Using the Sediment Quality Triad to Characterize Toxic Conditions in the Chesapeake Bay (2002): An Assessment of Tidal River Segments in the Bohemia, Elk, Northeast, and Severn Rivers

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Prepared by:

Alfred E. Pinkney
Beth L. McGee*
Peter C. McGowan
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401

Daniel J. Fisher
University of Maryland System
Agricultural Experiment Station
Wye Research and Education Center
P.O. Box 169
Queenstown, Maryland 21658

Jeffrey Ashley
David Velinsky
Academy of Natural Sciences
Patrick Center for Environmental Research
1900 Benjamin Franklin Parkway
Philadelphia, Pennsylvania 19144

Prepared for:

U.S. Environmental Protection Agency
Chesapeake Bay Program Office
410 Severn Avenue
Annapolis, MD 21403
In fulfillment of Interagency Agreement Number DW1494414401

*Current address:
Chesapeake Bay Foundation
6 Herndon Avenue
Annapolis, MD 21403

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EXECUTIVE SUMMARY

In 1999, the Chesapeake Bay Program Toxics Subcommittee characterized the tidal tributaries of the Chesapeake Bay for their potential for adverse effects due to chemical contamination. One finding was that, due to a paucity of data, many segments were characterized as *Areas with Insufficient or Inconclusive Data*. The purpose of the current study was to help fill these data gaps. The study, a collaborative effort between the U.S. Fish and Wildlife Service Chesapeake Bay Field Office, the University of Maryland Wye Research and Education Center, and Academy of Natural Sciences' Patrick Center, evaluated sediment chemistry, sediment toxicity and benthic community structure (i.e., the Sediment Quality Triad) at stations in tidal segments of the Bohemia (BOR), Elk (ELR), Northeast (NER), and Severn (SER) Rivers in Maryland. The specific objectives were to: 1) conduct the Sediment Quality Triad at 18 stations in the four tributaries, with 10-day sediment toxicity tests with the freshwater amphipod, *Hyalella azteca*, and 28-day tests with the estuarine amphipod, *Leptocheirus plumulosus*; 2) characterize water column concentrations of organic chemicals and metals; 3) evaluate the feasibility of conducting *in situ* 7-day water column toxicity tests with the sheepshead minnow, *Cyprinodon variegatus* in selected stations; and 4) provide a preliminary characterization of these four tributary segments.

Sediments were sampled between September 13 and 17, 2002, and toxicity tests started between October 10 and 16, 2002. This time of year was chosen to coincide with the recommended index period for the Long-Term Benthic Monitoring Program. For both amphipod species, we found no significant differences between survival in any test sediment and the control sediments. *H. azteca* had significant reductions in growth at Severn River stations 1, 4, and 5. The *L. plumulosus* test was more sensitive, showing toxicity based on growth and reproduction in all four rivers. Stations in the Bohemia River (BOR2, BOR3, and BOR4), the Severn River (SER4 and SER5), the Elk River (ELK2 and ELK 3), and the Northeast River (NER3 and NER4) were toxic. At only two stations, SER4 and SER5, did the two tests yield comparable results.

Sediment metal concentrations exceeded effects range - median (ER-M) values for nickel (SER1, 2, and 5; NER 2-5; and ELR4); copper (SER5), and zinc (SER 2 and 5). Except for copper (601 µg/g vs. ER-M of 270 µg/g), ER-M values were exceeded by less than a factor of two. The difference between acid volatile sulfide (AVS) and simultaneously extracted metals (SEM) was positive or only slightly negative at all stations, suggesting that toxicity was not attributable to SEM metals. Total PAH concentrations ranged from 0.717 µg/g to 16.9 µg/g, substantially less than the ER-M of 35 µg/g. Total PCBs ranged from 7.42 to 52.42 ng/g, less than the ER-M of 180 ng/g. The ER-M value for total chlordane (6.00 ng/g) was exceeded at SER2 (8.85 ng/g) and SER5 (7.63 ng/g). ER-M values were not exceeded for any other organochlorine pesticide.

Water column toxicity and chemical sampling was conducted in May/June 2003, to capture possible impacts of spring runoff. The *in situ* larval sheepshead minnow tests in the Severn River showed that overlying water had no effect on survival or growth. Semi-permeable membrane devices (SPMDs) and polar organic chemical integrative samplers (POCIS) were deployed at five stations (BOR2, ELR2, NER3, NER5, and SER5). Contaminants observed in SPMDs from all stations included the chlordanes, DDD, dieldrin, the nonachlors, dacthal, pentachloroanisole (PCA), and the current-use pesticides, acetochlor and chlorpyrifos. Estimated water column concentrations did not exceed Maryland aquatic life water quality

criteria. SPMD samples from all stations also detected PAHs. Only SER5 showed elevated PAHs, with estimated concentrations of fluoranthene, pyrene, and chrysene at about 1000 to 13000 pg/L. Lower concentrations (~400 to 900 pg/L) of the ubiquitous PAHs, fluoranthene and pyrene, were estimated at each station. The POCIS samples were analyzed for the hormones, 17β-estradiol and estrone, and tetracycline antibiotics. Only NER3 had measurable levels of 17β-estradiol at (~ 4 ng/L). Chlortetracycline was detected at NER5 and oxytetracycline at NER3. POCIS samples from SER5 contained all three antibiotics - ocytetracycline, tetracycline, and chlortetracycline.

Dissolved metals concentrations from samples collected during base flow periods at each of the rivers were generally low. No metals were detected at concentrations that exceeded Maryland chronic ambient water quality criteria. Copper in Back Creek (SER5) was detected at 5.79 μg/L, which approached but did not exceed the estuarine criterion of 6.1 μg/L.

Based on the Benthic Index of Biotic Integrity (B-IBI) scores, Severn River stations were classified as degraded (SER5) or severely degraded (SER1-4). All four Bohemia River stations and three of four Elk River stations were classified as degraded or severely degraded. Two of five Northeast River stations met the benthic restoration goal (3 or higher) and two of five were marginal (2.7-2.9). Correlation analysis between the B-IBI and MERM-Q, a summary of chemical contamination, did not indicate a significant association between these variables.

We provide tentative recommendations for characterization of these segments by integrating our results with recent information, including fish tissue and water quality data. These represent our best professional judgment and should not be considered as the final designation, which is the responsibility of the Toxics Subcommittee. The Elk and Bohemia Rivers were originally jointly classified as an *Area with Insufficient or Inconclusive Data.* Based on the current study and recent monitoring data, each would be classified as an *Area of Emphasis*. For both rivers, there are exposure (fish tissue advisory) and effects (sediment toxicity and impaired benthic community) data exceeding thresholds, but insufficient evidence of a relationship between the two. The Northeast River, also originally classified as an *Area with Insufficient or Inconclusive Data,* would maintain that classification. Although there are both exposure (fish tissue) and effects (sediment toxicity) data exceeding thresholds, there is insufficient evidence of a relationship. This could qualify for placement as an *Area of Emphasis*. However, in contrast to the other systems, only one of the five stations had a degraded benthic community. Except for nickel, there were no chemical concentrations that exceeded an ER-M. On the whole, we consider these data to be conflicting and therefore, recommend designating this segment as an *Area with Insufficient or Inconclusive Data.* The Severn River, originally classified as an *Area of Emphasis* would maintain that classification. There are both exposure (sediment and fish tissue) and effects (sublethal sediment toxicity) data exceeding thresholds. Although there is benthic degradation, it may be discounted for use in the characterization due to documented extensive hypoxia. Since there is insufficient evidence of a relationship between exposure and effects, the *Area of Emphasis* classification is recommended.

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INTRODUCTION

The 1994 *Chesapeake Bay Toxics Reduction and Prevention Strategy* directs the Chesapeake Bay Program Signatories to: "Support and conduct the necessary biological and chemical assessments, including ambient toxicity and community structure, of Bay habitats to ensure future characterization of all tidal Bay habitats through the Regions of Concern identification protocol". To this end, for the past several years, the U.S. EPA's Chesapeake Bay Program has funded the Ambient Toxicity Program. In June 1999, the Chesapeake Bay Program Toxics Subcommittee finalized a report characterizing the tidal tributaries of the Chesapeake Bay with respect to their potential for adverse effects due to chemical contamination (U.S. EPA 1999a). One of the findings was that there was a paucity of data over much of the Bay that resulted in the characterization of many segments as *Areas with Insufficient or Inconclusive Data.* The objective of our study was to help fill these identified data gaps.

The study, a collaborative effort between the U.S. Fish and Wildlife Service Chesapeake Bay Field Office, the University of Maryland Wye Research and Education Center, and the Academy of Natural Sciences' Patrick Center, evaluated sediment chemistry, sediment toxicity and benthic community structure (i.e., the Sediment Quality Triad) at stations in tidal segments of the Bohemia, Elk, Northeast, and Severn Rivers in Maryland. These were segments previously characterized as *Areas with Insufficient or Inconclusive Data* (Bohemia, Elk, and Northeast) or an *Area of Emphasis* (Severn River) with need for further sampling. The Triad sampling was scheduled during the summer/fall index period for determining the Benthic Index of Biotic Integrity (B-IBI). An additional goal was to examine concentrations of water column contaminants in these tributaries, with sampling scheduled for the spring to capture possible influences from runoff. To evaluate the feasibility of conducting *in situ* toxicity tests with a prototype caging system, larval sheepshead minnows (*Cyprinidon variegatus*) were exposed in the Severn River and a reference area (Wye River).

The Sediment Quality Triad has been successfully applied in the Chesapeake Bay (e.g., Baltimore Harbor, Anacostia River) and nation-wide (e.g., Puget Sound, San Francisco Bay, Gulf of Mexico) to characterize ambient conditions in freshwater, estuarine and marine systems (e.g., Long and Chapman 1985, Chapman *et al.* 1987, McGee *et al.* 1999, Schlekat *et al.* 1994). The combination of potential cause (chemistry) and effect (biology) measurements makes the Triad one of the most complete and powerful tools available to determine the extent and significance of pollution-induced degradation. Although water column contaminant levels are useful to distinguish among sources (new inputs versus historic contamination) and loadings of contaminants, they are temporally and spatially quite patchy, potentially confounding our ability to characterize the potential for toxicant related impact. Therefore, the focus of this approach is on the sedimentary environment because sediments accumulate and integrate toxic chemical inputs from multiple sources over time; hence, determination of sediment quality is essential to determine trends in toxic contaminants.

The specific objectives of this project were to: 1) conduct the sediment quality triad study at 18 stations in the four Chesapeake Bay tributaries, with 10-day sediment toxicity tests with the freshwater amphipod, *Hyalella azteca*, and 28-day tests with the estuarine amphipod, *Leptocheirus plumulosus*; 2) characterize water column concentrations of organic chemicals and metals in these tributaries; 3) evaluate the feasibility of conducting *in situ* 7-day water column toxicity tests with the sheepshead minnow, *Cyprinodon variegatus*, in two Severn River stations; and 4) provide a preliminary characterization of these tidal segments with respect to adverse effects from chemical contamination. Obtaining data for regulatory purposes was not a project objective. Thus, no external (third-party) data validation was undertaken.

Detailed results of the analysis of the toxicity testing (Fisher *et al.* 2004) are provided as Appendix A. The sediment and water column chemistry (Ashley and Velinsky 2004) and passive sampler results (Alvarez *et al.* 2004) are provided as Appendices B and C, respectively. Benthic data are provided as Appendix D. This report focuses on data integration and interpretation, resulting in the preliminary characterization.

METHODS

Study areas

Sampling was targeted primarily in tidal segments identified as having "Insufficient or Inconclusive Data" for characterization (U.S. EPA 1999a). The segments identified by the Toxics Subcommittee for inclusion in the study, were as follows: the Bohemia (BOR), Elk (ELR), Northeast (NER), and Severn (SER) Rivers in Maryland. These segments were then cross referenced with locations of the Long-Term Benthic (LTB) monitoring stations sampled by Versar, Inc. (Columbia, MD). This resulted in the selection of stations SER4, BOR2, ELR1, and NER1 (Table 1). For the remaining stations, the tidal segments were divided into sections and one station was randomly selected within each section. In some cases, minor adjustments were made to avoid extremely shallow water, submerged aquatic vegetation beds, locations covered with shell, and avoid duplication of effort with that of the Maryland Department of the Environment (MDE) Total Maximum Daily Load sampling. The resulting Sediment Quality Triad station locations are shown in Figures 1 and 2.

Sediment sample collection

Sediment sampling protocols followed those described in U.S. EPA/U.S. ACE (1995) and the Quality Assurance Project Plan developed for this study (U.S. FWS 2002). In brief, designated sampling stations were located with the aid of a hand-held GPS unit, equipped with a differential antenna. Final station coordinates (latitude and longitude) were recorded on site (Table 1). Sediments were collected between September 13 and 17, 2002, using a stainless steel 0.023 m^2 petite Ponar grab sampler. Timing of the sampling was chosen to be within the July 15-September 30 sampling period for the Long-Term Benthic (LTB) Monitoring program (Llanso *et al.* 2004). Samples for sediment toxicity testing and chemistry represented composite samples. At each station, the top 2-3 cm of several grabs was placed into a pre-cleaned stainless steel bowl, homogenized with a stainless steel spoon until uniform in color and texture then placed

into separate pre-cleaned containers for sediment chemistry and toxicological analyses. Collected sediments were kept on ice and subsequently refrigerated (toxicological and grain size samples) or frozen (chemical samples) until analysis. Between stations, the grab sampler, stainless steel bowl and mixing utensils were rinsed sequentially in 10% nitric acid, distilled water, acetone and distilled water to remove residual contaminants. Bottom water quality parameters (dissolved oxygen (D.O.), temperature, salinity, pH) and depth were measured at each station with a Hydrolab Surveyor IV (Hydrolab Inc., Austin, TX). Criteria for acceptability of representative grab samples included intact samples with sufficient depth penetration (>10cm) and a relatively undisturbed sediment surface. Observations of sample acceptability, depth of penetration, and qualitative characteristics (i.e., odor, color, etc) were recorded on field data sheets.

An additional petite Ponar grab sample was collected at each station for benthic macro-invertebrate community analysis. The contents of the grab were sieved through a 500 μm screen. Material retained on the sieve was rinsed into a plastic container, relaxed with MS-222 (3-aminobenzoic acid ethyl ester), and preserved with 10% buffered formalin containing rose bengal.

Sediment toxicity tests

Sediment toxicity was assessed using the chronic 28-day U.S. Environmental Protection Agency (EPA) survival, growth and reproduction test with the estuarine amphipod, *Leptocheirus plumulosus* (U.S. EPA/U.S. ACE 2001) and the 10-day survival and growth test with the freshwater amphipod *Hyalella azteca* (U.S. EPA 2000). Both are static-renewal tests. Detailed testing protocols are provided in Fisher *et al.* (2004, Appendix A). *Leptocheirus* tests were started on October 10 and 11, 2002 and *Hyalella* tests on October 15 and 16, 2002.

Sediment physico-chemical characterization

Analyses included textural properties such as grain size and total organic carbon content, as well as molar quantities of acid volatile sulfides and simultaneously extracted metals (AVS and SEM), concentrations of trace metals and organic compounds including polychlorinated biphenyls (PCBs), organochlorine pesticides (OCs) and polycyclic aromatic hydrocarbons (PAHs). The list of analytes was based on previous chemical characterizations of sediments in the Ambient Toxicity Program (Tables 2 and 3). In addition, porewater concentrations of ammonia were analyzed in sediments prior to use in toxicity tests as well as on a subsample of those designated for chemical analysis.

Details on analytical protocols and Quality Assurance/Quality Control measures can be found in Ashley and Velinsky (2004, Appendix B). In brief, congener specific PCBs and OCs were analyzed using a Hewlett Packard 5890 gas chromatograph equipped with a ^{63}Ni electron capture detector and a 5% phenylmethyl silicon capillary column. Polycyclic aromatic hydrocarbons were identified and quantified using a capillary gas chromatograph (Hewlett Packard 5890) and a mass spectrometer (5972) operated in selected ion monitoring mode.

Trace metals in sediments were determined using a "total" acid digestion with 10 mL HNO_3, 2 mL HCl, and 5 mL HF on 0.2 g dry sediment in an open Teflon beaker. The sample was digested to near dryness, digested with an additional 2 mL $HClO_4$ to near dryness and dissolved in 0.5% HNO_3. Iron (Fe), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn) were analyzed by flame atomic absorption spectrophotometry (FLAAS), using a Perkin Elmer 5100 ZL; aluminum (Al) and chromium (Cr) were analyzed by inductively coupled plasma-mass spectrometer (ICP-MS) using a Perkin Elmer Elan 6100 ICP-MS; Cd was analyzed by graphite furnace atomic absorption spectrophotometer using a Perkin Elmer 5100 ZL. For mercury (Hg) analysis, reductive flow injection analysis (FIA) was used, with the ICP-MS as the detector.

For arsenic (As) analysis, two mL aliquots of the original digest were taken to near dryness and re-dissolved in 10% HCl. Arsenic was analyzed by hydride generation coupled to a cryogenic trap system (Braman *et al.* 1977) using a hydrogen-burning quartz cuvette in an atomic absorption spectrophotometer (Perkin Elmer 2380) as a detector (Andreae 1977). For selenium (Se) analysis, 2-3 mL aliquots of the original digests were digested in 4 N HCl with $K_2S_2O_8$ to convert all Se to selenite, and analyzed using a hydrogen-burning quartz cuvette in an atomic absorption spectrophotometer (Perkin Elmer 2380) as a detector (Cutter 1978, 1983).

Acid volatile sulfide and simultaneous extracted metals (SEM) were analyzed using a modification of the methods outlined in Allen *et al.* (1993). Acid volatile sulfur was analyzed via acid distillation under N_2 and specific ion probe detection of the resultant HS^-. The final trace metal samples were analyzed by Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES; Perkin Elmer Optima 3000XL), using the manufacturer's recommended operating conditions. Samples for solid phase organic carbon and total nitrogen were analyzed using the method outlined in U.S. EPA (1992), while grain size was measured using the methods in Folk (1980).

Benthic community analysis

Benthic macroinvertebrate community samples were sorted, processed, and analyzed by Versar, Inc. (Columbia, MD), according to methods used in the LTB program (Llanso *et al.* 2004). The following benthic community parameters were calculated for each station: taxa richness (i.e., number of species), Shannon-Weiner diversity, total abundance, and the Benthic Index of Biotic Integrity (B-IBI). The B-IBI was developed specifically to interpret benthic community data in Chesapeake Bay (Weisberg *et al.* 1997). The B-IBI is a multiple matrix index developed to identify to the degree to which the benthic assemblage meets the Chesapeake Bay Program's Benthic Community Restoration Goals. It also provides a way to compare benthic communities across different habitats in the Bay. The B-IBI ranges from 1-5. Stations with scores of greater than or equal to 3 are considered to meet the restoration goals. Scores from 2.7 to 2.9 are considered marginal; 2.1 to 2.6 are indicative of a degraded benthic community; and scores less than 2 are considered severely degraded (Llanso 2002).

Deployment and analysis of integrative samplers

Water column chemistry was analyzed in the spring to integrate high flow periods, in which substantial agricultural and urban/suburban runoff frequently occurs. We deployed a prototype integrated water sampler, similar in concept to the semi-permeable membrane device (SPMD), to detect the presence and relative amounts of polar organic compounds in the water column at the study sites. These Polar Organic Compound Integrative Samplers (POCIS) consist of a hydrophilic polyethersulfone membrane containing an admixture of a hyper-crosslinked polystyrene-divinylbenzene solid-phase extraction resin and S-X3 BioBead-dispersed Ambersorb®1500. The membrane-sorbent "sandwich" is secured between two stainless steel washers and four of these devices were mounted in a stainless steel canister. The POCIS were analyzed for the hormones 17-βestradiol and estrone, and the antibiotics, tetracycline, oxytetracycline, and chlortetracycline. All of these can be derived from intensive agriculture but are also known to have other sources including releases from treated or untreated sewage (Shore *et al.* 1995; Daughton and Ternes 1999). SPMDs were analyzed for PCBs, OCs, PAHs, and current use pesticides including chlorpyrifos, permethrin, atrazine, diazinon, alachlor, and metolachlor. A complete list of analytes and laboratory methods is provided in Alvarez *et al.* (2004, Appendix C).

SPMDs and POCIS were deployed on April 28-29, 2003 at the following locations: BOR2, ELR2, ELR4, NOR3, NOR5, SER3, and SER5. The devices were attached with plastic ties to concrete cinder blocks and lowered onto the sediment such that they were approximately 0.2 m above the bottom. Water quality parameters were monitored weekly and the samplers were retrieved on June 8-9, 2003 and shipped to the U.S. Geological Survey's Columbia Environmental Research Center (CERC, Columbia, MO) for analysis. During the course of the study, the samplers at ELR4 and SER3 were lost, possibly from vandalism. Field blank SPMDs and POCIS accompanied the SPMDs and POCIS during deployment, retrieval, and transportation to CERC (Appendix C).

Water column metals sampling and analyses

Water samples were collected during base flow on June 24-25, 2003 from ELR2 and 4, BOR2, NER3 and 5, and SER3. Clean techniques including the use of acid-washed and Teflon materials and the clean hands/dirty hands procedure were used to avoid sample contamination (Reidel 2002). Field filtration and duplicate samples were collected to evaluate contamination and precision. Trace elements were collected using a pumping system consisting of a Masterflex peristaltic pump using acid-washed C-flex tubing, with acid-washed PFA Teflon line.

Samples for Al, Cd, Cu, Ni, Pb and Zn in all the sites except the Severn River were analyzed by direct ICP-MS using a Perkin-Elmer Elan 6100 ICP-MS. Samples from the Severn River could not be determined directly because of interferences from the salt matrix (2 to 10 ‰ salinity). Severn River samples for Al, Cd, Cu, Ni, Pb and Zn were concentrated using an APDC/NaDDDC - chloroform extraction (Bruland *et al.* 1979; Nolting and de Jong 1994) into dilute HNO_3 and determined by ICP-MS. Chromium in all water samples was analyzed using by ICP-MS using Dynamic Reaction Cell (DRC) technology, with NH_3 as the reaction gas (Nixon *et al.* 2002). In the Severn River

samples, Cr was determined by ICP-MS, using the DRC, and standards made in clean seawater (NASS-4) diluted to the same salinity as the Severn River. Total Hg was analyzed by digestion with BrCl, and analyzed by cold vapor trapping (Bloom and Fitzgerald 1988), using ICP-MS as the detector. Total arsenic and selenium, done separately, were determined by hydride generation, cryogenic trap, chromatographic separation atomic absorption spectrophotometry, using a Perkin Elmer 2380 Atomic Absorption spectrophotometer (Andreae 1977; Braman *et al.* 1977). Samples for total Se were digested using potassium persulfate and analyzed by hydride generation, cryogenic trap, chromatographic separation atomic absorption spectrophotometry, using a Perkin Elmer 2380 atomic absorption spectrophotometer (Cutter 1978, 1983). Dissolved As was additionally analyzed into various inorganic and organic fractions, which were not part of the original scope of work

In situ Cyprinidon variegatus test

Cyprinodon variegatus larvae were exposed *in situ* at two sites in the Severn River (SER3 and 5) and a control site in the Wye River from May 27-June 3, 2003. Ten 10-day old larvae were added to each of four replicate larvae baskets at each site. Details of the caging apparatus and deployment system are provided in Appendix A. Each day, the outer cages were pulled to the surface and the fish were observed. Mortalities were counted and water quality measurements were taken. Fish were fed TetraMin® Tropical Flake ground to 200 μm. At the end of the 7-day test period, the surviving fish were collected, taken to the lab, dried and weighed according to U.S. EPA (1994) methods.

Data analysis

Associations between biological and chemical data were evaluated both quantitatively and qualitatively. The Acid Volatile Sulfide-Simultaneously Extracted Metals (AVS-SEM) approach for sediment quality for metals was used to evaluate potential bioavailability (DiToro *et al.* 1990). In addition, sediment concentrations of contaminants were compared to the Effects Range-Median (ER-M) values in Long *et al.* (1995) and Long and Morgan (1991). Long and Morgan (1991) and Long *et al.* (1995) indicate that the reliability of the ER-M values for total chlordane, dieldrin, and total DDT compounds is low due to the limited dataset, poor correlation with effects data, or both. MacDonald *et al.* (2000) published consensus based sediment quality guidelines for contaminants in freshwater systems. The predictive ability of these values (probable effect concentrations (PECs)) for these organochlorine pesticides is much improved over the ER-M values. Unfortunately, at this time there are no consensus- based guidelines for saltwater systems; however, for comparative purposes, exceedances of the PECs will be provided in the data tables.

In addition, for the sediment analytes for which an ER-M value exists, the chemical concentration at the site was divided by the ER-M for that contaminant. The quotients were averaged, yielding a mean ER-M quotient (MERM-Q), which is used as a hazard index for sediment contamination. Several researchers have found this to be a useful way to summarize chemical data and evaluate relationships among chemical and biological endpoints (McGee *et al.* 1999, Long *et al.* 1998). Spearman rank correlation was used to

discern the significance of the relationships between the MERM-Q and biological endpoints (McGee *et al.* 2001).

The characterization recommendation was based on the data obtained in the current study along with that obtained from the LTB Program, Maryland Department of the Environment's Fish Tissue data base, Maryland Department of Natural Resources water quality monitoring data summaries, and other available sources. The recommendations follow the guidelines developed by the Toxics Characterization Workgroup (U.S. EPA 1999b).

RESULTS

Sample collection

Measured water quality parameters and qualitative descriptions of grab samples are provided for each site (Table 4). For the most part, grab penetration was adequate and sediments were muddy (*i.e.*, at least 50% silt+clay fraction, Table 5). Dissolved oxygen was low (<4 mg/L) at four of the five Severn River stations. At all other stations, D.O. was above 5.0 mg/L (Table 4).

Sediment toxicity tests

Performance criteria of $80% survival in the *H. azteca* and *L. plumulosus* controls were obtained. The mean control survival in the two *H. azteca* tests was 99% and 96% while the mean survival in the two *L. plumulosus* tests was 84% and 82% (Table 6a). In addition, there was measurable growth in all of the *H. azteca* control amphipods and measurable growth and reproduction in all *L. plumulosus* control amphipods.

There were no significant differences between *H. azteca* survival and control survival in any test sediments (Table 6a). Neither were there differences in growth in any test sediment from the Bohemia, Elk, or Northeast Rivers compared with the control sediments. The average *H. azteca* dry weight at the end of the ten-day test ranged from 0.169 mg at ELK1 to 0.216 mg at NER5. There were significant differences in *H. azteca* growth between control and sediments from three stations in the Severn River (Tables 6b, c). Amphipod dry weight at the end of the ten-day test was significantly less than the control dry weight (0.175 mg) at SER1 (0.128 mg), SER4 (0.148 mg), and SER5 (0.148 mg). These reductions in dry weight represent a 27% reduction from the control amphipod weight at SER1 and a 15% difference from the control amphipod weight at both SER4 and SER5.

There were no significant differences between *L. plumulosus* survival in any test sediments from any of these rivers compared with control sediments (Table 6a). The *L. plumulosus* survival ranged from 54% at ELK2 to 91% at SER2, compared with control survival of 82% (test 1) and 84% (test 2). In the Bohemia River, there were significant effects on growth rate (mg dry weight/day) at three stations; BOR2 (0.033 mg mg/day), BOR3 (0.028 mg/day), and BOR4 (0.026 mg/day; Table 6b). This is compared to the control amphipod growth rate of 0.053 mg/day. These reductions in growth rate represent a 38% decrease at BOR2, a 47% decrease at BOR3, and a 51% decrease at BOR4 compared to amphipod growth in the control treatment (Table 6c). In addition,

there was also a significant reduction in amphipod reproduction at station BOR4, with the number of neonates per survivor being reduced by 87%, from 1.31 in the control to 0.17 at BOR4.

In the Elk River samples, there were significant reductions in *L. plumulosus* growth rate and reproduction at ELK2 and ELK3 (Tables 6b,c). Amphipods in ELK2 sediments at the end of 28 days showed an average growth rate of 0.023 mg/day, a reduction of 42% from the control growth rate (0.040 mg/day). At station ELK3, the average growth rate was also 0.023 mg/day. Amphipods in ELK2 sediments at the end of 28 days had an average reproduction of 0.04 neonates/survivor, a reduction of 97% from the control reproduction (1.18 neonates/survivor). At station ELK3, the average reproduction was 0.14 neonates/survivor, a reduction of 88% from the control (Table 6c).

In the Northeast River samples, there were significant reductions in *L. plumulosus* growth rate and reproduction at NER3 and NER4 (Tables 6b,c). Amphipods in NER3 sediments at the end of 28 days showed an average growth rate of 0.020 mg/day, a reduction of 50% from the control growth rate (0.040 mg/day). At station NER4, the average growth rate was 0.022 mg/day, a reduction of 45% from the control growth rate. Amphipods in NER3 sediments at the end of 28 days had an average reproduction of 0.45 neonates/survivor, a reduction of 62% from the control reproduction (1.18 neonates/survivor). At station NER4, the average reproduction was 0.15 neonates/survivor, a reduction of 87% from the control.

In the Severn River samples, there were significant reductions in *L. plumulosus* growth rate and reproduction at SER4 and SER5 (Tables 6b,c). Amphipods in SER4 sediments at the end of 28 days showed an average growth rate of 0.032 mg/day, a reduction of 40% from the control growth rate (0.053 mg/day). At station SER5, the average growth rate was 0.029 mg/day, a reduction of 45% from the control growth rate. Amphipods in SER4 sediments at the end of 28 days had an average reproduction of 0.20 neonates/survivor, a reduction of 85% from the control (1.31 neonates/survivor). At station SER5, the average reproduction was 0.19 neonates/survivor, a reduction of 86% from the control.

Values for pH, salinity and dissolved oxygen were acceptable for all test and control sediments. Pore water ammonia was relatively low in all test beakers, with a highest recorded value of 12.0 mg/L for any test sediment and 8.5 mg/L for the control sediment. Overlying ammonia was also low, with a highest recorded value of 3.0 mg/L for any test sediment and 1.3 mg/L for the control sediment. These values are well below the level of 60 mg/L in pore water that would be considered to be a problem by the U.S. EPA (U.S. EPA/ACE, 2001).

Sediment physico-chemical characterization

Sediment textural characteristics and concentrations of select chemical constituents at each station are summarized (Tables 5, 7 – 9; see Appendix B for details). Sediment grain size varied from 55.7 to 99.1 % silt/clay, with total organic carbon content ranging from 1.7% to 10.9% (Table 5).

Sediment metal concentrations exceeded ER-M values for nickel (SER1, 2, and 5; NER2-5; and ELR4); copper (SER5), and zinc (SER2 and 5; Table 7a). Except for copper (601.1 vs. ER-M of 270 μg/g), ER-M values were exceeded by less than a factor of two. The difference between AVS and SEM was positive or only slightly negative at all stations, suggesting an excess of sulfides relative to SEM (Table 7b).

Concentrations of total PAHs ranged from 0.717 ppm to 16.9 ppm, substantially less than the ER-M of 35.0 ppm (Table 8). The only PAH exceedance was for benzo(e)pyrene at SER5 (1915 vs. ER-M of 1600 ng/g). Total PCBs ranged from 7.42 ng/g to 52.42 ng/g, less than the ER-M of 180 ng/g. The ER-M value for total chlordane (6.00 ng/g) was exceeded at SER2 (8.85 ng/g) and SER5 (7.63 ng/g). These concentrations did not exceed the PEC of 17.6 ng/g. .ER-M values were not exceeded for any other organochlorine pesticide. The MERM-Q ranged from 0.059 at ELR2 to 0.598 at SER5 (Table 10).

Benthic community analysis

The benthic community varied in abundance and diversity among the four rivers, based on the Benthic Index of Biotic Integrity (B-IBI) scores. A summary of the analysis of benthic community health is presented in Table 11. The taxa list and abundances for each station are provided in Appendix D.

The Severn River stations were classified as degraded (SER5: B-IBI score of 2.33) or severely degraded (SER1-4; scores ranging from 1.00 to 1.33). All four Bohemia River stations and three of four Elk River stations were classified as degraded or severely degraded. In contrast, two of five stations in the Northeast River met the benthic restoration goal (score of 3 or higher) and two of five were marginal (NER3 and NER5 each with a 2.67 score). Only NER4 was rated as severely degraded at 1.67. Results of correlation analysis between the B-IBI at each station and MERM-Q, did not indicate a significant association between these variables (p=0.189, Figure 3).

In situ Cyprinidon variegatus test

Larval sheepshead minnows that were exposed for seven days *in situ* at two sites in the Severn River (SER3 and SER5) did not show any differences in survival, growth, or biomass when compared to sheepshead minnows exposed at the control site in the Wye River. There was greater than 97% survival at all sites and all fish showed significant growth (dry weight per survivor) and biomass (dry weight per initially exposed) over the seven-day exposure period (Appendix A).

Water column chemistry

Dissolved metals concentrations from samples collected during base flow periods at each of the rivers were generally low. None were detected at concentrations that exceeded Maryland chronic ambient water quality criteria for aquatic life. Copper in Back Creek (SER5) was detected at 5.79 μg/L, which approaches but does not exceed the estuarine criterion of 6.1 μg/L (Table 8c).

SPMDs at all five stations had measurable concentrations of a wide variety of OC pesticides (Table 12a). ELR2 and 4, and SER5 showed the highest concentrations of sequestered OC-pesticide contaminants with approximately 250-300 total ng per SPMD. Sequestered concentrations of OC-pesticide contaminants from the remaining three stations were similar to each other and ranged from 116 to 126 total ng per SPMD. Contaminants observed at all five stations included the chlordanes, DDD, dieldrin, the nonachlors, dacthal, PCA, and the current use pesticides, acetochlor and chlorpyrifos. Estimated water column concentrations of OCs or current use pesticides did not exceed Maryland water quality criteria for aquatic life (Table 12b). SPMD samples from all five stations also had measurable concentrations of PAHs. Only SER5 showed elevated concentrations of sequestered PAH contaminants – approximately 1000 to 13000 pg/L of fluoranthene, pyrene, and chrysene. The ubiquitous PAHs, fluoranthene and pyrene, were observed at low concentrations (~ 400 to 900 pg/L) at each station (Table 12c).

Only the POCIS from NER3 had measurable concentrations of the targeted hormone 17β-estradiol at ~ 4 ng/L. Neither this compound nor estrone was detected in any of the POCIS samples. Tetracycline antibiotics were identified in POCIS extracts from three of the stations. Chlortetracycline was isolated in samples from NER5 and oxytetracycline was measured at NOR3. POCIS samples from SER5 contained all three antibiotics - ocytetracycline, tetracycline, and chlortetracycline (Table 12c).

DISCUSSION

Benthic community analysis

B-IBI values calculated for the LTB samples collected by Versar at station 204 in the Severn River were consistent with the value calculated for our (co-located) station SER4. Versar collected three samples on 9/17/02, four days later than our collection at SER4. Our SER4 B-IBI was 1.33 whereas the three Versar samples were scored as 1.33, 2.00, and 2.67. Dissolved oxygen measurements were similar – 3.68 mg/L at SER4 on 9/13/02 vs. 4.1 mg/L at 204 on 9/17/02 (Appendix D). For the Elk River, LTB random station 09427, collected 9/20/02 had a B-IBI of 2.2 (L. Scott, Versar, Inc. pers. comm.) Co-located station ELR1 had a similar B-IBI of 2.60. Bottom D.O. was 6.9 mg/L for 09427 and 9.84 mg/L for ELR1. In contrast, very different B-IBI scores were reported between the LTB and Sediment Quality Triad Stations for the Bohemia River. The Versar B-IBI score for all three station 029 samples collected on 9/20/02 was 3.00. The value calculated for our co-located station (BOR2) sampled on 9/17/02 was 1.80. Dissolved oxygen measurements were similar for both samples (6.41 mg/L for BOR2, 6.34 mg/L for 029; Appendix D).

No LTB stations were sampled in the Northeast River in 2002 so historical data must be used for the comparison with our data. Random sites 04625 and 07625 are co-located with NER1 and were collected in Aug 1997 and September 2000, respectively. Whereas NER1 had a B-IBI score of 3.0, the B-IBI scores for 04625 and 07625 were 2.0 and 3.5, respectively. Interestingly, bottom D.O. values were 9.3 mg/L in 1997 when the results indicated a severely degraded community and 0.4 mg/L in 2000 when the benthic community met the restoration goal. Thus, these data indicate the need to carefully

interpret the dissolved oxygen data, since the benthic community is more reflective of long-term rather than short term concentrations. Further data are needed to determine a trend in B-IBI in this system.

Sediment quality triad interpretation

There are eight possible outcomes for a sediment quality triad investigation (Table 13). In the present study, only SER5 had a "hit" in all three categories – sediment contamination with multiple chemicals above ER-Ms; sediment toxicity; and benthic degradation, as indicated by the B-IBI. Thus, the result at SER5 provided evidence of contaminant-induced degradation. Bottom dissolved oxygen at this station was low (3.27 mg/L), however, at the time the sample was collected. Hence, benthic degradation may also be attributable to low dissolved oxygen, if, as stated above, this was a chronic occurrence at this location. The degraded environment at SER5, in Back Creek, may result from poor flushing of this area which has high boat activity, including marinas. The high sediment concentrations of zinc and copper may be the result of leaching and/or maintenance activities causing releases of active ingredients in boat paints. Total PAH concentrations were also fairly high (about one half of the ER-M value), which may also result from petroleum releases from boating and marina activities.

There were four other cases (BOR2-4, ELR3, NER3, 4, and SER1, 4) in which both sediment toxicity and degraded benthic communities were observed (Table 13). This outcome is less clear and may indicate that unmeasured chemicals are causing benthic degradation. It is also possible that benthic degradation may be partially attributable to chemicals and partially the result of low dissolved oxygen. For example, long term data from the Maryland Department of Natural Resources (DNR) station WT7.1 on the Severn River upstream of the Route 50 Bridge (Figure 4; MD DNR 2004) suggest frequent hypoxic periods. Llanso *et al.* (2004) reported extensive areas of low dissolved oxygen in the tidal Severn, especially in the upper portion. They stated that a decreasing trend in the B-IBI score reported in 2003 compared with previous years at fixed station 204 (corresponding to our SER4) may be due to an enlargement of the hypoxic area. The tidal Severn River is currently on the Maryland 303(d) list of impaired waters due to nutrients and sediments (MDE 2004a), both of which may contribute to low oxygen conditions.

No explanation is currently available for the Sediment Quality Triad outcomes for BOR2-4 and ELR3. Long-term monitoring data from the MD DNR fixed station ET2.2 in the Bohemia River and ET2.3 in the Elk River (Figure 5) suggest that D.O. concentrations are rarely lower than 5.0 mg/L (MD DNR 2004). However, MDE (2004a) has a 303(d) listing for the tidal Bohemia for nutrients, and the tidal Upper Elk River for nutrients and sediments, both of which could decrease D.O. concentrations.

Northeast River stations 3 and 4 also had a similar Sediment Quality Triad outcome, *i.e.*, sediment toxicity and degraded benthos, but little evidence of sediment contamination. The lack of chemical contamination in the current samples is not consistent with the 303(d) listing of the tidal Northeast River [in 1996 but still included in the 2004 list] for lead and zinc, as well as nutrients and sediments (MDE 2004a). No readily apparent

explanation is available for the outcome for Elk River station 2, where sediment toxicity occurred but there was no evidence of chemical contamination or benthic community impacts. For both outcomes 4 and 7 (Table 13), Chapman *et al.* (1992), state that toxicity could be attributed to unmeasured chemicals.

Characterization of chemical impacts on living resources
Below we integrate our data with other information to provide a preliminary characterization for the segments. According to the U.S. EPA (1999b) guidelines, concentration or exposure data include water and sediment contaminant concentrations, fish and shellfish tissue data, and fish consumption advisories. Effects data include water column or sediment toxicity and impaired benthic community structure. For the characterization, we relied primarily on data from the current study, LTB data, fish tissue monitoring results, and long-term dissolved oxygen data. The characterizations represent our best professional judgment and should not be considered to be the final designations, which are the responsibility of the Toxics Subcommittee.

The category data requirements for *Area of Emphasis* and *Area of Insufficient or Inconclusive Data* are provided below:

An *Area of Emphasis* is appropriate when there is a significant potential for chemical contaminated-related problem. According to U.S. EPA (1999b), there must be:

> 1) Multiple measurements of chemical contamination in the water column, bottom sediments, and/or finfish/shellfish tissue at concentrations exceeding the established water column, sediment, or tissue thresholds, respectively; and/or
> 2) Multiple observations of one or more adverse effects on living resources exposed to the waters and/or sediments of that area.

Thus, this category is appropriate 1) when there is limited or no effects data but exposure data that exceed thresholds; 2) there are limited or no effects data but observations of adverse effects; or 3) there are both effects and exposure data exceeding thresholds but no relationship between the two.

An *Area with Insufficient or Inconclusive Data* is appropriate when:

> 1) Either the measurement of chemical contaminants in water, sediment, or finfish/shellfish tissue are too limited temporally and/or spatially, are inconclusive or conflicting, or are of unknown quality and cannot support the level of confidence required to characterize the region into one of the other three categories; AND/OR
> 2) Either the measurements of the potential adverse effects on living resources are too limited temporally and/or spatially, are inconclusive or conflicting, or are of unknown quality and cannot support the level of confidence required to characterize the region into one of the other three categories.

An area can be placed into this category if either condition 1) or condition 2) is met or if both conditions are met (U.S. EPA 1999b).

Bohemia River

The Bohemia River segment was classified as an *Area with Insufficient or Inconclusive Data* (U.S. EPA 1999a). It was grouped with the Elk River in the original classification. U.S. EPA (1999a) stated that data were too limited spatially to define the Elk/Bohemia segment. They also stated that there was evidence of metals contamination in sediments and degraded benthic communities in areas where there is adequate dissolved oxygen. McGee *et al.* (2001) sampled two stations in the Bohemia River in an attempt to refine the classification. They reported that, with the exception of nickel and zinc, the sediment concentrations of trace metals and PAHs were well below ER-M values, although concentrations of total DDT, chlordane and dieldrin exceeded ER-M values at one of the two stations. They did not observe sediment toxicity but confirmed that the benthic community was severely degraded. They recommended that additional sediment quality triad samples be collected, particularly in the Elk River, in order to complete the characterization.

The current Sediment Quality Triad results indicated sublethal toxicity to *L. plumulosus*. Three of the four stations exhibited toxic sediments, with 40-50% growth inhibition in *L. plumulosus* and an 87% reduction in reproduction at one station (BOR4). However, there were no cases of sediment concentrations exceeding the ER-M values. Fish consumption advisories are in place with the general population recommendation of 12 meals per year for channel catfish (MDE 2004b). Using the MDE fish tissue spreadsheet (Beaman, pers. comm.), the general population equation for PCBs is:

Meals per year = 3756 divided by concentration;
Thus, average PCB concentration = 3756 divided by meals per year.

The advisory for channel catfish (12 meals per year) translates to an average fish tissue concentration of 313 ng PCB/g. The advisory for white perch (17 meals per year) translates to 221 ng PCB/g.

All four of the Bohemia stations indicated a degraded to severely degraded benthic community in the 2002 Sediment Quality Triad study. The LTB data for fixed station 029 (=BOR2) indicate that the initial mean B-IBI in 1985-1987 was 2.38 (degraded) and the 2000-2002 value was 2.68 (marginal) with the improvement statistically significant (Llanso *et al.* 2004). The summer 2003 B-IBI for this station was 2.56. There is no evidence of prolonged hypoxia (MD DNR 2004), and the triad stations sampled in September 2002 all had dissolved oxygen concentrations above 6.0 mg/L.

Using the U.S. EPA (1999b) guidelines, this segment would be classified as an *Area of Emphasis,* because there are both exposure (fish tissue advisory) and effects (sediment toxicity and impaired benthic community) data exceeding thresholds but there is insufficient evidence of a relationship between the two.

Elk River

The Elk River segment was originally grouped with the Bohemia and considered to be an *Area with Insufficient or Inconclusive Data* (U.S. EPA 1999a). Data from the original classification are described above in the description for the Bohemia. The McGee *et al.* (2001) data are for the Bohemia and do not apply here.

In the current Sediment Quality Triad study, two of the four stations exhibited sublethal sediment toxicity (42% decrease in growth and 88-97% decrease in reproduction of *L. plumulosus*). Fish consumption advisories are in place (MDE 2004b) with the general population recommendation of 8 meals per year for channel catfish (translates to 470 ng PCB/g) and 9 meals per year for white perch (translates to 417 ng PCB/g).

Only one of these stations, ELR3, had a degraded benthic community in the 2002 Sediment Quality Triad study. Stations ELR1 and ELR4 are at the upper edge of the degraded category (both with B-IBI of 2.60) and ELR2 meets the benthic restoration goal with a B-IBI of 3.40. No LTB fixed station data were available for this area. Based on DNR fixed station monitoring, there is no evidence of prolonged hypoxia (MD DNR 2004).

Using the U.S. EPA (1999b) guidelines, this segment would be classified as an *Area of Emphasis* because there are both exposure (fish tissue) and effects (benthic community impairment) data exceeding thresholds but insufficient evidence of a relationship between the two.

Northeast River

The Northeast River was originally categorized as an *Area with Insufficient or Inconclusive Data* (U.S. EPA 1999a). The rationale stated that no effects data were available; sediment metals and a few PAHs were at concentrations that indicate probable effects on living resources; and data were sparsely distributed.

In the current Sediment Quality Triad study, two of the four stations (NER3and 4) exhibited sublethal sediment toxicity (45-50% decrease in growth, 62-87% decrease in reproduction of *L. plumulosus*). However, except for exceedances of the ER-M for nickel at NER2-5), there was little evidence of sediment contamination. Fish consumption advisories are in place (MDE 2004b), with the general population recommendation of 18 meals per year for channel catfish (translates to 209 ng PCB/g) and 15 meals per year for white perch (translates to 250 ng PCB/g).

In the Sediment Quality Triad study, only one station, NER4, was rated as severely degraded, while two stations were rated as marginal, and two were rated as meeting benthic restoration goals. Based on the DNR fixed station monitoring, there is evidence of hypoxia during the summer months (MD DNR 2004), although dissolved oxygen was above 7.0 mg/L when the samples were collected.

Thus, this segment might qualify as an *Area of Emphasis* because there are both exposure (fish tissue) and effects (sediment toxicity) data exceeding thresholds but

there is insufficient evidence of a relationship between the two. However, in contrast to the other systems, only one of the five locations was scored as having a degraded benthic community and, except for nickel, there were no ER-M exceedances. On the whole, it seems justified to consider these data as conflicting, and therefore, we recommend designating this segment as an *Area with Insufficient or Inconclusive Data.*

Severn River

This river was originally classified as an *Area of Emphasis*, with a recommendation for further sampling for confirmation (U.S. EPA 1999a). The rationale for this classification was: 1) evidence of metals, pesticides, and PAHs in sediments that indicate probable adverse effects on living resources; and 2) water column and sediment toxicity in laboratory studies; in contrast to 3) a healthy benthic community.

From the Sediment Quality Triad study, there are exposure data indicating sediment concentrations exceeding multiple ER-Ms at SER-5 and the exceedance of several ER-Ms at stations SER1 and 2. MDE (2004b) currently lists a fish consumption advisory for white perch from the Severn River with an allowable consumption of 31 meals per year for the general population. This translates into a total PCB concentration of 121 ng/g.

For effects data, the Sediment Quality Triad showed evidence of sublethal toxicity at SER1 (*Hyalella*), and SER4 and 5 (*Hyalella* and *Leptocheirus*). There was evidence of contaminant-related toxicity and degradation of the benthic community at SER5. In contrast, at the other four stations there was benthic community degradation but no clear evidence that it was related to contaminants. Dissolved oxygen concentrations were less than 4.0 mg/L in four of the five SER samples collected in September 2002. Llanso *et al.* (2004) stated that recent data for the Severn indicate a decreasing trend in the B-IBI, which they attributed to an expanding area with chronic low dissolved oxygen. Thus, based on documented concerns about low dissolved oxygen, the benthic impairment may not qualify as contaminant-related effects data.

According to the U.S. EPA (1999b) guidelines, this segment would be classified as an *Area of Emphasis* because there are both exposure (sediment and fish tissue concentrations) and effects (sediment toxicity) data exceeding thresholds but there is insufficient evidence of a relationship between the two.

REFERENCES

Allen, H.E., G. Fu, and B. Deng. 1993. Analysis of acid-volatile sulfide and simultaneously extracted metals (SEM) for estimation of potential toxicity in aquatic sediments. *Environ. Toxicol. Chem.* 12:1441-1453.

Alvarez, D.A., W.A. Cranor, J.N. Huckins, R.C. Clark, and S.D. Perkins. 2004. Assessment of organic contaminants in integrative samplers from Chesapeake Bay tributaries. U.S. Geological Survey Columbia Environmental Research Center,

Columbia, MO. Report prepared for U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, March 2004.

American Society for Testing and Materials. (1984). Annual Book of ASTM Standards, Vol. 11.01, Standard Specification for Reagent Water, D 1193-77 (re-approved 1983). ASTM, Philadelphia, PA.

Andreae, M.O. 1977. Determination of arsenic species in natural waters. *Anal. Chem.* 49:820-823.

Ashley, J.T.F, and D. J. Velinsky. 2004. Using the Sediment Quality Triad to characterize toxic conditions in the Chesapeake Bay. Data Summary Report. Updated March 10, 2004. Final. Submitted to the U.S. EPA Chesapeake Bay Program.

Bloom, N. and W.F. Fitzgerald. 1988. Determination of volatile mercury species at the picogram level by low-temperature gas chromatography with cold vapor atomic fluorescence detection. *Anal. Chim. Acta* 208:151-161.

Braman, R.S., D.L. Johnson, C.C. Foreback, J.M. Ammons, and J.L. Bricker. 1977. Separation and determination of nanogram amounts of inorganic arsenic and methylarsenic compounds. *Anal. Chem.* 49: 621-625.

Bruland, K.W., R.P. Franks, G.A. Knauer, and J.H Martin. 1979. Sampling and analytical methods for the determination of copper cadmium, zinc and nickel at the nanogram per liter level in seawater. *Anal. Chim Acta.* 105:223-245.

Chapman, P.M., R.N. Dexter, and E.R. Long. 1987. Synoptic measures of sediment contamination, toxicity and infaunal community structure (the Sediment Quality Triad) in San Francisco Bay. *Mar. Ecol. Prog. Ser*. 37:75-96.

Chapman, P.M., E.A. Power, and G.A. Burton. 1992. Integrative assessments in aquatic ecosystems. In: G.A. Burton, ed., *Sediment Toxicity Assessment*, Lewis Publishers, Chelsea, MI, pp. 313-340.

Cutter, G.A.1978. Species determination of selenium in natural waters. *Anal. Chim. Acta* 98: 59-66.

Cutter, G. A.1983. Elimination of nitrite interference in the determination of selenium by hydride generation. *Anal. Chim. Acta.* 149:391-394.

Daughton, C.G. and T.A. Ternes. 1999. Pharmaceuticals and personal care products in the environment: agents of subtle change? *Environ. Health Perspect. Supp.* 107: 907-938.

DiToro, D.M, J.D. Mahony, D.J. Hansen, K.J. Scott, M.B. Hicks, S.M. Mayr, and M.S. Redmond. 1990. Toxicity of cadmium in sediments: the role of acid volatile sulfide. *Environ. Toxicol. Chem*. 9:1487-1502.

Fisher, D.J., G.P. Ziegler, L.T. Yonkos, and M. Shepard. 2004. Using the Sediment Quality Triad and integrative water sampling devices to characterize chemical contaminant impacts in Chesapeake Bay tributaries. March 2004. Final report submitted to U.S. EPA Chesapeake Bay Program.

Folk, R.L. 1980. *Petrology of Sedimentary Rocks.* Hemphill Publishing Co, Austin, Texas 183 p.

Llanso, R.J. 2002. Methods for calculating the Chesapeake Bay Benthic Index of Biotic Integrity. Versar, Inc., Columbia, MD.

Llanso, R.J., F.S. Kelley, and L.C. Scott. 2004. Chesapeake Bay Water Quality Monitoring Program. Long –Term Benthic Monitoring and Assessment Component Level 1. Comprehensive Report. Versar, Inc., Columbia, MD.

Long, E.R. and P.M. Chapman. 1985. A Sediment Quality Triad: Measures of sediment contamination, toxicity and infaunal community composition in Puget Sound. *Mar. Poll. Bull*. 10:405-415.

Long, E.R. and L.G. Morgan. 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA, 175 pp + appendices.

Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environ. Manag*. 19:81-97.

Long, E.R., L.J. Field, and D.D. MacDonald. 1998. Predicting toxicity in marine sediments with numerical sediment quality guidelines. *Environ. Toxicol. Chem*. 17:714-727.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Arch. Environ. Contam. Toxicol*. 39:20-31.

Maryland Department of the Environment (MDE). 2004a. Maryland's draft 2004 list of impaired surface waters [303(d) list] and integrated assessment of water quality in Maryland. http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/draft_2004_303d_for_pubnotice.asp

Maryland Department of the Environment (MDE). 2004b. Recommended maximum yearly fish consumption from select Maryland waters. http://www.mde.state.md.us/assets/document/fish/advisory_summary.pdf

Maryland Department of Natural Resources (DNR) 2004. Fixed station monthly monitoring. http://mddnr.chesapeakebay.net/bay_cond/

McGee, B.L., D.J. Fisher, L.T. Yonkos, G.P. Ziegler, and S. Turley. 1999. Assessment of sediment contamination, acute toxicity and population viability of the estuarine amphipod *Leptocheirus plumulosus* in Baltimore Harbor. *Environ. Toxicol. Chem.* 18:2151-2160.

McGee, B.L., D.J. Fisher, J. Ashley and D. Velinsky. 2001. Using the Sediment Quality Triad to characterize toxic conditions in the Chesapeake Bay (1999): An assessment of tidal river segments in the Bohemia, Magothy, Patuxent, Potomac, James and York Rivers. EPA 903-R-01-008. Chesapeake Bay Program, Annapolis, MD.

Nixon, D.E., J. Butz, S.J. Eckdahl, MF. Burit, and K.R. Neighbauer. 2002. Determination of chromium in serum and urine. Perkin-Elmer Instruments, Shelton CT.

Nolting, R. F. and J. T. M. de Jong. 1994. Sampling and analytical methods for the determination of trace elements in surface seawater. *Int. J. Environ. Anal. Chem.* 57:189-196.

Reidel, G.F. 2002. Ultraclean sampling of trace elements in natural waters. Procedure No. B-01-17, Rev 1 (07/02), Academy of Natural Sciences, Philadelphia, PA. 4 p.

Schlekat, C.E., B.L. McGee, D.M. Boward, E. Reinharz, D.J. Velinsky, and T.L. Wade. 1994. Tidal river sediments in the Washington, D.C. area. III. Biological effects associated with sediment contamination. *Estuaries* 17:334-344.

Shore, L.S., D.I. Correll, and P.K. Chakraborty. 1995. Relationship of fertilization with chicken manure and concentrations of estrogens in small streams. In: K. Steele, ed, *Animal Waste and the Land-Water Interface*, CRC Press, Boca Raton, FL, pp. 155-163.

U.S. EPA. 1992. Methods for the determination of chemical substances in marine and estuarine environmental samples. EPA/600/R-92/121, Office of Research and Development, U.S. EPA, Washington, D.C.

U.S. EPA. 1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. EPA/600/R-94/025. Office of Research and Development, Washington, DC.

U.S. EPA. 1999a. Targeting toxics: A characterization report. A tool for directing management and monitoring actions in the Chesapeake Bay's tidal rivers. EPA 903-R-99-010. Chesapeake Bay Program, Annapolis, MD.

U.S. EPA. 1999b. Targeting toxics: A characterization report. A tool for directing management and monitoring actions in the Chesapeake Bay's tidal rivers. A technical workplan. EPA 903-R-99-011. Chesapeake Bay Program, Annapolis, MD.

U.S. EPA. 2000. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates. Second Edition. EPA/600/R-99/064. Office of Research and Development, Duluth, MN.

U.S. EPA/U.S. ACE. 1995. QA/QC Guidance for sampling and analysis of sediments, water and tissues for dredged material evaluations. EPA 823-B-95-001. U.S. Environmental Protection Agency/ U.S. Army Corps of Engineers, Washington, DC.

U.S. EPA/U.S. ACE. 2001. Methods for Assessing the Chronic Toxicity of Sediment associated Contaminants with *Leptocheirus plumulosus*. First Edition. EPA/600/R-01/020.U.S. Environmental Protection Agency/ U.S. Army Corps of Engineers, Washington, DC.

U.S. FWS. 2002. Quality Management and Quality Assurance Project Plan (QMQAPP) for using the Sediment Quality Triad and integrative water sampling devices to characterize contaminant impacts in Chesapeake Bay tributaries. Prepared for U.S. EPA Chesapeake Bay Program by the U.S. FWS Chesapeake Bay Field Office, Annapolis, MD.

Weisberg, S.B., J.A. Ranasinght, D.M. Dauer, L.C. Schaffner, R.J. Diaz, J.B. Frithsen. 1997. An estuarine Benthic Index of Biotic Integrity (B-IBI) for Chesapeake Bay. *Estuaries* 20:149-158.

TABLES

Table 1. Sediment Quality Triad station identification and location

River	Segment	LTB Station ID	Study ID	Latitude	Longitude
Severn	WT-7	N/A	SER1	39.07649	76.59332
Severn	WT-7	N/A	SER2	39.05416	76.55703
Severn	WT-7	N/A	SER3	39.02211	76.52634
Severn	WT-7	204 (fixed site)	SER4	39.00695	76.50487
Severn[A]	WT-7	N/A	SER5	38.96343	76.48159
Northeast	ET-1	(04625, 07625 random sites)[B]	NER1	39.5891	75.957
Northeast	ET-1	N/A	NER2	39.5778	75.9564
Northeast	ET-1	N/A	NER3	39.5654	75.9657
Northeast	ET-1	N/A	NER4	39.5485	75.9792
Northeast	ET-1	N/A	NER5	39.5460	75.9958
Bohemia	ET-2	N/A	BOR1	39.4685	75.8718
Bohemia	ET-2	029 (fixed site)	BOR2	39.4790	75.8884
Bohemia	ET-2	N/A	BOR3	39.4745	75.9224
Bohemia	ET-2	N/A	BOR4	39.4791	75.9452
Elk	ET-2	09427 (2002 random site)	ELR1	39.5411	75.8715
Elk	ET-2	N/A	ELR2	39.5123	75.8947
Elk	ET-2	N/A	ELR3	39.5105	75.9227
Elk	ET-2	N/A	ELR4	39.4638	75.9825

[A] Located in Back Creek upstream of confluence with Severn River

[B] 04625 - random site sampled in 1997; 07625 - random site sampled in 2000

Table 2. List of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and organochlorine pesticides (OCs) analyzed in sediment for the 2002 Sediment Quality Triad study.

PAHs	PCB Congeners*		
2-Methylnaphthalene	1	40	137+176
Azulene	3	100	163+138
1-Methylnaphthalene	4+10	63	158
Biphenyl	7	74	129+178
Acenaphthylene	6	70+76	187+182
Acenaphthene	8+5	66	183
Fluorene	19	95	128
1-Methylfluorene	12+13	91	185
Phenanthrene	18	56+60	174
Anthracene	17	101	177
o-Terphenyl	24+27	99	202+171
2-Methylphenanthrene	16+32	83	157+200
2-Methylanthracene	29	97	172+197
1-Methylanthracene + 1-Methylphenanthrene	26	87+81	180
9-Methylanthracene	25	85	193
3,6-dimethylphenanthrene	31+28	136	191
Flouranthene	53+33+21	77+110	199
Pyrene	22	82	170+190
9,10-Dimethylanthracene	45	151	198
2,3-Benzofluorene	46	135+144	201
Benzo(a)anthracene	52	107	203+196
Chrysene + Triphenylene	49	149	189
Benzo(b)fluoranthene	47	118	208+195
7,12-Dimethylbenz(a)anthracene	48	134	207
Benzo(k)fluoranthene	44	131	194
Benzo(e)pyrene	37+42	146	205
Benzo(a)pyrene	41+71	153+132+105	206
Perylene	64	141	209
3-Methylcholanthrene			
Ideno(1,2,3-cd)pyrene			
1,2,3,4-Dibenzanthracene			
Benzo(g,h,i) perylene			
Anthanthrene			
Coronene			

OC Pesticides	
DDD (o,p, and pp)	Endrin
DDE (o,p, and pp)	Aldrin
DDT (o,p, and pp)	endosulfan I
BHC (alpha, beta, gamma, and delta)	endosulfan II
Lindane	Endrin
Heptachlor	
heptachlor epoxide	
Chlordanes (oxy, gamma, and alpha)	
Nonachlors (cis and trans	
Dieldrin	

* PCB congeners appearing as pairs or triplets were coeluted and reported as sum.

Table 3. List of inorganic parameters and methods for the sediment samples

Parameter List	**Reference Method**
Grain Size	Folk (1974)
Percent Water	NOAA (1975)
Total Organic Carbon	EPA 440.0
Total Nitrogen (sediments)	EPA 440.0
Pore Water Ammonia	ASTM (1984)
Acid Volatile Sulfur	DiToro et al. (1990)
Metals and Metalloids	
Aluminum*	
Arsenic (III+V)	
Dimethyl Arsenic	
Total Arsenic*	
Cadmium*	
Chromium*	
Copper*	
Iron*	
Lead*	
Mercury	
Nickel*	
Selenium	
Zinc*	

* Denote elements measured for Simultaneously Extractable Metals analysis.

Table 4. Measured water quality parameters and qualitative descriptions of grab samples

Station ID	Sampling date	Depth (m)	Temperature (C^o)	Conductivity µs/cm	pH	D.O (ppm)	D.O (%)	Salinity (ppt)	Grab penetration/sediment description
SER1	9/13/2002	3.3	24.44	21.9	7.04	2.22	29.5	13.2	good/fine sediments: black, sulfide odor
SER2	9/13/2002	6.6	24.99	24.9	7.38	5.97	82.1	15.2	good/fine mud: black over grey, sulfide odor
SER3	9/13/2002	7.6	25.03	26.4	7.48	3.68	49.1	16.3	good/fine clay, brownish grey, no odor
SER4	9/13/2002	6.8	25.60	24.9	7.71	3.68	49.6	15.7	good/fine sediments: grey brown
SER5	9/13/2002	2.2	24.94	26.1	7.44	3.27	43.9	15.7	good/fine sediments; brownish over dark grey, no odor
NER1	9/16/2002	1.8	23.64	5.3	7.84	7.14	85.2	2.9	good/fine sediments; greyish brown, no odor
NER2	9/16/2002	2.4	23.66	5.4	7.88	7.06	84.6	3	good/fine sediments; greyish brown, no odor
NER3	9/16/2002	1.8	23.60	5.7	7.67	7.02	84.3	3.2	good/fine sediments; dark brown, well mixed, no odor
NER4	9/16/2002	1.5	23.55	5.5	7.75	7.21	86.4	3.1	good/fine sediments; dark brown, well mixed, no odor
NER5	9/16/2002	3	24.20	4.7	8.33	8.76	106.1	2.6	good/fine sediments; brown over grey, no odor
BOR1	9/17/2002	1.8	24.07	10.6	6.89	6.84	84.1	6	good/fine sediments; black, slight oxidized layer
BOR2	9/17/2002	1.9	24.04	10.9	6.67	6.41	79.1	6.2	good/fine sediments; brown over grey, no odor
BOR3	9/17/2002	1.7	23.95	11.0	7.14	7.23	89.1	6.3	good/brown over grey, sulfide odor
BOR4	9/17/2002	4.5	23.87	11.0	7.11	6.69	82.2	6.2	marginal/some sand mixed in; brown over dark grey
ELR1	9/17/2002	0.2	25.81	12.1	7.93	9.84	125.8	6.9	Good/fine sediments; well mixed, silty clay
ELR2	9/17/2002	4.4	24.31	11.1	7.25	7.09	88.1	6.3	fair/fine sediments; brown over grey black, some sand
ELR3	9/17/2002	0.4	24.68	11.0	7.47	7.7	96.6	6.3	good/fine sediments; brown over grey
ELR4	9/17/2002	2.3	23.84	11.2	7.09	6.39	78.6	6.4	Not recorded

Table 5. Sediment grain size, total nitrogen, organic carbon, and porewater ammonium concentrations for the 2002 Sediment Quality Triad samples.

Station ID	Grain size (%<0.063 Φm)	Total Nitrogen (% N)	Total Organic Carbon (% C)	Porewater Ammonium (mg/L)
SER 1	91.8	0.42	5.0	7.2
SER 2	95.8	0.46	5.5	9.6
SER 3	72.3	0.20	2.5	7.7
SER 4	72.9	0.16	2.1	2.4
SER 5	97.6	0.35	4.2	2.2
NER 1	89.6	0.18	2.5	13.3
NER 2	93.5	0.23	2.8	13.4
NER 3	99.1	0.28	4.4	13.2
NER 4	81.9	0.23	10.9	12.8
NER 5	57.3	0.19	10.4	5.9
BOR 1	85.0	0.19	2.7	8.9
BOR 2	56.4	0.12	1.7	5.8
BOR 3	96.4	0.22	3.2	5.3
BOR 4	67.4	0.12	1.9	3.6
ELR 1	98.6	0.22	3.0	5.2
ELR 2	55.7	0.13	1.7	1.7
ELR 3	97.8	0.21	3.1	2.5
ELR 4	95.4	0.22	3.3	3.9

Table 6a. Sediment toxicity data for the 2002 Sediment Quality Triad samples – effects on survival.

