	--	--	--	--	--	--	--	--	--	62	--	--	--	--	--
2,4-dimethylphenol	--	143	--	--	--	--	108	--	124	--	--	--	--	--	--	--	--	--	114	--	102	--	--	--	--	--
2,4-dichlorophenol	--	88	--	--	--	--	55	--	68	--	--	--	--	--	--	--	--	--	63	--	60	--	--	--	--	--
4-chloro-3-methylphenol	--	112	--	--	--	--	97	--	110	--	--	--	--	--	--	--	--	--	87	--	78	--	--	--	--	--
2,4,6-trichlorophenol	--	88	--	--	--	--	65	--	78	--	--	--	--	--	--	--	--	--	74	--	69	--	--	--	--	--
2,4,5-trichlorophenol	--	100	--	--	--	--	66	--	78	--	--	--	--	--	--	--	--	--	54	--	50	--	--	--	--	--
2,4-dinitrophenol	--	108	--	--	--	--	78	--	54	--	--	--	--	--	--	--	--	--	34	--	32	--	--	--	--	--
4,6-dinitro-2-methylphenol	--	103	--	--	--	--	54	--	64	--	--	--	--	--	--	--	--	--	37	--	64	--	--	--	--	--
Hexachloroethane	--	16	--	--	--	--	38	--	69	--	--	--	--	--	--	--	--	--	61	--	67	--	--	--	--	--
Bis(2-chloroethoxy)methane	--	91	--	--	--	--	68	--	74	--	--	--	--	--	--	--	--	--	87	--	81	--	--	--	--	--
Dimethylphthalate	--	91	--	--	--	--	65	--	92	--	--	--	--	--	--	--	--	--	68	--	69	--	--	--	--	--
Diethylphthalate	--	94	--	--	--	--	65	--	79	--	--	--	--	--	--	--	--	--	68	--	69	--	--	--	--	--
Di-n-butylphthalate	--	98	--	--	--	--	67	--	74	--	--	--	--	--	--	--	--	--	71	--	73	--	--	--	--	--
Butylbenzylphthalate	--	100	--	--	--	--	57	--	61	--	--	--	--	--	--	--	--	--	47	--	56	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	86	--	--	--	--	58	--	65	--	--	--	--	--	--	--	--	--	45	--	49	--	--	--	--	--
Di-n-octyl phthalate	--	102	--	--	--	--	52	--	52	--	--	--	--	--	--	--	--	--	50	--	53	--	--	--	--	--
Bis(2-chloroethyl)ether	--	85	--	--	--	--	60	--	90	--	--	--	--	--	--	--	--	--	81	--	81	--	--	--	--	--
Bis(2-chloroisopropyl)ether	--	64	--	--	--	--	69	--	47	--	--	--	--	--	--	--	--	--	88	--	89	--	--	--	--	--
4-chlorophenyl phenyl ether	--	68	--	--	--	--	--	--	68	--	--	--	--	--	--	--	--	--	60	--	61	--	--	--	--	--
4-bromophenyl phenyl ether	--	77	--	--	--	--	51	--	60	--	--	--	--	--	--	--	--	--	59	--	63	--	--	--	--	--
N-nitroso-di-n-propylamine	--	99	--	--	--	--	56	--	74	--	--	--	--	--	--	--	--	--	62	--	72	--	--	--	--	--
N-nitrosodiphenylamine(1)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3-nitroaniline	--	52	--	--	--	--	79	--	50	--	--	--	--	--	--	--	--	--	33	--	32	--	--	--	--	--
Benzyl alcohol	--	118	--	--	--	--	80	--	115	--	--	--	--	--	--	--	--	--	29	--	101	--	--	--	--	--
Isophorone	--	92	--	--	--	--	72	--	92	--	--	--	--	--	--	--	--	--	79	--	80	--	--	--	--	--
Benzoic acid	--	74	--	--	--	--	80	--	96	--	--	--	--	--	--	--	--	--	98	--	106	--	--	--	--	--
Benzidine	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3,3-dichloroben d	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

-- = Not analyzed
( ) = Outside QA limit. Source: Federal Register Vol. 49, No. 209, Oct. 26, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule.