A Department of Ecology Report

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Results of Sediment Trap Monitoring during Pier Maintenance along the Seattle Waterfront at Piers 62/63

Summary

Settling particulate matter (SPM) was collected with moored sediment traps in the vicinity of Piers 62/63 along the Seattle Waterfront to evaluate whether piling replacement activities were redistributing contaminated bottom sediments onto an adjacent sediment cap.

The data collected seem to indicate that contaminated bottom sediments were being resuspended in a localized area immediately adjacent to the Pier 62/63 construction site. There were some indications (primarily sediment standard exceedances for low molecular weight polynuclear aromatic hydrocarbons LPAH)) that a portion of this material was reaching a sediment cap located to the north. However, given the magnitude of the sediment standard exceedances on the sediment cap and the short-term duration of the piling replacement project, it does not appear that long-term recontamination of the cap would be expected to occur. A relatively rapid reduction in LPAH levels is also expected due to weathering processes.

The data collected suggest that the use of piling jetting is an acceptable technique for replacement or repair of in-water pilings provided the size and duration of the project is appropriate for the surrounding conditions. Some pre-existing information on the contaminants of concern in the construction area is also desirable.

Background

The Seattle Parks Department applied for and was granted permits to repair Piers 58, 59, 62, and 63 located along the central Seattle Waterfront. During review of the permit application concern was raised that certain in-water construction activities (piling jetting) had the potential to mobilize contaminated sediments located under Piers 62/63 and recontaminate an adjacent clean sediment cap.

by Dale Norton
September 1996
Prepared for Seattle Parks Dept., Berger/Abam Engineers Inc., and Caicos Corp.
Ecology Publication No. 96-334 Waterbody No. WA-09-0010

As a result of these concerns, special monitoring requirements were included in the permittee's Corp Permit (reference #95-2-01958) and Hydraulic Project Approval (control #00-B4768-02) to evaluate redistribution of contaminated sediments during removal and replacement of pilings under Pier 63. The special monitoring requirements called for placement of sediment traps at a minimum of two locations adjacent to the Pier 62/63 construction site. Sediment traps were chosen for use in monitoring due to their ability to collect recently deposited particulates and the availability of other comparable data on the area of interest (Norton and Michelsen, 1995; Hart Crowser, 1990).

It is anticipated that information from this study will be useful to natural resource agencies in determining the potential for sediment redistribution from similar in-water construction activities (i.e., utilizing piling jetting) that occur in the future.

Methods

Sampling

Prior to the start of construction activities, moored sediment traps were deployed at three stations in the vicinity of Piers 62/63. Station locations, shown in Figure 1, were selected to characterize the following types of areas: immediately adjacent to the construction site (S2), on the sediment cap at the nearest point to construction (S1), and a reference location removed from the construction area (S3). All traps were positioned three feet above the bottom. Water depths ranged from 30 feet (MLLW) at station S1 to 55 feet at S3. Sampling began February 14 and ended April 17, 1996 for a total deployment period of 63 days. To collect enough material for a variety of analyses and reduce the possibility of missing data points two independent moorings were installed at each station. Station positions were recorded by measuring distances to fixed on-shore structures with an optical rangefinder. Depth readings were also recorded at each station.

Prior to deployment, the collection cylinders were cleaned with sequential washes of hot tap water/Liquinox® detergent, 10% nitric acid, distilled deionized water, and pesticide-grade acetone, then wrapped in aluminum foil until used in the field. At deployment the traps were filled with two liters of high salinity distilled water (4% NaCl), which contained sodium azide (2%) as a preservative to reduce microbial degradation of the samples during the deployment period.

Upon retrieval of the traps, water overlying the sediment layer in the collection cylinders was removed with a peristaltic pump. The salinity of water immediately overlying the sediment layer was determined to see if the traps had been disturbed and preservative was still present. SPM was then transferred to 1/2 gallon sample containers and taken to the laboratory for processing, where the particulate fraction was isolated with the use of a centrifuge. Prior to determining sample weights and conducting physical and chemical analyses, all visual nekton was removed from the samples.

Analysis

All samples were placed in appropriate containers, properly labeled and held on ice while in the field. Sample tracking procedures followed those outlined in the Manchester Laboratory Users Manual (Ecology, 1991a).

Table 1 summarizes the analytical methods and laboratories used for this project. All chemical analyses of samples for the pier maintenance study were conducted using procedures specified in the Puget Sound Protocols (PSEP, 1986) as amended and updated. In addition the type and frequency of laboratory quality assurance (QA) samples at a minimum followed those specified in the Manchester QA Manual (Ecology, 1988) with the following exception: to reduce the overall project cost, matrix spikes were not performed with this data set.

Quality of the data set was evaluated with the following sample types: internal standards, method blanks, laboratory splits and surrogate spikes. Detailed QA review of the data set was performed by staff at the Ecology/EPA Manchester Laboratory. Individual case narratives and the laboratory data sheets for each sample are included in Appendix A.

Overall, no major analytical problems were encountered in the analysis of samples for this study. Consequently, the data generated are considered acceptable for use as qualified in the following tables and noted in the case narratives.

Unless otherwise indicated, all concentrations in this document are reported on a dry weight basis.

Results

Gross Sedimentation Rates

Sediment accumulation rates for the study area determined from sediment trap data are listed in Table 2. Two types of accumulation rates are listed:

- Mass accumulation ($g/cm^2/yr$), which is the measured sediment flux into the traps
- Accumulation rate (cm/yr), which is calculated to represent the actual thickness of new sediment once the particulates have consolidated on the bottom

Both these values should be viewed as estimates of gross sedimentation (i.e., net sedimentation + resuspension). Calculations used to generate the reported sedimentation rates are shown below:

- Mass accumulation ($g/cm^2/yr$)= [(P/A)/D] x Y

  P= Amount of material collected (dry grams)

A= Collection area of cylinder (cm^2)

D= Number of days sediment trap was deployed

Y= Number of days in a year (365)

- Accumulation rate (cm/yr)= Mass accumulation ($g/cm^2/yr$)/Dry density (g/cm^3)

  Dry density= [Wet density x (Bottom Sediment % solids/100)]

  Wet density= Estimated from Puget Sound Density Model using % solids data from in-situ bottom sediments (Crecelius, 1989)

Mass accumulation rates, on a dry weight basis, ranged from 1.5 to 4.2 $g/cm^2/yr$. Mean sedimentation rates for each of the three stations are shown in Figure 2. The highest rate was measured at station S2 (mean= 3.7 $g/cm^2/yr$) immediately adjacent to the construction site. Mean rates on the sediment cap and the background station were 1.5 $g/cm^2/yr$ and 2.0 $g/cm^2/yr$, respectively. Also shown in Figure 2 are sedimentation rates for the area from two previous studies conducted in 1990 and 1995. In general, rates at stations S1 and S3 are within a factor of 2-3 compared to these earlier rates. The rates at S2 are elevated by a factor of 4-6 compared to the previous data.