Station ID	*Hyalella azteca* 10-day survival			*Leptocheirus plumulosus* 28-day survival		
	Date	Mean	SD	Date	Mean	SD
Control	10/15-10/25/02	98.8	3.5	10/11-11/8/02	84.0	8.9
SER1	10/15-10/25/02	100.0	0.0	10/11-11/8/02	89.0	7.4
SER2	10/15-10/25/02	96.3	5.2	10/11-11/8/02	91.0	7.4
SER3	10/15-10/25/02	100.0	0.0	10/11-11/8/02	90.0	5.0
SER4	10/15-10/25/02	95.0	5.4	10/11-11/8/02	82.0	18.9
SER5	10/15-10/25/02	95.0	7.6	10/11-11/8/02	75.0	20.0
BOR1	10/15-10/25/02	96.3	7.4	10/11-11/8/02	82.0	10.4
BOR2	10/15-10/25/02	98.8	3.5	10/11-11/8/02	87.0	4.5
BOR3	10/15-10/25/02	91.3	11.3	10/11-11/8/02	83.0	10.4
BOR4	10/15-10/25/02	86.3	23.9	10/11-11/8/02	81.0	12.5
Control	10/16-10/26/02	96.3	7.4	10/10-11/07/02	82.0	7.6
NER1	10/16-10/26/02	95.0	10.7	10/10-11/07/02	66.0	16.0
NER2	10/16-10/26/02	91.3	6.4	10/10-11/07/02	71.0	17.8
NER3	10/16-10/26/02	95.0	5.4	10/10-11/07/02	79.0	20.4
NER4	10/16-10/26/02	96.3	5.2	10/10-11/07/02	78.0	11.5
NER5	10/16-10/26/02	95.0	5.4	10/10-11/07/02	89.0	14.8
ELR1	10/16-10/26/02	96.3	5.2	10/10-11/07/02	73.0	25.2
ELR2	10/16-10/26/02	92.5	10.4	10/10-11/07/02	54.0	29.5
ELR3	10/16-10/26/02	92.5	8.9	10/10-11/07/02	64.0	16.4
ELR4	10/16-10/26/02	98.8	3.5	10/10-11/07/02	57.0	14.8

Table 6b. Sediment toxicity data for the 2002 Sediment Quality Triad samples – sublethal effects. (* indicates a treatment significantly ($p<0.05$) less than control)

Tributary		*H. azteca* growth		*L. plumulosus* growth		*L. plumulosus* reproduction	
		Avg dry wt (mg)	SD	Rate[A]	SD	Neonates per survivor	SD
Lab. control (1)[B]		0.175	0.0170	0.053	0.0109	1.31	0.821
Severn River	SER1	0.128*	0.0104	0.072	0.0035	1.67	0.470
Severn River	SER2	0.152	0.0149	0.040	0.0106	1.39	0.516
Severn River	SER3	0.151	0.0155	0.052	0.0148	1.01	0.781
Severn River	SER4	0.148*	0.0337	0.032*	0.0089	0.20*	0.188
Severn River	SER5	0.148*	0.0131	0.029*	0.0075	0.19*	0.196
Bohemia River	BOR1	0.176	0.0216	0.037	0.0116	1.35	0.783
Bohemia River	BOR2	0.198	0.0163	0.033*	0.0067	0.72	0.427
Bohemia River	BOR3	0.181	0.0191	0.028*	0.0072	0.92	0.560
Bohemia River	BOR4	0.194	0.0212	0.026*	0.0130	0.17*	0.205
Lab. control (2)[B]		0.170	0.0401	0.040	0.0086	1.18	0.405
Elk River	ELR1	0.169	0.0229	0.035	0.01010	0.72	0.414
Elk River	ELR2	0.187	0.0173	0.023*	0.0063	0.04*	0.089
Elk River	ELR3	0.182	0.0125	0.023*	0.0084	0.14*	0.220
Elk River	ELR4	0.179	0.0208	0.029	0.0198	0.60	0.469
Northeast River	NER1	0.185	0.0128	0.026	0.0122	0.64	0.309
Northeast River	NER2	0.190	0.0403	0.027	0.0087	0.67	0.693
Northeast River	NER3	0.195	0.0150	0.020*	0.0099	0.45*	0.427
Northeast River	NER4	0.202	0.0205	0.022*	0.0036	0.15*	0.096
Northeast River	NER5	0.216	0.0123	0.026	0.0067	0.60	0.286

[A] Initial average dry weight=0.026 mg; Growth rate = (Final dry weight – 0.026)/28 (number of days)

[B] Tests were performed in separate batches: *H. azteca*—Lab control (1), Severn, Bohemia 10/15/02-10/25/02; Lab control (2), Elk, Northeast 10/16/02-10/26/02.
L. plumulosus - Lab control (1), Severn, Bohemia 10/11/02-11/8/02; Lab control (2), Elk, Northeast 10/10/02-11/7/02.

Table 6c. Summary of lethal and sublethal effects for the 2002 Sediment Quality Triad stations. Value is the percent reduction from the control treatment for each specific endpoint that showed a significant hit (%=0.05).

River & Station	*H. azteca* 10 day		*L. plumulosus* 28 day		
	Survival	Weight	Survival	Growth Rate	Reproduction
Bohemia River 1					
Bohemia River 2				37.7%	
Bohemia River 3				47.2%	
Bohemia River 4				50.9%	87.1%
Severn River 1		26.9%			
Severn River 2					
Severn River 3					
Severn River 4		15.4%		39.6%	84.7%
Severn River 5		15.4%		45.3%	85.5%
Elk River 1					
Elk River 2				42.5%	97.0%
Elk River 3				42.5%	88.1%
Elk River 4					
Northeast River 1					
Northeast River 2					
Northeast River 3				50.0%	61.9%
Northeast River 4				45.0%	87.3%
Northeast River 5					

Table 7a. Sediment trace metal concentrations (ug/g dry weight) in the 2002 Sediment Quality Triad stations. Underlined values exceed ER-M values, italicized values exceed the consensus-based PEC.

Station ID	Trace Metal									
	Total As	**Cd**	**Cr**	**Al**	**Fe**	**Cu**	**Zn**	**Ni**	**Pb**	**Hg**
SER1	21.0	2.0	88.3	70111	44043	119.8	383.1	*65.0*	96.7	0.216
SER2	27.0	2.8	*125.8*	68415	65059	113.7	*503.5*	*77.1*	*136.3*	0.488
SER3	20.5	0.6	*122.4*	57531	67671	47.1	280.2	42.7	58.1	0.184
SER4	22.2	0.2	*116.6*	56127	70281	37.1	229.0	37.8	62.5	0.148
SER5	28.5	0.8	*178.7*	66148	97355	*601.1*	*616.5*	*60.9*	*139.7*	0.612
NER1	6.0	0.3	83.2	66331	32365	29.6	122.0	47.1	31.6	0.078
NER2	8.3	0.4	91.3	75478	38431	41.9	172.9	*61.5*	39.5	0.117
NER3	11.8	0.9	87.1	83631	45473	56.6	301.1	*87.5*	57.8	0.222
NER4	9.3	0.9	67.2	60875	33279	43.9	249.3	*74.7*	41.2	0.302
NER5	7.5	0.6	58.7	49125	26700	29.8	170.3	*56.5*	29.1	0.206
BOR1	12.3	0.4	70.3	59880	35169	28.3	160.6	34.1	38.0	0.123
BOR2	9.9	0.3	55.8	43400	25818	20.9	125.8	25.5	30.6	0.099
BOR3	14.2	0.4	75.2	76897	43612	34.4	238.3	*51.1*	52.1	0.212
BOR4*	9.1	0.3	53.8	57978	31255	20.8	162.0	32.2	33.1	0.154
ELR1	14.2	0.3	75.6	74977	41330	31.0	206.0	44.5	47.7	0.217
ELR2	8.4	0.1	48.5	50464	28579	14.0	88.4	25.8	16.6	0.050
ELR3	10.6	0.4	76.0	75062	40418	32.8	213.5	*50.8*	50.7	0.215
ELR4	10.9	0.5	71.8	76313	42358	61.9	252.1	*56.6*	52.0	0.197
ER-L	8.2	1.2	81.0			34.0	150.0	20.9	46.7	0.15
ER-M	70.0	9.6	370.0			270.0	410.0	51.6	218.0	0.70
PEC	33.0	4.98	111.0			149.0	459.0	48.6	128.0	1.10

*Values are based on the average of three replicate samples collected from this station.

Table 7b. Sediment acid volatile sulfide (AVS) and simultaneously extracted metals (SEM) for the 2002 Sediment Quality Triad stations. Concentrations are umoles/g wet weight.

Station ID	AVS	SEM Cu	SEM Cr	SEM Zn	SEM Ni	SEM Pb	SEM Cd	Sum SEM	AVS-SEM
SER1	6.15	0.001	0.019	0.778	0.018	0.049	0.003	0.867	5.29
SER2	7.80	0.001	0.028	0.863	0.014	0.053	0.003	0.962	6.84
SER3	3.72	0.029	0.032	0.684	0.056	0.040	0.001	0.842	2.88
SER4	3.29	0.063	0.047	0.688	0.057	0.059	0.001	0.914	2.37
SER5	9.39	0.504	0.082	1.883	0.039	0.123	0.002	2.633	6.76
NER1	3.01	0.031	0.034	0.368	0.063	0.040	0.001	0.537	2.48
NER2	2.33	0.060	0.039	0.505	0.093	0.048	0.001	0.747	1.59
NER3	0.80	0.064	0.037	0.798	0.150	0.054	0.002	1.105	-0.30
NER4	0.69	0.040	0.034	1.026	0.219	0.061	0.003	1.383	-0.69
NER5	0.58	0.038	0.028	0.805	0.185	0.048	0.002	1.106	-0.53
BOR1	0.63	0.029	0.033	0.442	0.049	0.040	0.001	0.594	0.04
BOR2	0.81	0.029	0.033	0.442	0.049	0.040	0.001	0.594	0.22
BOR3	1.16	0.051	0.039	0.646	0.086	0.054	0.001	0.878	0.28
BOR4*	0.81	0.05	0.03	0.70	0.09	0.05	0.00	0.93	-0.12
ELR1	0.19	0.065	0.037	0.601	0.063	0.056	0.001	0.823	-0.64
ELR2	0.39	0.036	0.027	0.254	0.038	0.024	0.001	0.378	0.01
ELR3	0.97	0.063	0.044	0.760	0.091	0.068	0.001	1.027	-0.05
ELR4	2.80	0.064	0.042	0.796	0.116	0.063	0.001	1.084	1.72

* Values are based on the average of three replicate samples collected at this station.

Table 7c. Dissolved trace metals concentrations in water samples collected from several 2002 Sediment Quality Triad Stations compared with Maryland Ambient Water Quality Criteria. All concentrations are reported as ug/L.

				Station ID				Chronic Ambient Water Quality[A]		
Trace Metal	**SER 3[B]**	**SER 5[B]**	**BOR[C]**	**NER 3[C]**	**NER 5[C]**	**ELR2[C]**	**ELR4[C]**	**Freshwater**	**Estuarine**	**Saltwater**
As lll	0.16	0.24	0.11	0.04	0.04	0.05	0.02			
Monophenylarsenic	0.02	0.03	0.00	0.00	0.01	0.00	0.00			
As lll+V	0.26	0.43	0.62	0.28	0.26	0.63	0.37			
Mono Methylarsenic	0.03	0.03	0.02	0.02	0.02	0.02	0.01			
Dimethyarsenic	0.35	0.56	0.06	0.14	0.12	0.03	0.03			
Arsenic (Total)	0.64	1.02	0.69	0.43	0.40	0.69	0.42	150		36
Cadmium	0.001	0.053	0.010	0.013	0.010	0.018	0.010	0.25		8.8
Chromium	0.03	0.12	0.64	0.51	0.22	0.34	0.18			
Copper	1.18	5.79	2.83	3.25	2.42	2.87	1.55	9	6.1	3.1
Lead	0.006	0.028	0.66	0.43	0.21	0.35	0.10	2.5		8.1
Mercury	0.00014	0.00023	0.0012	0.0019	0.00096	0.0016	0.00065	0.77		0.94
Nickel	0.96	1.30	1.45	2.90	2.51	1.57	1.86	52		8.2
Selenium (Total)	0.12	0.11	0.13	0.14	0.14	0.21	0.14	5		71
Zinc	0.26	2.53	1.73	1.05	0.14	2.41	0.28	120		81

[A] Toxic substances criteria for ambient surface waters as identified in COMAR 26.08.02.03-2.
Estuarine criterion for copper is listed as a single value, rather than separate acute and chronic values.

[B] Estuarine/saltwater sites as defined in COMAR 26.08.03-1 (Note: if an estuarine criterion is not available for a given chemical, the saltwater criterion is applied).

[C] Freshwater sites as defined in COMAR 26.08.03-1.

Table 8. Sediment polycyclic aromatic hydrocarbon (PAH) concentrations for the 2002 Sediment Quality Triad stations. Concentrations are ng/g dry weight. Underlined values exceed ERM values, italicized values exceed the consensus-based PEC (ND= Not detected; BDL=Below detection limit, INT=Interference, no data)

PAH	Station ID										Effects Level		
	SER 1	SER2	SER3	SER4	SER5	NER1	NER2	NER3	NER4	NER5	ER-L	ER-M	PEC
2-Methylnaphthalene	44.4	207.7	69.4	44.7	145.3	54.7	118.8	206.9	234.1	151.4	70.0	670.0	
Azulene	ND	ND	ND	ND	ND	1.2	ND	ND	1.1	ND			
1-Methylnaphthalene	23.1	155.1	53.5	32.8	99.1	32.9	63.3	124.6	162.9	100.5			
Biphenyl	15.4	90.2	31.1	20.0	59.9	16.4	30.8	64.1	90.8	54.6			
Acenaphthylene	35.5	91.2	31.8	21.0	97.8	54.9	38.5	74.9	99.1	61.3	44.0	640.0	
Acenaphthene	21.5	66.8	24.4	13.4	67.9	16.1	28.2	47.2	55.2	36.3	15.0	500.0	
Fluorene	20.5	95.3	24.6	17.2	68.2	18.7	28.8	69.0	86.5	54.5	35.0	640.0	536
1-Methylfluorene	13.5	41.8	10.3	9.7	30.4	8.8	14.2	27.3	37.3	23.2			
Phenanthrene	139.4	370.3	117.2	111.8	609.2	83.2	127.5	323.2	371.1	286.1	240.0	1380.0	1170.0
Anthracene	56.0	176.7	62.6	57.9	232.9	52.4	62.2	141.5	151.8	118.7	85.3	960.0	845.0
o-Terphenyl	ND	ND	ND	ND	1.6	ND	ND	1.0	0.9	0.6			
2-Methylphenanthrene	45.2	114.2	32.3	36.3	152.5	38.1	44.7	104.8	102.7	77.4			
2-Methylanthracene	20.4	81.5	23.8	27.3	122.0	43.1	34.3	76.3	74.1	53.1			
1-Methylanthracene + 1-Methylphenanthrene	46.5	114.1	32.4	34.8	131.9	33.4	44.5	111.1	107.9	78.2			
9-Methylanthracene	2.4	ND	1.5	2.2	ND	ND	ND	3.8	5.1	ND			
3,6-dimethylphenanthrene	ND	9.4	BDL	BDL	13.6	6.6	5.2	6.0	8.7	5.3			
Flouranthene	779.6	625.0	203.5	173.2	*2465.1*	242.0	187.1	328.7	354.4	254.1	600.0	3600.0	2230.0
Pyrene	725.5	553.2	186.0	170.7	*1889.2*	298.3	204.0	377.5	418.3	294.3	665.0	2600.0	1520.0
9,10-Dimethylanthracene	5.8	13.7	2.5	BDL	22.6	2.4	2.7	8.5	5.5	4.2			
2,3-Benzofluorene	62.5	47.6	19.8	33.3	135.2	36.9	21.2	37.3	36.0	20.9			
Benzo(a)anthracene	404.4	271.0	116.9	162.3	884.5	297.8	113.4	224.6	224.5	171.3	261.0	1600.0	1050.0
Chrysene + Triphenylene	492.8	260.7	82.1	89.4	*1724.5*	257.6	91.2	231.9	235.2	152.4	384.0	2800.0	1290.0
Benzo(b)fluoranthene	649.5	532.7	157.6	192.3	1216.3	281.4	159.1	244.6	201.6	184.7			
7,12-Dimethylbenz(a)anthracene	45.0	ND	BDL	BDL	91.7	17.3	22.0	22.0	16.7	19.5			
Benzo(k)fluoranthene	417.9	325.5	137.7	144.3	615.2	174.2	117.1	182.4	128.6	111.7			
Benzo(e)pyrene	600.2	291.5	96.5	139.5	<u>1915.6</u>	184.1	86.6	144.0	213.0	109.7	430.0	1600.0	
Benzo(a)pyrene	441.2	212.2	66.8	94.6	*1963.8*	207.8	70.2	134.7	192.6	115.4	430.0	2500.0	1450.0
Perylene	347.1	138.4	47.4	74.3	498.9	672.7	704.9	641.4	460.5	306.8			
3-Methylcholanthrene	90.0	ND	ND	ND	156.9	66.7	42.1	39.1	31.5	45.0			
Ideno(1,2,3-cd)pyrene	INT	INT	INT	INT	INT	INT	INT	INT	INT	INT			
1,2,3,4-Dibenzanthracene	155.5	BDL	BDL	47.3	345.7	73.9	BDL	61.8	53.5	37.6			
Benzo(g,h,i) perylene	478.2	308.1	87.2	119.8	797.0	185.6	103.4	160.5	148.2	108.7			
Anthanthrene	232.9	122.3	BDL	40.4	353.1	96.0	BDL	82.3	57.0	40.4			
Coronene	INT	INT	INT	INT	INT	INT	INT	INT	INT	INT			
Total PAHs	6411.6	5316.4	1719.1	1910.4	16908.0	3555.1	2566.1	4303.2	4366.1	3077.9	4000.0	35000.0	22800.0

Table 8. Continued

PAH	Station ID								Effects Level		
	BOR1	BOR2	BOR3	BOR4*	ELR1	ELR2	ELR3	ELR4	ER-L	ER-M	PEC
2-Methylnaphthalene	34.8	40.2	85.1	67.7	89.9	12.5	63.0	132.3	70.0	670.0	
Azulene	ND	ND	ND	1.3	ND	ND	ND	ND			
1-Methylnaphthalene	20.6	19.3	41.7	34.1	42.0	12.0	33.9	67.1			
Biphenyl	13.3	11.7	23.8	19.2	26.6	4.6	18.7	37.8			
Acenaphthylene	13.5	9.4	25.4	20.8	20.1	2.8	20.7	39.0	44.0	640.0	
Acenaphthene	9.6	7.1	16.1	14.9	15.7	2.0	12.6	26.8	15.0	500.0	
Fluorene	11.8	9.3	24.2	19.3	26.7	2.7	20.3	37.1	35.0	640.0	536
1-Methylfluorene	4.5	3.1	10.0	10.1	9.2	ND	10.3	19.9			
Phenanthrene	60.6	41.3	114.9	97.5	110.1	16.1	100.3	180.4	240.0	1380.0	1170.0
Anthracene	21.7	15.0	54.1	48.3	44.0	3.6	43.6	95.9	85.3	960.0	845.0
o-Terphenyl	ND	ND	0.6	0.5	ND	ND	0.7	ND			
2-Methylphenanthrene	18.9	11.4	43.9	33.2	27.8	2.8	35.3	63.5			
2-Methylanthracene	6.9	4.4	29.9	25.2	15.4	1.1	26.1	36.0			
1-Methylanthracene + 1-Methylphenanthrene	16.9	10.4	40.2	31.6	23.9	1.7	33.5	62.7			
9-Methylanthracene	ND	0.4	1.4	1.2	1.8	ND	1.1	2.3			
3,6-dimethylphenanthrene	BDL	BDL	2.3	2.7	BDL	ND	3.2	5.8			
Flouranthene	83.3	52.8	133.3	111.8	135.8	15.0	127.4	184.0	600.0	3600.0	2230.0
Pyrene	95.2	58.7	148.7	124.9	159.2	15.7	148.1	215.1	665.0	2600.0	1520.0
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND			
2,3-Benzofluorene	11.7	15.7	14.6	11.6	9.9	5.1	18.3	33.6			
Benzo(a)anthracene	67.3	146.0	102.9	75.3	74.0	64.2	78.1	90.2	261.0	1600.0	1050.0
Chrysene + Triphenylene	54.7	9.5	83.9	65.0	83.2	66.4	71.3	85.9	384.0	2800.0	1290.0
Benzo(b)fluoranthene	122.7	56.0	175.7	100.7	105.9	33.3	113.5	105.0			
7,12-Dimethylbenz(a)anthracene	ND	ND	BDL	8.6	BDL	ND	ND	ND			
Benzo(k)fluoranthene	94.9	70.2	120.1	88.2	127.5	45.1	108.3	140.2			
Benzo(e)pyrene	56.3	27.3	90.9	69.7	76.0	1.8	68.9	81.7	430.0	1600.0	
Benzo(a)pyrene	36.6	21.0	47.0	52.3	61.9	ND	50.8	71.3	430.0	2500.0	1450.0
Perylene	230.9	101.2	247.2	176.6	265.5	409.1	228.7	295.9			
3-Methylcholanthrene	41.3	17.8	34.3	23.0	ND	ND	34.2	ND			
Ideno(1,2,3-cd)pyrene	INT	INT	INT	INT	INT	INT	INT	INT			
1,2,3,4-Dibenzanthracene	ND	ND	ND	ND	BDL	ND	ND	ND			
Benzo(g,h,i) perylene	69.2	24.1	92.7	64.4	60.1	BDL	71.6	67.9			
Anthanthrene	ND	ND	ND	ND	ND	ND	ND	ND			
Coronene	INT	INT	INT	INT	INT	INT	INT	INT			
Total PAHs	1197.3	713.2	1805.1	1384.9	1612.3	717.5	1542.8	2177.5	4000.0	3500.0	22800.0

* concentrations are the average of three replicate samples collected from this station

Table 9. Summary of organochlorine pesticide and total PCB analysis of the 2002 Sediment Quality Triad samples. Concentrations are ng/g dry weight. Underlined values exceed the ER-M; italicized values exceed the PEC (ND= Not detected; BDL=Below detection limit)

Organochlorine	**Station ID**					**Effects Level**		
	SER1	**SER2**	**SER3**	**SER4**	**SER5**	**ER-L**	**ER-M**	**PEC**
o,p,DDE	0.53	1.05	0.30	0.25	0.82			
p,p,DDE	1.78	3.75	0.59	0.45	2.05	2.2	27.0	
o,p DDT	4.76	2.99	0.97	1.13	3.23			
p,p DDT	3.26	3.92	2.73	1.74	5.08			
o,p DDD	0.55	2.77	0.39	0.37	1.09			
p,p DDD	0.99	4.39	0.86	0.65	2.37			
Total DDXs	11.88	18.86	5.83	4.60	14.64	3.0	350.0	572.0
alpha BHC	0.66	0.76	0.36	0.30	0.41			4.99
beta BHC	1.06	1.27	0.15	0.17	0.72			
delta BHC	0.33	0.58	0.30	0.32	0.54			
Lindane	1.16	1.67	0.23	0.65	1.07			4.99
heptachlor	0.76	3.40	1.07	0.42	3.39			
heptachlor epoxide	0.65	1.10	0.36	0.40	0.31			16.0
oxychlordane	0.85	1.42	0.57	0.58	0.97			
Gamma chlordane	1.39	0.71	0.25	0.29	0.85			
alpha chlordane	0.93	0.87	0.29	0.30	0.57			
cis nonachlor	0.26	0.51	BDL	BDL	0.60			
trans nonachlor	0.78	0.83	0.24	0.20	0.94			
Total Chlordanes	5.62	<u>8.85</u>	2.79	2.19	<u>7.63</u>	0.50	6.00	17.6
Dieldrin	ND	ND	ND	ND	ND	0.02	8.00	61.8
Endrin	1.16	1.52	0.51	0.69	2.07	0.02	45.0	207.0
Aldrin	0.31	0.49	0.23	0.29	0.41			
endosulfan I	ND	ND	0.19	ND	ND			
endosulfan II	ND	ND	0.43	ND	ND			
Total PCBs	**28.06**	**41.43**	**12.42**	**7.42**	**52.42**	**22.70**	**180.00**	**676.00**

Table 9. Continued

Organochlorine	Station ID					Effects Level		
	NER1	NER2	NER3	NER4	NER5	ER-L	ER-M	PEC
o,p,DDE	0.17	0.32	BDL	0.47	0.41			
p,p,DDE	0.66	0.95	ND	2.21	1.93	2.2	27.0	
o,p DDT	1.22	1.28	0.19	1.68	0.81			
p,p DDT	4.63	3.08	0.48	3.56	2.18			
o,p DDD	0.37	0.29	0.06	0.56	0.46			
p,p DDD	0.99	1.25	0.05	2.23	2.24			
Total DDXs	8.04	7.17	0.78	10.72	8.03	3.0	350.0	572.0
alpha BHC	0.35	0.31	0.16	0.38	0.14			4.99
beta BHC	0.23	0.32	0.06	0.33	0.14			
delta BHC	0.38	0.39	0.08	0.42	0.23			
Lindane	0.81	0.86	0.14	0.99	0.20			4.99
Heptachlor	0.39	0.61	BDL	1.09	0.55			
Heptachlor epoxide	0.57	0.60	0.11	0.61	0.27			16.0
Oxychlordane	0.46	0.45	0.02	0.48	0.16			
Gamma chlordane	0.37	0.54	0.09	0.49	0.21			
alpha chlordane	0.53	0.31	0.05	0.60	0.16			
cis nonachlor	BDL	0.33	BDL	0.28	0.59			
trans nonachlor	ND	0.09	BDL	0.30	0.25			
Total Chlordanes	2.33	2.93	0.27	3.85	2.18	0.50	6.00	17.6
Dieldrin	NQ	NQ	NQ	NQ	NQ	0.02	8.00	61.8
Endrin	1.13	1.20	0.20	1.31	0.69	0.02	45.0	207.0
Aldrin	0.31	0.28	0.10	0.42	0.20			
endosulfan I	0.24	0.25	0.09	0.32	0.12			
endosulfan II	0.56	0.59	0.20	0.74	0.12			
Total PCBs	**8.12**	**16.95**	**36.66**	**30.98**	**17.00**	**22.70**	**180.00**	**676.00**

Table 9. Continued.

Organochlorine	Station ID				Effects Level		
	BOR1	BOR2	BOR3	BOR4*	ER-L	ER-M	PEC
o,p,DDE	0.29	0.20	0.45	0.36			
p,p,DDE	0.72	0.43	1.21	1.34	2.2	27.0	
o,p DDT	0.55	0.55	1.11	16.93			
p,p DDT	0.78	0.56	1.70	2.66			
o,p DDD	0.24	0.20	0.70	0.59			
p,p DDD	1.00	0.76	2.02	9.67			
Total DDXs	3.59	2.69	7.19	31.54	3.0	350.0	572.0
alpha BHC	0.07	0.08	0.16	0.17			4.99
beta BHC	0.04	0.02	0.06	0.12			
delta BHC	0.13	0.10	0.15	0.20			
Lindane	0.09	0.13	0.13	0.33			4.99
heptachlor	0.19	0.16	1.01	0.40			
heptachlor epoxide	0.14	0.12	0.19	0.26			16.0
oxychlordane	0.09	0.07	0.10	0.14			
Gamma chlordane	0.27	0.06	0.30	0.45			
alpha chlordane	0.08	0.07	0.12	0.17			
cis nonachlor	0.15	0.13	0.42	0.15			
trans nonachlor	0.14	0.13	0.22	0.27			
Total Chlordanes	1.06	0.75	2.36	1.84	0.50	6.00	17.6
Dieldrin	ND	ND	ND	ND	0.02	8.00	61.8
Endrin	0.05	0.12	0.18	6.84	0.02	45.0	207.0
Aldrin	0.06	0.06	0.12	0.16			
endosulfan I	0.02	0.05	0.11	3.95			
endosulfan II	0.02	0.05	0.11	3.95			
Total PCBs	**12.53**	**9.65**	**27.83**	**28.54**	**22.70**	**180.00**	**676.00**

***** Values are based on the average of three replicate samples collected at this station.

Table 9. Continued.

Organochlorine	Station ID				Effects Level		
	ELR1	ELR2	ELR3	ELR4	ER-L	ER-M	PEC
o,p,DDE	0.60	0.19	0.58	0.09			
p,p,DDE	2.34	0.40	2.50	3.55	2.2	27.0	
o,p DDT	0.86	0.43	1.00	1.13			
p,p DDT	2.03	0.76	1.78	2.56			
o,p DDD	0.75	0.16	0.70	0.72			
p,p DDD	2.34	0.51	2.19	2.22			
Total DDXs	8.92	2.45	8.74	10.26	3.0	350.0	572.0
Alpha BHC	0.17	0.16	0.26	0.27			4.99
beta BHC	0.08	0.04	0.14	0.15			
delta BHC	0.22	0.20	0.31	0.37			
lindane	0.23	0.16	0.49	0.44			4.99
heptachlor	0.53	0.17	0.50	1.00			
heptachlor epoxide	0.19	0.21	0.36	0.30			16.0
oxychlordane	0.20	0.10	0.13	0.10			
gamma chlordane	0.12	0.06	0.16	0.19			
Alpha chlordane	0.17	0.11	0.19	0.21			
cis nonachlor	0.37	0.17	0.36	0.51			
trans nonachlor	0.28	0.16	0.25	0.47			
Total Chlordanes	1.86	0.98	1.95	2.79	0.50	6.00	17.6
Dieldrin	ND	ND	ND	ND	0.02	8.00	61.8
Endrin	0.23	0.27	0.66	0.69	0.02	45.0	207.0
Aldrin	0.08	0.12	0.22	0.30			
endosulfan I	0.14	0.09	0.17	0.13			
endosulfan II	0.14	0.09	0.17	0.13			
Total PCBs	**29.26**	**6.60**	**29.00**	**41.69**	**22.70**	**180.00**	**676.00**

Table 10. Mean Effects Range - Median Quotient (MERM-Q) for each station.

Station ID	MERM-Q
SER1	0.283
SER2	0.369
SER3	0.162
SER4	0.144
SER5	0.598
NER1	0.135
NER2	0.156
NER3	0.217
NER4	0.236
NER5	0.164
BOR1	0.099
BOR2	0.077
BOR3	0.153
BOR4*	0.119
ELR1	0.141
ELR2	0.059
ELR3	0.144
ELR4	0.179

* Value is based on the average of three replicate samples collected at this station.

Table 11. Summary of the Chesapeake Bay Benthic Index of Biological Integrity (B-IBI) analysis for the 2002 Sediment Quality Triad stations.

Station ID	B-IBI Score	B-IBI Condition	Comments
SER1	1.00	Severely Degraded	Essentially an azoic station (only one taxa collected)
SER2	1.00	Severely Degraded	Essentially an azoic station (only one taxa collected)
SER3	1.33	Severely Degraded	Low biomass, abundance, diversity, percent carnivore-omnivore taxa and percentage of pollution-sensitive taxa.
SER4	1.33	Severely Degraded	Low biomass, abundance, diversity, percent carnivore-omnivore taxa and percentage of pollution-sensitive taxa.
SER5	2.33	Degraded	Low abundance, diversity, and percent carnivore-omnivore taxa.
NER1	3.00	Meets Goal	Good total abundance and percentage of carnivore-omnivore abundance
NER2	3.00	Meets Goal	Good total abundance and percentage of carnivore-omnivore abundance
NER3	2.67	Marginal	Poor score for percent pollution-indicative taxa, pollution-sensitive taxa, and Tanypodinae to Chironomid ratio. Good score for total abundance and carnivore-omnivore abundance
NER4	1.67	Severely Degraded	Poor score for percent pollution-indicative taxa, pollution-sensitive taxa, Tanypodinae to Chironomid ratio, carnivore-omnivore abundance, and tolerance score
NER5	2.67	Marginal	Poor score for carnivore-omnivore abundance and percent pollution-indicative taxa. However, the value for percent pollution-indicative taxa was very near the threshold of 95% for a score of 3 would have classified the station as Meets Goal.
BOR1	1.40	Severely Degraded	Low biomass, diversity, and percentage of pollution-sensitive taxa. High percentage of pollution-indicative taxa.
BOR2	1.80	Severely Degraded	Low biomass and percentage of pollution-sensitive taxa. High percentage of pollution-indicative taxa.
BOR3	2.20	Degraded	Low abundance and high percentage of pollution-indicative taxa.
BOR4	2.60	Degraded	High biomass (above upper threshold) and high percentage of pollution-indicative taxa.
ELR1	2.60	Degraded	High biomass (above upper threshold) and high percentage of pollution-indicative taxa.
ELR2	3.40	Meets Goal	High percentage of pollution-sensitive taxa and low percentage of pollution-indicative taxa, both of which are indicative of good benthic community condition.
ELR3	2.20	Degraded	Low abundance and high percentage of pollution-indicative taxa.
ELR4	2.60	Degraded	High biomass (above upper threshold) and high percentage of pollution-indicative taxa.

Table 12a. Mean (n=2) polychlorinated biphenyl and pesticide concentrations in SPMDs placed at selected Sediment Quality Triad stations in 2002. Results reported as ng/SPMD (ND=Not detected).

Target Analyte	Station ID				
	SER5[A]	BOR2[B]	NER3[B]	NER5[B]	ELR2[B]
Total PCBs	ND	ND	ND	ND	ND
Pesticides					
Trifluralin	ND	ND	1.73	2.62	ND
HCB	ND	ND	ND	ND	ND
PCA	60.5	9.95	27.75	17.75	13.8
a-BHC	ND	ND	1.58	ND	ND
Diazinon	13.025	ND	8.79	ND	ND
Atrazine	ND	ND	ND	ND	ND
Lindane	ND	4.915	7.65	2.485	6.635
b-BHC	4.185	3.26	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND
Acetochlor	21.8	33.45	17.65	40	93.25
Alachlor	ND	1.03	ND	0.695	3.875
d-BHC	6.52	2.055	ND	ND	2.26
Metolachlor	4.96	2.01	2.98	ND	ND
Dacthal	2.67	2.545	1.855	1.78	3.82
Chlorpyrifos	9.205	6.44	10.22	12.45	8.09
Oxychlordane	ND	0.835	ND	ND	0.795
Heptachlor Epoxide	26.2	9.01	6.195	4.785	8.43
Trans-Chlordane	15.2	4.15	6.32	4.585	12.35
Trans-Nonachlor	10.595	3.175	3.615	2.13	7.34
o,p'-DDE	ND	ND	ND	ND	12.6
cis-Chlordane	25.6	12.7	7.57	6.29	30.55
Endosulfan	ND	ND	5.68	3.23	ND
p,p'-DDE	ND	ND	ND	ND	5.765
Dieldrin	55.5	17.45	15.35	14.85	34.45
o,p'-DDD	3.475	5.665	1.73	4.085	21.35
Endrin	3.215	ND	ND	2.395	0.86
cis-Nonachlor	4.825	ND	ND	ND	2.155
o,p'-DDT	5.84	ND	ND	0.57	3.41
p,p'-DDD	6.165	13.8	6.165	7.91	53.2
Endosulfan-II	6.915	0.805	2.1	1.565	3.25
p,p'-DDT	3.555	ND	1.55	1.395	5.855
Endosulfan Sulfate	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND
8-Cyhalothrin	ND	ND	ND	ND	ND
cis-Permethrin	2.74	ND	ND	ND	ND
Trans-Permethrin	ND	ND	ND	ND	ND

Table 12b. Mean (n=2) estimated water column concentrations of polychlorinated biphenyl PCBs), organochlorine pesticides, and polycyclic aromatic hydrocarbons (PAHs) in SPMDs placed at selected Sediment Quality Triad stations in 2002. Results reported as ug/L (ND=Not detected).

Target Analyte	Station ID					Chronic Aquatic Life Criteria ug/L[A]		
	SER5[B]	BOR2[C]	NER3[C]	NER5[C]	ELR2[C]	Freshwater	Estuarine	Saltwater
Total PCBs	ND	ND	ND	ND	ND	0.014		0.03
α-BHC	ND	ND	0.0001	ND	ND			
PCA	0.00008	0.00001	0.00003	0.00002	0.00002			
Lindane	ND	0.00029	0.00046	0.00015	0.00040	0.95D		0.16D
Endrin	0.00003	ND	ND	0.00002	0.00001	0.036		0.0023
Dacthal	0.00005	0.00004	0.00003	0.00003	0.00001			
Chlorpyrifos	0.00004	0.00003	0.00005	0.00006	0.00042	0.083D		
Diazinon	0.00214	ND	0.00150	ND	ND			
Oxychlordane	ND	0.00000	ND	ND	0.00000			
Heptachlor Epoxide	0.00028	0.00010	0.00007	0.00005	0.00009	0.00380		0.00360
trans-Chlordane	0.00002	0.00002	0.00002	0.00001	0.00002			
cis-Chlordane	0.00009	0.00006	0.00003	0.00002	0.00005			
cis-Nonachlor	0.00002	ND	ND	ND	0.00000			
trans-Nonachlor	0.00004	0.00002	0.00002	0.00001	0.00002			
Total Chlordane	0.00044	0.00019	0.00014	0.00009	0.00018	0.0043		0.004
Dieldrin	0.00050	0.00016	0.00014	0.00013	0.00031	0.056		0.0019
o,p'-DDT	0.00001	ND	ND	0.00000	0.00000			
p,p'-DDT	0.00001	ND	0.00000	0.00000	0.00001	0.001		0.001
o,p'-DDD	0.00001	0.00002	0.00001	0.00001	0.00004			
p,p'-DDD	0.00002	0.00005	0.00002	0.00002	0.00004			
o,p'-DDE	ND	ND	ND	ND	0.00002			
p,p'-DDE	ND	ND	ND	ND	0.00001			
Acenaphthene	0.00134	ND	ND	ND	ND			
Fluorene	0.00119	ND	ND	ND	ND			
Phenanthrene	0.00282	ND	ND	ND	ND			
Anthracene	0.00045	ND	ND	ND	ND			
Fluoranthene	0.01330	ND	0.00049	0.00072	0.00042			
Pyrene	0.00694	0.00013	0.00032	0.00063	0.00094			
Benz[a]anthracene	0.00046	ND	ND	ND	ND			
Chrysene	0.00103	ND	ND	ND	0.00012			
Benzo[b]fluoranthene	0.00112	ND	0.00007	0.00006	ND			
Benzo[k]fluoranthene	0.00051	ND	ND	ND	0.00003			
Benzo[a]pyrene	0.00015	ND	ND	ND	ND			
Indeno[1,2,3-cd]pyrene	0.00013	ND	ND	ND	ND			
Benzo[g,h,I]perylene	0.00022	ND	ND	ND	ND			

[A]Toxic substances criteria for ambient surface waters as identified in COMAR 26.08.03.

[B]Estuarine/saltwater sites, (note: if an estuarine criterion is not available, the saltwater criterion is applied) as defined in COMAR 26.08.02

[c]Freshwater sites as defined in COMAR 26.08.02

[D] Acute criterion listed because no chronic criterion available

Table 12c. Mean (n=2) polycyclic aromatic hydrocarbon (PAHs), hormone, and antibiotic concentrations in SPMDs and POCIS placed at selected Sediment Quality Triad sites in 2002. Results reported as ng/SPMD and ng/POCIS (ND=Not detected).

Target Analyte	Station ID				
PAHs (SPMDs)	**SER5[A]**	**NER3[B]**	**NER5[B]**	**BOR2[B]**	**ELR2[B]**
Naphthalene	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND
Acenaphthene	70	ND	ND	ND	ND
Fluorene	95	ND	ND	ND	ND
Phenanthrene	240	ND	ND	ND	ND
Anthracene	45	ND	ND	ND	ND
Fluoranthene	5540	220	300	ND	145
Pyrene	3430	315	310	75	395
Benz[a]anthracene	170	ND	ND	ND	ND
Chrysene	1040	ND	ND	ND	100
Benzo[b]fluoranthene	390	20	10	ND	25
Benzo[k]fluoranthene	210	ND	ND	ND	20
Benzo[a]pyrene	65	ND	ND	ND	ND
Indeno[1,2,3-cd]pyrene	55	ND	ND	ND	ND
Dibenz[a,h]anthracene	ND	ND	ND	ND	ND
Benzo[g,h,i]perylene	55	ND	ND	ND	ND
Benzo[b]thiophene	ND	ND	ND	ND	ND
2-methylnaphthalene	30	ND	ND	ND	ND
1-methylnaphthalene	ND	ND	ND	ND	ND
Biphenyl	ND	ND	ND	ND	ND
1-ethylnaphthalene	ND	ND	ND	ND	ND
1,2-dimethylnaphthalene	1ND	ND	ND	ND	ND
4-methylbiphenyl	ND	ND	ND	ND	ND
2,3,5-trimethylnaphthalene	70	ND	ND	ND	ND
1-methylfluorene	200	ND	10	ND	ND
Dibenzothiophene	20	ND	10	ND	ND
2-methylphenanthrene	150	20	20	ND	ND
9-methylanthracene	ND	ND	ND	ND	ND
3,6-dimethylphenanthrene	140	ND	ND	ND	ND
2-methylfluoranthene	130	ND	ND	ND	ND
Benzo[b]naphtho[2,1-d]thiophene	125	ND	ND	ND	ND
Benzo[e]pyrene	225	20	20	ND	35
Perylene	20	190	160	35	65
3-methylcholanthrene	ND	ND	ND	ND	ND
Hormones (POCIS)					
17β-Estradiol	ND	102	ND	ND	ND
Estrone	ND	ND	ND	ND	ND
Antibiotics (POCIS)					
Oxytetracycline	80	175	ND	ND	ND
Tetracycline	205	ND	ND	ND	ND
Chlortetracycline	85	ND	170	ND	ND

[A]Estuarine/saltwater stations as defined in COMAR 26.08.02 (Note: if an estuarine criterion is not available, the saltwater criterion is applied)
[B]Freshwater stations as defined in COMAR 26.08.02

Table 13. Interpretation of Sediment Quality Triad responses (from Chapman *et al.* 1992) and application to 2002 Sediment Quality Triad stations*.

Outcome number	Sediment contamination	Toxicity	Benthic alteration	Possible conclusions
1	+	+	+	Strong evidence for pollution-induced degradation
2	-	-	-	Strong evidence that there is no pollution-induced degradation
3	+	-	-	Contaminants are not bioavailable
4	-	+	-	Unmeasured chemicals or conditions exist with the potential to cause degradation
5	-	-	+	Alteration is not due to toxic chemicals
6	+	+	-	Toxic chemicals are stressing the system
7	-	+	+	Unmeasured toxic chemicals are causing degradation
8	+	-	+	Chemicals are not bioavailable or alteration is not due to toxic chemicals
2002 Sediment Quality Triad Stations				
BOR1	-	-	+	Outcome 5
BOR2-4	-	+	+	Outcome 7
ELR1,4	-	-	+	Outcome 5
ELR2	-	+	-	Outcome 4
ELR3	-	+	+	Outcome 7
NER1,2	-	-	-	Outcome 2
NER3,4	-	+	+	Outcome 7
NER5	-	-	+	Outcome 5
SER1,4	-	+	+	Outcome 7
SER2,3	-	-	+	Outcome 5
SER5	+	+	+	Outcome 1

* Responses are shown as either positive (+) or negative (-), indicating whether or not measurable differences between reference conditions/measures were determined.

FIGURES

Figure 1. Location of 2002 Sediment Quality Triad Sations in the Northeast, Elk, and Bohemia Rivers.

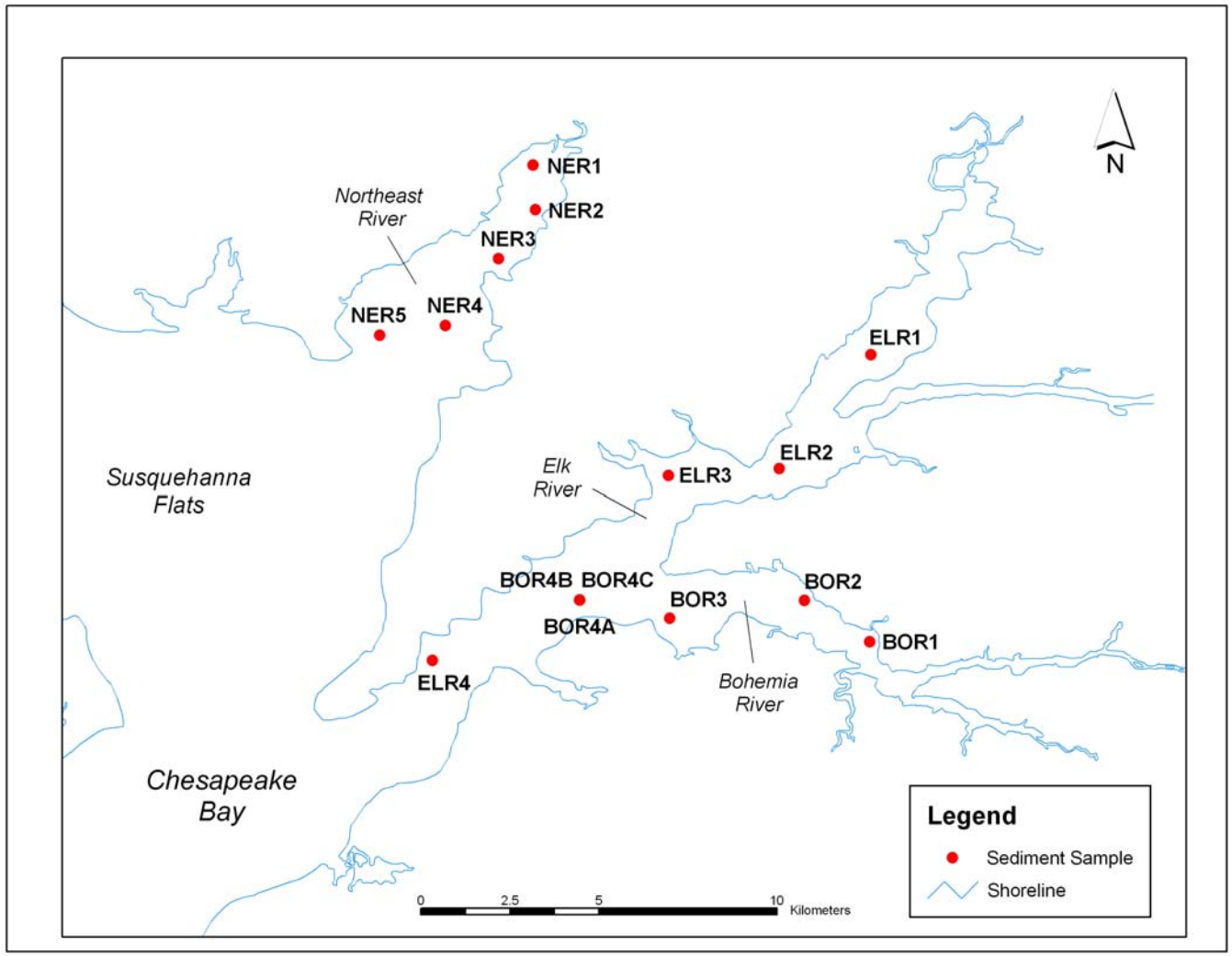


Figure 2. Location of 2002 Sediment Quality Triad stations in the Severn River

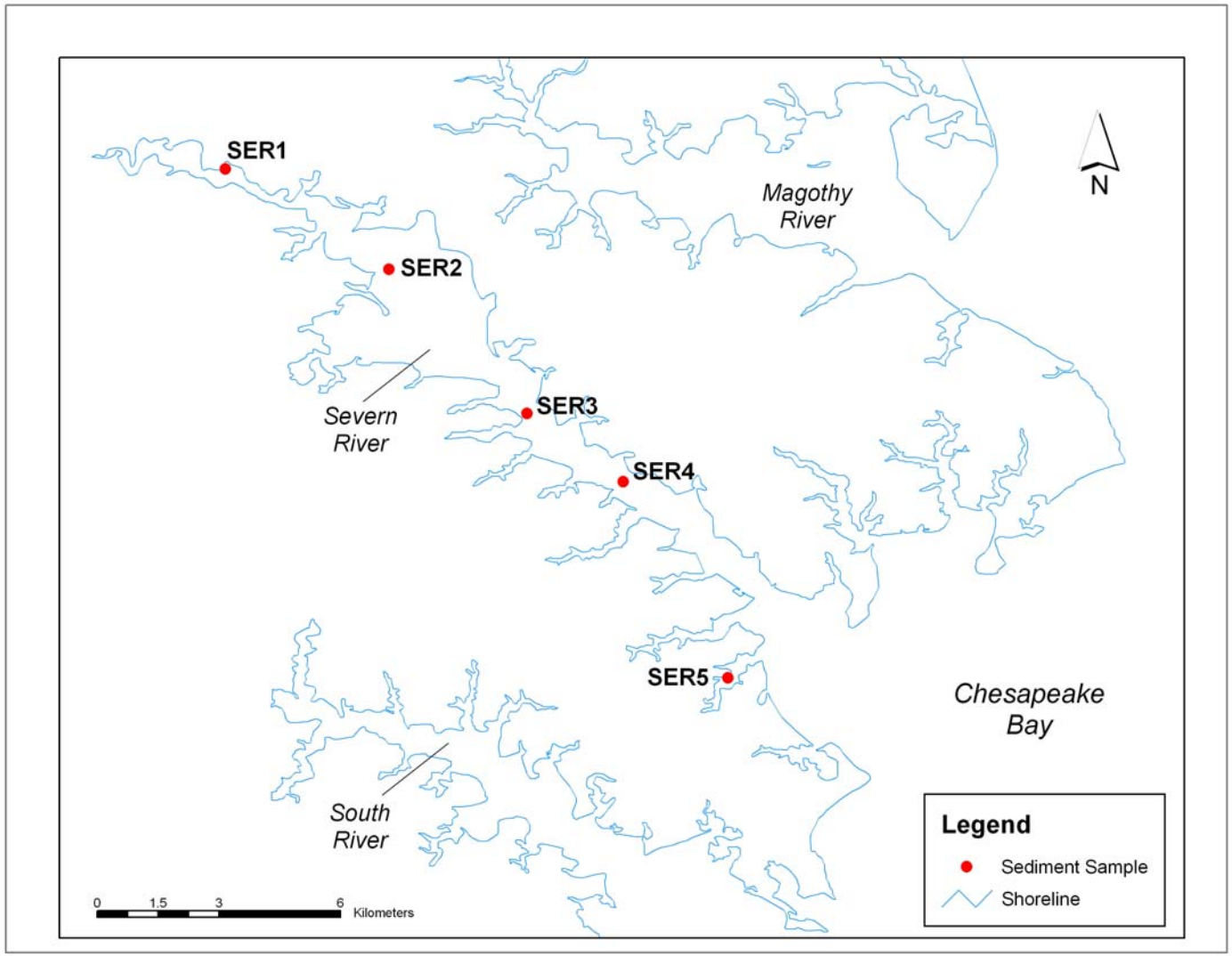


Figure 3. Relationship between the Benthic IBI scores and the mean ER-M quotient in the 2002 Sediment Quality Triad study. Results of Spearman Rank Order correlation were not significant (p=0.189) with r =-0.321

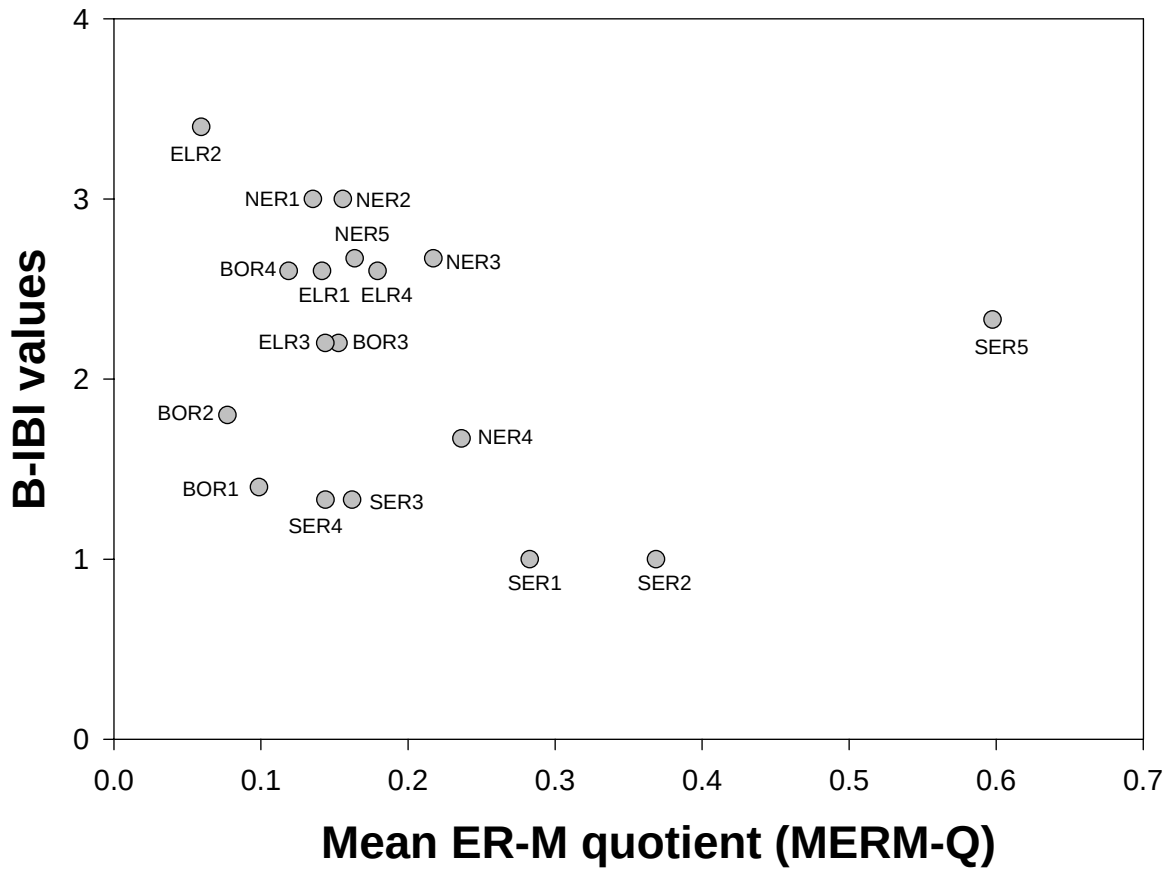


Figure 4. Map showing fish tissue and water quality monitoring stations in relation to the 2002 Sediment Quality Triad Stations in the Severn River

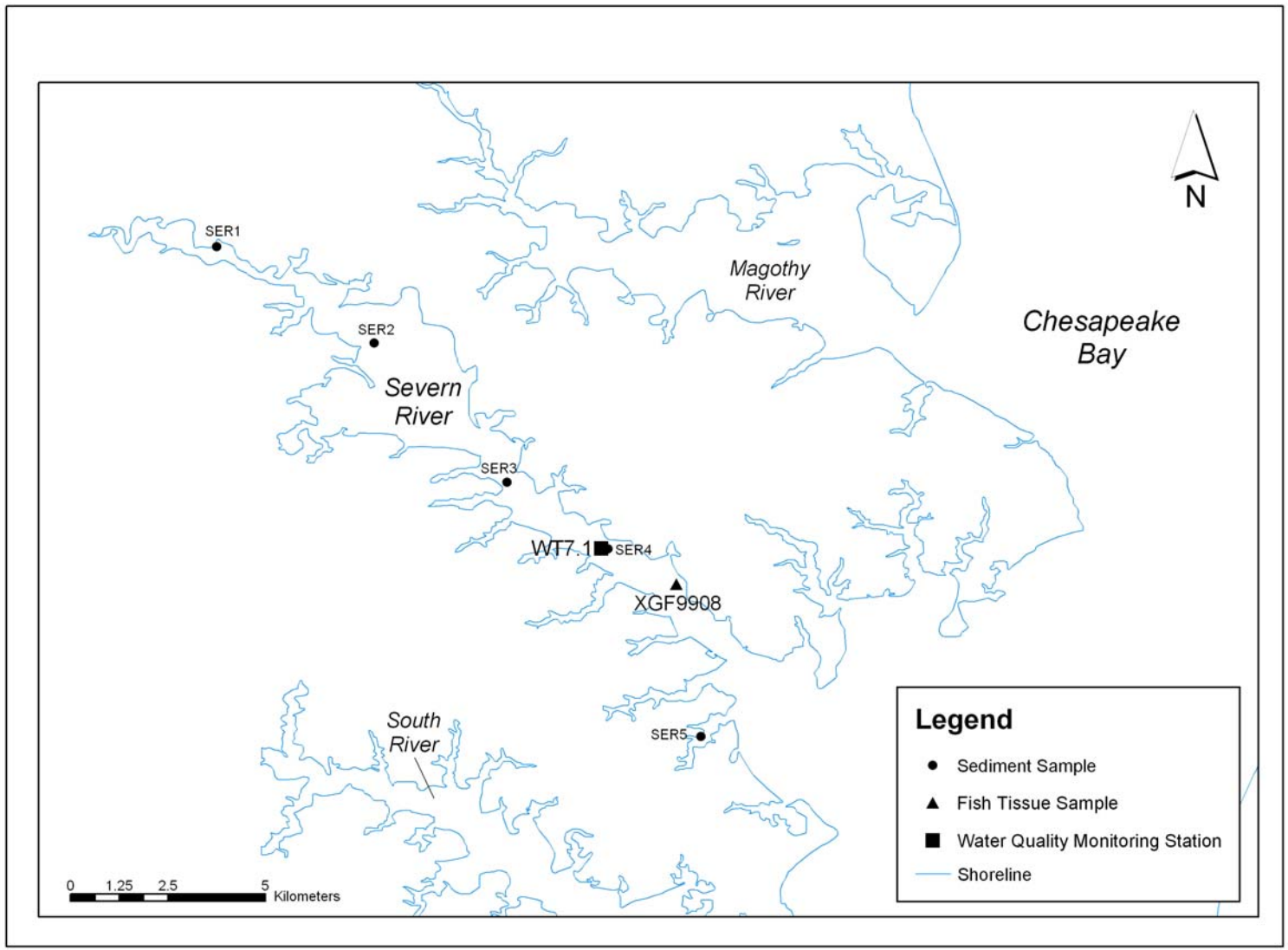
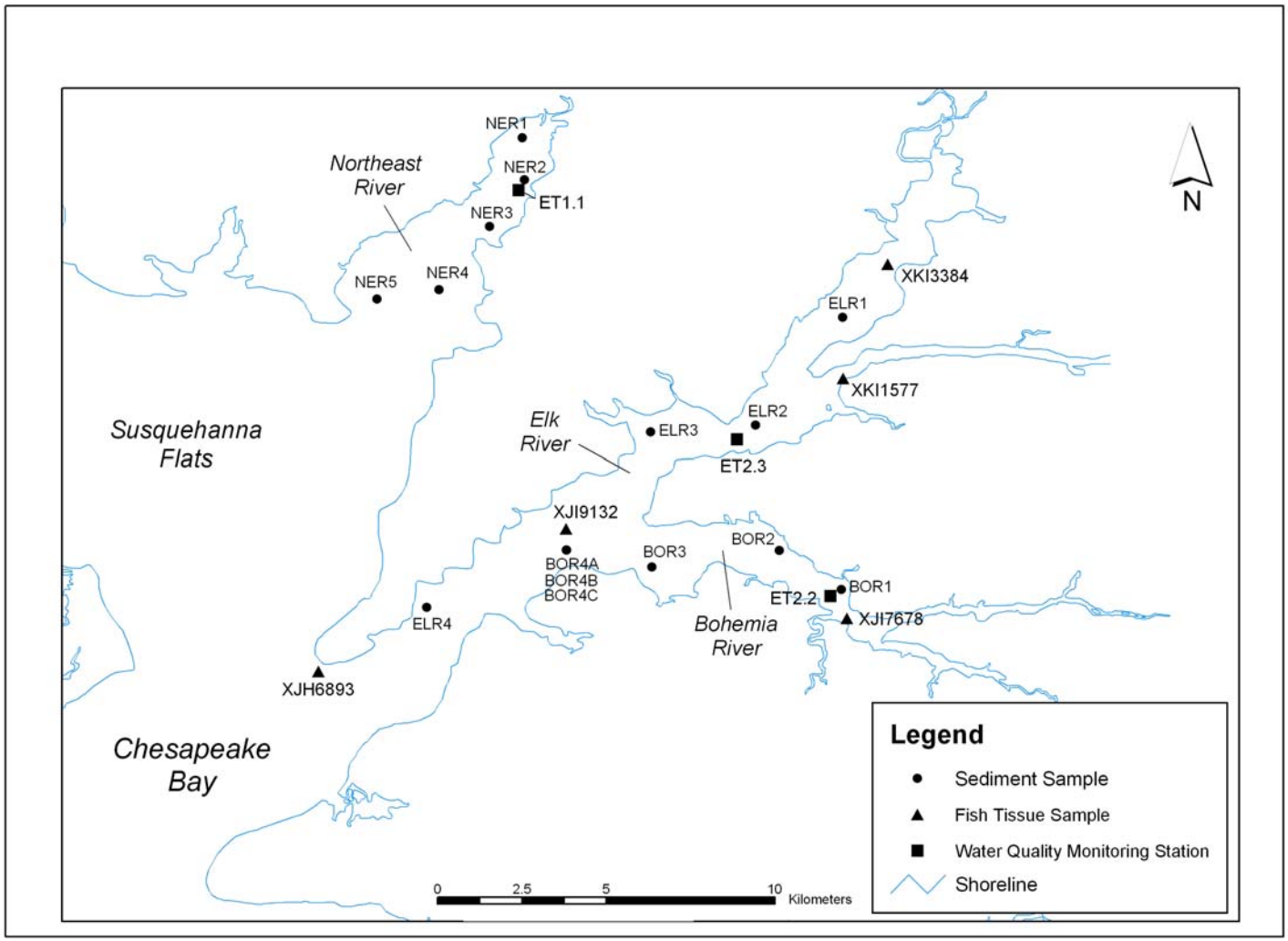


Figure 5. Map showing fish tissue and water quality monitoring stations in relation to the 2002 Sediment Quality Triad Stations in the Northeast, Elk, and Bohemia Rivers



Appendix A

Using the sediment quality triad and integrative water sampling devices to characterize chemical contaminant impacts in Chesapeake Bay tributaries – Toxicity test results (Fisher *et al.* 2004)

APPENDIX A

FINAL REPORT

Using the Sediment Quality Triad and Integrative Water Sampling Devices to Characterize Chemical Contaminant Impacts in Chesapeake Bay Tributaries – TOXICITY TEST RESULTS

EPA/IAG # CB98365201

Prepared by:

Daniel J. Fisher, Ph.D.
Gregory P. Ziegler
Lance T. Yonkos
Mark Shepard
University of Maryland System
Agricultural Experiment Station
Wye Research and Education Center
Box 169
Queenstown, Maryland 21658

Prepared for:

Ms. Kelly Shenk, Toxics Coordinator
U.S. Environmental Protection Agency
Chesapeake Bay Program Office
410 Severn Avenue
Annapolis, MD 21403

March 2004

FOREWORD

This study was part of a larger project designed to use the Sediment Quality Triad, integrative water samplers, and *in situ* fish exposures to characterize toxic conditions in tidal segments of the upper Chesapeake Bay for which little data existed or for which existing information was inconclusive. A team of scientists worked jointly to complete this goal. Dr. Beth McGee of the U. S. Fish and Wildlife Service (USFWS), Chesapeake Bay Field Office was project coordinator and was in charge of collecting the sediment samples and writing the final summary report. The chemical analyses were conducted by Drs. David Velinsky and Jeffrey Ashley, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA. The toxicity test results that are covered in this report are based on studies conducted at the University of Maryland Wye Research and Education Center under the direction of Dr. Daniel Fisher.

ABSTRACT

The goal of this study was to assess the toxicity of sediments and overlying water from tidal segments of the upper Chesapeake Bay. The focus was on assessing areas for which little data existed or for which existing information was inconclusive. The toxicity information presented here is one part of a larger study designed to use the Sediment Quality Triad, integrative water samplers, and *in situ* fish exposures to characterize toxic conditions in these stream segments. Eighteen stations were examined in this study. Four stations were sampled in the Bohemia River, five in the Severn River, four in the Elk River, and five in the Northeast River. The toxicity of these sediments was assessed using 28-d survival, growth and reproduction of the amphipod *Leptocheirus plumulosus* and 10-d survival and growth of the amphipod *Hyalella azteca* in whole sediment bioassays. In addition, at two stations in the Severn River, larval sheepshead minnow (*Cyprinodon variegatus*) were tested *in situ* for seven days to assess toxicity of the overlying water.

Results show that there were no significant differences between survival in any test sediment and the control sediments for either amphipod species. The *H. azteca* test showed significant reductions in growth at three sites in the Severn River (SER 1, SER4, and SER5). All other sediments from the Bohemia, Elk and Northeast Rivers did not cause toxicity to this freshwater amphipod. In contrast, the *L. plumulosus* test was more sensitive than the *H. azteca* test, showing toxicity based on growth and reproduction in all river systems. Sites that were toxic were found in the Bohemia River (BOR2, BOR3, and BOR4), the Severn River (SER4 and SER5), the Elk River (ELK2 and ElK 3), and the Northeast River (NER3 and NER4). Thus, the *L. plumulosus* test indicated that 9 of the 18 sites tested were toxic while the *H. azteca* indicated toxicity in only one river system, the Severn (three toxic sites). At only two sites, SER4 and SER5, did the two tests give comparable results.

The *in situ* larval *Cyprinodon variegatus* tests in the Severn River showed that overlying water in this river had no effect on survival or growth of the fish. Larvae survived and grew as well as control fish, even at site SER5 that resulted in sediment toxicity to both amphipod species.

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INTRODUCTION

The objective of this study was to use the sediment quality triad, integrative water sampling devices, and *in situ* water column tests to characterize chemical contaminant impacts in Chesapeake Bay Tributaries. The focus was on assessing areas for which little data existed or for which existing information was inconclusive. The river systems sampled during this study were in the northern part of the bay. Tributaries sampled included the Elk River, Northeast River, Bohemia River and Severn River in Maryland. The intent was to maximize the spatial coverage of toxics monitoring by limiting the number of toxicological analyses and coordinating with ongoing benthic monitoring programs. Eighteen stations were sampled for the sediment triad analyses. This report covers the results of the toxicity tests using 28-d survival, growth and reproduction of the amphipod *Leptocheirus plumulosus* and 10-d survival and growth of the freshwater amphipod *Hyalella azteca*. In addition, *in situ* 7-d larval survival and growth water column toxicity tests were conducted with the estuarine sheepshead minnow *Cyprinodon variegatus* at two sites in the Severn River. All sediment toxicity tests were conducted at the University of Maryland Wye Research and Education Center (WREC) in Queenstown, MD.

The Sediment Quality Triad has been successfully applied in the Chesapeake Bay and nation-wide (e.g., Baltimore Harbor, Anacostia River, Puget Sound, San Francisco Bay, Gulf of Mexico) to characterize ambient conditions in freshwater, estuarine and marine systems (e.g., Long and Chapman 1985, Chapman et al. 1987, Hall et al. 1991, 1992, 1994, 2000, McGee et al. 1999). This weight of evidence approach consists of complementary measures of sediment chemistry, benthic community structure and sediment toxicity. The combination of potential cause (chemistry) and effect (biology) measurements makes the Triad one of the most complete and powerful tools available to determine the extent and significance of pollution-induced degradation.

