



**Norfolk Combined Sewer Overflow
(Duwamish River)
Sediment Cap Recontamination**

Phase I Investigation

February 2003

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Norfolk Combined Sewer Overflow (Duwamish River) Sediment Cap Recontamination

Phase I Investigation

by
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Abstract

Sediments were sampled for PCBs in the vicinity of the Norfolk Combined Sewer Overflow (CSO) outfall on the Duwamish River, where a cleanup was conducted in 1999. The cleanup involved dredging of contaminated sediment and backfilling with clean sand.

PCB-contaminated sediment found outside the cleanup area could potentially erode and move onto the clean backfill sediment cap. The contamination, located in the vicinity of a Boeing storm drain outfall, exceeds Sediment Management Standards. Below the outfall, PCB recontamination was found at one location within the cleanup area.

In general, results from this study are consistent with previous findings from post-remedial monitoring conducted by King County. However, PCB contamination also was found above Sediment Management Standards at one location not previously sampled by King County, between the Boeing storm drain and Norfolk CSO outfalls.

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Introduction

Contaminated sediments in the Duwamish River near the Norfolk Combined Sewer Overflow (CSO) were removed in 1999 by dredging and replaced by clean backfill sediment. This cleanup followed an investigation showing that the sediments were contaminated with mercury, 1,4-dichlorobenzene, bis(2-ethylhexyl)phthalate, and polychlorinated biphenyls (PCBs) at concentrations exceeding Washington State Sediment Management Standards (SMS) sediment chemical criteria values (EBDRP, 1996).

Post cleanup monitoring by King County has raised concerns about possible recontamination of the sediments with PCBs. No other chemicals are implicated in the recontamination. Data from the 2001 sampling round showed an increase in PCB concentrations within the cleanup area (King County, 2001). However, these data are from only four monitoring locations. Data from the 2002 sampling round did not show an increase in PCB concentrations over 2001 at all four monitoring locations (King County, 2002).

Due to concern about the possibility of recontamination of the sediment, the Toxics Cleanup Program at Ecology's Northwest Regional Office requested an assessment of PCB concentrations in the vicinity of the monitoring program locations. The primary objective of the study was to establish whether there may be PCB-contaminated sediment not included in the 1999 cleanup that could potentially erode and move onto the clean backfill sediment cap.

Other objectives were:

- Verify previous sampling results in the vicinity of the Boeing storm drain outfall (King County, 2001) and characterize a wider area of the sediments and bank soil with respect to PCB concentrations.
- Evaluate the spatial PCB concentration pattern between the Norfolk CSO and Boeing storm drain outfalls, and downstream of the Boeing outfall.
- Compare PCB concentrations with regulatory criteria (Washington Sediment Management Standards).
- Collect and archive sediment samples for potential future use in source identification through fingerprinting.

Study Area

The study area is located on the Duwamish River on the southwest side of Boeing Field, King County International Airport (Figure 1). The river is tidally influenced at this location, and all of the study area is exposed during low tides. Two outfalls are located within the study area, one from King County's Norfolk CSO and the other from a storm drain on Boeing Company's property ("Boeing storm drain"). Reference sampling locations are located upstream of the study area, on each side of the river. Approximate positions of the sampling locations are shown in Figure 2. More detailed descriptions of the sampling locations are provided in Appendix A, Table A1.

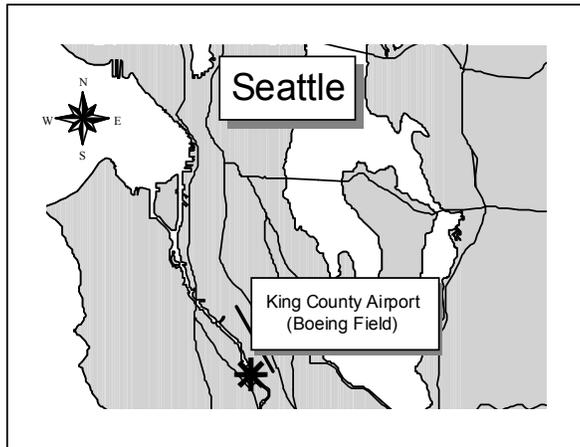


Figure 1. Study area location.

BSD Boeing storm drain outfall
NCSO Norfolk Combined Sewer Overflow outfall.