These data suggest that piling maintenance activities were resuspending bottom sediments immediately adjacent to Pier 63. However, the substantial increase in sedimentation noted at the construction site appears to be localized in a small area around Piers 62/63.

Chemical Concentrations

The results of percent solids, total organic carbon (TOC), mercury, and polynuclear aromatic hydrocarbons (PAH) analysis of SPM from the vicinity of Pier 63 are summarized in Table 3. Percent solids (post centrifugation) ranged from 29 to 35%. TOC levels were fairly consistent between stations ranging from 2.9 to 4.5%. The highest TOC concentrations were measured at station S2 adjacent to the construction site.

Mercury concentrations were fairly low and similar at S1 (sediment cap) and S2 (Pier 63) with concentrations of 0.39 and 0.34 mg/kg, respectively. In contrast, mercury levels at station S3 (reference) were elevated by approximately a factor of two (0.62 mg/kg) compared to levels at the other two stations.

Organics concentrations were somewhat variable among the three stations monitored. The highest concentrations for all of the individual compounds were measured at station S2, while the lowest concentrations were typically present at the reference station (S3). Low molecular weight PAH (LPAH) concentrations near Piers 63 were elevated by an order of magnitude compared to concentrations measured on the sediment cap (S1). Likewise, high molecular weight PAH

(HPAH) levels at Pier 63 were elevated by approximately a factor of five compared to the sediment cap. Small black chunks of creosote were noted in the sediment trap samples collected at Pier 63. This was the only location where this material was observed.

Figure 3 illustrates the relative distribution of LPAH and HPAH in each of the sediment trap samples. At both the cap and reference site the sum of HPAH exceeded the sum of LPAH compounds. This is a common pattern observed in most aged sediments since weathering processes such as evaporation, photochemical oxidation, dissolution, and microbial degradation tend to preferentially remove PAHs with molecular weights less than that of fluoranthene (Merill and Wade, 1985). In contrast, the sum of LPAH exceeded the sum of HPAH at station S2. This pattern suggests recent sources have played an important role in the PAH contamination observed at this station. The organics data collected seem to confirm the idea that piling maintenance activities were having a substantial impact on sediment quality in a localized area immediately adjacent to Pier 63.

Comparison to Sediment Management Standards

In 1991, Ecology adopted the Sediment Management Standards (SMS), WAC 173-204 (Ecology, 1995). These standards identified specific contaminant levels below which no adverse effects would be observed in benthic communities, the "Sediment Quality Standards - Marine Criteria (MC)". The standards also established "Cleanup Screening Levels (CSL)" which represent the upper limit of allowable minor adverse effects on biological resources. Contaminant concentrations above the CSLs are a high priority for remediation activities.

Concentrations of selected chemicals in SPM are compared to the SMS in Table 4. Seven individual chemicals (primarily LPAHs) exceeded the CSL in SPM adjacent to the construction site at Piers 62/63. In most instances, concentrations of these individual chemicals exceeded the CSL by a factor of five or more. Slight exceedances of the CSL for three individual chemicals were also observed at station S1 located on the sediment cap. However, the magnitude of the exceedances were much less than those observed immediately adjacent to the construction site. Mercury was the only chemical present at concentrations above the CSL at the reference station. Mercury has been identified as a widespread problem along the central Seattle Waterfront area in previous studies (Norton and Michelsen, 1995).

For perspective, data on contaminant levels associated with SPM in the area from two previous studies conducted in 1990 and 1995 are also presented in Table 4. In general, contaminant levels at both S1 (on cap) and S3 (reference) were similar to those determined during these earlier studies. In contrast, LPAH and HPAH levels near the construction site were substantially elevated compared to the earlier studies.

The data collected seem to indicate that piling replacement activities at Piers 62/63 were resuspending contaminated bottom sediments and redistributing them over a localized area

immediately adjacent to the pier. There are some indications (CSL exceedances for LPAHs) that some of this material was reaching the sediment cap located to the north. However, as previously stated, weathering processes tend to degrade LPAHs fairly rapidly in the aquatic environment. Given the magnitude of the CSL exceedances for LPAHs on the sediment cap and the short-term duration of the piling replacement project it does not appear that long-term recontamination of the sediment cap is likely to occur as a result of this construction project. The data collected suggest that the use of piling jetting is an acceptable technique for replacement or repair of in-water pilings, provided the size and duration of the project is appropriate for the surrounding conditions. Some information on the contaminants of concern in the construction area is also desirable.

References

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Hart Crowser, 1990. Pier 64/65 Sediment Quality Assessment Port of Seattle Agreement No. P-032081 Elliott Bay/Seattle Washington. Prepared for the Port of Seattle. Contract No. J-2854.

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Contacts

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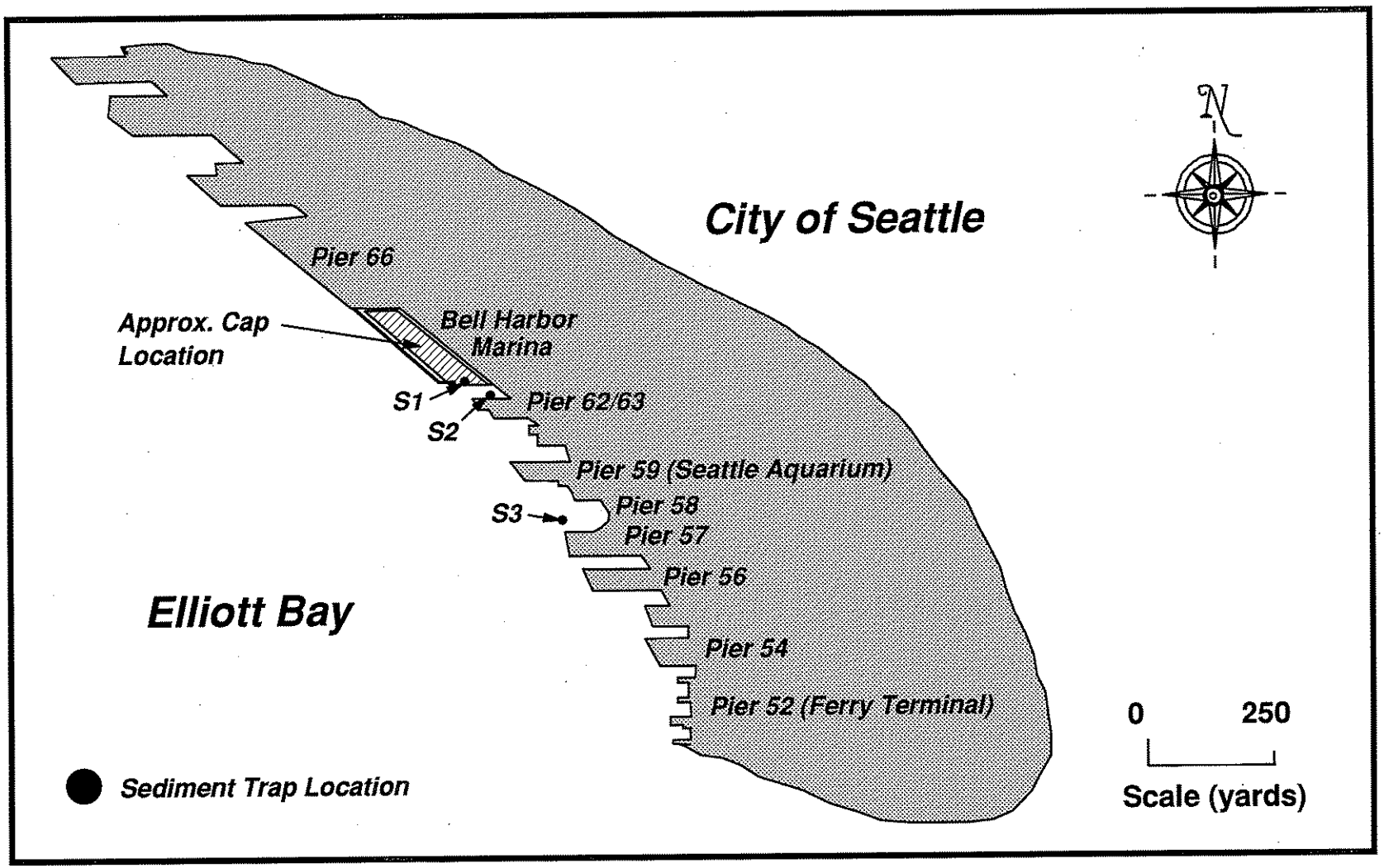