The toxicity information generated in this report is part of a larger effort to characterize these river systems. The benthic community, sediment chemistry data and integrative water sampler data will be combined with this toxicity data in a final report to be prepared for the Chesapeake By Program by Dr. Beth M. McGee of the U. S. Fish and Wildlife Service (USFWS), Chesapeake Bay Field Office.

MATERIALS AND METHODS

Sample Stations

Eighteen stations were sampled in this study for the sediment quality triad analyses. The river systems sampled during this study were the Bohemia River, the Severn River, the Elk River, and the Northeast River. Four stations were sampled in the Bohemia River (BOR), five in the Severn River (SER), four in the Elk River (ELK), and five in the Northeast River (NER). The station abbreviations, numbers and coordinates are presented in Table 1. The dates of the toxicity tests are also given in Table 1.

In addition, two stations in the Severn River were chosen to cage larval sheepshead minnows for the *in situ* overlying water toxicity tests. Information on these stations is also given in Table 1.

Sample Collection, Handling, and Storage

Sediment collection methods followed those described in U.S. EPA/U.S. ACE (1995) and briefly described below. Samples from the Severn River were collected on September 13, 2002 and delivered to the WREC on September 17, 2002. Samples from the Northeast River were collected on September 16, 2002 and delivered to the WREC on September 17, 2002. Samples from the Bohemia and Elk Rivers were collected on September 17, 2002 and delivered to the WREC on September 17, 2002.

Samples were collected at each station by the USFWS with a stainless steel petite ponar grab (0.023 m^2). Samples for sediment toxicity testing and chemistry represent composite samples. At each station, the top 2 - 3 cm of several grabs were placed into a pre-cleaned stainless steel bowl and homogenized with a stainless steel spoon until uniform in color and texture. Subsamples were placed into separate pre-cleaned containers for sediment chemistry and toxicological analyses. Observations of sample acceptability, depth of penetration and qualitative characteristics (i.e., odor, color, etc) were recorded on field data sheets. Care was taken to avoid sediments in direct contact with the sides of the grab sampler. Collected sediments were kept on ice in the dark and subsequently refrigerated (toxicological and grain size samples) or frozen (chemical samples) until analyses.

Between stations, the grab sampler, stainless steel bowl and mixing utensils were rinsed sequentially in 10% nitric acid and methanol to remove residual contaminants. In addition, the first grab taken at each station was discarded and considered an *in situ* rinse. All sampling containers for chemical, biological and toxicological analyses were labeled with the date, type of sample, and sample location.

All toxicity samples were transported to the WREC on ice in coolers, out of direct sunlight. The samples were held at the WREC in refrigerators in the dark at 4EC until sieving and initiation of the toxicity tests. Prior to the initiation of tests the *L. plumulosus* test sediments were sieved through a 250 Fm mesh stainless steel sieve while the *H. azteca* test sediments were sieved through a 500 Fm mesh stainless steel sieve. Sieving was done to remove indigenous organisms that might interfere with the tests, especially the test species that might be present in the environmental samples. The *L. plumulosus* test sediments were sieved through a finer sieve in order to facilitate the removal of neonates at test conclusion. Final details on sediment collection will be covered in the final report prepared by the USFWS.

Sediment Toxicity Tests

Sediment toxicity was assessed using the chronic 28-d Environmental Protection Agency (EPA) survival, growth and reproduction method with the estuarine amphipod, *Leptocheirus plumulosus* (U.S. EPA/U.S. ACE, 2001) and the 10-d survival and growth method with the freshwater amphipod *Hyalella azteca* (U.S. EPA, 2000). *L. plumulosus* used in the tests were from cultures maintained at the WREC while *Hyalella azteca* were obtained from Chesapeake Cultures of Hayes, VA. Test start and end dates are shown in Table 1.

Summaries of the test methods are given in Tables 2 and 3. The EPA 28-d chronic *Leptocheirus plumulosus* test is a static renewal exposure with survival, growth, and reproduction as the endpoints while the 10-d *Hyalella azteca* test is a static renewal test with survival and growth as endpoints.

In situ Larval Fish Exposures

Cyprinodon variegatus larvae were exposed *in situ* at two sites in the Severn River (SER3 and SER5) and a control site in the Wye River (Table 1). Water depth was approximately 2 meters at SER5 and the Wye control site and 3 meters at SER3. The fish caging system is shown in Figure 1. The auger pole (A) was twisted into the bottom at each site after the outer protective cage was slipped onto the pole. The cage could be raised and lowered via a pulley system. The top of the protective basket was locked in place. The cages had openings on the sides, tops and bottoms to allow for flow through the unit. The cages were lowed to approximately 0.5 to 1 meter from the bottom depending on the site. The depth in the shallow sites determined the fixed position of the protective cage so that the cage was always under water, even at low tide. Ten 10-d old larvae fish were added to each of four replicate larvae baskets (C) at each site. The baskets were capped and a flotation ring was attached so that they would float on the surface when the protective cage was pulled to the surface for observations and feeding of the larvae. All mesh was either stainless steel or nitex. The mesh size was adequate for flow of water through the chambers while still retaining the larval fish.

Each day the outer cages were pulled to the surface and the fish were observed. Mortalities were counted and water quality measurements were taken. Fish were fed TetraMin® Tropical Flake ground to 200 Fm. At the end of the 7-d test period the surviving fish were collected, taken to the lab, dried and weighed.

Data Analysis

Statistical procedures for the analysis of the sediment and overlying water toxicity test data are presented in U.S. EPA (2000) and U.S. EPA/ACE (2001). Survival data were Arc Sine Square Root transformed prior to analysis. Alpha was 0.05 for all statistical tests. Data were assessed for normality and homogeneity of variance using the Chi-Square Test and the Bartlett's Test, respectively. If the data met the assumptions of normality and homogeneity of variance they were analyzed via ANOVA followed by comparisons between test sediments and the control using Dunnett's Test. If the assumptions were not met the data were analyzed using a Steel's Many-One Rank Test. Data for all of the *L. plumulosus* endpoints met the assumptions of normality and homogeneity of variance. Data for all of the *H. azteca* endpoints failed one or both of these tests except for the growth endpoint in the Bohemia and Severn River tests. The survival data for the sheepshead minnow *in situ* test did not meet the homogeneity of variance assumption but the growth and biomass were normal and had homogeneous variance.

RESULTS

Water Quality

Measurements for water quality during the tests are given in Tables 4 through 8. Pore water ammonia was relatively low in all test beakers, with a highest recorded value of 12.0 mg/L for any test sediment and 8.5 mg/L for the control sediment. Overlying ammonia was

also low, with a highest recorded value of 3.0 mg/L for any test sediment and 1.3 mg/L for the control sediment. These values are well below the level of 60 mg/L in pore water that would be considered to be a problem by the U.S. EPA (U.S. EPA/ACE, 2001). Values for pH, salinity and dissolved oxygen were acceptable for all test and control sediments. Dissolved oxygen values for the *in situ* sheepshead minnow test at the Severn River site near the Golf Course (SR3) were consistently higher (mean of 13.8 mg/L) than the other two *in situ* test sites (Table 8).

Reference Toxicant Tests

The cadmium chloride reference toxicity test for *L. plumulosus* resulted in a 96-h LC50 of 0.19 mg/L as cadmium. This value falls within the acceptable range (± 2 standard deviations) for cadmium reference toxicity tests with this species conducted at the WREC laboratory (0.12 to 0.37 mg/L as cadmium). The potassium chloride reference toxicity test for *H. azteca* resulted in a 96-h LC50 of 660 mg/L KCl. This value falls within the acceptable range (± 2 standard deviations) for potassium chloride reference toxicity tests on this species conducted at the WREC laboratory (277 to 674 mg/L KCl).

Sediment Toxicity Tests

Performance criteria of $80% amphipod survival in the *L. plumulosus* and *H. azteca* controls were obtained in all toxicity tests. The mean control survival in the two *H. azteca* tests was 98.8% (Table 9) and 96.3% (Table 11) while the mean survival in the two *L. plumulosus* tests was 84% (Table 10) and 82% (Table 12). In addition, there was measurable growth in all of the *H. azteca* control amphipods and measurable growth and reproduction in all *L. plumulosus* control amphipods. Individual replicate data and mean data for all endpoints in the sediment tests can be found in Tables 9 through 12.

There were no significant differences between *H. azteca* survival and growth in any test sediment and the control sediments from the Bohemia River (Table 9), the Elk River (Table 11) or the Northeast River (Table 11). The *H. azteca* survival in sediments from these rivers ranged from 86.3% at BOR4 to 98.8% in a control treatment and at BOR2 and ELK4. The average *H. azteca* dry weight at the end of the ten-day test ranged from 0.169 mg at ELK1 to 0.216 mg at NER5. There were no significant differences in *H. azteca* survival in any test sediment and the control sediment in the Severn River with survival ranging from 95% at SER4 and SER5 to 100% at SER1 and SER3 (Table 9). There were significant differences in *H. azteca* growth between control and sediments from three sites in the Severn River (Table 9). Amphipod dry weight at the end of the ten-day test was significantly less than the control amphipod dry weight (0.175 mg) at SER1 (0.128 mg), SER4 (0.148 mg), and SER5 (0.148 mg). These reductions in dry weight represent a 26.9% reduction from the control amphipod weight at SER1 and a 15.4% difference from the control amphipod weight at both SER4 and SER5.

There were more instances of sublethal toxicity indicated in the *L. plumulosus* tests than in the *H. azteca* tests conducted in these river systems. There were no significant differences between *L. plumulosus* survival in any test sediments from any of these rivers and control sediments (Tables 10 and 12). The *L. plumulosus* survival ranged from 54% at ELK2 to 91% at SER2. In the Bohemia River there were significant effects on growth rate (mg dry

weight/day) at three stations; BOR2 (0.033 mg mg/d), BOR3 (0.028 mg/d), and BOR4 (0.026 mg/d) (Table 10). This is compared to the control amphipod growth rate of 0.053 mg/d. These reductions in growth rate represent a 37.7% decrease at BOR2, a 47.2% decrease at BOR3, and a 50.9% decrease at BOR4 compared to amphipod growth in the control treatment. In addition, there was also a significant reduction in amphipod reproduction at station BOR4, with the number of neonates per survivor being reduced by 87.1%, from 1.31 in the control to 0.17 at BOR4.

In the Severn River there were significant reductions in *L. plumulosus* growth rate and reproduction at SER4 and SER5 (Table 10). Amphipods in SER4 sediments at the end of 28 days showed an average growth rate of 0.032 mg/d, a reduction of 39.6% from the control growth rate (0.053 mg/d). At station SER5 the average growth rate was 0.029 mg/d, a reduction of 45.3% from the control growth rate. Amphipods in SER4 sediments at the end of 28 days had an average reproduction of 0.20 neonates/survivor, a reduction of 84.7% from the control reproduction (1.31 neonates/survivor). At station SER5 the average reproduction was 0.19 neonates/survivor, a reduction of 85.5% from the control reproduction.

In the Elk River there were significant reductions in *L. plumulosus* growth rate and reproduction at ELK2 and ELK3 (Table 12). Amphipods in ELK2 sediments at the end of 28 days showed an average growth rate of 0.023 mg/d, a reduction of 42.5% from the control growth rate (0.040 mg/d). At station ELK3 the average growth rate was also 0.023 mg/d. Amphipods in ELK2 sediments at the end of 28 days had an average reproduction of 0.04 neonates/survivor, a reduction of 97.0% from the control reproduction (1.18 neonates/ survivor). At station ELK3 the average reproduction was 0.14 neonates/survivor, a reduction of 88.1% from the control reproduction.

In the Northeast River there were significant reductions in *L. plumulosus* growth rate and reproduction at NER3 and NER4 (Table 12). Amphipods in NER3 sediments at the end of 28 days showed an average growth rate of 0.020 mg/d, a reduction of 50.0% from the control growth rate (0.040 mg/d). At station NER4 the average growth rate was 0.022 mg/d, a reduction of 45.0% from the control growth rate. Amphipods in NER3 sediments at the end of 28 days had an average reproduction of 0.45 neonates/survivor, a reduction of 61.9% from the control reproduction (1.18 neonates/survivor). At station NER4 the average reproduction was 0.15 neonates/survivor, a reduction of 87.3% from the control reproduction.

In situ Larval Fish Exposures

Larval sheepshead minnows that were exposed for seven days *in situ* at two sites in the Severn River (SER3 and SER5) did not show any differences in survival, growth, or biomass when compared to sheepshead minnows exposed at the control site in the Wye River (Table 13). There was greater than 97% survival at all sites and all fish showed significant growth (dry weight per survivor) and biomass (dry weight per initially exposed) over the seven-day exposure period.

DISCUSSION

A summary of the test results can be found in Table 14. This table shows the sites that were toxic, the endpoints that were affected and the percentage difference from the control treatment for each specific endpoint. Two sites in the Severn River, SER4 and SER5, were the only sites that were toxic to both the freshwater amphipod *Hyalella azteca* and the estuarine amphipod *Leptocheirus plumulosus*. Neither sediment had an effect on survival but both sites yielded amphipods that were smaller than the control amphipods. The small 15.4% difference in growth detected as significant in the *H. azteca* must be viewed with caution. Generally in these amphipod tests a 20% difference from the control value is considered "biologically" significant rather than just statistically significant. Since there was also a substantial hit in both growth and reproduction in the *L. plumulosus* tests at these sites there is most likely something going on at these two sites that needs further study.

The *L. plumulosus* test was more sensitive than the *H. azteca* test in determining sediment toxicity. The *L. plumulosus* test picked up toxicity at 9 of the 18 sites tested compared to the *H. azteca* test that only picked up toxicity at 3 of the 18 sites tested. This may be a function of niche. *L. plumulosus* is a burrowing amphipod that would probably be exposed to more contaminants than the surface dwelling amphipod *H. azteca*.

Each river system had sediments that were toxic to *L. plumulosus*. Again, there were no sites that caused significant reductions in survival compared to control survival. Some of the more toxic sites caused severe reductions in reproductions. For example, sediments from Site 2 in the Elk River caused a 97% reduction in *L. plumulosus* reproduction. Significant reductions in amphipod reproduction could have substantial effects on the population growth of this species. There were no sites that resulted in an amphipod reproductive effect that did not also cause a significant reduction in amphipod growth. Therefore, in this study, amphipod growth was as sensitive an indicator of effect as amphipod reproduction.

Although sediments at three sites in the Severn River caused significant effects on both *L. plumulosus* and *H. azteca*, overlying water in the river did not cause toxicity in the larval sheepshead minnow *in situ* toxicity test. This is most apparent at SER 5, where both a sediment tests and an *in situ* were conducted. The sediments from this site caused a reduction in growth in both amphipod tests and in reproduction in the *L. plumulosus* test but the water overlying these sites did not have an effect on survival or growth of larval *Cyprinodon variegatus*. Whatever is causing the toxicity in the sediments does not seem to be in the overlying water at concentrations that affect the larval fish.

REFERENCES

Chapman, P.M., R.N. Dexter, and E.R. Long. 1987. Synoptic measures of sediment contamination, toxicity and infaunal community structure (the Sediment Quality Triad) in San Francisco Bay. *Mar. Ecol. Prog. Ser.* 37:75-96.

Hall, L.W., Jr., M.C. Ziegenfuss, S.A. Fischer, R.W. Alden, III, E. Deaver, J. Gooch and N. Debert-Hastings. 1991. A Pilot Study for Ambient Toxicity Testing in Chesapeake Bay. Volume 1 - Year 1 Report CBP/TRS 64/91. U.S. EPA Chesapeake Bay Program, Annapolis, MD.

Hall, L.W. Jr., M.C. Ziegenfuss, S.A. Fischer, R.D. Anderson, W.D. Killen, R.W. Alden, III, E. Deaver, J. Gooch and N. Shaw. 1992. A Pilot Study for Ambient Toxicity Testing in Chesapeake Bay - Year 2 report. CBP/TRS 82/92. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.

Hall, L.W., Jr., M.C. Ziegenfuss, R.D. Anderson, W.D. Killen, R.W. Alden, and P. Adolphson. 1994. A Pilot Study for Ambient Toxicity Testing in Chesapeake Bay. Year 3 Report CBP/TRS 116/94. U.S. EPA Chesapeake Bay Program, Annapolis, MD.

Hall, L.W., Jr., R.D. Anderson, A. Messing, J. Winfield, A.K. Jenkins, I.J. Weber, R.W. Alden, D. Goshorn and M. McGinty. 2000. Ambient Toxicity Testing in Chesapeake Bay. Year 8 Report. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.

Long, E.R. and P.M. Chapman. 1985. A Sediment Quality Triad: Measures of sediment contamination, toxicity and infaunal community composition in Puget Sound. *Mar. Poll. Bull*. 10:405-415.

McGee, B.L., D.J. Fisher, L.T. Yonkos, G.P. Ziegler, and S. Turley. 1999. Assessment of sediment contamination, acute toxicity, and population viability of the estuarine amphipod *Leptocheirus plumulosus* in Baltimore Harbor, Maryland, USA. *Environ. Toxicol. Chem.* 18:2151-2160.

U.S. EPA. 2000. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates. Second Edition. EPA/600/R-99/064. U.S. Environmental Protection Agency, Office of Research and Development, Duluth, MN.

U.S. EPA/U.S. ACE. 1995. QA/QC Guidance for sampling and analysis of sediments, water and tissues for dredged material evaluations. EPA 823-B-95-001. U.S. Environmental Protection Agency/ U.S. Army Corps of Engineers, Washington, D.C.

U.S. EPA/U.S. ACE. 2001. Methods for Assessing the Chronic Toxicity of Sediment associated Contaminants with *Leptocheirus plumulosus*. First Edition. EPA/600/R-01/020.U.S. Environmental Protection Agency/ U.S. Army Corps of Engineers, Washington, D.C.

Table 1. Sample station locations and dates of toxicity tests.

River System	Station Name	Latitude/Longitude (Decimal degrees)	Test Dates
Bohemia	BOR1	39.46845 / 75.87177	10/11-11/8/02 Lepto; 10/15-10/25/02 Hyalella
	BOR2	39.47903 / 75.88837	10/11-11/8/02 Lepto; 10/15-10/25/02 Hyalella
	BOR3	39.47451 / 75.92241	10/11-11/8/02 Lepto; 10/15-10/25/02 Hyalella
	BOR4	39.47909 / 75.94521	10/11-11/8/02 Lepto; 10/15-10/25/02 Hyalella
Severn	SER1	39.07649 / 76.59332	10/11-11/8/02 Lepto; 10/15-10/25/02 Hyalella
	SER2	39.05416 / 76.55703	10/11-11/8/02 Lepto; 10/15-10/25/02 Hyalella
	SER3	39.02211 / 76.52634	10/11-11/8/02 Lepto; 10/15-10/25/02 Hyalella
	SER4	39.00695 / 76.50487	10/11-11/8/02 Lepto; 10/15-10/25/02 Hyalella
	SER5	38.96343 / 76.48159	10/11-11/8/02 Lepto; 10/15-10/25/02 Hyalella
Elk	ELK1	39.54113 / 75.87154	10/10-11/7/02 Lepto; 10/16-10/26/02 Hyalella
	ELK2	39.51228 / 75.89471	10/10-11/7/02 Lepto; 10/16-10/26/02 Hyalella
	ELK3	39.51052 / 75.92272	10/10-11/7/02 Lepto; 10/16-10/26/02 Hyalella
	ELK4	39.46380 / 75.98253	10/10-11/7/02 Lepto; 10/16-10/26/02 Hyalella
Northeast	NER1	39.58909 / 75.95703	10/10-11/7/02 Lepto; 10/16-10/26/02 Hyalella
	NER2	39.57779 / 75.95639	10/10-11/7/02 Lepto; 10/16-10/26/02 Hyalella
	NER3	39.56544 / 75.96565	10/10-11/7/02 Lepto; 10/16-10/26/02 Hyalella
	NER4	39.54846 / 75.97916	10/10-11/7/02 Lepto; 10/16-10/26/02 Hyalella
	NER5	39.54604 / 75.99584	10/10-11/7/02 Lepto; 10/16-10/26/02 Hyalella
Severn *in situ* tests	SER3 – Golf Course	39.02080 / 76.52632	5/27-6/3/03
	SER5 – Back Creek	38.96310 / 76.48268	5/27-6/3/03
	Wye Decorsey Cove	38.91075 / 76.15066	5/27-6/3/03

Table 2. Test conditions for 28-d sediment toxicity tests with *Leptocheirus plumulosus*.

1. Test type	Whole sediment, static renewal
2. Temperature	25 ^{o}C
3. Overlying water	Filtered Wye River water diluted to 5 ppt
4. Light	Ambient laboratory
5. Photoperiod	16:8 (L/D)
6. Test chamber	1 L glass beaker covered with watch glass
7. Sediment volume	175 ml (2 cm)
8. Overlying water volume	800 ml
9. Water renewal	3 x /week, replace 400 ml
10. Size and life stage of amphipods	neonates; size sorted on nested 250 and 500 :m mesh sieves
11. Number of organisms/replicate	20
12. Number of replicates	5
13. Feeding	TetraMin 3x/week
14. Aeration	1-2 bubbles/sec with 1 ml pipette
15. Water quality	Salinity, pH and total ammonia at beginning and end of test. Temperature and D.O. daily. Pore water ammonia in dummy beaker at test initiation.
16. Test duration	28 d
17. Endpoints	Survival, growth (mg/ind/d), reproduction (neonates/female, neonates/survivor)
18. Performance criteria	Control survival $\geq$ 80% Measurable growth and reproduction

Table 3. Test conditions for 10-d whole sediment toxicity tests with *Hyalella azteca*.

1. Test type	Whole sediment, static renewal of overlying water
2. Temperature	23 ± 1EC
3. Overlying water	95:5 well water/saltwater mix
4. Renewal of overlying water	2 volume additions/d using automatic renewal system
5. Light	Wide-spectrum fluorescent lights, 100 to 1000 lux
6. Photoperiod	16:8 (L/D)
7. Test chamber	300 mL lip-less beaker with screened hole for water renewal
8. Sediment volume	100 ml
9. Overlying water volume	175 ml
10. Size and life stage of amphipods	7- to 14-d old; size sorted on nested 710 and 500 Fm mesh sieves
11. Number of organisms/replicate	10
12. Number of replicates	8
13. Feeding	1.0 ml YCT daily
14. Aeration	none
15. Water quality	Alkalinity, hardness, and total ammonia at beginning and end of test. Temperature D.O., and pH daily. Pore water ammonia in dummy beaker at test initiation.
16. Test duration	10 d
17. Endpoints	Survival and growth
18. Performance criteria	Control survival $\geq$ 80% Measurable growth in control amphipods

Table 4. Water chemistry summary for the Bohemia and Severn Rivers 10-d amphipod *Hyalella azteca* sediment toxicity test conducted 10/15 - 10/25/02 (mean over (S.D.) unless otherwise stated).

Station	DO mg/L	pH range	Temp EC	Conductivity Fmhos	Alkalinity mg/L $CaCO_3$	Hardness mg/L $CaCO_3$	Ammonia mg/L		
							Overlying		Pore-water d-0
							d-0	d-10	
Control	7.0 (0.69)	7.87-8.28	23.0 (0.24)	2550 (70.71)	117.5 (10.61)	220 (16.97)	0.7	1.1	8.5
BOR 1	6.7 (0.72)	7.66-8.02	22.9 (0.16)	2450 (70.71)	127.5 (17.68)	216 (45.25)	0.6	1.0	11.0
BOR 2	6.7 (0.67)	7.66-8.05	23.0 (0.18)	2500 (0.00)	130 (7.07)	210 (2.83)	0.3	0.9	7.0
BOR 3	6.9 (0.50)	7.81-8.10	22.9 (0.15)	2500 (0.00)	130 (14.14)	214 (19.80)	0.3	0.8	7.0
BOR 4	7.0 (0.53)	7.77-8.11	22.9 (0.18)	2525 (35.36)	132.5 (17.68)	214 (8.49)	0.2	0.8	5.0
SER 1	7.1 (0.48)	7.84-8.13	22.9 (0.21)	2625 (35.36)	127.5 (17.68)	210 (8.49)	0.5	1.0	8.5
SER 2	7.2 (0.51)	7.85-8.12	22.8 (0.17)	2700 (141.42)	132.5 (3.54)	208 (22.63)	0.3	0.8	7.5
SER 3	7.0 (0.62)	7.76-8.13	22.9 (0.24)	2625 (35.36)	127.5 (17.68)	220 (28.28)	0.2	0.8	8.5
SER 4	7.2 (0.46)	7.84-8.15	23.0 (0.25)	2675 (35.36)	127.5 (17.68)	224 (5.66)	<0.2	0.8	4.0
SER 5	7.2 (0.61)	7.82-8.29	23.0 (0.21)	2675 (35.36)	137.5 (10.61)	196 (45.25)	<0.2	0.7	3.5

Table 5. Water chemistry summary for the Bohemia and Severn Rivers 28-d amphipod *Leptocheirus plumulosus* sediment toxicity test conducted 10/11 - 11/8/02 (mean over (S.D.) unless otherwise stated).

Station	Temp EC	DO mg/L	pH range	Salinity ‰	Ammonia mg/L		
					Overlying		Porewater
					day-0	day-28	d-0
Control	24.1 (0.71)	7.9 (0.59)	8.10-9.10	5.0 (0.00)	1.1	<0.2	8.5
BOR 1	24.0 (0.81)	7.8 (0.61)	7.90-8.84	5.3 (0.35)	1.1	<0.2	11.0
BOR 2	24.0 (0.78)	7.8 (0.56)	7.90-8.94	5.3 (0.35)	1.0	<0.2	7.0
BOR 3	23.9 (0.78)	7.8 (0.49)	8.05-8.68	5.3 (0.35)	1.0	<0.2	7.0
BOR 4	24.0 (0.70)	7.8 (0.64)	8.04-8.84	5.3 (0.35)	0.8	<0.2	5.0
SER 1	24.0 (0.76)	7.5 (0.53)	8.08-8.79	5.5 (0.71)	1.5	<0.2	8.5
SER 2	24.0 (0.76)	7.7 (0.44)	8.18-8.75	5.8 (1.06)	1.2	<0.2	7.5
SER 3	23.9 (0.71)	7.7 (0.44)	8.18-9.14	5.5 (0.71)	1.1	<0.2	8.5
SER 4	24.1 (0.77)	7.7 (0.42)	8.21-9.14	5.5 (0.71)	0.4	<0.2	4.0
SER 5	24.0 (0.72)	7.7 (0.45)	8.22-9.10	5.5 (0.71)	0.4	<0.2	3.5

Table 6. Water chemistry summary for the Elk and Northeast Rivers 10-d amphipod *Hyalella azteca* sediment toxicity test conducted 10/16 - 10/26/02 (mean over (S.D.) unless otherwise stated).

Station	DO mg/L	pH range	Temp EC	Conductivity Fmhos	Alkalinity mg/L $CaCO_3$	Hardness mg/L $CaCO_3$	Ammonia mg/L		
							Overlying		Pore-water d-0
							d-0	d-10	
Control	7.1 (0.56)	7.52-8.35	22.9 (0.26)	2675 (106.07)	147 (3.54)	256 (16.97)	1.1	1.2	8.5
ELR 1	7.1 (0.40)	7.69-8.26	22.9 (0.20)	2625 (35.36)	147 (3.54)	256 (39.60)	1.2	1.0	8.0
ELR 2	6.9 (0.47)	7.68-8.07	22.9 (0.21)	2575 (35.36)	142.5 (3.54)	244 (11.31)	0.8	0.8	3.5
ELR 3	6.9 (0.64)	7.63-8.10	22.8 (0.28)	2550 (0.00)	142.5 (3.54)	236 (16.97)	0.6	0.8	4.0
ELR 4	7.0 (0.40)	7.71-8.07	22.9 (0.18)	2575 (35.36)	135 (7.07)	180 (28.28)	0.9	0.8	5.0
NER 1	5.6 (0.52)	7.15-7.60	22.9 (0.26)	2425 (106.07)	130 (14.14)	228 (0.00)	3.0	0.4	11.0
NER 2	5.7 (0.70)	7.21-7.91	22.9 (0.25)	2450 (70.71)	137.5 (3.54)	222 (25.46)	2.6	0.5	10.5
NER 3	5.2 (0.64)	7.19-7.56	22.9 (0.22)	2450 (70.71)	135 (7.07)	202 (19.80)	2.7	0.4	11.0
NER 4	5.8 (0.76)	7.36-7.79	22.9 (0.24)	2475 (35.36)	142.5 (3.54)	228 (22.63)	1.2	0.8	12.0
NER 5	6.1 (0.90)	7.38-7.95	22.9 (0.30)	2500 (0.00)	130 (3.54)	210 (14.14)	1.2	1.0	10.0

Table 7. Water chemistry summary for the Elk and Northeast Rivers 28-d amphipod *Leptocheirus plumulosus* sediment toxicity test conducted 10/10 - 11/7/02 (mean over (S.D.) unless otherwise stated).

Station	Temp EC	DO mg/L	pH range	Salinity ‰	Ammonia mg/L		
					Overlying		Porewater
					day-0	day-28	d-0
Control	23.9 (0.67)	7.9 (0.45)	8.08-9.12	5.0 (0.00)	1.3	<0.2	8.5
ELR 1	23.9 (0.64)	8.0 (0.58)	8.11-9.01	5.0 (0.00)	1.1	<0.2	8.0
ELR 2	24.0 (0.66)	7.9 (0.48)	8.03-8.97	5.0 (0.00)	0.6	<0.2	3.5
ELR 3	23.9 (0.69)	7.9 (0.47)	7.99-8.59	5.3 (0.35)	0.5	<0.2	4.0
ELR 4	23.9 (0.68)	7.9 (0.49)	8.04-8.95	5.3 (0.35)	0.7	<0.2	5.0
NER 1	23.9 (0.56)	7.8 (0.49)	7.55-8.87	5.0 (0.00)	1.9	<0.2	11.0
NER 2	23.8 (0.58)	7.8 (0.34)	7.96-8.68	5.0 (0.00)	1.9	<0.2	10.5
NER 3	23.8 (0.55)	7.7 (0.53)	7.82-8.72	5.0 (0.00)	1.9	<0.2	11.0
NER 4	24.0 (0.58)	7.9 (0.53)	8.05-8.92	5.0 (0.00)	1.8	<0.2	12.0
NER 5	23.9 (0.56)	7.7 (0.51)	8.04-9.00	5.0 (0.00)	1.5	<0.2	10.0

Table 8. Water chemistry summary for the Severn River 7-d sheepshead minnow (*Cyprinodon variegatus*) *in situ* toxicity test conducted 5/27 – 6/3/03 (mean (S.D.) unless otherwise stated).

Sample site	DO (mg/L)	Temp (EC)	Salinity (‰)
Control (Wye River - DeCorsey Cove)	4.8 (0.95)	17.8 (0.70)	6.0 (0.00)
SR3 (Severn River – Golf Course)	13.8 (0.55)	18.6 (0.52)	5.8 (0.65)
SR5 (Severn River – Back Creek)	9.0 (0.17)	18.3 (0.57)	5.0 (0.00)

Table 9. Toxicity test summary for the Bohemia and Severn Rivers 10-d amphipod *Hyalella azteca* sediment toxicity test conducted 10/15 - 10/25/02. An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving amphipods	0 Mean Rep. dry wt. (mg)	0 (SD) Treatment % Survival	0 (SD) Treatment dry wt. (mg)
Control A	10	0.176	98.8 (3.54)	0.175 (0.0170)
Control B	10	0.170		
Control C	10	0.174		
Control D	10	0.160		
Control E	10	0.214		
Control F	10	0.167		
Control G	10	0.161		
Control H	9	0.175		
BOR 1 A	10	0.142	96.3 (7.44)	0.176 (0.0216)
BOR 1 B	10	0.199		
BOR 1 C	10	0.195		
BOR 1 D	10	0.151		
BOR 1 E	9	0.175		
BOR 1 F	10	0.197		
BOR 1 G	8	0.166		
BOR 1 H	10	0.184		
BOR 2 A	10	0.220	98.8 (3.54)	0.198 (0.0163)
BOR 2 B	10	0.210		
BOR 2 C	10	0.193		
BOR 2 D	10	0.188		
BOR 2 E	10	0.216		
BOR 2 F	9	0.174		
BOR 2 G	10	0.183		
BOR 2 H	10	0.197		
BOR 3 A	7	0.147	91.3 (11.26)	0.181 (0.0191)
BOR 3 B	10	0.179		
BOR 3 C	10	0.190		
BOR 3 D	8	0.179		
BOR 3 E	9	0.199		
BOR 3 F	10	0.181		
BOR 3 G	10	0.162		
BOR 3 H	9	0.206		

Table 9. Continued. An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving amphipods	0 Mean Rep. dry wt. (mg)	0 (SD) Treatment % Survival	0 (SD) Treatment dry wt. (mg)
BOR 4 A	8	0.172	86.3 (23.87)	0.194 (0.0212)
BOR 4 B	10	0.175		
BOR 4 C	10	0.175		
BOR 4 D	10	0.188		
BOR 4 E	9	0.208		
BOR 4 F	10	0.216		
BOR 4 G	3	0.186		
BOR 4 H	9	0.228		
SER 1 A	10	0.131	100.0 (0.00)	0.128* (0.0104)
SER 1 B	10	0.112		
SER 1 C	10	0.117		
SER 1 D	10	0.137		
SER 1 E	10	0.134		
SER 1 F	10	0.140		
SER 1 G	10	0.120		
SER 1 H	10	0.135		
SER 2 A	9	0.143	96.3 (5.18)	0.152 (0.0149)
SER 2 B	10	0.154		
SER 2 C	10	0.157		
SER 2 D	10	0.132		
SER 2 E	9	0.146		
SER 2 F	10	0.145		
SER 2 G	10	0.183		
SER 2 H	9	0.154		
SER 3 A	10	0.157	100.0 (0.00)	0.151 (0.0155)
SER 3 B	10	0.178		
SER 3 C	10	0.147		
SER 3 D	10	0.166		
SER 3 E	10	0.134		
SER 3 F	10	0.146		
SER 3 G	10	0.133		
SER 3 H	10	0.145		

Table 9. Continued. An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving amphipods	0 Mean Rep. dry wt. (mg)	0 (SD) Treatment % Survival	0 (SD) Treatment dry wt. (mg)
SER 4 A	10	0.158	95.0 (5.35)	0.148*(0.0337)
SER 4 B	10	0.169		
SER 4 C	9	0.151		
SER 4 D	9	0.186		
SER 4 E	10	0.144		
SER 4 F	10	0.072		
SER 4 G	9	0.141		
SER 4 H	9	0.159		
SER 5 A	10	0.144	95.0 (7.56)	0.148*(0.0131)
SER 5 B	10	0.155		
SER 5 C	9	0.154		
SER 5 D	10	0.146		
SER 5 E	10	0.143		
SER 5 F	8	0.133		
SER 5 G	10	0.174		
SER 5 H	9	0.135		

Table 10. Toxicity test summary for the Bohemia and Severn Rivers 28-d amphipod *Leptocheirus plumulosus* sediment toxicity test conducted 10/11- 11/8/02. An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving Amphipods	Replicate Growth Rate[1] (mg/individual/day)	# Neonates	0 (SD) Treatment Survival (%)	0 (SD) Treatment Growth rate	0 (SD) Treatment Neonates (per survivor)
Control A	18	0.046	6	84.0 (8.94)	0.053 (0.0109)	1.31 (0.821)
Control B	14	0.042	17			
Control C	16	0.047	18			
Control D	18	0.068	47			
Control E	18	0.060	33			
BOR 1 A	18	0.048	25	82.0 (10.37)	0.037 (0.0116)	1.35 (0.783)
BOR 1 B	19	0.048	38			
BOR 1 C	15	0.038	31			
BOR 1 D	16	0.021	18			
BOR 1 E	14	0.031	2			
BOR 2 A	16	0.039	2	87.0 (4.47)	0.033* (0.0067)	0.72 (0.427)
BOR 2 B	17	0.040	18			
BOR 2 C	18	0.028	18			
BOR 2 D	18	0.025	7			
BOR 2 E	18	0.035	18			
BOR 3 A	19	0.026	19	83.0 (10.37)	0.028* (0.0072)	0.92 (0.560)
BOR 3 B	15	0.026	3			
BOR 3 C	17	0.040	28			
BOR 3 D	18	0.026	10			
BOR 3 E	14	0.021	20			
BOR 4 A	14	0.018	2	81.0 (12.45)	0.026* (0.0130)	0.17* (0.205)
BOR 4 B	17	0.022	0			
BOR 4 C	20	0.046	4			
BOR 4 D	16	0.031	0			
BOR 4 E	14	0.013	7			
SER 1 A	16	0.077	40	89.0 (7.42)	0.072 (0.0035)	1.67 (0.470)
SER 1 B	20	0.070	29			
SER 1 C	17	0.074	26			
SER 1 D	18	0.068	24			
SER 1 E	18	0.072	28			

[1]Dry 0 dry weight = 0.022 mg; Growth rate = (Final dry weight – 0.022)/28.

Table 10. Continued. An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving Amphipods	Replicate Growth Rate[1] (mg/individual/day)	# Neonates	0 (SD) Treatment Survival (%)	0 (SD) Treatment Growth rate	0 (SD) Treatment Neonates (per survivor)
SER 2 A	18	0.046	39	91.0 (7.42)	0.040 (0.0106)	1.39 (0.516)
SER 2 B	16	0.030	17			
SER 2 C	19	0.039	19			
SER 2 D	18	0.054	30			
SER 2 E	21	0.029	22			
SER 3 A	17	0.060	17	90.0 (5.00)	0.052 (0.0148)	1.01 (0.781)
SER 3 B	19	0.029	14			
SER 3 C	18	0.068	7			
SER 3 D	17	0.049	40			
SER 3 E	18	0.056	11			
SER 4 A	10	0.041	5	82.0 (18.91)	0.032* (0.0089)	0.20* (0.188)
SER 4 B	18	0.022	0			
SER 4 C	17	0.025	4			
SER 4 D	21	0.029	2			
SER 4 E	17	0.041	3			
SER 5 A	10	0.042	0	75.0 (20.00)	0.029* (0.0075)	0.19* (0.196)
SER 5 B	16	0.027	7			
SER 5 C	20	0.025	4			
SER 5 D	17	0.028	0			
SER 5 E	12	0.023	4			

[1]Dry 0 dry weight = 0.022 mg; Growth rate = (Final dry weight – 0.022)/28.

Table 11. Toxicity test summary for the Northeast and Elk Rivers 10-d amphipod *Hyalella azteca* sediment toxicity test conducted 10/16 - 10/26/02. An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving amphipods	0 Mean Rep. dry wt. (mg)	0 (SD) Treatment % Survival	0 (SD) Treatment dry wt. (mg)
Control A	10	0.194	96.3 (7.44)	0.170 (0.0401)
Control B	10	0.172		
Control C	10	0.166		
Control D	10	0.204		
Control E	10	0.175		
Control F	9	0.079		
Control G	10	0.165		
Control H	8	0.204		
ELK 1 A	10	0.205	96.3 (5.18)	0.169 (0.0229)
ELK 1 B	9	0.155		
ELK 1 C	9	0.183		
ELK 1 D	10	0.177		
ELK 1 E	10	0.144		
ELK 1 F	10	0.135		
ELK 1 G	10	0.170		
ELK 1 H	9	0.181		
ELK 2 A	10	0.174	92.5 (10.35)	0.187 (0.0173)
ELK 2 B	7	0.197		
ELK 2 C	9	0.214		
ELK 2 D	10	0.173		
ELK 2 E	9	0.161		
ELK 2 F	9	0.201		
ELK 2 G	10	0.191		
ELK 2 H	10	0.184		
ELK 3 A	9	0.175	92.5 (8.86)	0.182 (0.0125
ELK 3 B	8	0.193		
ELK 3 C	10	0.177		
ELK 3 D	10	0.157		
ELK 3 E	10	0.195		
ELK 3 F	8	0.185		
ELK 3 G	9	0.192		
ELK 3 H	10	0.182		

Table 11. Continued. An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving amphipods	0 Mean Rep. dry wt. (mg)	0 (SD) Treatment % Survival	0 (SD) Treatment dry wt. (mg)
ELK 4 A	11	0.155	98.8 (3.54)	0.179 (0.0208)
ELK 4 B	10	0.174		
ELK 4 C	10	0.174		
ELK 4 D	10	0.167		
ELK 4 E	10	0.169		
ELK 4 F	10	0.169		
ELK 4 G	9	0.215		
ELK 4 H	10	0.206		
NER 1 A	7	0.178	95.0 (10.69)	0.185 (0.0128)
NER 1 B	10	0.205		
NER 1 C	10	0.203		
NER 1 D	10	0.185		
NER 1 E	9	0.171		
NER 1 F	10	0.175		
NER 1 G	10	0.177		
NER 1 H	10	0.189		
NER 2 A	9	0.216	91.3 (6.41)	0.190 (0.0403)
NER 2 B	9	0.228		
NER 2 C	9	0.187		
NER 2 D	10	0.178		
NER 2 E	9	0.196		
NER 2 F	9	0.100		
NER 2 G	8	0.221		
NER 2 H	10	0.192		
NER 3 A	10	0.193	95.0 (5.35)	0.195 (0.0150)
NER 3 B	10	0.173		
NER 3 C	9	0.206		
NER 3 D	9	0.191		
NER 3 E	9	0.182		
NER 3 F	9	0.190		
NER 3 G	10	0.200		
NER 3 H	10	0.222		

Table 11. Continued. An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving amphipods	0 Mean Rep. dry wt. (mg)	0 (SD) Treatment % Survival	0 (SD) Treatment dry wt. (mg)
NER 4 A	10	0.228	96.3 (5.18)	0.202 (0.0205)
NER 4 B	10	0.182		
NER 4 C	10	0.189		
NER 4 D	9	0.185		
NER 4 E	10	0.215		
NER 4 F	10	0.191		
NER 4 G	9	0.233		
NER 4 H	9	0.191		
NER 5 A	9	0.222	95.0 (5.35)	0.216 (0.0123)
NER 5 B	10	0.209		
NER 5 C	9	0.210		
NER 5 D	9	0.191		
NER 5 E	10	0.226		
NER 5 F	9	0.228		
NER 5 G	10	0.224		
NER 5 H	10	0.216		

Table 12. Toxicity test summary for the Northeast and Elk Rivers 28-d amphipod *Leptocheirus plumulosus* sediment toxicity test conducted 10/10- 11/7/02. An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving Amphipods	Replicate Growth Rate[1] (mg/individual/day)	# Neonates	0 (SD) Treatment Survival (%)	0 (SD) Treatment Growth rate	0 (SD) Treatment Neonates (per survivor)
Control A	17	0.046	28	82.0 (7.58)	0.040 (0.0086)	1.18 (0.405)
Control B	16	0.028	16			
Control C	18	0.038	25			
Control D	14	0.037	18			
Control E	17	0.050	10			
ELK 1 A	15	0.049	17	73.0 (25.15)	0.035 (0.0101)	0.72 (0.414)
ELK 1 B	20	0.034	17			
ELK 1 C	10	0.021	16			
ELK 1 D	9	0.037	5			
ELK 1 E	17	0.032	2			
ELK 2 A	5	0.023	1	54.0 (29.45)	0.023* (0.0063)	0.04* (0.089)
ELK 2 B	17	0.020	0			
ELK 2 C	3	0.018	0			
ELK 2 D	14	0.034	0			
ELK 2 E	14	0.021	0			
ELK 3 A	17	0.026	0	64.0 (16.36)	0.023* (0.0084)	0.14* (0.220)
ELK 3 B	10	0.032	5			
ELK 3 C	14	0.011	0			
ELK 3 D	14	0.028	3			
ELK 3 E	9	0.018	0			
ELK 4 A	11	0.018	3	57.0 (14.83)	0.029 (0.0198)	0.60 (0.469)
ELK 4 B	16	0.005	10			
ELK 4 C	12	0.057	0			
ELK 4 D	10	0.038	11			
ELK 4 E	8	0.028	8			
NER 1 A	11	0.014	6	66.0 (15.97)	0.026 (0.0122)	0.64 (0.309)
NER 1 B	15	0.042	13			
NER 1 C	14	0.029	3			
NER 1 D	17	0.030	17			
NER 1 E	9	0.013	5			

[1]Dry 0 dry weight = 0.026 mg; Growth rate = (Final dry weight – 0.026)/28.

Table 12. Continued. An * indicates a treatment significantly < the control (%=0.05).

Treatment Rep	# Surviving Amphipods	Replicate Growth Rate[1] (mg/individual/day)	# Neonates	0 (SD) Treatment Survival (%)	0 (SD) Treatment Growth rate	0 (SD) Treatment Neonates (per survivor)
NER 2 A	14	0.021	0	71.0 (17.82)	0.027 (0.0087)	0.67 (0.693)
NER 2 B	19	0.035	30			
NER 2 C	14	0.016	0			
NER 2 D	9	0.036	10			
NER 2 E	15	0.026	10			
NER 3 A	19	0.034	13	79.0 (20.43)	0.020* (0.0099)	0.45* (0.427)
NER 3 B	20	0.022	0			
NER 3 C	11	0.012	8			
NER 3 D	12	0.009	7			
NER 3 E	17	0.023	0			
NER 4 A	16	0.024	4	78.0 (11.51)	0.022* (0.0036)	0.15* (0.096)
NER 4 B	14	0.016	2			
NER 4 C	19	0.023	4			
NER 4 D	16	0.024	2			
NER 4 E	13	0.025	0			
NER 5 A	20	0.028	15	89.0 (14.75)	0.026 (0.0067)	0.60 (0.286)
NER 5 B	20	0.025	5			
NER 5 C	13	0.015	13			
NER 5 D	19	0.037	10			
NER 5 E	17	0.030	8			

[1]Dry 0 dry weight = 0.026 mg; Growth rate = (Final dry weight – 0.026)/28.

Table 13. Severn River *Cyprinodon variegtus* 7-d short-term chronic *in situ* water column toxicity test results (5/27-6/3/03). An * indicates a treatment significantly < the control (%=0.05).

Treatment rep	# Surviving larvae	0 Rep. Growth[1] dry weight (mg)	0 Rep Biomass[2] dry weight (mg)	0 (SD) Treatment %Survival	0 (SD) Treatment Growth	0 (SD) Treatment Biomass
Ctl (Decorsey) A	10	1.09	1.09	97.5 (5.00)	1.23 (0.107)	1.20 (0.122)
Ctl (Decorsey) B	10	1.34	1.34			
Ctl (Decorsey) C	9	1.23	1.11			
Ctl (Decorsey) D	10	1.27	1.27			
Back Creek A	10	1.37	1.37	100.0 (0.00)	1.30 (0.137)	1.30 (0.134)
Back Creek B	10	1.38	1.38			
Back Creek C	10	1.35	1.35			
Back Creek D	10	1.10	1.10			
Severn River A	9	1.01	0.91	97.5 (0.00)	1.11 (0.091)	1.09 (0.132)
Severn River B	10	1.16	1.16			
Severn River C	10	1.06	1.06			
Severn River D	10	1.21	1.21			
Ctl Day 0 A	10	0.67			0.65 (0.025)	
Ctl Day 0 B	10	0.63				
Ctl Day 0 C	10	0.64				
Ctl Day 0 D	10	0.68				

[1]Growth = replicate dry weight/number of fish alive at end of test.
[2]Biomass = replicate dry weight/number of fish at start of test.

Table 14. Summary of toxicity hits from the Bohemia , Severn, Elk, and Northeast River sediment toxicity tests. Value is the percent reduction from the control treatment for each specific endpoint that showed a significant hit (%=0.05).

River & Station	*H. azteca* 10 day		*L. plumulosus* 28 day		
	Survival	Weight	Survival	Growth Rate	Reproduction
Bohemia River 1					
Bohemia River 2				37.7%	
Bohemia River 3				47.2%	
Bohemia River 4				50.9%	87.1%
Severn River 1		26.9%			
Severn River 2					
Severn River 3					
Severn River 4		15.4%		39.6%	84.7%
Severn River 5		15.4%		45.3%	85.5%
Elk River 1					
Elk River 2				42.5%	97.0%
Elk River 3				42.5%	88.1%
Elk River 4					
Northeast River 1					
Northeast River 2					
Northeast River 3				50.0%	61.9%
Northeast River 4				45.0%	87.3%
Northeast River 5					

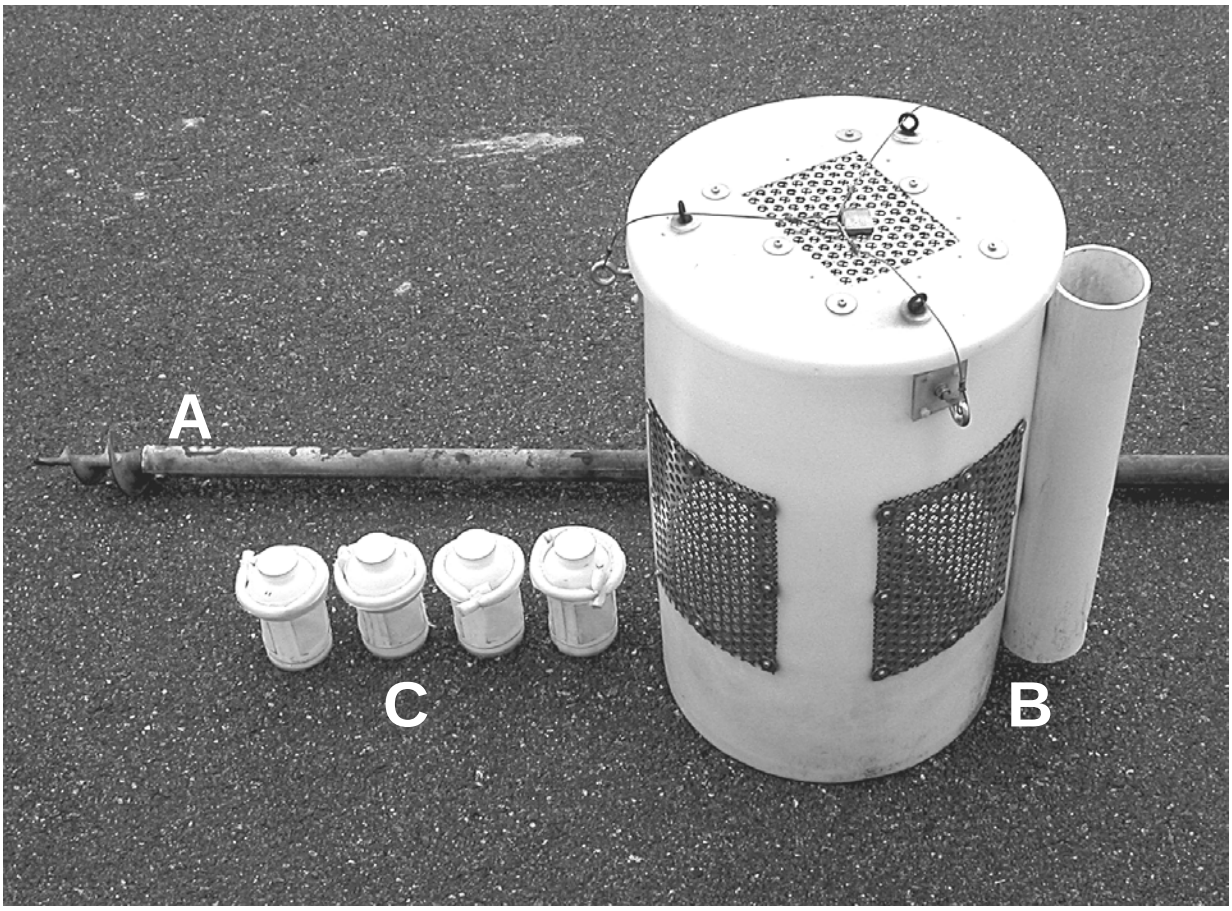

Figure 1. Cage system for *in situ* larval fish exposures: (A) Cage attachment pole with auger, (B) Outer protective cage (750 cm X 480 cm), and (C) Fish larvae baskets (1 L).

Appendix B

Using sediment quality triad to characterize toxic conditions in the Chesapeake Bay. Data summary report (Ashley and Velinsky 2004)

APPENDIX B

USING SEDIMENT QUALITY TRIAD TO CHARACTERIZE

TOXIC CONDITIONS IN THE CHESAPEAKE BAY

CB-98-3683-01-0

DATA SUMMARY REPORT

Updated: March 10, 2004

FINAL

Project Officers: **Jeffrey Ashley, David Velinsky**
Patrick Center for Environmental Research
Academy of Natural Sciences
1900 Benjamin Franklin Parkway
Philadelphia, PA 19144

Submitted to: **Kelly Eisenman, US EPA**
Beth McGee, US FWS
Dan Fisher, UM

DATA SUMMARY REPORT The following report summarizes the results of the chemical analyses performed for project CB-98-3683-01-0 entitled "**Using the Sediment Quality Triad and Integrative Water Sampling Devices to Characterize Chemical Contaminant Impacts in Chesapeake Bay Tributaries**". The report also summarizes the results of the quality assurance and control measures that were followed for sediment chemical/physical analysis and water column trace metal analysis. Table 1 outlines the parameters measured for this study and Appendices I, II, and III tabulate sampling stations, concentrations of all analytes, and polychlorinated biphenyl (PCB) homologue groups, respectively.

Sampling Summary
Sediment samples were collected by US FWS and ANSP personnel in mid-September of 2002 (Appendix I). Multiple surface sediment samples (petite-ponar) were taken from the Severn, Northeast, Bohemia, and Elk rivers. Multiple grabs were composited in a pre-cleaned mixing bowl and divided into pre-clean (certified) glass jars, plastic bags and tubes for chemical analysis. Data are presented in Appendices I, II and III with quality control data following.

Water samples for dissolved trace metals (< 0.45 μm) were collected in June of 2003 (Appendix I) by ANSP personnel. Water samples were collected using an all Teflon pumping system from just below the water surface (ca. 0.2-0.3m). Data are presented in Appendix I and IV with quality control data following.

I. Organic Contaminants:

a) Extractions and Analyses:

Sediment samples were frozen and stored until extraction. Samples were thawed and homogenized using a stainless steel spatula prior to sub-sampling. A 9-12 g sub-sample of wet sediment was used for organic contaminant analysis. Approximately 30 g of Na_2SO_4 (previously Soxhlet extracted with hexane and dried) was added to the sub-sample to eliminate water. The mixture was transferred into a mortar and ground with a pestle. The dried sample was placed in a glass thimble and was Soxhlet extracted with ca. 200 mL dichloromethane (DCM) for 18 hours.

Liquid-solid chromatography using alumina as the stationary phase was used as a clean-up step prior to PAH and PCB analysis. The collected eluate was concentrated by evaporation under a N_2 stream and analyzed for PAHs before a further clean-up procedure using florisil. PCBs (as well as heptachlor, nonachlors, and DDEs) were eluted from a column containing florisil using petroleum ether. The remaining organochlorine pesticides were eluted using 50:50 petroleum ether and dichloromethane.

Activated elemental copper wool was used to remove elemental sulfur which interferes with the detection of PCB congeners when using an electron capture detector. Prior to use, the copper

was washed by 10% HCl and rinsed with dichloromethane. The cleaned copper (0.5 - 1 g) was exposed to each sample during extraction and subsequently turned black in those samples solutions containing sulfur due to the formation of CuS. Additional copper was added to each auto sampling vial prior to instrumental analysis.

Congener specific PCBs and organochlorine pesticides (Table 1) were analyzed using a Hewlett Packard 5890 gas chromatograph equipped with a ^{63}Ni electron capture detector and a 5% phenylmethyl silicon capillary column. The identification and quantification of PCB congeners followed the '610 Method' described by Swackhamer (1987) in which the identities and concentrations of each congener in a mixed Aroclor standard (25:18:18 mixture of Aroclors 1232, 1248 and 1262) were determined by calibration with individual PCB congener standards. Congener identities in the sample extracts were based on their chromatographic retention times relative to the internal standards added. In cases where two or more congeners could not be chromatographically resolved, the combined concentrations were reported (Table 1). Organochlorine pesticides (OCPs) were identified and quantified based on comparisons (retention times and peak areas) with a known calibration standard prepared from individual compounds.

Polycyclic aromatic hydrocarbons (Table 1; Appendix I) were identified and quantified using a capillary gas chromatograph (Hewlett Packard 5890) and a mass spectrometer (HP 5989A) operated in selected ion monitoring mode (United States Department of Agriculture, Beltsville, MD). Each PAH was identified by its retention time relative to the retention time of mixed standards (Accustandard), and this identification was confirmed by the abundance of a secondary mass fragment relative to the molecular ion. Internal standards were added to all the samples and calibration standards prior to instrumental analysis: 2,3,6-trichlorobiphenyl (PCB#30) and 2,2',3,4,4',5,6,6'-octachlorobiphenyl (PCB#204) for PCBs, and d_8-napthalene,d_{10}-fluorene, d_{10}-fluoranthene and d_{12}-benzo[*g,h,i*]perylene for PAHs.

b) Analytical Quality Assurance:

Analyte loss through analytical manipulations was assessed by the addition of surrogate PCB congeners 14, 65 and 166, and perdeuterated PAHs (d_{10}-phenanthrene and d_{10}-anthracene) prior to extraction by Soxhlet apparatus. These surrogates are not present in the environment. Average recoveries of congeners 14, 65 and 166 were 85 ± 6%, 92 ± 11% and 89 ± 6% (see individual recoveries in Appendix II) . Recoveries of d_{10}-phenanthrene and d_{10}-anthracene were 97 ±14% and 102 ± 16%, respectively (see individual recoveries in Appendix II). Due to the high recoveries of all surrogates and the low standard deviations arising from each, reported values of organic contaminant concentrations in this study <u>were not</u> corrected for analyte loss.

Laboratory blanks were generated to monitor possible laboratory contamination and to assess the blank-based (or matrix based) detection limits for individual PAHs (Table 2a), individual PCB congeners (Table 2b) and individual organochlorine pesticides (Table 2c). Matrix blanks consisting of approximately 30 g of clean Na_2SO_4 were analyzed using the same procedures as

the samples. In the quantification of each analyte, the method detection limit (MDL) was estimated as the sum of the average peak area of the matrix blanks and three standard deviations.

The blank-based detection limits for PAHs, detection limits ranged from 0.86 ng/g dry wt (o-terphenyl) to 127 ng/g dry wt (1,2,3,4-dibenzanthracene) (Table 2a). The blank-based detection limits for PCBs (Table 2b) and OCPs (Table 2c) ranged from to 0.01 ng/g dry wt (PCB congener 209) to 2.36 ng/g dry wt (PCB congener 64) and from 0.15 ng/g dry wt (o,p-DDE) to 5.90 ng/g dry wt (endrin), respectively. Most individual analyte concentrations for actual samples were well above detection limits. However, some concentrations fell below detection limits (designated BDL in Appendix II) while only a few were routinely not detected at all (designated ND in Appendix II).

A NIST standard reference material (SRM #1944a; New York/New Jersey Waterway Sediment) was used to evaluate extraction efficiency and overall analytical accuracy. A percent recovery was calculated by dividing the recovered concentration obtained in our laboratory by the reported value published by NIST, expressed as a percentage. PAH (n=3) and PCB/OCP (n=3) values were compared to reported NIST values (Tables 3a to c). Analyte recoveries for PAHs ranged from 52% to 158 % (Table 3a), with the majority of concentrations falling within 20% of the NIST values. The mean recovery for PAHs was 93 ± 27%. Considering analyte loss through sample extraction and preparation, the range and variability of these recoveries is well within that expected for PAH analysis.

For PCBs (Table 3b), recoveries ranged from 19 to 110%, with most values falling short of those reported by NIST. The mean recovery for PCBs was 55 ± 23%. Considering the average PCB surrogate recovery was 63% (for these SRM extractions) and that some discrepancies exist between which congeners are quantified and ultimately reported (e.g., co-eluting versus non-co-eluting), PCB recoveries suggest a reasonable degree of accuracy in PCER ability to quantify PCBs.

NIST reports the concentrations of only six OCPs in their SRM 1944 as opposed to the 21 OCPs quantified in this study. Recoveries for lindane, alpha chlordane, o,p-DDD, p,p-DDD, and pp-DDT were 116%, 68%, 89%, 101%, and 89%, respectively (Table 3c). The recoveries for gamma chlordane were large (309%). Values this high usually indicate one of two things: a problem with the concentration value assigned for that analyte in the calibration standard or a problem with the ability to resolve that analyte without interference using the analytical instrumentation.

As an additional quality assurance process to resolve the discrepancy in gamma chlordane concentrations within SRMs, our laboratory recently completed (October, 2003) the analysis of NIST SRM 1946 Lake Superior Fish Tissue (Table 4) . Using the same calibration standard as was used in this study, the recovery for gamma chlordane was 105% of that reported by NIST. Based on this, it is suggested that the calibration standard concentration was correct and that matrix interference may be the likely cause of enhanced gamma-chlordane concentrations in SRM 1944a (Table 3c). It is likely that matrix interferences in the sediment SRM would occur in actual sediment samples as well. However, the majority of samples had concentrations well below those found in the SRM.

To assess precision of the organic contaminant analyses, sample duplicates of two randomly selected samples (SER1 and NER3), and a triplicate analysis (ELR3) were performed (Table 5). The mean RPDs between duplicate samples for individual PAHs were reported as 24% (SER1) and 12% (NER3) (Table 5a) . For individual PCBs, mean RPD values for SER1 and NER3 were 24% and 12%, respectively (Table 5b). For individual DDXs and individual chlordanes, mean RPDs of 21 and 22% (SER1), and 28 and 23% (NER3) were reported (Table 5c). The triplicate analysis of sample ELR3 reveals a similarly high degree of precision, with average relative standard deviations (RSDs) for individual PAHs, PCBs, DDXs and chlordanes being reported as 15, 18, 12, and 20%, respectively. The low RPDs and RSDs reported in the duplicate and triplicate analysis in this study exemplify ANSP's high degree of precision in determining concentrations of organic contaminants.

Rather than compare RPDs and RSDs on a individual basis, total PAHs, total PCBs, total DDXs and total chlordanes were calculated and the RPDs and RSDs resulting from this were calculated (Table 6). RPDs ranged from 1 to 19% whereas RSDs ranged from 11 to 19%. These results again show a very high degree of analytical precision in the determination of total values for PAHs, PCBs, DDXs and chlordanes.

II. Trace Metals and Acid Volatile Sulfur Sedimentary Metals

a) Sediment Digestions and Elemental Analyses

Trace metals in sediments were determined using a "total" acid digestion with 10 mL HNO_3, 2 ml HCl, and 5 ml HF on 0.2 g dry sediment in an open Teflon beaker. The sample was digested to near dryness, digested with an additional 2 ml $HCLO_4$ to near dryness and dissolved in 0.5% HNO_3. Iron (Fe), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn) were analyzed by flame atomic absorption spectrophotometry (FLAAS), using a Perkin Elmer 5100 ZL; aluminum (Al) and chromium (Cr) were analyzed by inductively coupled plasma-mass spectrometer (ICP-MS) using a Perkin Elmer Elan 6100 ICP-MS; Cd was analyzed by graphite furnace atomic absorption spectrophotometer using a Perkin Elmer 5100 ZL. For mercury (Hg) analysis, reductive flow injection analysis (FIA) was used, using the ICP-MS as the detector.

For arsenic (As) analysis, two ml aliquots of the original digest were taken to near dryness and redissolved in 10% HCl. Arsenic was analyzed by hydride generation coupled to a cryogenic trap system (Braman et al, 1977) using a hydrogen-burning quartz cuvette in an atomic absorption spectrophotometer (Perkin Elmer 2380) as a detector (Andreae, 1977). For selenium (Se) analysis, 2-3 ml aliquots of the original digests were digested in 4 N HCl with $K_2S_2O_8$ to convert all Se to selenite, and analyzed using a hydrogen-burning quartz cuvette in an atomic absorption spectrophotometer (Perkin Elmer 2380) as a detector (Cutter 1978; 1983). Selenium in the sediments was not part of the original scope of work. Final trace metal data are shown in Appendix II.

b) Analytical Quality Assurance

Calibration blanks, sample duplicates, and instrument duplicates were analyzed to insure instrument performance and accuracy. Sample blanks, duplicates, spikes, serial dilutions, and NIST Standard Reference Materials (1646- Estuarine Sediment, MESS-2) were digested with the samples to insure adequate recoveries and assess accuracy of analysis.

The limits of detection and blank concentrations for trace metals were summarized (Table 2d to f). To assess precision, replicate analyses were conducted and the results summarized (Table 7). The relative percent differences (RPD) for instrument duplicates were below 8% for all parameters. Sample duplicate analysis of four samples yielded RPDs that ranged from < 1 to 13% except for Cu in one sample (ID 9169; ELR4) which exhibited a RPD of 86% (Table 7). Sample spike recoveries were between 38-111% of the added concentrations (Table 8). Cr recoveries were low at 70% of the added spike. It should be noted that recoveries of Cr from the NIST sample (see below) were better with a recovery of certified value of 85%. Al recoveries were also low, with both spiked samples yielding recoveries of 36% and 43%, presumably due to this digestion technique. Therefore, Al concentrations determined in this study should be considered only a portion of the total Al within the sediments. Total sedimentary Se could not be analyzed as part of this project (note: not part of proposal) due to equipment failure.

Recoveries for NIST SRM 1646 Estuarine Sediment analysis were compared to the certified values obtained using total sediment digestion techniques and were and ranged from 77 to 96% of the reported concentration for all elements, with the average recovery being 89±6% (Table 9). Al recoveries, in contrast to the spiked samples, were excellent (96%), perhaps suggesting differences in sedimentary metal bonding between the SRM sediment matrix and the sample matrix.

For As analysis by hydride generation-AAs, four process blank samples were prepared. These blanks contained no As but were processed by identical means to actual samples. These blanks averaged 0.04 ± 0.41 :g/L as dissolved arsenic. Assuming a 10 ml sample volume and 0.22 g dw sample weight (the average), this corresponds to 0.002 ± 0.019 :g/g dw. Two samples were spiked for recovery determination, with recoveries of 102 and 90% for samples 9159 and 9169, respectively. NIST SRM 1646 was also digested for hydride-generated AAs. The certified value for As is 11.6 ± 1.3 :g/g dw; our measured value was close at 10.3 :g/g dw, the percent recovery being 89 % (Table 9), the duplicate analyses for As were within 8% (Table 7).