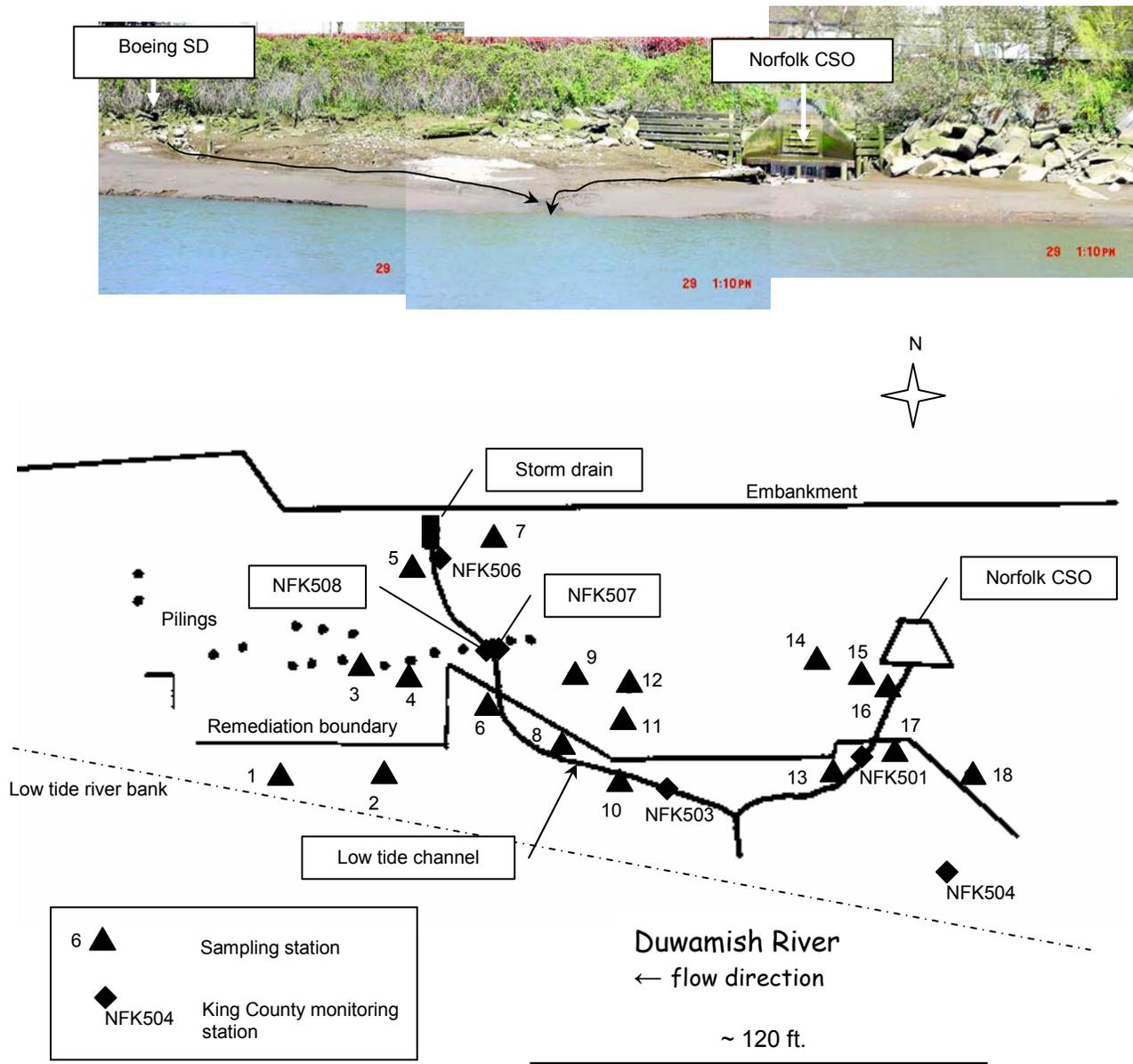


Figure 2. Sampling locations.

Photo: sampling area in the vicinity of the Norfolk CSO and Boeing Storm Drain outfalls. Lines with arrows indicate low tide channels from the outfalls. Distance between outfalls is approximately 120 ft.

Schematic map: sampling locations. Not to scale, locations are approximate. Stations below the remediation boundary (e.g., Station 1) are within the area remediated in 1999. Station 19 location is the same as Station 7 (field duplicate). Not shown: upstream reference Stations 20 and 21. Cleanup boundary location from EBD RP (1999; Appendix E).

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Methods

Sampling

Sampling was conducted July 9, 2002, on a minus-2-foot tide, when all of the area to be sampled was exposed and accessible on foot. Due to the close proximity of sampling stations, fixed landmarks and marking stakes, rather than Global Positioning Systems, were used to locate the stations. The position of each sampling point was marked with a stake constructed from a two-foot length of white PVC pipe. The sampling point identification number, punched into a stainless steel tag, was attached to each stake. Bearings relative to two landmarks, and distances between adjacent sampling points, also were recorded (Appendix A, Tables A1 and A2).

At each sampling location, the upper 10 cm of sediment was transferred with a stainless steel spoon into a stainless steel bowl and stirred to a uniform consistency. A dedicated sampling bowl and spoon was used for each station. The homogenized sediment was then placed in glass jars with Teflon lid liners. The jars had previously been cleaned to EPA QA/QC specifications (EPA, 1990).

Stainless steel spoons and bowls were cleaned by washing with Liquinox detergent, followed by sequential rinses with tap water, 10% nitric acid, deionized water, and pesticide grade methanol. The equipment was then air-dried in a fume hood and wrapped in aluminum foil.

Puget Sound Estuary Protocols (PSEP) procedures (EPA, 1996) for collection, preservation, transportation, and storage of the sediment samples were followed in an effort to limit sources of bias. Sediment samples were placed on ice immediately after collection and transported to the Ecology/EPA Manchester Environmental Laboratory within two days of collection. The grain size samples were shipped to the contract laboratories via Manchester Laboratory. Chain-of-custody was maintained throughout the sampling and analysis. Other details regarding sampling methods are given in Blakley (2002).

Laboratory Procedures

Analytical methods and laboratories used for analysis of samples are shown in Table 1. All samples were stored at Ecology headquarters under chain-of-custody procedures prior to being shipped to Manchester Laboratory for analysis. Samples submitted for analysis are listed in Appendix A, Table A3.

Table 1. Analytical Methods and Laboratories Used.

Analyte	Method	Reference	Laboratory
Percent Solids	Gravimetric (160.3)	PSEP, 1996	Manchester
Total Organic Carbon	Combustion/CO ₂ Measurement @ 70°C	PSEP, 1996	Manchester
Grain Size	Sieve and Pipet	PSEP, 1996	Rosa Environmental
PCBs (as Aroclors)	EPA 3540 (Soxhlet extraction) EPA 8082 GC-ECD	EPA SW-846	Manchester

Quality Assurance

Quality control measures included analyses of laboratory method blanks, duplicates, matrix spikes, surrogate spikes, internal standards, and a standard reference material. In addition, a blind field duplicate was included in the samples. This duplicate was taken from a sample that had been homogenized and then split into two separate aliquots in the field for analysis.

Overall, results from laboratory quality control (QC) evaluations were acceptable and within established laboratory QC limits, with some minor exceptions. These are discussed in the quality assurance (QA) reviews (Case Narratives) provided in Appendix C.

The QA evaluation with respect to project objectives (Blakley, 2002) is discussed below.

PCB analyses

Results relating to sample contamination, precision, and bias are summarized in Table 2. No evidence for sample contamination was found in method blanks, at a detection limit of 11 ug/kg dw.

Precision, expressed as relative percent difference (RPD), was about 3% for matrix spike duplicates. For field and laboratory duplicates, the RPD was about 30%, which exceeded the project objective of 20%. Incomplete mixing of samples that were subdivided into duplicates might account for the higher RPD (lower precision), since both field and laboratory, but not matrix spike, duplicates were obtained by subdividing samples. There was no evidence for an additional loss of analytical precision in field duplicates relative to laboratory duplicates, since RPD values were similar in both cases.

Estimates of bias from Aroclor recoveries consistently suggest that measurements underestimated actual concentrations. Matrix spike recoveries were about 80% of the actual concentration (i.e., 20% low bias) while the Standard Reference Material recovery was about 70%. The latter exceeds the project goal of 20-25% bias.

Table 2. Data Quality Evaluation for PCB Analyses.

Data Quality Component	Basis for Evaluation	No. Samples	Result
Sample contamination	Laboratory method blanks	4	No Aroclors detected
Precision	Blind field duplicates	1	RPD = 25% (Aroclor 1254)
	Laboratory duplicates	2	Average RPD = 33% (Aroclor 1248)
	Matrix spike duplicates (% recovery)	2	Average RPD = 2% (Aroclor 1016) Average RPD = 4% (Aroclor 1260)
Bias	Surrogate recovery	27	Average = 134% (tetrachloro-m-xylene) Average = 145% (decachlorobiphenyl)
	Matrix spike recovery	4	Average = 79% (Aroclor 1016) Average = 80% (Aroclor 1260)
	Laboratory control sample recovery	2	Average = 86% (Aroclor 1016) Average = 93% (Aroclor 1260)
	Standard Reference Material recovery	2	Average = 71% (Aroclor 1260)

RPD=Relative Percent Difference. Calculated as $100*(X_1-X_2)/((X_1+X_2)/2)$ where X_1 and X_2 are measured values.

