Analysis of Polychlorinated Biphenyl (PCB) Residues in Stream Sediment Samples Collected September 9, 1999 from the Bayou Creek System

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INTRODUCTION

Stream sediment samples were collected for PCB analyses from Big and Little Bayou Creeks on September 9, 1999. This report includes 41 samples analyzed for PCBs of which 9 were duplicate assays (*i.e.* BB1A, BB1, BB3, BB7, LB2A, LB2A, LB2, LB3, LB4). There were also 31 QA samples. Sampling stations BB1 through BB9 on Big Bayou Creek (26 samples) and LB2A through LB4 on Little Bayou Creek (13 samples) were included in this field survey (Figure 1; Tables 1, 2). Two samples at the new reference station, upstream of BB1 and designated BB1A, also were collected. In addition, Massac Creek (MC) was sampled and served as a reference station independent of the Bayou Creek system. A minimum of two samples were collected for PCB assays from each of the sampling stations. Three Aroclors (*i.e.* 1248, 1254, and 1260) were determined for each sample. With respect to Little Bayou Creek, an additional 16 dried sediment samples, including 6 duplicates, were analyzed for PCBs in the clay/silt fractions (Table 3).

METHODS

Sediment Collection

Sediment samples were restricted to the upper 5-10 cm of sediment soil, including depositional areas when found. All sediment samples were collected in acetone-rinsed 0.47 L glass jars with teflon or aluminum foil-lined lids. Stainless steel spoons and scoops used for collections were acetone-rinsed between sampling stations.

Sediment Extraction

Wet sediment extractions of PCBs were performed following U.S EPA SW-846 Method 3540C for Soxhlet extraction (U.S. EPA, 1997; Erickson 1997). All solvents used were pesticide grade and were screened for organic contaminants prior to use. Weighed sub-samples (average wet weight 76.80 g; average dry weight 62.21 g) were extracted with 300 mL of acetone/methylene chloride (1:1 v:v) in a 500-mL Soxhlet extractor for 15 h. The extract was concentrated to near dryness in a Roto-evaporator (Buchi Model RE121). The reconstituted samples (5.0 mL in iso-octane) were cleaned of interferences as described below and then analyzed by gas chromatography. The dry clay/silt fractions from Little Bayou Creek sediments were also analyzed. The sediment sample was air-dried for 7d and sieved (past 180-μm mesh) to obtain the clay/silt fraction. This fraction was then extracted as described above. All sieves and trays were stainless-steel and solvent cleaned between samples.

Sample Cleanup

Lipid and pesticide cleanup was performed by eluting a 2.0 mL sample through a micro-column of 2.0 g activated 100-200 mesh Florisil® (100 ^{o}C/24 h) with 10.0 mL hexane and evaporated to 2.0 mL (Erickson, 1997; U.S EPA, 1997 Method 3620B). Elemental sulfur was removed by shaking 2-propanol (2 mL) and tetrabutylammonium sulfite (2 mL), adding ultra-pure water (8 mL) and reshaking. The organic extract was removed and mixed with 2.0 mL concentrated sulfuric acid (Jensen *et al.*, 1977; U.S EPA, 1997 Method 3660B). A 4 μL sub-sample was analyzed by gas chromatography.

Analysis by Gas Chromatography

Samples were analyzed for Aroclors 1248, 1254, and 1260 according to SW-846 Method 8082 using gas chromatography (U.S. EPA, 1997). Analysis was performed using a Hewlett-Packard (HP) Model 5890A gas chromatograph equipped with an electron capture detector and an HP Model 7673A Automatic Sampler. Samples were analyzed using a 60 m x 0.53 mm ID SPB-5 (0.5-μm film) fused silica megabore column (Supelco, Inc.) with ultra-high purity helium and nitrogen as carrier and makeup gases, respectively. Temperature program: 160 ^{o}C (6 min) ramp at 10 ^{o}C/min to 235 ^{o}C (0 min) ramp at 0.9 ^{o}C/min to 260 ^{o}C (10 min); Injector temperature, 280 ^{o}C; Detector temperature, 300 ^{o}C.