AVS and SEM

Acid volatile sulfur was analyzed via acid distillation under N_2 and specific ion probe detection of the resultant HS^-. Recoveries of sulfide spikes were excellent, averaging 88.6 ± 20 % (n=6) driven in large part due to one low recovery (56%). Duplicate AVS analysis of three samples (9160, 9169, 9159) yielded RPDs of 13, 15, and 111%, respectively. However, sample 9159 had much lower AVS concentrations than the other duplicated samples (0.58 :mole S/g wet wt.), resulting in a relatively high RPD (Table 7).

The leachate from the AVS analysis was filtered and analyzed for a number of trace metals and metalloids. Spike sample recoveries showed a relative percent difference of 65 % with an

average recovery of 82% (n=2, Table 8). The high RPD of spike samples is due to the interactions of dissolved sulfide with other mineral phases within the sample such as iron oxides. Duplicate analyses of samples were performed on random samples and analytes. The RPDs for duplicates ranged from <7% except for SEM-Cu in which the RPD was 13%. Instrument duplicates were generally below 5% RPD (Table 7).

Water Column Metals

a) Water Digestions and Elemental Analyses

Samples for Al, Cd, Cu, Ni, Pb and Zn in all the sites except the Severn River were analyzed by direct ICP-MS using a Perkin-Elmer Elan 6100 ICP-MS. Samples from the Severn River could not be determined directly because of interferences from the salt matrix (2 to 10 ‰ salinity). Severn River samples for Al, Cd, Cu, Ni, Pb and Zn were concentrated using an APDC/NaDDDC - chloroform extraction (Bruland et al. 1979; Nolting and de Jong, 1994) into dilute HNO_3 and determined by ICP-MS. Cr in all water samples were analyzed using by ICP-MS using Dynamic Reaction Cell (DRC) technology, with NH_3 as the reaction gas (Nixon et al., 2002). In the Severn River samples Cr was determined by ICP-MS, using the DRC, and standards made in clean seawater (NASS-4) diluted to the same salinity as the Severn River. Total Hg was analyzed by digestion with BrCl, and analyzed by cold vapor trapping (Bloom and Fitzgerald, 1988) using ICP-MS as the detector.

Total arsenic and selenium, done separately, in all samples was determined by hydride generation, cryogenic trap, chromatographic separation atomic absorption spectrophotometry, using a Perkin Elmer 2380 Atomic Absorption spectrophotometer (Andreae 1977; Braman et al. 1977). Samples for total Se were digested using potassium persulfate and analyzed by hydride generation, cryogenic trap, chromatographic separation atomic absorption spectrophotometry, using a Perkin Elmer 2380 atomic absorption spectrophotometer (Cutter, 1978; Cutter 1983). Dissolved As was additionally analyzed into various inorganic and organic fractions, which were not part of the original scope of work (i.e., proposal).

b) Water Chemistry: Analytical Quality Assurance

Along with samples, blank, spikes, field duplicate samples and Standard Reference Materials (SRMs) were analyzed with each batch of samples (Tables 10-12). Values for all elements using direct ICP-MS analysis, and for hydride generation (As and Se) and cold vapor (Hg) analyses. Cd, Cr, Cu, Ni, Pb and Zn for Severn River samples are discussed separately below. Generally, the QA/QC values were within the desired limits, with the following exceptions. For Se, the RPD for and the repeatability of the spike was rather high (20 and 21% respectively). This was due to the sample and spike concentrations were somewhat low, and there was accordingly significant variability. The filter blank for Zn is high (0.73 :g/L), and the SRM is high (1.35 measured versus 0.93 :g/L expected). This probably reflects contamination, and repeated analyses of the sample did not improve them.

QA/QC values for the extracted water samples from the Severn River are reported in Tables 10-12. The extracted filter blank for Zn was high, although acceptable, given the concentrations measure in the samples. SRM values were, for Cd, high, the values for Cu, Ni, Pb are low, the values for Ni are low, and the value for Zn is high. Recoveries of spiked samples ranged from 70 to 100%. Reproducibility of duplicate samples was generally acceptable for most elements, although Cd and Pb were rather high, but each were affected by one high sample out of four replicates (the same sample) which suggests contamination. With this sample eliminated the RPDs would be 14.3 and 2.6% respectively.

III. Grain Size

Sediment samples were analyzed for the amount of sand, silt and clay material (Folk, 1974). Grain size ranged from 0 to 3.8 % gravel, 1.5 to 43.5 % sand, 26.4 to 61.0% silt, and 14.3 to 57.1 % clay (Table 13). The amount of fine grain material (< 63 μm fraction) ranged from 1 to 44% with higher amounts of clay+silt at BOR (0 = 26%) compared to the other locations (ca. 0 = 13 to 15%). Three samples were analyzed in duplicate, with RPDs ranging from 0 to 34% (Table 13).

IV. Organic Carbon and Total Nitrogen

The sediments were analyzed for total carbon and nitrogen. Samples were treated in a desiccator with fuming HCL to remove any inorganic carbon prior to analysis on CE Flash 1112 high temperature combustion analyzer (Table 14). Blanks were analyzed and generally contained carbon and nitrogen below the detection limit. Aspartic acid was used as a primary standard and NIST standard reference materials (SRM 2704 for carbon; SRM 1570a for nitrogen) were analyzed in each analytical batch (*i.e.*, each day of analysis). There was good agreement between the NIST values and those obtained through this study. Organic carbon recoveries of NIST sediment were 96 ± 3% (n = 4) and for total nitrogen recoveries of NIST sediment were 86 ± 4% (n=4). Each sample was analyzed in duplicate and the average RPD values for all samples were <7% for organic carbon and < 5% for total nitrogen (including sample with higher RPD; Table 11). Sample BOR4C (9165) had substantially higher RPD (ca. 25%; Table 14). This sample was re-run and results did not improve. The low content of carbon and nitrogen is the most likely cause of the higher RPD.

V. Percent Water

Sub-samples (~5 g) were taken to measure water content. These sub-samples were weighed and allowed to dry at 100EC for 24 hours, cooled to room temperature in a desiccator, and reweighed to ± 0.001 g. Percent water ranged from 48 to 83% water with an overall average of 63% (Table 15).

VI. Porewater NH_4 + NH_3 (i.e., ammonium)

Porewater from each sediment sample was centrifuged and filtered after collection and storage (-4^{o}C). Dissolved ammonium+ammonia were determined using the indophenol method (ASTM, 1984; US EPA 1983) using an Alpkem Autoanalyzer (RFA 300) and the manufacturer's operating parameters. The water was then analyzed for concentrations of NH_4+NH_3 (i.e., ammonium) using a modified indophenol. Porewater ammonium concentrations ranged from 1.7 to 13.3 mg N/L. Analysis of reference standards for ammonium resulted in recoveries of 104 to 113% (average of 107%) and reagent blanks averaged < 0.01 mg N/L (Table 1). Duplicate analyses produced RPDs were less than 2% (n = 2) while spike recoveries ranged from 86 to 93% (Table 16).

References

American Society for Testing and Materials. (1984). Annual Book of ASTM Standards, Vol 11.01, Standard Specification for Reagent Water, D 1193-77 (reapproved 1983). ASTM, Philadelphia, PA.

Andreae, M.O. 1977. Determination of arsenic species in natural waters. *Analytical Chemistry* 49:820-823.

Bloom, N. and W.F. Fitzgerald. 1988. Determination of volatile mercury species at the picogram level by low-temperature gas chromatography with cold vapour atomic fluorescence detection. *Anal. Chim. Acta* 208:151-161.

Braman, R.S., D.L. Johnson, C.C. Foreback, J.M. Ammons, and J.L. Bricker. 1977. Separation and determination of nanogram amounts of inorganic arsenic and methylarsenic compounds. *Anal. Chem*. 49: 621-625.

Bruland, K.W., R.P. Franks, G.A. Knauer and J.H Martin. 1979. Sampling and analytical methods for the determination of copper cadmium, zinc and nickel at the nanogram per liter level in seawater. *Anal. Chim Acta*. 105:223-245.

Cutter, G.A. 1978. Species determination of selenium in natural waters. *Anal. Chim. Acta* 98: 59-66.

Cutter, G. A. 1983. Elimination of nitrite interference in the determination of selenium by hydride generation. *Anal. Chim. Acta*. 149:391-394.

Di Toro D.M., J.D. Mahony, D.J. Hansen, K.J. Scott, A.R. Carlson and G.T. Ankley. 1992. Acid volatile sulfide predicts the acute toxicity of cadmium and nickel in sediments. *Environ. Sci. Technol.* 26:96-101.

Folk, R.L. (1974). *Petrology of Sedimentary Rocks*. Hemphill Publ. Co. Austin TX. 182pp.

National Oceanographic and Atmospheric Administration (1985). Standard Analytical Procedures of the NOAA National Analytical Facility, 1985-1986; Extractable Toxic Organic Compounds. NOAA Tech. Memo. NMFS F/NWC-92. 121pp.

Nixon, D.E., J. Butz, S.J. Eckdahl, MF. Burit and K.R. Neighbauer. 2002. Determination of chromium in serum and urine. PerkinElmer Instruments, Shelton Connecticut

Nolting, R. F. and J. T. M. de Jong. 1994. Sampling and analytical methods for the determination of trace elements in surface seawater. International Journal of Environmental Analytical Chemisty 57:189-196.

Smoley, C.K. 1992. Methods for the Determination of Metals in Environmental Samples. EMSL/ORD U.S. Environmental Protection Agency, Cincinnati, Ohio, CRC Press, Inc.

Swackhamer, D.L. 1987. Quality Assurance Plan for Green Bay Mass Balance Study - PCBs and Dieldrin. U.S. Environmental Protection Agency, Great Lakes National Program Office.

United States Environmental Protection Agency (US EPA). 1983. Methods for chemical analysis of water and wastes. EPA 600/4 79 020, U.S. EPA, Washington D.C.

US EPA. 1992. Methods for the Determination of Chemical Substances in Marine and Estuarine Environmental Matrices-2nd Edition. US Environmental Protection Agency, EPA 600/R-97/072, Washington DC.

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Table1. List of Sediment and Water Column Analytes

POLYCYCLIC AROMATIC HYDROCARBONS	POLYCHLORINATED BIPHENYLS		ORGANOCHLORINE PESTICIDES	SIMULTANEOUSLY EXTRACTABLE METALS
2-Methylnaphthalene	PCB 1	PCB 85	opDDE	Copper
Azulene	PCB 3	PCB 136	ppDDE	Chromium
1-Methylnaphthalene	PCB 4+10	PCB 77+110	op DDT	Zinc
Biphenyl	PCB 7	PCB 82	pp DDT	Nickel
Acenaphthylene	PCB 6	PCB 151	o,p DDD	Lead
Acenaphthene	PCB 8+5	PCB 135+144	p,p DDD	Cadmium
Fluorene	PCB 19	PCB 107	alpha BHC	
1-Methylfluorene	PCB 12+13	PCB 149	beta BHC	
Phenanthrene	PCB 18	PCB 118	delta BHC	
Anthracene	PCB 17	PCB 134	lindane	
o-Terphenyl	PCB 24+27	PCB 131	heptachlor	**SEDIMENTARY METALS**
2-Methylphenanthrene	PCB 16+32	PCB 146	heptachlor epoxide	Arsenic (III+V)
2-Methylanthracene	PCB 29	PCB 153+132+105	oxychlordane	Dimethyl Arsenic
1-Methylanthracene + 1-Methylphenanthrene	PCB 26	PCB 141	gamma chlordane	Total Arsenic
9-Methylanthracene	PCB 25	PCB 137+176	alpha chlordane	Cadmium
3,6-dimethylphenanthrene	PCB 31+28	PCb 163+138	cis nonachlor	Chromium
Flouranthene	PCB 53+33+21	PCB 158	trans nonachlor	Aluminum
Pyrene	PCB 22	PCB 129+178	dieldrin	Iron
9,10-Dimethylanthracene	PCB 45	PCB 187+182	endrin	Copper
2,3-Benzofluorene	PCB 46	PCB 183	aldrin	Zinc
Benzo(a)anthracene	PCB 52	PCB 128	endosulfan I	Nickel
Chrysene + Triphenylene	PCB 49	PCB 185	endosulfan II	Lead
Benzo(b)fluoranthene	PCB 47	PCB 174		Mercury
7,12-Dimethylbenz(a)anthracene	PCB 48	PCB 177		
Benzo(k)fluoranthene	PCB 44	PCB 202+171		
Benzo(e)pyrene	PCB 37+42	PCB 157+200		
Benzo(a)pyrene	PCB 41+71	PCB 172+197		**ANCILLARY PARAMETERS**
Perylene	PCB 64	PCB 180		Grain Size
3-Methylcholanthrene	PCB 40	PCB 193		Percent Water
Ideno(1,2,3-cd)pyrene	PCB 100	PCB 191		Total Carbon
1,2,3,4-Dibenzanthracene	PCB 63	PCB 199		Total Nitrogen
Benzo(g,h,i) perylene	PCB 74	PCB 170+190		Pore Water Ammonia
Anthanthrene	PCB 70+76	PCB 198		Acid Volatile Sulfur
Coronene	PCB 66	PCB 201		
	PCB 95	PCB 203+196		
	PCB 91	PCB 189		
	PCB 56+60	PCB 208+195		
	PCB 101	PCB 207		
	PCB 99	PCB 194		
	PCB 83	PCB 205		
	PCB 97	PCB 206		
	PCB 87+81	PCB 209		

Table 2. Limits of Detection and Blank Concentrations: Organic Contaminants and Trace Metals

Compound	BLK 040703 ng	BLK 040902 ng	BLK 041103 ng	average ng	stdev ng	(LOD) ng
a) POLYCYCLIC AROMATIC HYDROCARBONS						
2-Methylnaphthalene	1.26	1.14	2.70	1.70	0.86	**4.29**
Azulene	0.40	0.84	0.62	0.62	0.22	**1.28**
1-Methylnaphthalene	0.53	3.18	2.51	2.07	1.37	**6.19**
Biphenyl	0.46	0.97	0.71	0.71	0.25	**1.47**
Acenaphthylene	0.58	1.21	0.88	0.89	0.32	**1.84**
Acenaphthene	0.85	1.79	1.30	1.31	0.47	**2.72**
Fluorene	1.90	2.60	0.73	1.74	0.95	**4.58**
1-Methylfluorene	0.85	0.99	0.89	0.91	0.08	**1.14**
Phenanthrene	2.13	1.91	0.79	1.61	0.72	**3.76**
Anthracene	1.76	2.12	1.78	1.89	0.20	**2.49**
o-Terphenyl	0.64	0.75	0.67	0.69	0.06	**0.86**
2-Methylphenanthrene	0.79	0.93	0.83	0.85	0.07	**1.06**
2-Methylanthracene	1.49	1.75	1.56	1.60	0.13	**2.00**
1-Meanthracn + 1-Mephenanthrn	0.65	0.76	0.68	0.70	0.06	**0.87**
9-Methylanthracene	1.05	1.23	1.10	1.13	0.09	**1.41**
3,6-dimethylphenanthrene	1.85	0.21	3.60	1.89	1.70	**6.97**
Flouranthene	3.46	0.98	2.63	2.35	1.26	**6.14**
Pyrene	0.74	0.79	0.04	0.52	0.42	**1.79**
9,10-Dimethylanthracene	3.05	3.27	3.69	3.34	0.32	**4.30**
2,3-Benzofluorene	13.03	1.56	1.76	5.45	6.57	**25.15**
Benzo(a)anthracene	656.43	31.13	33.80	32.47	1.88	**38.11**
Chrysene + Triphenylene	339.85	1.66	1.87	1.76	0.15	**2.22**
Benzo(b)fluoranthene	27.88	29.43	32.41	30.92	2.11	**37.26**
7,12-Dimethylbenz(a)anthracene	16.28	17.38	0.55	8.96	11.90	**44.67**
Benzo(k)fluoranthene	7.18	7.67	8.62	8.14	0.67	**10.16**
Benzo(e)pyrene	3.23	3.46	3.90	3.68	0.32	**4.63**
Benzo(a)pyrene	2.10	2.25	2.54	2.39	0.21	**3.01**
Perylene	1.83	1.95	0.36	1.38	0.88	**4.03**
3-Methylcholanthrene	55.15	58.18	63.99	61.08	4.11	**73.42**
Ideno(1,2,3-cd)pyrene	73.61	76.90	34.70	55.80	29.84	**145.31**
1,2,3,4-Dibenzanthracene	48.43	51.03	4.15	27.59	33.15	**127.03**
Benzo(g,h,i) perylene	18.40	19.58	0.44	10.01	13.53	**50.60**
Anthanthrene	69.21	70.30	55.25	62.78	10.65	**94.71**
b) POLYCHLORINATED BIPHENYLS						
Congener(s)	**BLK 040703 ng**	**BLK 040902 ng**	**BLK 041103 ng**	**average ng**	**stdev ng**	**(LOD) ng**
PCB 1	0.21	0.65	0.62	0.49	0.25	**1.23**
PCB 3	0.87	0.04	1.40	0.77	0.68	**2.82**
PCB 4+10	0.13	0.13	0.09	0.12	0.02	**0.18**
PCB 7	0.05	0.05	0.05	0.05	0.00	**0.06**
PCB 6	0.06	0.11	0.06	0.08	0.03	**0.16**
PCB 8+5	0.21	0.18	0.19	0.19	0.01	**0.23**
PCB 19	0.11	0.07	0.06	0.08	0.03	**0.16**
PCB 12+13	0.04	0.04	0.04	0.04	0.00	**0.04**
PCB 18	0.04	0.04	0.02	0.03	0.01	**0.07**
PCB 17	0.04	0.04	0.04	0.04	0.00	**0.04**
PCB 24+27	0.36	0.31	0.23	0.30	0.07	**0.50**
PCB 16+32	0.14	0.08	0.08	0.10	0.03	**0.20**
PCB 29	0.12	0.09	0.10	0.10	0.02	**0.16**

Table 2. Limits of Detection and Blank Concentrations: Organic Contaminants and Trace Metals

Compound	BLK 040703 ng	BLK 040902 ng	BLK 041103 ng	average ng	stdev ng	(LOD) ng
PCB 26	0.05	0.05	0.05	0.05	0.00	**0.05**
PCB 25	0.08	0.06	0.05	0.06	0.02	**0.12**
PCB 31+28	0.28	0.19	0.13	0.20	0.08	**0.43**
PCB 53+33+21	0.08	0.10	0.10	0.09	0.01	**0.13**
PCB 22	0.23	0.23	0.20	0.22	0.02	**0.27**
PCB 45	0.03	0.05	0.04	0.04	0.01	**0.08**
PCB 46	0.05	0.07	0.08	0.07	0.02	**0.12**
PCB 52	0.14	0.15	0.17	0.15	0.01	**0.19**
PCB 49	0.19	0.12	0.13	0.15	0.04	**0.26**
PCB 47	1.17	0.97	0.85	1.00	0.16	**1.49**
PCB 48	0.07	0.05	0.03	0.05	0.02	**0.10**
PCB 44	0.05	0.08	0.09	0.07	0.02	**0.13**
PCB 37+42	0.07	0.06	0.12	0.08	0.03	**0.17**
PCB 41+71	0.20	0.18	0.17	0.18	0.02	**0.24**
PCB 64	0.35	1.35	0.50	0.73	0.54	**2.36**
PCB 40	0.02	0.03	0.06	0.04	0.02	**0.09**
PCB 100	0.05	0.07	0.09	0.07	0.02	**0.13**
PCB 63	0.03	0.11	0.09	0.07	0.04	**0.20**
PCB 74	0.09	0.19	0.04	0.11	0.08	**0.34**
PCB 70+76	0.08	0.11	0.11	0.10	0.02	**0.15**
PCB 66	0.04	0.07	0.06	0.06	0.01	**0.10**
PCB 95	0.04	0.07	0.08	0.06	0.02	**0.13**
PCB 91	0.03	0.04	0.07	0.05	0.02	**0.11**
PCB 56+60	0.18	0.29	0.10	0.19	0.09	**0.47**
PCB 101	0.03	0.05	0.06	0.05	0.01	**0.08**
PCB 99	0.03	0.03	0.04	0.03	0.01	**0.05**
PCB 83	0.02	0.03	0.05	0.03	0.02	**0.08**
PCB 97	0.03	0.04	0.04	0.03	0.00	**0.05**
PCB 87+81	0.06	0.08	0.09	0.08	0.02	**0.12**
PCB 85	0.04	0.04	0.04	0.04	0.00	**0.04**
PCB 136	0.02	0.03	0.04	0.03	0.01	**0.06**
PCB 77+110	0.05	0.07	0.05	0.06	0.01	**0.08**
PCB 82	0.02	0.04	0.05	0.04	0.01	**0.08**
PCB 151	0.04	0.05	0.06	0.05	0.01	**0.08**
PCB 135+144	0.02	0.04	0.05	0.04	0.01	**0.08**
PCB 107	0.02	0.03	0.06	0.04	0.02	**0.09**
PCB 149	0.03	0.09	0.07	0.06	0.03	**0.15**
PCB 118	0.04	0.10	0.08	0.07	0.03	**0.17**
PCB 134	0.13	0.21	0.11	0.15	0.06	**0.32**
PCB 131	0.00	0.01	0.01	0.01	0.00	**0.02**
PCB 146	0.06	0.10	0.08	0.08	0.02	**0.15**
PCB 153+132+105	0.15	0.20	0.14	0.16	0.03	**0.25**
PCB 141	0.03	0.05	0.03	0.04	0.01	**0.07**
PCB 137+176	0.16	0.14	0.20	0.16	0.03	**0.25**
PCb 163+138	0.10	0.12	0.10	0.11	0.01	**0.14**
PCB 158	0.08	0.10	0.09	0.09	0.01	**0.12**
PCb 129+178	0.05	0.05	0.05	0.05	0.00	**0.06**
PCB 187+182	0.05	0.07	0.09	0.07	0.02	**0.13**
PCB 183	0.06	0.07	0.10	0.07	0.02	**0.15**
PCB 128	0.03	0.05	0.04	0.04	0.01	**0.07**
PCB 185	0.05	0.08	0.07	0.06	0.02	**0.11**
PCB 174	0.03	0.03	0.05	0.04	0.01	**0.08**
PCB 177	0.03	0.04	0.10	0.06	0.04	**0.17**

Table 2. Limits of Detection and Blank Concentrations: Organic Contaminants and Trace Metals

Compound	BLK 040703 ng	BLK 040902 ng	BLK 041103 ng	average ng	stdev ng	(LOD) ng
PCB 202+171	0.06	0.03	0.10	0.06	0.04	**0.17**
PCB 157+200	0.04	0.06	0.07	0.06	0.02	**0.10**
PCB 172+197	0.06	0.09	0.04	0.06	0.03	**0.14**
PCB 180	0.06	0.08	0.08	0.07	0.01	**0.10**
PCB 193	0.07	0.06	0.09	0.07	0.01	**0.12**
PCB 191	0.06	0.11	0.09	0.09	0.02	**0.15**
PCB 199	0.07	0.06	0.04	0.06	0.01	**0.10**
PCB 170+190	0.06	0.09	0.13	0.09	0.03	**0.20**
PCB 198	0.04	0.06	0.06	0.05	0.01	**0.09**
PCB 201	0.01	0.09	0.12	0.08	0.06	**0.24**
PCB 203+196	0.09	0.12	0.17	0.13	0.04	**0.26**
PCB 189	0.08	0.15	0.35	0.19	0.14	**0.62**
PCB 208+195	0.07	0.10	0.21	0.13	0.07	**0.35**
PCB 207	0.04	0.05	0.07	0.05	0.02	**0.11**
PCB 194	0.06	0.07	0.08	0.07	0.01	**0.10**
PCB 205	0.03	0.05	0.04	0.04	0.01	**0.06**
PCB 206	0.06	0.11	0.12	0.10	0.03	**0.19**
PCB 209	0.01	0.01	0.01	0.01	0.00	**0.01**

c) ORGANOCHLORINE PESTICIDES

Compound	BLK 040703 ng	BLK 040902 ng	BLK 041103 ng	average ng	stdev ng	(LOD) ng
opDDE	0.04	0.10	0.07	0.07	0.03	**0.15**
ppDDE	0.04	0.04	0.04	0.04	0.00	**0.04**
op DDT	1.19	1.62	2.16	1.65	0.49	**3.11**
pp DDT	1.75	3.39	3.01	2.72	0.86	**5.29**
o,p DDD	0.47	0.47	0.41	0.45	0.04	**0.57**
p,p DDD	0.45	0.46	0.59	0.50	0.08	**0.74**
alpha BHC	1.06	0.74	1.00	0.93	0.17	**1.43**
beta BHC	0.23	0.19	0.39	0.27	0.11	**0.58**
delta BHC	0.67	0.67	0.68	0.67	0.01	**0.70**
lindane	0.87	1.13	1.42	1.14	0.27	**1.96**
heptachlor	0.14	0.20	0.10	0.15	0.05	**0.30**
heptachlor epoxide	0.60	0.97	0.62	0.73	0.21	**1.35**
oxychlordane	0.19	0.57	0.36	0.37	0.19	**0.95**
gamma chlordane	0.48	0.81	0.59	0.63	0.16	**1.12**
alpha chlordane	0.37	0.22	0.43	0.34	0.11	**0.66**
cis nonachlor	0.11	0.16	0.15	0.14	0.03	**0.22**
trans nonachlor	0.07	0.13	0.11	0.10	0.03	**0.18**
dieldrin	NQ	NQ	NQ	NQ	NQ	NQ
endrin	0.67	3.30	1.18	1.72	1.39	**5.90**
aldrin	0.58	0.64	0.77	0.66	0.10	**0.96**
endosulfan I	0.44	0.32	0.82	0.53	0.26	**1.30**
endosulfan II	0.27	0.31	0.52	0.37	0.14	**0.77**

Table 2. Limits of Detection and Blank Concentrations: Organic Contaminants and Trace Metals

d) SEDIMENTARY METALS

Parameter	Units	BLK 022503	BLK 022503	BLK 042303	ReDig Blk 1 BLK 041603	ReDig Blk 2 BLK 042503	ReDig Blk 3 BLK 041603	Mean	Std Dev	Mean	Std Dev	Units
Aslll+V	(ug/L)	0.20	0.25		-0.08	-0.01	0.02	0.08	0.14	0.036	0.07	ug/g dw
DMA	(ug/L)	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.000	0.00	ug/g dw
AsT	(ug/L)	0.20	0.25		-0.08	-0.01	0.02	0.08	0.14	0.036	0.07	ug/g dw
Cd	(ug/L)	0.00	-0.01					-0.01	0.00	-0.001	0.00	ug/g dw
Cr	(ug/L)	26.70	56.40					41.55	21.00	3.957	2.00	ug/g dw
Al	(mg/L)	0.11	0.16					0.14	0.04	0.013	0.00	mg/g dw
Fe	(mg/L)	0.37	0.13					0.25	0.17	0.024	0.02	mg/g dw
Cu	(mg/L)	0.00	0.00					0.00	0.00	0.000	0.00	ug/g dw
Zn	(mg/L)	0.02	0.02					0.02	0.00	0.002	0.00	ug/g dw
Ni	(mg/L)	0.00	0.00					0.00	0.00	0.000	0.00	ug/g dw
Pb[1]	(mg/L)			0.00				0.00	0.01	0.000	0.00	ug/g dw

1= HF was not added; not a total digest

e) SIMULTANEOUSLY EXTRACTABLE METALS

Metal	Units	BLK110502	BLK 110602	BLK 110702	Mean	Std Dev	Mean	Std Dev	Units
Cu	(mg/L)		0.00		0.00	0.00	<0.01	0.000	ug/g dw
Cr	(ug/L)	1.82	1.52	1.92	1.63	0.30	0.045	0.008	ug/g dw
Zn	(mg/L)	0.04	0.07	0.04	0.05	0.01	0.001	0.000	ug/g dw
Ni	(mg/L)	0.00		0.00	0.00	0.00	<0.01	0.000	ug/g dw
Pb	(mg/L)		0.00		0.00	0.01	<0.01	0.000	ug/g dw
Cd	(ug/L)	-0.02	-0.04	-0.05	-0.04	0.01	<0.01	0.000	ug/g dw
Cd	(mg/L)		0.00		0.00	0.00	<0.01	0.000	ug/g dw

f) MERCURY

Compound	Units	DIG BLK1	DIG BLK2	Mean	Std Dev	Mean	Std Dev	Units
Hg	(ng/g)	-0.16	-0.12	-0.144	0.030	<0.01	0.002	ug/g dw

* Limits of Detection (LOD) for organic contaminants based on the average mass in ng from the laboratory blanks plus 3 standard deviations.

* NQ = not quantifiable due to chromatographic inteference

Table 3. Comparison between PCER and NIST for SRM 1944 New York/New Jersey Waterway Sediment (Organic Contaminants)

a) POLYCYCLIC AROMATIC HYDROCARBONS

Compound	PCER value n=1 ng/g dry	NIST value ng/g dry		% Recovery
2-Methylnaphthalene	0.56	0.95	*	**59**
1-Methylnaphthalene	0.50	0.52	*	**96**
Biphenyl	0.25	0.32	*	**78**
Acenaphthene	0.45	0.57	*	**79**
Fluorene	0.44	0.85	*	**52**
Phenanthrene	4.56	5.27		**87**
Anthracene	1.21	1.77		**69**
2-Methylphenanthrene	1.16	1.9	*	**61**
2-Methylanthracene	0.70	0.58	*	**120**
1-Meanthracn + 1-Mephenanthrn	1.59	1.7	*	**93**
Flouranthene	8.35	8.92		**94**
Pyrene	8.04	9.7		**83**
Chrysene + Triphenylene	4.72	5.91		**80**
Benzo(b)fluoranthene	3.34	3.87		**86**
Benzo(k)fluoranthene	2.27	2.3		**99**
Benzo(e)pyrene	5.19	3.28		**158**
Benzo(a)pyrene	4.70	4.3		**109**
Perylene	1.56	1.17		**134**
Anthanthrene	1.13	0.9	*	**125**
			mean	**93**
			std dev	**27**

b) POLYCHLORINATED BIPHENYLS

Compound	SRM 1944 trial A ng/g dry	SRM 1944 trial B ng/g dry	SRM 1944 trial C ng/g dry	PCER average n=3 ng/g dry	PCER std dev ng/g dry	NIST value ng/g dry	NIST std dev ng/g dry	%Recovery
8+5	21.4	28.4	24.9	24.6	3.5	22.3	2.3	**110**
18	16.7	19.7	18.5	18.0	1.5	51.0	2.6	**35**
31+28	76.7	89.2	82.5	81.4	6.3	159.5	4.3	**51**
52	24.4	28.3	26.3	25.9	2.0	79.4	2.0	**33**
49	22.5	25.4	24.3	23.7	1.5	53.0	1.7	**45**
44	32.1	34.3	31.1	31.9	1.7	60.2	2.0	**53**
66+95	81.4	91.6	88.6	85.8	5.2	136.9	13.2	**63**
99	11.4	12.3	12.1	11.7	0.5	37.4	2.4	**31**
87+81	12.6	13.0	12.9	12.6	0.2	29.9	4.3	**42**
77+110	40.5	43.3	41.9	41.2	1.4	63.5	4.7	**65**
151	7.7	7.9	7.8	7.7	0.1	16.9	0.4	**45**
149	17.9	19.6	19.5	18.7	0.9	49.7	1.2	**38**
118	17.5	18.5	18.3	17.8	0.5	58.0	4.3	**31**
153+132+105	46.6	48.1	48.0	46.7	0.9	98.5	4.0	**47**
163+138	39.8	43.0	42.5	41.1	1.7	62.1	3.0	**66**
187+182	11.2	12.5	12.9	12.0	0.9	25.1	1.0	**48**
128	5.7	5.7	6.1	5.7	0.2	8.5	0.3	**68**
180	26.4	30.7	31.4	29.1	2.7	44.3	1.2	**66**
170+190	19.7	22.8	21.8	21.1	1.6	22.6	1.4	**93**

Table 3. Comparison between PCER and NIST for SRM 1944 New York/New Jersey Waterway Sediment (Organic Contaminants)

b) POLYCHLORINATED BIPHENYLS

Compound	SRM 1944 trial A ng/g dry	SRM 1944 trial B ng/g dry	SRM 1944 trial C ng/g dry	PCER average n=3 ng/g dry	PCER std dev ng/g dry	NIST value ng/g dry	NIST std dev ng/g dry		%Recovery
194	6.6	5.9	7.5	6.6	0.8	11.2	1.4		**59**
206	7.9	8.8	11.5	9.3	1.9	9.2	0.5		**101**
209	1.3	1.2	1.3	1.3	0.1	6.8	0.3		**19**
								mean	**55**
								std dev	**23**

c) ORGANOCHLORINE PESTICIDES

Compound	SRM 1944 trial A ng/g dry	SRM 1944 trial B ng/g dry	SRM 1944 trial C ng/g dry	PCER average n=3 ng/g dry	PCER std dev ng/g dry	NIST value ng/g dry	NIST std dev ng/g dry		%Recovery
lindane	1.77	1.92	3.28	2.3	0.8	2.0	0.3	*	**116**
gamma chlordane	24.16	19.85	30.09	25	5	8	2	*	**309**
alpha chlordane	10.29	8.64	14.86	11.26	3.22	16.51	0.83		**68**
o,p DDD	29.86	29.66	42.26	34	7	38	8	*	**89**
p,p DDD	94.82	98.41	132.66	109	21	108	16	*	**101**
pp DDT	82.69	85.54	136.80	102	30	119	11		**85**

* indicates a NIST value which is uncertified, though recommended for comparison for results obtained using similar procedures

Table 4. Comparison between PCER and NIST for SRM 1946 Lake Superior Fish Tissue (Organic Contaminants)

ORGANOCHLORINE PESTICIDES

Compound	SRM 1944 trial A ng/g dry	SRM 1944 trial B ng/g dry	SRM 1944 trial C ng/g dry	PCER average n=3 ng/g dry	PCER std dev ng/g dry	NIST value ng/g dry	NIST std dev ng/g dry	%Recovery
alpha BHC	6.12	5.26	6.72	6.03	0.73	5.72	0.65	**105**
lindane	1.12	2.45	1.23	1.60	0.73	1.14	0.18	**140**
heptachlor epoxide	12.35	11.69	11.90	11.98	0.33	5.50	0.23	**218**
oxychlordane	16.77	17.97	18.64	17.79	0.94	18.90	1.50	**94**
gamma chlordane	8.96	8.59	8.67	8.74	0.19	8.36	0.91	**105**
alpha chlordane	24.74	24.03	25.01	24.60	0.51	32.50	1.80	**76**
dieldrin	14.86	13.98	14.23	14.36	0.45	32.50	3.50	**44**
o,p ddd	1.33	3.10	1.31	1.91	1.03	2.20	0.25	**87**
p,p ddd	12.93	12.93	12.72	12.86	0.12	17.70	2.80	**73**
pp ddt	40.43	39.94	42.96	41.11	1.62	37.20	3.50	**111**

Table 5. Replicate Ananlysis of Individual Organic Analytes

a) POLYCYCLIC AROMATIC HYDROCARBONS

CHEM ID	9149	9149 dup	average	RPD	9157	9157 dup	average	RPD	9168	9168 DUP	9168 TRIP	AVERAGE	STD	RELATIVE
STATION ID	SER1	SER1			NER3	NER3			ELR3	ELR3	ELR3		DEV	STD DEV
	ng/g	ng/g	ng/g	%	ng/g	ng/g	ng/g	%	ng/g	ng/g	ng/g	ng/g		%
2-Methylnaphthalene	35.8	52.9	44.4	**38**	174.1	239.8	206.9	**32**	71.0	55.1	62.9	63.0	8	**13**
Azulene	ND	ND	ND		ND	ND	ND		ND	ND	ND	ND		
1-Methylnaphthalene	24.8	21.3	23.1	**15**	113.9	135.2	124.6	**17**	35.7	35.6	30.4	33.9	3	**9**
Biphenyl	15.3	15.5	15.4	**1**	58.6	69.7	64.1	**17**	19.6	20.1	16.5	18.7	2	**10**
Acenaphthylene	32.7	38.3	35.5	**16**	64.4	85.4	74.9	**28**	21.2	23.4	17.7	20.7	3	**14**
Acenaphthene	22.3	20.6	21.5	**8**	39.6	54.8	47.2	**32**	13.5	12.3	11.9	12.6	1	**6**
Fluorene	22.4	18.6	20.5	**19**	70.9	67.1	69.0	**6**	22.4	19.2	19.4	20.3	2	**9**
1-Methylfluorene	14.4	12.6	13.5	**13**	21.4	33.3	27.3	**44**	12.8	9.0	9.2	10.3	2	**21**
Phenanthrene	147.7	131.0	139.4	**12**	342.9	303.4	323.2	**12**	100.0	108.5	92.5	100.3	8	**8**
Anthracene	62.7	49.3	56.0	**24**	149.2	133.8	141.5	**11**	49.2	46.2	35.3	43.6	7	**17**
o-Terphenyl	ND	ND	ND		1.1	1.0	1.0	**13**	0.6	0.8	ND	0.7		
2-Methylphenanthrene	50.1	40.2	45.2	**22**	110.7	98.9	104.8	**11**	35.7	38.5	31.8	35.3	3	**10**
2-Methylanthracene	24.8	16.1	20.4	**43**	85.0	67.7	76.3	**23**	28.1	27.9	22.2	26.1	3	**13**
1-Meanthracn + 1-Mephenanthrene	52.0	41.1	46.5	**23**	121.0	101.2	111.1	**18**	35.9	36.0	28.7	33.5	4	**13**
9-Methylanthracene	3.6	1.3	2.4	**97**	ND	3.8	3.8		1.2	1.2	1.0	1.1	0	**10**
3,6-dimethylphenanthrene	BDL	BDL	ND		5.8	6.1	6.0	**6**	BDL	BDL	3.2	3.2		
Flouranthene	870.1	689.1	779.6	**23**	335.6	321.8	328.7	**4**	130.1	137.4	114.8	127.4	12	**9**
Pyrene	778.1	672.9	725.5	**14**	377.3	377.7	377.5	**0**	155.1	156.0	133.2	148.1	13	**9**
9,10-Dimethylanthracene	7.2	4.5	5.8	**45**	ND	8.5	8.5		ND	ND	ND	ND		
2,3-Benzofluorene	60.6	64.4	62.5	**6**	38.4	36.2	37.3	**6**	11.8	18.8	24.4	18.3	6	**34**
Benzo(a)anthracene	373.5	435.2	404.4	**15**	226.6	222.6	224.6	**2**	85.1	83.1	66.0	78.1	10	**13**
Chrysene + Triphenylene	463.7	521.8	492.8	**12**	240.3	223.6	231.9	**7**	83.6	70.5	59.9	71.3	12	**17**
Benzo(b)fluoranthene	598.6	700.3	649.5	**16**	237.8	251.4	244.6	**6**	126.4	124.1	90.1	113.5	20	**18**
7,12-Dimethylbenz(a)anthracene	37.2	52.7	45.0	**35**	23.5	20.5	22.0	**14**	ND	ND	ND	ND		
Benzo(k)fluoranthene	381.7	454.0	417.9	**17**	175.9	189.0	182.4	**7**	104.9	110.8	109.4	108.3	3	**3**
Benzo(e)pyrene	581.4	618.9	600.2	**6**	140.7	147.3	144.0	**5**	79.8	64.6	62.4	68.9	9	**14**
Benzo(a)pyrene	375.6	506.8	441.2	**30**	133.0	136.3	134.7	**2**	63.0	52.5	37.0	50.8	13	**26**
Perylene	265.7	428.4	347.1	**47**	621.5	661.3	641.4	**6**	256.9	226.6	202.7	228.7	27	**12**
3-Methylcholanthrene	ND	90.0	90.0		39.0	39.2	39.1	**1**	36.2	37.2	29.0	34.2	4	**13**
Ideno(1,2,3-cd)pyrene	5758.5	7607.3	6682.9	**28**	2068.6	2277.7	2173.2	**10**	1006.1	614.6	458.6	693.1	282	**41**
1,2,3,4-Dibenzanthracene	120.3	190.7	155.5	**45**	60.9	62.6	61.8	**3**	ND	ND	ND	ND		
Benzo(g,h,i) perylene	455.1	501.2	478.2	**10**	149.4	171.7	160.5	**14**	93.7	71.0	50.1	71.6	22	**30**
Anthanthrene	205.2	260.6	232.9	**24**	68.1	96.5	82.3	**34**	ND	ND	ND	ND		
Coronene	INT	INT	INT		INT	INT	INT		ND	ND	ND	ND		
			mean	24			**mean**	12					**mean**	15

b) POLYCHLORINATED BIPHENYLS

CHEM ID	9149	9149 dup	average	RPD	9157	9157 dup	average	RPD	9168	9168 DUP	9168 TRIP	AVERAGE	STD DEV	RELATIVE
STATION ID	SER1	SER1			NER3	NER3			ELR3	ELR3	ELR3			STD DEV
	ng/g	ng/g	ng/g	%	ng/g	ng/g	ng/g	%	ng/g	ng/g	ng/g	ng/g		%
PCB 1	0.70	BDL	BDL		0.85	0.60	0.73	**33**	0.61	ND	ND	ND		
PCB 3	ND	ND	ND		ND	ND	ND		ND	ND	ND	ND		
PCB 4+10	BDL	BDL	BDL		0.06	BDL	0.06		0.07	BDL	0.06	BDL	0.01	
PCB 7	0.06	BDL	BDL		0.05	0.08	0.07	**51**	0.06	0.04	0.05	0.05	0.01	**20**
PCB 6	BDL	BDL	BDL		0.13	0.10	0.11	**32**	0.08	BDL	0.09	BDL	0.01	
PCB 8+5	1.05	1.50	1.27	**35**	0.69	0.49	0.59	**34**	0.47	0.32	0.79	0.53	0.24	**45**
PCB 19	BDL	0.13	BDL		0.06	0.08	0.07	**21**	0.18	0.05	0.12	0.12	0.06	**54**
PCB 12+13	0.08	ND	ND		ND	ND	ND		0.08	0.07	0.11	0.09	0.02	**25**
PCB 18	ND	2.47	ND		ND	ND	ND		ND	ND	ND	ND		
PCB 17	11.70	ND	ND		6.80	6.51	6.66	**4**	4.17	3.89	5.78	4.62	1.02	**22**

Table 5. Replicate Ananlysis of Individual Organic Analytes

b) POLYCHLORINATED BIPHENYLS

CHEM ID STATION ID	9149 SER1 ng/g	9149 dup SER1 ng/g	average ng/g	RPD %	9157 NER3 ng/g	9157 dup NER3 ng/g	average ng/g	RPD %	9168 ELR3 ng/g	9168 DUP ELR3 ng/g	9168 TRIP ELR3 ng/g	AVERAGE ng/g	STD DEV	RELATIVE STD DEV %
PCB 24+27	BDL	BDL	BDL		BDL	BDL	BDL		BDL	BDL	BDL	BDL		
PCB 16+32	BDL	0.14	BDL		0.24	0.13	0.19	**57**	0.14	0.06	0.26	0.16	0.10	**64**
PCB 29	BDL	0.09	BDL		0.19	0.23	0.21	**18**	0.07	0.06	BDL	0.06	0.01	**13**
PCB 26	0.24	0.17	0.21	**32**	0.19	0.25	0.22	**30**	0.24	0.19	0.19	0.20	0.03	**14**
PCB 25	0.17	0.16	0.17	**4**	0.08	0.12	0.10	**48**	0.19	0.15	0.14	0.16	0.03	**17**
PCB 31+28	0.72	0.69	0.70	**4**	1.31	1.17	1.24	**11**	0.71	0.75	0.94	0.80	0.12	**15**
PCB 53+33+21	0.26	0.24	0.25	**9**	0.41	0.33	0.37	**21**	0.23	0.14	0.20	0.19	0.05	**25**
PCB 22	0.42	0.40	0.41	**4**	0.44	0.49	0.47	**9**	0.37	0.29	0.36	0.34	0.04	**13**
PCB 45	0.09	0.11	0.10	**18**	0.10	0.13	0.11	**25**	0.13	0.10	0.12	0.12	0.01	**11**
PCB 46	0.09	0.09	0.09	**10**	0.07	0.10	0.08	**25**	0.11	0.08	0.12	0.10	0.02	**18**
PCB 52	0.68	0.71	0.69	**4**	0.70	0.74	0.72	**6**	0.39	0.42	0.45	0.42	0.03	**7**
PCB 49	0.78	0.87	0.82	**11**	0.71	0.75	0.73	**5**	0.54	0.47	0.59	0.54	0.06	**11**
PCB 47	0.95	1.11	1.03	**16**	1.43	1.15	1.29	**22**	1.13	0.80	1.22	1.05	0.22	**21**
PCB 48	0.08	0.08	0.08	**4**	0.28	0.18	0.23	**40**	0.14	0.07	0.07	0.09	0.04	**42**
PCB 44	0.53	0.47	0.50	**11**	ND	0.86	ND		0.39	ND	0.34	ND	0.03	
PCB 37+42	ND	0.33	ND		0.16	0.10	0.13	**48**	0.45	ND	ND	ND		
PCB 41+71	0.31	0.39	0.35	**24**	0.14	0.18	0.16	**27**	0.16	0.12	0.13	0.14	0.02	**15**
PCB 64	BDL	BDL	BDL		BDL	BDL	BDL		3.23	2.16	3.23	2.88	0.62	**21**
PCB 40	0.09	0.24	0.16	**88**	0.42	0.20	0.31	**72**	ND	0.16	0.24	ND	0.06	
PCB 100	ND	ND	ND		ND	ND	ND		22.04	40.69	37.76	33.50	10.03	**30**
PCB 63	BDL	0.13	BDL		ND	ND	ND		0.22	0.16	0.16	0.18	0.03	**19**
PCB 74	0.36	0.34	0.35	**6**	0.48	0.43	0.46	**12**	0.25	0.19	0.26	0.23	0.04	**17**
PCB 70+76	0.95	1.09	1.02	**14**	0.98	0.92	0.95	**7**	0.65	0.54	0.54	0.58	0.06	**11**
PCB 66	0.65	0.97	0.81	**40**	0.54	0.74	0.64	**32**	0.38	0.31	0.39	0.36	0.04	**11**
PCB 95	0.64	0.72	0.68	**12**	0.69	0.43	0.56	**47**	0.41	0.39	0.39	0.40	0.01	**3**
PCB 91	0.30	0.40	0.35	**31**	0.09	0.14	0.12	**42**	0.13	0.12	0.13	0.13	0.01	**6**
PCB 56+60	0.87	0.97	0.92	**11**	1.63	1.57	1.60	**4**	0.84	0.87	0.92	0.88	0.04	**5**
PCB 101	0.99	1.27	1.13	**25**	0.60	0.55	0.58	**9**	0.44	0.48	0.48	0.47	0.02	**4**
PCB 99	0.90	1.07	0.99	**17**	0.41	0.43	0.42	**6**	0.34	0.33	0.35	0.34	0.01	**3**
PCB 83	0.06	0.12	0.09	**64**	0.09	0.13	0.11	**33**	0.08	0.07	0.07	0.07	0.00	**3**
PCB 97	0.23	0.31	0.27	**32**	0.19	0.21	0.20	**9**	0.12	0.14	0.15	0.14	0.02	**12**
PCB 87+81	0.27	0.30	0.28	**10**	0.33	0.38	0.35	**13**	0.19	0.26	0.24	0.23	0.04	**15**
PCB 85	0.14	0.19	0.16	**32**	0.26	0.23	0.24	**11**	0.15	0.15	0.13	0.15	0.01	**9**
PCB 136	0.11	0.11	0.11	**2**	0.12	0.09	0.11	**25**	0.10	0.10	0.09	0.10	0.01	**6**
PCB 77+110	1.73	2.13	1.93	**21**	1.42	1.37	1.40	**3**	0.83	0.93	0.99	0.92	0.08	**9**
PCB 82	0.06	0.11	0.08	**58**	0.14	0.15	0.14	**3**	0.08	0.07	0.09	0.08	0.01	**12**
PCB 151	0.34	0.41	0.38	**20**	0.32	0.37	0.34	**14**	0.26	0.19	0.25	0.23	0.03	**15**
PCB 135+144	0.30	0.35	0.32	**17**	0.31	0.24	0.27	**26**	0.20	0.17	0.15	0.17	0.02	**14**
PCB 107	0.16	0.24	0.20	**42**	0.18	0.20	0.19	**14**	0.16	0.10	0.12	0.12	0.03	**26**
PCB 149	1.46	1.92	1.69	**27**	0.96	0.93	0.94	**2**	0.72	0.69	0.90	0.77	0.11	**15**
PCB 118	1.01	1.39	1.20	**32**	0.97	0.94	0.95	**4**	0.46	0.51	0.57	0.51	0.05	**10**
PCB 134	ND	ND	ND		ND	ND	ND		ND	ND	ND	ND		
PCB 131	0.03	0.04	0.03	**40**	0.05	0.05	0.05	**10**	0.04	0.02	0.03	0.03	0.01	**24**
PCB 146	0.47	0.65	0.56	**31**	0.46	0.46	0.46	**1**	0.36	0.35	0.45	0.39	0.06	**14**
PCB 153+132+105	3.94	4.98	4.46	**23**	2.68	2.62	2.65	**2**	2.07	1.88	2.37	2.11	0.25	**12**
PCB 141	0.20	0.27	0.23	**26**	0.17	0.16	0.16	**7**	0.11	0.10	0.13	0.12	0.01	**11**
PCB 137+176	BDL	BDL	BDL		ND	0.12	0.12		BDL	BDL	BDL	BDL		
PCb 163+138	2.42	3.23	2.83	**28**	2.69	2.42	2.55	**11**	1.51	1.43	1.72	1.55	0.15	**10**
PCB 158	BDL	BDL	BDL		BDL	BDL	BDL		0.12	0.10	0.22	0.15	0.06	**44**
PCb 129+178	0.12	0.29	0.20	**86**	0.19	0.29	0.24	**43**	0.16	0.20	0.16	0.17	0.02	**14**
PCB 187+182	0.85	1.13	0.99	**28**	0.79	0.69	0.74	**14**	0.57	0.38	0.63	0.53	0.13	**25**
PCB 183	0.51	0.63	0.57	**21**	0.70	0.42	0.56	**49**	0.39	0.33	0.39	0.37	0.04	**10**
PCB 128	0.29	0.35	0.32	**19**	0.34	0.25	0.30	**30**	0.23	0.22	0.25	0.23	0.02	**8**

Table 5. Replicate Ananlysis of Individual Organic Analytes

b) POLYCHLORINATED BIPHENYLS

CHEM ID	9149	9149 dup	average	RPD	9157	9157 dup	average	RPD	9168	9168 DUP	9168 TRIP	AVERAGE	STD DEV	RELATIVE
STATION ID	SER1	SER1			NER3	NER3			ELR3	ELR3	ELR3			STD DEV
	ng/g	ng/g	ng/g	%	ng/g	ng/g	ng/g	%	ng/g	ng/g	ng/g	ng/g		%
PCB 185	0.07	0.08	0.07	**7**	0.15	0.14	0.15	**6**	0.16	0.09	0.16	0.14	0.04	**28**
PCB 174	0.18	0.40	0.29	**75**	0.48	0.38	0.43	**22**	0.28	0.28	0.35	0.31	0.04	**14**
PCB 177	0.43	0.57	0.50	**28**	0.45	0.44	0.45	**3**	0.29	0.27	0.33	0.30	0.03	**12**
PCB 202+171	0.34	0.49	0.41	**35**	0.53	0.57	0.55	**7**	0.35	0.40	0.39	0.38	0.03	**7**
PCB 157+200	0.15	0.07	0.11	**72**	0.27	0.32	0.29	**16**	0.23	0.18	0.21	0.21	0.03	**14**
PCB 172+197	0.18	0.12	0.15	**35**	0.16	0.23	0.20	**40**	0.28	0.18	0.18	0.21	0.06	**29**
PCB 180	1.36	1.32	1.34	**3**	1.40	1.35	1.38	**3**	0.77	0.73	0.89	0.80	0.08	**10**
PCB 193	0.15	0.16	0.15	**11**	0.16	0.27	0.22	**52**	0.30	0.26	0.25	0.27	0.03	**11**
PCB 191	BDL	BDL	BDL		ND	0.22	ND		0.17	0.13	0.21	0.17	0.04	**23**
PCB 199	0.06	0.06	0.06	**1**	0.11	0.09	0.10	**15**	0.06	0.06	0.11	0.08	0.03	**38**
PCB 170+190	1.44	1.77	1.60	**21**	1.34	0.96	1.15	**33**	0.58	0.54	0.79	0.64	0.14	**21**
PCB 198	0.06	0.07	0.07	**14**	0.10	0.12	0.11	**12**	0.17	0.17	0.14	0.16	0.02	**12**
PCB 201	0.84	1.00	0.92	**18**	1.23	1.22	1.23	**0**	1.17	0.96	1.33	1.15	0.18	**16**
PCB 203+196	0.90	1.21	1.06	**29**	1.55	1.40	1.48	**10**	0.96	0.86	1.21	1.01	0.18	**18**
PCB 189	BDL	BDL	BDL		0.68	0.61	0.64	**10**	0.18	0.21	0.33	0.24	0.08	**34**
PCB 208+195	0.44	0.42	0.43	**6**	0.81	0.74	0.78	**9**	3.72	2.81	3.96	3.49	0.61	**17**
PCB 207	0.09	0.11	0.10	**19**	0.50	0.54	0.52	**7**	0.36	0.32	0.48	0.39	0.08	**22**
PCB 194	0.49	0.62	0.56	**23**	0.39	0.42	0.41	**7**	0.30	0.26	0.33	0.29	0.04	**12**
PCB 205	0.05	0.05	0.05	**1**	0.11	0.14	0.13	**25**	0.08	0.06	ND	ND	0.01	
PCB 206	0.91	1.18	1.05	**26**	5.01	4.57	4.79	**9**	5.95	4.43	5.89	5.42	0.86	**16**
PCB 209	1.14	1.28	1.21	**11**	8.16	8.18	8.17	**0**	4.16	3.11	4.34	3.87	0.66	**17**
			mean	24			**mean**	20					**mean**	18

c) ORGANOCHLORINE PESTICIDES

CHEM ID	9149	9149 dup	average	RPD	9157	9157 dup	average	RPD	9168	9168 DUP	9168 TRIP	AVERAGE	STD DEV	RELATIVE
STATION ID	SER1	SER1			NER3	NER3			ELR3	ELR3	ELR3			STD DEV
	ng/g	ng/g	ng/g	%	ng/g	ng/g	ng/g	%	ng/g	ng/g	ng/g	ng/g		%
opDDE	0.43	0.62	0.53	**35**	0.46	0.49	0.47	**6**	0.60	0.52	0.60	0.58	0.05	**8**
ppDDE	1.65	1.92	1.78	**15**	2.33	2.10	2.21	**10**	2.46	2.32	2.71	2.50	0.20	**8**
op DDT	10.99	11.00	11.00	**0**	4.32	3.43	3.88	**23**	1.09	0.81	1.10	1.00	0.16	**16**
pp DDT	6.80	8.27	7.54	**20**	5.95	10.48	8.22	**55**	1.65	1.69	1.99	1.78	0.19	**11**
o,p DDD	1.53	1.02	1.28	**40**	1.53	1.08	1.31	**35**	0.68	0.58	0.85	0.70	0.14	**19**
p,p DDD	2.50	2.07	2.28	**19**	5.18	5.14	5.16	**1**	2.14	1.94	2.49	2.19	0.28	**13**
			mean DDXs	**21**			**mean DDXs**	**22**					**mean DDX**	**12**
alpha BHC	1.08	1.29	1.19	**17**	0.69	0.66	0.68	**4**	0.25	0.24	0.30	0.26	0.04	**14**
beta BHC	1.57	2.21	1.89	**34**	0.48	0.72	0.60	**41**	0.12	0.09	0.21	0.14	0.07	**47**
delta BHC	0.72	0.47	0.59	**43**	0.80	0.70	0.75	**14**	0.30	0.27	0.37	0.31	0.05	**15**
lindane	2.25	1.89	2.07	**17**	1.82	1.73	1.77	**5**	0.53	0.34	0.61	0.49	0.14	**28**
heptachlor	0.72	0.80	0.76	**10**	1.22	0.97	1.09	**23**	0.58	0.37	0.53	0.50	0.11	**22**
heptachlor epoxide	1.61	0.72	1.16	**77**	1.07	1.11	1.09	**3**	0.36	0.33	0.41	0.36	0.04	**10**
oxychlordane	1.39	1.65	1.52	**17**	0.90	0.81	0.86	**10**	0.13	0.15	0.12	0.13	0.02	**12**
gamma chlordane	3.06	3.37	3.21	**10**	1.20	1.06	1.13	**12**	0.17	0.13	0.19	0.16	0.03	**20**
alpha chlordane	2.15	2.16	2.15	**0**	1.04	1.71	1.38	**49**	0.15	0.20	0.22	0.19	0.04	**20**
cis nonachlor	0.18	0.35	0.26	**65**	0.34	0.22	0.28	**41**	0.49	0.27	0.32	0.36	0.12	**33**
trans nonachlor	0.71	0.85	0.78	**19**	0.27	0.33	0.30	**22**	0.23	0.21	0.31	0.25	0.05	**21**
			mean chlorda	**28**			**mean chlorda**	**23**					**mean chlorda**	**20**
dieldrin	ND	ND	ND		ND	ND	ND		ND	ND	ND	ND		
endrin	1.82	3.55	2.68	**64**	2.99	3.05	3.02	**2**	0.66	0.62	0.69	0.66	0.04	**6**
aldrin	0.67	0.46	0.56	**37**	0.74	0.78	0.76	**5**	0.22	0.18	0.26	0.22	0.04	**18**
endosulfan I	1.15	0.88	1.02	**27**	1.15	1.07	1.11	**8**	0.59	0.56	0.73	0.63	0.09	**14**
endosulfan II	ND	ND	ND		0.75	0.73	0.74	**4**	0.14	0.17	0.19	0.17	0.03	**17**

Table 6a. Replicate Analysis of Total Organic Contaminants (Lab and Field)

Duplicates

CHEM ID STATION ID	9149 SER1	9149 dup SER1	average	RPD	9157 NER3	9157 dup NER3	average	RPD
Total PAH (ng/g)	11841	14258	13049	**19**	6295	6645	6470	**5**
Total PCB (ng/g)	157	161	159	**2**	114	113	113	**1**
Total DDX (ng/g)	23.91	24.91	24.41	**4**	19.77	22.72	21.24	**14**
Total chlordanes (ng/g)	9.81	9.89	9.85	**1**	6.04	6.22	6.13	**3**

Triplicates

CHEM ID STATION ID	9168 ELR3	9168 DUP ELR3	9168 TRIP ELR3	average	std dev	RSD
TOTAL PAH (ng/g)	2679	2201	1820	2234	430	**19**
Total PCB (ng/g)	73	85	93	84	10	**12**
total DDX (ng/g)	8.63	7.85	9.74	8.74	0.95	**11**
total chlordanes (ng/g)	2.10	1.65	2.10	1.95	0.26	**13**

Table 6b. Replicate Analysis of Total Organic Contaminants: Field Samples

CHEM ID	9163	DATA	9164	DATA	9165	DATA		
STATION ID	BOR4-A	QUAL	BOR4-B	QUAL	BOR4-C	QUAL		
RIVER LOCATION	Bohemia River		Bohemia River		Bohemia River		Mean	RSD
EXTRACTION MASS (g)	10.76		12.64		11.34			
% Water	51		55		56		54	4.6
Total Organic Carbon (% dw)	1.89		2.16		1.66	J	2	13.1
Total Nitrogen (% dw)	0.11		0.13		0.11	J	0.12	12.8
pw Ammonia+Ammonium (mg N/L)	3.2		4.4		3.1		4	20.4
Grain Size (< 0.063 mm %)	66.8		68.5		66.9		67	1.4
Summary (ng/g dry wt)								
TOTAL PAH	1170		1446		1539		1385	13.9
TOTAL PCB	24		28		31		28	14.1
TOTAL CHLORDANES	2.90		1.41		1.22		1.8	49.8
TOTAL DDXs	82.83		5.81		6.00		32	140.8

Table 7a. Replicate Analysis of Sedimentary Metals, AVS and SEM

SEDIMENTARY METALS		Sample ID:	NER1	NER1	average	RPD	SER 5	SER 5	average	RPD	SER 1	SER 1	average	RPD	ELR 4	ELR 4	average	RPD
		Chem ID:	9154a	9154b			9153	9153 REP			9149	9149 REP			9169a	9169b		
REPLICATE ANALYSIS (INSTR																		
Element	**Units**	**Method**																
AsT	(ug/g)	HGA	5.45	5.87	5.66	**7.6**									10.3	10.9	10.6	**6.3**
Cd	(ug/g)	GFAAS	0.281	0.278	0.28	**1.0**									0.5	0.5	0.50	**0.4**
Cr	(ug/g)	ICP	83.17	83.07	83.12	**0.1**									71.4	73.1	72.3	**2.4**
Al	(mg/g)	ICP																
Fe	(mg/g)	Flame	34.28	34.32	34.30	**0.1**									44.4	44.5	44.5	**0.1**
Cu	(ug/g)	Flame	28.64	27.80	28.22	**3.0**									35.7	35.9	35.8	**0.6**
Zn	(ug/g)	Flame	114.62	114.05	114.33	**0.5**									274.1	273.7	273.9	**0.1**
Ni	(ug/g)	Flame	46.9	46.9	46.9	**0.0**									55.23	55.17	55.20	**0.1**
Pb	(ug/g)	Flame	32.15	33.48	32.82	**4.0**									53.5	54.6	54.0	**2.0**
Hg	(ng/g)	ICP					579	619	599	7	219	214	216	2.1	192	195	194	1.5
Units: Based on dry wt of sediment																		

		Sample ID:	NER1	NER1	average	RPD	SER1	SER1	average	RPD	SER5	SER5	average	RPD	ELR4	ELR4	average	RPD
		Chem ID:	9154	9154dup			9149	9149dup			9153	9153dup			9169	9169dup		
REPLICATE ANALYSIS (SAMPLE)																		
AsT	(ug/g)	HGA	5.7	6.36	6.0	**11.7**	21.06	20.98	21.02	**0.3**					10.6	10.8	10.7	**1**
Cd	(ug/g)	GFAAS	0.29	0.30	0.3	**3.5**									0.5	0.5	0.5	**1**
Cr	(ug/g)	ICP	83.1	83.3	83.2	**0.2**									72.3	68.2	70.2	**6**
Al	(mg/g)	ICP	66.3	66.4	66.3	**0.1**									76.1	66.5	71.3	**13**
Fe	(mg/g)	Flame	33.1	31.7	32.4	**4.4**									43.1	41.7	42.4	**3**
Cu	(ug/g)	Flame	28.7	30.5	29.6	**5.9**					599.3	602.9	601.1	**0.6**	35.3	88.4	61.9	**86**
Zn	(ug/g)	Flame	118.9	125.1	122.0	**5.2**									259.1	245.1	252.1	**6**
Ni	(ug/g)	Flame	46.9	47.2	47.1	**0.6**									57.2	56.8	57.0	**1**
Pb	(ug/g)	Flame	32.2	30.9	31.6	**3.9**									52.8	51.2	52.0	**3**
Hg	(ng/g)	ICP									599	625	612	4.3	194	202	198	4.0
Units: Based on dry wt of sediment																		

Table 7a. Replicate Analysis of Sedimentary Metals, AVS and SEM

AVS and SEM			Sample ID:	NER 5	NER 5 dup	average	RPD	BOR 1	BOR 1 dup	average	RPD	ELR 4	ELR 4	average	RPD
			Chem ID:	9159	9159 DUP			9160	9160 DUP			9169	9169 DUP		
REPLICATE ANALYSIS (SAMPLE)															
AVS	(µmoles/g)	Wet		0.26	0.90	0.58	111	4.37	3.83	4.10	13.1	3.01	2.59	2.80	15
Cu	(µmoles/g)	Wet		0.042	0.036	0.039	**13.9**	0.029	0.029	0.029	**1.8**	0.063	0.066	0.064	**4.9**
Cr	(µmoles/g)	Wet													
Zn	(µmoles/g)	Wet		0.796	0.818	0.807	**2.8**	0.452	0.446	0.449	**1.5**	0.806	0.805	0.805	**0.1**
Ni	(µmoles/g)	Wet		0.180	0.186	0.183	**3.7**	0.049	0.048	0.048	**2.9**	0.117	0.116	0.116	**1.0**
Pb	(µmoles/g)	Wet		0.048	0.048	0.048	**1.1**	0.040	0.037	0.038	**6.3**	0.064	0.063	0.063	**0.8**
Cd	(µmoles/g)	Wet										0.001	0.001	0.001	**0.4**
Cu	(µmoles/g)	Dry		0.086	0.075	0.081	**13.9**	0.087	0.085	0.086	**1.8**	0.202	0.212	0.207	**4.9**
Cr	(µmoles/g)	Dry													
Zn	(µmoles/g)	Dry		1.651	1.697	1.674	**2.8**	1.333	1.314	1.324	**1.5**	2.589	2.585	2.587	**0.1**
Ni	(µmoles/g)	Dry		0.373	0.387	0.380	**3.7**	0.145	0.141	0.143	**2.9**	0.376	0.372	0.374	**1.0**
Pb	(µmoles/g)	Dry		0.101	0.100	0.100	**1.1**	0.117	0.110	0.114	**6.3**	0.204	0.203	0.204	**0.8**
Cd	(µmoles/g)	Dry										0.005	0.005	0.005	**0.4**