Total PCB concentration values may be underestimates due to an additional factor. All field samples contained a mixture of Aroclors 1248 and 1254, with one exception. PCB concentrations were quantified based on the Aroclor GC/MS chart pattern the samples most closely resembled, and the concentration of the second Aroclor in the sample was not quantified. This problem did not arise in matrix spikes with Aroclors 1016 and 1260, since the GC/MS chart patterns for these Aroclors do not overlap.

Organic carbon

Estimates of precision for total organic carbon values are available from laboratory and field duplicates. The RPD was 11.2% for field duplicates (Appendix B, Table B1), and the average RPD was 9.2% for two sets of laboratory duplicates. Both of these values meet the project objective of 20%. Bias could not be quantified, and no project objective was established for this parameter.

Grain size

Precision estimates for size fractions are available from field duplicates (Appendix B, Table B1). The RPD values ranged from 5.9% for sand to 56.7% for gravel. Additional estimates are available from two sets of laboratory triplicates. Because there are three replicate measurements, the relative standard deviation (RSD) was used to estimate precision. The average RSD for the two sets of laboratory triplicates ranged from about 1% for silt, to 65% for gravel. The latter value exceeds the project objective of 10%. The low precision for gravel size fraction in both field and laboratory replicates may reflect the sensitivity of this parameter to uneven distribution between replicates of a relatively small number of large particles. Bias could not be quantified, and is therefore not evaluated here.

Percent solids

The RPD estimate of precision was 8% from field duplicates (Appendix B, Table B1). For two sets of laboratory duplicates, the average RPD was 1%. Both of these values meet the project objective of 10%. Bias could not be quantified, and is therefore not evaluated here.

Summary

Although QA project objectives were not always met, these are goals and not requirements. The data are acceptable for the purposes of this study. In particular, conclusions regarding two stations with high PCB concentrations are robust, first because the concentrations exceed regulatory criteria by an order of magnitude, and second because duplicate Aroclor measurements at both stations indicate that precision is adequate. On the other hand, TOC-normalized values near the regulatory criteria should be viewed with caution, particularly for values just below the criteria since there may be a bias towards underestimation of actual PCB concentrations.

Results

The results of this study are summarized in Table 3. With one exception, all of the samples contained a mixture of Aroclors 1248 and 1254. However, PCB concentrations were quantified based only on the Aroclor pattern the samples most closely resembled, and the concentration of the second Aroclor was not quantified. At Station 21 the sample contained a mixture of Aroclors 1248 and 1260.

In most cases (65% of the stations), PCB concentrations were less than 100 $\mu\text{g}/\text{kg}$ dw. Five stations (25%) had concentrations in the range of 130-270 $\mu\text{g}/\text{kg}$. Considerably higher concentrations were found at Stations 4 and 7, and in both cases duplicate measurements confirm the results. At Station 4, laboratory duplicate values were 6,200 and 8,900 $\mu\text{g}/\text{kg}$ (mean = 7,550). The concentration at Station 7 was 4,600 $\mu\text{g}/\text{kg}$, and 5,900 $\mu\text{g}/\text{kg}$ for a blind field replicate (mean = 5,250 $\mu\text{g}/\text{kg}$).

General patterns for conventional parameters are shown in Figure 3. Twelve stations had more than 50% sand, while five of the remaining stations had more than 50% silt. Percent solids tended to be higher at stations with high sand content, while total organic carbon (TOC) tended to be higher in silty samples. Stations with higher TOC and silt content (i.e., the five on the left side in Figure 3) were all in the vicinity of the Norfolk CSO outfall, with the exception of Station 1.

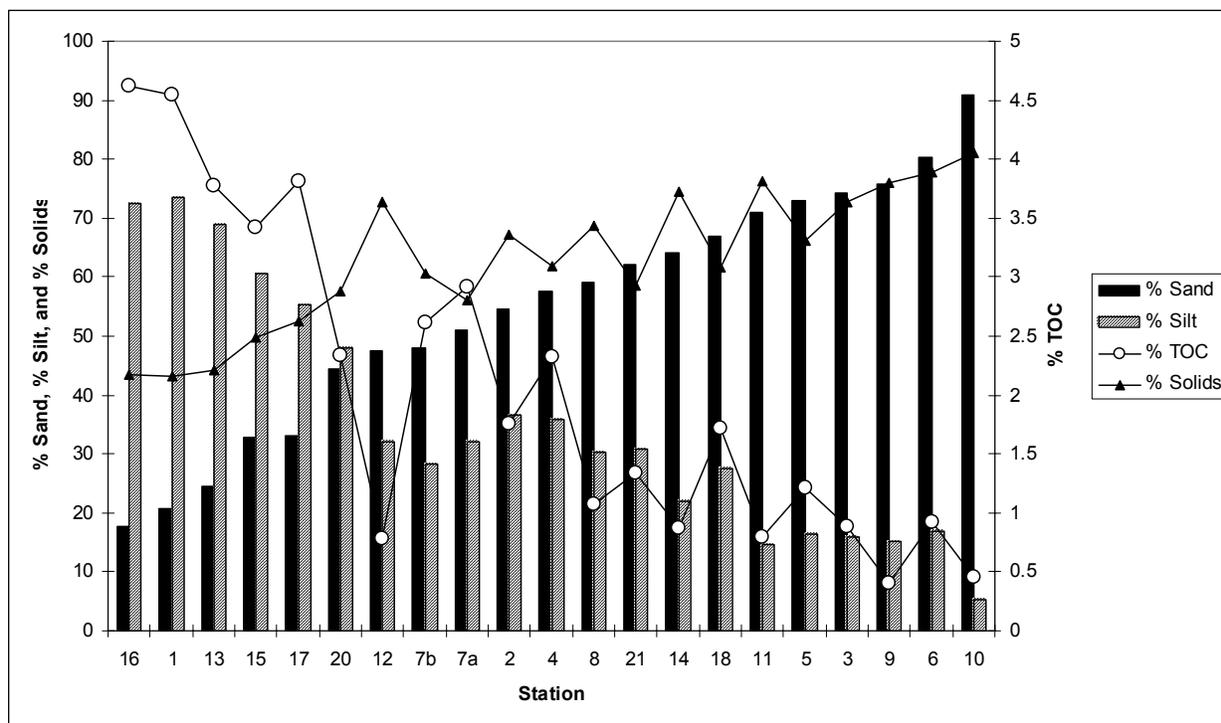


Figure 3. Characteristics of samples from each station. Stations 7a and 7b represent field duplicates from Station 7. Stations are arrayed in increasing order of sand content.