PCB peak heights were quantified using an HP Model 3396A integrator and multiple-peak linear regression analysis was performed with Lotus-123® software. Aroclor levels were calculated from heights of 6 to 9 peaks for Aroclor 1248, and 4-6 peaks for Aroclors 1254 and 1260. Five external standards were used for calibration curves and for every tenth sample either a solvent blank or a standard was analyzed. The Lotus program regresses data from PCB standards to the sample being analyzed. Each peak selected for each Aroclor class is statistically analyzed (*e.g.* standard deviation; standard error; relative deviation). Unless the specified number of acceptable peaks per Aroclor were obtained, the sample was reanalyzed. This included further cleanup for pesticides or sulfur as indicated, as well as a new standard curve. Chromatographs and bench records for all PCB assays will be maintained as given below under quality assurance.

Quality Assurance

Permanent bench records were kept of all assays and annotated as required under Good Laboratory Practices (Federal Register, 40 CFR, Part 160, August 17, 1989). All printouts and graphic recordings were filed and are open for inspection. These bench records will be archived within two years after the close of the project but retrievable upon request. Chain of Custody were maintained for all samples collected. Quality assurance included 1) assays for certified and prepared standards, 2) duplicate assays, 3) recoveries, and 5) glassware solvent blanks. Nine stations were analyzed in duplicate by taking and weighing an additional sub-sample from the same jar. These duplicates were prepared and analyzed as a regular sample.

RESULTS

Results for PCB analyses of Big Bayou sediments are given in Table 1. Although PCBs were detected at BB3, BB4, BB7, BB8, and BB9, all values were below the minimum quantitation limit (*i.e.* lowest standard). The analysis of wet sediment samples revealed little or no detectable PCB contamination (Table 1). For the next sampling interval, sediment assays for Big Bayou Creek will be based on the clay/silt fraction and greater attention will be given to stations BB3 through BB7.

The analysis of wet sediments collected from Little Bayou Creek revealed detectable concentrations of PCB at all stations (*i.e.* LB2A, LB2, LB3, LB4). However, the values were below 0.030 µg/g. The higher values were observed at LB2A which is

situated downstream of effluent 011. To obtain more analytical precision, 16 sediment samples from Little Bayou Creek were dried and sieved prior to the analysis of the clay/silt fractions (Table 3). The resulting concentrations were higher by about one order of magnitude. As before, the higher concentrations were found at station LB2A. These ranged from 0.065 to 0.141 µg/g for Aroclor 1248 and 0.044 to 0.101 µg/g for Aroclor 1254. Values for the three Aroclor were totaled for each sample and the results are given in Table 3. Total PCB concentrations in µg/g ranged from 0.128 to 0.291 at LB2A; 0.059 to 0.139 at LB2; 0.099 to 0.140 at LB3; and 0.065 to 0.092 at LB4. The major source of PCB contamination likely is effluent 011. It should be noted that water samples collected in September 1999 and October 1998 from BB2A and BB2 contained detectable concentrations of PCBs (Birge and Price, 1999a, 1999b). The occurrences constituted violations of the State of Kentucky PCB water quality standard. Additional sampling should be conducted on Little Bayou Creek, including all effluent ditches. There is no official standard for PCB sediment contamination. However, numerous credible sources place the limit at or below 0.10 mg/Kg (ppm). A listing of these sources is appended at the end of this report.

Results of quality assurance assays are given in Tables A1 through A5. Confirmatory analysis of sediment samples were conducted on wet sediments using a second GC unit. The results given in tables A1 and A2 are similar to those given in Table 1 and Table 2. All control assays were negative (Table 3). Percent PCB recoveries varied from 99% to 117% for the regular sample series (Table A4) and 81% to 104% for the confirmatory series.