			Sample ID:	NER 4	NER 4	average	RPD	NER 5	NER 5	average	RPD	BOR 1	BOR 1	average	RPD
			Chem ID:	9158 A	9158 B			9159 A	9159 B			9160 A	9160 B		
REPLICATE ANALYSIS (INSTRUMENT)															
Cu	(µmoles/g)	Wet						0.041	0.039	0.040	**5.5**	0.028	0.028	0.028	**0.8**
Cr	(µmoles/g)	Wet						0.028	0.027	0.027	**1.4**	0.033	0.034	0.033	**3.9**
Zn	(µmoles/g)	Wet										0.434	0.430	0.432	**1.0**
Ni	(µmoles/g)	Wet										0.047	0.047	0.047	**1.6**
Pb	(µmoles/g)	Wet		0.066	0.066	0.066	**0.5**								
Cd	(µmoles/g)	Wet						0.002	0.002	0.002	**2.3**	0.001	0.001	0.001	**2.2**
Cu	(µmoles/g)	Dry						0.086	0.081	0.083	**5.5**	0.082	0.081	0.082	**0.8**
Cr	(µmoles/g)	Dry						0.057	0.056	0.057	**1.4**	0.096	0.100	0.098	**3.9**
Zn	(µmoles/g)	Dry										1.280	1.268	1.274	**1.0**
Ni	(µmoles/g)	Dry										0.137	0.140	0.138	**1.6**
Pb	(µmoles/g)	Dry		0.161	0.162	0.162	**0.5**								
Cd	(µmoles/g)	Dry						0.005	0.005	0.005	**2.3**	0.003	0.003	0.003	**2.2**

Table 7a. Replicate Analysis of Sedimentary M

			Sample ID:	ELR 3	ELR 3	average	RPD	ELR 4	ELR 4	average	RPD
			Chem ID:	9168 A	9168 B			9169 A	9169 B		
REPLICATE ANALYSIS (INSTRUMENT)											
Cu	(µmoles/g)	Wet						0.062	0.061	0.062	**2.1**
Cr	(µmoles/g)	Wet						0.042	0.042	0.042	**0.9**
Zn	(µmoles/g)	Wet						0.771	0.769	0.770	**0.3**
Ni	(µmoles/g)	Wet						0.115	0.116	0.116	**1.0**
Pb	(µmoles/g)	Wet		0.073	0.073	0.073	**0.6**				
Cd	(µmoles/g)	Wet									
Cu	(µmoles/g)	Dry		0.201	0.197	0.199	**2.1**				
Cr	(µmoles/g)	Dry		0.135	0.134	0.135	**0.9**				
Zn	(µmoles/g)	Dry		2.476	2.470	2.473	**0.3**				
Ni	(µmoles/g)	Dry		0.369	0.373	0.371	**1.0**				
Pb	(µmoles/g)	Dry		0.227	0.226	0.227	**0.6**				
Cd	(µmoles/g)	Dry									

Table 7a. Replicate Analysis of Sedimentary Metals, AVS and SEM

Field Duplicates for Trace Metals									
CHEM ID		**9163**	**DATA**	**9164**	**DATA**	**9165**	**DATA**		
STATION ID		BOR4-A	QUAL	BOR4-B	QUAL	BOR4-C	QUAL		
RIVER LOCATION		Bohemia River		Bohemia River		Bohemia River		**Mean**	**RSD**
EXTRACTION MASS (g)		10.76		12.64		11.34			
% Water		51		55		56		54	4.6
Total Organic Carbon (% dw)		1.89		2.16		1.66	J	2	13.1
Total Nitrogen (% dw)		0.11		0.13		0.11	J	0.12	12.8
pw Ammonia+Ammonium (mg		3.2		4.4		3.1		4	20.4
Grain Size (< 0.063 mm %)		66.8		68.5		66.9		67	1.4
SEDIMENTARY METALS (ug/g dw except Al and Fe in mg/g dw)									
Total As	HGA	9.3		8.7		9.4		9	4.5
Cd	GFAAS	0.3		0.3		0.3		0.3	2.3
Cr	ICP	53.6		53.2		54.8		54	1.5
Al	ICP	58.6		58.1		57.3		58	1.1
Fe	Flame	31.5		31.1		31.1		31	0.8
Cu	Flame	21.0		21.1		20.4		21	1.8
Zn	Flame	163.0		163.4		159.5		162	1.3
Ni	Flame	31.9		32.8		32.0		32	1.6
Pb	Flame	32.4		33.8		33.3		33	2.1
SIMULTANEOUSLY EXTRACTABLE METALS									
Units: wet weight		(umoles/g)		(umoles/g)		(umoles/g)			
AVS		0.90		1.20		0.34		0.814	54.0
	Method								
Cu	Flame	0.055		0.044		0.051		0.050	11.1
Cr	ICP	0.036		0.035		0.033		0.035	5.1
Zn	Flame	0.729		0.694		0.688		0.704	3.1
Ni	Flame	0.089		0.087		0.084		0.087	2.5
Pb	Flame	0.056		0.053		0.055		0.055	3.0
Cd	GFAAS	0.001		0.001		0.001		0.001	3.4
Units: dry wt									
Cu	Flame	0.127		0.099		0.121		0.116	12.7
Cr	ICP	0.084		0.078		0.078		0.080	4.2
Zn	Flame	1.679		1.560		1.628		1.622	3.7
Ni	Flame	0.204		0.196		0.200		0.200	2.1
Pb	Flame	0.130		0.119		0.130		0.126	4.7
Cd	GFAAS	0.003		0.003		0.003		0.003	4.1

Table 7b. Replicate Analysis of Sedimentary Metals, AVS and SEM for Field Samples

Field Duplicates for Trace Metals									
CHEM ID		**9163**	**DATA**	**9164**	**DATA**	**9165**	**DATA**		
STATION ID		**BOR4-A**	**QUAL**	**BOR4-B**	**QUAL**	**BOR4-C**	**QUAL**		
RIVER LOCATION		**Bohemia River**		**Bohemia River**		**Bohemia River**		**Mean**	**RSD**
EXTRACTION MASS (g)		10.76		12.64		11.34			
% Water		51		55		56		54	4.6
Total Organic Carbon (% dw)		1.89		2.16		1.66	J	2	13.1
Total Nitrogen (% dw)		0.11		0.13		0.11	J	0.12	12.8
pw Ammonia+Ammonium (mg N/L)		3.2		4.4		3.1		4	20.4
Grain Size (< 0.063 mm %)		66.8		68.5		66.9		67	1.4
SEDIMENTARY METALS (ug/g dw except Al and Fe in mg/g dw)									
Total As	HGA	9.3		8.7		9.4		9	4.5
Cd	GFAAS	0.3		0.3		0.3		0.3	2.3
Cr	ICP	53.6		53.2		54.8		54	1.5
Al	ICP	58.6		58.1		57.3		58	1.1
Fe	Flame	31.5		31.1		31.1		31	0.8
Cu	Flame	21.0		21.1		20.4		21	1.8
Zn	Flame	163.0		163.4		159.5		162	1.3
Ni	Flame	31.9		32.8		32.0		32	1.6
Pb	Flame	32.4		33.8		33.3		33	2.1
SIMULTANEOUSLY EXTRACTABLE METALS									
Units: wet weight		(umoles/g)		(umoles/g)		(umoles/g)			
AVS		0.90		1.20		0.34		0.814	54.0
	Method								
Cu	Flame	0.055		0.044		0.051		0.050	11.1
Cr	ICP	0.036		0.035		0.033		0.035	5.1
Zn	Flame	0.729		0.694		0.688		0.704	3.1
Ni	Flame	0.089		0.087		0.084		0.087	2.5
Pb	Flame	0.056		0.053		0.055		0.055	3.0
Cd	GFAAS	0.001		0.001		0.001		0.001	3.4
Units: dry wt									
Cu	Flame	0.127		0.099		0.121		0.116	12.7
Cr	ICP	0.084		0.078		0.078		0.080	4.2
Zn	Flame	1.679		1.560		1.628		1.622	3.7
Ni	Flame	0.204		0.196		0.200		0.200	2.1
Pb	Flame	0.130		0.119		0.130		0.126	4.7
Cd	GFAAS	0.003		0.003		0.003		0.003	4.1

Table 8. Spike Recoveries for Trace Metals

SEDIMENTARY METALS

	spike units	Actual Spike	**Sample ID** **Chem ID**	**NER 1** **9154** **spike recovery (%)**	**ELR 4** **9169** **spike recovery (%)**
AsIII+V	ppb	5.0		102	90
DMA	ppb	5.0		93	105
Cd	ppb/ppb	1.00 / 2.00		86/88	81/91
Cr	ppb	20.0		78	69
Al	ppm	1.0		42	38
Fe	ppm	5.0		105	105
Cu	ppm	1.0		104	101
Zn	ppm	1.0		103	102
Ni	ppm	1.0		107	110
Pb	ppm	1.0		116	111

Table 8. Spike Recoveries for Trace Metals

SEMS

			Sample ID	ELR 3	ELR 4	ELR 4	NER 4	NER 5	NER 5
			Chem ID	9168	9169	9169 DUP	9158	9159	9159 DUP
				spike recovery (%)	spike recovery (%)	spike recovery (%)	spike recovery (%)	spike recovery (%)	spike recovery (%)
		Actual Spike							
AVS	µmoles	2.6						56	
Cu	ppm	1.0			102			99	
Cr	ppb	20.0			139			148	
Zn	ppm	1.0			106				105
Ni	ppm	1.0				100			110
Pb	ppm	3.0		100			102		
Cd	ppb	2.0						101	

Table 8. Spike Recoveries for Trace Meta

SEMS

			Sample ID Chem ID	BOR4-C 9165 spike recovery (%)	blank spike 11/5/03 spike recovery (%)	blank spike 11/6/02 spike recovery (%)	blank spike 11/7/02 spike recovery (%)	blank spike 11/8/02 spike recovery (%)
		Actual Spike						
AVS	µmoles	2.6		109	97	98	98	69
Cu	ppm	1.0						
Cr	ppb	20.0						
Zn	ppm	1.0						
Ni	ppm	1.0						
Pb	ppm	3.0						
Cd	ppb	2.0						

Table 8. Spike Recoveries for Trace Metals

MERCURY

			Sample ID	BOR	ELR 4		NER 1	SER 5
		Actual Spike (ng)	Chem ID	9160 EXT SPK	9169 SPK	srm 1646 SPK	9154 EXT SPK	9153 SPK
from	matrix	0		0.25	3.60		0.31	8.55
from	spike	5		0.50	0.99		0.50	0.98
expected	(ng/ml)	50		0.75	4.59		0.81	9.53
%	Recovered			102	93	115	101	102

Table 8. Spike Recoveries for Trace Metals

MERCURY

		Actual Spike (ng)	Sample ID Chem ID	SER 5 9153 EXT SPK	SRM MESS2	SRM MESS2 RE
from	matrix	0		0.97		
from	spike	5		0.50	±9	±9
expected	(ng/ml)	50		1.47		
%	Recovered			95	86	84

Table 9. Comparison between PCER and NIST Certified values for SRM 1646 Estuarine Sediment and SRM MESS2

SEDIMENTARY METALS

					SRM 1646 trial 1	SRM 1646 trial 2	SRM 1646 trial 3	NIST Certified Value			% Recovery
Analyte		Method	Units								
AsT	Blk Corr	HGA	(ug/g)		10.3			11.6	±1.3		**89**
Cd	Blk Corr	GFAAS	(ug/g)		0.3			0.36	±0.07		**77**
Cr	Blk Corr	ICP	(ug/g)		64.5			76	±3		**85**
Al	Blk Corr	ICP	(mg/g)		60.0			62.5	±0.02		**96**
Fe	Blk Corr	Flame	(mg/g)		31.4			33.5	±1.0		**94**
Cu	Blk Corr	Flame	(ug/g)		16.2			18	±3		**90**
Zn	Blk Corr	Flame	(ug/g)		124.5			138	±6		**90**
Ni	Blk Corr	Flame	(ug/g)		28.0			32	±3		**88**
Pb	Blk Corr	Flame	(ug/g)	No HF		24.6	25.5	28.2	±1.8		**89**
						average Pb	25.0				
										average	**89**
										std dev	**5.4**

MERCURY

Method	Analyte		SRM MESS2 trial 1	SRM MESS2 trial2	Certified Value		% Recovery
ICP	Hg	(ng/g wet)	78.8	77.7	92	±9	**85**

Table 10: Standard Reference Material for Dissolved Trace Metals

Note: Concentrations or recoveries are dissolved (< 0.2 μm) fraction

Summary Table				
Element	**Units**	**Blank**	**SRM Certified Conc**	**SRM Measured Conc**
As	μg/L	0.000	1.10 ± 0.04	1.09±0.07
Cd	μg/L	0.000	0.012 ± 0.002	0.012±0.001
Cr	μg/L	0.09	0.33 ± 0.02	0.30 ± 0.01
Cu	μg/L	0.15	1.81 ± 0.08	1.89± 0.02
Hg	ng/L	0.086	N.A.	N.A.
Ni	μg/L	0.18	0.67 ± 0.08	0.63± 0.04
Pb	μg/L	0.04	0.086 ± 0.007	0.096 ± 0.005
Se	μg/L	0.006	0.04**	0.02 ± 0.01
Zn	μg/L	0.73	0.93 ± 0.10	1.35 ± 0.11

Summary Table					
Element	**Units**	**Direct Filter Blank**	**Extracted Fil. Blank**	**SRM Certified Conc**	**SRM Measured Conc**
As	μg/L				
Cd	μg/L	0.000	0.000	0.019 ±0.002	0.034 ± 0.018
Cr	μg/L		0.050	0.17 ±0.02	0.11
Cu	μg/L	0.020	0.030	1.62 ± 0.11	1.30 ± 0.06
Hg	ng/L				
Ni	μg/L	0.020	0.030	0.71 ± 0.05	0.44 ± 0.01
Pb	μg/L	0.003	0.018	0.027 ± 0.005	0.015 ± 0.001
Se	μg/L				
Zn	μg/L	0.030	0.580	1.10 ± 0.14	1.27 ± 0.31

Table 10: Standard Reference Material for Dissolved Trace Metals

Note: Concentrations or recoveries are dissolved (< 0.2 μm) fraction

Sample ID	Date	*Element* *Units*	Hg (ng/L)	Hg (ng/L)	As III (ug/l)	As III+V (ug/l)	MMA (ug/l)	DMA (ug/l)	As Total (ug/l)	Se Total (ug/l)	Cr (ug/L)	Ni (ug/L)	Cu (ug/L)	Zn (ug/L)	Cd (ug/L)	Pb (ug/L)
Standard Reference Material I																
RICCA Hg	7/14/03			0.094												
	Certified Concentration		0.100													
	% Recovery			94.3												
Standard Reference Material II																
CASS 3	10/2/03					1.01		0.06	1.07							
CASS 3	10/2/03					1.13		0.00	1.13							
CASS 3-1	2/2/04									0.02						
CASS 3-2	2/2/04									0.01						
					Mean	1.07		0.03	1.10	0.02						
					Std Dev	0.08		0.04	0.04	0.01						
					Certified Concentration											
					Mean				1.09	0.04	*<<UnCertified*					
					Std Dev				0.07							
					% Recovery				99	271						
Standard Reference Material III																
SLEW 2	2/23/04										0.11					
SLEW 2-1	2/24/04											0.43	1.34	1.05	0.046	0.016
SLEW 2-2	2/24/04											0.44	1.25	1.48	0.021	0.015
					Mean							0.44	1.30	1.27	0.034	0.015
					Stds Dev							0.01	0.06	0.31	0.018	0.001
					Certified Concentration											
					Mean						0.17	0.71	1.62	1.10	0.019	0.027
					Std Dev						0.02	0.05	0.11	0.14	0.002	0.005
					% Recovery						150	162	125	87	57	176
Standard Reference Material IV																
SLRS 4	9/15/03														0.015	
SLRS 4	9/15/03														0.013	
SLRS 4	10/16/03										0.30	0.61	1.87	1.27	0.012	0.100
SLRS 4	10/16/03										0.29	0.66	1.90	1.43	0.011	0.093
					Mean						0.30	0.63	1.89	1.35	0.013	0.096
					Std Dev						0.00	0.04	0.02	0.11	0.002	0.005
					Certified Concentration											
					Mean						0.33	0.67	1.81	0.93	0.012	0.086
					Std Dev						0.02	0.08	0.08	0.1	0.002	0.007
					% Recovery						112	106	96	69	95	89

Table 11: Analytical Replication for Dissolved Trace Metals

Note: Concentrations or recoveries are dissolved (< 0.2 μm) fraction

Sample ID	Date Sampled	Hg (ng/L)	As III (ug/l)	As III+V (ug/l)	MMA (ug/l)	DMA (ug/l)	As Total (ug/l)	Se Total (ug/l)	Cr (ug/L)	Ni (ug/L)	Cu (ug/L)	Zn (ug/L)	Cd (ug/L)	Pb (ug/L)
SER 5a	6/11/03	0.23	0.24	0.42	0.03	0.55	1.00	0.12	0.13	1.30	5.79	2.53	0.053	0.028
SER 5b	6/11/03		0.25	0.43	0.03	0.56	1.03	0.09						
SER 5FDa	6/11/03	0.24	0.24	0.42	0.03	0.60	1.04	0.05	0.19	1.50	5.76	2.85	0.026	0.019
SER 5FDb	6/11/03								0.19	1.47	5.62	2.79	0.026	0.019
SER 5FDc	6/11/03	0.25												
SER5FDdup	6/11/03									1.46	5.68	2.71	0.020	0.018
	Mean	0.24	0.24	0.42	0.03	0.57	1.03	0.09	0.17	1.43	5.71	2.72	0.031	0.021
	Std Dev	0.01	0.01	0.01	0.00	0.03	0.02	0.03	0.03	0.09	0.08	0.14	0.015	0.005
	%RSD	4.9	2.1	2.0	8.3	4.4	2.2	38.5	19.7	6.2	1.3	5.2	48.0	22.8
NER 3	6/24/03			0.28	0.02	0.14	0.43							
NER 3	6/24/03			0.27	0.02	0.14	0.43							
	Mean			0.28	0.02	0.14	0.43							
	Std Dev			0.01	0.000	0.002	0.01							
	%RSD			3.1	0.8	1.4	1.5							
NER 5a	6/24/03							0.14						
NER 5b	6/24/03							0.15						
	Mean							0.14						
	Std Dev							0.003						
	%RSD							2.1						
ELR 2	6/24/03			0.60	0.02	0.03	0.64		0.33	1.59	2.89	2.42	0.019	0.343
ELR 2	6/24/03			0.67	0.03	0.04	0.74		0.34	1.56	2.84	2.40	0.018	0.351
	Mean			0.63	0.02	0.03	0.69		0.34	1.57	2.87	2.41	0.02	0.35
	Std Dev			0.05	0.01	0.01	0.07		0.00	0.02	0.04	0.01	0.00	0.01
	%RSD			8.6	31.7	30.9	10.4		0.8	1.3	1.2	0.6	3.5	1.6
BOR 2a	6/24/03		0.11	0.67	0.02	0.07	0.76							
BOR 2b	6/24/03		0.11	0.56	0.01	0.04	0.62							
	Mean		0.11	0.62	0.02	0.06	0.69							
	Std Dev		0.00	0.08	0.01	0.02	0.10							
	%RSD		1.6	12.3	30.3	41.4	15.2							

Table 12: Spike Recoveries for Dissolved Trace Metals

Note: Concentrations or recoveries are dissolved (< 0.2 µm) fraction

Summary Table					
Element	**Units**	**Blank**	**Spike Conc**	**Spike Rec(%)**	**RPD**
As	µg/L	-0.003	5.00	95	6.4
Cd	µg/L	-0.001	0.10	101	3.5
Cr	µg/L	0.09	2.00	91	0.8
Cu	µg/L	0.15	2.00	97	1.2
Hg	ng/L	0.086	1.00	98	1.2
Ni	µg/L	0.18	2.00	104	1.3
Pb	µg/L	0.04	0.10	115	1.6
Se	µg/L	0.006	0.05	103	20.2
Zn	µg/L	0.73	2.00	90	0.6

Summary Table		Direct	Extracted			
Element	**Units**	**Filter Blank**	**Fil. Blank**	**Spike Conc**	**Spike Rec (%)**	**RPD**
As	µg/L					
Cd	µg/L	0.000	-0.008	2.00	100	48
Cr	µg/L		0.050	2.00	93	19.7
Cu	µg/L	0.020	0.030	2.00	70	1.3
Hg	ng/L					
Ni	µg/L	0.020	0.030	2.00	87	6.2
Pb	µg/L	0.003	0.018	2.00	87	22.8
Se	µg/L					
Zn	µg/L	0.030	0.580	2.00	70	5.2

Table 12: Spike Recoveries for Dissolved Trace Metals

Note: Concentrations or recoveries are dissolved (<0.2 um) fraction

			Element	Hg Recovery	As III Recovery	As III+V Recovery	MMA Recovery	DMA Recovery	As Total	Se Total Recovery
			Units	%	%	%	%	%		%
Sample ID	**Date**	**Spike Amt**	**Preparation**							
SER 5+50pg	6/11/03	50pg	Analysis	97.7						
SER 5+5ng	6/11/03	5ng	Boiling							89.0
SER 5+6ng	6/11/03	6ng	Analysis		63.9	75.1	93.3	73.0		
BOR 2+6ng	6/24/03	6ng	Analysis		77.9					
BOR 2+5ng	6/24/03	5ng	Analysis			113.6	96.2	94.3		
5ng Spike	2/2/04	5ng	Boiling							118.4
SER 5LS2	6/11/03	2.0ppb	Analysis							
ELR 2LS1	6/24/03	0.1ppb	Analysis							
ELR 2LS2	6/24/03	2.0ppb	Analysis							
ELR 2LSpk	6/24/03	1.0ppb	Analysis							
ESpike 3	2/24/04	1.0ppb	Extraction							
SER3+sp	6/11/03	1.0ppb	Extraction							
SER5LS2	6/11/03	2.0ppb	Analysis							
			Average	97.7	70.9	94.3	94.8	83.7		103.7
			Std Dev	NC	9.9	27.3	2.0	15.0		20.8
Field Spikes				**Hg ng/L**	**As III**	**As III+V ng/L**	**MMA ng/L**	**DMA ng/L**	**As Total**	**Se Total ng/L**
			actual spike >>	**1.95**		**4.98**	**4.98**	**4.98**		**0.047**
SER 5(avg)	6/11/03			0.24	0.24	0.42	0.03	0.57		0.11
SER 5FSpk	6/11/03			2.09	1.37	8.80	5.02	5.51		0.16
			%Recovery	94.7		168.2	100.2	99.1		105.3

Note AsV 10ppm stock solution was found to be bad.

Table 12: Spike Recoveries for Dissolved Trace Metals

Note: Concentrations or recoveries are dissolved (<0.2 um) fraction

	Cr Recovery %	Ni Recovery %	Cu Recovery %	Zn Recovery %	Cd Recovery %	Pb Recovery %	Comments	
Sample ID								
SER 5+50pg								
SER 5+5ng								
SER 5+6ng								
BOR 2+6ng								
BOR 2+5ng								
5ng Spike								
SER 5LS2	92.7						LSpike 2:	2ppb (20uL 1000ppb stock added into 10mL sample)
ELR 2LS1	90.0	115.0	115.0	40.0	100.7	115.0	LSpike 1:	0.1ppb (10uL 100ppb stock added into 10mL sample)
ELR 2LS2	91.4	103.8	96.8	90.0	98.8	117.6	LSpike 2:	2ppb (20uL 1000ppb stock added into 10mL sample)
ELR 2LSpk					97.2		LSpk	1ppb (10uL 1000ppb stock added into 10mL sample)
ESpike 3		71.3	101.3	87.3	95.9	81.8		
SER3+sp		109.0	89.1	74.7	97.1	83.6		
SER5LS2		87.0	70.0	70.0	100.2	86.8	LSpike 2:	2ppb (20uL 1000ppb stock added into 10mL sample)
	91.4	97.2	94.4	72.4	98.3	97.0		
	1.4	17.8	16.6	20.0	1.9	17.7		
Field Spikes	**Cr ng/L 0.99**	**Ni ng/L 0.99**	**Cu ng/L 0.99**	**Zn 66 ng/L 0.99**	**Cd ng/L 0.99**	**Pb ng/L 0.99**		
SER 5(avg)	0.16	1.41	5.72	2.68	0.033	0.022		
SER 5FSpk	1.13	1.95	6.41	2.89	0.941	0.836		
							* For T Se did not average FDupl	
	97.4	53.8	69.2	20.8	91.6	82.1		

Note AsV 10ppm s

Table 13. Sediment Grain Size

Grain Size

Station ID	Chem ID	Sand/Silt/Clay Analyses >2 mm	<2mm >0.063mm	<0.063mm >0.039mm	<0.039mm	>< 0.063mm comparison % >0.063mm	%<0.063mm
SER1 (Ave)	9149	0.0	8.3	33.4	58.4	8.3	91.8
SER2	9150	0.0	4.2	61.0	34.8	4.2	95.8
SER3	9151	0.0	27.7	23.1	49.2	27.7	72.3
SER4	9152	0.0	27.0	30.7	42.2	27.0	72.9
SER5	9153	0.0	2.4	54.2	43.4	2.4	97.6
NER1	9154	0.0	10.4	60.9	28.7	10.4	89.6
NER2 (Ave)	9155	0.0	6.5	50.3	43.3	6.5	93.5
NER3	9157	0.0	1.0	54.5	44.6	1.0	99.1
NER4	9158	0.0	18.1	60.3	21.6	18.1	81.9
NER5	9159	0.0	42.7	43.0	14.3	42.7	57.3
BOR1	9160	0.0	15.0	48.2	36.8	15.0	85.0
BOR2	9161	0.0	43.5	28.2	28.2	43.5	56.4
BOR3	9162	0.0	3.6	40.4	56.0	3.6	96.4
BOR4A	9163	0.0	33.2	36.4	30.4	33.2	66.8
BOR4B	9164	0.0	31.5	37.1	31.4	31.5	68.5
BOR4C	9165	0.0	33.1	36.2	30.7	33.1	66.9
ELR1 (Ave)	9166	0.0	1.5	41.5	57.1	1.5	98.6
ELR2	9167	3.8	40.5	26.4	29.3	44.3	55.7
ELR3	9168	0.0	2.2	48.9	48.9	2.2	97.8
ELR4	9169	0.0	4.6	44.9	50.5	4.6	95.4

Table 13. Sediment Grain Size

RPD VALUES

Station ID	Chem ID	Sand Fraction % >0.063 mm	Silt Fraction % <0.063mm >0.039mm	Clay Fraction % <0.039mm
ELR1	9166	1.5	37	61.6
ELR1-DUP	9166	1.4	46	52.6
RPD		**7**	**22**	**16**
NER-2	9155	6.5	51.3	42.2
NER2-DUP	9155	6.5	49.2	44.3
RPD		**0**	**4**	**5**
SER1	9149	8.9	39.1	52.1
SER1-DUP	9149	7.6	27.7	64.7
RPD		**16**	**34**	**22**
Aveage RPD		**7.7**	**20**	**14**

median	3.4
Mean	13.1
Min	1.5
Max	44.3
ELR	13.1
BOR	26.7
NER	15.7
SER	13.9

Field Replicates

		>2 mm	<2mm >0.063mm	<0.063mm >0.039mm	<0.039mm	% >0.063mm	%<0.063mm
BOR4A	9163	0.0	33.2	36.4	30.4	33.2	66.8
BOR4B	9164	0.0	31.5	37.1	31.4	31.5	68.5
BOR4C	9165	0.0	33.1	36.2	30.7	33.1	66.9
	Mean	0.0	32.6	36.6	30.8	32.6	67.4
	RSD	NC	2.9	1.3	1.7	2.9	1.4

Table 14. Concentrations of total organic carbon and total nitrogen

Sample ID	Lab ID	Total Algal Nitrogen % N	RPD N	Qual	Total Algal Carbon % C	RPD C	Qual			
SER1 (Ave)	9149	0.42	9		5.0	4		**SER**	**%N**	**%C**
SER2	9150	0.46	0		5.5	5		Average	0.32	3.84
SER3	9151	0.20	4		2.5	4		Std. Dev.	0.13	1.50
SER4	9152	0.16	8		2.1	5				
SER5	9153	0.35	6		4.2	1				
NER1	9154	0.18	10		2.5	1		**NER**	**%N**	**%C**
NER2 (Ave)	9155	0.23	2		2.8	1		Average	0.22	6.21
NER3	9157	0.28	2		4.4	0		Std. Dev.	0.04	4.12
NER4	9158	0.23	4		10.9	9				
NER5	9159	0.19	11		10.4	9				
BOR1	9160	0.19	11		2.7	18		**BOR**	**%N**	**%C**
BOR2	9161	0.12	9		1.7	2		Average	0.15	2.20
BOR3	9162	0.22	4		3.2	1		Std. Dev.	0.05	0.60
BOR4A	9163	0.11	6		1.9	5				
BOR4B	9164	0.13	4		2.2	2				
BOR4C	9165	0.11	25	J	1.7	21	J			
ELR1 (Ave)	9166	0.22	7		3.0	0				
ELR2	9167	0.13	13		1.7	13		**ELR**	**%N**	**%C**
ELR3	9168	0.21	5		3.1	1		Average	0.20	2.76
ELR4	9169	0.22	3		3.3	1		Std. Dev.	0.05	0.74

Field Replicates

BOR4 AVG

Mean	Stdv	%RSD	
0.12	0.02	13	Carbon
1.90	0.25	13	Nitrogen

Table 15. Percent Sedimentary Water

SITE ID	Chem ID	% Water
SER 1	9149	**82**
SER 2	9150	**83**
SER 3	9151	**67**
SER 4	9152	**65**
SER 5	9153	**72**
NER 1	9154	**61**
NER 2	9155	**65**
RINSEATE BLANK	9156	**NA**
NER 3	9157	**70**
NER 4	9158	**54**
NER 5	9159	**48**
BOR 1	9160	**64**
BOR 2	9161	**54**
BOR 3	9162	**69**
BOR 4-A	9163	**53**
BOR 4-B	9164	**55**
BOR 4-C	9165	**56**
ELR 1	9166	**66**
ELR 2	9167	**51**
ELR 3	9168	**68**
ELR 4	9169	**66**

Mean	Stdev	RSD%
54.6	1.5	2.7

Overall	
median	65
Mean	63
Min	48
Max	83

Table 16. Porewater analysis for dissolved ammonium

Sample ID	Lab ID	Diss. Ammonium mg N/L	RPD N	Qual	Comments
SER 1	9149	7.2			
SER 2	9150	9.6			
SER 3	9151	7.7			
SER 4	9152	2.4			
SER 5	9153	2.2			
NER 1	9154	13.3			
NER 2	9155	13.4			
NER 2 rinseate	9156	NS			Missing Sample or No sample
NER 3	9157	13.2			
NER 4	9158	12.8			
NER 5	9159	5.9			
BOR 1	9160	8.9			
BOR 2	9161	5.8			
BOR 3	9162	5.3			
BOR 4A	9163	3.2			
BOR 4B	9164	4.4			
BOR 4C	9165	3.1			
ELR 1	9166	5.2			
ELR 2	9167	1.7			
ELR 3	9168	2.5			
ELR 4	9169	3.9			

Min	1.71
Max	13.35
Avg	6.58

Field Replication
BOR4 AVG

Mean	Stdv	%RSD
3.54	0.72	20

Appendix I - 2002 and 2003 CBFO Triad Sediment and Water Column Sampling Stations

Triad Sediment Sampling Stations

Date Collected: September 13 to 17, 2002

Group: US FWS-CBPO and ANSP-PCER

Site	General Location	Lat. (d)	Long. (d)	Bottom Depth (m)	Dated Collected	Time	PCER Chem ID #
SER1	Severn River-Upstream nr Pt. Lookout	39.07649	76.59332	5.5	9/13/02	1022	9149
SER2	Severn River-b/w channel marker 9+10	39.05416	76.55703	7.0	9/13/02	1106	9150
SER3	Severn River-near golf course	39.02211	76.52634	5.8	9/13/02	1205	9151
SER4	Severn River-near Rt 50 Bridge	39.00695	76.50487	3.4	9/13/02	0903	9152
SER5	Severn River-Back Creek tributary	38.96343	76.48159	5.2	9/13/02	1306	9153
NER1	Northeast River-Upstream	39.58909	75.95703	4.9	9/16/02	1016	9154
NER2	Northeast River	39.57779	75.95639	4.9	9/16/02	1051	9155
NER3	Northeast River-mouth of 4 marinas	39.56544	75.96565	7.3	9/16/02	1115	9157
NER4	Northeast River-b/w bouy #9 and 8(?)	39.54846	75.97916	5.2	9/16/02	1125	9158
NER5	Northeast River-near Carpenter Pt.	39.54604	75.99584	4.0	9/16/02	NT	9159
BOR1	Bohemia River-mouth of Manor Creek	39.46845	75.87177	3.7	9/17/02	0921	9160
BOR2	Bohemia River-near Stony Point	39.47903	75.88837	5.8	9/17/02	1001	9161
BOR3	Bohemia River-in Veazy Cove	39.47451	75.92241	4.0	9/17/02	1028	9162
BOR4A	Bohemia River-near mouth (Trip 1)	39.47909	75.94521	4.3	9/17/02	1101	9163
BOR4B	Bohemia River-near mouth (Trip 2)	39.47909	75.94521	4.3	9/17/02	1101	9164
BOR4C	Bohemia River-near mouth (Trip 3)	39.47909	75.94521	4.3	9/17/02	1101	9165
ELR1	Elk River-Upstream near SAV bed	39.54113	75.87154	3.4	9/17/02	1208	9166
ELR2	Elk River-near Gr buoys 21+23	39.51228	75.89471	3.7	9/17/02	1250	9167
ELR3	Elk River-in cove near canal anchorage	39.51052	75.92272	4.0	9/17/02	1330	9168
ELR4	Elk River-near Elk Neck State Park	39.4638	75.98253	4.3	9/17/02	1415	9169
NER2r	Northeast River (Rinsate Sample)	39.57779	75.95639	4.9	9/16/02	1051	9156

ELR= Elk River

BOR = Bohemia River

NER = Northeast River

SER = Severn River

NT = Not Taken

Triad Water Column Sampling Stations

Date Collected: June, 2003

Group: ANSP-ERC and PCER

Station ID	Sampling Dates	Time	Bottom Depth (m)	Lat. (dms)	Long. (dms)	Temp. (deg. C)	Sal. (psu)	Cond (mS)	D.O. (mg/L)	pH
SER 3	6/11/03	1030	1.0	39 01' 13.6"	76 31' 34.2"	21.5	5.4	8.89	7.76	NT
SER 3	6/11/03	1030	5.5	39 01' 13.6"	76 31' 34.2"	18.1	7.2	10.87	NT	NT
SER 5	6/11/03	1135	0.5	38 57' 50.1"	76 28' 50.9"	22.4	4.8	8.13	8.68	NT
SER 5	6/11/03	1135	3.0	38 57' 50.1"	76 28' 50.9"	19.3	5.6	8.82	3.4	NT
NER 3	6/24/03	1015	2.5	39 33' 56.1"	75 57' 57.4"	23.5	0.1	0.2	10.1	8.4
NER 5	6/24/03	1047	2.0	39 32' 52.0"	75 59' 47.9"	23.1	0.1	0.2	10.49	8.44
ELR 4	6/24/03	1123	2.0	39 27' 42.7"	75 59' 06.6"	23.4	0.1	0.3	9.51	7.81
ELR 2	6/24/03	1154	4.3	39 38' 43.4"	75 53' 44.4"	23.1	0.2	0.4	7.2	7.15
BOR 2	6/24/03	1219	2.7	39 28' 34.5"	75 53' 12.3"	25.3	0.2	0.5	5.95	7.49

NT = Not Taken

Appendix II - Concentrations for All Analyte

CHEM ID		9149		9150		9151		9152	
STATION ID		**SER1**	**DQ**	**SER2**	**DQ**	**SER3**	**DQ**	**SER4**	**DQ**
RIVER LOCATION		Severn River		Severn River		Severn River		Severn River	
EXTRACTION MASS (g)		10.36		10.16		9.62		10.19	
% Water		82		83		67		65	
Total Organic Carbon (% dw)		4.96		5.48		2.49		2.07	
Total Nitrogen (% dw)		0.42		0.46		0.20		0.16	
pw Ammonia+Ammonium (mg N/L)		7.2		9.6		7.7		2.4	
Grain Size (< 0.063 mm %)		91.8		95.8		72.3		72.9	
Summary (ng/g dry wt)									
TOTAL PAH		6412		5316		1719		1910	
TOTAL PCB		40		68		21		15	
TOTAL CHLORDANES		5.62		8.85		2.79		2.19	
TOTAL DDXs		11.88		18.86		5.83		4.60	
SURROGATE RECOVERIES (%)	**METHOD**								
Phenanthrene-D10	GC-MS	96		90		83		110	
Anthracene-D10	GC-MS	77		96		84		112	
2-Methylnaphthalene	GC-MS	44.4		207.7		69.4		44.7	
Azulene	GC-MS		ND		ND		ND		ND
1-Methylnaphthalene	GC-MS	23.1		155.1		53.5		32.8	
Biphenyl	GC-MS	15.4		90.2		31.1		20.0	
Acenaphthylene	GC-MS	35.5		91.2		31.8		21.0	
Acenaphthene	GC-MS	21.5		66.8		24.4		13.4	
Fluorene	GC-MS	20.5		95.3		24.6		17.2	
1-Methylfluorene	GC-MS	13.5		41.8		10.3		9.7	
Phenanthrene	GC-MS	139.4		370.3		117.2		111.8	
Anthracene	GC-MS	56.0		176.7		62.6		57.9	
o-Terphenyl	GC-MS		ND		ND		ND		ND
2-Methylphenanthrene	GC-MS	45.2		114.2		32.3		36.3	
2-Methylanthracene	GC-MS	20.4		81.5		23.8		27.3	
1-Methylanthracene + 1-Methylphenanthrene	GC-MS	46.5		114.1		32.4		34.8	
9-Methylanthracene	GC-MS	2.4			ND	1.5		2.2	
3,6-dimethylphenanthrene	GC-MS		ND	9.4			BDL		BDL
Flouranthene	GC-MS	779.6		625.0		203.5		173.2	
Pyrene	GC-MS	725.5		553.2		186.0		170.7	
9,10-Dimethylanthracene	GC-MS	5.8		13.7		2.5			BDL
2,3-Benzofluorene	GC-MS	62.5		47.6		19.8		33.3	
Benzo(a)anthracene	GC-MS	404.4		271.0		116.9		162.3	
Chrysene + Triphenylene	GC-MS	492.8		260.7		82.1		89.4	
Benzo(b)fluoranthene	GC-MS	649.5		532.7		157.6		192.3	
7,12-Dimethylbenz(a)anthracene	GC-MS	45.0			ND		BDL		BDL
Benzo(k)fluoranthene	GC-MS	417.9		325.5		137.7		144.3	
Benzo(e)pyrene	GC-MS	600.2		291.5		96.5		139.5	
Benzo(a)pyrene	GC-MS	441.2		212.2		66.8		94.6	
Perylene	GC-MS	347.1		138.4		47.4		74.3	
3-Methylcholanthrene	GC-MS	90.0			ND		ND		ND
Ideno(1,2,3-cd)pyrene	GC-MS		INT		INT		INT		INT
1,2,3,4-Dibenzanthracene	GC-MS	155.5			BDL		BDL	47.3	
Benzo(g,h,i) perylene	GC-MS	478.2		308.1		87.2		119.8	
Anthanthrene	GC-MS	232.9		122.3			BDL	40.4	
Coronene	GC-MS		INT		INT		INT		INT
POLYCHLORINATED BIPHENYLS (ng/g dry)									
SURROGATE RECOVERIES (%)									
PCB 14	GC-ECD	82		85		78		78	
PCB 65	GC-ECD	90		100		90		87	
PCB 166	GC-ECD	82		87		87		83	

Appendix II - Concentrations for All Analyte

CHEM ID		9149		9150		9151		9152	
STATION ID		SER1	DQ	SER2	DQ	SER3	DQ	SER4	DQ
RIVER LOCATION		Severn River		Severn River		Severn River		Severn River	
EXTRACTION MASS (g)		10.36		10.16		9.62		10.19	
PCB 1	GC-ECD		BDL		ND		BDL	0.43	
PCB 3	GC-ECD		ND		ND		ND		ND
PCB 4+10	GC-ECD		BDL		ND		ND		ND
PCB 7	GC-ECD		BDL	0.10		0.04		0.04	
PCB 6	GC-ECD		BDL	0.10			BDL	0.05	
PCB 8+5	GC-ECD	1.27		1.48		0.09		0.14	
PCB 19	GC-ECD		BDL		ND	0.07		0.07	
PCB 12+13	GC-ECD		ND		ND		ND		ND
PCB 18	GC-ECD		ND		ND		ND		ND
PCB 17	GC-ECD		NQ		NQ		NQ		NQ
PCB 24+27	GC-ECD		BDL		BDL		BDL		BDL
PCB 16+32	GC-ECD		BDL	0.25		0.08		0.14	
PCB 29	GC-ECD		BDL	0.34		0.12		0.07	
PCB 26	GC-ECD	0.21		0.44		0.19		0.16	
PCB 25	GC-ECD	0.17		0.48		0.10		0.17	
PCB 31+28	GC-ECD	0.70		2.57		0.56		0.37	
PCB 53+33+21	GC-ECD	0.25		0.44		0.13		0.10	
PCB 22	GC-ECD	0.41		1.19		0.29		0.27	
PCB 45	GC-ECD	0.10		0.42		0.08		0.08	
PCB 46	GC-ECD	0.09		0.25		0.09		0.08	
PCB 52	GC-ECD	0.69		1.78		0.20		0.11	
PCB 49	GC-ECD	0.82		1.91		0.27		0.21	
PCB 47	GC-ECD	1.03		1.83		1.17		1.48	
PCB 48	GC-ECD	0.08		0.23		0.12		0.08	
PCB 44	GC-ECD	0.50		1.12		0.16		0.13	
PCB 37+42	GC-ECD		ND	0.51		0.32		0.25	
PCB 41+71	GC-ECD	0.35		0.43		0.16		0.19	
PCB 64	GC-ECD		BDL		ND	1.69		1.16	
PCB 40	GC-ECD	0.16		0.43			ND		ND
PCB 100	GC-ECD		NQ		NQ		NQ		NQ
PCB 63	GC-ECD		BDL		ND		ND		ND
PCB 74	GC-ECD	0.35		0.71		0.22		0.18	
PCB 70+76	GC-ECD	1.02		1.90		0.47		0.27	
PCB 66	GC-ECD	0.81		1.04		0.33		0.24	
PCB 95	GC-ECD	0.68		1.09		0.33		0.08	
PCB 91	GC-ECD	0.35		1.04		0.12		0.13	
PCB 56+60	GC-ECD	0.92		3.15		0.80		0.55	
PCB 101	GC-ECD	1.13		1.65		0.31		0.18	
PCB 99	GC-ECD	0.99		1.40		0.22		0.16	
PCB 83	GC-ECD	0.09		0.23		0.07		0.05	
PCB 97	GC-ECD	0.27		0.50		0.09		0.05	
PCB 87+81	GC-ECD	0.28		0.36		0.17		0.11	
PCB 85	GC-ECD	0.16		0.36		0.08		0.03	
PCB 136	GC-ECD	0.11		0.24		0.04		0.03	
PCB 77+110	GC-ECD	1.93		2.77		0.48		0.31	
PCB 82	GC-ECD	0.08		0.18		0.05		0.04	
PCB 151	GC-ECD	0.38		0.65		0.13		0.09	
PCB 135+144	GC-ECD	0.32		0.51		0.09		0.07	
PCB 107	GC-ECD	0.20		0.38		0.08		0.06	
PCB 149	GC-ECD	1.69		2.53		0.38		0.26	
PCB 118	GC-ECD	1.20		1.68		0.37		0.24	
PCB 134	GC-ECD		ND		ND		ND		ND
PCB 131	GC-ECD	0.03		0.06		0.01		0.01	
PCB 146	GC-ECD	0.56		1.05		0.22		0.16	
PCB 153+132+105	GC-ECD	4.46		6.19		1.06		0.69	
PCB 141	GC-ECD	0.23		0.25		0.12		0.04	
PCB 137+176	GC-ECD		BDL	0.28			BDL		BDL
PCb 163+138	GC-ECD	2.83		2.93		0.72		0.54	

Appendix II - Concentrations for All Analyte

CHEM ID		9149		9150		9151		9152	
STATION ID		SER1	DQ	SER2	DQ	SER3	DQ	SER4	DQ
RIVER LOCATION		Severn River		Severn River		Severn River		Severn River	
EXTRACTION MASS (g)		10.36		10.16		9.62		10.19	
PCB 158	GC-ECD		BDL		ND		ND		ND
PCb 129+178	GC-ECD	0.20		0.30		0.23		0.16	
PCB 187+182	GC-ECD	0.99		0.91		0.27		0.14	
PCB 183	GC-ECD	0.57		0.62		0.29		0.19	
PCB 128	GC-ECD	0.32		0.36		0.15		0.10	
PCB 185	GC-ECD	0.07		0.19		0.15		0.10	
PCB 174	GC-ECD	0.29		0.26		0.09		0.05	
PCB 177	GC-ECD	0.50		0.64		0.22		0.17	
PCB 202+171	GC-ECD	0.41		0.69		0.21		0.20	
PCB 157+200	GC-ECD	0.11		0.40		0.15		0.16	
PCB 172+197	GC-ECD	0.15		0.36		0.19		0.14	
PCB 180	GC-ECD	1.34		1.34		0.35		0.32	
PCB 193	GC-ECD	0.15		0.48		0.28		0.11	
PCB 191	GC-ECD		BDL	0.38		0.27		0.12	
PCB 199	GC-ECD	0.06		0.26		0.16		0.07	
PCB 170+190	GC-ECD	1.60		1.14		0.61		0.36	
PCB 198	GC-ECD	0.07		0.30		0.15		0.10	
PCB 201	GC-ECD	0.92		1.07		0.35		0.24	
PCB 203+196	GC-ECD	1.06		1.12		0.41		0.27	
PCB 189	GC-ECD		BDL	1.32		1.14		0.26	
PCB 208+195	GC-ECD	0.43		0.54		0.32		0.16	
PCB 207	GC-ECD	0.10		0.37		0.13		0.06	
PCB 194	GC-ECD	0.56		0.43		0.18		0.14	
PCB 205	GC-ECD	0.05			ND		ND	0.05	
PCB 206	GC-ECD	1.05		2.32		0.66			ND
PCB 209	GC-ECD	1.21		3.09		1.08		0.80	
ORGANOCHLORINE PESTICIDES (ng/g dry)									
opDDE	GC-ECD	0.53		1.05		0.30		0.25	
ppDDE	GC-ECD	1.78		3.75		0.59		0.45	
op DDT	GC-ECD	4.76		2.99		0.97		1.13	
pp DDT	GC-ECD	3.26		3.92		2.73		1.74	
o,p DDD	GC-ECD	0.55		2.77		0.39		0.37	
p,p DDD	GC-ECD	0.99		4.39		0.86		0.65	
Total DDXs	GC-ECD	**11.88**		**18.86**		**5.83**		**4.60**	
alpha BHC	GC-ECD	0.66		0.76		0.36		0.30	
beta BHC	GC-ECD	1.06		1.27		0.15		0.17	
delta BHC	GC-ECD	0.33		0.58		0.30		0.32	
lindane	GC-ECD	1.16		1.67		0.23		0.65	
heptachlor	GC-ECD	0.76		3.40		1.07		0.42	
heptachlor epoxide	GC-ECD	0.65		1.10		0.36		0.40	
oxychlordane	GC-ECD	0.85		1.42		0.57		0.58	
gamma chlordane	GC-ECD	1.39		0.71		0.25		0.29	
alpha chlordane	GC-ECD	0.93		0.87		0.29		0.30	
cis nonachlor	GC-ECD	0.26		0.51		BDL		BDL	
trans nonachlor	GC-ECD	0.78		0.83		0.24		0.20	
Total Chlordanes	GC-ECD	**5.62**		**8.85**		**2.79**		**2.19**	
dieldrin	GC-ECD		NQ		NQ		NQ		NQ
endrin	GC-ECD	1.16		1.52		0.51		0.69	
aldrin	GC-ECD	0.31		0.49		0.23		0.29	
endosulfan I	GC-ECD	ND		ND		0.19		ND	
endosulfan II	GC-ECD	ND		ND		0.43		ND	
SEDIMENTARY METALS (ug/g dw except Al and Fe in mg/g dw)									
Total As	HGA	21.0		27.0		20.5		22.2	
Cd	GFAAS	2.0		2.8		0.6		0.2	

Appendix II - Concentrations for All Analyte

CHEM ID		9149		9150		9151		9152	
STATION ID		**SER1**	**DQ**	**SER2**	**DQ**	**SER3**	**DQ**	**SER4**	**DQ**
RIVER LOCATION		Severn River		Severn River		Severn River		Severn River	
EXTRACTION MASS (g)		10.36		10.16		9.62		10.19	
Cr	ICP	88.3		125.8		122.4		116.6	
Al	ICP	70.1		68.4		57.5		56.1	
Fe	Flame	44.0		65.1		67.7		70.3	
Cu	Flame	119.8		113.7		47.1		37.1	
Zn	Flame	383.1		503.5		280.2		229.0	
Ni	Flame	65.0		77.1		42.7		37.8	
Pb	Flame	96.7		136.3		58.1		62.5	
SIMULTANEOUSLY EXTRACTABLE METALS									
Units: wet weight		(umoles/g)		(umoles/g)		(umoles/g)		(umoles/g)	
AVS		6.15		7.80		3.72		3.29	
	Method								
Cu	Flame	0.001		0.001		0.029		0.063	
Cr	ICP	0.019		0.028		0.032		0.047	
Zn	Flame	0.778		0.863		0.684		0.688	
Ni	Flame	0.018		0.014		0.056		0.057	
Pb	Flame	0.049		0.053		0.040		0.059	
Cd	GFAAS	0.003		0.003		0.001		0.001	
Units: dry wt									
Cu	Flame	0.008		0.009		0.092		0.185	
Cr	ICP	0.130		0.183		0.101		0.138	
Zn	Flame	5.317		5.625		2.144		2.017	
Ni	Flame	0.122		0.090		0.176		0.166	
Pb	Flame	0.335		0.343		0.124		0.172	
Cd	GFAAS	0.017		0.021		0.002		0.002	
MERCURY									
Units: dry wt		(ng/g)		(ng/g)		(ng/g)		(ng/g)	
Hg	ICP	216.3		488.4		183.9		147.7	

Appendix II - Concentrations for All Analyte

CHEM ID		9153		9154		9155		9156	
STATION ID		**SER5**	**DQ**	**NER1**	**DQ**	**NER2**	**DQ**	**rinse blank**	**DQ**
RIVER LOCATION		Back Creek		Northeast River		Northeast River			
EXTRACTION MASS (g)		9.83		9.83		10.50		10.43	
% Water		72		61		65		65	
Total Organic Carbon (% dw)		4.21		2.5		2.8		NA	
Total Nitrogen (% dw)		0.35		0.18		0.23		NA	
pw Ammonia+Ammonium (mg N/L)		2.2		13.3		13.4		NA	
Grain Size (< 0.063 mm %)		97.6		89.6		93.5		NA	
Summary (ng/g dry wt)									
TOTAL PAH		16908		3555		2566		383	
TOTAL PCB		86		12		24		1	
TOTAL CHLORDANES		7.63		2.33		2.93		0.27	
TOTAL DDXs		14.64		8.04		7.17		0.78	
SURROGATE RECOVERIES (%)	**METHOD**								
Phenanthrene-D10	GC-MS	90		93		86		none added	
Anthracene-D10	GC-MS	103		101		96		none added	
2-Methylnaphthalene	GC-MS	145.3		54.7		118.8		4.4	
Azulene	GC-MS		ND	1.2			ND		ND
1-Methylnaphthalene	GC-MS	99.1		32.9		63.3		4.4	
Biphenyl	GC-MS	59.9		16.4		30.8			ND
Acenaphthylene	GC-MS	97.8		54.9		38.5			ND
Acenaphthene	GC-MS	67.9		16.1		28.2			ND
Fluorene	GC-MS	68.2		18.7		28.8			ND
1-Methylfluorene	GC-MS	30.4		8.8		14.2			ND
Phenanthrene	GC-MS	609.2		83.2		127.5		11.4	
Anthracene	GC-MS	232.9		52.4		62.2			BDL
o-Terphenyl	GC-MS	1.6			ND		ND		ND
2-Methylphenanthrene	GC-MS	152.5		38.1		44.7			ND
2-Methylanthracene	GC-MS	122.0		43.1		34.3			ND
1-Methylanthracene + 1-Methylphenanthrene	GC-MS	131.9		33.4		44.5			ND
9-Methylanthracene	GC-MS		ND		ND		ND		ND
3,6-dimethylphenanthrene	GC-MS	13.6		6.6		5.2			BDL
Flouranthene	GC-MS	2465.1		242.0		187.1			BDL
Pyrene	GC-MS	1889.2		298.3		204.0			ND
9,10-Dimethylanthracene	GC-MS	22.6		2.4		2.7			ND
2,3-Benzofluorene	GC-MS	135.2		36.9		21.2		7.9	
Benzo(a)anthracene	GC-MS	884.5		297.8		113.4		244.4	
Chrysene + Triphenylene	GC-MS	1724.5		257.6		91.2		111.1	
Benzo(b)fluoranthene	GC-MS	1216.3		281.4		159.1			ND
7,12-Dimethylbenz(a)anthracene	GC-MS	91.7		17.3		22.0			ND
Benzo(k)fluoranthene	GC-MS	615.2		174.2		117.1			ND
Benzo(e)pyrene	GC-MS	1915.6		184.1		86.6			ND
Benzo(a)pyrene	GC-MS	1963.8		207.8		70.2			ND
Perylene	GC-MS	498.9		672.7		704.9			ND
3-Methylcholanthrene	GC-MS	156.9		66.7		42.1			ND
Ideno(1,2,3-cd)pyrene	GC-MS		INT		INT		INT		INT
1,2,3,4-Dibenzanthracene	GC-MS	345.7		73.9			ND		ND
Benzo(g,h,i) perylene	GC-MS	797.0		185.6		103.4			ND
Anthanthrene	GC-MS	353.1	INT	96.0			BDL		ND
Coronene	GC-MS				INT		INT		INT
POLYCHLORINATED BIPHENYLS (ng/g dry)									
SURROGATE RECOVERIES (%)									
PCB 14	GC-ECD	86		79		92		none added	
PCB 65	GC-ECD	104		97		116		none added	
PCB 166	GC-ECD	84		82		96		none added	

Appendix II - Concentrations for All Analyte

CHEM ID		9153		9154		9155		9156	
STATION ID		SER5	DQ	NER1	DQ	NER2	DQ	rinse blank	DQ
RIVER LOCATION		Back Creek		Northeast River		Northeast River			
EXTRACTION MASS (g)		9.83		9.83		10.50		10.43	
PCB 1	GC-ECD	0.77			BDL	0.75			ND
PCB 3	GC-ECD		ND		ND		ND		ND
PCB 4+10	GC-ECD		BDL		ND		BDL		BDL
PCB 7	GC-ECD	0.08		0.02		0.06			ND
PCB 6	GC-ECD	0.09			BDL	0.06			ND
PCB 8+5	GC-ECD	1.66		0.11		0.18		0.08	
PCB 19	GC-ECD	0.21		0.06		0.09			ND
PCB 12+13	GC-ECD		ND		ND		ND	0.03	
PCB 18	GC-ECD		ND		ND		ND	0.02	
PCB 17	GC-ECD		NQ		NQ		NQ		NQ
PCB 24+27	GC-ECD		BDL		BDL		BDL		ND
PCB 16+32	GC-ECD	0.51			BDL		BDL		BDL
PCB 29	GC-ECD	0.22		0.07		0.16			BDL
PCB 26	GC-ECD	0.46		0.10		0.15			BDL
PCB 25	GC-ECD	0.33		0.09		0.12			ND
PCB 31+28	GC-ECD	2.11		0.29		0.60			BDL
PCB 53+33+21	GC-ECD	0.77		0.11		0.14			BDL
PCB 22	GC-ECD	1.00		0.17		0.22			BDL
PCB 45	GC-ECD	0.28		0.05		0.07			BDL
PCB 46	GC-ECD	0.18		0.09		0.12			BDL
PCB 52	GC-ECD	1.99		0.13		0.32			BDL
PCB 49	GC-ECD	2.32		0.17		0.31			BDL
PCB 47	GC-ECD	2.87		0.74		0.54		0.52	
PCB 48	GC-ECD	0.36		0.07		0.12			ND
PCB 44	GC-ECD	1.80		0.19		0.31			BDL
PCB 37+42	GC-ECD	0.20		0.05		0.08			BDL
PCB 41+71	GC-ECD	0.34		0.10		0.12			BDL
PCB 64	GC-ECD	2.14			ND		BDL		ND
PCB 40	GC-ECD	0.45		0.20		0.33			BDL
PCB 100	GC-ECD		NQ		NQ		NQ		NQ
PCB 63	GC-ECD		ND		ND		ND		BDL
PCB 74	GC-ECD	0.79		0.16		0.22			BDL
PCB 70+76	GC-ECD	2.20		0.22		0.42			BDL
PCB 66	GC-ECD	1.70		0.09		0.25			BDL
PCB 95	GC-ECD	2.24		0.12		0.22			BDL
PCB 91	GC-ECD	0.80			ND	0.07			BDL
PCB 56+60	GC-ECD	2.42		0.41		0.61			BDL
PCB 101	GC-ECD	2.42		0.14		0.28			BDL
PCB 99	GC-ECD	1.95		0.14		0.22		0.02	
PCB 83	GC-ECD	0.22		0.04		0.09			BDL
PCB 97	GC-ECD	0.74		0.06		0.13			BDL
PCB 87+81	GC-ECD	0.54		0.15		0.25			BDL
PCB 85	GC-ECD	0.37		0.05		0.12		0.01	
PCB 136	GC-ECD	0.29		0.04		0.09			BDL
PCB 77+110	GC-ECD	4.16		0.43		0.64		0.03	
PCB 82	GC-ECD	0.19		0.04		0.07			BDL
PCB 151	GC-ECD	0.75		0.09		0.17			BDL
PCB 135+144	GC-ECD	0.50		0.09		0.16			BDL
PCB 107	GC-ECD	0.42		0.06		0.12			BDL
PCB 149	GC-ECD	3.40		0.28		0.51			BDL
PCB 118	GC-ECD	2.94		0.26		0.47			BDL
PCB 134	GC-ECD		ND		ND		ND		BDL
PCB 131	GC-ECD	0.08		0.02		0.05			BDL
PCB 146	GC-ECD	1.13		0.14		0.28			BDL
PCB 153+132+105	GC-ECD	8.63		0.80		1.29			BDL
PCB 141	GC-ECD	0.36		0.04		0.06			BDL
PCB 137+176	GC-ECD	0.18			ND		ND		BDL
PCb 163+138	GC-ECD	5.52		0.80		1.32			BDL

Appendix II - Concentrations for All Analyte

CHEM ID		9153		9154		9155		9156	
STATION ID		SER5	DQ	NER1	DQ	NER2	DQ	rinse blank	DQ
RIVER LOCATION		Back Creek		Northeast River		Northeast River			
EXTRACTION MASS (g)		9.83		9.83		10.50		10.43	
PCB 158	GC-ECD		BDL		BDL		BDL		BDL
PCb 129+178	GC-ECD	0.43		0.06		0.25			BDL
PCB 187+182	GC-ECD	1.43		0.09		0.27			BDL
PCB 183	GC-ECD	0.68		0.06		0.26			BDL
PCB 128	GC-ECD	0.56		0.11		0.24			BDL
PCB 185	GC-ECD	0.15		0.06		0.16			ND
PCB 174	GC-ECD	0.52			BDL	0.16			ND
PCB 177	GC-ECD	0.69		0.16		0.22			ND
PCB 202+171	GC-ECD	0.47		0.21		0.33			BDL
PCB 157+200	GC-ECD	0.39		0.10		0.21			ND
PCB 172+197	GC-ECD	0.23		0.07		0.17			ND
PCB 180	GC-ECD	2.39		0.36		0.54		0.03	
PCB 193	GC-ECD	0.16		0.08		0.38		0.04	
PCB 191	GC-ECD	0.09			BDL		ND		BDL
PCB 199	GC-ECD	0.07		0.05		0.13			BDL
PCB 170+190	GC-ECD	2.16		0.38		0.54			ND
PCB 198	GC-ECD	0.12		0.06		0.17			BDL
PCB 201	GC-ECD	1.22		0.27		0.52			BDL
PCB 203+196	GC-ECD	1.24		0.37		0.70			BDL
PCB 189	GC-ECD	0.37		0.23		1.13			BDL
PCB 208+195	GC-ECD	0.83		0.13		0.43			ND
PCB 207	GC-ECD	0.18		0.11		0.25			ND
PCB 194	GC-ECD	0.68		0.16		0.26			BDL
PCB 205	GC-ECD		ND		ND	0.13			ND
PCB 206	GC-ECD	2.25		0.65		1.64			BDL
PCB 209	GC-ECD	2.75		0.81		1.84		0.00	
ORGANOCHLORINE PESTICIDES (ng/g dry)									
opDDE	GC-ECD	0.82		0.17		0.32		BDL	
ppDDE	GC-ECD	2.05		0.66		0.95		ND	
op DDT	GC-ECD	3.23		1.22		1.28		0.19	
pp DDT	GC-ECD	5.08		4.63		3.08		0.48	
o,p DDD	GC-ECD	1.09		0.37		0.29		0.06	
p,p DDD	GC-ECD	2.37		0.99		1.25		0.05	
Total DDXs	GC-ECD	**14.64**		**8.04**		**7.17**		**0.78**	
alpha BHC	GC-ECD	0.41		0.35		0.31		0.16	
beta BHC	GC-ECD	0.72		0.23		0.32		0.06	
delta BHC	GC-ECD	0.54		0.38		0.39		0.08	
lindane	GC-ECD	1.07		0.81		0.86		0.14	
heptachlor	GC-ECD	3.39		0.39		0.61		BDL	
heptachlor epoxide	GC-ECD	0.31		0.57		0.60		0.11	
oxychlordane	GC-ECD	0.97		0.46		0.45		0.02	
gamma chlordane	GC-ECD	0.85		0.37		0.54		0.09	
alpha chlordane	GC-ECD	0.57		0.53		0.31		0.05	
cis nonachlor	GC-ECD	0.60		BDL		0.33		BDL	
trans nonachlor	GC-ECD	0.94		ND		0.09		BDL	
Total Chlordanes	GC-ECD	**7.63**		**2.33**		**2.93**		**0.27**	
dieldrin	GC-ECD		NQ		NQ		NQ		NQ
endrin	GC-ECD	2.07		1.13		1.20		0.20	
aldrin	GC-ECD	0.41		0.31		0.28		0.10	
endosulfan I	GC-ECD	ND		0.24		0.25		0.09	
endosulfan II	GC-ECD	ND		0.56		0.59		0.20	
SEDIMENTARY METALS (ug/g dw except Al and Fe i									
Total As	HGA	28.5		6.0		8.3			
Cd	GFAAS	0.8		0.3		0.4			

Appendix II - Concentrations for All Analyte

CHEM ID		9153		9154		9155		9156	
STATION ID		**SER5**	**DQ**	**NER1**	**DQ**	**NER2**	**DQ**	**rinse blank**	**DQ**
RIVER LOCATION		Back Creek		Northeast River		Northeast River			
EXTRACTION MASS (g)		9.83		9.83		10.50		10.43	
Cr	ICP	178.7		83.2		91.3			
Al	ICP	66.1		66.3		75.5			
Fe	Flame	97.4		32.4		38.4			
Cu	Flame	601.1		29.6		41.9			
Zn	Flame	616.5		122.0		172.9			
Ni	Flame	60.9		47.1		61.5			
Pb	Flame	139.7		31.6		39.5			
SIMULTANEOUSLY EXTRACTABLE METALS									
Units: wet weight		(umoles/g)		(umoles/g)		(umoles/g)			
AVS		9.39		3.01		2.33			
	Method								
Cu	Flame	0.504		0.031		0.060			
Cr	ICP	0.082		0.034		0.039			
Zn	Flame	1.883		0.368		0.505			
Ni	Flame	0.039		0.063		0.093			
Pb	Flame	0.123		0.040		0.048			
Cd	GFAAS	0.002		0.001		0.001			
Units: dry wt									
Cu	Flame	1.850		0.083		0.181			
Cr	ICP	0.300		0.090		0.118			
Zn	Flame	6.918		0.972		1.516			
Ni	Flame	0.144		0.167		0.279			
Pb	Flame	0.453		0.105		0.145			
Cd	GFAAS	0.006		0.002		0.004			
MERCURY									
Units: dry wt		(ng/g)		(ng/g)		(ng/g)			
Hg	ICP	612.2		77.6		116.7			

Appendix II - Concentrations for All Analyte

CHEM ID		9157		9158		9159		9160	
STATION ID		**NER3**	**DQ**	**NER4**	**DQ**	**NER5**	**DQ**	**BOR1**	**DQ**
RIVER LOCATION		Northeast River		Northeast River		Northeast River		Bohemia River	
EXTRACTION MASS (g)		10.66		10.12		10.16		10.99	
% Water		70		54		48		64	
Total Organic Carbon (% dw)		4.44		10.92		10.37		2.67	
Total Nitrogen (% dw)		0.28		0.23		0.19		0.19	
pw Ammonia+Ammonium (mg N/L)		13.2		12.8		5.9		8.9	
Grain Size (< 0.063 mm %)		99.1		81.9		57.3		85	
Summary (ng/g dry wt)									
TOTAL PAH		4303		4366		3078		1197	
TOTAL PCB		50		45		29		21	
TOTAL CHLORDANES		3.85		2.18		0.58		1.06	
TOTAL DDXs		10.72		8.03		0.71		3.59	
SURROGATE RECOVERIES (%)	**METHOD**								
Phenanthrene-D10	GC-MS	107		74		109		104	
Anthracene-D10	GC-MS	115		75		116		109	
2-Methylnaphthalene	GC-MS	206.9		234.1		151.4		34.8	
Azulene	GC-MS		ND	1.1			ND		ND
1-Methylnaphthalene	GC-MS	124.6		162.9		100.5		20.6	
Biphenyl	GC-MS	64.1		90.8		54.6		13.3	
Acenaphthylene	GC-MS	74.9		99.1		61.3		13.5	
Acenaphthene	GC-MS	47.2		55.2		36.3		9.6	
Fluorene	GC-MS	69.0		86.5		54.5		11.8	
1-Methylfluorene	GC-MS	27.3		37.3		23.2		4.5	
Phenanthrene	GC-MS	323.2		371.1		286.1		60.6	
Anthracene	GC-MS	141.5		151.8		118.7		21.7	
o-Terphenyl	GC-MS	1.0		0.9		0.6			ND
2-Methylphenanthrene	GC-MS	104.8		102.7		77.4		18.9	
2-Methylanthracene	GC-MS	76.3		74.1		53.1		6.9	
1-Methylanthracene + 1-Methylphenanthrene	GC-MS	111.1		107.9		78.2		16.9	
9-Methylanthracene	GC-MS	3.8		5.1			ND		ND
3,6-dimethylphenanthrene	GC-MS	6.0		8.7		5.3			BDL
Flouranthene	GC-MS	328.7		354.4		254.1		83.3	
Pyrene	GC-MS	377.5		418.3		294.3		95.2	
9,10-Dimethylanthracene	GC-MS	8.5		5.5		4.2			ND
2,3-Benzofluorene	GC-MS	37.3		36.0		20.9		11.7	
Benzo(a)anthracene	GC-MS	224.6		224.5		171.3		67.3	
Chrysene + Triphenylene	GC-MS	231.9		235.2		152.4		54.7	
Benzo(b)fluoranthene	GC-MS	244.6		201.6		184.7		122.7	
7,12-Dimethylbenz(a)anthracene	GC-MS	22.0		16.7		19.5			ND
Benzo(k)fluoranthene	GC-MS	182.4		128.6		111.7		94.9	
Benzo(e)pyrene	GC-MS	144.0		213.0		109.7		56.3	
Benzo(a)pyrene	GC-MS	134.7		192.6		115.4		36.6	
Perylene	GC-MS	641.4		460.5		306.8		230.9	
3-Methylcholanthrene	GC-MS	39.1		31.5		45.0		41.3	
Ideno(1,2,3-cd)pyrene	GC-MS		INT		INT		INT		INT
1,2,3,4-Dibenzanthracene	GC-MS	61.8		53.5		37.6			ND
Benzo(g,h,i) perylene	GC-MS	160.5		148.2		108.7		69.2	
Anthanthrene	GC-MS	82.3		57.0		40.4			ND
Coronene	GC-MS		INT		INT		INT		INT
POLYCHLORINATED BIPHENYLS (ng/g dry)									
SURROGATE RECOVERIES (%)									
PCB 14	GC-ECD	90		80		92		89	
PCB 65	GC-ECD	108		86		99		84	
PCB 166	GC-ECD	87		82		97		93	