Table 3. Sediment Sampling Results

Station	Sample	% Solids	% TOC	Grain size (%)				Aroclors µg/kg dw						Total PCBs TOC normalized mg/kg OC [‡]	
				Gravel	Sand	Silt	Clay	1016	1221	1232	1242	1248	1254		1260
1	288130	43.3	4.55	0.1	20.7	73.5	5.6	11u	11u	11u	11u	65j	11u	11u	1.4
2	288131	67.1	1.75	0.3	54.5	36.5	8.8	8.2u	8.2u	8.2u	8.2u	34j	8.2u	8.2u	1.9
3	288132	72.7	0.89	5.0	74.2	15.9	4.8	6.9u	6.9u	6.9u	6.9u	53j	6.9u	6.9u	6.0
4	288133	61.9	2.32	0.7	57.7	35.8	5.8	360u	360u	360u	360u	7,550j[†]	2800u	360u	330**
5	288134	66.2	1.21	6.0	73.0	16.5	4.5	14u	14u	14u	14u	270j[†]	280u	14u	22*
6	288135	77.7	0.92	0.8	80.4	16.8	2.0	5.9u	5.9u	5.9u	5.9u	150j	5.9u	5.9u	16*
7	288136	56.1	2.92	10.1	51.0	32.1	6.8	400u	400u	400u	400u	400u	4,600j	400u	160**
7 (field dup)	288148	60.7	2.61	18.1	48.1	28.3	5.6	490u	490u	490u	490u	490u	5,900j	490u	230**
8	288137	68.6	1.07	4.8	59.2	30.2	5.8	6.9u	6.9u	6.9u	6.9u	62j	6.9u	6.9u	5.8
9	288138	76.0	0.4	5.4	75.8	15.1	3.7	6.6u	6.6u	6.6u	6.6u	6.6u	43j	6.6u	11
10	288139	81.0	0.45	3.0	91.0	5.2	1.0	6.0u	6.0u	6.0u	6.0u	47j	6.0u	6.0u	10
11	288140	76.3	0.8	10.3	71.0	14.6	4.2	6.3u	6.3u	6.3u	6.3u	140j	6.3u	6.3u	18*
12	288141	72.8	0.78	7.3	47.5	32.0	13.3	6.8u	6.8u	6.8u	6.8u	6.8u	40j	6.8u	5.1
13	288142	44.2	3.78	0.1	24.5	68.9	6.6	11u	11u	11u	11u	11u	60j	11u	1.6
14	288143	74.5	0.87	9.3	64.1	22.0	4.6	7.2u	7.2u	7.2u	7.2u	7.2u	38j	7.2u	4.4
15	288144	49.8	3.42	0.6	32.8	60.7	5.8	9.6u	9.6u	9.6u	9.6u	9.6u	180j	9.6u	5.3
16	288145	43.4	4.62	0	17.6	72.6	9.7	11u	11u	11u	11u	11u	130j	11u	2.8
17	288146	52.6	3.81	0.1	33.1	55.3	11.5	9.0u	9.0u	9.0u	9.0u	9.0u	42j	9.0u	1.1
18	288147	61.7	1.72	0.2	66.8	27.4	5.6	7.5u	7.5u	7.5u	7.5u	7.5u	19j	7.5u	1.1
20	288149	57.6	2.33	0.1	44.5	48.1	7.2	8.6u	8.6u	8.6u	8.6u	8.6u	14j	8.6u	0.6
21	288150	58.5	1.34	1.3	62.0	30.7	6.2	8.8u	8.8u	8.8u	8.8u	8.8u	8.8u	30j	2.2

u = The analyte was not detected at or above the reported value.

j = The analyte was positively identified. The associated numerical result is an estimate.

‡ = Total PCB concentration is based on detected Aroclors (i.e., Aroclors flagged u are not included in the summation).

TOC = total organic carbon.

† = Lab duplicate mean.

* = Exceeds PCB Sediment Quality Standard (12 mg/Kg organic carbon).

** = Exceeds PCB Sediment Quality Standard and Cleanup Screening Level (65 mg/Kg organic carbon).

dw = dry weight.

Discussion

Spatial Distribution of PCBs in Sediments

Results of this study are consistent with previous data from King County follow-up monitoring of the Norfolk CSO sediment cleanup (summarized in Figure 4). PCB concentrations over 1 mg/kg dw have previously been found outside the 1999 cleanup boundary, in the vicinity of the Boeing storm drain outfall (King County stations NFK506, 507, and 508). Despite the more extensive sampling coverage in the present study, concentrations over 1 mg/kg dw were only found near NFK508, at Station 4, and about 20 feet from NFK506, at Station 7 (Table 3).

A PCB concentration of over 1 mg/kg dw also was reported at NFK503 in 2001, but this result was not confirmed by 2002 monitoring data or supported by data from the present study. NFK503 is located in the channel formed by discharges from the Boeing storm drain outfall, and samples from Stations 6, 8 and 10, all located on the channel banks, did not exceed 1 mg/kg dw (Table 3).

Data for Station 6 provide some evidence for recontamination of the Norfolk CSO sediment cleanup area. This station is within the cleanup boundary and had an elevated PCB concentration relative to reference areas (150 µg/kg dw versus 14 and 30 µg/kg at Stations 20 and 21, respectively). On the other hand, at Station 10, also within the cleanup boundary and on the Boeing storm drain discharge channel bank, the PCB concentration was lower (47 µg/kg dw).

Comparison with Regulatory Criteria

Regulatory criteria for PCBs in marine and low salinity sediments are provided in the Washington State Sediment Management Standards (SMS) (Chapter 173-204 WAC). Two criteria levels are established in the SMS. The criteria are for total PCB concentrations on a TOC-normalized basis.

The Sediment Quality Standard (SQS) is a "no effects" level used as a sediment quality goal for Washington State sediments. For PCBs, the SQS is 12 mg/Kg organic carbon. The Cleanup Screening Level (CSL) is a "minor adverse effects" concentration used as an upper regulatory level for source control and cleanup decision making. For PCBs, the CSL is 65 mg/Kg organic carbon.

TOC-normalized PCB concentrations exceeded the SQS at five stations (Figure 5). At two of these stations the concentrations were also well above the CSL.

In previous sampling conducted by King County, exceedances of the CSL and/or SQS were observed at sampling stations in the vicinity of the Boeing storm drain outfall and in the channel below the outfall (Figure 6). Similarly, in this study all of the exceedances were in the vicinity of the storm drain outfall, with the exception of an exceedance of the SQS at Station 11 (Figure 5).

Split Sample Comparison

Simultaneous with this sampling work, Boeing Company contractor personnel collected samples from 14 of the stations for independent analysis. Results of that analysis were provided to Ecology (Bets, 2002). For TOC-normalized PCB concentrations, the relative percent difference between split samples was 62% (average for 14 stations). In general, the values reported by Boeing tended to be higher than those reported in Table 3, although the same analytical method (EPA 8082) was used. Despite this, there was a general concordance on stations exceeding the SMS, with two exceptions. At Stations 15 and 16, Boeing reported values of 20.9 and 13 mg/kg organic carbon, respectively, which exceed the PCB SQS of 12 mg/kg organic carbon. However, the values for these two stations in Table 3 (5.3 and 2.8 mg/kg organic carbon) do not exceed the SQS.