REFERENCES

Birge, W.J. and D.J. Price. 1999a. Analysis of Metals and Polychlorinated Biphenyl (PCB) Residues in Water Samples Collected September 9, 1999 from the Bayou Creek System. DRAFT REPORT, December 3, 1999. Submitted to Jon Maybriar, Division of Waste Management.

Birge, W.J. and D.J. Price. 1999b. Report to FFOU on Metals, Mercury and Polychlorinated Biphenyl (PCB) Residues in Water Samples Collected October 20, 1998 from the Bayou Creek System. DRAFT REPORT, January 26, 1999. Submitted to Jon Maybriar, Division of Waste Management.

Erickson, M.D. 1997. Analytical Chemistry of PCBs, 2nd edition. CRC Press, Boca Raton, FL. pp.667.

Federal Register. 1989. Good Laboratory Practice Standards. 40 CFR Part 160. August 17, 1989. Washington, DC.

Jensen, S., Renberg, L., Reutergådh, L. 1977. Residue analysis of sediment and sewage sludge for organochlorines in the presence of elemental sulfur. *Anal Chem*. 49(2):316-318.

U.S. EPA. 1997. Test methods for evaluating solid wastes, SW-846, Final Update 3. Office of Solid Waste and Emergency Response, Washington, DC.

Table 1. PCB results for PGDP stream sediment samples collected from Big Bayou Creek September 9, 1999.

Station Name	Date	Sample[a]	Duplicate[b]	Sample			Aroclor Conc. (µg/g)		
				Wet Wt. (g)	Dry Wt. (g)	% Moisture	1248	1254	1260
MC[c]	09/09/99	PSED1	A	71.03	58.82	17.19	<0.003	<0.003	<0.003
MC	09/09/99	PSED2	A	71.31	58.49	17.98	<0.003	<0.003	<0.003
BB1A	09/09/99	PSED1	A	75.76	64.35	15.06	<0.003	<0.003	<0.003
BB1A	09/09/99	PSED1	B	95.66	83.11	13.12	<0.002	<0.002	<0.002
BB1A	09/09/99	PSED2	A	68.48	56.50	17.49	<0.004	<0.004	<0.004
BB1	09/09/99	PSED1	A	85.19	68.81	19.23	<0.003	<0.003	<0.003
BB1	09/09/99	PSED1	B	84.00	68.09	18.94	<0.003	<0.003	<0.003
BB1	09/09/99	PSED2	A	88.26	74.21	15.92	<0.003	<0.003	<0.003
BB2	09/09/99	PSED1	A	66.09	53.85	18.52	<0.004	<0.004	<0.004
BB2	09/09/99	PSED2	A	82.97	68.63	17.28	<0.003	<0.003	<0.003
BB2A	09/09/99	PSED1	A	74.84	64.21	14.20	<0.003	<0.003	<0.003
BB2A	09/09/99	PSED2	A	88.49	75.61	14.56	<0.003	<0.003	<0.003
BB3	09/09/99	PSED1	A	79.51	63.94	19.58	0.003	<0.003	<0.003
BB3	09/09/99	PSED1	B	77.00	61.64	19.95	<0.003	<0.003	<0.003
BB3	09/09/99	PSED2	A	83.38	70.70	15.21	0.002*	<0.003	<0.003
BB4	09/09/99	PSED1	A	88.27	71.42	19.09	0.002*	<0.003	<0.003
BB4	09/09/99	PSED2	A	52.95	42.02	20.64	<0.005	<0.005	<0.005

[a] PSED1 and PSED2 are two samples collected separately.
[b] Duplicates A and B were taken from the same sample.
[c] MC identifies Massac Creek, a control stream independent of the Bayou Creek system.
* PCBs detected, however value below Minimum Quantitation Limit (MQL).

Table 1,Continued. PCB results for PGDP stream sediment samples collected from Big Bayou Creek September 9, 1999.