Appendix II - Concentrations for All Analyte

CHEM ID		9157		9158		9159		9160	
STATION ID		NER3	DQ	NER4	DQ	NER5	DQ	BOR1	DQ
RIVER LOCATION		Northeast River		Northeast River		Northeast River		Bohemia River	
EXTRACTION MASS (g)		10.66		10.12		10.16		10.99	
PCB 1	GC-ECD	0.73		0.64		0.61			BDL
PCB 3	GC-ECD		ND	1.60		1.76			ND
PCB 4+10	GC-ECD	0.06		0.07		0.08			BDL
PCB 7	GC-ECD	0.07		0.05		0.06		0.02	
PCB 6	GC-ECD	0.11			ND		ND		BDL
PCB 8+5	GC-ECD	0.59		0.69		0.42		0.20	
PCB 19	GC-ECD	0.07		0.10		0.12		0.07	
PCB 12+13	GC-ECD		ND		ND		ND		ND
PCB 18	GC-ECD		ND		ND		ND		ND
PCB 17	GC-ECD		NQ		NQ		NQ		NQ
PCB 24+27	GC-ECD		BDL		BDL		BDL		BDL
PCB 16+32	GC-ECD	0.19		0.23		0.22			BDL
PCB 29	GC-ECD	0.21		0.15		0.11		0.04	
PCB 26	GC-ECD	0.22		0.24		0.18		0.08	
PCB 25	GC-ECD	0.10		0.13		0.10		0.08	
PCB 31+28	GC-ECD	1.24		1.08		0.68		0.36	
PCB 53+33+21	GC-ECD	0.37		0.22		0.20		0.13	
PCB 22	GC-ECD	0.47		0.35		0.24		0.19	
PCB 45	GC-ECD	0.11		0.36		0.09		0.08	
PCB 46	GC-ECD	0.08		0.09		0.10		0.08	
PCB 52	GC-ECD	0.72		0.66		0.39		0.20	
PCB 49	GC-ECD	0.73		0.57		0.39		0.26	
PCB 47	GC-ECD	1.29		0.50		0.42		0.50	
PCB 48	GC-ECD	0.23		0.13		0.16		0.10	
PCB 44	GC-ECD		ND	0.18		0.10		0.23	
PCB 37+42	GC-ECD	0.13		0.19		0.08		0.24	
PCB 41+71	GC-ECD	0.16		0.15		0.12		0.09	
PCB 64	GC-ECD		BDL		ND	2.02		3.07	
PCB 40	GC-ECD	0.31		0.40		0.16		0.08	
PCB 100	GC-ECD		NQ		NQ		NQ		NQ
PCB 63	GC-ECD		ND	0.28			ND	0.20	
PCB 74	GC-ECD	0.46		0.39		0.28		0.14	
PCB 70+76	GC-ECD	0.95		1.03		0.67		0.34	
PCB 66	GC-ECD	0.64		0.91		0.53		0.34	
PCB 95	GC-ECD	0.56		0.42		0.22		0.18	
PCB 91	GC-ECD	0.12		0.09		0.05		0.07	
PCB 56+60	GC-ECD	1.60		1.37		0.72		0.57	
PCB 101	GC-ECD	0.58		0.62		0.37		0.22	
PCB 99	GC-ECD	0.42		0.31		0.21		0.19	
PCB 83	GC-ECD	0.11		0.07		0.06		0.03	
PCB 97	GC-ECD	0.20		0.21		0.13		0.07	
PCB 87+81	GC-ECD	0.35		0.31		0.16		0.05	
PCB 85	GC-ECD	0.24		0.18		0.12		0.08	
PCB 136	GC-ECD	0.11		0.13		0.09		0.05	
PCB 77+110	GC-ECD	1.40		1.17		0.66		0.41	
PCB 82	GC-ECD	0.14		0.13		0.07		0.05	
PCB 151	GC-ECD	0.34		0.34		0.22		0.13	
PCB 135+144	GC-ECD	0.27		0.24		0.13		0.07	
PCB 107	GC-ECD	0.19		0.15		0.07		0.07	
PCB 149	GC-ECD	0.94		0.91		0.59		0.36	
PCB 118	GC-ECD	0.95		0.75		0.46		0.26	
PCB 134	GC-ECD		ND		ND		ND		ND
PCB 131	GC-ECD	0.05		0.05		0.03		0.02	
PCB 146	GC-ECD	0.46		0.39		0.29		0.18	
PCB 153+132+105	GC-ECD	2.65		2.44		1.58		0.93	
PCB 141	GC-ECD	0.16		0.19		0.10		0.08	
PCB 137+176	GC-ECD	0.12			ND		ND		ND
PCb 163+138	GC-ECD	2.55		2.12		1.29		0.79	

Appendix II - Concentrations for All Analyte

CHEM ID		9157		9158		9159		9160	
STATION ID		NER3	DQ	NER4	DQ	NER5	DQ	BOR1	DQ
RIVER LOCATION		Northeast River		Northeast River		Northeast River		Bohemia River	
EXTRACTION MASS (g)		10.66		10.12		10.16		10.99	
PCB 158	GC-ECD		BDL	0.21		0.07			BDL
PCb 129+178	GC-ECD	0.24		0.30		0.10		0.06	
PCB 187+182	GC-ECD	0.74		0.64		0.34		0.21	
PCB 183	GC-ECD	0.56		0.46		0.28		0.28	
PCB 128	GC-ECD	0.30		0.29		0.18		0.11	
PCB 185	GC-ECD	0.15		0.15		0.14		0.11	
PCB 174	GC-ECD	0.43		0.33		0.30		0.13	
PCB 177	GC-ECD	0.45		0.36		0.28		0.18	
PCB 202+171	GC-ECD	0.55		0.44		0.32		0.14	
PCB 157+200	GC-ECD	0.29		0.29		0.18		0.13	
PCB 172+197	GC-ECD	0.20		0.38		0.22		0.89	
PCB 180	GC-ECD	1.38		1.29		0.73		0.33	
PCB 193	GC-ECD	0.22		0.22		0.18		0.14	
PCB 191	GC-ECD		ND	0.29		0.12			ND
PCB 199	GC-ECD	0.10		0.08		0.05		0.08	
PCB 170+190	GC-ECD	1.15		0.87		0.50		0.28	
PCB 198	GC-ECD	0.11		0.12		0.08		0.14	
PCB 201	GC-ECD	1.23		1.21		0.62		0.43	
PCB 203+196	GC-ECD	1.48		1.01		0.56		0.54	
PCB 189	GC-ECD	0.64		0.35		0.28		0.17	
PCB 208+195	GC-ECD	0.78		2.76		1.28		1.13	
PCB 207	GC-ECD	0.52		0.35		0.18		0.27	
PCB 194	GC-ECD	0.41		0.29		0.21		0.16	
PCB 205	GC-ECD	0.13		0.07		0.09		0.06	
PCB 206	GC-ECD	4.79		4.67		2.03		1.51	
PCB 209	GC-ECD	8.17		3.47		1.46		1.20	
ORGANOCHLORINE PESTICIDES (ng/g dry)									
opDDE	GC-ECD	0.47		0.41		0.24		0.29	
ppDDE	GC-ECD	2.21		1.93		0.47		0.72	
op DDT	GC-ECD	1.68		0.81			NA	0.55	
pp DDT	GC-ECD	3.56		2.18			NA	0.78	
o,p DDD	GC-ECD	0.56		0.46			NA	0.24	
p,p DDD	GC-ECD	2.23		2.24			NA	1.00	
Total DDXs	GC-ECD	**10.72**		**8.03**		**0.71**		**3.59**	
alpha BHC	GC-ECD	0.38		0.14			NA	0.07	
beta BHC	GC-ECD	0.33		0.14			NA	0.04	
delta BHC	GC-ECD	0.42		0.23			NA	0.13	
lindane	GC-ECD	0.99		0.20			NA	0.09	
heptachlor	GC-ECD	1.09		0.55		0.17		0.19	
heptachlor epoxide	GC-ECD	0.61		0.27			NA	0.14	
oxychlordane	GC-ECD	0.48		0.16			NA	0.09	
gamma chlordane	GC-ECD	0.49		0.21			NA	0.27	
alpha chlordane	GC-ECD	0.60		0.16			NA	0.08	
cis nonachlor	GC-ECD	0.28		0.59		0.26		0.15	
trans nonachlor	GC-ECD	0.30		0.25		0.15		0.14	
Total Chlordanes	GC-ECD	**3.85**		**2.18**		**0.58**		**1.06**	
dieldrin	GC-ECD		NQ		NQ		NA		NQ
endrin	GC-ECD	1.31		0.69			NA	0.05	
aldrin	GC-ECD	0.42		0.20			NA	0.06	
endosulfan I	GC-ECD	0.32		0.12			NA	0.02	
endosulfan II	GC-ECD	0.74		0.12			NA	0.02	
SEDIMENTARY METALS (ug/g dw except Al and Fe i									
Total As	HGA	11.8		9.3		7.5		12.3	
Cd	GFAAS	0.9		0.9		0.6		0.4	

Appendix II - Concentrations for All Analyte

CHEM ID		9157		9158		9159		9160	
STATION ID		**NER3**	**DQ**	**NER4**	**DQ**	**NER5**	**DQ**	**BOR1**	**DQ**
RIVER LOCATION		Northeast River		Northeast River		Northeast River		Bohemia River	
EXTRACTION MASS (g)		10.66		10.12		10.16		10.99	
Cr	ICP	87.1		67.2		58.7		70.3	
Al	ICP	83.6		60.9		49.1		59.9	
Fe	Flame	45.5		33.3		26.7		35.2	
Cu	Flame	56.6		43.9		29.8		28.3	
Zn	Flame	301.1		249.3		170.3		160.6	
Ni	Flame	87.5		74.7		56.5		34.1	
Pb	Flame	57.8		41.2		29.1		38.0	
SIMULTANEOUSLY EXTRACTABLE METALS									
Units: wet weight		(umoles/g)		(umoles/g)		(umoles/g)		(umoles/g)	
AVS		0.80		0.69		0.58		0.63	
	Method								
Cu	Flame	0.064		0.040		0.038		0.029	
Cr	ICP	0.037		0.034		0.028		0.033	
Zn	Flame	0.798		1.026		0.805		0.442	
Ni	Flame	0.150		0.219		0.185		0.049	
Pb	Flame	0.054		0.061		0.048		0.040	
Cd	GFAAS	0.002		0.003		0.002		0.001	
Units: dry wt									
Cu	Flame	0.217		0.097		0.080		0.084	
Cr	ICP	0.125		0.082		0.057		0.098	
Zn	Flame	2.722		2.501		1.670		1.304	
Ni	Flame	0.512		0.532		0.383		0.145	
Pb	Flame	0.184		0.150		0.100		0.117	
Cd	GFAAS	0.007		0.007		0.005		0.003	
MERCURY									
Units: dry wt		(ng/g)		(ng/g)		(ng/g)		(ng/g)	
Hg	ICP	222.3		301.8		205.5		123.2	

Appendix II - Concentrations for All Analyte

CHEM ID		9161		9162		9163		9164	
STATION ID		**BOR2**	**DQ**	**BOR3**	**DQ**	**BOR4-A**	**DQ**	**BOR4-B**	**DQ**
RIVER LOCATION		Bohemia River		Bohemia River		Bohemia River		Bohemia River	
EXTRACTION MASS (g)		10.04		10.19		10.76		12.64	
% Water		54		69		51		55	
Total Organic Carbon (% dw)		1.67		3.15		1.89		2.16	
Total Nitrogen (% dw)		0.12		0.22		0.11		0.13	
pw Ammonia+Ammonium (mg N/L)		5.8		5.3		3.2		4.4	
Grain Size (< 0.063 mm %)		56.4		96.4		66.8		68.5	
Summary (ng/g dry wt)									
TOTAL PAH		783		1805		1170		1446	
TOTAL PCB		15		39		24		28	
TOTAL CHLORDANES		0.75		2.36		2.90		1.41	
TOTAL DDXs		2.69		7.19		82.83		5.81	
SURROGATE RECOVERIES (%)	**METHOD**								
Phenanthrene-D10	GC-MS	73		97		110		121	
Anthracene-D10	GC-MS	74		105		116		129	
2-Methylnaphthalene	GC-MS	40.2		85.1		48.2		70.2	
Azulene	GC-MS		ND		ND		ND	1.1	
1-Methylnaphthalene	GC-MS	19.3		41.7		23.4		35.3	
Biphenyl	GC-MS	11.7		23.8		13.4		19.9	
Acenaphthylene	GC-MS	9.4		25.4		15.3		22.6	
Acenaphthene	GC-MS	7.1		16.1		11.2		15.8	
Fluorene	GC-MS	9.3		24.2		15.9		20.0	
1-Methylfluorene	GC-MS	3.1		10.0		8.5		10.5	
Phenanthrene	GC-MS	41.3		114.9		86.0		101.2	
Anthracene	GC-MS	15.0		54.1		42.2		49.0	
o-Terphenyl	GC-MS		ND	0.6			ND	0.6	
2-Methylphenanthrene	GC-MS	11.4		43.9		29.4		35.8	
2-Methylanthracene	GC-MS	4.4		29.9		23.6		26.6	
1-Methylanthracene + 1-Methylphenanthrene	GC-MS	10.4		40.2		27.2		35.1	
9-Methylanthracene	GC-MS	0.4		1.4		1.0		1.4	
3,6-dimethylphenanthrene	GC-MS		BDL	2.3			BDL	1.9	
Flouranthene	GC-MS	52.8		133.3		104.6		110.3	
Pyrene	GC-MS	58.7		148.7		112.2		125.6	
9,10-Dimethylanthracene	GC-MS		ND		ND		ND		ND
2,3-Benzofluorene	GC-MS	15.7		14.6		10.8		11.3	
Benzo(a)anthracene	GC-MS	146.0		102.9		60.5		81.7	
Chrysene + Triphenylene	GC-MS	9.5		83.9		59.7		72.6	
Benzo(b)fluoranthene	GC-MS	56.0		175.7		83.5		96.3	
7,12-Dimethylbenz(a)anthracene	GC-MS		ND		BDL		ND	8.6	
Benzo(k)fluoranthene	GC-MS	70.2		120.1		90.2		80.5	
Benzo(e)pyrene	GC-MS	27.3		90.9		56.2		63.0	
Benzo(a)pyrene	GC-MS	21.0		47.0		51.0		63.0	
Perylene	GC-MS	101.2		247.2		149.4		184.1	
3-Methylcholanthrene	GC-MS	17.8		34.3			ND	21.8	
Ideno(1,2,3-cd)pyrene	GC-MS		INT		INT		INT		INT
1,2,3,4-Dibenzanthracene	GC-MS		ND		ND		ND		BDL
Benzo(g,h,i) perylene	GC-MS	24.1		92.7		46.5		80.1	
Anthanthrene	GC-MS		ND		ND		ND		ND
Coronene	GC-MS		INT		INT		INT		INT
POLYCHLORINATED BIPHENYLS (ng/g dry)									
SURROGATE RECOVERIES (%)									
PCB 14	GC-ECD	88		81		79		87	
PCB 65	GC-ECD	82		82		80		87	
PCB 166	GC-ECD	90		99		90		88	

Appendix II - Concentrations for All Analyte

CHEM ID		9161		9162		9163		9164	
STATION ID		BOR2	DQ	BOR3	DQ	BOR4-A	DQ	BOR4-B	DQ
RIVER LOCATION		Bohemia River		Bohemia River		Bohemia River		Bohemia River	
EXTRACTION MASS (g)		10.04		10.19		10.76		12.64	
PCB 1	GC-ECD		BDL		ND	0.33		0.41	
PCB 3	GC-ECD		ND		ND		ND		ND
PCB 4+10	GC-ECD		BDL	0.07		0.04		0.03	
PCB 7	GC-ECD	0.02		0.05		0.04		0.03	
PCB 6	GC-ECD		BDL		ND	0.05			ND
PCB 8+5	GC-ECD	0.22		0.40		0.31		0.27	
PCB 19	GC-ECD	0.06		0.12		0.07		0.06	
PCB 12+13	GC-ECD		ND		ND		ND		ND
PCB 18	GC-ECD		ND		ND		ND		ND
PCB 17	GC-ECD		NQ		NQ		NQ		NQ
PCB 24+27	GC-ECD		BDL		BDL		BDL		BDL
PCB 16+32	GC-ECD	0.11		0.11		0.17		0.11	
PCB 29	GC-ECD		BDL	0.08		0.14		0.05	
PCB 26	GC-ECD	0.12		0.21		0.18		0.10	
PCB 25	GC-ECD	0.08		0.17		0.16		0.08	
PCB 31+28	GC-ECD	0.41		0.75		0.50		0.58	
PCB 53+33+21	GC-ECD	0.08		0.27		0.18		0.11	
PCB 22	GC-ECD	0.18		0.34		0.23		0.15	
PCB 45	GC-ECD	0.06		0.15		0.08		0.09	
PCB 46	GC-ECD	0.07		0.14		0.13		0.05	
PCB 52	GC-ECD	0.16		0.34		0.19		0.26	
PCB 49	GC-ECD	0.21		0.55		0.29		0.38	
PCB 47	GC-ECD	0.72		0.65		0.47		0.71	
PCB 48	GC-ECD	0.04		0.19		0.11		0.07	
PCB 44	GC-ECD	0.13		0.33			ND	0.07	
PCB 37+42	GC-ECD	0.13		0.33		0.10		0.05	
PCB 41+71	GC-ECD	0.06		0.19		0.09		0.08	
PCB 64	GC-ECD	1.01		2.89			ND	2.08	
PCB 40	GC-ECD		ND		ND	0.16		0.14	
PCB 100	GC-ECD		NQ		NQ		NQ		NQ
PCB 63	GC-ECD	0.08		0.37		0.17		0.13	
PCB 74	GC-ECD	0.10		0.20		0.12		0.20	
PCB 70+76	GC-ECD	0.24		0.55		0.36		0.42	
PCB 66	GC-ECD	0.23		0.41		0.31		0.36	
PCB 95	GC-ECD	0.12		0.34		0.20		0.20	
PCB 91	GC-ECD	0.05		0.13		0.12		0.09	
PCB 56+60	GC-ECD	0.39		0.78		0.50		0.64	
PCB 101	GC-ECD	0.14		0.39		0.23		0.31	
PCB 99	GC-ECD	0.14		0.27		0.17		0.21	
PCB 83	GC-ECD	0.03		0.07		0.07		0.05	
PCB 97	GC-ECD	0.06		0.10		0.08		0.10	
PCB 87+81	GC-ECD			0.21		0.13		0.14	
PCB 85	GC-ECD	0.08	ND	0.11		0.06		0.13	
PCB 136	GC-ECD	0.07		0.09		0.05		0.08	
PCB 77+110	GC-ECD	0.33		0.77		0.46		0.60	
PCB 82	GC-ECD	0.05		0.09		0.08		0.05	
PCB 151	GC-ECD	0.12		0.22		0.14		0.14	
PCB 135+144	GC-ECD	0.07		0.16		0.12		0.11	
PCB 107	GC-ECD	0.06		0.14		0.09		0.06	
PCB 149	GC-ECD	0.25		0.86		0.46		0.50	
PCB 118	GC-ECD	0.21		0.63		0.35		0.37	
PCB 134	GC-ECD		ND		ND		ND		ND
PCB 131	GC-ECD	0.02		0.05		0.03		0.01	
PCB 146	GC-ECD	0.15		0.46		0.32		0.24	
PCB 153+132+105	GC-ECD	0.75		2.30		1.24		1.42	
PCB 141	GC-ECD	0.05		0.23		0.11		0.10	
PCB 137+176	GC-ECD	0.12		0.12		0.06			BDL
PCb 163+138	GC-ECD	0.64		1.74		0.90		1.06	

Appendix II - Concentrations for All Analyte

CHEM ID		9161		9162		9163		9164	
STATION ID		BOR2	DQ	BOR3	DQ	BOR4-A	DQ	BOR4-B	DQ
RIVER LOCATION		Bohemia River		Bohemia River		Bohemia River		Bohemia River	
EXTRACTION MASS (g)		10.04		10.19		10.76		12.64	
PCB 158	GC-ECD		BDL	0.05		0.20		0.09	
PCb 129+178	GC-ECD	0.06		0.16		0.14		0.19	
PCB 187+182	GC-ECD	0.19		0.62		0.33		0.41	
PCB 183	GC-ECD	0.14		0.43		0.22		0.25	
PCB 128	GC-ECD	0.09		0.25		0.15		0.14	
PCB 185	GC-ECD	0.07		0.14		0.11		0.11	
PCB 174	GC-ECD	0.10		0.32		0.18		0.20	
PCB 177	GC-ECD	0.13		0.30		0.19		0.22	
PCB 202+171	GC-ECD	0.12		0.30		0.19		0.25	
PCB 157+200	GC-ECD	0.07		0.29		0.15		0.15	
PCB 172+197	GC-ECD	0.08		0.23		0.18		0.18	
PCB 180	GC-ECD	0.26		0.87		0.44		0.55	
PCB 193	GC-ECD	0.10		0.38		0.22		0.14	
PCB 191	GC-ECD		ND	0.31			ND		ND
PCB 199	GC-ECD	0.07		0.10		0.06		0.04	
PCB 170+190	GC-ECD	0.23		0.67		0.66		0.68	
PCB 198	GC-ECD	0.04		0.28		0.13		0.08	
PCB 201	GC-ECD	0.35		1.26		0.71		0.79	
PCB 203+196	GC-ECD	0.39		1.04		0.58		0.65	
PCB 189	GC-ECD		BDL	0.58		0.24		0.22	
PCB 208+195	GC-ECD	1.00		0.74		2.00		2.22	
PCB 207	GC-ECD	0.18		0.48		0.23		0.26	
PCB 194	GC-ECD	0.14		0.29		0.17		0.19	
PCB 205	GC-ECD	0.06		0.14			ND	0.07	
PCB 206	GC-ECD	1.47		5.22		2.98		3.50	
PCB 209	GC-ECD	1.12		3.78		2.26		2.64	
ORGANOCHLORINE PESTICIDES (ng/g dry)									
opDDE	GC-ECD	0.20		0.45		0.28		0.38	
ppDDE	GC-ECD	0.43		1.21		0.81		1.63	
op DDT	GC-ECD	0.55		1.11		49.27		0.83	
pp DDT	GC-ECD	0.56		1.70		5.74		0.87	
o,p DDD	GC-ECD	0.20		0.70		0.77		0.53	
p,p DDD	GC-ECD	0.76		2.02		25.96		1.57	
Total DDXs	GC-ECD	**2.69**		**7.19**		**82.83**		**5.81**	
alpha BHC	GC-ECD	0.08		0.16		0.20		0.19	
beta BHC	GC-ECD	0.02		0.06		0.15		0.13	
delta BHC	GC-ECD	0.10		0.15		0.22		0.25	
lindane	GC-ECD	0.13		0.13		0.60		0.24	
heptachlor	GC-ECD	0.16		1.01		0.38		0.39	
heptachlor epoxide	GC-ECD	0.12		0.19		0.37		0.30	
oxychlordane	GC-ECD	0.07		0.10		0.21		0.12	
gamma chlordane	GC-ECD	0.06		0.30		1.11		0.11	
alpha chlordane	GC-ECD	0.07		0.12		0.26		0.14	
cis nonachlor	GC-ECD	0.13		0.42		0.23		0.10	
trans nonachlor	GC-ECD	0.13		0.22		0.34		0.24	
Total Chlordanes	GC-ECD	**0.75**		**2.36**		**2.90**		**1.41**	
dieldrin	GC-ECD		NQ		NQ		NQ		NQ
endrin	GC-ECD	0.12		0.18		19.82		0.39	
aldrin	GC-ECD	0.06		0.12		0.20		0.18	
endosulfan I	GC-ECD	0.05		0.11		11.62		0.12	
endosulfan II	GC-ECD	0.05		0.11		11.62		0.12	
SEDIMENTARY METALS (ug/g dw except Al and Fe i									
Total As	HGA	9.9		14.2		9.3		8.7	
Cd	GFAAS	0.3		0.4		0.3		0.3	

Appendix II - Concentrations for All Analyte

CHEM ID		9161	DQ	9162	DQ	9163	DQ	9164	DQ
STATION ID		BOR2		BOR3		BOR4-A		BOR4-B	
RIVER LOCATION		Bohemia River		Bohemia River		Bohemia River		Bohemia River	
EXTRACTION MASS (g)		10.04		10.19		10.76		12.64	
Cr	ICP	55.8		75.2		53.6		53.2	
Al	ICP	43.4		76.9		58.6		58.1	
Fe	Flame	25.8		43.6		31.5		31.1	
Cu	Flame	20.9		34.4		21.0		21.1	
Zn	Flame	125.8		238.3		163.0		163.4	
Ni	Flame	25.5		51.1		31.9		32.8	
Pb	Flame	30.6		52.1		32.4		33.8	
SIMULTANEOUSLY EXTRACTABLE METALS									
Units: wet weight		(umoles/g)		(umoles/g)		(umoles/g)		(umoles/g)	
AVS		0.81		1.16		0.90		1.20	
	Method								
Cu	Flame	0.029		0.051		0.055		0.044	
Cr	ICP	0.033		0.039		0.036		0.035	
Zn	Flame	0.442		0.646		0.729		0.694	
Ni	Flame	0.049		0.086		0.089		0.087	
Pb	Flame	0.040		0.054		0.056		0.053	
Cd	GFAAS	0.001		0.001		0.001		0.001	
Units: dry wt									
Cu	Flame	0.084		0.168		0.127		0.099	
Cr	ICP	0.098		0.130		0.084		0.078	
Zn	Flame	1.304		2.130		1.679		1.560	
Ni	Flame	0.145		0.284		0.204		0.196	
Pb	Flame	0.117		0.178		0.130		0.119	
Cd	GFAAS	0.003		0.003		0.003		0.003	
MERCURY									
Units: dry wt		(ng/g)		(ng/g)		(ng/g)		(ng/g)	
Hg	ICP	99.3		212.4		162.5		154.4	

Appendix II - Concentrations for All Analyte

CHEM ID		9165		9166		9167		9168		9169	
STATION ID		BOR4-C	DQ	ELR1	DQ	ELR2	DQ	ELR3	DQ	ELR4	DQ
RIVER LOCATION		Bohemia River		Elk River		Elk River		Elk River		Elk River	
EXTRACTION MASS (g)		11.34		9.72		10.16		10.37		9.88	
% Water		56		66		51		68		66	
Total Organic Carbon (% dw)		1.66	J	2.99		1.66		3.13		3.27	
Total Nitrogen (% dw)		0.11	J	0.22		0.13		0.21		0.22	
pw Ammonia+Ammonium (mg N/L)		3.1		5.2		1.7		2.5		3.9	
Grain Size (< 0.063 mm %)		66.9		98.6		55.7		97.8		95.4	
Summary (ng/g dry wt)											
TOTAL PAH		1539		1612		718		1543		2177	
TOTAL PCB		31		42		13		40		64	
TOTAL CHLORDANES		1.22		1.86		0.98		1.95		2.79	
TOTAL DDXs		6.00		8.92		2.45		8.74		10.26	
SURROGATE RECOVERIES (%)	**METHOD**										
Phenanthrene-D10	GC-MS	112		100		80		92		113	
Anthracene-D10	GC-MS	118		104		82		100		126	
2-Methylnaphthalene	GC-MS	84.6		89.9		12.5		63.0		132.3	
Azulene	GC-MS	1.4			ND		ND		ND		ND
1-Methylnaphthalene	GC-MS	43.7		42.0		12.0		33.9		67.1	
Biphenyl	GC-MS	24.4		26.6		4.6		18.7		37.8	
Acenaphthylene	GC-MS	24.5		20.1		2.8		20.7		39.0	
Acenaphthene	GC-MS	17.7		15.7		2.0		12.6		26.8	
Fluorene	GC-MS	22.0		26.7		2.7		20.3		37.1	
1-Methylfluorene	GC-MS	11.5		9.2			ND	10.3		19.9	
Phenanthrene	GC-MS	105.4		110.1		16.1		100.3		180.4	
Anthracene	GC-MS	53.8		44.0		3.6		43.6		95.9	
o-Terphenyl	GC-MS	0.5			ND		ND	0.7		ND	
2-Methylphenanthrene	GC-MS	34.3		27.8		2.8		35.3		63.5	
2-Methylanthracene	GC-MS	25.3		15.4		1.1		26.1		36.0	
1-Methylanthracene + 1-Methylphenanthrene	GC-MS	32.4		23.9		1.7		33.5		62.7	
9-Methylanthracene	GC-MS	1.1		1.8			ND	1.1		2.3	
3,6-dimethylphenanthrene	GC-MS	3.6			BDL		ND	3.2		5.8	
Flouranthene	GC-MS	120.5		135.8		15.0		127.4		184.0	
Pyrene	GC-MS	137.0		159.2		15.7		148.1		215.1	
9,10-Dimethylanthracene	GC-MS		ND		ND		ND		ND		ND
2,3-Benzofluorene	GC-MS	12.8		9.9		5.1		18.3		33.6	
Benzo(a)anthracene	GC-MS	83.6		74.0		64.2		78.1		90.2	
Chrysene + Triphenylene	GC-MS	62.8		83.2		66.4		71.3		85.9	
Benzo(b)fluoranthene	GC-MS	122.4		105.9		33.3		113.5		105.0	
7,12-Dimethylbenz(a)anthracene	GC-MS		ND		BDL		ND	ND			ND
Benzo(k)fluoranthene	GC-MS	94.0		127.5		45.1		108.3		140.2	
Benzo(e)pyrene	GC-MS	89.7		76.0		1.8		68.9		81.7	
Benzo(a)pyrene	GC-MS	42.9		61.9			ND	50.8		71.3	
Perylene	GC-MS	196.3		265.5		409.1		228.7		295.9	
3-Methylcholanthrene	GC-MS	24.2			ND		ND	34.2			ND
Ideno(1,2,3-cd)pyrene	GC-MS		INT		INT		INT		INT		INT
1,2,3,4-Dibenzanthracene	GC-MS		ND		BDL		ND		ND		ND
Benzo(g,h,i) perylene	GC-MS	66.7		60.1			ND	71.6		67.9	
Anthanthrene	GC-MS		ND		ND		ND		ND		ND
Coronene	GC-MS		INT		INT		INT		ND		INT
POLYCHLORINATED BIPHENYLS (ng/g dry)											
SURROGATE RECOVERIES (%)											
PCB 14	GC-ECD	92		85		83		79		92	
PCB 65	GC-ECD	95		90		87		80		98	
PCB 166	GC-ECD	97		93		94		83		96	

Appendix II - Concentrations for All Analyte

CHEM ID		9165		9166		9167		9168		9169	
STATION ID		BOR4-C	DQ	ELR1	DQ	ELR2	DQ	ELR3	DQ	ELR4	DQ
RIVER LOCATION		Bohemia River		Elk River		Elk River		Elk River		Elk River	
EXTRACTION MASS (g)		11.34		9.72		10.16		10.37		9.88	
PCB 1	GC-ECD	0.57			ND	0.43			ND	0.57	
PCB 3	GC-ECD		ND		ND		ND		ND	2.76	
PCB 4+10	GC-ECD	0.05		0.08			BDL		BDL		BDL
PCB 7	GC-ECD	0.04		0.08		0.03		0.05		0.07	
PCB 6	GC-ECD	0.07			ND		BDL		BDL		ND
PCB 8+5	GC-ECD	0.33		0.51		0.33		0.53		0.56	
PCB 19	GC-ECD	0.10		0.18		0.05		0.12		0.11	
PCB 12+13	GC-ECD		ND	0.12			ND	0.09		0.14	
PCB 18	GC-ECD		ND		ND	0.03			ND		ND
PCB 17	GC-ECD		NQ		NQ		NQ		NQ		NQ
PCB 24+27	GC-ECD		BDL		BDL		BDL		BDL		BDL
PCB 16+32	GC-ECD	0.17		0.14		0.10		0.16		0.32	
PCB 29	GC-ECD		BDL	0.10		0.03		0.06		0.15	
PCB 26	GC-ECD	0.11		0.17		0.13		0.20		0.26	
PCB 25	GC-ECD	0.11		0.14		0.12		0.16		0.16	
PCB 31+28	GC-ECD	0.55		0.77		0.20		0.80		1.48	
PCB 53+33+21	GC-ECD	0.12		0.17		0.05		0.19		0.30	
PCB 22	GC-ECD	0.25		0.34		0.09		0.34		0.47	
PCB 45	GC-ECD	0.09		0.13		0.02		0.12		0.12	
PCB 46	GC-ECD	0.06		0.12		0.05		0.10			ND
PCB 52	GC-ECD	0.32		0.49		0.09		0.42		1.18	
PCB 49	GC-ECD	0.38		0.68		0.10		0.54		1.01	
PCB 47	GC-ECD	1.50		1.32		0.65		1.05		2.28	
PCB 48	GC-ECD	0.08		0.16		0.06		0.09		0.18	
PCB 44	GC-ECD	0.05			ND	0.13			ND		ND
PCB 37+42	GC-ECD	0.13			ND		ND		ND		ND
PCB 41+71	GC-ECD	0.12		0.14		0.09		0.14		0.15	
PCB 64	GC-ECD	1.52		3.00		2.62		2.88		3.61	
PCB 40	GC-ECD		ND	0.21		0.08			ND	0.19	
PCB 100	GC-ECD		NQ		NQ		NQ		NQ		NQ
PCB 63	GC-ECD	0.15		0.21		0.28		0.18		0.28	
PCB 74	GC-ECD	0.18		0.23		0.14		0.23		0.55	
PCB 70+76	GC-ECD	0.50		0.60		0.21		0.58		1.36	
PCB 66	GC-ECD	0.35		0.49		0.14		0.36		0.57	
PCB 95	GC-ECD	0.27		0.30		0.14		0.40		0.92	
PCB 91	GC-ECD	0.11		0.22		0.07		0.13		0.20	
PCB 56+60	GC-ECD	0.73		0.85		0.22		0.88		1.32	
PCB 101	GC-ECD	0.29		0.42		0.11		0.47		1.06	
PCB 99	GC-ECD	0.23		0.36		0.12		0.34		0.60	
PCB 83	GC-ECD	0.05		0.08		0.06		0.07		0.10	
PCB 97	GC-ECD	0.09		0.12		0.08		0.14		0.35	
PCB 87+81	GC-ECD	0.17		0.21		0.05		0.23		0.57	
PCB 85	GC-ECD	0.12		0.14		0.06		0.15		0.27	
PCB 136	GC-ECD	0.07		0.14		0.06		0.10		0.17	
PCB 77+110	GC-ECD	0.70		0.92		0.18		0.92		2.15	
PCB 82	GC-ECD	0.06		0.11		0.05		0.08		0.20	
PCB 151	GC-ECD	0.14		0.24		0.08		0.23		0.39	
PCB 135+144	GC-ECD	0.13		0.19		0.07		0.17		0.38	
PCB 107	GC-ECD	0.07		0.14		0.05		0.12		0.19	
PCB 149	GC-ECD	0.58		0.76		0.16		0.77		1.32	
PCB 118	GC-ECD	0.42		0.55		0.10		0.51		1.31	
PCB 134	GC-ECD		ND		ND		ND		ND		ND
PCB 131	GC-ECD	0.01		0.04		0.02		0.03		0.05	
PCB 146	GC-ECD	0.31		0.42		0.15		0.39		0.54	
PCB 153+132+105	GC-ECD	1.68		2.07		0.35		2.11		3.55	
PCB 141	GC-ECD	0.12		0.14		0.08		0.12		0.15	
PCB 137+176	GC-ECD	0.11		0.09		0.07			BDL	0.09	
PCb 163+138	GC-ECD	1.14		1.46		0.35		1.55		3.01	

Appendix II - Concentrations for All Analyte

CHEM ID		9165		9166		9167		9168		9169	
STATION ID		BOR4-C	DQ	ELR1	DQ	ELR2	DQ	ELR3	DQ	ELR4	DQ
RIVER LOCATION		Bohemia River		Elk River		Elk River		Elk River		Elk River	
EXTRACTION MASS (g)		11.34		9.72		10.16		10.37		9.88	
PCB 158	GC-ECD	0.07		0.08		0.04		0.15		0.33	
PCb 129+178	GC-ECD	0.18		0.18		0.14		0.17		0.25	
PCB 187+182	GC-ECD	0.40		0.53		0.11		0.53		0.67	
PCB 183	GC-ECD	0.25		0.34		0.21		0.37		0.52	
PCB 128	GC-ECD	0.20		0.23		0.11		0.23		0.46	
PCB 185	GC-ECD	0.07		0.14		0.13		0.14		0.19	
PCB 174	GC-ECD	0.26		0.30		0.10		0.31		0.44	
PCB 177	GC-ECD	0.27		0.27		0.10		0.30		0.35	
PCB 202+171	GC-ECD	0.34		0.31		0.14		0.38		0.58	
PCB 157+200	GC-ECD	0.16		0.20		0.14		0.21		0.24	
PCB 172+197	GC-ECD	0.19		0.22		0.10		0.21		0.25	
PCB 180	GC-ECD	0.64		0.67		0.13		0.80		1.19	
PCB 193	GC-ECD	0.12		0.21		0.23		0.27		0.22	
PCB 191	GC-ECD	0.11		0.14		0.09		0.17		0.19	
PCB 199	GC-ECD	0.08		0.06		0.04		0.08		0.13	
PCB 170+190	GC-ECD	0.67		0.52		0.23		0.64		0.93	
PCB 198	GC-ECD	0.09		0.15			ND	0.16		0.22	
PCB 201	GC-ECD	0.89		1.22		0.30		1.15		1.35	
PCB 203+196	GC-ECD	0.74		1.05		0.26		1.01		1.15	
PCB 189	GC-ECD	0.18		0.40			ND	0.24		0.48	
PCB 208+195	GC-ECD	2.62		3.47		0.44		3.49		4.12	
PCB 207	GC-ECD	0.28		0.39		0.11		0.39		0.39	
PCB 194	GC-ECD	0.20		0.32		0.07		0.29		0.30	
PCB 205	GC-ECD		ND	0.12			ND		ND	0.13	
PCB 206	GC-ECD	3.97		5.52		0.73		5.42		6.51	
PCB 209	GC-ECD	2.96		4.03		0.50		3.87		4.72	
ORGANOCHLORINE PESTICIDES (ng/g dry)											
opDDE	GC-ECD	0.41		0.60		0.19		0.58		0.09	
ppDDE	GC-ECD	1.59		2.34		0.40		2.50		3.55	
op DDT	GC-ECD	0.68		0.86		0.43		1.00		1.13	
pp DDT	GC-ECD	1.37		2.03		0.76		1.78		2.56	
o,p DDD	GC-ECD	0.47		0.75		0.16		0.70		0.72	
p,p DDD	GC-ECD	1.48		2.34		0.51		2.19		2.22	
Total DDXs	GC-ECD	**6.00**		**8.92**		**2.45**		**8.74**		**10.26**	
alpha BHC	GC-ECD	0.13		0.17		0.16		0.26		0.27	
beta BHC	GC-ECD	0.08		0.08		0.04		0.14		0.15	
delta BHC	GC-ECD	0.14		0.22		0.20		0.31		0.37	
lindane	GC-ECD	0.15		0.23		0.16		0.49		0.44	
heptachlor	GC-ECD	0.43		0.53		0.17		0.50		1.00	
heptachlor epoxide	GC-ECD	0.11		0.19		0.21		0.36		0.30	
oxychlordane	GC-ECD	0.09		0.20		0.10		0.13		0.10	
gamma chlordane	GC-ECD	0.12		0.12		0.06		0.16		0.19	
alpha chlordane	GC-ECD	0.11		0.17		0.11		0.19		0.21	
cis nonachlor	GC-ECD	0.13		0.37		0.17		0.36		0.51	
trans nonachlor	GC-ECD	0.24		0.28		0.16		0.25		0.47	
Total Chlordanes	GC-ECD	**1.22**		**1.86**		**0.98**		**1.95**		**2.79**	
dieldrin	GC-ECD		NQ		NQ		NQ		NQ		
endrin	GC-ECD	0.30		0.23		0.27		0.66		0.69	
aldrin	GC-ECD	0.11		0.08		0.12		0.22		0.30	
endosulfan I	GC-ECD	0.11		0.14		0.09		0.17		0.13	
endosulfan II	GC-ECD	0.11		0.14		0.09		0.17		0.13	
SEDIMENTARY METALS (ug/g dw except Al and Fe i											
Total As	HGA	9.4		14.2		8.4		10.6		10.9	
Cd	GFAAS	0.3		0.3		0.1		0.4		0.5	

Appendix II - Concentrations for All Analyte

CHEM ID		9165	DQ	9166	DQ	9167	DQ	9168	DQ	9169	DQ
STATION ID		BOR4-C		ELR1		ELR2		ELR3		ELR4	
RIVER LOCATION		Bohemia River		Elk River		Elk River		Elk River		Elk River	
EXTRACTION MASS (g)		11.34		9.72		10.16		10.37		9.88	
Cr	ICP	54.8		75.6		48.5		76.0		71.8	
Al	ICP	57.3		75.0		50.5		75.1		76.3	
Fe	Flame	31.1		41.3		28.6		40.4		42.4	
Cu	Flame	20.4		31.0		14.0		32.8		61.9	
Zn	Flame	159.5		206.0		88.4		213.5		252.1	
Ni	Flame	32.0		44.5		25.8		50.8		56.6	
Pb	Flame	33.3		47.7		16.6		50.7		52.0	
SIMULTANEOUSLY EXTRACTABLE METALS											
Units: wet weight		(umoles/g)		(umoles/g)		(umoles/g)		(umoles/g)		(umoles/g)	
AVS		0.34		0.19		0.39		0.97		2.80	
	Method										
Cu	Flame	0.051		0.065		0.036		0.063		0.064	
Cr	ICP	0.033		0.037		0.027		0.044		0.042	
Zn	Flame	0.688		0.601		0.254		0.760		0.796	
Ni	Flame	0.084		0.063		0.038		0.091		0.116	
Pb	Flame	0.055		0.056		0.024		0.068		0.063	
Cd	GFAAS	0.001		0.001		0.001		0.001		0.001	
Units: dry wt											
Cu	Flame	0.121		0.199		0.077		0.196		0.206	
Cr	ICP	0.078		0.115		0.058		0.136		0.136	
Zn	Flame	1.628		1.842		0.548		2.359		2.558	
Ni	Flame	0.200		0.192		0.081		0.282		0.374	
Pb	Flame	0.130		0.172		0.051		0.210		0.204	
Cd	GFAAS	0.003		0.003		0.001		0.004		0.005	
MERCURY											
Units: dry wt		(ng/g)		(ng/g)		(ng/g)		(ng/g)		(ng/g)	
Hg	ICP	146.2		217.0		49.9		214.9		196.5	

* Values for F1 analytes(all PCBs and 5 OCPs which include opDDE, ppDDE, heptachlor, cis and trans nonachlor) were corrected for different concentrations of internal std used in samples and calibration standard for some samples.

*The value of internal standard 30 used in samples 9149 through 9157dup was determined to be 1.79X as concentrated as the internal standard 30 used in the calibration

*The value of internal standard 204 used in samples 9149 through 9157dup was determined to be 2.31X as concentrated as the internal standard 204 used in the

* Values for PCB surrogates in samples 9149 through 9157dup were also corrected for differences in concentration between those surrogates added to samples and those added to calibration standard.

* PCB surrogates 14, 65, and 166 which were added to samples 9149 through 9157dup were determined to be .741, .743, and .628X as concentrated as those used in the calibration standard.

*For example, in sample 9149 a mass of 21.545 ng was quantified. To correct for differences in internal std and surrogate concentraion with respect to the calibration std, this mass is multiplied by 1.79 and .741 to obtain the correct mass.

PCB surogate 14 mass quantified (ng)	21.545
internal std correction factor	1.79
surrogate correction factor	0.741
corrected PCB 14 mass for sample 9149 (ng)	28.577
% recovery for PCB surrogate 14 (35ng added before extraction)	82

DQ = data qualifier
NA = not analyzed
ND = analyte not detected
BDL = analyte concentration below detection limits
NQ = not quantifiable due to chromatograhic interference or lack of internal standard

Appendix III. PCB Homologue Distribution

CHEM ID	**9149**	**9150**	**9151**	**9152**	**9153**	**9154**	**9155**	**9156**	**9157**	**9158**	**9159**
STATION ID	SER1	SER2	SER3	SER4	SER5	NER1	NER2	rinse blank	NER3	NER4	NER5
TOTAL PCBS (ng/g) dry	40	69	21	15	87	12	24	1	50	45	29
Monochlorobiphinyl (ng/g dry)	0.00	0.00	0.00	0.43	0.77	0.00	0.75	0.00	0.73	2.24	2.37
%Mono	**0**	**0**	**0**	**3**	**1**	**0**	**3**	**0**	**1**	**5**	**8**
Dichlorobiphenyl (ng/g dry)	1.27	1.67	0.13	0.23	1.84	0.12	0.30	0.11	0.83	0.81	0.56
%Di	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**14**	**2**	**2**	**2**
Trichlorobiphenyl (ng/g dry)	1.61	5.74	1.63	1.41	5.33	0.85	1.46	0.02	2.75	2.49	1.78
% Tri-	**4**	**8**	**8**	**10**	**6**	**7**	**6**	**3**	**6**	**6**	**6**
Tetrachlorobiphenyl (ng/g dry)	7.59	17.24	6.32	5.14	22.68	2.98	4.29	0.53	8.39	7.97	6.71
% Tetra-	**19**	**25**	**30**	**35**	**26**	**25**	**18**	**68**	**17**	**18**	**23**
Pentachlorobiphenyl (ng/g dry)	7.37	11.61	2.31	1.41	16.89	1.42	2.56	0.05	5.11	4.30	2.54
% Penta-	**18**	**17**	**11**	**10**	**20**	**12**	**11**	**6**	**10**	**10**	**9**
Hexachlorobiphenyl (ng/g dry)	10.43	14.13	2.82	1.95	20.28	2.33	4.04	0.00	7.58	7.05	4.40
% Hexa-	**26**	**21**	**13**	**13**	**24**	**19**	**17**	**0**	**15**	**16**	**15**
Heptachlorobiphenyl (ng/g dry)	6.04	8.43	4.15	2.18	9.60	1.65	4.20	0.07	6.47	5.75	3.57
% Hepta-	**15**	**12**	**20**	**15**	**11**	**14**	**18**	**9**	**13**	**13**	**12**
Octachlorobiphenyl (ng/g dry)	3.45	4.46	1.81	1.29	4.74	1.24	2.70	0.00	4.75	5.93	3.17
% Octa-	**9**	**7**	**9**	**9**	**5**	**10**	**11**	**0**	**10**	**13**	**11**
Nonachlorobiphenyl (ng/g dry)	1.18	2.73	0.82	0.07	2.48	0.77	1.91	0.00	5.36	5.19	2.28
% Nona-	**3**	**4**	**4**	**0**	**3**	**6**	**8**	**0**	**11**	**12**	**8**
Decachlorobiphenyl (ng/g dry)	1.21	3.09	1.08	0.80	2.75	0.81	1.84	0.00	8.17	3.47	1.46
% Deca-	**3**	**5**	**5**	**5**	**3**	**7**	**8**	**1**	**16**	**8**	**5**

Appendix III. PCB Homologue Distribution

CHEM ID	**9160**	**9161**	**9162**	**9163**	**9164**	**9165**	**9166**	**9167**	**9168**	**9169**
STATION ID	BOR1	BOR2	BOR3	BOR4-A	BOR4-B	BOR4-C	ELR1	ELR2	ELR3	ELR4
TOTAL PCBS (ng/g) dry	21	15	40	24	28	32	42	13	41	65
Monochlorobiphinyl (ng/g dry)	0.00	0.00	0.00	0.33	0.41	0.57	0.00	0.43	0.00	3.32
%Mono	**0**	**0**	**0**	**1**	**1**	**2**	**0**	**3**	**0**	**5**
Dichlorobiphenyl (ng/g dry)	0.21	0.23	0.53	0.44	0.34	0.49	0.78	0.36	0.66	0.77
%Di	**1**	**2**	**1**	**2**	**1**	**2**	**2**	**3**	**2**	**1**
Trichlorobiphenyl (ng/g dry)	1.01	1.07	2.09	1.60	1.22	1.43	1.93	0.78	1.94	3.10
% Tri-	**5**	**7**	**5**	**7**	**4**	**5**	**5**	**6**	**5**	**5**
Tetrachlorobiphenyl (ng/g dry)	6.68	3.76	8.52	3.42	6.14	6.58	9.29	5.03	8.22	14.32
% Tetra-	**32**	**25**	**22**	**14**	**22**	**21**	**22**	**38**	**20**	**22**
Pentachlorobiphenyl (ng/g dry)	1.68	1.28	3.27	2.01	2.27	2.55	3.53	1.05	3.50	7.62
% Penta-	**8**	**9**	**8**	**8**	**8**	**8**	**8**	**8**	**9**	**12**
Hexachlorobiphenyl (ng/g dry)	2.63	2.16	6.19	3.62	3.75	4.31	5.56	1.45	5.63	9.97
% Hexa-	**13**	**15**	**16**	**15**	**13**	**14**	**13**	**11**	**14**	**16**
Heptachlorobiphenyl (ng/g dry)	2.70	1.49	5.18	3.02	3.22	3.56	4.09	1.68	4.28	5.97
% Hepta-	**13**	**10**	**13**	**13**	**12**	**11**	**10**	**13**	**11**	**9**
Octachlorobiphenyl (ng/g dry)	2.82	2.13	4.25	3.79	4.19	4.80	6.56	1.30	6.39	7.71
% Octa-	**14**	**14**	**11**	**16**	**15**	**15**	**16**	**10**	**16**	**12**
Nonachlorobiphenyl (ng/g dry)	1.85	1.71	5.74	3.32	3.89	4.41	6.12	0.87	6.02	7.14
% Nona-	**9**	**11**	**15**	**14**	**14**	**14**	**15**	**6**	**15**	**11**
Decachlorobiphenyl (ng/g dry)	1.20	1.12	3.78	2.26	2.64	2.96	4.03	0.50	3.87	4.72
% Deca-	**6**	**8**	**10**	**10**	**9**	**9**	**10**	**4**	**10**	**7**

Appendix IV - Water Column Concentrations of Trace Metals

Note: Concentrations are dissolved (<0.2 um)
All concentrations are blank corrected

		Element	Hg	As III	MP	As III+V	MMA	DMA
		Units	(ng/L)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)
Sample ID	**Location**	**Date**						
Event 1								
SER 3	Severn River	6/11/03	0.14	0.16	0.02	0.26	0.03	0.35
SER 5	Severn River	6/11/03	0.23	***0.24***	***0.03***	***0.43***	***0.03***	***0.56***
Event 2								
NER 3	Northeast River	6/24/03	1.86	0.04	0.00	***0.28***	***0.02***	***0.14***
NER 5	Northeast River	6/24/03	0.96	0.04	0.01	0.26	0.02	0.12
ELR 2	Elk River	6/24/03	1.57	0.05	0.00	0.63	0.02	0.03
ELR 4	Elk River	6/24/03	0.65	0.02	0.00	0.37	0.01	0.03
BOR 2	Bohemia River	6/24/03	1.20	***0.11***	***0.00***	***0.62***	***0.02***	***0.06***
Field Blanks								
Filt Blk 1	Severn River	6/11/03	0.08	0.00	0.00	0.00	0.00	0.00
Filt Blk 2	Northeast River	6/24/03	0.09	0.00	0.00	0.00	0.00	0.00
		Average	0.09	0.00	0.00	0.00	0.00	0.00

Appendix IV - Water Column Concentrations of Trace Metals

Note: Concentrations are dissolved (<0.2 um)
All concentrations are blank corrected

		Element	**As Total Dis**	**Se Total Dis**	**Cr**	**Ni**	**Cu**	**Zn 64**
		Units	**(ug/l)**	**(ug/l)**	**(ug/L)**	**(ug/L)**	**(ug/L)**	**(ug/L)**
Sample ID	**Location**	**Date**						
Event 1								
SER 3	Severn River	6/11/03	0.64	0.12	0.03	0.96	1.18	
SER 5	Severn River	6/11/03	***1.02***	***0.11***	0.12	1.30	5.79	
Event 2								
NER 3	Northeast River	6/24/03	***0.43***	0.14	0.51	2.90	3.25	1.78
NER 5	Northeast River	6/24/03	0.40	***0.14***	0.22	2.51	2.42	0.94
ELR 2	Elk River	6/24/03	0.69	0.21	0.34	***1.57***	***2.87***	***3.84***
ELR 4	Elk River	6/24/03	0.42	0.14	0.18	1.86	1.55	1.59
BOR 2	Bohemia River	6/24/03	***0.69***	0.13	0.64	1.45	2.83	3.56
Field Blanks								
Filt Blk 1	Severn River	6/11/03	0.00	0.006	0.03	0.03	0.027	
Filt Blk 2	Northeast River	6/24/03	0.00	0.006	0.09	0.18	0.15	0.73
		Average	0.00	0.01	0.06	0.11	0.09	0.73

Appendix IV - Water Column Concentrations of Trace Metals

Note: Concentrations are dissolved (<0.2 um)
All concentrations are blank corrected

		Element	**Zn**	**Cd**	**Pb**
		Units	**(ug/L)**	**(ug/L)**	**(ug/L)**
Sample ID	**Location**	**Date**			
Event 1					
SER 3	Severn River	6/11/03	0.26	0.001	0.006
SER 5	Severn River	6/11/03	2.53	0.053	0.028
Event 2					
NER 3	Northeast River	6/24/03	1.05	0.013	0.43
NER 5	Northeast River	6/24/03	0.14	0.010	0.21
ELR 2	Elk River	6/24/03	***2.41***	***0.018***	***0.35***
ELR 4	Elk River	6/24/03	0.28	0.010	0.10
BOR 2	Bohemia River	6/24/03	1.73	0.010	0.66
Field Blanks					
Filt Blk 1	Severn River	6/11/03	0.580	0.001	0.018
Filt Blk 2	Northeast River	6/24/03	0.74	0.009	0.042
		Average	0.66	0.005	0.030

Appendix C

Assessment of organic contaminants in integrative samplers from Chesapeake Bay tributaries (Alvarez *et al.* 2004)

APPENDIX C

ASSESSMENT OF ORGANIC CONTAMINANTS IN INTEGRATIVE SAMPLERS FROM CHESAPEAKE BAY TRIBUTARIES

By

David A. Alvarez
Walter L. Cranor
James N. Huckins
Randal C. Clark
And
Stephanie D. Perkins

USGS/Columbia Environmental Research Center
4200 New Haven Road
Columbia, MO 65201

Prepared For:

Fred Pinkney
Environmental Contaminants Specialist
U.S. Fish and Wildlife Service
Annapolis, MD 21401

Final Report

March 1, 2004

Prepared by:

_____

David Alvarez
Research Chemist

Prepared by:

_____

Walter Cranor
Chemist

Reviewed by:

_____

Thomas May
Research Chemist

Reviewed by:

_____

Paul Heine
CERC Quality Assurance Officer

Reviewed by:

_____

William Brumbaugh
Research Chemist

Approved by:

_____

Carl Orazio, Chief
Environmental Chemistry Branch

Approved by:

_____

Michael Mac, Center Director
Columbia Environmental Research Center

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EXECUTIVE SUMMARY

This work was conducted as the final phase of a three year collaborative effort between the U.S. Geological Survey's Columbia Environmental Research Center (CERC) and the U.S. Fish and Wildlife Service to provide baseline knowledge on the presence of selected chemicals in several rivers and their tributaries in the Chesapeake Bay region. In the spring of 2003, semipermeable membrane devices (SPMDs) and polar organic chemical integrative samplers (POCIS) were successfully deployed at 5 sites for 40 to 42 days. The sites were Elk River (ELR2), Bohemia River (BOR2), Northeast River (NOR3 and NOR5), and Back Creek (SER5) a tributary of the Severn River.

SPMD samples from all five study sites had measurable levels of a wide variety of organochlorine (OC) pesticides. Elk River and Back Creek showed the highest levels of sequestered OC-pesticide contaminants with totals at ~ 300 and ~250 total ng per SPMD. Sequestered levels of OC-pesticide contaminants from the remaining three sites were similar to each other and ranged from 116 to 126 total ng per SPMD. Specific contaminants which were observed at all five sites included the chlordanes, DDD, dieldrin, the nonachlors, dacthal, PCA, and the current use pesticides acetochlor and chlorpyrifos. SPMD samples from all five study sites also had measurable levels of PAHs. Only Back Creek showed elevated levels of sequestered PAH contaminants with ~ 1000 to 13000 pg/L of fluoranthene, pyrene, and chrysene. The ubiquitous PAHs fluoranthene and pyrene were observed at low levels (~ 400 to 900 pg/L) at each site.

Only the POCIS samples from Station 3 of the Northeast River had measurable levels of the targeted hormone 17β-estradiol at ~ 4 ng/L. No other targeted hormones were detected in any of the POCIS samples from the study sites. Various tetracycline antibiotics were identified in POCIS extracts from three of the sites. Chlortetracycline was isolated in samples from Station 5 of the Northeast River and oxytetracycline was measured at Station 3 of the Northeast River. POCIS samples from Back Creek contained all three antibiotics, ocytetracycline, tetracycline, and chlortetracycline.

Elucidation of the potential biological effects from exposure to complex mixtures of chemicals requires further research. The water concentrations of select contaminants observed in this study would appear to be of some concern. This would be especially true for Elk River and Back Creek and, to a lesser extent, the remaining three sites. Since information describing the location of the sites was not provided, it is impossible for CERC scientists to make any conclusions on the potential sources of the identified contaminants.

INTRODUCTION

Input of bioconcentratable toxic organic contaminants such as organochlorine pesticides (OCs), polychlorinated biphenyls (PCBs), etc., are of continuing concern. Also, more polar organic chemicals such as hormones and antibiotics, widely used in concentrated animal feeding operations (CAFO) animal husbandry, are increasingly being recognized as emerging contaminants of concern (1,2,3). A majority of these "emerging contaminants" do not bioconcentrate and in fact have historically been viewed as being benign (e.g. antibiotics).

Assessing the potential detrimental impacts of the complex mixture of contaminants present in aquatic systems requires a holistic approach. Unfortunately, nearly all currently employed contaminant assessment approaches are based on single point in time sampling techniques. Scientists at the USGS's Columbia Environmental Research Center (CERC) have an ongoing research program designed to develop a holistic assessment approach for addressing the presence and potential toxicological consequences of organism exposure to a wide variety of environmental contaminants.

CERC scientists have developed a semipermeable membrane device (SPMD) for passive integrative monitoring of aquatic contaminants. (4,5,6,7,8) The SPMD consists of layflat polyethylene (PE) tubing containing a thin film of a high molecular weight ($\geq$ 600 Da) neutral lipid such as triolein. Other sequestration phases such as high molecular weight silicone fluids, adsorbents, etc., may also be used. The polymeric membrane used in the SPMD sampler functions by allowing the readily bioavailable contaminant molecules to pass through transient membrane cavities approaching 10 Å in cross sectional diameter. Transfer through these polymeric cavities appears to be very similar to the transport of contaminants through biomembranes (9). Phenomenologically, the SPMD appears to mimic key aspects of uptake of dissolved chemicals by aquatic organisms. Uptake generally involves active transport to a biomembrane surface, diffusion through the exterior mucosal layer and the biomembrane, and in the case of bioconcentratable contaminants, export away from the membrane's inner surface to lipid containing tissues. Although contaminant uptake is complex, the process can be simplified to its passive elements which include diffusion of organic chemicals through thin liquid phase layers, then the nonpolar regions of the biomembranes and finally into the organism's lipid pool. The SPMD has been employed as a passive integrative sampler (5) and appears to simulate these key portions of uptake of chemicals by a broad array of species.

By using a combination of integrative samplers developed at CERC, a more complete assessment of waterborne anthropogenic contaminants is possible. Of particular concern are the more water-soluble chemicals and current use pesticides for which no time weighted assessment technique is widely available. Scientists at CERC have recently developed an integrative sampler for polar organic compounds, the polar organic chemical integrative sampler or POCIS (10), which functions to address the more polar waterborne contaminants.

During 2003, scientists at CERC in joint research efforts with U.S Fish and Wildlife scientists, assessed the potential impacts of anthropogenic contaminants in selected aquatic systems in the Chesapeake Bay region. Presented herein are the results of the analyses of the SPMD and POCIS integrative samplers for a broad spectrum of organic contaminants.

EXPERIMENTAL

Materials and Reagents: Analytical standards of all targeted analytes (Table I), were obtained from AccuStandard Inc., New Haven, CT, ChemService Inc., West Chester, PA, Crescent Chemical, Islandia, NY, or Sigma Aldrich, St. Louis, MO. All laboratory chemicals were ACS Reagent grade and organic solvents were Optima grade from Fisher Scientific Co., Pittsburgh, PA. Florisil® (60-100 mesh) is obtained from Fisher Scientific Company, Pittsburgh, PA. The Florisil® was first heated at 475°C for 8 hours, then blended with 5 % (W:W) of deionized water and equilibrated at 130°C for 48 hours. The Florisil® was subsequently stored at room temperature over P_2O_5 as a desiccant. Silica gel (SG-60, 70-230 mesh) was obtained from Thomas Scientific, Swedesboro, NJ. The silica gel was first washed with 40:60 methyl tert-butyl ether:hexane (V:V) followed by 100% hexane. The silica gel was then activated at 130°C for a minimum of 72 hours before use and stored at room temperature over P_2O_5 as a desiccant. Phosphoric acid/silica gel (PASG) was made by combining ACS reagent grade phosphoric acid and the silica gel described above in a 40:60 (W:W) ratio, blending to achieve homogeneity, and subsequently storing at room temperature over P_2O_5 as a desiccant. Potassium silicate (KS, a sorbent developed and used at CERC) was made by combining a methanolic solution of ACS reagent grade potassium hydroxide with the silica gel described above in the ratio of 250 mL of methanol to 56 grams of potassium hydroxide to 100 grams of silica gel. After mixing for 1.5 hours and solvent removal, the potassium silicate was activated at 130°C for 48 hours before use and subsequently stored at room temperature over P_2O_5 as a desiccant. Low density polyethylene (PE) layflat tubing was purchased from Environmental Sampling Technologies, St. Joseph, MO. The PE tubing was a 2.54 cm wide, No. 940, untreated (pure PE; no slip additives, antioxidants, etc.) clear tubing. The wall thickness of this lot ranged from 84 to 89 μm. Polyethersulfone membrane disks (47 mm diameter, 0.1 μm d_p) were purchased from Pall Gelman Sciences, Inc. (Ann Arbor, MI). Isolute® ENV+ solid resin was purchased from Jones Chromatography (Lakewood, CA). Ambersorb® 1500 was obtained from Rohm and Haas (Philadelphia, PA). S-X3 Bio-Beads (200-400 mesh) were purchased from Bio-Rad Laboratories (Hercules, CA). The stainless steel materials used in construction of POCIS were purchased from McMaster-Carr (Elmhurst, IL). The Oasis® HLB SPE cartridges (200 mg of sorbent, 6 mL capacity) were obtained from Waters Corp., Milford, MA. Polypropylene centrifuge tubes (50mL, 30 x 115 mm style) were purchased from Becton Dickinson Labware, Franklin Lakes, NJ.

Instrumentation: A Perkin-Elmer Series 410 HPLC (Perkin-Elmer, Inc., Norwalk, CN), was employed as the solvent delivery system for size exclusion chromatography (SEC) cleanup. This HPLC unit was equipped with a ThermoFinnigan AS3000 autosampler (ThermoFinnigan, San Jose, CA). The SEC column was a 300-mm X 21.2-mm i.d. (10-

µm d_p, 100 Å pore size) Phenogel column (Phenomenex, Inc., Torrance, CA), equipped with a 50-mm X 7.5-mm i.d. Phenogel guard column. The SEC system was completed with a D-Star DFW-20 fixed wavelength ultra violet (UV) detector (D-Star Instruments, Manassas, VA) and an Isco Foxy 200 fraction collector (Isco, Inc., Lincoln, NE).