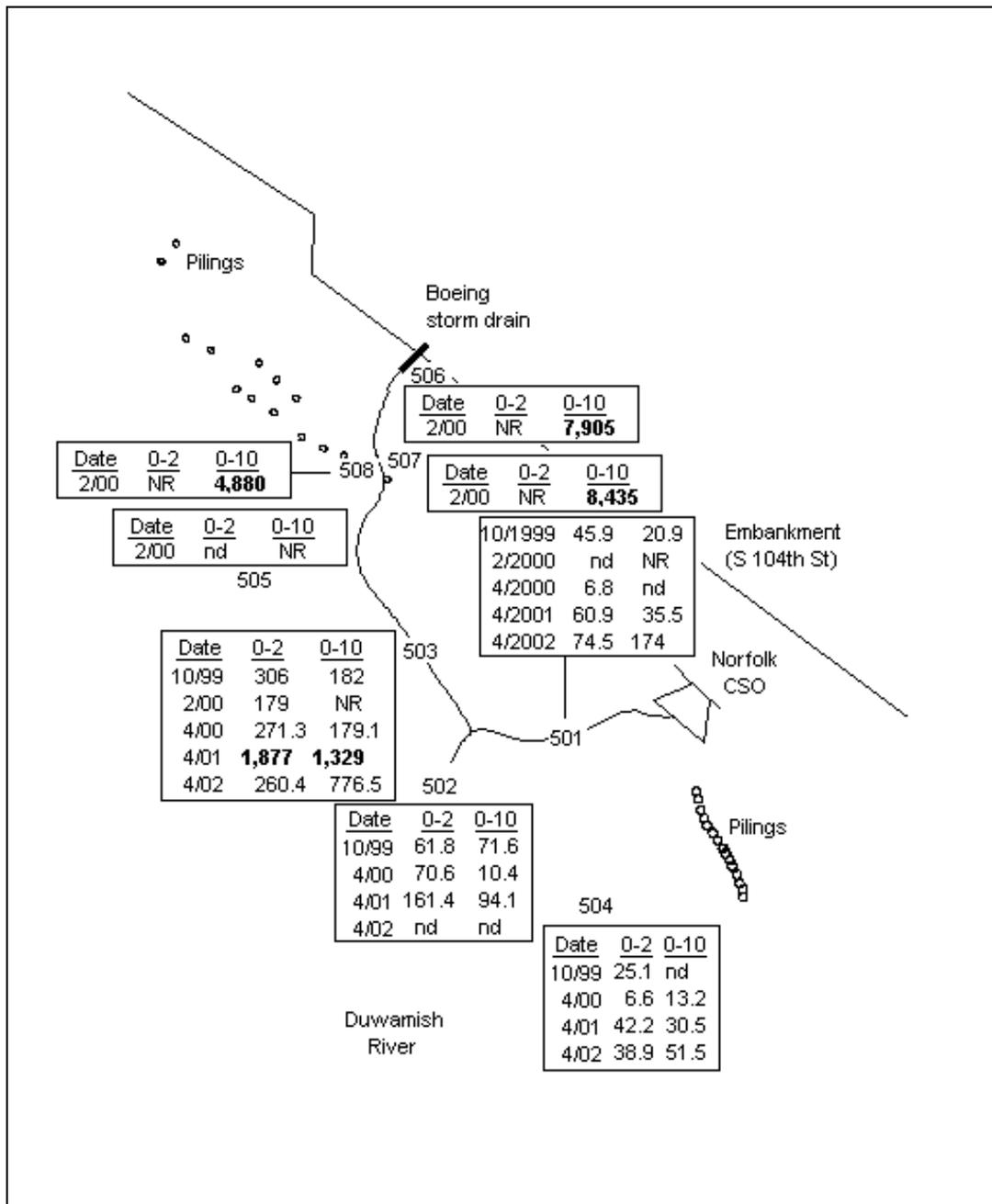


Figure 4. Summary of PCB concentrations ($\mu\text{g}/\text{Kg dw}$) from King County post-remedial monitoring at stations NFK501-NFK508.

Rows in the tables at each sampling location show date (month/year), 0-2 cm depth PCB concentration and 0-10 cm concentration (nd = not detected, NR = not reported). Sources: King County, 2000; King County, 2001; King County, 2002.

Approximate remediation boundary is shown in Figure 2. The TOC-normalized concentrations, for comparison with Sediment Management Standards, are shown in Figure 6.

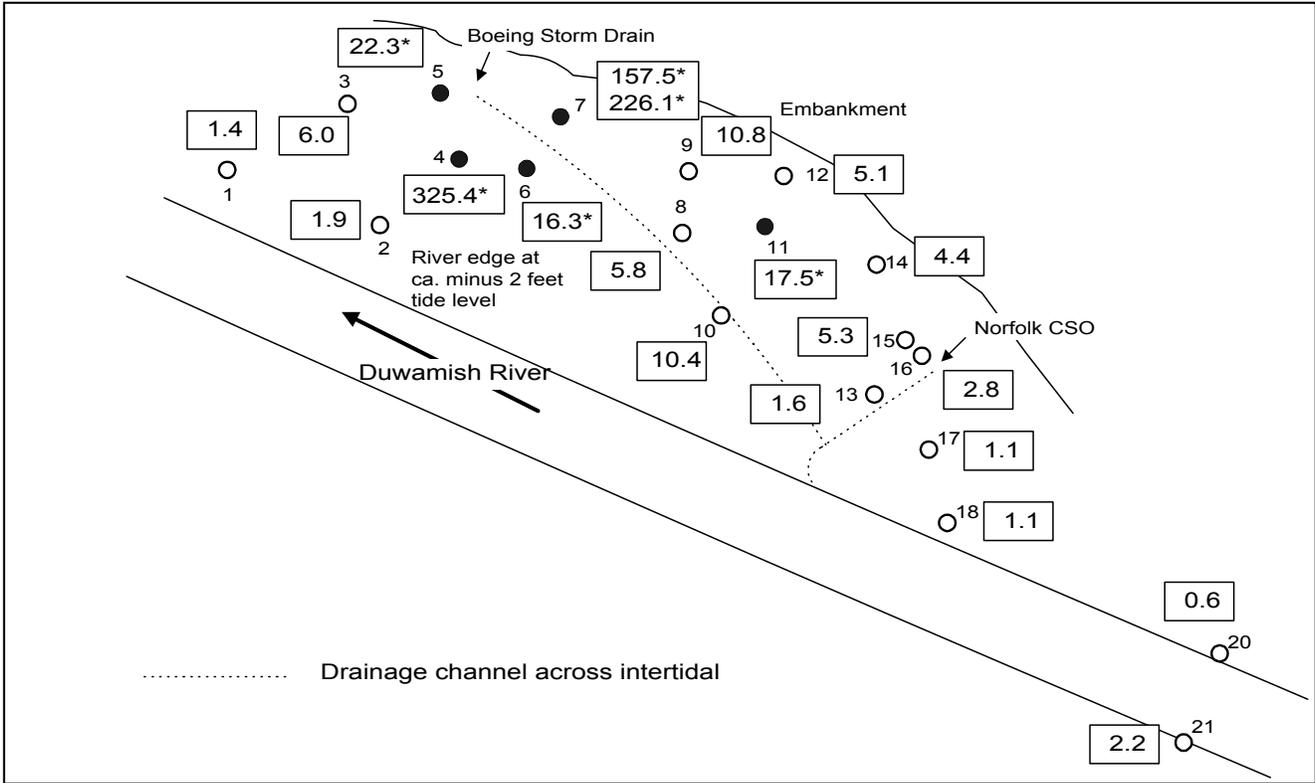


Figure 5. TOC-normalized PCB concentrations from this study (mg/Kg OC).