Figure 1: Sediment Trap Sampling Stations for the Seattle Waterfront Pier Maintenance Project.

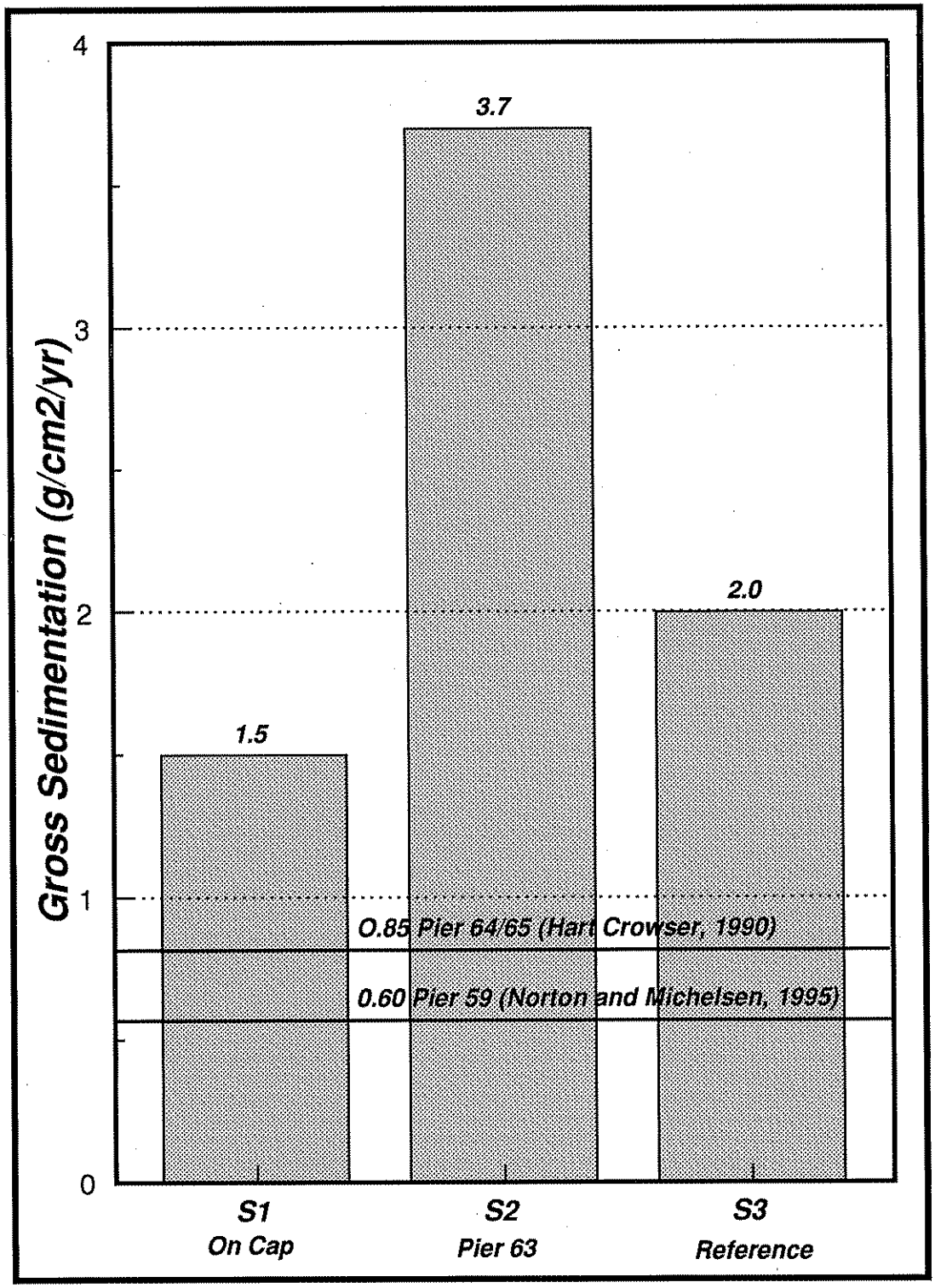

Figure 2: Comparison of Sediment Accumulation Rates in the Vicinity of Piers 62/63.