Station Name	Date	Sample[a]	Duplicate[b]	Sample: Wet Wt. (g)	Sample: Dry Wt. (g)	% Moisture	Aroclor Conc. (µg/g): 1248	1254	1260
BB5	09/09/99	PSED1	A	80.32	47.77	40.53	<0.004	<0.004	<0.004
BB5	09/09/99	PSED2	A	82.58	61.66	25.33	<0.003	<0.003	<0.003
BB6	09/09/99	PSED1	A	69.05	41.00	40.62	<0.005	<0.005	<0.005
BB6	09/09/99	PSED2	A	83.43	65.16	21.90	<0.003	<0.003	<0.003
BB7	09/09/99	PSED1	A	57.17	47.02	17.75	<0.004	0.003*	0.002*
BB7	09/09/99	PSED1	B	84.72	60.89	28.13	<0.003	<0.003	<0.003
BB7	09/09/99	PSED2	A	95.11	73.90	22.30	<0.003	<0.003	<0.003
BB8	09/09/99	PSED1	A	80.42	63.04	21.61	0.003*	<0.003	<0.003
BB8	09/09/99	PSED2	A	90.96	66.77	26.59	<0.003	<0.003	<0.003
BB9	09/09/99	PSED1	A	77.93	55.53	28.74	<0.004	<0.004	<0.004
BB9	09/09/99	PSED2	A	63.83	51.07	19.99	<0.004	0.003*	0.002*

[a] PSED1 and PSED2 are two samples collected separately.
[b] Duplicates A and B were taken from the same sample.
[c] MC identifies Massac Creek, a control stream independent of the Bayou Creek system.
* PCBs detected, however value below Minimum Quantitation Limit (MQL).

Table 2. PCB results for PGDP stream sediment samples collected from Little Bayou Creek September 9, 1999.

Station Name	Date	Sample[a]	Duplicate[b]	Sample			Aroclor Conc. (µg/g)		
				Wet Wt. (g)	Dry Wt. (g)	% Moisture	1248	1254	1260
LB2A	09/09/99	PSED1	A	86.31	76.20	11.71	0.016	<0.003	0.002*
LB2A	09/09/99	PSED1	B	92.24	87.72	4.90	0.010	<0.002	0.002
LB2A	09/09/99	PSED2	A	66.53	57.55	13.50	0.029	<0.003	0.014
LB2A	09/09/99	PSED2	B	65.38	57.71	11.73	0.022	<0.003	0.006
LB2	09/09/99	PSED1	A	81.51	67.87	16.73	0.002*	<0.003	0.001*
LB2	09/09/99	PSED2	A	74.66	56.93	23.75	0.002*	<0.004	0.001*
LB2	09/09/99	PSED2	B	76.14	62.93	17.35	0.003	<0.003	0.001*
LB3	09/09/99	PSED1	A	78.12	66.75	14.55	0.006	<0.003	0.002*
LB3	09/09/99	PSED2	A	67.33	54.96	18.37	0.011	<0.004	0.003*
LB3	09/09/99	PSED2	B	72.10	62.64	13.12	0.011	<0.003	0.002*
LB4	09/09/99	PSED1	A	59.63	50.54	15.24	0.013	<0.004	0.006
LB4	09/09/99	PSED2	A	55.09	46.30	15.96	0.009	<0.004	0.004
LB4	09/09/99	PSED2	B	75.15	64.25	14.50	0.007	<0.003	0.003

