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Characterization of Selected Bed-Sediment-Bound Organic and Inorganic Contaminants and Toxicity, Barnegat Bay and Major Tributaries, New Jersey, 2012

Data Series 867

U.S. Department of the Interior
U.S. Geological Survey

Cover. U.S. Geological Survey personnel collecting sediment sample in the Barnegat Bay, New Jersey. Photograph by Timothy J. Reilly, U.S. Geological Survey.

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By Kristin M. Romanok, Timothy J. Reilly, Anthony R. Lopez, John J. Trainor, Michelle L. Hladik, Jacob K. Stanley, and Daniel Farrar

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Conversion Factors, Datums, and Acronyms

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
	Area	
hectare (ha)	0.003861	square mile (mi^2)
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
liter (L)	33.82	ounce, fluid (fl. oz)
liter (L)	2.113	pint (pt)
liter (L)	1.057	quart (qt)
liter (L)	0.2642	gallon (gal)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C=(°F-32)/1.8

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Concentrations of chemical constituents in bed-sediment are given either in milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg).

Specific conductance is given in millisiemens per centimeter at 22.8 degrees Celsius (mS/cm).

Acronyms

ANSP	Academy of Natural Sciences of Drexel University
ER-L	Effects Range-Low
ER-M	Effects Range-Medium
GIS	Geographical Information System
GPS	Global Positioning System
NEP	National Estuary Program
NJDEP	New Jersey Department of Environmental Protection
NOAA	National Oceanic and Atmospheric Administration
OGRL	Organic Geochemistry Research Laboratory
PFRG	Pesticide Fate Research Laboratory
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RUSTL	Rutgers University Soil Testing Laboratory
SIM	Selected ion monitoring
SQG	Sediment Quality Guidelines
SRM	Standard Reference Material
TIE	Toxicology Identification Evaluation
USACE-ERDC	U.S. Army Corps of Engineers—Engineer Research and Development Center
USEPA	U.S. Environmental Protection Agency

Characterization of Selected Bed-Sediment-Bound Organic and Inorganic Contaminants and Toxicity, Barnegat Bay and Major Tributaries, New Jersey, 2012

By K.M. Romanok, Timothy J. Reilly, Anthony R. Lopez, John J. Trainor, Michelle L. Hladik, Jacob K. Stanley[1], and Daniel Farrar[1]

Abstract

A study of bed-sediment toxicity and organic and inorganic contaminants was conducted by the U.S. Geological Survey (USGS) in cooperation with the New Jersey Department of Environmental Protection (NJDEP). Bed-sediment samples were collected once from 22 sites in Barnegat Bay and selected major tributaries during August–September 2012 and analyzed for toxicity and a suite of organic and inorganic contaminants by the USGS and the U.S. Army Corps of Engineers. Sampling sites were selected to coincide with an existing water-quality monitoring network used by the NJDEP and others in order to evaluate water-quality conditions in Barnegat Bay and the surrounding watershed. Two of the 22 sites are reference sites and are within or adjacent to the study area; bed-sediment samples from reference sites allow for comparisons of results for the Barnegat Bay watershed to results from less affected settings within the region. Toxicity testing was conducted by exposing the estuarine amphipod *Leptocheirus plumulosus* and the freshwater amphipod *Hyalella azteca* to sediments for 28 days, and the percent survival, difference in biomass, and individual dry weights were measured. Reproductive effects also were evaluated for estuarine samples. Bed-sediment samples from four sites within Barnegat Bay were subjected to a toxicity identification evaluation to determine probable causes of toxicity. Samples were analyzed for a suite of 94 currently-used pesticides, 21 legacy pesticides, 24 trace elements, 40 polycyclic aromatic hydrocarbons, 7 polychlorinated biphenyls (PCBs) as Arochlor mixtures, and 145 individual PCB congeners. Concentrations of detected compounds were compared to sediment-quality guidelines, where appropriate.