Values flagged with asterisk exceed the Sediment Quality Standard (12 mg/Kg OC) and in some cases, the Cleanup Screening Level (65 mg/Kg OC). Data from Table 2.

Approximate boundary of 1999 remediation area is shown in Figure 2.

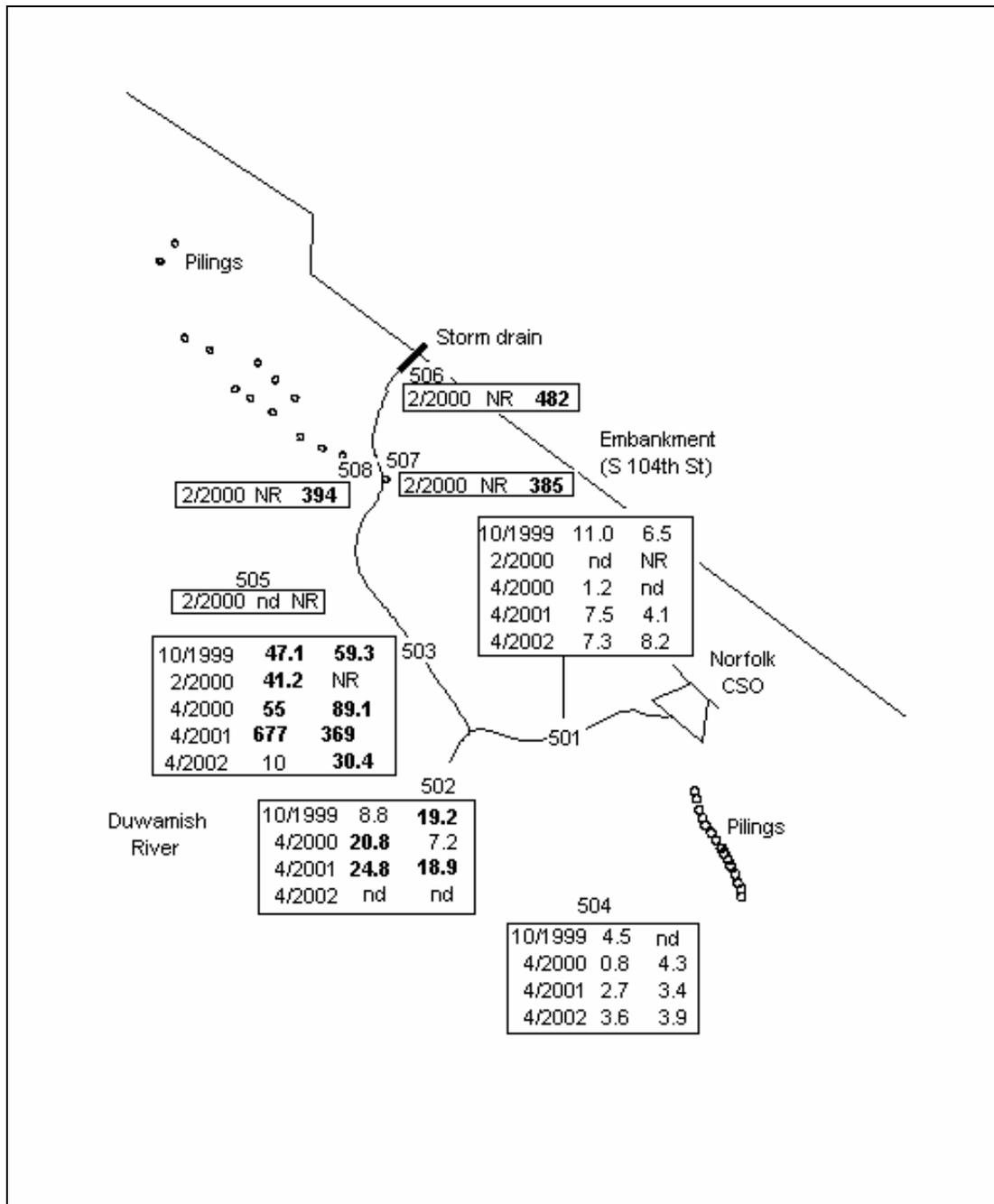


Figure 6. TOC-normalized PCB concentrations (mg/Kg OC) from King County post-remedial monitoring for comparison with Sediment Management Standards.

Values in bold font exceed the Sediment Quality Standard (12 mg/Kg OC) and in some cases, the Cleanup Screening Level (65 mg/Kg OC). Sources: King County, 2000; King County, 2001; King County, 2002.

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Conclusions and Recommendations

Conclusions

Results of this study are consistent with the previous finding from King County monitoring data that there is an area of PCB-contaminated sediment in the vicinity of the Boeing storm drain outfall. At least part of this area was not included in the 1999 cleanup, based on a comparison of sampling locations with a map of the cleanup boundaries. PCB contamination has been observed at stations NFK506, NFK507 and NFK508 (Figure 6) and Stations 5 and 7 (Figure 5), for example, which are all outside the cleanup boundary. The Sediment Quality Standard (12 mg/kg organic carbon) was exceeded at five locations: Stations 4, 5, 6, 7 and 11. All of these stations are in the vicinity of the Boeing storm drain outfall, with the exception of Station 11, which is located between the Boeing storm drain and Norfolk CSO outfalls. At Stations 4 and 7, the PCB concentrations also exceeded the Cleanup Screening Level (65 mg/kg organic carbon). Station 6 appears to lie within the cleanup boundary and may therefore represent an instance of recontamination. King County also has reported exceedances of PCB sediment criteria at two locations (NFK503 and NFK502) within the cleanup boundary (Figure 6).

This study did not investigate the existence of ongoing sources of PCB sediment contamination. King County (2000) suggested that “... *the most likely source of PCB recontamination is the erosion of PCB-contaminated sediments located inshore of the remediation site and adjacent to the Boeing storm drain pipe.*” Redistribution of eroded sediments could account for recontamination at Station 6 in the present study, since inshore of this station there is PCB contamination at Station 4.

Recommendations

Stations 4, 5, 6, 7 and 11 should be included in remediation of the PCB-contaminated sediment since these stations exceed the Sediment Management Standards Cleanup Screening Level.