Gas chromatographic analyses for PAHs (Table I) were conducted on an Agilent 6890 GC equipped with an Agilent 7683 autosampler (Agilent Technologies, Inc., Wilmington, DE). In all analyses, 1.0 µL of sample extract was injected using the "cool-on-column" technique with helium as the carrier gas. A HP-5MS (30 m x 0.25 mm i.d. x 0.25 µm film thickness) capillary column (Agilent Technologies, Inc., Wilmington, DE) was used with the following temperature program: injection at 50 °C, held for 2 min, then ramped at 25 °C/min to 130 °C, held for 1 min, followed by 6 °C/min ramp to 310 °C and held at 310 °C for 5 min. Detection was performed with a 5973 mass selective detector (Agilent Technologies, Inc., Palo Alto, CA) in the selected ion mode (SIM). Detector zone temperatures were set at 310 °C for the MSD transfer line, 150 °C at the quadrapole, and 230 °C at the source. Quantitation of the analytes was accomplished using a six-point curve with internal calibration. Calibration standard concentrations were 0.02, 0.05, 0.10, 0.50, 1.0, 2.0, and 4.0 µg/mL for each of the analytes with the internal standards, 2-methylnaphthalene-d_{10} and benzo[e]pyrene-d_{12}, maintained at 0.250 µg/mL.

Gas chromatographic analyses, for all analytes excluding PAHs, hormones and antibiotics (Table I), were conducted using Hewlett Packard 5890 series gas chromatographs (GC) equipped with a Hewlett Packard 7673A autosamplers (Hewlett Packard, Inc., Palo Alto, CA). In all analyses, 1.0 µL of sample extract was injected using the "cool-on-column" technique with hydrogen as the carrier gas. Analyses were performed using DB-35MS (30 m x 0.25 mm i.d. x 0.25 µm film thickness) capillary columns (J&W Scientific, Folsom, CA) with the following temperature program: injection at 90 ^{o}C; then ramped at 15 ^{o}C/min to 165 ^{o}C; followed by 2.5 ^{o}C/min ramp to 250 ^{o}C; and finally ramped at 10 ^{o}C/min to 320 ^{o}C. The electron capture detector (ECD, Hewlett Packard, Inc., Palo Alto, CA) was maintained at 330 ^{o}C. Quantitation of organochlorine pesticides (OCs) was accomplished using a six-point curve with PCB congener I-30 as retention time reference compound and PCB congener I-207 as the instrumental internal standard (IIS). The levels of the OC standards spanned an 80-fold range of concentration for each compound. Quantitation of total PCBs was accomplished using a six-point curve employing standard solutions containing a 1:1:1:1 mixture of Aroclor® 1242, 1248, 1254, and 1260 with PCB congener I-30 as retention time reference compound and PCB congener I-207 as IIS. The levels of the PCB standards spanned a 20-fold concentration range from 50 to1,000 total ng/mL.

The HPLC system used in the analysis of the hormones and antibiotics (Table I) consisted of a Hewlett Packard 1090 Series II Liquid Chromatograph with a diode array detector (Hewlett Packard, Palo Alto, CA) with the ChemStation for LC software package revision A.08.03 (Agilent Technologies, Inc., Palo Alto, CA). A Supelco (Supelco, Bellefonte, PA) Discovery® C_8 analytical column (150 x 4.6 mm, 5 µm d_p), a Phenomenex Security Guard C_8 cartridge was used for both the hormone and antibiotics analysis. A mobile phase of 65:35 water:acetonitrile with a flow rate of 1 mL/min were

used during hormone analysis. Antibiotic analysis utilized a mobile phase of 25 mM KH_2PO_4 (pH 3) buffer:acetonitrile 80:20 with a flow rate of 1 mL/min. Detection of the hormones and antibiotics occurred at 281 and 365 nm respectively. Peak purity/confirmation was performed by observing the UV spectra profiles of the analytes. Multi-point calibration curves (10, 25, 50, 100, 200, 300, 400, and 500 ng of each hormone and each antibiotic injected on column) were run on a daily basis. All samples and standards were dissolved in the appropriate mobile phase prior to analysis. Analytical standards for the tetracycline antibiotics were kept cool, protected from light and made fresh daily once placed in mobile phase due to potential degradation of the analytes.

Analytical Standard Solutions: When available, certified stock solutions were purchased directly from the supplier at appropriate concentration levels. Primary stock solutions of analytical standards were made by serial dilution of the commercially available solutions or by accurately weighing portions of the neat materials (weights corrected for assayed purity) and diluting with an appropriate volume of suitable solvent to make final concentrations at 500 ng/mL to 200 µg/mL. Solutions were protected from light, stored at either -20°C or room temperature as appropriate for the individual chemical, and prepared fresh every six months or more often as necessary. Working solutions of mixed standards were prepared by transferring predetermined amounts of each stock solution into a volumetric flask and making to volume. These solutions were made fresh as needed.

Sample Storage and Custody: The SPMDs and POCIS for this study were prepared at CERC between April 16 and April 18 of 2003. These were stored in a laboratory freezer at -15 °C from fabrication until time of their shipment to the USF&WS Chesapeake Bay Field Office on Monday, April 21 of 2003. Following field deployment and receipt of the samples at CERC on Thursday, June 12, 2003, the samples were stored, as received, in a laboratory freezer at -15 °C until needed for processing.

SPMD Preparation, Deployment, Processing, and Analyses for PAHs, PCBs and OC-Pesticides

SPMD Preparation: The SPMDs for the project were constructed at CERC using 86 cm lengths of LDPE tubing with 1.0 mL (0.91 g) of triolein (Nu-Check Prep Inc. Elysian, MN, this 99% triolein, Lot T-235-05-L was further purified at CERC (11) on 11-19-01) being added to each SPMD. The active surface area of the finished device was ~ 440 cm^2. Each of the four deployed SPMDs (for each site) and the two SPMDs used as Field Blanks (for each site) were spiked with 4.0 µg of Phenanthrene-d_{10} (permeability reference compound [PRC]). Four SPMDs were loaded onto deployment devices (for each of seven deployment sites). These were placed into labeled, solvent rinsed cans which were then flushed with argon and sealed. The Field Blank SPMDs were placed into labeled, solvent rinsed pint cans (two per can). These cans were also flushed with argon and sealed. All cans were then shipped to the USF&WS Chesapeake Bay Field Office for deployment by US FWS personnel.

SPMD Deployment: Samplers at study Sites # 3 and # 7 were lost during deployment. The deployment dates and site descriptions for the remaining five study sites were identified on the USF&WS "Chain of Custody Record" as follows;

Station No.	Deployment	Retrieval	Station Location
Site # 1	4/28/03	6/9/03	"ELR2"-Elk River # 2
Site # 2	4/28/03	6/9/03	"BOR2"-Bohemia River # 2
Site # 4	4/28/03	6/9/03	"NER5"-Northeast River # 5
Site # 5	4/28/03	6/9/03	"NER3"-Northeast River # 3
Site # 6	4/29/03	6/8/03	"SER5"-Back Creek

SPMD Processing and Residue Enrichment: There was one canister containing four SPMDs at each deployment site. During processing, two SPMDs from each canister were combined to give two 2-SPMD composites. Compositing extracts was performed because it was anticipated that sequestered contaminant concentrations would be too low to be detected in a single SPMD extract. Sample processing was similar to procedures previously described (7), with specific details noted in the following sections

SPMD Cleanup: SPMDs as received from field exposures were subjected to cleanup before dialysis. This cleanup was applied to all SPMDs received from the field as well as to all QA/QC SPMDs generated in conjunction with the analysis sets. The steps associated with the cleanup were applied to each SPMD individually and sequentially, and were as follows. The sealed metal cans containing deployment canisters holding the field deployed SPMDs were opened and the SPMDs were removed from the deployment canisters. The SPMDs were then rinsed by immersion into 100 mL of hexane. Then, the hexane was discarded. The SPMDs were placed individually into a large flat stainless steel pan and washed using running tap water and a clean brush to remove all remaining surface adhering material. SPMD tether loops outside the lipid containment seals were cut off and discarded at this point. Next, the water was drained from the exterior of each SPMD. The SPMDs were then separately immersed in a glass tank containing 1 N HCl for a period of approximately 30 seconds. Then, they were rinsed with tap water to remove the acid. Afterwards, all surface water was removed from individual SPMDs by using successive rinses of acetone followed by isopropanol. SPMDs were air dried by laying the SPMD on a piece of solvent-rinsed aluminum foil. (Note, exposure time was minimized to prevent airborne chemical uptake by the SPMDs)

SPMD Dialysis: Glass canning jars (one pint) with solvent-rinsed aluminum foil under the lid were used for the dialysis step. The 86 cm SPMDs (1.0 mL lipid) were individually submersed in 165 mL of hexane in each jar and were dialyzed individually at 18 ^{o}C for 18 hours. The hexane was removed and transferred into an evaporation flask.

A second volume of 165 mL of hexane was added to the dialysis jar and the SPMDs were dialyzed for an additional 6 hours at 18 ^{o}C. The second dialysate was transferred into the flask containing the first dialysate. The SPMDs were then discarded. The combined dialysates were reduced to a volume of 3 - 5 mL on a rotoevaporation system, and quantitatively transferred through a pre-rinsed glass fiber filter into appropriately labeled test tubes.

Post-Dialysis Sample Splitting: Because different enrichment techniques were required for the targeted environmental contaminants, the samples were split into two equal portions prior to further fractionation and enrichment. These were identified as the "PAH" fractions and the "OC" fractions. After splitting, the two fractions were each reduced to a volume of ~ 1 mL using high purity N_2 blow-down. The procedures employed to enrich the "OC" and "PAH" fractions are presented separately as follows:

Processing of "PAH" Fractions

The size exclusion chromatography (SEC) system previously described was employed for the initial cleanup step.

SEC Calibration: The SEC system was calibrated on a daily basis by the injection of a solution of compounds representative of the analytes and potentially interfering materials. The substances contained in the calibration solution, in sequence of elution, were diethylhexylphthalate (DEHP; a model compound with lipid-like chromatographic behavior), biphenyl and naphthalene (small aromatic analytes), coronene (a large PAH later eluting than any anticipated analyte), and elemental sulfur (a problematic interfering substance encountered frequently in environmental samples). Elution of these components was monitored at 254 nm using the D-Star DFW-20 fixed wavelength UV detector.

SEC Processing: SEC cleanup was accomplished using a Collect fraction defined by the calibration of the system on the day of operation. The Collect fraction was initiated at the point 70% of the time between the apex of the DEHP chromatographic peak and the apex of the biphenyl chromatographic peak. The Collect fraction was terminated at 70% of the time between the apex of the coronene chromatographic peak and the apex of the sulfur chromatographic peak. The fractions collected were amended with ~ 2 mL of isooctane, reduced to a volume of ~ 1 mL on a rotoevaporation system, and quantitatively transferred with hexane into appropriately labeled test tubes.

Column Cleanup: The post-SEC "PAH" fractions were then processed using open column chromatography. The "PAH" fractions, at ~ 0.5 mL in hexane, were treated using a tri-adsorbent column consisting of from top to bottom, 3 g phosphoric acid/silica gel; 3 g of KS; and 3 g of silica gel. The tri-adsorbent column was eluted with 50 mL of 4% (V:V) MTBE:Hexane. This procedure resulted in a solution suitable for GC analysis of PAH residues. The fractions collected were amended with ~2 mL of isooctane, reduced to a volume of ~ 0.5 mL on a rotoevaporation system, and quantitatively transferred with hexane into labeled GC vials. Following addition of an appropriate

amount of IIS, sample volumes were adjusted to 1.0 mL. These samples were then ready for GC-MSD analysis for PAHs. Gas chromatographic analyses were conducted using the systems previously described.

Processing of "OC" Fractions

SEC of "OC" Fractions: This procedure was as previously described for the processing of "PAH" fractions with the following modification. The collect fraction was initiated at the point 50% of the time between the apex of the DEHP chromatographic peak and the apex of the biphenyl chromatographic peak. The collect fraction was terminated at 70% of the time between the apex of the coronene chromatographic peak and the apex of the sulfur chromatographic peak.

Preliminary Column Cleanup of "OC" Fractions: The post-SEC "OC" fractions were then processed using open column chromatography. The "OC" fractions, at 1.0 mL in hexane, were applied to Florisil columns (5 g) and subsequently eluted with 60 mL of 75:25 (V:V) MTBE:Hexane giving a fraction identified as FL1. Each column was then eluted with a 70 mL portion of acetone giving a fraction identified as FL2. Each fraction collected was amended with ~ 2 mL of isooctane, reduced to a volume of ~ 1 mL on a rotoevaporation system, and quantitatively transferred with hexane into an appropriately labeled test tube.

Secondary Column Cleanup of "FL1" and "FL2" Fractions: Both type of "OC" fractions (i.e. FL1 & FL2) were processed using open column chromatography. These (FL1 And FL2), at ~1 mL in isooctane, were applied to silica gel columns (5 g). Two fractions were eluted; fraction SG1 (46 mL of hexane) and SG2 (75 mL of 40:60 (V:V) MTBE:Hexane). The SG1 and SG2 fractions from the FL1 fractions were both retained and were identified as "SG1" and "SG2" respectively. The SG1 fractions from the FL2 fractions were discarded. The SG2 fractions from the FL2 samples were retained and identified as "FL2" All fractions were then reduced to a volume of ~ 0.5 mL and quantitatively transferred with hexane into labeled GC vials. Samples were amended with appropriate IIS and the volumes adjusted to 1.0 mL using hexane and high purity N_2 blow-down. These samples, identified as "SG1" "SG2" and "FL2," were then ready for GC-ECD analysis for PCBs, OC-pesticides, and the highly polar targeted analytes (i.e. Alochlor, Acetochlor, and Metolachlor) respectively. Gas chromatographic analyses were conducted using the systems previously described.

POCIS Analysis for Hormones and Antibiotics

POCIS Description: There were two canisters containing POCIS at each deployment site. In each canister, there were two POCIS constructed using the sorbent admixture of 80:20 (w/w) Isolute ENV+:S-X3 dispersed Ambersorb 1500 for sampling the hormones and two POCIS constructed using the Oasis HLB sorbent for sampling the antibiotics. During processing, the two POCIS with similar sorbents from each canister were combined to give a sample equivalent to two devices. Compositing extracts is performed in cases where it is suspected that contaminant concentrations may be too low to be

detected in a single extract. This task resulted in replicate two-POCIS composites from each site.

POCIS Cleaning and Extraction (i.e., Recovery of Analytes) for Hormones: Each POCIS was removed from its deployment canister and rinsed with water to remove any debris. The contents of the POCIS were then transferred with methanol into 1 cm (i.d.) glass chromatography columns fitted with a glass wool plug. Solvent extraction (elution) of sequestered analytes was achieved with the addition of 50 mL of 1:1:8 (V:V:V) MeOH:toluene:DCM. The collected eluate was evaporated by rotary evaporation to 2-3 mL, 20 mL of MeOH was added to the flask and evaporated again to approximately 1 mL. The additional MeOH was necessary to form an azeotrope to facilitate the removal of the toluene from the sample. The sample was then quantitatively transferred through a pre-rinsed glass fiber filter into appropriately labeled test tubes with acetone and subsequently evaporated under high purity N_2 to 0.5 mL.

Processing of Extracted POCIS Hormone Fractions: Each filtered POCIS extract designated for hormone analysis, was divided between two vials for injection on SEC using the 30% window as previously described. The post-SEC samples were evaporated and transferred into GC vials with acetone, taken to near dryness under high purity N_2, and reconstituted with 0.5 mL of 50:50 Hexane:dichloromethane. The samples were applied to KS columns for further cleanup and fractionation. Gravity flow glass chromatography columns (1 cm i.d.) containing 3 g of KS were rinsed with 25 mL methanol followed by 25 mL 75% dichloromethane/Hexane prior to sample application. The sample was applied in ~ 0.5 mL dichloromethane to the KS with 3 rinses of 75% dichloromethane /Hexane. A total of 25 mL of 75% dichloromethane /Hexane was used to wash the column following sample application. Analyte elution was accomplished using 20 mL of 2:49:49 (V:V:V) methanol: dichloromethane:hexane. The hormone containing fractions from KS were evaporated, transferred into vials, taken to dryness under high purity N_2, redissolved in 0.5 mL 1:1 water:acetonitrile and analyzed by HPLC.

POCIS Cleaning and Extraction (i.e., Recovery of Analytes) for Antibiotics: The POCIS were cleaned and the sorbent was transferred into columns as described previously. Elution of the antibiotics occurred by the addition of 40 mL of methanol to the sorbent. The eluate was evaporated by rotary evaporation to 1-2 mL and quantitatively transferred through a pre-rinsed glass fiber filter into appropriately labeled test tubes with 3 rinses of methanol. The filtered samples were then evaporated under high purity N_2 to 0.5 mL.

Processing of Extracted POCIS Antibiotic Fractions: The filtered POCIS sample extracts to be analyzed for antibiotics, underwent subsequent cleanup by application to Oasis SPE cartridges. The extracts at 0.5 mL of methanol were diluted to 10 mL with McIlvaine-EDTA buffer solution. The Oasis cartridge was conditioned prior to sample application with successive rinses of 3 mL methanol, 2 mL RO water, and 2 mL McIlvaine-EDTA buffer solution. The sample was then applied to the cartridge followed by washing of the cartridge with 2 mL of 5% methanol/water. The tetracyclines were eluted with the addition of 3 mL methanol. The post-Oasis samples were taken to dryness and then re-

dissolved in 1.0 mL of 25 mM KH_2PO_4 buffer (pH 3). The samples were filtered into vials and analyzed by HPLC.

RESULTS AND DISCUSSIONS

Quality Control: Field blank SPMDs and POCIS accompanied the SPMDs and POCIS during deployment, retrieval, and transportation to CERC. These field blanks were processed and analyzed exactly as the deployed samples. Analysis of the field blank samples gave no coincident GC or HPLC peaks at levels significantly higher than those associated with the laboratory control SPMDs and POCIS and indicated a successful deployment and retrieval. A series of control SPMD and POCIS samples were processed and analyzed exactly as the study samples. The method detection limit (MDL) and method quantitation limit (MQL) for analysis of the study specific SPMD and POCIS samples were determined for each analyte by measuring the values of coincident GC-MSD, GC-ECD, and HPLC peaks for each compound in these control samples. The MDL was defined as the mean plus three standard deviations of values so determined (12). The MQL was defined as the mean plus 10 standard deviations of values so determined (12). For individual analytes having no coincident chromatographic peak, an assumed value equal to the low sample reject for the method was used to calculate the mean. In the cases where the MQLs were below the level of the calibration curve employed, the MQLs were set at the value of the lowest level of the calibration curve in quantifying the analyte levels. The MDLs and MQLs for analysis of the study samples for all targeted analytes in SPMDs and POCIS are presented in Table II.

QC checks were employed to demonstrate an acceptable outcome of sample analyses. These checks included; 1) evaluation of the performance of the SEC system by daily (each operation day) injection of a known quantity of ^{14}C-2,5,2',5'-tetrachlorobiphenyl (^{14}C-TCB, the amount of radioactivity used per spike was about 48,000 disintegrations per minute) and measuring recovery through the system ; 2) evaluation of the combined dialysis and SEC process for SPMDs. This ^{14}C-SPMD spike was prepared by fortifying a blank SPMD with approximately 161,000 disintegrations per minute of ^{14}C-Dibenz[a,h]anthracene and measuring recovery through the combined dialysis and SEC processing steps; and 3) monitoring the recoveries of all analytes of interest through the entire extraction, dialysis, SEC, chromatographic fractionation and enrichment procedures by using spiked control matrix blanks. These matrix spikes were prepared by fortifying an individual blank matrix (i.e., SPMDs and POCIS) with targeted analytes (Table I). The spiking levels were intended to approximate levels near the method quantitation limit (MQL) and were intended to be representative of levels found in environmental samples. Recovery of ^{14}C-TCB through the SEC system averaged 96.9% (n=2). For the ^{14}C-SPMD spike, post-SEC recovery was 89.9 %. For the SPMD spike (Table III), recoveries of PAHs and OCs were consistent with recovery levels reported in conjunction with analytical method validation conducted concurrently with the first years work on this joint USF&WS / USGS project. Recovery of total PCBs was 74.3%. Recovery of targeted analytes from the POCIS were unexpectedly lower than studies with 36 to 71% recovered. It is unknown what caused the loss in recovery. Values from the analyses of SPMD and POCIS extracts are given in Tables IV through IX.

Derivation of Water Concentrations from SPMD Residues (Modeling): SPMD uptake kinetic data are required to accurately estimate aquatic concentrations of environmental contaminants. Using models previously developed (4), data from the analysis of the PRC levels (Table IX), and data from uptake kinetic studies, the aquatic concentrations of selected contaminants present in SPMDs exposed during this study were estimated for the 30-day exposure (Table X).

An example of the overall estimation procedure is as follows. The analyte sampling rate (R_{sw}) is determined from laboratory exposures conducted under about the same conditions (i.e., water temperature and exposure duration) as the field study. The linear SPMD uptake of OCs from water was described by Huckins, et al. (4) as follows:

$$C_L = C_W k_o K_{mW} A t / V_L \quad (1)$$

substituting R_{sw} for $k_o K_{mW} A$ in equation 2 gives

$$C_L = C_W R_{sw} t / V_L \quad (2)$$

where C_L is the concentration of the analyte in the lipid, C_W is the concentration of the analyte in the water, t is the exposure time in days, and V_L is the volume of the lipid. Rearranging equation 3 results in

$$C_W = C_L V_L / R_{sw} t \quad (3)$$

Because the analytes present in the membrane were also recovered during the dialysis procedure, equation 4 can be rewritten as

$$C_W = C_{SPMD} M_{SPMD} / R_{sw} t \quad (4)$$

where C_{SPMD} is the concentration of the individual analyte in the SPMD and M_{SPMD} is the mass of the SPMD. In the present case we use the uptake rate constant (k_{uw}) defined as L/dg (Liters per day per gram) of SPMD (membrane + lipid).

$$C_W = C_{SPMD} / (R_{sw} / M_{SPMD})\, t \quad (5)$$

$$C_W = C_{SPMD} / k_{uw}\ t \quad (6)$$

SPMD sampling rates can change due to changes in temperature, flow velocity of the surrounding water, and buildup of periphyton on the membrane surface. To account for changes in these variables from the laboratory calibration studies, PRCs are used to allow estimation of actual exposure R_{SW} values. PRCs are noninterfering (analytically) compounds, such as perdeuterated (all hydrogen atom replaced by deuterium atoms) PAHs with moderate to fairly high fugacity (escaping tendency), added to the SPMD's triolein prior to deployment (4). Measuring the PRC loss over the exposure period provides in situ k_e values which when compared to the calibration k_e values can serve as

an indicator to differences in the environmental conditions. If large differences exist between the k_e calibration and exposure values, adjustments can be made to the laboratory calibration data to better reflect actual sampling rates. The k_{eprc} values are derived as follows

$$C_{SPMD} = C_{SPMDo} \exp(-k_{eprc} t) \quad (7)$$

$$k_{eprc} = \ln(C_{SPMDo} / C_{SPMD}) / t \quad (8)$$

where C_{SPMDo} is the initial concentration of the PRC and C_{SPMD} is the concentration of PRC remaining in the SPMD following exposure. Comparison of the k_{eprc} values derived from the field-exposed SPMDs (Equations 7 or 8), to the k_e values of the PRCs measured in SPMD calibration exposures (i.e., k_{eprc} / k_{ec}), provides an estimate of the relative effect of environmental variables on SPMD sampling. Laboratory k_{ec} values of PRCs are determined by direct measurement or by

$$k_{ec} = R_s / K_{SPMD} V_{SPMD} d_{SPMD} \quad (9)$$

where K_{SPMD} is the equilibrium SPMD-water partition coefficient and d_{SPMD} is the SPMD density (g/mL). Estimates of in situ R_s values from the k_{ec}s of PRCs can be made with the following relationship

$$R_{sf} = (k_{eprc} / k_{ec}) R_{sc} \quad (10)$$

The estimated bioavailable waterborne concentration of selected contaminants present at the sampling sites are presented in Table X. These values were generated using an average R_{sc} for a temperature of 18^{o}C.

Derivation of Water Concentrations from POCIS Residues (Modeling): The POCIS and SPMD integrative samplers share similar functional attributes allowing models derived for the SPMD to be applied. Contaminant sampling models have been discussed in detail (13). From these models, the following equation is derived

$$C_W = C_{POCIS} / (R_s \cdot t) \quad (11)$$

where C_W is the estimated water concentration, C_{POCIS} is the total mass of the analyte in the POCIS sample extract, R_s is the sampling rate in L/d, and t is the deployment time in days. R_s data has been determined in the laboratory for select chemicals under various flow conditions (14). Due to a lack of information on the specific conditions at each deployment site, R_s values for highly turbulent systems were used in the calculations to serve as a worst case scenario. The results are given in Table XI. The biological consequence of organism exposure to these levels of waterborne polar organic chemicals is unknown.

Observations and Findings: All study samples were processed concurrently with the above referenced quality control samples. Therefore, the results obtained from processing and analyses conducted on these samples are taken to be similar to the observed results for the quality control samples described. During the chromatographic

analysis of study sample fractions, conditions were optimized to give sufficient resolution for quantitation of the targeted analytes (Table XII and Figures 1,2,3,4,5).

The results of the GC and HPLC analyses are given for all targeted analytes and are presented in Tables IV through VIII with representative chromatograms given in Figures 1, 4, 5, 6, 7, & 8. Estimated water concentrations of selected analytes are presented in Tables X and XI.

SPMD samples from all five study sites had measurable levels of a wide variety of OC pesticides (Tables IV through VIII). Site # 1 and site # 6 (Elk River and Back Creek respectively) showed the highest levels of sequestered OC-pesticide contaminants with totals at ~ 300 and ~250 total ng per SPMD respectively. Sequestered levels of OC-pesticide contaminants from the remaining three sites were similar to each other and ranged from 116 to 126 total ng per SPMD. These values are in sharp contrast to levels of contaminants observed using SPMDs during the first year of this three year study where only a very few contaminants were observed and then only at much lower levels than reported here (15). Specific contaminants which were observed at all five sites at levels well above the MQLs were 1) chlordanes, 2) DDD, 3) dieldrin, 4) nonachlors, 5) dacthal, 6) pentochloroanisole (PCA), and the current use pesticides acetochlor and chlorpyrifos. It should be noted that many chlorinated pesticides have been banned – some for nearly 20 years (16). The apparent longevity of these chlorinated contaminants may result in a continued reduction in habitat quality. For instance, dieldrin, the DDT complex, and the chlordane components along with a much larger set of diverse environmental contaminants have been reported to cause endocrine-disruption in some organisms (17).

SPMD samples from all five study sites also had measurable levels of PAHs (Tables IV through VIII). Only site # 6 (Back Creek) showed elevated levels of sequestered PAH contaminants. The ubiquitous PAHs, fluoranthene and pyrene, were observed at low levels (~ 100 to 400 ng per SPMD) for sites # 1, # 2, # 4, and # 5. For site # 6, µg quantities of fluoranthene, pyrene, and chrysene were observed with numerous PAHs present in the ~ 100 to 400 ng per SPMD range (Table VIII).

Only the POCIS samples from Site # 5 (Northeast River) had measurable levels of the targeted hormone 17β-estradiol. No other targeted hormones were detected in any of the POCIS samples from the study sites (Tables IV to VII). The concentration of 17β-estradiol of Site # 5 water was calculated to be ~ 4 ng/L (Table XI). The hormone 17β-estradiol is readily leached from chicken litter into aquatic systems via surface run-off following initial land application (1,18,19). Hormone residues are less likely to found in areas containing aged litter. Aquatic organisms, livestock and human inputs can also add to the 17β-estradiol loading making identification of a point source difficult.

The analytical methods for these POCIS sample analyses were developed at CERC from previously reported work (20,21). Various tetracycline antibiotics were identified in POCIS extracts from three of the sites. Chlortetracycline was isolated in samples from Station 5 of the Northeast River and oxytetracycline was measured at Station 3 of the

Northeast River. POCIS samples from Back Creek contained all three antibiotics, ocytetracycline, tetracycline, and chlortetracycline.

Elucidation of the potential biological effects from exposure to complex mixtures of chemicals requires further research. The water concentrations of select contaminants (Table X) observed in this study would appear to be of some concern. This would be especially true for Site # 1 and Site # 6, Elk River and Back Creek respectively, and, to a lesser extent, the remaining three sites.

SUMMARY

Scientists at the U.S. Geological Survey working with members of the U.S. Fish and Wildlife Service have entered the third year of a holistic assessment of the presence and potential impacts of anthropogenic contaminants on the water resources of the Chesapeake Bay region. Analysis of the SPMDs indicated that Back Creek and Elk River were significantly more contaminated than the remaining sites. The hormone 17β-estradiol was only identified in POCIS samples from Station 5 of the Northeast River. Various tetracycline antibiotics were found in three of the study sites. However, information on the location of the sites was not available, therefore, any conclusions on the sources of identified chemicals cannot be made.

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LITERATURE CITED

1. Nichols, D.J.; Daniel, T.C.; Moore, P.A.; Edwards, D.R., Pote, D.H. 1997. *J. Environ. Qual.*, 26, 1002-1006.
2. Miller, C.V., Foster, G.D., Huff, T.B. Organic Compounds and Trace Elements in the Pocomoke River and Tributaries, Maryland. 1999. *U.S. Geological Survey Open-File Report 99-57, Baltimore, MD.*
3. Kolpin, D.W., Furlong, E.T., Meyer, M.T., Thurman, E.M., Zaugg, S.D., Barber, L.B., Buxton, H.T. 2002. *Environ. Sci. Technol.*, 36, 1202-1211.
4. Huckins, J.N., Manuweera, G.K., Petty, J.D., MacKay, D., Lebo, J.A. 1993. Environ. Sci. Technol., 27, 2489-2496.
5. Petty, J.D., Huckins, J.N., and Zajicek, J.L. 1993. Chemosphere, 27, 1609-1624.
6. Petty, J.D., Huckins, J.N., Orazio, C.E., Lebo, J.A., Poulton, B.C., Gale, R.W., Charbonneau, C.S., Kaiser, E.M. 1995. Environ. Sci. Technol., 29, 2561-2566.
7. Lebo, J.A., Gale, R.W., Petty, J.D., Huckins, J.N., Echols, K.R., Schroeder, D.J., Inmon, L.E. 1995. Environ. Sci. Technol., 29, 2886-2892.

8. Huckins, J.N., Tubergen, M.W., Manuweera, G.K. 1990. Chemosphere, 20, 533-553.
9. Oppenhuizen, A., Velde, E.W., Gobas, F.A.P., Leim, D.A.K., Steen, J.M.D. 1985. Chemosphere, 14, 1871-1896
10. Petty, J.D., Huckins, J.N., Alvarez, D.A. A device for the sequestration and concentration of polar organic chemicals from water. U.S. Patent Number 6,478,691, November 12, 2002.
11. Lebo, J.A., Almeida, F.V., Cranor, W.L., Petty, J.D., Huckins, J.N., Rastall, A.C., Alvarez, D.A., Mogensen, B.B., Johnson, B.T. 2004. Chemosphere, 54, 1217-1224
12. Keith, L.H. 1991 Environmental Sampling and Analysis: A Practical Guide, CRC Press, Inc.; Boca Raton, FL, pp 101-113.
13. Alvarez, D.A., Doctoral Thesis, University of Missouri-Columbia, Columbia, MO, 1999.
14. Alvarez, D.A., Petty, J.D., Huckins, J.N., Jones-Lepp, T.L., Getting, D.T., Goddard, J.P., Manahan, S.E. 2004. Environ. Tox. Chem. *in press*.
15. Petty, J.D.; Huckins, J.N.; Cranor, W.L.; Alvarez, D.A.; Lebo, J.A.; and Clark, R.C. *Assessment of Waterborne Bioavailable Organic Contaminants Originating From Concentrated Animal Feeding Operations.* March 31, 2001, USGS report prepared for B.L. McGee, US F&WS, Annapolis, MD.
16. Colborn, T., Vom Saal, F.S., Soto, A.M. 1993. Environ. Health Perspect., 101, 378-384
17. Davis, W.P., Bortone, S.A. In "Chemically Induced Alterations in Sexual and Functional Development: The Wildlife/Human Connection", Colborn, T., Clement, C. Eds., Princeton Scientific Publishing: Princeton, NJ, 1992, pp 113-127
18. Shore, L.S., Correll, D.L., Chakraborty, P.K. Relationship of fertilization with chicken manure and concentrations of estrogens in small streams. In, *Animal Waste and the Land-Water Interface*, Steele, K., ed., CRC Press, Boca Raton, FL. 1995, pp. 155-162.
19. Furhacker, M., Breithofer, A., Jungbauer, A. 1999. *Chemosphere*, 39, 1903-1909.
20. AOAC Official Methods of Analysis. Official Method 995.09 Chlortetracycline, Oxytetracycline, and Tetracycline in Edible Animal Tissues. Chapter 23, p 20 (2000).
21. Rogstad, A.; Hormazabal, V.; Yndestad, M. 1988. *J. Liq. Chromatogr.* 11, 2337-2347.

Table I. Organic Contaminants Targeted for Analysis at CERC

PCBs (SPMDs)

Total PCBs

Pesticides (SPMDs)

Trifluralin
HCB*
PCA**
α-BHC***
Diazinon
Atrazine
Lindane
β-BHC***
Heptachlor
Acetochlor
Alachlor
δ-BHC***
Metolachlor
Dacthal
Chlorpyrifos
Oxychlordane
Heptachlor Epoxide
trans-Chlordane
trans-Nonachlor
o,p'-DDE
cis-Chlordane
Endosulfan
p,p'-DDE
Dieldrin
o,p'-DDD
Endrin
cis-Nonachlor
o,p'-DDT
p,p'-DDD
Endosulfan-II
p,p'-DDT
Endosulfan Sulfate
Methoxychlor
Mirex
8-Cyhalothrin
cis-Permethrin
trans-Permethrin

* Hexachlorobenzene
** Pentachloroanisole
*** Benzenehexachloride

PAHs (SPMDs)

Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benz[a]anthracene
Chrysene
Benzo[b]fluoranthene
Benzo[k]fluoranthene
Benzo[a]pyrene
Indeno[1,2,3-cd]pyrene
Dibenz[a,h]anthracene
Benzo[g,h,i]perylene

Benzo[b]thiophene
2-methylnaphthalene
1-methylnaphthalene
Biphenyl
1-ethylnaphthalene
1,2-dimethylnaphthalene
4-methylbiphenyl
2,3,5-trimethylnaphthalene
1-methylfluorene
Dibenzothiophene
2-methylphenanthrene
9-methylanthracene
3,6-dimethylphenanthrene
2-methylfluoranthene
Benzo[b]naphtho[2,1-d]thiophene
Benzo[e]pyrene
Perylene
3-methylcholanthrene

Hormones (POCIS)

17β-Estradiol
Estrone

Antibiotics (POCIS)

Oxytetracycline
Tetracycline
Chlortetracycline

Table II. MDL and MQL Values For Targeted Analytes in SPMDs and POCIS

PCBs (SPMDs)	MDL ng/SPMD	MQL ng/SPMD
TOTAL PCBs	10	50
Pesticides (SPMDs)		
Trifluralin	0.05	0.25
HCB	0.20	1.00
PCA	0.20	1.00
α-BHC	0.20	1.00
Diazinon	0.25	1.25
Atrazine	20.0	100
Lindane	0.20	1.00
β-BHC	0.20	1.00
Heptachlor	0.20	1.00
Acetochlor	0.25	1.25
Alachlor	0.25	1.25
δ-BHC	0.20	1.00
Metolachlor	1.00	5.00
Dacthal	0.20	1.00
Chlorpyrifos	0.25	0.25
Oxychlordane	0.20	1.00
Heptachlor Epoxide	0.20	1.00
Trans-Chlordane	0.20	1.00
Trans-Nonachlor	0.20	1.00
o,p'-DDE	0.20	1.00
cis-Chlordane	0.20	1.00
Endosulfan	0.20	1.00
p,p'-DDE	0.20	1.00
Dieldrin	0.20	1.00
o,p'-DDD	0.20	1.00
Endrin	0.20	1.00
cis-Nonachlor	0.20	1.00
o,p'-DDT	0.20	1.00
p,p'-DDD	0.20	1.00
Endosulfan-II	0.20	1.00
p,p'-DDT	0.20	1.00
Endosulfan Sulfate	0.20	1.00
Methoxychlor	0.20	1.00
Mirex	0.20	1.00
8-Cyhalothrin	0.10	0.50
cis-Permethrin	0.60	3.00
Trans-Permethrin	0.40	2.00

PAHs (SPMDs)	MDL ng/SPMD	MQL ng/SPMD
Naphthalene	76	160
Acenaphthylene	5	20
Acenaphthene	5	20
Fluorene	5	20
Phenanthrene	49	140
Anthracene	5	20
Fluoranthene	24	73
Pyrene	12	37
Benz[a]anthracene	5	20
Chrysene	74	170
Benzo[b]fluoranthene	5	20
Benzo[k]fluoranthene	5	20
Benzo[a]pyrene	5	20
Indeno[1,2,3-cd]pyrene	5	20
Dibenz[a,h]anthracene	5	20
Benzo[g,h,i]perylene	5	20
Benzo[b]thiophene	5	20
2-methylnaphthalene	44	50
1-methylnaphthalene	19	44
Biphenyl	5	20
1-ethylnaphthalene	5	20
1,2-dimethylnaphthalene	5	20
4-methylbiphenyl	5	20
2,3,5-trimethylnaphthalene	5	20
1-methylfluorene	5	20
Dibenzothiophene	5	20
2-methylphenanthrene	5	20
9-methylanthracene	5	20
3,6-dimethylphenanthrene	5	20
2-methylfluoranthene	5	20
Benzo[b]naphtho[2,1-d]thiophene	5	20
Benzo[e]pyrene	5	20
Perylene	5	20
3-methylcholanthrene	5	20
Hormones (POCIS)	ng/POCIS	ng/POCIS
17β-Estradiol	5.0	25
Estrone	5.0	25
Antibiotics (POCIS)	ng/POCIS	ng/POCIS
Oxytetracycline	5.0	25
Tetracycline	5.0	25
Chlortetracycline	5.0	25

Table III. Recovery of PAHs, OC-Pesticides and PCBs From SPMD Spike

	Percent Recovery		Percent Recovery
Total PCBs	74.3	Naphthalene	19.0
		Acenaphthylene	33.4
Trifluralin	11.1	Acenaphthene	37.5
HCB	66.3	Fluorene	48.4
PCA	94.7	Phenanthrene	64.4
α-BHC	24.8	Anthracene	66.1
Diazinon	4.8	Fluoranthene	74.1
Atrazine	35.5	Pyrene	73.7
Lindane	80.3	Benz[a]anthracene	80.7
β-BHC	57.6	Chrysene	75.3
Heptachlor	51.8	Benzo[b]fluoranthene	82.5
Acetochlor	6.4	Benzo[k]fluoranthene	77.0
Alachlor	6.0	Benzo[a]pyrene	82.3
δ-BHC	51.2	Indeno[1,2,3-cd]pyrene	82.9
Metolachlor	4.1	Dibenz[a,h]anthracene	81.9
Dacthal	48.3	Benzo[g,h,i]perylene	79.1
Chlorpyrifos	32.5		
Oxychlordane	67.3		
Heptachlor Epoxide	71.5		
trans-Chlordane	61.2		
trans-Nonachlor	54.1		
O,p'-DDE	74.7		
cis-Chlordane	61.1		
Endosulfan	72.9		
P,p'-DDE	30.9		
Dieldrin	70.6		
O,p'-DDD	70.6		
Endrin	38.0		
cis-Nonachlor	44.2		
O,p'-DDT	69.6		
P,p'-DDD	62.4		
Endosulfan-II	60.7		
P,p'-DDT	99.2		
Endosulfan Sulfate	51.4		
Methoxychlor	103		
Mirex	60.6		
8-Cyhalothrin	12.0		
cis-Permethrin	6.8		
trans-Permethrin	9.1		

Table IV. Site 1 (Elk River station #2) chemical analyses from SPMDs and POCIS (corrected for background). Results expressed as ng/SPMD or ng/POCIS.

PCBs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
TOTAL PCBs	<MQL	<MQL
Pesticides (SPMDs)	ng/SPMD	ng/SPMD
Trifluralin	<MDL	<MDL
HCB	<MDL	<MDL
PCA	13.2	14.4
α-BHC	<MQL	<MQL
Diazinon	<MQL	<MDL
Atrazine	<MDL	<MDL
Lindane	6.47	6.80
β-BHC	<MQL	<MQL
Heptachlor	<MDL	<MDL
Acetochlor	93.2	93.3
Alachlor	4.08	3.67
δ-BHC	2.26	2.26
Metolachlor	<MDL	<MQL
Dacthal	4.26	3.38
Chlorpyrifos	8.56	7.62
Oxychlordane	1.59	<MDL
Heptachlor Epoxide	10.1	6.76
Trans-Chlordane	12.3	12.4
Trans-Nonachlor	7.47	7.21
o,p'-DDE	12.7	12.5
cis-Chlordane	30.3	30.8
Endosulfan	<MDL	<MDL
p,p'-DDE	4.88	6.65
Dieldrin	33.5	35.4
o,p'-DDD	20.7	22.0
Endrin	<MDL	1.72
cis-Nonachlor	1.92	2.39
o,p'-DDT	3.08	3.74
p,p'-DDD	51.0	55.4
Endosulfan-II	2.17	4.33
p,p'-DDT	5.65	6.06
Endosulfan Sulfate	<MQL	<MQL
Methoxychlor	<MDL	<MDL
Mirex	<MDL	<MDL
8-Cyhalothrin	<MDL	<MDL
cis-Permethrin	<MDL	<MDL
Trans-Permethrin	<MDL	<MDL

PAHs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
Naphthalene	<MDL	<MDL
Acenaphthylene	<MDL	<MDL
Acenaphthene	<MDL	<MDL
Fluorene	<MDL	<MDL
Phenanthrene	<MDL	<MDL
Anthracene	<MDL	<MDL
Fluoranthene	160	130
Pyrene	430	360
Benz[a]anthracene	<MQL	<MQL
Chrysene	110	90
Benzo[b]fluoranthene	30	20
Benzo[k]fluoranthene	20	20
Benzo[a]pyrene	<MQL	<MQL
Indeno[1,2,3-cd]pyrene	<MQL	<MDL
Dibenz[a,h]anthracene	<MDL	<MDL
Benzo[g,h,i]perylene	<MQL	<MQL
Benzo[b]thiophene	<MDL	<MDL
2-methylnaphthalene	<MDL	<MDL
1-methylnaphthalene	<MDL	<MDL
Biphenyl	<MDL	<MDL
1-ethylnaphthalene	<MDL	<MDL
1,2-dimethylnaphthalene	<MDL	<MDL
4-methylbiphenyl	<MDL	<MDL
2,3,5-trimethylnaphthalene	<MDL	<MDL
1-methylfluorene	<MDL	<MDL
Dibenzothiophene	<MDL	<MDL
2-methylphenanthrene	<MQL	<MQL
9-methylanthracene	<MDL	<MDL
3,6-dimethylphenanthrene	<MDL	<MDL
2-methylfluoranthene	<MDL	<MDL
Benzo[b]naphtho[2,1-d]thiophene	<MDL	<MDL
Benzo[e]pyrene	40	30
Perylene	70	60
3-methylcholanthrene	<MDL	<MDL
Hormones (POCIS)	ng/POCIS	ng/POCIS
17β-Estradiol	<MDL	<MDL
Estrone	<MDL	<MDL
Antibiotics (POCIS)	ng/POCIS	ng/POCIS
Oxytetracycline	<MDL	<MDL
Tetracycline	<MDL	<MDL
Chlortetracycline	<MDL	<MDL

Table V. Site 2 (Bohema River station #2) chemical analyses from SPMDs and POCIS (corrected for background). Results expressed as ng/SPMD or ng/POCIS.

PCBs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
TOTAL PCBs	<MDL	<MDL
Pesticides (SPMDs)	ng/SPMD	ng/SPMD
Trifluralin	<MDL	<MDL
HCB	<MDL	<MDL
PCA	10.8	9.10
α-BHC	<MQL	<MQL
Diazinon	<MQL	<MDL
Atrazine	<MDL	<MDL
Lindane	5.61	4.22
β-BHC	3.31	3.21
Heptachlor	<MDL	<MDL
Acetochlor	36.9	30.0
Alachlor	<MQL	2.06
δ-BHC	2.82	1.29
Metolachlor	<MDL	4.02
Dacthal	3.67	1.42
Chlorpyrifos	7.35	5.53
Oxychlordane	1.67	<MDL
Heptachlor Epoxide	10.2	7.82
Trans-Chlordane	4.58	3.72
Trans-Nonachlor	3.36	2.99
o,p'-DDE	<MDL	<MDL
cis-Chlordane	13.1	12.3
Endosulfan	<MDL	<MDL
p,p'-DDE	<MDL	<MDL
Dieldrin	17.2	17.7
o,p'-DDD	5.55	5.78
Endrin	<MQL	<MQL
cis-Nonachlor	<MDL	<MDL
o,p'-DDT	<MQL	<MQL
p,p'-DDD	13.9	13.7
Endosulfan-II	1.61	<MQL
p,p'-DDT	<MQL	<MQL
Endosulfan Sulfate	<MQL	<MQL
Methoxychlor	<MDL	<MDL
Mirex	<MDL	<MDL
8-Cyhalothrin	<MDL	<MDL
cis-Permethrin	<MDL	<MDL
Trans-Permethrin	<MDL	<MDL

PAHs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
Naphthalene	<MDL	<MDL
Acenaphthylene	<MDL	<MDL
Acenaphthene	<MDL	<MDL
Fluorene	<MDL	<MQL
Phenanthrene	<MDL	<MDL
Anthracene	<MDL	<MDL
Fluoranthene	<MQL	<MQL
Pyrene	70	80
Benz[a]anthracene	<MDL	<MDL
Chrysene	<MDL	<MDL
Benzo[b]fluoranthene	<MQL	<MQL
Benzo[k]fluoranthene	<MQL	<MQL
Benzo[a]pyrene	<MDL	<MDL
Indeno[1,2,3-cd]pyrene	<MDL	<MDL
Dibenz[a,h]anthracene	<MDL	<MDL
Benzo[g,h,i]perylene	<MDL	<MDL
Benzo[b]thiophene	<MDL	<MDL
2-methylnaphthalene	<MDL	<MDL
1-methylnaphthalene	<MDL	<MDL
Biphenyl	<MDL	<MDL
1-ethylnaphthalene	<MDL	<MDL
1,2-dimethylnaphthalene	<MDL	<MDL
4-methylbiphenyl	<MDL	<MDL
2,3,5-trimethylnaphthalene	<MDL	<MDL
1-methylfluorene	<MDL	<MDL
Dibenzothiophene	<MDL	<MDL
2-methylphenanthrene	<MDL	<MDL
9-methylanthracene	<MDL	<MDL
3,6-dimethylphenanthrene	<MDL	<MDL
2-methylfluoranthene	<MDL	<MDL
Benzo[b]naphtho[2,1-d]thiophene	<MDL	<MDL
Benzo[e]pyrene	<MQL	<MQL
Perylene	30	40
3-methylcholanthrene	<MDL	<MDL
Hormones (POCIS)	ng/POCIS	ng/POCIS
17β-Estradiol	<MDL	<MDL
Estrone	<MDL	<MDL
Antibiotics (POCIS)	ng/POCIS	ng/POCIS
Oxytetracycline	<MDL	<MDL
Tetracycline	<MDL	<MDL
Chlortetracycline	<MDL	<MDL

Table VI. Site 4 (Northeast River station #5) chemical analyses from SPMDs and POCIS (corrected for background). Results expressed as ng/SPMD or ng/POCIS.

PCBs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
TOTAL PCBs	<MDL	<MDL
Pesticides (SPMDs)	ng/SPMD	ng/SPMD
Trifluralin	2.44	2.80
HCB	<MDL	<MDL
PCA	18.1	17.4
α-BHC	<MDL	<MQL
Diazinon	<MQL	<MQL
Atrazine	<MDL	<MDL
Lindane	2.32	2.65
β-BHC	<MDL	<MDL
Heptachlor	<MDL	<MDL
Acetochlor	45.6	34.4
Alachlor	1.39	<MQL
δ-BHC	<MDL	<MDL
Metolachlor	<MQL	<MQL
Dacthal	1.82	1.74
Chlorpyrifos	12.5	12.4
Oxychlordane	<MDL	<MDL
Heptachlor Epoxide	4.85	4.72
Trans-Chlordane	4.43	4.74
Trans-Nonachlor	2.14	2.12
o,p'-DDE	<MDL	<MDL
cis-Chlordane	6.32	6.26
Endosulfan	3.28	3.18
p,p'-DDE	<MDL	<MDL
Dieldrin	14.6	15.1
o,p'-DDD	4.08	4.09
Endrin	2.35	2.44
cis-Nonachlor	<MQL	<MQL
o,p'-DDT	<MDL	1.14
p,p'-DDD	8.52	7.30
Endosulfan-II	2.02	1.11
p,p'-DDT	1.70	1.09
Endosulfan Sulfate	<MQL	<MQL
Methoxychlor	<MDL	<MDL
Mirex	<MDL	<MDL
8-Cyhalothrin	<MDL	<MDL
cis-Permethrin	<MDL	<MDL
Trans-Permethrin	<MDL	<MDL

PAHs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
Naphthalene	<MDL	<MDL
Acenaphthylene	<MDL	<MDL
Acenaphthene	<MQL	<MQL
Fluorene	<MQL	<MQL
Phenanthrene	<MQL	<MQL
Anthracene	<MQL	<MQL
Fluoranthene	300	300
Pyrene	310	310
Benz[a]anthracene	<MQL	<MQL
Chrysene	<MQL	<MQL
Benzo[b]fluoranthene	<MQL	20
Benzo[k]fluoranthene	<MQL	<MQL
Benzo[a]pyrene	<MQL	<MQL
Indeno[1,2,3-cd]pyrene	<MDL	<MDL
Dibenz[a,h]anthracene	<MDL	<MDL
Benzo[g,h,i]perylene	<MQL	<MQL
Benzo[b]thiophene	<MDL	<MDL
2-methylnaphthalene	<MQL	<MQL
1-methylnaphthalene	<MQL	<MQL
Biphenyl	<MDL	<MDL
1-ethylnaphthalene	<MDL	<MDL
1,2-dimethylnaphthalene	<MDL	<MDL
4-methylbiphenyl	<MDL	<MDL
2,3,5-trimethylnaphthalene	<MDL	<MDL
1-methylfluorene	20	<MDL
Dibenzothiophene	20	<MDL
2-methylphenanthrene	20	20
9-methylanthracene	<MDL	<MDL
3,6-dimethylphenanthrene	<MDL	<MDL
2-methylfluoranthene	<MDL	<MDL
Benzo[b]naphtho[2,1-d]thiophene	<MDL	<MDL
Benzo[e]pyrene	20	20
Perylene	150	170
3-methylcholanthrene	<MDL	<MDL

Hormones (POCIS)	ng/POCIS	ng/POCIS
17β-Estradiol	<MDL	<MDL
Estrone	<MDL	<MDL
Antibiotics (POCIS)	ng/POCIS	ng/POCIS
Oxytetracycline	<MDL	<MDL
Tetracycline	<MDL	<MDL
Chlortetracycline	160	180

Table VII. Site 5 (Northeast River station #3) chemical analyses from SPMDs and POCIS (corrected for background). Results expressed as ng/SPMD or ng/POCIS.

PCBs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
TOTAL PCBs	<MDL	<MDL
Pesticides (SPMDs)	ng/SPMD	ng/SPMD
Trifluralin	1.76	1.70
HCB	<MDL	<MDL
PCA	28.3	27.2
α-BHC	1.61	1.55
Diazinon	3.43	14.15
Atrazine	<MDL	<MDL
Lindane	6.79	8.51
β-BHC	<MDL	<MDL
Heptachlor	<MDL	<MDL
Acetochlor	18.0	17.3
Alachlor	<MQL	<MQL
δ-BHC	<MDL	<MDL
Metolachlor	5.96	<MQL
Dacthal	1.87	1.84
Chlorpyrifos	10.7	9.74
Oxychlordane	<MDL	<MQL
Heptachlor Epoxide	5.12	7.27
Trans-Chlordane	4.47	8.17
Trans-Nonachlor	2.45	4.78
o,p'-DDE	<MDL	<MDL
cis-Chlordane	6.82	8.32
Endosulfan	5.12	6.24
p,p'-DDE	<MDL	<MDL
Dieldrin	15.6	15.1
o,p'-DDD	3.46	<MQL
Endrin	<MDL	<MQL
cis-Nonachlor	<MQL	<MQL
o,p'-DDT	<MDL	<MQL
p,p'-DDD	5.98	6.35
Endosulfan-II	2.15	2.05
p,p'-DDT	1.38	1.72
Endosulfan Sulfate	<MDL	<MQL
Methoxychlor	<MDL	<MDL
Mirex	<MDL	<MDL
8-Cyhalothrin	<MDL	<MDL
cis-Permethrin	<MDL	<MDL
Trans-Permethrin	<MDL	<MDL

PAHs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
Naphthalene	<MDL	<MDL
Acenaphthylene	<MDL	<MDL
Acenaphthene	<MDL	<MDL
Fluorene	<MQL	<MQL
Phenanthrene	<MDL	<MDL
Anthracene	<MQL	<MQL
Fluoranthene	220	220
Pyrene	320	310
Benz[a]anthracene	<MQL	<MQL
Chrysene	<MDL	<MDL
Benzo[b]fluoranthene	20	20
Benzo[k]fluoranthene	<MQL	<MQL
Benzo[a]pyrene	<MQL	<MQL
Indeno[1,2,3-cd]pyrene	<MDL	<MDL
Dibenz[a,h]anthracene	<MDL	<MDL
Benzo[g,h,i]perylene	<MQL	<MQL
Benzo[b]thiophene	<MDL	<MDL
2-methylnaphthalene	<MDL	<MDL
1-methylnaphthalene	<MDL	<MDL
Biphenyl	<MDL	<MDL
1-ethylnaphthalene	<MDL	<MDL
1,2-dimethylnaphthalene	<MDL	<MDL
4-methylbiphenyl	<MDL	<MDL
2,3,5-trimethylnaphthalene	<MDL	<MDL
1-methylfluorene	<MDL	<MDL
Dibenzothiophene	<MDL	<MDL
2-methylphenanthrene	20	20
9-methylanthracene	<MDL	<MDL
3,6-dimethylphenanthrene	<MDL	<MDL
2-methylfluoranthene	<MDL	<MDL
Benzo[b]naphtho[2,1-d]thiophene	<MDL	<MDL
Benzo[e]pyrene	20	20
Perylene	160	220
3-methylcholanthrene	<MDL	<MDL
Hormones (POCIS)	ng/POCIS	ng/POCIS
17β-Estradiol	94	110
Estrone	<MDL	<MDL
Antibiotics (POCIS)	ng/POCIS	ng/POCIS
Oxytetracycline	140	210
Tetracycline	<MDL	<MDL
Chlortetracycline	<MDL	<MDL

Table VIII. Site 6 (Back Creek) chemical analyses from SPMDs and POCIS (corrected for background). Results expressed as ng/SPMD or ng/POCIS.

PCBs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
TOTAL PCBs	<MQL	<MQL
Pesticides (SPMDs)	ng/SPMD	ng/SPMD
Trifluralin	<MDL	<MDL
HCB	<MDL	<MDL
PCA	55.1	65.9
α-BHC	<MDL	<MDL
Diazinon	5.15	20.9
Atrazine	<MDL	<MDL
Lindane	<MDL	<MDL
β-BHC	4.90	3.47
Heptachlor	<MDL	<MDL
Acetochlor	23.8	19.8
Alachlor	<MQL	<MQL
δ-BHC	7.34	5.70
Metolachlor	9.92	<MQL
Dacthal	3.10	2.24
Chlorpyrifos	9.64	8.77
Oxychlordane	<MQL	<MQL
Heptachlor Epoxide	27.5	24.9
Trans-Chlordane	14.7	15.7
Trans-Nonachlor	9.69	11.5
o,p'-DDE	<MDL	<MDL
cis-Chlordane	25.3	25.9
Endosulfan	<MDL	<MDL
p,p'-DDE	<MDL	<MDL
Dieldrin	55.1	55.9
o,p'-DDD	2.50	4.45
Endrin	1.97	4.46
cis-Nonachlor	3.78	5.87
o,p'-DDT	4.73	6.95
p,p'-DDD	3.46	8.87
Endosulfan-II	3.63	10.2
p,p'-DDT	<MDL	7.11
Endosulfan Sulfate	<MDL	<MDL
Methoxychlor	<MDL	<MDL
Mirex	<MDL	<MDL
8-Cyhalothrin	<MDL	<MDL
cis-Permethrin	5.48	<MDL
Trans-Permethrin	<MDL	<MDL

PAHs (SPMDs)	Rep. #1 ng/SPMD	Rep. #2 ng/SPMD
Naphthalene	<MDL	<MDL
Acenaphthylene	<MDL	<MDL
Acenaphthene	60	80
Fluorene	90	100
Phenanthrene	240	240
Anthracene	40	50
Fluoranthene	5420	5660
Pyrene	3340	3520
Benz[a]anthracene	160	180
Chrysene	990	1090
Benzo[b]fluoranthene	350	430
Benzo[k]fluoranthene	180	240
Benzo[a]pyrene	60	70
Indeno[1,2,3-cd]pyrene	50	60
Dibenz[a,h]anthracene	<MQL	<MQL
Benzo[g,h,i]perylene	50	60
Benzo[b]thiophene	<MDL	<MDL
2-methylnaphthalene	<MDL	60
1-methylnaphthalene	<MDL	<MQL
Biphenyl	<MDL	<MQL
1-ethylnaphthalene	<MDL	<MDL
1,2-dimethylnaphthalene	<MQL	20
4-methylbiphenyl	<MDL	<MDL
2,3,5-trimethylnaphthalene	<MDL	140
1-methylfluorene	200	200
Dibenzothiophene	20	20
2-methylphenanthrene	150	150
9-methylanthracene	<MDL	<MDL
3,6-dimethylphenanthrene	140	140
2-methylfluoranthene	130	130
Benzo[b]naphtho[2,1-d]thiophene	120	130
Benzo[e]pyrene	210	240
Perylene	20	20
3-methylcholanthrene	<MDL	<MDL
Hormones (POCIS)	ng/POCIS	ng/POCIS
17β-Estradiol	<MDL	<MDL
Estrone	<MDL	<MDL
Antibiotics (POCIS)	ng/POCIS	ng/POCIS
Oxytetracycline	<MDL	160
Tetracycline	210	200
Chlortetracycline	<MDL	170

Table IX. Permeability Reference Compound (Phenanthrene-d_{10}) Recovery

QA/QC Sample	μg PRC
Field Blank, Site # 1	5.44*
Field Blank, Site # 2	5.47*
Field Blank, Site # 4	5.33*
Field Blank, Site # 5	5.76*
Field Blank, Site # 6	5.53*
Mean	5.51*

Exposure Site	μg PRC
Site # 1	0.23**
Site # 2	1.05**
Site # 4	0.64**
Site # 5	0.87**
Site # 6	0.64**

Exposure Site	k_{eprc} (d^{-1})
Site # 1	0.076
Site # 2	0.039
Site # 4	0.051
Site # 5	0.044
Site # 6	0.054

$$k_{eprc} = \frac{\ln(C_{SPMDo} / C_{SPMD})}{t}$$

* C_{SPMDso}

** C_{SPMD}

Table X. Estimated Aqueous Concentrations of Select Contaminants Sequestered in Deployed SPMDs

	Site # 1 pg/L	Site # 2 pg/L	Site # 4 pg/L	Site # 5 pg/L	Site # 6 pg/L
α-BHC	N.A.	N.A.	N.A.	67	N.A
PCA	22	11	23	33	79
Lindane	400	290	150	460	N.A.
Endrin	7.3	N.A.	20	N.A.	27
Oxychlordane	0.9	4.5	N.A.	N.A.	N.A.
Dacthal	14	41	31	33	47
Chlorpyrifos	420	29	60	47	44
Diazinon	N.A.	N.A.	N.A.	1500	2140
Heptachlor Epoxide	90	96	51	66	280
trans-Chlordane	19	17	5.7	23	19
cis-Chlordane	46	58	22	31	89
cis-Nonachlor	4.7	N.A.	N.A.	N.A.	16
trans-Nonachlor	17	15	7.5	15	37
Dieldrin	310	160	130	140	500
o,p'-DDT	4.0	N.A.	1.0	N.A.	5.4
p,p'-DDT	10	N.A.	2.0	2.0	10
o,p'-DDD	43	22	12	12	10
p,p'-DDD	41	47	20	19	16
o,p'-DDE	15	N.A.	N.A.	N.A.	N.A.
p,p'-DDE	5.5	N.A.	N.A.	N.A.	N.A.
Acenaphthene	N.A.	N.A.	N.A.	N.A.	1340
Fluorene	N.A.	N.A.	N.A.	N.A.	1190
Phenanthrene	N.A.	N.A.	N.A.	N.A.	2820
Anthracene	N.A.	N.A.	N.A.	N.A.	450
Fluoranthene	420	N.A.	720	490	13300
Pyrene	940	130	630	320	6940
Benz[a]anthracene	N.A.	N.A.	N.A.	N.A.	460
Chrysene	120	N.A.	N.A.	N.A.	1030
Benzo[b]fluoranthene	N.A.	N.A.	58	67	1120
Benzo[k]fluoranthene	33	N.A.	N.A.	N.A.	510
Benzo[a]pyrene	N.A.	N.A.	N.A.	N.A.	150
Indeno[1,2,3-cd]pyrene	N.A.	N.A.	N.A.	N.A.	130
Benzo[g,h,I]perylene	N.A.	N.A.	N.A.	N.A.	220

NOTE: N.A. = Not Applicable

* Estimated using extrapolated value for PRC corrected Rs

Table XI. Estimated Aqueous Concentrations of Select Contaminants Sequestered in Deployed POCIS

	Site # 1 pg/L	Site # 2 pg/L	Site # 4 pg/L	Site # 5 pg/L	Site # 6 pg/L
17β-Estradiol	N.A.	N.A.	N.A.	4000	N.A.

NOTE: N.A. = Not Applicable

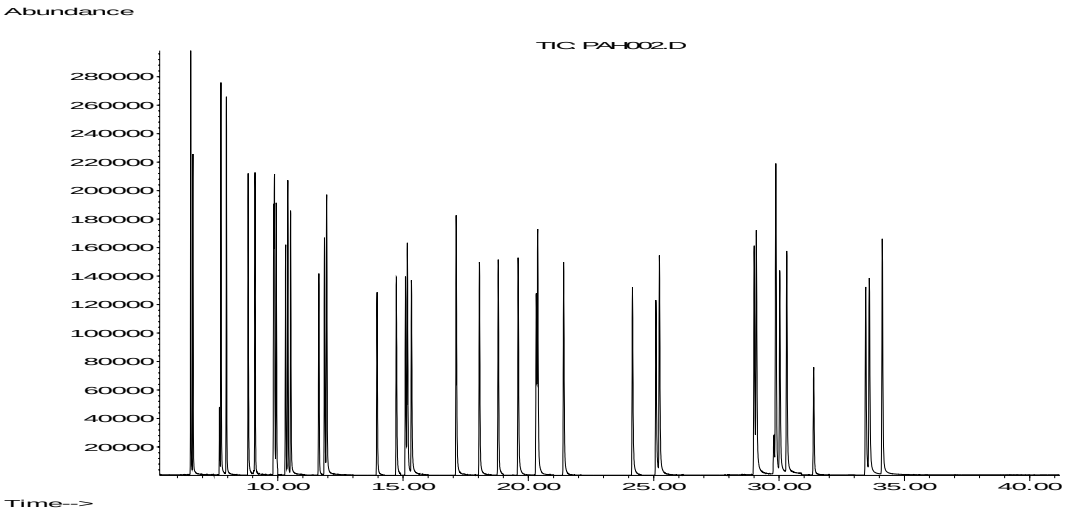
Table XII. Elution Order of Targeted Analytes During Instrumental Analysis*

	Retention Time Min.		Retention Time min.
PCBs (GC-ECD)		**PAHs (GC-MSD)**	
TOTAL PCBs	8.80 – 44.50	Naphthalene	6.52
		Acenaphthylene	9.87
Pesticides (GC-ECD)		Acenaphthene	10.40
		Fluorene	11.95
Trifluralin	8.16	Phenanthrene	15.18
HCB	10.49	Anthracene	15.33
PCA	10.66	Fluoranthene	19.59
α-BHC	11.02	Pyrene	20.37
Diazinon	12.14	Benz[a]anthracene	25.08
Atrazine	12.35	Chrysene	25.21
Lindane	12.90	Benzo[b]fluoranthene	28.99
β-BHC	14.57	Benzo[k]fluoranthene	29.08
Heptachlor	14.71	Benzo[a]pyrene	30.01
Acetochlor	14.95	Indeno[1,2,3-cd]pyrene	33.44
Alachlor	15.59	Dibenz[a,h]anthracene	33.57
δ-BHC	16.02	Benzo[g,h,i]perylene	34.09
Metolachlor	17.61		
Dacthal	17.98	Benzo[b]thiophene	6.60
Chlorpyrifos	18.17	2-methylnaphthalene	7.73
Oxychlordane	19.31	1-methylnaphthalene	7.95
Heptachlor Epoxide	20.05	Biphenyl	8.81
trans-Chlordane	21.67	1-ethylnaphthalene	9.09
trans-Nonachlor	21.92	1,2-dimethylnaphthalene	9.94
o,p'-DDE	22.10	4-methylbiphenyl	10.51
cis-Chlordane	22.33	2,3,5-trimethylnaphthalene	11.64
Endosulfan	22.46	1-methylfluorene	13.96
p,p'-DDE	24.37	Dibenzothiophene	14.73
Dieldrin	24.49	2-methylphenanthrene	17.12
o,p'-DDD	25.71	9-methylanthracene	18.04
Endrin	26.59	3,6-dimethylphenanthrene	18.79
cis-Nonachlor	27.39	2-methylfluoranthene	21.40
o,p'-DDT	27.58	Benzo[b]naphtho[2,1-d]thiophene	24.14
p,p'-DDD	28.59	Benzo[e]pyrene	29.86
Endosulfan-II	28.76	Perylene	30.29
p,p'-DDT	30.49	3-methylcholanthrene	31.36
Endosulfan Sulfate	32.13		
Methoxychlor	36.08	**Hormones (HPLC)**	
Mirex	36.51	17β-Estradiol	10.14
8-Cyhalothrin	37.30	Estrone	14.25
cis-Permethrin	41.35		
trans-Permethrin	42.02	**Antibiotics (HPLC)**	
		Oxytetracycline	3.49
		Tetracycline	4.15
		Chlortetracycline	7.85

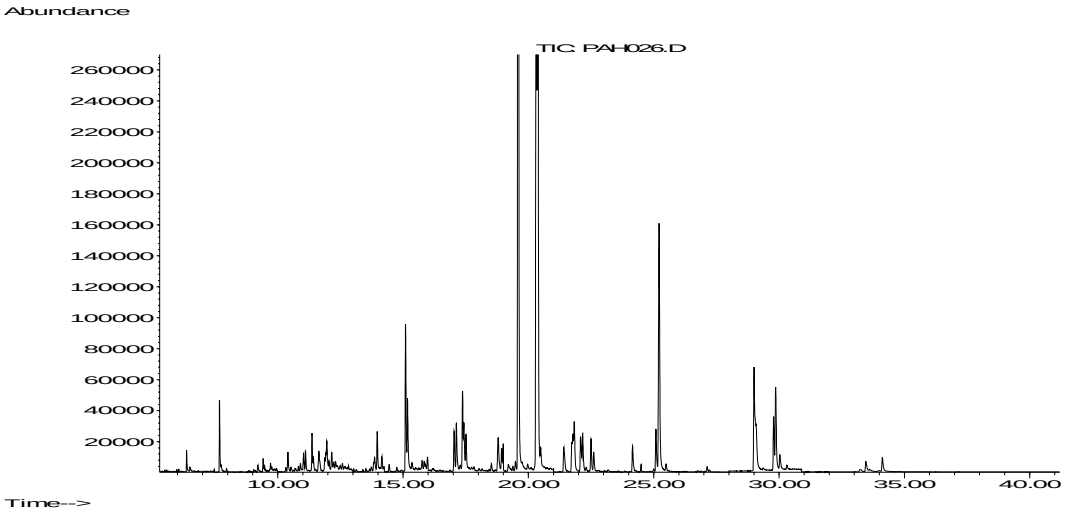
* NOTE: Slight variations in retention times were noted on a run by run basis. Retention times as given reflect the example provided in Figures 1,2, and 3.