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Introduction

The Barnegat Bay Estuarine System is located along the southeastern shore of New Jersey. In 1995, the U.S. Environmental Protection Agency (EPA) officially accepted the Barnegat Bay Estuary into the National Estuary Program (NEP), making it one of 28 estuary programs in the United States (NJDEP, 2010). Through this program, Federal, State, local, and public stakeholders seek to restore and preserve the natural resources throughout the bay (NJDEP, 2010). based on concerns about non-point-source contamination affecting water quality and habitat loss or alteration, the NEP conducted an assessment of the bay from 2000 to 2001.

On the basis of data collected from water-quality, sediment-quality, benthos, and fish-tissue samples from the 2000–2001 NEP study, the overall condition of the bay was deemed fair. Sediment quality indexes of the bay indicate that 1 percent of sediment is rated poor for sediment toxicity and 12 percent is rated fair or poor for sediment contamination (EPA, 2007a). The sediment samples collected during the NEP study were compared to Sediment Quality Guidelines (SQG) established by Long and others (1998) to assess sediment toxicity, where available.

The sediment index used by the NEP contains 91 chemical constituents, including metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and legacy pesticides. None of the pesticides that are currently being applied within the Barnegat Bay watershed were included in the NEP study (Roy Meyer, NJDEP, written commun., 2011). The purpose of the study was to determine (1) the occurrence and distribution of selected contaminants in bed sediments, (2) the toxicity of these bed sediments to amphipods, and where possible, (3) to identify potential sources of toxicity within Barnegat Bay and major tributaries. Therefore, during August–September 2012, the U.S. Geological Survey (USGS), in cooperation with the New Jersey Department of

Environmental Protection, collected and analyzed bed-sediment samples from 22 sites within the Barnegat Bay watershed. The sites were evenly distributed between contributing tributaries to the bay and the bay itself. Bed-sediment samples were analyzed to determine the concentration of currently-used and legacy pesticides, trace elements, priority and alkylated PAHs, PCBs as Arochlors mixtures and individual PCB congeners, organic carbon, and total nitrogen. Values for acute and chronic toxicity, pH, specific conductance, and grain size were determined. The data presented in this report can be used to assess biological changes (loss of submerged aquatic vegetation, decline in hard clams, and increase in invasive species) that could be caused or exacerbated by sediment toxicity.

Geographic Setting

The 75 square mile (mi^2) Barnegat Bay Estuarine System is located within the 660-mi^2 watershed along the southeastern shores of New Jersey (NJDEP, 2012; fig. 1). The watershed, New Jersey Department of Environmental Protection (NJDEP) Watershed Management Area (WMA) 13, encompasses 37 municipalities in Ocean and Monmouth Counties with a total population of more than 550,000. The population increases dramatically in the summer owing to seasonal rentals and vacationers. As of 2006, 30 percent of the watershed was classified as urban land (Barnegat Bay Partnership , 2010).

The watershed hosts a variety of plant communities, including barrier islands-coastal dune scrub, maritime forests, submerged aquatic vegetation, tidal wetlands and upland forests, and freshwater wetlands. These plant communities include biologically significant species such as American beachgrass (*Ammophila breviligulata*), bayberry (*Myrica pensylvanica*), sour gum (*Nyssa sylvatica*), a variety of benthic algae such as *Ulva lactuca*, meadowland species including *Spartina alterniflora*, pitch pines (*Pinus rigida*) and scrub oaks (*Quercus ilicifolia*), and New Jersey rush (*Juncus caesariennsis),* and sandy myrtle (*Leiophyllum buxifolium)* (Barnegat Bay Partnership, 2010). In 2008, approximately 157,000 acres were protected by Federal and State programs; additional acres of protected lands are funded by county and private trusts (Barnegat Bay Partnership, 2010)

Several river systems flow into the bay (fig. 1). The northernmost contribution is from the Manasquan River, through the Point Pleasant Canal which was constructed in 1925. Other major tributary systems, which were evaluated in this study, are Metedeconk River, Toms River, Cedar Creek, Forked River, Oyster Creek, Mill Creek, and Cedar Run.