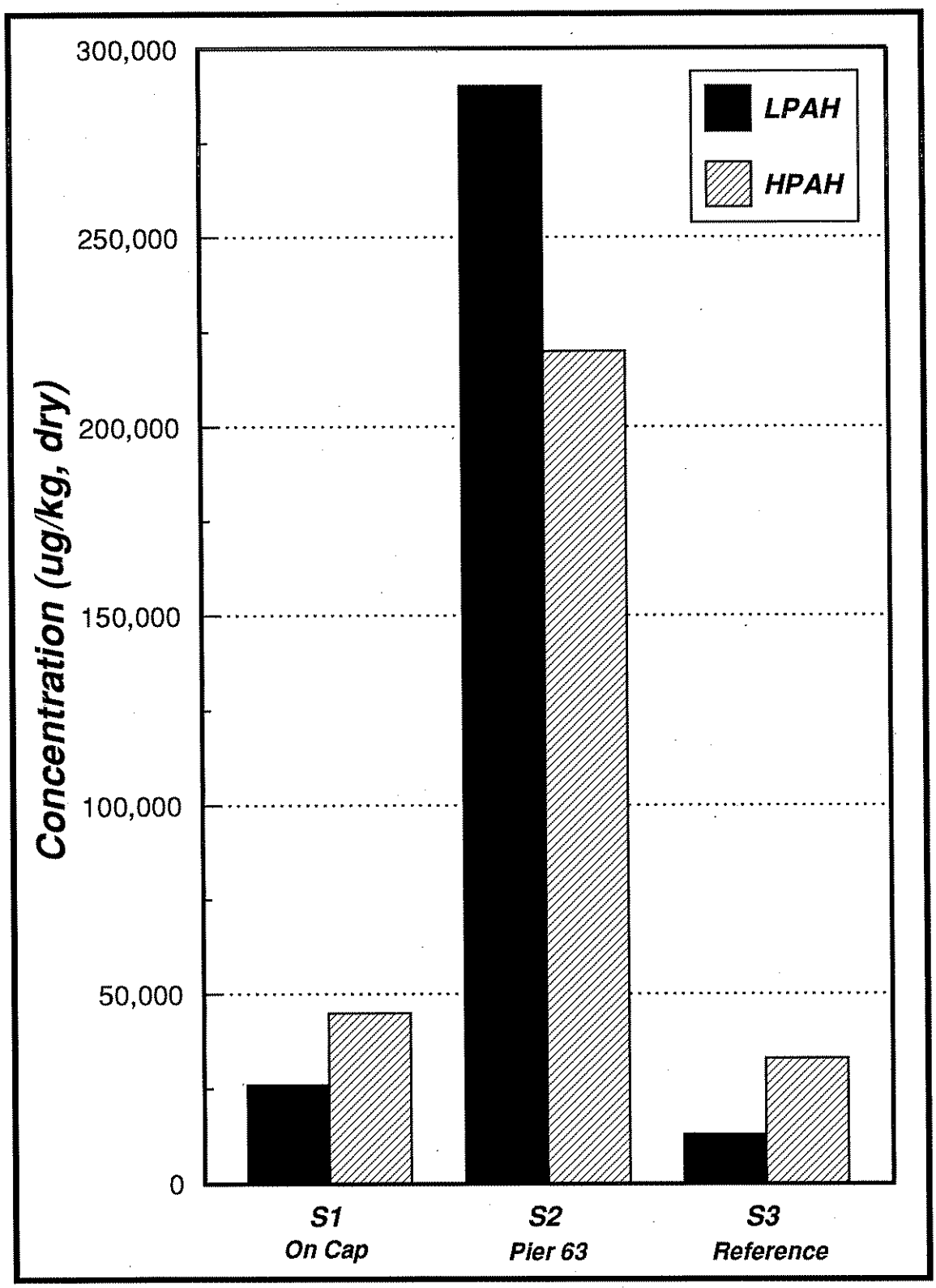

Figure 3: Comparison of PAH Concentrations in Settling Particulate Matter in the Vicinity of Piers 62/63.

Table 1: Analytical methods used for the Seattle Waterfront Pier Maintenance Project.

Analysis	Method	Reference	Laboratory
Percent Solids	Dry @ 104°C	PSEP, 1986	Ecology/EPA- Manchester, WA.
Total Organic Carbon	Combustion/CO2 Measurement	PSEP, 1986	Sound Analytical Services, Inc., Tacoma, WA.
Mercury	CVAA (245.5)	EPA, 1986	Ecology/EPA- Manchester, WA.
Polynuclear Aromatic Hydrocarbons	GC/MS (8270)	EPA, 1986	Ecology/EPA- Manchester, WA.

CVAA= Cold Vapor Atomic Absorption

CC/MS= Gas Chromatography/Mass Spectrometry

Table 2: Gross sediment accumulation rates for the Seattle Waterfront Pier maintenance project, from sediment trap data collected February 14 to April 17 1996.

Station	Deployment Period	Number Days Deployed	Collection Area cm^2	SPM Wet g Collected	SPM Percent Solids	BS Percent Solids	SPM Dry g Collected	Dry Density* g/cm^3	Mass Accumulation g/cm^2/year	Accumulation Rate (cm/year)
S-1A	2/14-4/17/9	63	78.5	67	31.2	39	20.9	0.51	1.5	3.0
-1B	2/14-4/17/9	63	78.5	66	30.2	39	19.9	0.51	1.5	2.9
								Mean=	**1.5**	**3.0**
S-2A	2/14-4/17/9	63	78.5	145	30.0	39	43.5	0.51	3.2	6.3
-2B	2/14-4/17/9	63	78.5	128	44.4	39	56.8	0.51	4.2	8.2
								Mean=	**3.7**	**7.3**
S-3A	2/14-4/17/9	63	78.5	102	26.4	39	26.9	0.51	2.0	3.9
-3B	2/14-4/17/9	63	78.5	85	32.4	39	27.5	0.51	2.0	4.0
								Mean=	**2.0**	**4.0**
								Overall Range=	**1.5-4.2**	**2.9-8.2**
								Overall Mean=	**2.4**	**4.7**

BS= Bottom Sediment

SPM= Settling Particulate Matter

Table 3: Summary of analysis of sediment trap samples collected for the Seattle Waterfront Pier maintenance project, February to April 1996.

Location	Pier 64 On Cap		Adjacent to Pier 63		South of Pier 59 Reference	
Station	S1		S2		S3	
Solids (%)	31		35		29	
Total Organic Carbon (%)	2.9		4.5		3.2	
Mercury (MG/KG, dry)	0.39		0.34		0.62	
ORGANICS (UG/KG, DRY)						
Acenaphthene	2100		42000		1100	
Acenaphthylene	480		1300	j	330	
Naphthalene	990		35000		650	
Fluorene	3400		45000		1700	
Anthracene	7100		29000		3300	
Phenanthrene	12000		140000		6700	
Sum LPAH	26000		290000	j	13000	
Fluoranthene	12000		92000		7200	
Benzo(a)anthracene	4200		17000		3000	
Chrysene	6400		19000		4100	
Pyrene	8000		55000		5500	
Benzofluoranthenes	7000		18000		6100	
Benzo(a)pyrene	3300		7700		3000	
Dibenzo(a,h)anthracene	490	j	1500	j	610	j
Indeno(1,2,3-cd)pyrene	1800		5200	j	2000	
Benzo(g,h,i)perylene	1600		3000		1700	
Sum HPAH	45000	j	220000	j	33000	j
Total PAH	71000	j	510000	j	46000	j
Dibenzofuran	2000		34000		970	
Retene	450		1200	j	1000	
Carbazole	1600		8200		750	
1-methylnaphthalene	570		17000		300	
2-methylnaphthalene	1300		35000		620	
2-chloronaphthalene	160	u	1500	u	150	u

u= Not detected at detection limit shown

j= Estimated concentration

Table 4: Comparison of mercury and selected organics in sediment trap samples to Ecology's Sediment Management Standards (WAC 173-204) and other data on the central Seattle Waterfront.