Figure 1

GC-MSD Analysis for PAHs



1.0 µg/mL PAH mixed standard. See Table IX for components and retention times.

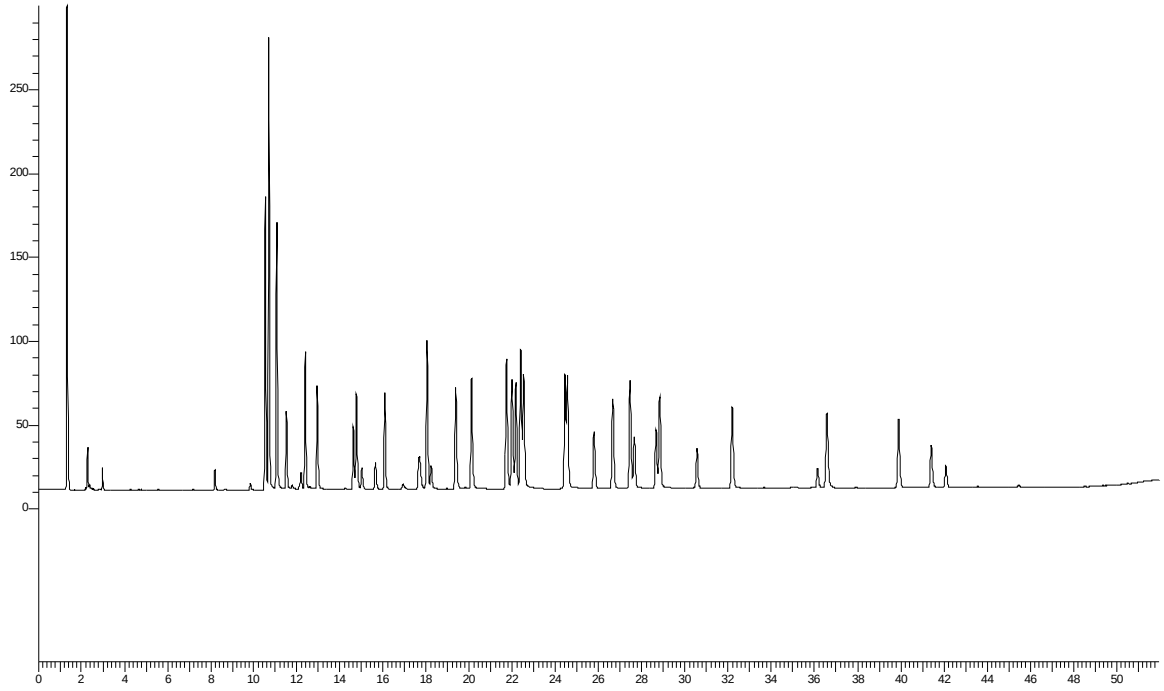


Representative SPMD sample - Site 6 Repilcate A (Back Creek)

Note: Agilent 6890 series gas chromatograph (GC) equipped with a HP-5MS (30 m x 0.25 mm i.d. x 0.25 µm film thickness) capillary column (Agilent Technologies, Inc., Wilmington, DE) with the following temperature program: injection at 50 °C, held for 2 min, then 25 °C/min to 130 °C, held for 1 min, followed by 6 °C/min to 310 °C and held at 310 °C for 5 min.

Figure 2

GC-ECD Analysis of OC-Pesticide Standards

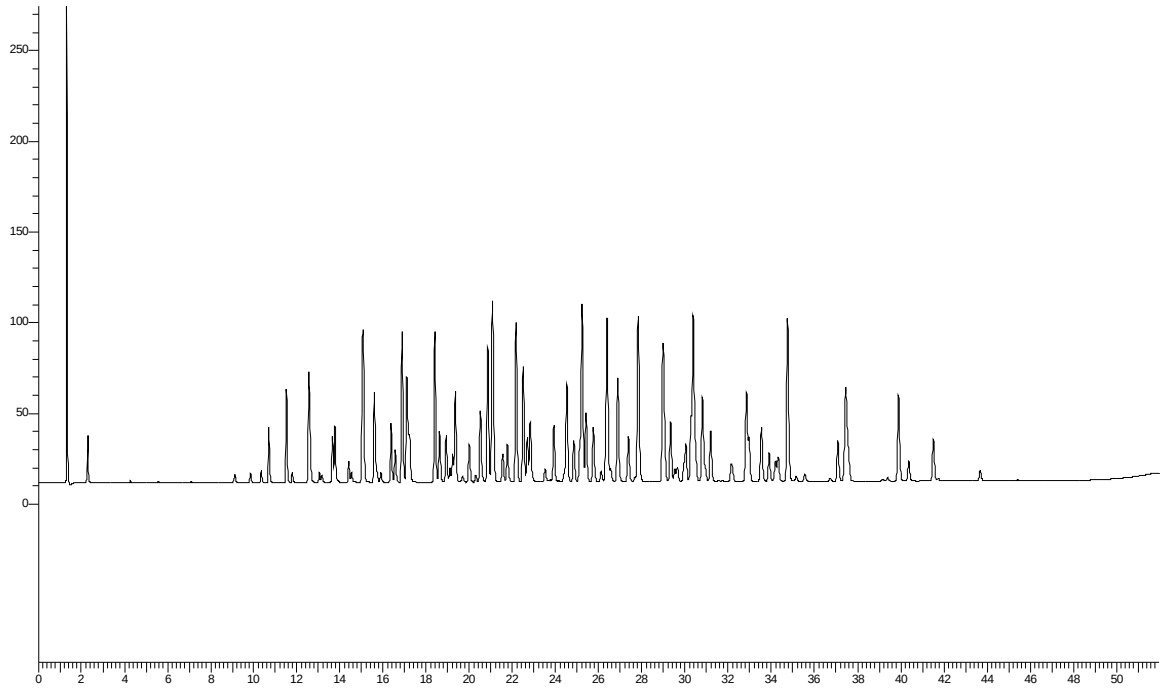


OC-Pesticide mixed standard, calibration Level # 4 (i.e. mid-range). See Table IX for components and retention times.

Note: Hewlett Packard 5890 series gas chromatograph (GC) equipped with a DB-35MS (30 m x 0.25 mm i.d. x 0.25 µm film thickness) capillary column (J&W Scientific, Folsom, CA) with the following temperature program: injection at 90^{o}C; then 15^{o}C/min to 165^{o}C; followed by 2.5^{o}C/min to 250^{o}C; then at 10^{o}C/min to 320^{o}C. The electron capture detector (ECD) was maintained at 330^{0}C (Hewlett Packard, Inc., Palo Alto, CA).

Figure 3

GC-ECD Analysis of PCB Standard

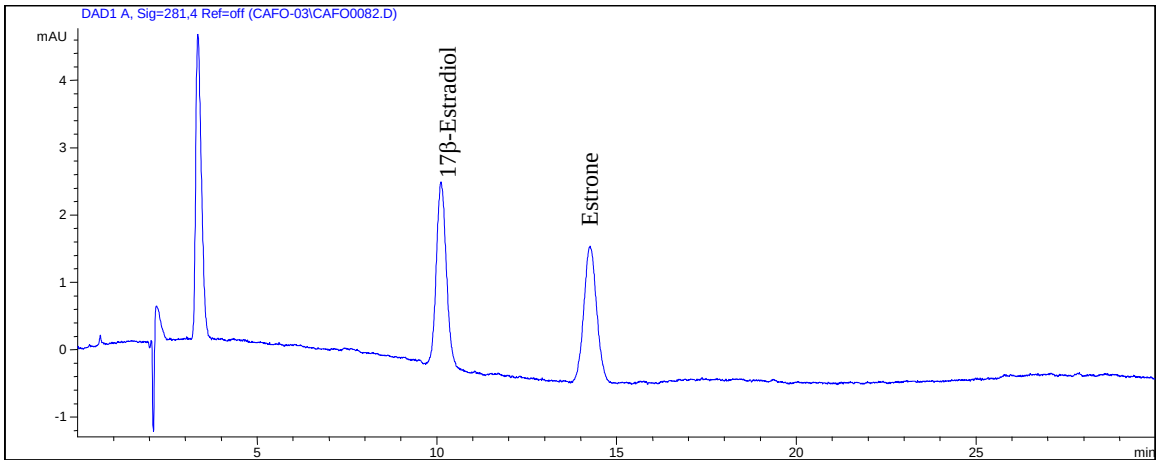


500 total ng/mL 1:1:1:1 mixture of Aroclor® (1242:1248:1254:1260) standard, calibration Level # 4 (i.e. mid-range). See Table IX for components and retention times.

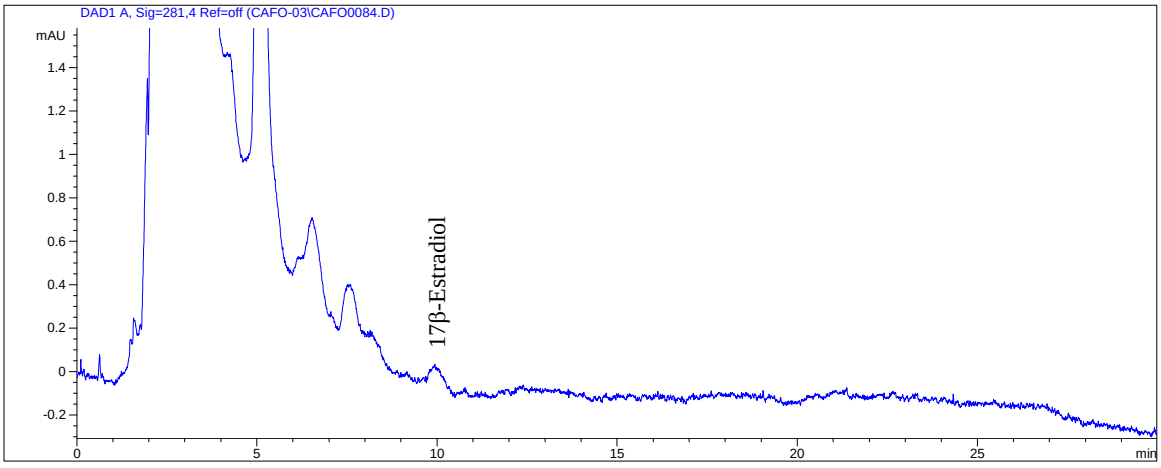
Note: Hewlett Packard 5890 series gas chromatograph (GC) equipped with a DB-35MS (30 m x 0.25 mm i.d. x 0.25 µm film thickness) capillary column (J&W Scientific, Folsom, CA) with the following temperature program: injection at 90°C; then 15°C/min to 165°C; followed by 2.5°C/min to 250°C; then at 10°C/min to 320°C. The electron capture detector (ECD) was maintained at 330°C (Hewlett Packard, Inc., Palo Alto, CA).

Figure 4

HPLC Analysis for Hormones



200 ng on column of a mixed Hormone standard (mid-level standard). See Table IX for component retention times.

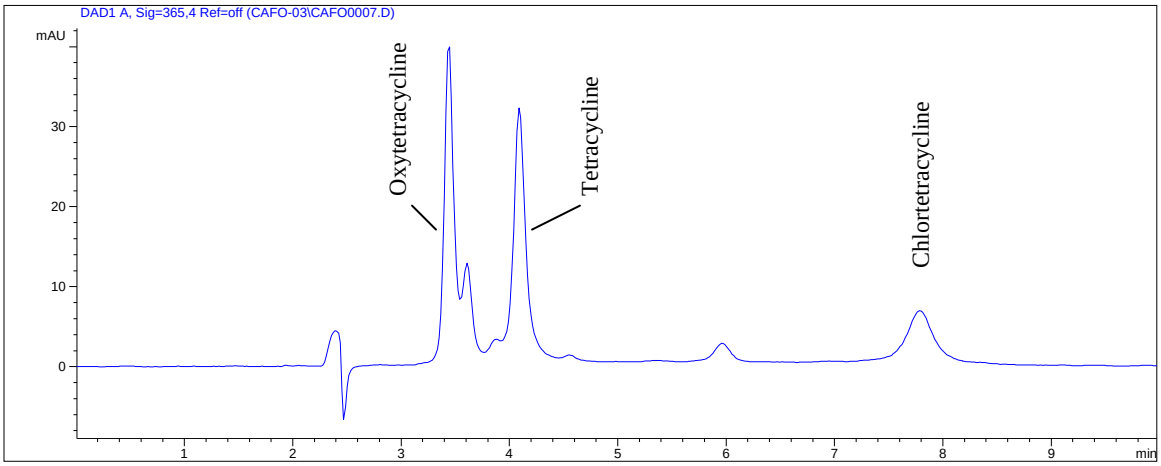


Representative POCIS sample – Site 5 Replicate A (Northeast River station #3)

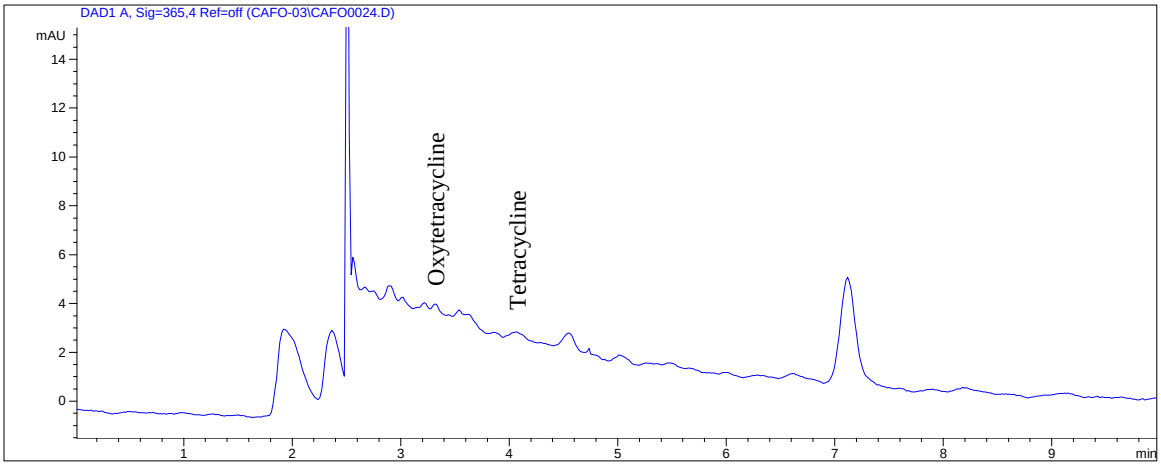
Note: Hewlett Packard 1090 Series II liquid chromatograph (HPLC) equipped with a C_8 (150 x 4.6 mm, 5 µm d_p) analytical column (Supelco, Bellefonte, PA) with a mobile phase of 65:35 water:acetonitrile and a 1 mL/min flow rate. The diode array detector was maintained at a wavelength of 281 nm for estrogen detection (Hewlett Packard, Inc., Palo Alto, CA).

Figure 5

HPLC Analysis for Antibiotics



500 ng on column of a mixed Antibiotic standard (high-level standard). See Table IX for component retention times.



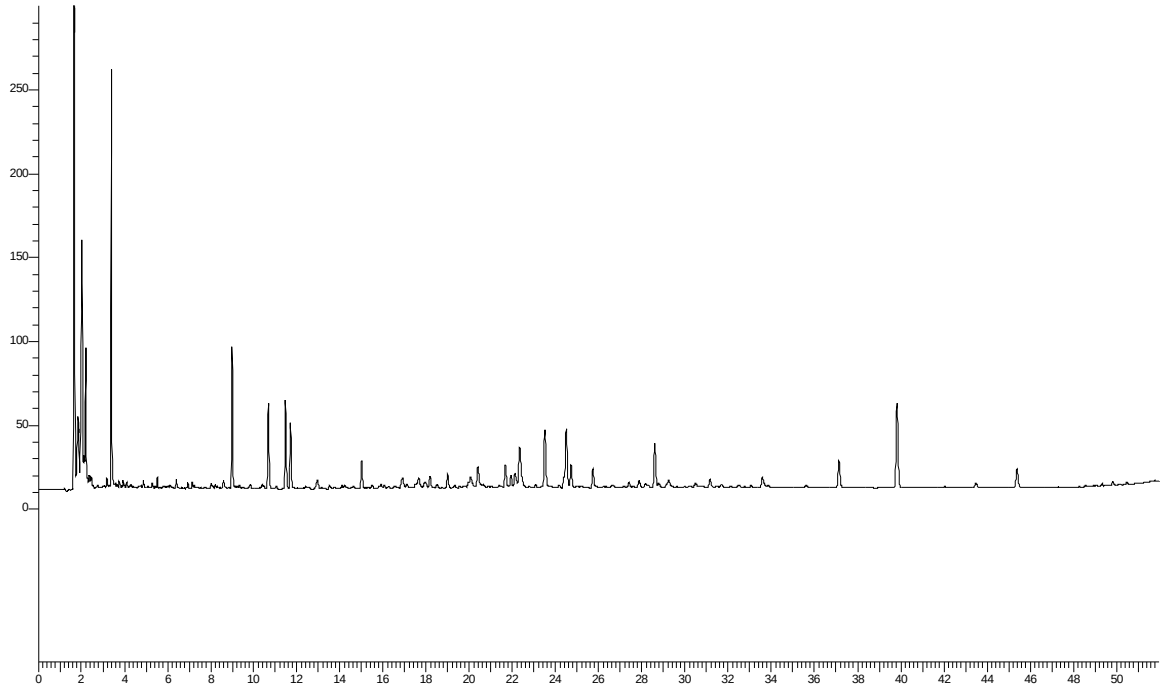
Representative POCIS sample – Site 6 Replicate B (Back Creek)

Note: Hewlett Packard 1090 Series II liquid chromatograph (HPLC) equipped with a C_8 (150 x 4.6 mm, 5 µm d_p) analytical column (Supelco, Bellefonte, PA) with a mobile phase of 80:20 25 mM KH_2PO_4 (pH 3) buffer:acetonitrile and a 1 mL/min flow rate. The diode array detector was maintained at a wavelength of 365 nm for estrogen detection (Hewlett Packard, Inc., Palo Alto, CA).

Figure 6

Representative GC-ECD Profile of an

SPMD "OC Pesticide" Fraction (SG2)

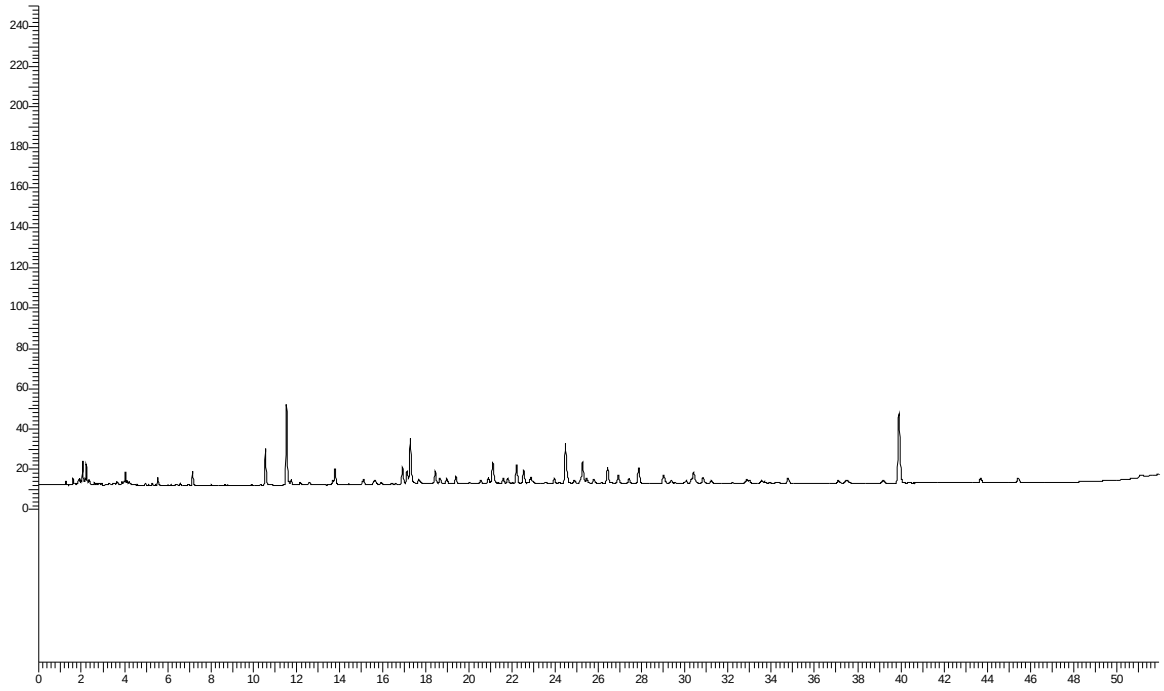


Site # 1 Elk River Station #2 Replicate "A"

Figure 7

Representative GC-ECD Profiles of an

SPMD "PCB" Fractions (SG1)



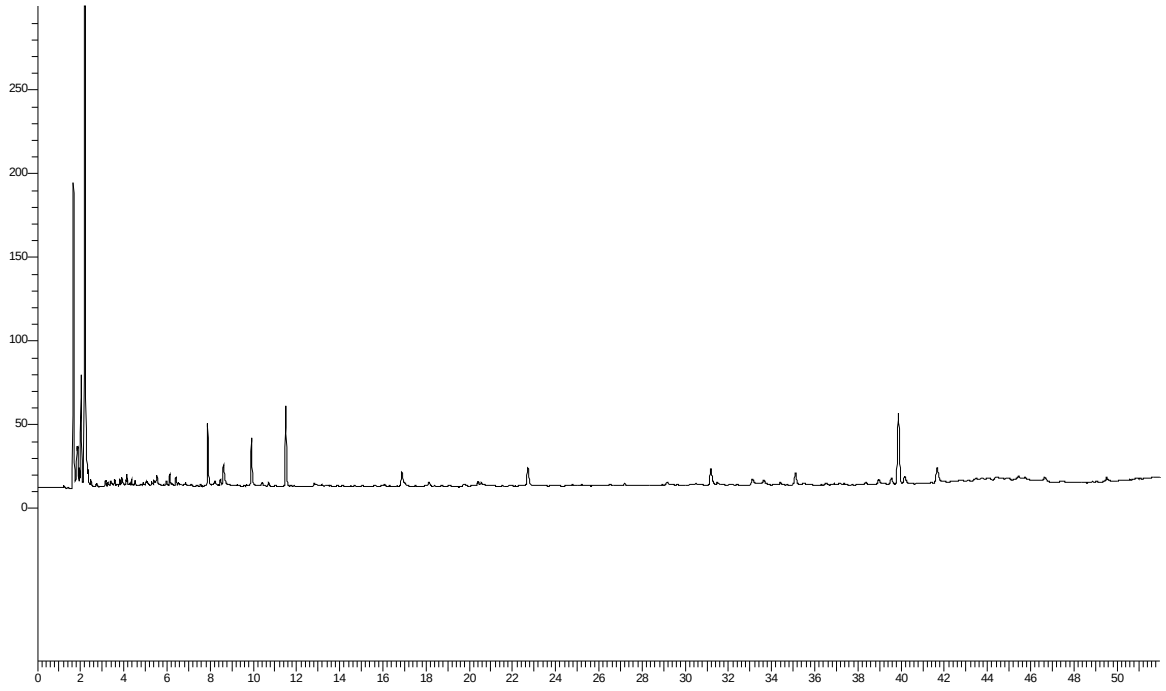
Site # 1 Elk River Station #2 Replicate "A"

Note: Hewlett Packard 5890 series gas chromatograph (GC) equipped with a DB-35MS (30 m x 0.25 mm i.d. x 0.25 µm film thickness) capillary column (J&W Scientific, Folsom, CA) with the following temperature program: injection at 90^{o}C; then 15^{o}C/min to 165^{o}C; followed by 2.5^{o}C/min to 250^{o}C; then at 10^{o}C/min to 320^{o}C. The electron capture detector (ECD) was maintained at 330^{0}C (Hewlett Packard, Inc., Palo Alto, CA).

Figure 8

Representative GC-ECD Profile of an SPMD

"Polar OC Pesticide" Fraction (FL2)



Site # 1 Elk River Station #2 Replicate "A"

Note: Hewlett Packard 5890 series gas chromatograph (GC) equipped with a DB-35MS (30 m x 0.25 mm i.d. x 0.25 µm film thickness) capillary column (J&W Scientific, Folsom, CA) with the following temperature program: injection at 90^{o}C; then 15^{o}C/min to 165^{o}C; followed by 2.5^{o}C/min to 250^{o}C; then at 10^{o}C/min to 320^{o}C. The electron capture detector (ECD) was maintained at 330^{0}C (Hewlett Packard, Inc., Palo Alto, CA).

Appendix D

Report on benthic analyses and Benthic Index of Biological Integrity (B-IBI) calculations (Scott 2004)

APPENDIX D

Report on Benthic Analyses and Benthic Index of Biological Integrity (B-IBI) Calculations

Lisa C. Scott
Versar, Inc.
9200 Rumsey Road
Columbia, MD 21045

January 2004

Attached are the data tables for each of the 18 stations we processed for the triad work. There are two separate files, one contains the oligohaline stations and the other contains low and high mesohaline stations. Different metrics are used to score the oligohaline as opposed to the mesohaline so it is simpler for our programmer to make two separate files.

You will also find in the two files our data for Station 29 in the Elk River and Station 204 in the Severn River. We take 3 replicates at these stations so I provided you with the data for all 3 reps. If you are diligent person you may find that the B-IBI calculation I provide for Station 29 does not match what we provide on the web. The reason is that for LTB we use a station's long-term salinity record to set the habitat for B-IBI calculations. As a result, Station 29 is a long-term oligohaline site. However, as you will remember, summer 2002 was a very dry year so the actual salinity recorded at the time of sample collection places the station in the low mesohaline range. Because your data were classified and scored based on the salinity recorded at the time of sampling, I recalculated Station 29 using the point in time salinity measurement. Since the goal of your project is to determine the health of the community at the time of collection, using the low mesohaline score for Station 29 is the accurate measure for you. Since we use fixed station information for determining changes over time, using the long-term average habitat suits our needs. There was no such habitat difference with Station 204 as the point-in-time and long-term average were both high mesohaline.

A table summarizing your results and comments on the scoring is proved below.

Station	B-IBI Score	B-IBI Condition	Comments
BOR 1	1.40	Severely Degraded	Low biomass, diversity, and percentage of pollution-sensitive taxa. High percentage of pollution-indicative taxa.
BOR 2	1.80	Severely Degraded	Low biomass and percentage of pollution-sensitive taxa. High percentage of pollution-indicative taxa.
BOR 3	2.20	Degraded	Low abundance and high percentage of pollution-indicative taxa.
BOR 4	2.60	Degraded	High biomass (above upper threshold) and high percentage of pollution-indicative taxa.
ELR 1	2.60	Degraded	High biomass (above upper threshold) and high percentage of pollution-indicative taxa.
ELR 2	3.40	Meets Goal	High percentage of pollution-sensitive taxa and low percentage of pollution-indicative taxa, both of which are indicative of good benthic community condition.
ELR 3	2.20	Degraded	Low abundance and high percentage of pollution-indicative taxa.
ELR 4	2.60	Degraded	High biomass (above upper threshold) and high percentage of pollution-indicative taxa.
NER 1	3.00	Meets Goal	Good total abundance and percentage of carnivore-omnivore abundance
NER 2	3.00	Meets Goal	Good total abundance and percentage of carnivore-omnivore abundance
NER 3	2.67	Marginal	Poor score for percent pollution-indicative taxa, pollution-sensitive taxa, and Tanypodinae to Chironomid ratio. Good score for total abundance and carnivore-omnivore abundance
NER 4	1.67	Severely Degraded	Poor score for percent pollution-indicative taxa, pollution-sensitive taxa, Tanypodinae to Chironomid ratio, carnivore-omnivore abundance, and tolerance score
NER 5	2.67	Marginal	Poor score for carnivore-omnivore abundance and percent pollution-indicative taxa. However, the value for percent pollution-indicative taxa was very near the threshold of 95% for a score of 3 would have classified the station as Meets Goal.
SER 1	1.00	Severely Degraded	Essentially an azoic station (only one taxa collected)
SER 2	1.00	Severely Degraded	Essentially an azoic station (only one taxa collected)
SER 3	1.33	Severely Degraded	Low biomass, abundance, diversity, percent carnivore-omnivore taxa and percentage of pollution-sensitive taxa.
SER 4	1.33	Severely Degraded	Low biomass, abundance, diversity, percent carnivore-omnivore taxa and percentage of pollution-sensitive taxa.
SER5	2.33	Degraded	Low abundance, diversity, and percent carnivore-omnivore taxa.

Appendix D1. Chesapeake Bay Benthic Index of Biological Integrity metrics and scores for 2002 Sediment Quality Triad sites located in olighaline habitats.

Station: NER 1	Location: Northeast River-Upstream	Date: 16SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.58909	Longitude: 75.95703

BOTTOM ENVIRONMENT

BIBI-Habitat: Oligohaline	Salinity (ppt): 2.90	Temperature (C): 23.64
pH: 7.84	Botom DO: 7.14	Depth (m): 1.80

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 3.00 — Condition: Meets Goal — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	2.13		Oligohaline Pollution Indicative Spp. Abund.	94.44	3
Abundance (#/m2)	818	5	Tolerance Score	8.16	3
Deep Deposit Feeder Abundance (%)	47.22		Oligohaline Pollution Sensitive Spp. Abund.	0.00	1
Carnivore-Omnivore Abundance (%)	52.78	5	Tanypodinae/Chironomidae Abundance Ratio	94.12	1

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Branchiura sowerbyi	23	0.09318
Chaoborus spp.	45	0.00114
Chironomidae		0.00114
Chironomus spp.	23	
Coelotanypus spp.	341	0.11591
Limnodrilus hoffmeisteri	227	
Oligochaeta		0.00114
Procladius spp.	23	
Tubificidae imm. w/o c.c. *	136	
Total Abundance w/ Epi.	818	
Total Abundance w/o Epi.	818	
Number of Taxa w/ Epi.	6	
Number of Taxa w/o Epi.	6	
Total Biomass w/ Epi.		0.21250
Total Biomass w/o Epi.		0.21250

Appendix D1. Continued.

Station: NER 2	Location: Northeast River	Date: 16SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.57779	Longitude: 75.95639

BOTTOM ENVIRONMENT

BIBI-Habitat: Oligohaline	Salinity (ppt): 3.00	Temperature (C): 23.66
pH: 7.88	Botom DO: 7.06	Depth (m): 2.40

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 3.00 — Condition: Meets Goal — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	1.77		Oligohaline Pollution Indicative Spp. Abund.	91.89	3
Abundance (#/m2)	841	5	Tolerance Score	8.28	3
Deep Deposit Feeder Abundance (%)	48.65		Oligohaline Pollution Sensitive Spp. Abund.	0.00	1
Carnivore-Omnivore Abundance (%)	43.24	5	Tanypodinae/Chironomidae Abundance Ratio	100.00	1

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Chaoborus spp.	68	0.00227
Coelotanypus spp.	295	0.14091
Oligochaeta		0.00114
Streblospio benedicti	68	0.00114
Tubificidae imm. w/ c.c.	23	
Tubificidae imm. w/o c.c.	386	
Total Abundance w/ Epi.	841	
Total Abundance w/o Epi.	841	
Number of Taxa w/ Epi.	5	
Number of Taxa w/o Epi.	5	
Total Biomass w/ Epi.		0.14545
Total Biomass w/o Epi.		0.14545

Appendix D1. Continued.

Station: NER 3	Location: Northeast River-mouth of 4 marinas	Date: 16SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.56544	Longitude: 75.96565

BOTTOM ENVIRONMENT

BIBI-Habitat: Oligohaline	Salinity (ppt): 3.20	Temperature (C): 23.60
pH: 7.67	Botom DO: 7.02	Depth (m): 1.80

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.67 — Condition: Marginal — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	1.96		Oligohaline Pollution Indicative Spp. Abund.	100.00	1
Abundance (#/m2)	568	5	Tolerance Score	7.98	3
Deep Deposit Feeder Abundance (%)	52.00		Oligohaline Pollution Sensitive Spp. Abund.	0.00	1
Carnivore-Omnivore Abundance (%)	44.00	5	Tanypodinae/Chironomidae Abundance Ratio	100.00	1

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Branchiura sowerbyi	68	0.23182
Coelotanypus spp.	250	0.22273
Limnodrilus hoffmeisteri	68	
Oligochaeta		0.00114
Streblospio benedicti	23	0.00114
Tubificidae imm. w/o c.c. *	159	
Total Abundance w/ Epi.	568	
Total Abundance w/o Epi.	568	
Number of Taxa w/ Epi.	4	
Number of Taxa w/o Epi.	4	
Total Biomass w/ Epi.		0.45682
Total Biomass w/o Epi.		0.45682

Appendix D1. Continued.

Station: NER 4	Location: Northeast River-b/w bouy #9 and 8(?)	Date: 16SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.54846	Longitude: 75.97916

BOTTOM ENVIRONMENT

BIBI-Habitat: Oligohaline	Salinity (ppt): 3.10	Temperature (C): 23.55
pH: 7.75	Botom DO: 7.21	Depth (m): 1.50

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.67 — Condition: Severely Degraded — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	1.78		Oligohaline Pollution Indicative Spp. Abund.	97.62	1
Abundance (#/m2)	955	5	Tolerance Score	9.30	1
Deep Deposit Feeder Abundance (%)	80.95		Oligohaline Pollution Sensitive Spp. Abund.	0.00	1
Carnivore-Omnivore Abundance (%)	11.90	1	Tanypodinae/Chironomidae Abundance Ratio	100.00	1

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Coelotanypus spp.	114	0.08182
Limnodrilus hoffmeisteri	91	
Musculium spp.	23	0.00114
Oligochaeta		0.07045
Streblospio benedicti	45	0.00114
Tubificidae imm. w/ c.c.	91	
Tubificidae imm. w/o c.c. *	591	
Total Abundance w/ Epi.	955	
Total Abundance w/o Epi.	955	
Number of Taxa w/ Epi.	5	
Number of Taxa w/o Epi.	5	
Total Biomass w/ Epi.		0.15454
Total Biomass w/o Epi.		0.15454

Appendix D1. Continued.

Station: NER 5	Location: Northeast River-near Carpenter Pt.	Date: 16SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.54604	Longitude: 75.99584

BOTTOM ENVIRONMENT

BIBI-Habitat: Oligohaline	Salinity (ppt): 2.60	Temperature (C): 24.20
pH: 8.33	Botom DO: 8.76	Depth (m):

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.67 — Condition: Marginal — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	2.05		Oligohaline Pollution Indicative Spp. Abund.	95.31	1
Abundance (#/m2)	1455	5	Tolerance Score	8.76	3
Deep Deposit Feeder Abundance (%)	79.69		Oligohaline Pollution Sensitive Spp. Abund.	3.13	3
Carnivore-Omnivore Abundance (%)	12.50	1	Tanypodinae/Chironomidae Abundance Ratio	62.50	3

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Aulodrilus pigueti	182	
Chironomidae		0.00114
Chironomus spp.	68	
Coelotanypus spp.	114	0.04773
Limnodrilus hoffmeisteri	136	
Marenzelleria viridis	45	0.11591
Oligochaeta		0.02955
Polydora cornuta	45	0.00114
Rangia cuneata	23	38.17033
Tubificidae imm. w/o c.c. *	841	
Total Abundance w/ Epi.	1455	
Total Abundance w/o Epi.	1455	
Number of Taxa w/ Epi.	7	
Number of Taxa w/o Epi.	7	
Total Biomass w/ Epi.		38.36579
Total Biomass w/o Epi.		38.36579

Appendix D2. Chesapeake Bay benthic Index of Biological Integrity metrics and scores for 2002 Sediment Quality Triad sites located in low and high mesohaline habitats habitats.

Station: BOR 1	Location: Bohemia River-mouth of Manor Creek	Date: 17SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.46845	Longitude: 75.87177

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.00	Temperature (C): 24.07
pH: 6.89	Botom DO: 6.84	Depth (m): 1.80

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.40 — Condition: Severely Degraded — # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	1.60	1	Pollution Indicative Species Abundance (%)	91.67	1
Abundance (#/m2)	545	3	Pollution Indicative Species Biomass (%)	96.55	
Biomass (g/m2)	0.10	1	Pollution Sensitive Species Abundance (%)	0.00	
Carnivore-Omnivore Abundance (%)	41.67		Pollution Sensitive Species Biomass (%)	0.00	1
Deep Deposit Feeder Abundance (%)	54.17				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Chironomidae		0.00114
Chironomus spp.	23	
Coelotanypus spp.	205	0.09545
Oligochaeta		0.00114
Polydora cornuta	23	0.00114
Tubificidae imm. w/ c.c.	23	
Tubificidae imm. w/o c.c.	273	
Total Abundance w/ Epi.	545	
Total Abundance w/o Epi.	545	
Number of Taxa w/ Epi.	5	
Number of Taxa w/o Epi.	5	
Total Biomass w/ Epi.		0.09886
Total Biomass w/o Epi.		0.09886

Appendix D2. Continued.

Station: BOR 2	Location: Bohemia River-near Stony Point	Date: 17SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.47903	Longitude: 75.88837

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.20	Temperature (C): 24.04
pH: 6.67	Botom DO: 6.41	Depth (m): 1.90

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.80 — Condition: Severely Degraded — # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	2.13	3	Pollution Indicative Species Abundance (%)	83.33	1
Abundance (#/m2)	545	3	Pollution Indicative Species Biomass (%)	96.59	
Biomass (g/m2)	0.10	1	Pollution Sensitive Species Abundance (%)	0.00	
Carnivore-Omnivore Abundance (%)	41.67		Pollution Sensitive Species Biomass (%)	0.00	1
Deep Deposit Feeder Abundance (%)	33.33				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Aulodrilus pigueti	23	
Coelotanypus spp.	227	0.09545
Leptocheirus plumulosus	45	0.00114
Oligochaeta		0.00114
Polydora cornuta	45	0.00114
Streblospio benedicti	45	0.00114
Tubificidae imm. w/o c.c.	159	
Total Abundance w/ Epi.	545	
Total Abundance w/o Epi.	545	
Number of Taxa w/ Epi.	6	
Number of Taxa w/o Epi.	6	
Total Biomass w/ Epi.		0.10000
Total Biomass w/o Epi.		0.10000

Appendix D2. Continued.

Station: BOR 3	Location: Bohemia River-in Veazy Cove	Date: 17SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.47451	Longitude: 75.92241

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.30	Temperature (C): 23.95
pH: 7.14	Botom DO: 7.23	Depth (m): 1.70

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.20 — Condition: Degraded — # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	2.41	3	Pollution Indicative Species Abundance (%)	64.29	1
Abundance (#/m2)	318	1	Pollution Indicative Species Biomass (%)	0.08	
Biomass (g/m2)	18.54	3	Pollution Sensitive Species Abundance (%)	28.57	
Carnivore-Omnivore Abundance (%)	21.43		Pollution Sensitive Species Biomass (%)	99.90	3
Deep Deposit Feeder Abundance (%)	28.57				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ameroculodes species complex	23	0.00227
Coelotanypus spp.	68	0.01364
Marenzelleria viridis	23	0.00909
Oligochaeta		0.00227
Rangia cuneata	68	18.51585
Streblospio benedicti	45	0.00114
Tubificidae imm. w/o c.c.	91	
Total Abundance w/ Epi.	318	
Total Abundance w/o Epi.	318	
Number of Taxa w/ Epi.	6	
Number of Taxa w/o Epi.	6	
Total Biomass w/ Epi.		18.54426
Total Biomass w/o Epi.		18.54426

Appendix D2. Continued.

Station: BOR 4	Location: Bohemia River-near mouth	Date: 17SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.47909	Longitude: 75.94521

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.20	Temperature (C): 23.87
pH: 7.11	Botom DO: 6.69	Depth (m): 4.50

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.60 | Condition: Degraded | # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	2.46	3	Pollution Indicative Species Abundance (%)	28.07	1
Abundance (#/m2)	1295	3	Pollution Indicative Species Biomass (%)	0.04	
Biomass (g/m2)	42.00	1	Pollution Sensitive Species Abundance (%)	54.39	
Carnivore-Omnivore Abundance (%)	15.79		Pollution Sensitive Species Biomass (%)	99.94	5
Deep Deposit Feeder Abundance (%)	10.53				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Boccardiella ligerica	45	0.00227
Coelotanypus spp.	159	0.01364
Cyathura polita	45	0.00227
Marenzelleria viridis	91	0.05455
Mytilopsis leucophaeata (Epi)	45	0.05000
Oligochaeta		0.00114
Polydora cornuta	182	0.00227
Rangia cuneata	568	41.91577
Streblospio benedicti	68	0.00455
Tubificidae imm. w/o c.c.	136	
Total Abundance w/ Epi.	1341	
Total Abundance w/o Epi.	1295	
Number of Taxa w/ Epi.	9	
Number of Taxa w/o Epi.	8	
Total Biomass w/ Epi.		42.04646
Total Biomass w/o Epi.		41.99646

Appendix D2. Continued.

Station: ELR 1	Location: Elk River-Upstream near SAV bed	Date: 17SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.54113	Longitude: 75.87154

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.90	Temperature (C): 25.81
pH: 7.93	Botom DO: 9.84	Depth (m): 0.20

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.60 — Condition: Degraded — # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	1.96	3	Pollution Indicative Species Abundance (%)	54.41	1
Abundance (#/m2)	3091	3	Pollution Indicative Species Biomass (%)	0.00	
Biomass (g/m2)	190.65	1	Pollution Sensitive Species Abundance (%)	31.62	
Carnivore-Omnivore Abundance (%)	2.94		Pollution Sensitive Species Biomass (%)	99.88	5
Deep Deposit Feeder Abundance (%)	51.47				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Chironomidae		0.00114
Coelotanypus spp.	23	0.00114
Cyathura polita	45	0.04091
Harnischia spp.	23	
Hobsonia florida	341	0.01136
Marenzelleria viridis	114	0.15682
Oligochaeta		0.21364
Polydora cornuta	68	0.00227
Rangia cuneata	818	190.21530
Streblospio benedicti	68	0.00455
Tubificidae imm. w/o c.c.	1591	
Total Abundance w/ Epi.	3091	
Total Abundance w/o Epi.	3091	
Number of Taxa w/ Epi.	9	
Number of Taxa w/o Epi.	9	
Total Biomass w/ Epi.		190.64712
Total Biomass w/o Epi.		190.64712

Appendix D2. Continued.

Station: ELR 2	Location: Elk River-near Gr buoys 21+23	Date: 17SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.51228	Longitude: 75.89471

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.30	Temperature (C): 24.31
pH: 7.25	Botom DO: 7.09	Depth (m): 4.40

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 3.40 — Condition: Meets Goal — # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	2.41	3	Pollution Indicative Species Abundance (%)	6.90	5
Abundance (#/m2)	659	3	Pollution Indicative Species Biomass (%)	3.52	
Biomass (g/m2)	0.26	1	Pollution Sensitive Species Abundance (%)	72.41	
Carnivore-Omnivore Abundance (%)	20.69		Pollution Sensitive Species Biomass (%)	87.22	5
Deep Deposit Feeder Abundance (%)	0.00				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Boccardiella ligerica	91	0.00114
Carinoma tremaphoros	23	0.02045
Chiridotea almyra	23	0.00227
Cyathura polita	91	0.01818
Gammarus spp. (Epi)	23	0.00227
Marenzelleria viridis	227	0.20454
Rangia cuneata	159	0.00227
Streblospio benedicti	45	0.00909
Total Abundance w/ Epi.	682	
Total Abundance w/o Epi.	659	
Number of Taxa w/ Epi.	8	
Number of Taxa w/o Epi.	7	
Total Biomass w/ Epi.		0.26023
Total Biomass w/o Epi.		0.25795

Appendix D2. Continued.

Station: ELR 3	Location: Elk River-in cove near canal anchorage	Date: 17SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.51052	Longitude: 75.92272

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.30	Temperature (C): 24.68
pH: 7.47	Botom DO: 7.70	Depth (m): 0.40

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.20 — Condition: Degraded — # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	2.10	3	Pollution Indicative Species Abundance (%)	55.56	1
Abundance (#/m2)	409	1	Pollution Indicative Species Biomass (%)	0.21	
Biomass (g/m2)	15.31	3	Pollution Sensitive Species Abundance (%)	22.22	
Carnivore-Omnivore Abundance (%)	83.33		Pollution Sensitive Species Biomass (%)	98.72	3
Deep Deposit Feeder Abundance (%)	0.00				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ameroculodes species complex	23	0.00114
Apocorophium lacustre (Epi)	23	0.00114
Chironomidae		0.00114
Coelotanypus spp.	227	0.03182
Cricotopus spp.	23	
Cyathura polita	45	0.04318
Gammarus spp. (Epi)	68	0.00909
Mytilopsis leucophaeata (Epi)	68	0.00227
Neanthes succinea	23	0.16136
Procladius spp.	23	
Rangia cuneata	45	15.07041
Total Abundance w/ Epi.	568	
Total Abundance w/o Epi.	409	
Number of Taxa w/ Epi.	10	
Number of Taxa w/o Epi.	7	
Total Biomass w/ Epi.		15.32154
Total Biomass w/o Epi.		15.30904

Appendix D2. Continued.

Station: ELR 4	Location: Elk River-near Elk Neck State Park	Date: 17SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.4638	Longitude: 75.98253

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.40	Temperature (C): 23.84
pH: 7.09	Botom DO: 6.39	Depth (m): 2.50

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.60 — Condition: Degraded — # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	2.48	3	Pollution Indicative Species Abundance (%)	50.00	1
Abundance (#/m2)	955	3	Pollution Indicative Species Biomass (%)	0.04	
Biomass (g/m2)	64.24	1	Pollution Sensitive Species Abundance (%)	40.48	
Carnivore-Omnivore Abundance (%)	38.10		Pollution Sensitive Species Biomass (%)	99.94	5
Deep Deposit Feeder Abundance (%)	19.05				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ameroculodes species complex	23	0.00227
Coelotanypus spp.	295	0.02727
Cyathura polita	45	0.00455
Marenzelleria viridis	91	0.18864
Mytilopsis leucophaeata (Epi)	23	0.00114
Neanthes succinea	23	0.00114
Oligochaeta		0.00114
Polydora cornuta	45	0.00455
Rangia cuneata	250	64.01343
Tubificidae imm. w/o c.c.	182	
Total Abundance w/ Epi.	977	
Total Abundance w/o Epi.	955	
Number of Taxa w/ Epi.	9	
Number of Taxa w/o Epi.	8	
Total Biomass w/ Epi.		64.24411
Total Biomass w/o Epi.		64.24298

Appendix D2. Continued.

Station: SER 1	Location: Severn River-Upstream nr Pt. Lookout	Date: 13SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.07649	Longitude: 76.59332

BOTTOM ENVIRONMENT

BIBI-Habitat: High Mesohaline Mud	Salinity (ppt): 13.20	Temperature (C): 24.44
pH: 7.04	Botom DO: 2.22	Depth (m): 3.30

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.00 — Condition: Severely Degraded — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	0.00	1	Pollution Indicative Species Abundance (%)	100.00	
Abundance (#/m2)	23	1	Pollution Indicative Species Biomass (%)	100.00	1
Biomass (g/m2)	0.00	1	Pollution Sensitive Species Abundance (%)	0.00	
Carnivore-Omnivore Abundance (%)	0.00	1	Pollution Sensitive Species Biomass (%)	0.00	1
Deep Deposit Feeder Abundance (%)	0.00				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Streblospio benedicti	23	0.00114
Total Abundance w/ Epi.	23	
Total Abundance w/o Epi.	23	
Number of Taxa w/ Epi.	1	
Number of Taxa w/o Epi.	1	
Total Biomass w/ Epi.		0.00114
Total Biomass w/o Epi.		0.00114

Appendix D2. Continued.

Station: SER 2	Location: Severn River-b/w channel marker 9+10	Date: 13SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.05416	Longitude: 76.55703

BOTTOM ENVIRONMENT

BIBI-Habitat: High Mesohaline Mud	Salinity (ppt): 15.20	Temperature (C): 24.99
pH: 7.38	Botom DO: 5.97	Depth (m): 6.60

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.00 — Condition: Severely Degraded — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	0.00	1	Pollution Indicative Species Abundance (%)	100.00	
Abundance (#/m2)	68	1	Pollution Indicative Species Biomass (%)	100.00	1
Biomass (g/m2)	0.00	1	Pollution Sensitive Species Abundance (%)	0.00	
Carnivore-Omnivore Abundance (%)	0.00	1	Pollution Sensitive Species Biomass (%)	0.00	1
Deep Deposit Feeder Abundance (%)	0.00				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Streblospio benedicti	68	0.00227
Total Abundance w/ Epi.	68	
Total Abundance w/o Epi.	68	
Number of Taxa w/ Epi.	1	
Number of Taxa w/o Epi.	1	
Total Biomass w/ Epi.		0.00227
Total Biomass w/o Epi.		0.00227

Appendix D2. Continued.

Station: SER 3	Location: Severn River-near golf course	Date: 13SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.02211	Longitude: 76.52634

BOTTOM ENVIRONMENT

BIBI-Habitat: High Mesohaline Mud	Salinity (ppt): 16.30	Temperature (C): 25.03
pH: 7.48	Botom DO: 3.68	Depth (m): 7.60

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.33 — Condition: Severely Degraded — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	0.99	1	Pollution Indicative Species Abundance (%)	82.76	
Abundance (#/m2)	659	1	Pollution Indicative Species Biomass (%)	17.39	3
Biomass (g/m2)	0.21	1	Pollution Sensitive Species Abundance (%)	3.45	
Carnivore-Omnivore Abundance (%)	0.00	1	Pollution Sensitive Species Biomass (%)	0.54	1
Deep Deposit Feeder Abundance (%)	6.90				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Heteromastus filiformis	23	0.15454
Leptocheirus plumulosus	45	0.01591
Rangia cuneata	23	0.00114
Streblospio benedicti	545	0.03636
Tubificoides spp.	23	0.00114
Total Abundance w/ Epi.	659	
Total Abundance w/o Epi.	659	
Number of Taxa w/ Epi.	5	
Number of Taxa w/o Epi.	5	
Total Biomass w/ Epi.		0.20909
Total Biomass w/o Epi.		0.20909

Appendix D2. Continued.

Station: SER 4	Location: Severn River-near Rt 50 Bridge	Date: 13SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 39.00695	Longitude: 76.5048667

BOTTOM ENVIRONMENT

BIBI-Habitat: High Mesohaline Mud	Salinity (ppt): 15.70	Temperature (C): 25.60
pH: 7.71	Botom DO: 3.68	Depth (m): 6.80

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.33 — Condition: Severely Degraded — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	1.81	1	Pollution Indicative Species Abundance (%)	69.23	
Abundance (#/m2)	886	1	Pollution Indicative Species Biomass (%)	14.10	3
Biomass (g/m2)	0.26	1	Pollution Sensitive Species Abundance (%)	10.26	
Carnivore-Omnivore Abundance (%)	7.69	1	Pollution Sensitive Species Biomass (%)	11.45	1
Deep Deposit Feeder Abundance (%)	12.82				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Americamysis bigelowi (Epi)	45	0.00114
Glycinde solitaria	45	0.01818
Heteromastus filiformis	68	0.11591
Macoma mitchelli	68	0.00114
Neanthes succinea	23	0.07273
Oligochaeta		0.00114
Rangia cuneata	45	0.01136
Streblospio benedicti	591	0.03636
Tubificidae imm. w/o c.c.	23	
Tubificoides spp.	23	0.00114
Total Abundance w/ Epi.	932	
Total Abundance w/o Epi.	886	
Number of Taxa w/ Epi.	9	
Number of Taxa w/o Epi.	8	
Total Biomass w/ Epi.		0.25909
Total Biomass w/o Epi.		0.25795

Appendix D2. Continued.

Station: SER 5	Location: Severn River-Back Creek tributary	Date: 13SEP2002
Gear: VV-YM	Sampled Area: 0.044 sq.m	Latitude: 38.96343	Longitude: 76.48159

BOTTOM ENVIRONMENT

BIBI-Habitat: High Mesohaline Mud	Salinity (ppt): 15.70	Temperature (C): 24.94
pH: 7.44	Botom DO: 3.27	Depth (m): 2.20

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.33 — Condition: Degraded — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Weiner Index	1.88	1	Pollution Indicative Species Abundance (%)	52.38	
Abundance (#/m2)	477	1	Pollution Indicative Species Biomass (%)	0.21	5
Biomass (g/m2)	0.54	3	Pollution Sensitive Species Abundance (%)	19.05	
Carnivore-Omnivore Abundance (%)	9.52	1	Pollution Sensitive Species Biomass (%)	65.97	3
Deep Deposit Feeder Abundance (%)	23.81				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Chironomidae		0.00114
Chironomus spp.	23	
Macoma balthica	91	0.35909
Neanthes succinea	23	0.18182
Streblospio benedicti	227	0.00114
Tubificoides spp.	114	0.00114
Total Abundance w/ Epi.	477	
Total Abundance w/o Epi.	477	
Number of Taxa w/ Epi.	5	
Number of Taxa w/o Epi.	5	
Total Biomass w/ Epi.		0.54432
Total Biomass w/o Epi.		0.54432

Appendix D3. Data for Long-term benthic monitoring stations that coincide with 2002 Sediment Quality Triad stations.

LTB: BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 2002 (CRUISE 01:2002/2003) 029 RECLASSIFIED BY SALINITY

Station: LTB-029-01	Location:		Date: 20SEP02		
Gear: BC-WC	Sampled Area: 0.022 sq.m	Latitude: 39.4794567	Longitude: -75.9447967		
BOTTOM ENVIRONMENT					
BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.87		Temperature (C): 24.00		
pH:	Botom DO: 6.34		Depth (m): 7.00		
BENTHIC INDEX OF BIOTIC INTEGRITY					
B-IBI Score: 3.00	Condition: Meets Goal		# Attributes Scored: 5		
	Value	Score		Value	Score
Shannon-Weiner Index	2.77	5	Pollution Indicative Species Abundance (%)	33.67	1
Abundance (#/m2)	4410	3	Pollution Indicative Species Biomass (%)	0.01	
Biomass (g/m2)	87.03	1	Pollution Sensitive Species Abundance (%)	30.61	
Carnivore-Omnivore Abundance (%)	3.06		Pollution Sensitive Species Biomass (%)	99.92	5
Deep Deposit Feeder Abundance (%)	28.57				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ameroculodes species complex	45	0.00450
Coelotanypus spp.	90	0.00450
Cyathura polita	45	0.00900
Gammarus spp. (Epi)	90	0.00450
Hobsonia florida	135	0.00225
Macoma mitchelli	90	0.00450
Marenzelleria viridis	135	0.41400
Mytilopsis leucophaeata (Epi)	45	0.00450
Oligochaeta		0.02025
Polydora cornuta	945	0.03150
Rangia cuneata	1170	86.53950
Streblospio benedicti	495	0.00225
Tubificidae imm. w/o c.c.	900	
Tubificoides spp.	360	0.00225
Total Abundance w/ Epi.	4545	
Total Abundance w/o Epi.	4410	
Number of Taxa w/ Epi.	13	
Number of Taxa w/o Epi.	11	
Total Biomass w/ Epi.		87.04350
Total Biomass w/o Epi.		87.03450

Appendix D3. Continued

LTB: BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 2002 (CRUISE 01:2002/2003) 029 RECLASSIFIED BY SALINITY

Station: LTB-029-02	Location:	Date: 20SEP02
Gear: BC-WC	Sampled Area: 0.022 sq.m Latitude: 39.4794567	Longitude: -75.9447967

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.87	Temperature (C): 24.00
pH:	Botom DO: 6.34	Depth (m): 7.00

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 3.00 — Condition: Meets Goal — # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	2.65	5	Pollution Indicative Species Abundance (%)	41.67	1
Abundance (#/m2)	4320	3	Pollution Indicative Species Biomass (%)	0.04	
Biomass (g/m2)	139.15	1	Pollution Sensitive Species Abundance (%)	22.92	
Carnivore-Omnivore Abundance (%)	11.46		Pollution Sensitive Species Biomass (%)	99.88	5
Deep Deposit Feeder Abundance (%)	35.42				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Coelotanypus spp.	315	0.04050
Cyathura polita	180	0.10800
Gammarus spp. (Epi)	45	0.00450
Hobsonia florida	270	0.00900
Oligochaeta		0.07200
Polydora cornuta	990	0.02250
Rangia cuneata	810	138.87900
Streblospio benedicti	225	0.01350
Tubificidae imm. w/o c.c.	1260	
Tubificoides spp.	270	0.00450
Total Abundance w/ Epi.	4365	
Total Abundance w/o Epi.	4320	
Number of Taxa w/ Epi.	9	
Number of Taxa w/o Epi.	8	
Total Biomass w/ Epi.		139.15350
Total Biomass w/o Epi.		139.14900

Appendix D3. Continued

LTB: BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 2002 (CRUISE 01:2002/2003) 029 RECLASSIFIED BY SALINITY

Station: LTB-029-03	Location:	Date: 20SEP02
Gear: BC-WC	Sampled Area: 0.022 sq.m Latitude: 39.4794567	Longitude: -75.9447967

BOTTOM ENVIRONMENT

BIBI-Habitat: Low Mesohaline	Salinity (ppt): 6.87	Temperature (C): 24.00
pH:	Botom DO: 6.34	Depth (m): 7.00

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 3.00 Condition: Meets Goal # Attributes Scored: 5

	Value	Score		Value	Score
Shannon-Weiner Index	2.89	5	Pollution Indicative Species Abundance (%)	20.88	1
Abundance (#/m2)	4095	3	Pollution Indicative Species Biomass (%)	0.01	
Biomass (g/m2)	95.05	1	Pollution Sensitive Species Abundance (%)	32.97	
Carnivore-Omnivore Abundance (%)	9.89		Pollution Sensitive Species Biomass (%)	99.94	5
Deep Deposit Feeder Abundance (%)	27.47				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Coelotanypus spp.	90	0.00900
Cyathura polita	315	0.18450
Edotea triloba (Epi)	45	0.00900
Gammarus daiberi (Epi)	90	0.00900
Hobsonia florida	225	0.00225
Marenzelleria viridis	225	0.52650
Oligochaeta		0.00225
Polydora cornuta	990	0.03600
Rangia cuneata	810	94.27950
Streblospio benedicti	315	0.00450
Tubificidae imm. w/o c.c.	450	
Tubificoides spp.	675	0.00450
Total Abundance w/ Epi.	4230	
Total Abundance w/o Epi.	4095	
Number of Taxa w/ Epi.	11	
Number of Taxa w/o Epi.	9	
Total Biomass w/ Epi.		95.06700
Total Biomass w/o Epi.		95.04900

LTB: BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 2002 (CRUISE 01:2002/2003) FIXED STATIONS

	Station: 204	Rep: 01
Watershed: Lower Western Shore	Habitat: High Mesohaline Mud	Date: 17SEP02
Gear: Young Grab	Sampled Area: 0.044 sq.m	Time: 6:42:26

BOTTOM ENVIRONMENT

Depth (m): 8.0	Salinity (ppt): 16.98	Temperature (C): 24.37
Dissolved Oxygen (mg/l): 4.1	Sediment Silt-Clay (%): 43.73	Total Carbon (%): 1.26

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.33 — Condition: Severely Degr. — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Wiener Index	1.15	1	Pollution Indicative Species Abundance (%)	84.40	
Abundance (#/m2)	4953	3	Pollution Indicative Species Biomass (%)	45.87	1
Biomass (g/m2)	0.37	1	Pollution Sensitive Species Abundance (%)	1.38	
Carnivore-Omnivore Abundance (%)	5.05	1	Pollution Sensitive Species Biomass (%)	6.73	1
Deep Deposit Feeder Abundance (%)	5.50				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Eteone heteropoda	68	0.00454
Glycinde solitaria	68	0.02499
Heteromastus filiformis	68	0.05453
Macoma mitchelli	364	0.00909
Mulinia lateralis	23	0.01590
Neanthes succinea	114	0.10678
Oligochaeta		0.00114
Streblospio benedicti	4044	0.14995
Tubificidae imm w/o cap chaetae	45	
Tubificoides spp.	159	0.00454
Total Abundance w/ Epi.	4953	
Total Abundance w/o Epi.	4953	
Number of Taxa w/ Epi.	9	
Number of Taxa w/o Epi.	9	
Total Biomass w/ Epi.		0.37147
Total Biomass w/o Epi.		0.37147

LTB: BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 2002 (CRUISE 01:2002/2003) FIXED STATIONS

	Station: 204	Rep: 02
Watershed: Lower Western Shore	Habitat: High Mesohaline Mud	Date: 17SEP02
Gear: Young Grab	Sampled Area: 0.044 sq.m	Time: 6:42:26

BOTTOM ENVIRONMENT

Depth (m): 8.0	Salinity (ppt): 16.98	Temperature (C): 24.37
Dissolved Oxygen (mg/l): 4.1	Sediment Silt-Clay (%): 43.73	Total Carbon (%): 1.26

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.00 — Condition: Severely Degr. — # Attributes Scored: 6

	Value	Score		Value	Score
Shannon-Wiener Index	2.32	3	Pollution Indicative Species Abundance (%)	69.60	
Abundance (#/m2)	2840	3	Pollution Indicative Species Biomass (%)	29.85	3
Biomass (g/m2)	0.30	1	Pollution Sensitive Species Abundance (%)	3.20	
Carnivore-Omnivore Abundance (%)	9.60	1	Pollution Sensitive Species Biomass (%)	15.67	1
Deep Deposit Feeder Abundance (%)	26.40				

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Chironomidae		0.00114
Chironomus spp.	45	
Cyclaspis varians	23	0.00227
Eteone heteropoda	45	0.00454
Geukensia demissa (Epi)	23	0.00114
Glycinde solitaria	91	0.04771
Heteromastus filiformis	227	0.10906
Leptocheirus plumulosus	45	0.00227
Macoma mitchelli	114	0.01363
Mulinia lateralis	23	0.01363
Neanthes succinea	23	0.03181
Oligochaeta		0.00114
Podarkeopsis levifuscina	68	0.00227
Streblospio benedicti	1613	0.07270
Tubificidae imm w/o cap chaetae	250	
Tubificoides spp.	273	0.00227
Total Abundance w/ Epi.	2863	
Total Abundance w/o Epi.	2840	
Number of Taxa w/ Epi.	14	
Number of Taxa w/o Epi.	13	
Total Biomass w/ Epi.		0.30558
Total Biomass w/o Epi.		0.30445

Appendix D3. Continued

LTB: BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 2002 (CRUISE 01:2002/2003) FIXED STATIONS

Station: 204		Rep: 03
Watershed: Lower Western Shore	Habitat: High Mesohaline Mud	Date: 17SEP02
Gear: Young Grab	Sampled Area: 0.044 sq.m	Time: 6:42:26

BOTTOM ENVIRONMENT

Depth (m): 8.0	Salinity (ppt): 16.98	Temperature (C): 24.37
Dissolved Oxygen (mg/l): 4.1	Sediment Silt-Clay (%): 43.73	Total Carbon (%): 1.26

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.67		Condition: Marginal		# Attributes Scored: 6		
	Value	Score			Value	Score
Shannon-Wiener Index	2.64	3	Pollution Indicative Species Abundance (%)		55.24	
Abundance (#/m2)	2386	5	Pollution Indicative Species Biomass (%)		10.44	3
Biomass (g/m2)	0.47	1	Pollution Sensitive Species Abundance (%)		3.81	
Carnivore-Omnivore Abundance (%)	14.29	3	Pollution Sensitive Species Biomass (%)		5.34	1
Deep Deposit Feeder Abundance (%)	16.19					

BENTHIC ABUNDANCE (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Carinoma tremaphoros	45	0.02726
Chironomidae		0.00114
Chironomus spp.	23	
Cyclaspis varians	23	0.00114
Geukensia demissa (Epi)	23	0.00114
Glycinde solitaria	91	0.02499
Heteromastus filiformis	91	0.07725
Leptocheirus plumulosus	68	0.01590
Macoma mitchelli	386	0.00454
Mulinia lateralis	45	0.00114
Neanthes succinea	159	0.25219
Oligochaeta		0.00114
Parahesione luteola	23	0.00454
Pectinaria gouldii	23	0.00227
Streblospio benedicti	1136	0.04771
Tubificidae imm w/o cap chaetae	114	
Tubificoides spp.	159	0.00682
Total Abundance w/ Epi.	2408	
Total Abundance w/o Epi.	2386	
Number of Taxa w/ Epi.	15	
Number of Taxa w/o Epi.	14	
Total Biomass w/ Epi.		0.46917
Total Biomass w/o Epi.		0.46803