Sampling Site Selection and Description

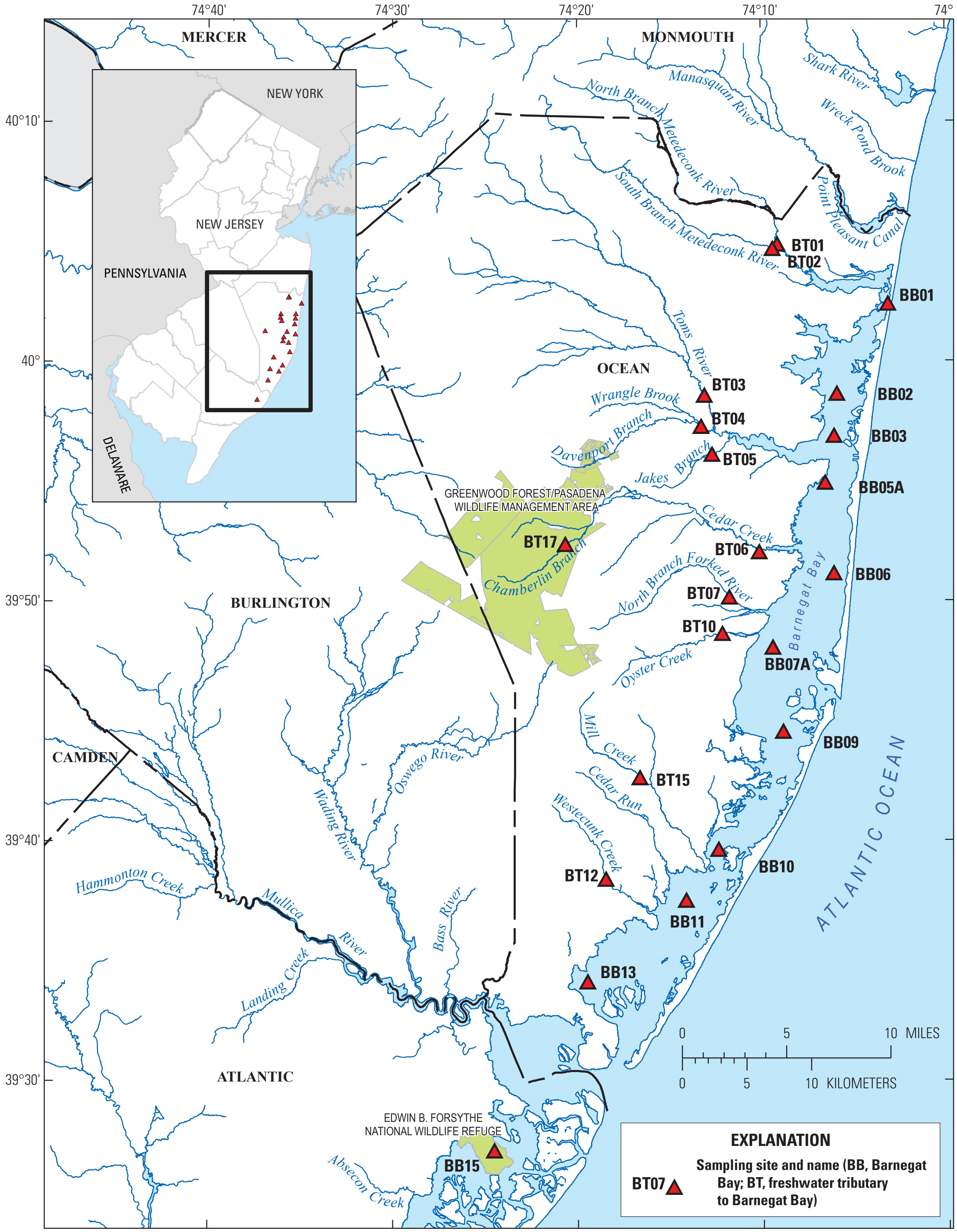
Twenty-two bed-sediment sampling sites were chosen to coincide with selected water-quality sampling sites used for the ongoing water-quality monitoring program by the NJDEP in partnership with the EPA, local government agencies and commissions, and a university in the Barnegat Bay watershed. Of these 22 sites, 11 are estuarine sites within Barnegat Bay, including one reference site in the Edwin B. Forsythe National Wildlife Refuge in northeastern Atlantic County, N.J. (BB15; fig. 1), and 11 are freshwater sites on tributaries to Barnegat Bay, including one reference site (BT17; fig. 1). Reference sites were chosen on the basis of geographic information systems (GIS) land-use analysis and stakeholder input to represent locations with minimal development and little potential for contamination. Once the sites were selected, the locations were determined using a hand-held global positioning system (GPS); detailed notes and photographs were taken to document the sampling sites.