Location	Pier 64	Adjacent to	South of Pier 59			Central Seattle	
	On Cap	Pier 63	Reference	Sediment Standards		Waterfront[1]	
Station	S1	S2	S3	MC	CSL	median(range)	Pier 64/65[2]
Total Organic Carbon (%)	2.9	4.5	3.2	-	-	6.9 (3.2-18.7)	4.3
METALS (MG/KG, DRY)							
Mercury	0.39	0.34	0.62	0.41	0.59	0.89 (0.5-4.4)	0.75
ORGANICS (MG CHEMICAL/KG ORGANIC CARBON)							
Acenaphthene	72	930	34	16	57	-	13
Acenaphthylene	17	29 j	10	66	66	-	26
Naphthalene	34	780	20	99	170	-	5.3
Fluorene	120	1000	53	23	79	-	26
Anthracene	240	640	100	220	1200	-	170
Phenanthrene	410	3100	210	100	480	-	160
Sum LPAH	890	6500 j	430	370	780	660 (140-2400)	400
Fluoranthene	410	**2000**	230	160	1200	-	330
Benzo(a)anthracene	140	**380**	94	110	270	-	210
Chrysene	220	420	130	110	460	-	350
Pyrene	280	1200	170	1000	1400	-	300
Benzofluoranthenes	240	400	190	230	450	-	440
Benzo(a)pyrene	110	170	94	99	210	-	230
Dibenzo(a,h)anthracene	17 j	33 j	19 j	12	33	-	35
Indeno(1,2,3-cd)pyrene	62	120 j	63	34	88	-	110
Benzo(g,h,i)perylene	55	67	53	31	78	-	98
Sum HPAH	1500 j	4800 j	1000 j	960	5300	1300 (260-7100)	2100
Dibenzofuran	69	760	30	15	58	45 (10-220)	-
2-methylnaphthalene	45	780	19	38	64	700 (140-2400)	-

u= Not detected at detection limit shown

j= Estimated concentration

MC= Sediment Quality Standards- Marine Criteria

CSL= Cleanup Screening Level

[1]= Elliott Bay Waterfront Recontamination Study: Vol. 1 (Norton and Michelsen, 1995)

[2]= Pier 64/65 Sediment Quality Assessment (Hart Crowser, 1990)

= Exceeds the CSL

Appendix A

Results of Laboratory Analysis

State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East Port Orchard WA. 98366

May 9, 1996

Project: Seattle Aquarium

Samples: 16-8072, 8075, 8078

Laboratory: Sound Analytical

By: Pam Covey

Case Summary

These samples were received at the Manchester Environmental Laboratory (MEL) on April 19, 1996 and sent to Sound Analytical on April 24, 1996 for TOC analysis using PSEP method.

The samples were analyzed within acceptable holding limits, and the method blank associated with these samples has shown the process is free from contamination.

One sample was analyzed in triplicate and was within acceptable limits for the Relative Percent Difference (RPD).

For consistency with MEL reporting protocol, all non-detect values have been qualified with a "U" (the analyte was not detected at or above the reported result).

The results are acceptable for use as amended.

SOUND ANALYTICAL SERVICES, INC.

ANALYTICAL & ENVIRONMENTAL CHEMISTS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: WA St. Dept. of Ecology Date: May 6, 1996

Report On: Analysis of Solid Report No.: 56147

IDENTIFICATION:
Samples received on 04-24-96
Project: Seattle Aquarium

ANALYSIS:

TOC Per PSEP
Date Analyzed: 5-3-96
Units: mg/kg

Lab Sample No.	Client ID	Result	%	PQL
56147-1	16-8072	29,000	2.9	100
56147-2	16-8075	45,000	4.5	100
56147-3	16-8078	32,000	3.2	100

ND - Not Detected
PQL - Practical Quantitation Limit

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

QUALITY CONTROL REPORT

General Chemistry

Client: WA St. Dept. of Ecology
Lab No: 56147q
Units: mg/kg

QC Batch No. 256
Date Analyzed: 5-3-96

METHOD BLANK

Parameter	Result	PQL
Total Organic Carbon	100U ND	100

ND = Not Detected
PQL = Practical Quantitation Limit

TRIPLICATE

Parameter	Sample Result	Duplicate Result	Triplicate Result	%RSD
Total Organic Carbon	31,200	31,300	29,800	2.7

%RSD = Percent Relative Standard Deviation

May 1, 1996

To: Dale Norton

From: Randy Knox, Metals Chemist

Subject: Seattle Aquarium Project RB/L Water

QUALITY ASSURANCE SUMMARY

Data quality for this project is excellent. No significant quality assurance issues are noted with the data.

SAMPLE INFORMATION

The samples from the Seattle Aquarium Project were received by the Manchester Laboratory on 4/19/96 in good condition.

HOLDING TIMES

All analyses were performed within the USEPA Contract Laboratory Program (CLP) holding times for metals analysis (28 days for mercury, 180 days for all other metals).

INSTRUMENT CALIBRATION

Instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. Continuing calibration standards and blanks were analyzed at a frequency of 10% during the run and again at the end of the analytical run. All initial and continuing calibration verification standards were within the relevant USEPA (CLP) control limits. AA calibration gave a correlation coefficient (r) of 0.995 or greater, also meeting CLP calibration requirements.

PROCEDURAL BLANKS

The procedural blanks associated with these samples show no analytically significant levels of analytes.

SPIKED SAMPLES ANALYSIS

Spiked and duplicate spiked sample analysis were not performed on this data set.

PRECISION DATA

Precision data was not requested for this data set.

LABORATORY CONTROL SAMPLE (LCS) ANALYSIS

LCS analyses are within the windows established for each parameter.

Please call Bill Kammin at SCAN 360-871-8801 to further discuss this project.