If additional work is conducted to further delineate PCB-contaminated sediments, sampling around Station 7 is particularly recommended. This location exceeded the PCB Cleanup Screening Level and is in an area at the foot of the river’s embankment that has not been investigated previously. Additional sampling should define the area of contamination around Station 7.

Sampling from the embankment above Station 7 also is recommended to evaluate this material as a possible source of PCB contamination.

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Appendices

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Appendix A

Sample Locations and Descriptions

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Table A1. Sample locations and descriptions.

Sampling station	Approximate elevation* (ft)	Time	Bearings to known points (degrees)†		Sample description
			Navigation light	Light pole	
1	+3.5	NR	254	147	Silt
2	+3.5	NR	258	148	Silt, with sand below 3 cm
3	+4.5	NR	255	147	Silty sand
4	+4	NR	258	151	Sand
5	+5	NR	256	150	Gravelly sand
6	+0.5	1200	258	151	Sand
7	+4.5	1230	257	154	Sandy silt
8	0	1155	263	150	Sand
9	+5	NR	259	152	Rocky sand
10	-0.5	1101	261	150	Sand
11	+4.5	1145	256	152	Gravelly sand, with debris (clay pipe)
12	+5	1130	258	153	Rocky sand, with clay below 3 cm
13	-1	1052	264	148	Silt, small amt sand
14	+4.5	1125	260	153	Rocky sand
15	+1	1115	262	155	Silt, plant fibers
16	-1	1109	262	156	Silt, plant fibers
17	+1	1044	266	153	Silty sand
18	0	1025	268	154	Silty sand, with sandy cap
19	Field duplicate at Station 7				
20	+0.5	1000	---	---	Silty sand
21	+1	0940	---	---	Very fine clay (silt)

* = Datum MLLW (= 0 ft). Elevations are approximate.

† = See Figure A1 for locations of these reference points.

NR = Not recorded; between 1230 and 1300.

Table A2. Distances (ft.) between sampling stations 1-17.

Sampling station															
	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16
1															
2	38														
3	32	29													
4		23													
5			21												
6				16	27										
SD				17	8	20									
8						39									
9						32.5	14								
10							21								
11									23						
12								22		12.5					
14									38		30				
15													18		
16														5	
17									57			17.5			22

SD = southwest corner of Boeing storm drain outfall.

Table A3: Sediment samples submitted for analysis on July 2002.

Station	Sample #	Comments
01	288130	
02	288131	
03	288132	
04	288133	
05	288134	
06	288135	
07	288136	
08	288137	
09	288138	
10	288139	
11	288140	
12	288141	
13	288142	
14	288143	
15	288144	
16	288145	
17	288146	
18	288147	
19	288148	Field duplicate at Station 7
20	288149	Reference location
21	288150	Reference location

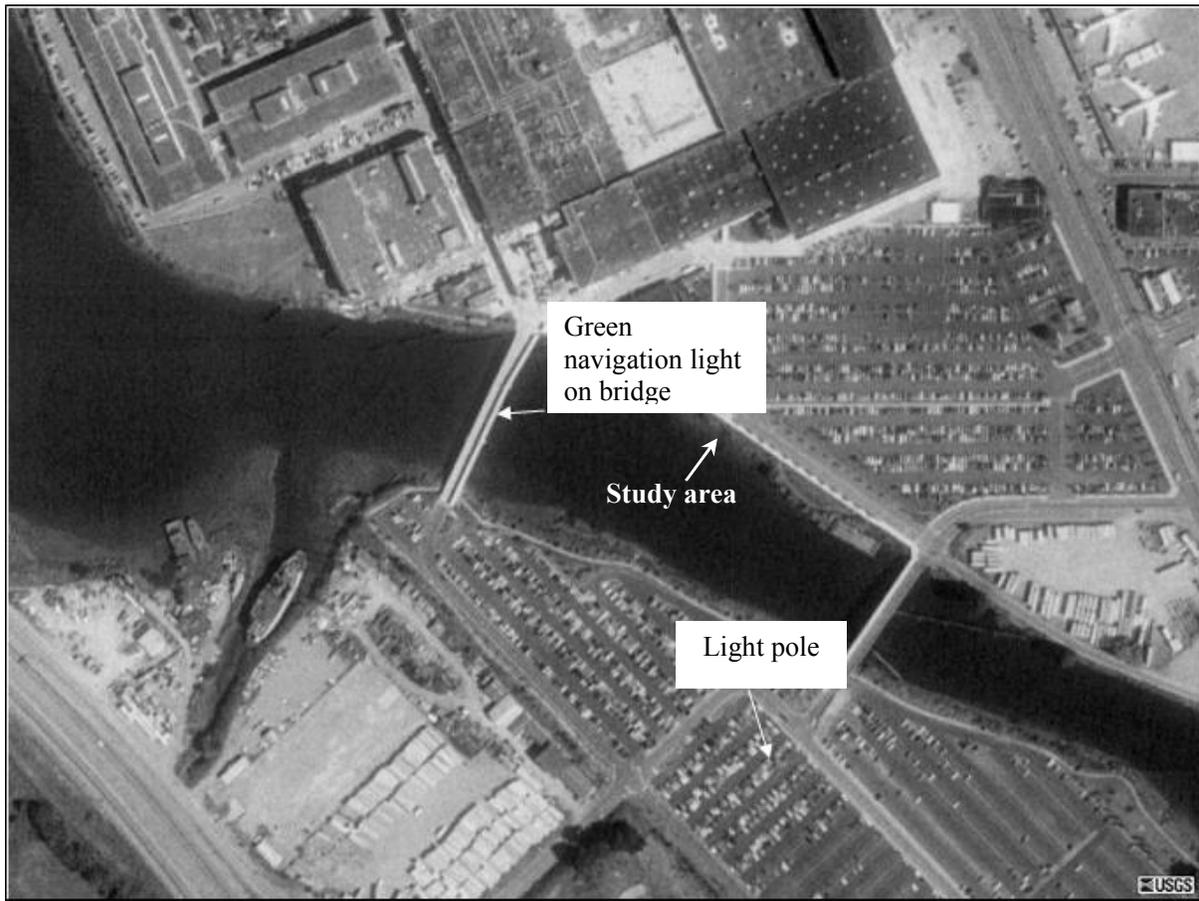


Figure A1. Locations of reference points used for bearings in Table A1.

Appendix B

Data Quality

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Table B1. Blind Field Duplicate Results for Station 7

	Sample number		RPD (%)
	288136	288148	
Analyte			
Percent solids	57.6	61.7	-6.9
Total Organic Carbon (%)	2.92	2.61	11.2
Grain Size (%)			
Gravel	10.1	18.1	-56.7
Sand	51.0	48.1	5.9
Silt	32.1	28.3	12.6
Clay	6.8	5.6	19.4
PCBs (as Aroclors) ppb			
Aroclor 1016	400u	490u	nc
Aroclor 1221	400u	490u	nc
Aroclor 1232	400u	490u	nc
Aroclor 1242	400u	490u	nc
Aroclor 1248	400u	490u	nc
Aroclor 1254	4,600j	5,900j	-24.8
Aroclor 1260	400u	490u	nc

RPD = relative percent difference.