The Barnegat Bay estuarine sites were selected to match NJDEP water-quality stations, where possible; when necessary, a nearby site was identified and sampled (table 1). The minimally affected reference site for the Barnegat Bay is site BB15. This site was chosen because of restrictions on motorized boats and limited access. An important limitation of this site is that the sediment samples were collected from an anoxic tidal flat.

The Barnegat Bay freshwater tributary sites were selected from NJDEP water-quality monitoring sites, and USGS topographic maps were used to identify tributaries within the watershed. Field visits were conducted to identify depositional areas within stream reaches that would be suitable for bed-sediment sampling (table 1). The freshwater reference site BT17 is on the Chamberlin Branch of Cedar Creek, located in the Greenwood Forest/Pasadena Wildlife Management Area in Ocean County, N.J.

Purpose and Scope

This report describes the methods and procedures used to determine the concentration of legacy and currently-used pesticides, trace elements, priority and alkylated PAHs, PCBs as Arochlor mixtures and individual PCB congeners, and sediment toxicity, as well as values for pH, specific conductance, organic carbon, total nitrogen, and grain size in sediment samples collected from estuarine sites and freshwater tributary sites within the Barnegat Bay watershed, N.J., during August–September 2012. Sediment samples were analyzed for a suite of 94 currently-used pesticides, 21 legacy pesticides, 24 trace elements, 40 PAHs, 14 PCB Arochlors, and 145 PCB congeners. Concentrations of detected compounds are reported. Results are compared to Sediment Quality Guidelines (SQG) (Long and others, 1998), where available. Sediment toxicity and Phase I Sediment Toxicity Identification Evaluation (TIE) results are also reported. Percentages of dissolved organic carbon and total nitrogen, grain-size distributions, and values of sediment-quality characteristics are also presented.



Base from U.S. Geological Survey digital line graph files 1:24,000,
U.S. Fish and Wildlife Service, and New Jersey Department of Environmental Protection
North American Datum of 1983

Figure 1. Locations of 11 estuarine and 11 freshwater bed-sediment sampling sites in the Barnegat Bay watershed, New Jersey.

Table 1. Description of sampling sites in the Barnegat Bay watershed, New Jersey.

[USGS, U.S. Geological Survey; DD, decimal degrees; BB, Barnegat Bay; BT, Barnegat Tributary; *, New Jersey Department of Environmental Protection Water-Quality Monitoring Station]