RLK:rlk

Manchester Environmental Laboratory

Department of Ecology

Analysis Report for

Mercury

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Project Officer: Dale Norton
Date Reported: 30-APR-96

Method: EPA245.5
Matrix: Sediment/Soil
Analyte: Mercury

Sample	QC	Field ID	Result	Qualifier	Units	Received	Analyzed
96168072		SA1-C	0.124		mg/Kg, wet	04/19/96	04/30/96
96168075		SA2-C	0.119		mg/Kg, wet	04/19/96	04/30/96
96168078		SA3-C	0.182		mg/Kg, wet	04/19/96	04/30/96
27061310		SHGLC1845	100 %				04/30/96
BLN61311		SHGPB1845	0.005	U	mg/Kg		04/30/96

Authorized By: Randy L. Knox Release Date: 5-1-96 Page: 1

Washington State Department of Ecology
Manchester Laboratory

May 1, 1996

TO: Dale Norton

FROM: Aileen Smith

SUBJECT: General Chemistry Quality Assurance memo:
Seattle Aquarium Sediment Traps, week 16

SUMMARY

The data generated by the analyses of these samples is acceptable for use.

SAMPLE INFORMATION

These samples were received by Manchester Laboratory on 4/19/96 in good condition.

HOLDING TIMES

Analysis of these samples was performed within the EPA holding time for Percent Solids.

ANALYSIS PERFORMANCE

Instrument Calibration

Ovens have the temperature recorded before and after sample drying. Oven temperature was within control limits.

Precision Data

Results from replicate analyses were used to evaluate precision and were within acceptable limits..

Other Quality Assurance Measures and Issues

Please call Aileen Smith at Scan 360-871-8823, or Becky Bogaczyk if you have any questions.

cc: Bill Kammin
Project file

Manchester Environmental Laboratory

Department of Ecology

Analysis Report for

Percent solids soil/tissue

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Project Officer: Dale Norton
Date Reported: 26-APR-96

Method: EPA160.3
Matrix: Sediment/Soil
Analyte: Solids

Sample	QC	Field ID	Result	Qualifier	Units	Received	Analyzed
96168070		SA1-A	**31.2**		%	04/19/96	04/24/96
96168071		SA1-B	**30.2**		%	04/19/96	04/24/96
96168073		SA2-A	**31.2**		%	04/19/96	04/24/96
96168073	Duplicate		**28.1**		%	04/19/96	04/24/96
96168074		SA2-B	**44.4**		%	04/19/96	04/24/96
96168076		SA3-A	**26.4**		%	04/19/96	04/24/96
96168077		SA3-B	**32.4**		%	04/19/96	04/24/96

Authorized By: Arleen Smith Release Date: 5/1/96

MANCHESTER ENVIRONMENTAL LABORATORY

7411 Beach Drive E , Port Orchard Washington 98366

CASE NARRATIVE

June 19, 1996

Subject: Seattle Aquarium

Samples: 96 - 168072, -168075 and -168078

Case No. 1275 - 96

Officer: Dale Norton

By: Dickey D. Huntamer
Organics Analysis Unit

SEMIVOLATILE ORGANICS
Polynuclear Aromatic Hydrocarbons

ANALYTICAL METHODS:

The semivolatile soil samples were Soxhlet extracted with acetone following the Manchester modification of the EPA SW 846 8270 procedure with capillary GC/MS analysis of the sample extracts.. Normal QA/QC procedures were performed with the analyses except for matrix spikes.

HOLDING TIMES:

All sample and extraction holding times were within the recommended limits.

BLANKS:

Low levels of some target compounds were detected in the laboratory blanks. The EPA five times rule was applied to all target compounds which were found in the blank. Compounds that were found in the sample and in the blank were considered real and not the result of contamination if the levels in the sample are greater than or equal to five times the amount of compounds in the associated method blank.

SURROGATES:

The normal surrogate compounds were added to the sample prior to extraction. The surrogate spike recoveries were within acceptable QC limits.

MATRIX SPIKE AND MATRIX SPIKE DUPLICATE:

No matrix spikes were analyzed with these samples.

SPECIAL ANALYTICAL PROBLEMS:

No special analytical problems were encountered in the polynuclear aromatic hydrocarbon analyses. High concentrations of target analytes were found in sample -168075. A dilution of sample 96-168075 (DIL-1) was analyzed to bring the analytes concentrations into the linear calibration range of the instrument. The data is acceptable for use as reported.

DATA QUALIFIER CODES:

U	-	The analyte was not detected at or above the reported value.
J	-	The analyte was positively identified. The associated numerical value is an estimate.
UJ	-	The analyte was not detected at or above the reported estimated result.
REJ	-	The data are unusable for all purposes.
EXP	-	The result is equal to the number before EXP times 10 to the power of the number after EXP. As an example 3EXP6 equals 3×10^6.
NAF	-	Not analyzed for.
N	-	For organic analytes there is evidence the analyte is present in this sample.
NJ	-	There is evidence that the analyte is present. The associated numerical result is an estimate.
E	-	This qualifier is used when the concentration of the associated value exceeds the known calibration range.
bold	-	The analyte was present in the sample. (Visual Aid to locate detected compound on report sheet.)

Manchester Environmental Laboratory

Department of Ecology

Analysis Report for

Polyaromatic Hydrocarbons (PNA's)

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Sample: 96168072 **Date Received:** 04/19/96 **Method:** SW8270
Field ID: SA1-C **Date Prepared:** 04/23/96 **Matrix:** Sediment/Soil
Project Officer: Dale Norton **Date Analyzed:** 05/22/96 **Units:** ug/Kg Dry Wt.

Analyte	Result	Qualifier
Naphthalene	**990**	
2-Methylnaphthalene	**1290**	
1-Methylnaphthalene	**571**	
2-Chloronaphthalene	162	U
Acenaphthylene	**479**	
Acenaphthene	**2080**	
Dibenzofuran	**2000**	
Fluorene	**3400**	
Phenanthrene	**12200**	
Anthracene	**7100**	
Carbazole	**1570**	
Fluoranthene	**12400**	
Pyrene	**8000**	
Retene	**445**	
Benzo(a)anthracene	**4220**	
Chrysene	**6400**	
Benzo(b)fluoranthene	**5190**	
Benzo(k)fluoranthene	**1780**	
Benzo(a)pyrene	**3250**	
Indeno(1,2,3-cd)pyrene	**1840**	
Dibenzo(a,h)anthracene	**490**	**J**
Benzo(ghi)perylene	**1560**	

Surrogate Recoveries

2-Fluorophenol	**64**	**%**
D5-Phenol	**78**	**%**
D4-2-Chlorophenol	**70**	**%**
1,2-Dichlorobenzene-D4	**40**	**%**
D5-Nitrobenzene	**63**	**%**
2-Fluorobiphenyl	**71**	**%**
D10-Pyrene	**74**	**%**
D14-Terphenyl	**93**	**%**

Authorized By: D. Norton Release Date: 6/19/96 Page: 1

Manchester Environmental Laboratory

Department of Ecology

Analysis Report for

Polyaromatic Hydrocarbons (PNA's)

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Sample: 96168072 **Date Received:** 04/19/96 **Method:** SW8270
Field ID: SA1-C **Date Prepared:** 04/23/96 **Matrix:** Sediment/Soil
Project Officer: Dale Norton **Date Analyzed:** 05/22/96 **Units:** ug/Kg Dry Wt.