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.

nc = Not calculated because compounds were not detected.

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Appendix C

Manchester Environmental Laboratory Quality Assurance and Quality Control Case Narrative Summaries

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Manchester Environmental Laboratory
7411 Beach Dr E, Port Orchard, Washington 98366

Case Narrative

September 9, 2002

Subject: Norfolk CSO Sediment Phase I

Samples: 02288130 through 02288150

Officer: Nigel Blakely

By: John Weakland

PCBs Analysis

Analytical Methods

The soil samples were extracted by with methylene chloride following EPA SW-846 Method 3540 then solvent exchanged into hexane. Interferences were removed from the extracts by performing a Florisil cleanup procedure. The 0% Florisil fraction was collected and then exchanged to iso-octane. The extracts were treated with Mercury to remove sulfur interferences and then treated with sulfuric prior to analysis. The samples were then analyzed by GC-ECD using EPA SW-846 method 8082.

Holding Times

All samples were prepared and analyzed within the method holding times.

Calibration

The initial calibration was acceptable and within established QC limits.

The continuing calibrations were acceptable and within established QC limits with the following exceptions. The percent difference of both surrogates for the August 9 analysis exceeded limits indicating a high bias. Since all of the data is flagged for other reasons, no further qualification of the data is necessary. The ending continuing calibration of Aroclor 1016 for the August 9 run slightly exceeded established QC limits. However, only the laboratory control samples were affected and no further action was necessary.

Blanks

There were no target analytes present in any of the method blanks.

Surrogates

The percent recoveries of the surrogates were reasonable, acceptable, and within established QC limits with the following exceptions. The samples were inadvertently spiked with surrogates at a concentration above the linear range of the instrument. Therefore, the samples had to be diluted in order to calculate percent recoveries. Additionally, some of the samples had percent recoveries that exceeded the established QC limits indicating a high bias. This is attributed to the high surrogate responses of the bracketing calibrations that exceeded QC limits. However, since all of the data is qualified for other reasons, no further qualification of the data is necessary.

Sample Duplicates

Samples 02288133 and 02288134 were utilized for sample duplicates. The relative percent differences (RPD) for both sets of duplicates were acceptable and within established QC limits.

Matrix Spikes

Samples 02288130 and 02288131 were utilized for matrix spike/ matrix spike duplicates (MS/MSD). The percent recoveries and RPDs for both sets of MS/MSDs were acceptable and within established QC limits.

Laboratory Control Samples

The percent recoveries of both laboratory control samples were acceptable and with established QC limits.

Standard Reference Material

The percent recoveries of both Solid Reference Materials (ERA # 494) were acceptable and with established QC limits for Aroclor 1260.

Comments

During the extraction, sample 02288139 was inadvertently blown dry. Consequently the sample was re-extracted on July 15 with method blanks.

All of the samples, with the exception of sample 02288150, contained a mixture of Aroclors 1248 and 1254. The results are reported based on the pattern the samples most closely resemble. Because the mixture of 1248 and 1254 could not be resolved, the samples are qualified J, estimated value. Sample 02288150 contained a mixture of Aroclors 1248 and 1260. The sample most closely resembled Aroclor 1260 and is reported as such and qualified J, estimated value.

Manchester Environmental Laboratory
7411 Beach Dr E, Port Orchard, Washington 98366

Case Narrative

October 24, 2002

Subject: General Chemistry Norfolk CSO Sediment Phase I

Officer: Nigel Blakley

By: Dean Momohara

Summary

The data generated by the analysis of these samples can be used without qualification. The following methods were used in the analyses of these samples: EPA 415.1 for total organic carbon.

All analyses requested were evaluated by established regulatory quality assurance guidelines.

Sample Information

Samples were received by Manchester Environmental Laboratory on 07/09/02 and 07/10/02. All coolers were received at the proper temperature of between 2°C - 6°C. All samples were received in good condition.

Holding Times

All analyses were performed within established EPA holding times.

Calibration

Instrument calibrations and calibration checks were performed in accordance with the appropriate method. All calibration checks were within control limits. All calibration correlation coefficients were greater than 0.995. The instrument was calibrated with reagent grade dextrose and verified to be in calibration with a NIST traceable standard reference material. Balances are professionally calibrated yearly and calibrated in-house daily. Oven temperatures were recorded before and after each analysis batch and were within acceptable limits.

Method Blanks

No analytically significant levels of analyte were detected in the method blanks associated with these samples.

Matrix Spikes

NA

Replicates

All duplicate relative percent differences of samples with concentrations greater than 5 times the reporting limit were within acceptance limits of less than 20%.

Laboratory Control Samples

All laboratory control sample recoveries were within acceptance limits.

Other Quality Assurance Measures and Issues

U - The analyte was not detected at or above the reported result.

bold - The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Please call Dean Momohara at (360) 871-8808 to further discuss this project.

cc: Project File

Manchester Environmental Laboratory
7411 Beach Drive East, Port Orchard WA 98366

Case Summary

September 6, 2002

Project: Norfolk CSO
Samples: 28-8130-50
Laboratory: Rosa Environmental
By: Pam Covey

These samples required twenty-one (21) Grain Size analyses on sediment samples using Puget Sound Estuary Protocol (PSEP) method. Two samples were analyzed in duplicate. The samples were received at the Manchester Environmental Laboratory and sent to the contract lab on July 11, 2002 for Grain Size analyses.

The analyses were reviewed for qualitative and quantitative accuracy, validity and usefulness. See narrative from Rosa for further explanation on sample analysis anomalies.

The results are acceptable for use as reported.

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Manchester Environmental Laboratory
7411 Beach Dr E, Port Orchard, Washington 98366

Case Narrative

July 18, 2002

Subject: General Chemistry Quality Assurance Memo for Norfolk CSO Sediment Phase I

Officer: Nigel Blakley

By: Dean Momohara

Summary

The data generated by the analysis of these samples can be used without qualification.

All analysis requested was evaluated by established regulatory quality assurance guidelines.

Sample Information

Samples were received by Manchester Environmental Laboratory on 07/09/02 and 07/10/02 in good condition.

Holding Times

The analysis was performed within established EPA holding times.

Calibration

Balances are professionally calibrated yearly and calibrated in-house daily. Oven temperatures were recorded before and after each analysis batch.

Method Blanks

NA

Matrix Spikes

NA

Replicates

All duplicate relative percent differences were within acceptance limits of less than 20%.

Laboratory Control Samples

NA

Other Quality Assurance Measures and Issues

bold - The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Please call Dean Momohara at (360) 871-8808 to further discuss this project.

cc: Project File