USGS station number	Site name	Sampling date	Sampling time	Station description	Longitude (DD)	Latitude (DD)
01408123	BT01*	8/20/2012	1100	North Branch Metedeconk R near Laurelton, New Jersey	-74.1522	40.0814
01408152	BT02*	8/20/2012	1300	South Branch Metedeconk River near Laurelton (Chambers Bridge Road), New Jersey	-74.1567	40.0783
01408505	BT03*	8/21/2012	1100	Toms River at park footbridge, near Toms River, New Jersey	-74.2183	39.9764
01408640	BT04*	8/21/2012	1330	Wrangle Brook near South Toms River, New Jersey	-74.2214	39.9547
01408710	BT05*	8/22/2012	1000	Jakes Branch at South Toms River, New Jersey	-74.2117	39.9353
01409000	BT06*	8/22/2012	1215	Cedar Creek at Lanoka Harbor, New Jersey	-74.1692	39.8675
01409055	BT07*	8/23/2012	1030	North Branch Forked River at Forked River, New Jersey	-74.1964	39.8361
01409103	BT10*	9/11/2012	1120	Oyster Creek 50 feet upstream of cooling channel near Waretown, New Jersey	-74.2027	39.8110
01409281	BT12*	8/23/2012	1220	Westecunk Creek at Railroad Avenue at West Creek, New Jersey	-74.3081	39.6403
01409155	BT15	9/1/2012	1045	Mill Creek at Garden State Parkway access road near Manahawkin, New Jersey	-74.2774	39.7108
01408790	BT17	9/1/2012	1330	Chamberlin Branch at Jone Road near Whiting, New Jersey	-74.3442	39.8731
01408168	BB01*	8/30/2012	1200	Barnegat Bay at Mantoloking, New Jersey	-74.0522	40.0400
395839074055401	BB02*	8/30/2012	1040	Barnegat Bay near Lavallette, New Jersey	-74.0985	39.9776
395653074060501	BB03*	8/28/2012	1240	Barnegat Bay 700 feet north of Route 37 Bridge, New Jersey	-74.1015	39.9482
395458074063401	BB05A	8/28/2012	1200	Barnegat Bay between Ocean Gate and South Seaside Park, New Jersey	-74.1094	39.9158
395109074060701	BB06*	8/28/2012	1040	Barnegat Bay 1.2 miles south of Cedar Creek mouth, New Jersey	-74.1021	39.8526
394805074092601	BB07A	8/27/2012	1140	Barnegat Bay 0.5 mile south of Oyster Creek mouth, New Jersey	-74.1571	39.8013
394433074085201	BB09*	8/27/2012	1315	Barnegat Bay 2 miles south of Barnegat Inlet, New Jersey	-74.1479	39.7426
393939074122301	BB10*	8/29/2012	1520	Manahawkin Bay 800 feet south of Route 72 bridge, New Jersey	-74.2065	39.6610
393731074140801	BB11*	8/29/2012	1645	Little Egg Harbor 0.8 mi north of Westecunk Creek mouth, New Jersey	-74.2357	39.6254
393408074192801	BB13*	8/29/2012	1120	Little Egg Harbor near mouth of Tuckerton Creek, New Jersey	-74.3246	39.5690
392706074243201	BB15	9/1/2012	1340	Edwin B. Forsythe National Wildlife Refuge Danzenbaker Pool near Oceanville, New Jersey	-74.4088	39.4516

Methods

Sampling and analytical methods used for inorganic and organic compounds, sediment toxicity, pH, specific conductance, organic carbon, total nitrogen, and grain size are described. Sediment Quality Guidelines and Quality Assurance and Quality Control procedures are discussed.

Sampling Methods

Bed-sediment-quality samples were collected by USGS staff at 11 estuarine sites in Barnegat Bay and 11 freshwater sites on tributaries to Barnegat Bay, using standard methods outlined by the USGS and U.S. Environmental Protection Agency (EPA) (Hladik and others, 2009; Radtke, 2005; and EPA, 2001a). Sampling was conducted once during August–September 2012. The upper 2 centimeters (cm) of bed sediment at freshwater sites and the upper 10 cm of bed sediment at the bay sites were collected. Appropriate volumes of sediment were collected on the basis of analytical requirements. Samples were homogenized prior to the collection of subsamples. Subsamples were transferred into dedicated containers. Subsamples for grain-size analysis were oven dried at 100 degrees Celsius at the New Jersey Water Science Center by USGS personnel prior to shipment to the analyzing laboratory. Subsamples for chemical analyses were sieved (<2 millimeters) to remove plant debris and gravel, transferred to separate containers, preserved, and shipped to laboratories for analyses as described in the section "Analytical Methods." Unsieved samples for toxicity testing were collected in dedicated polyurethane containers and shipped to U.S. Army Corps of Engineers (USACE) for analysis.

Analytical Methods

Bed-sediment samples collected from sites in the Barnegat Bay watershed were analyzed for currently-used and legacy pesticides, trace elements, priority and alkylated PAHs, and PCBs. Sediment toxicity analysis was performed on all 22 sediment samples, and toxicity identification evaluation tests were performed on selected samples. Carbon and nitrogen content, pH and specific conductance, and grain-size percentages were measured in the sediment samples.