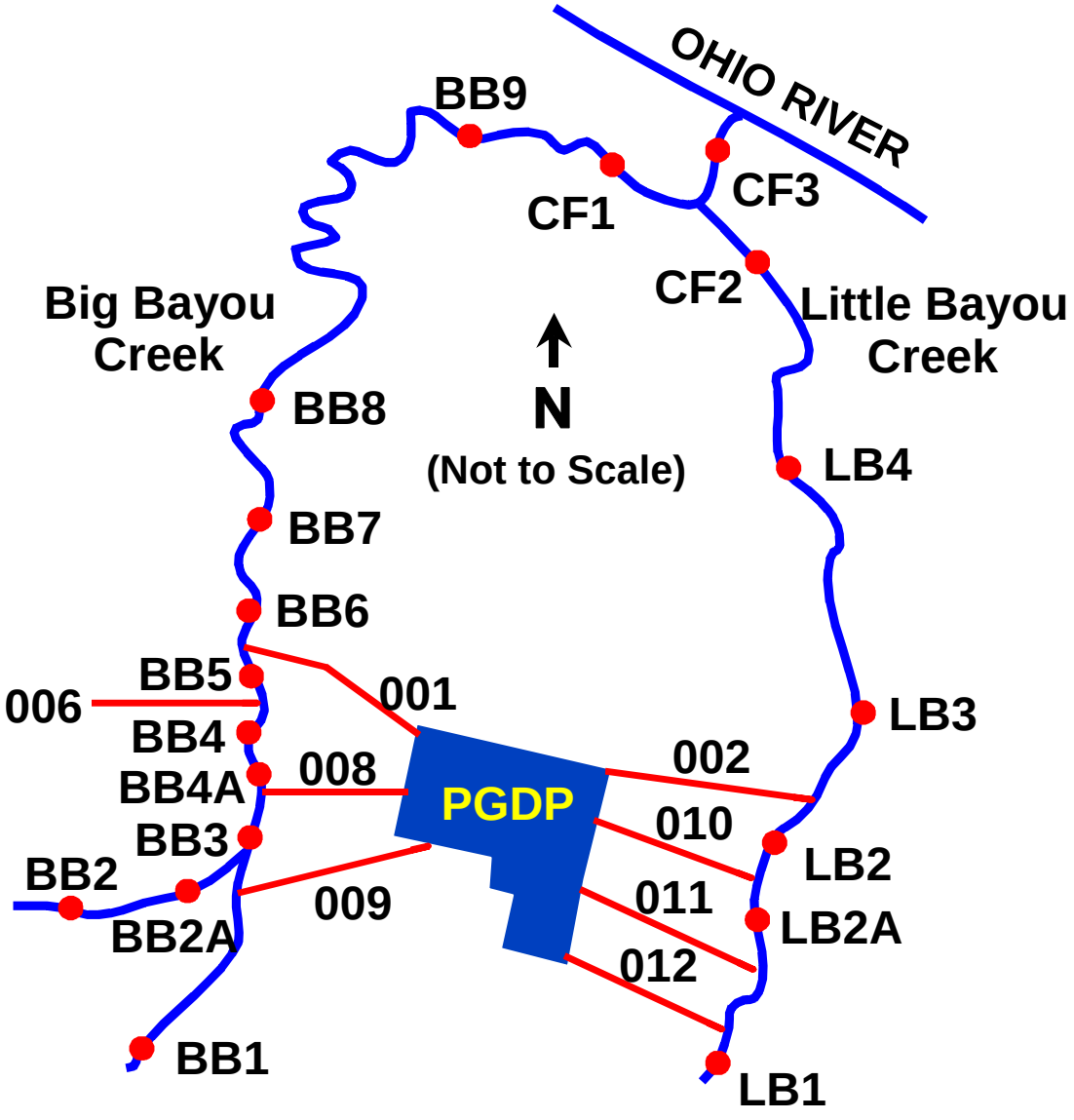
[a] PSED1 and PSED2 are two samples collected separately.
[b] Duplicates A and B were taken from the same sample.
* PCBs detected, however value below Minimum Quantitation Limit (MQL).

Table 3. PCB results for the clay/silt fraction of PGDP stream sediments collected from Big Bayou Creek September 9, 1999.