Tentatively Identified Compounds

CAS Number	Analyte Description	Result	Qualifier
673325	*Benzene, 1-Propynyl-*	758	NJ
1123097	*2-Cyclohexen-1-One, 3,5-Dimethyl-*	2960	NJ
2613890	*Propanedioic Acid, Phenyl-*	1530	NJ
827543	*Naphthalene, 2-Ethenyl-*	476	NJ
575439	*Naphthalene, 1,6-Dimethyl-*	761	NJ
571584	*Naphthalene, 1,4-Dimethyl-*	554	NJ
569415	*Naphthalene, 1,8-Dimethyl-*	316	NJ
581408	*Naphthalene, 2,3-Dimethyl-*	414	NJ
4695130	*Benzeneacetamide, .alpha.-phenyl-*	462	NJ
7320538	*Dibenzofuran, 4-Methyl-*	626	NJ
*3005001	*Unknown Hydrocarbon 01*	3840	NJ
544638	*Decanoic Acid, Tetra-*	17900	NJ
*3008001	*Unknown 01*	9400	NJ
*3008002	*Unknown 02*	4080	NJ
*3008003	*Unknown 03*	8860	NJ
56875673	*7-Hexadecenoic acid, methyl*	796	NJ
613127	*Anthracene, 2-Methyl-*	1830	NJ
112390	*Decanoic Acid, Methyl Ester Hexa-*	1540	NJ
610480	*Anthracene, 1-Methyl-*	2160	NJ
109295	*Oxacycloheptadecan-2-one*	16300	NJ
57103	*Hexadecanoic Acid*	49400	NJ
35465715	*2-Phenylnaphthalene*	2110	NJ
10544500	*Sulfur, Mol. (S8)*	3100	NJ
150867	*Phytol*	6880	NJ
57114	*Octadecanoic Acid*	7890	NJ
238846	*11h-Benzo[A]Fluorene*	1230	NJ
243174	*11h-Benzo[B]Fluorene*	1420	NJ
2381217	*Pyrene, 1-Methyl-*	640	NJ
*3008004	*Unknown 04*	6360	NJ
205436	*Benzo[b]naphtho[1,2-d]thiophene*	538	NJ
203123	*Benzo[ghi]fluoranthene*	993	NJ
195197	*Benzo[c]phenanthrene*	599	NJ
*3008005	*Unknown 05*	2540	NJ
*3005002	*Unknown Hydrocarbon 02*	1830	NJ
198550	*Perylene*	487	NJ

Authorized By: D. Norton Release Date: 6/19/96

Manchester Environmental Laboratory

Department of Ecology

Analysis Report for

Polyaromatic Hydrocarbons (PNA's)

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Sample: 96168072 **Date Received:** 04/19/96 **Method:** SW8270
Field ID: SA1-C **Date Prepared:** 04/23/96 **Matrix:** Sediment/Soil
Project Officer: Dale Norton **Date Analyzed:** 05/22/96 **Units:** ug/Kg Dry Wt.

Tentatively Identified Compounds (continued)

CAS Number	Analyte Description	Result	Qualifier
34347289	*Cholesta-5,22-dien-3-ol, (3.beta.)-*	4920	NJ
57885	*Cholesterol*	12800	NJ
313042	*Desmosterol*	4780	NJ

Authorized By: _____ Release Date: 6/19/96 Page: 3

Manchester Environmental Laboratory

Department of Ecology

Analysis Report for

Polyaromatic Hydrocarbons (PNA's)

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Sample: 96168075 **Date Received:** 04/19/96 **Method:** SW8270
Field ID: SA2-C **Date Prepared:** 04/23/96 **Matrix:** Sediment/Soil
Project Officer: Dale Norton **Date Analyzed:** 05/22/96 **Units:** ug/Kg Dry Wt.

Analyte	Result	Qualifier
Naphthalene	26300	E
2-Methylnaphthalene	27500	E
1-Methylnaphthalene	15500	
2-Chloronaphthalene	151	U
Acenaphthylene	1580	
Acenaphthene	31400	E
Dibenzofuran	26600	E
Fluorene	33100	E
Phenanthrene	90800	E
Anthracene	24800	E
Carbazole	8670	
Fluoranthene	67300	E
Pyrene	47100	E
Retene	551	
Benzo(a)anthracene	17500	
Chrysene	20000	
Benzo(b)fluoranthene	13400	
Benzo(k)fluoranthene	4800	
Benzo(a)pyrene	8170	
Indeno(1,2,3-cd)pyrene	3760	
Dibenzo(a,h)anthracene	1040	
Benzo(ghi)perylene	3370	

Surrogate Recoveries

2-Fluorophenol	76	%
D5-Phenol	89	%
D4-2-Chlorophenol	81	%
1,2-Dichlorobenzene-D4	44	%
D5-Nitrobenzene	72	%
2-Fluorobiphenyl	76	%
D10-Pyrene	87	%
D14-Terphenyl	98	%

Authorized By: _____ Release Date: 6/19/96 Page: 1

Manchester Environmental Laboratory

Department of Ecology

Analysis Report for

Polyaromatic Hydrocarbons (PNA's)

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Sample: 96168075 (Dilution - DIL1) **Date Received:** 04/19/96 **Method:** SW8270
Field ID: SA2-C **Date Prepared:** 04/23/96 **Matrix:** Sediment/Soil
Project Officer: Dale Norton **Date Analyzed:** 05/22/96 **Units:** ug/Kg Dry Wt.

Analyte	Result	Qualifier
Naphthalene	35200	
2-Methylnaphthalene	35400	
1-Methylnaphthalene	17400	
2-Chloronaphthalene	1510	U
Acenaphthylene	1270	J
Acenaphthene	42300	
Dibenzofuran	33600	
Fluorene	45400	
Phenanthrene	135000	
Anthracene	28800	
Carbazole	8160	
Fluoranthene	91800	
Pyrene	55300	
Retene	1220	J
Benzo(a)anthracene	16800	
Chrysene	18800	
Benzo(b)fluoranthene	12500	
Benzo(k)fluoranthene	5280	
Benzo(a)pyrene	7690	
Indeno(1,2,3-cd)pyrene	5200	J
Dibenzo(a,h)anthracene	1490	J
Benzo(ghi)perylene	3020	

Surrogate Recoveries

2-Fluorophenol	66	%
D5-Phenol	66	%
D4-2-Chlorophenol	66	%
1,2-Dichlorobenzene-D4	40	%
D5-Nitrobenzene	89	%
2-Fluorobiphenyl	71	%
D10-Pyrene	78	%
D14-Terphenyl	80	%

Authorized By: _____ Release Date: 6/19/96

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Department of Ecology

Analysis Report for

Polyaromatic Hydrocarbons (PNA's)

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Sample: 96168078 **Date Received:** 04/19/96 **Method:** SW8270
Field ID: SA3-C **Date Prepared:** 04/23/96 **Matrix:** Sediment/Soil
Project Officer: Dale Norton **Date Analyzed:** 05/22/96 **Units:** ug/Kg Dry Wt.