Station Name	Date	Sample[a]	Duplicate[b]	Sample Dry Wt. (g)	Aroclor Conc. (µg/g)			
					1248	1254	1260	Total
LB2A	09/09/99	S1	A	55.75	0.065	0.044	0.019	0.128
LB2A	09/09/99	S2	A	31.86	0.141	0.101	0.049	0.291
LB2A	09/09/99	S2	B	34.09	0.104	0.082	0.045	0.231
LB2	09/09/99	S1	A	38.35	0.036	0.048	0.049	0.133
LB2	09/09/99	S1	B	45.30	0.048	0.041	0.041	0.130
LB2	09/09/99	S2	A	43.41	0.032	0.052	0.045	0.129
LB2	09/09/99	S2	B	44.79	0.045	0.050	0.044	0.139
LB2	09/09/99	S1	A	38.35	0.035	0.017	0.012	0.064
LB2	09/09/99	S1	B	45.30	0.046	0.027	0.015	0.088
LB2	09/09/99	S2	A	43.41	0.023	0.015	0.021	0.059
LB2	09/09/99	S2	B	44.79	0.031	0.021	0.020	0.072
LB3	09/09/99	S1	A	22.69	0.066	0.051	0.023	0.140
LB3	09/09/99	S2	A	30.24	0.046	0.034	0.019	0.099
LB4	09/09/99	S1	A	31.09	0.036	0.037	0.019	0.092
LB4	09/09/99	S2	A	51.67	0.030	0.024	0.011	0.065
LB4	09/09/99	S2	B	53.16	0.030	0.023	0.021	0.074

[a] S1 and S2 are two samples collected separately.
[b] Duplicates A and B were taken from the same sample jar.

Figure 1. Location of Monitoring Stations and Continuously Flowing Effluents on Big and Little Bayou Creeks



BB1 to BB8 6.1 km
BB8 to Ohio River 7.4 km

Table A1. Confirmatory PCB results for PGDP stream sediment samples collected from Big Bayou Creek September 9, 1999.

Station Name	Date	Sample[a]	Duplicate[b]	Sample		% Moisture	Aroclor Conc. (µg/g)		
				Wet Wt. (g)	Dry Wt. (g)		1248	1254	1260
MC[c]	09/09/99	PSED1	A	71.03	58.82	17.19	<0.003	<0.003	<0.003
BB1A	09/09/99	PSED1	A	75.76	64.35	15.06	<0.003	<0.003	<0.003
BB1	09/09/99	PSED1	A	85.19	68.81	19.23	<0.003	<0.003	<0.003
BB2A	09/09/99	PSED1	A	74.84	64.21	14.20	<0.003	<0.003	<0.003
BB3	09/09/99	PSED2	A	83.38	70.70	15.21	<0.003	<0.003	<0.003
BB4	09/09/99	PSED1	A	88.27	71.42	19.09	<0.003	<0.003	<0.003
BB5	09/09/99	PSED1	A	80.32	47.77	40.53	<0.004	<0.004	<0.004
BB6	09/09/99	PSED2	A	83.43	65.16	21.90	<0.003	<0.003	<0.003
BB7	09/09/99	PSED2	A	95.11	73.90	22.30	<0.003	<0.003	<0.003
BB9	09/09/99	PSED1	A	77.93	55.53	28.74	<0.004	<0.004	<0.004

[a] PSED1 and PSED2 are two samples collected separately.
[b] Duplicates A and B were taken from the same sample.
[c] MC identifies Massac Creek, a control stream independent of the Bayou Creek system.

Table A2. Confirmatory PCB results for PGDP stream sediment samples collected from Little Bayou Creek September 9, 1999.

Station Name	Date	Sample[a]	Duplicate[b]	Sample			Aroclor Conc. (µg/g)		
				Wet Wt. (g)	Dry Wt. (g)	% Moisture	1248	1254	1260
LB2A	09/09/99	PSED2	B	65.38	57.71	11.73	0.037	<0.003	0.014
LB2	09/09/99	PSED2	B	76.14	62.93	17.35	0.003	<0.003	0.001*
LB3	09/09/99	PSED2	B	72.10	62.64	13.12	0.019	<0.003	0.003
LB4	09/09/99	PSED2	B	75.15	64.25	14.50	0.010	<0.003	0.003

[a] PSED1 and PSED2 are two samples collected separately.
[b] Duplicates A and B were taken from the same sample.
* PCBs detected, however value below Minimum Quantitation Limit (MQL).

Table A3. PCB concentrations in controls[a] for stream sediment samples from Bayou Creek System collected September 9, 1999.

	Aroclor Conc. (µg/mL)[b]		
Sample Name	1248	1254	1260
CON-102699-PCON1SED	<0.001	<0.001	<0.001
	<0.001	<0.001	<0.001
CON-102699-PCON2SED	<0.001	<0.001	<0.001
CON-102899-PCON3SED	<0.001	<0.001	<0.001
CON-102899-PCON4SED	<0.001	<0.001	<0.001
	<0.001	<0.001	<0.001
CON-110299-PCON5SED	<0.001	<0.001	<0.001

[a] Glassware, solvent and extraction thimbles extracted as a regular sample.
[b] Second number corresponds to confirmatory analysis on separate GC.

Table A4. PCB concentrations in procedure recoveries [a] for stream sediment samples from Bayou Creek System collected September 9, 1999.

Sample Name	Aroclor	µg Spike	Aroclor Conc. (µg) Expected Conc.	Aroclor Conc. (µg) Measured Conc.	Percent Recovery
RECO-102899-PPRR1	1248	1.0	1.000	1.171	117.1
RECO-102899-PPRR2	1248	1.0	1.000	1.145	114.5
RECO-102899-PPRR3	1254	1.0	1.000	0.991	99.1
RECO-102899-PPRR4	1254	1.0	1.000	1.093	109.3
RECO-110299-PPRR5	1260	1.0	1.000	1.054	105.4
RECO-110299-PPRR6	1260	1.0	1.000	1.127	112.7

[a] 300 mL of solvent were spiked with the respective Aroclor, extracted and analyzed as a regular sample.

Table A5. Confirmatory PCB concentrations in procedure recoveries [a] for stream sediment samples from Bayou Creek System collected September 9, 1999.

Sample Name	Aroclor	µg Spike	Aroclor Conc. (µg) Expected Conc.	Aroclor Conc. (µg) Measured Conc.	Percent Recovery
RECO-102899-PPRR1	1248	1.0	1.000	0.839	83.9
RECO-102899-PPRR2	1248	1.0	1.000	0.806	80.6
RECO-102899-PPRR3	1254	1.0	1.000	1.000	100.0
RECO-102899-PPRR4	1254	1.0	1.000	1.017	101.7
RECO-110299-PPRR5	1260	1.0	1.000	0.971	97.1
RECO-110299-PPRR6	1260	1.0	1.000	1.039	103.9

[a] 300 mL of solvent were spiked with the respective Aroclor, extracted and analyzed as a regular sample.

Summary of Sediment Criteria for PCBs

0.1 mg/Kg
-Based on U.S. EPA (1990) sediment cleanup level of 1.0 mg/Kg for 10^{-5} risk, adjusted for 10^{-6} cancer risk (risk assessment by Dr. Albert Westerman)
-Ruling by Judge W.L. Graham. March 27, 1997. Commonwealth of Kentucky. Franklin Circuit Court. Civil Action No. 86-CI-1566. Division II. Frankfort, KY.

0.001-0.14 mg/Kg
-sediment threshold limits
-based on equilibrium partitioning corrected for 2% organic carbon
-S.P. Pavlou. 1987. The Use of the Equilibrium Partitioning Approach in Determining Safe Levels of Contaminants in Marine Sediments. *In: Fate and Effects of Sediment-Bound Chemicals in Aquatic Systems*. K.L. Dickson, A.W. Maki, and W.A. Brungs, eds. Pergamon Press, Elmsford, NY. pp. 388-412.