Analyte	Result	Qualifier
Naphthalene	651	
2-Methylnaphthalene	617	
1-Methylnaphthalene	301	
2-Chloronaphthalene	147	U
Acenaphthylene	331	
Acenaphthene	1130	
Dibenzofuran	969	
Fluorene	1650	
Phenanthrene	6650	
Anthracene	3290	
Carbazole	754	
Fluoranthene	7170	
Pyrene	5470	
Retene	1020	
Benzo(a)anthracene	3030	
Chrysene	4120	
Benzo(b)fluoranthene	4410	
Benzo(k)fluoranthene	1640	
Benzo(a)pyrene	3040	
Indeno(1,2,3-cd)pyrene	2000	
Dibenzo(a,h)anthracene	609	J
Benzo(ghi)perylene	1720	

Surrogate Recoveries

2-Fluorophenol	70	%
D5-Phenol	80	%
D4-2-Chlorophenol	74	%
1,2-Dichlorobenzene-D4	45	%
D5-Nitrobenzene	69	%
2-Fluorobiphenyl	73	%
D10-Pyrene	77	%
D14-Terphenyl	92	%

Authorized By: _____ Release Date: 6/19/96 Page: 1

Manchester Environmental Laboratory

Department of Ecology

Analysis Report for

Polyaromatic Hydrocarbons (PNA's)

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Sample: 96168078 **Date Received:** 04/19/96 **Method:** SW8270
Field ID: SA3-C **Date Prepared:** 04/23/96 **Matrix:** Sediment/Soil
Project Officer: Dale Norton **Date Analyzed:** 05/22/96 **Units:** ug/Kg Dry Wt.

Tentatively Identified Compounds

CAS Number	Analyte Description	Result	Qualifier
767000	*Benzonitrile, 4-hydroxy*	2130	NJ
*3005001	*Unknown Hydrocarbon 01*	2350	NJ
*3005002	*Unknown Hydrocarbon 02*	1220	NJ
544638	*Decanoic Acid, Tetra-*	13800	NJ
*3008001	*Unknown 01*	4640	NJ
*3008002	*Unknown 02*	1840	NJ
*3008003	*Unknown 03*	1880	NJ
1120258	*9-Hexadecenoic Acid, Methyl Ester, (Z)-*	1750	NJ
5129602	*Pentadecanoic Acid, 14-Methyl-, Methyl Ester*	3950	NJ
2091294	*9-Hexadecenoic Acid*	28500	NJ
57103	*Hexadecanoic Acid*	59200	NJ
*3008004	*Unknown 04*	2150	NJ
10544500	*Sulfur, Mol. (S8)*	2220	NJ
150867	*Phytol*	2940	NJ
57114	*Octadecanoic Acid*	13200	NJ
243174	*11h-Benzo[B]Fluorene*	1610	NJ
*3008005	*Unknown 05*	5870	NJ
25732745	*3,4-Dihydrocyclopenta(cd)py*	722	NJ
192972	*Pyrene, Benzo[E]-*	3600	NJ
198550	*Perylene*	557	NJ
57885	*Cholesterol*	22400	NJ

Authorized By: D. Hinton Release Date: 6/10/96

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Analysis Report for

Polyaromatic Hydrocarbons (PNA's)

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Sample: BLN61224 **Method:** SW8270
Blank ID: BS6114A **Date Prepared:** 04/23/96 **Matrix:** Sediment/Soil
Project Officer: Dale Norton **Date Analyzed:** 05/22/96 **Units:** ug/Kg Dry Wt.

Analyte	Result	Qualifier
Naphthalene	79	U
2-Methylnaphthalene	79	U
1-Methylnaphthalene	79	U
2-Chloronaphthalene	79	U
Acenaphthylene	79	U
Acenaphthene	79	U
Dibenzofuran	79	U
Fluorene	79	U
Phenanthrene	79	U
Anthracene	79	U
Carbazole	79	U
Fluoranthene	79	U
Pyrene	79	U
Retene	158	U
Benzo(a)anthracene	79	U
Chrysene	79	U
Benzo(b)fluoranthene	79	U
Benzo(k)fluoranthene	79	U
Benzo(a)pyrene	158	U
Indeno(1,2,3-cd)pyrene	396	U
Dibenzo(a,h)anthracene	396	U
Benzo(ghi)perylene	79	U

Surrogate Recoveries

2-Fluorophenol	**46**	%
D5-Phenol	**58**	%
D4-2-Chlorophenol	**52**	%
1,2-Dichlorobenzene-D4	**50**	%
D5-Nitrobenzene	**59**	%
2-Fluorobiphenyl	**51**	%
D10-Pyrene	**70**	%
D14-Terphenyl	**76**	%

Authorized By: D. Norton Release Date: 6/19/96 Page: 1

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Department of Ecology

Analysis Report for

Polyaromatic Hydrocarbons (PNA's)

Project Name: Seattle Aquarium **LIMS Project ID:** 1275-96

Sample: BLN61225 **Method:** SW8270
Blank ID: BS6114AD **Date Prepared:** 04/23/96 **Matrix:** Sediment/Soil
Project Officer: Dale Norton **Date Analyzed:** 05/22/96 **Units:** ug/Kg Dry Wt.

Analyte	Result	Qualifier
Naphthalene	79	U
2-Methylnaphthalene	79	U
1-Methylnaphthalene	79	U
2-Chloronaphthalene	79	U
Acenaphthylene	79	U
Acenaphthene	79	U
Dibenzofuran	79	U
Fluorene	79	U
Phenanthrene	79	U
Anthracene	79	U
Carbazole	79	U
Fluoranthene	79	U
Pyrene	79	U
Retene	158	U
Benzo(a)anthracene	79	U
Chrysene	79	U
Benzo(b)fluoranthene	79	U
Benzo(k)fluoranthene	79	U
Benzo(a)pyrene	158	U
Indeno(1,2,3-cd)pyrene	396	U
Dibenzo(a,h)anthracene	396	U
Benzo(ghi)perylene	79	U

Surrogate Recoveries

2-Fluorophenol	**73**	**%**
D5-Phenol	**79**	**%**
D4-2-Chlorophenol	**77**	**%**
1,2-Dichlorobenzene-D4	**64**	**%**
D5-Nitrobenzene	**71**	**%**
2-Fluorobiphenyl	**65**	**%**
D10-Pyrene	**73**	**%**
D14-Terphenyl	**79**	**%**

Authorized By: D. Hamilton Release Date: 6/19/96 Page: 1