<0.13 mg/Kg
-sediment concentrations at or above may adversely effect aquatic life
-Chapman, P.M., R.C. Barrick, J.M. Neff, and R.C. Schwartz. 1987. Four Independent Approaches to Developing Sediment Quality Criteria Yield Similar Values for Model Contaminants. *Journal of Environmental Toxicology and Chemistry 6*: 723-725.

0.28 mg/Kg
-based on equilibrium partitioning, corrected for 4% organic carbon
-U.S. EPA. 1985. *National Perspective on Sediment Quality*. Washington, DC. 84 pp.

<10 μg/Kg NON-ELEVATED
≥20 μg/Kg SLIGHTLY ELEVATED
≥50 μg/Kg ELEVATED
≥200 μg/Kg HIGHLY ELEVATED
≥1500 μg/Kg EXTREME
-based on total PCBs direct analysis of sediments throughout the State of Illinois; tiered classification system based on standard deviations from background mean (<10 μg/Kg).
-Kelly, M.H. and R.L. Hite. 1984. *Evaluation of Illinois Stream Sediment Data 1974-1980*. IEPA/WPC/84-004. Illinois Environmental Protection Agency. Springfield, IL. 100 pp.

0.01 mg/Kg TOTAL NO EFFECT
0.07 mg/Kg TOTAL LOWEST EFFECT, 10.6 mg/Kg SEVERE EFFECT
0.007 mg/Kg 1016 LOWEST EFFECT, 1.06 mg/Kg SEVERE EFFECT
0.03 mg/Kg 1248 LOWEST EFFECT, 3.0 mg/Kg SEVERE EFFECT
0.06 mg/Kg 1254 LOWEST EFFECT, 0.68 mg/Kg SEVERE EFFECT
0.005 mg/Kg 1260 LOWEST EFFECT, 0.48 mg/Kg SEVERE EFFECT
-based on screening method, corrected for 2% organic carbon

-Persaud *et al*. 1991. (Draft). *The Provincial Sediment Quality Guidelines*. Water Resources Branch, Ontario Ministry of the Environment. Ottowa, Ontario, Canada.

0.08 mg/Kg TOTAL
0.015 mg/Kg 1016
0.07 mg/Kg 1248
0.115 mg/Kg 1254
-based on screening method, corrected for 2% organic carbon
-Hart, D.R. *et al*. 1988. *Development of Sediment Quality Guidelines*. Phase II - Guidelines Development. Beak Consultants, Ltd. Brampton, Ontario, Canada.

0.05 mg/Kg TOTAL
-based on background method
-Sullivan, J. *et al*. 1985. *Report on the Technical Subcommittee on Determination of Dredge Material Suitability for In-Water Disposal*. Wisconsin Department of Natural Resources. Madison, WI.
-Scheuttepelz, D. January 9, 1990. Revised January 16, 1990. Memo to Mark Giesfeldt: Development of Sediment Quality Criteria for the Litttle Menomonee River/Moss American Superfund Site. Wisconsin Department of Natural Resources. Madison, WI.

0.0058 mg/Kg TOTAL
-Based on screening method, corrected for 2% organic carbon for saltwater sediments
-Neff, J.M. *et al*. 1986. *Final Report- Sediment Quality Criteria Methodology Validation: Calculation of Screening Level Concentrations from Field Data*. Battelle, Washington, DC.

0.39 mg/Kg 1254
-based on equilibrium partitioning, corrected for 2% organic carbon
-U.S. EPA. 1988. *Interim Sediment Criteria Values for Nonpolar Hydrophobic Organic Contaminants*. SCD 17. Washington, DC. 36 pp.

0.05 mg/Kg TOTAL OPEN WATER
<2.0 mg/Kg TOTAL UNRESTRICTED LAND
>2.0 mg/Kg TOTAL RESTRICTED LAND
-method(s) unavailable, disposal of dredged sediments
-Anonymous. 1988. *Guidelines for the Management of Dredged Material*. Ontario Ministry of the Environment. Toronto, Ontario, Canada.