Organic and Inorganic Constituents

Ninety-four currently-used and legacy pesticides, as well as pesticide degradates, were analyzed for by the Pesticide Fate Research Group (PFRG) laboratory, Sacramento, California, using the methods described in Hladik and McWayne (2012; table 2). This method utilizes pressurized liquid extraction, a series of clean-up steps to remove sulfur and matrix interferences followed by gas chromatography-mass spectrometry (GC-MS) analysis operating in selective ion monitoring mode (SIM). The results are reported in micrograms per kilogram (µg/kg).

Twenty-one organochlorine pesticides were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center (USACE-ERDC), using the U.S. Environmental Protection Agency (EPA) Method 8081A, Organochlorine Pesticides with gas chromatography (EPA, 1996; table 3). This method determines pesticide concentrations in sediment samples using fused-silica, open-tubular, capillary columns with electron capture detectors (EPA, 1996). Results are reported in µg/kg.

Seven PCBs as Arochlors mixtures and 145 individual PCB congeners were analyzed by gas chromatography, using EPA Method 8082 at the USACE-ERDC laboratory (EPA, 2007b; table 4, at end of report). This method uses a single- or dual-column analysis system with electron capture detectors or electrolytic conductivity detectors (EPA, 2007b). Results are reported in µg/kg.

Forty priority and alkylated PAHs were analyzed for using EPA Methods 8270 and 8270C, Semivolatile Organic Compounds, with gas chromatography-mass spectrometry (GC-MS) at the USACE-ERDC laboratory (table 5; EPA, 2007c). Results are reported in µg/kg.

Twenty-four trace elements were analyzed for at the USACE-ERDC using EPA Method SW846/6010C with inductively coupled plasma-atomic emission spectrometry (ICP-AES) and SW846/6020A with inductively coupled plasma-mass spectrometry (ICP-MS; EPA, 2007d and e). Total mercury was analyzed using EPA 7471A with cold-vapor atomic absorption, based on the absorption of radiation at a wavelength of 253.7 nanometers (nm; EPA, 2007f) (table 6). Results are reported in milligrams per kilogram (mg/kg).

Sediment Toxicity and Toxicological Identification Evaluation

A 28-day toxicity evaluation was conducted at the USACE-ERDC for bed-sediment samples with survival and growth (weight and total biomass) as the determining endpoints. Estuarine samples were also analyzed for reproductive effects (ratio of neonates to survivors). The amphipod *Leptocheirus plumulosus* was used to evaluate the estuarine sediments using the EPA Method 600/R-01/020 (EPA, 2001b). Freshwater sediments were evaluated for the amphipod *Hyalella azteca,* using the EPA method 600/R-99/064 and ASTM 2010 standards (EPA, 2000, ASTM, 2010). Statistical analysis was used to determine significant differences between field samples and laboratory control and (or) field reference (BB15 and BT17) samples. The Kolmogorov-D test was used to determine normal versus non-normal distribution of the data, and the Bartlett's test was used to test the variance. If the variance of the data was determined to be unequal, a Wilcoxon Rank Sum test was used to determine whether significant differences occurred. If the variance of the data was determined to be equal, a Bonferroni T-test was used to determine significant differences. On the basis of the observed reproductive effects during the sediment toxicity study of the estuarine amphipods, a subset of the samples was selected for inclusion in a Phase I Toxicity Identification Evaluation (TIE) (EPA, 2007g).

Sediment TIE analysis consisted of repeating the 28-day toxicity test on splits of selected sediment samples with the addition of amendments or treatments to determine potential sources of toxicity. Five treatments were used: the addition of activated carbon (used to remove organic contaminants), SIR-300 cation exchange resin (used to remove metals), a mixture of activated carbon and SIR-300, sand (tests for dilution effects from the addition of amendments), and temperature reduction (tests for metabolic effects that may increase the toxicity of pyrethroid pesticides) (Hardwood and others, 2009; Weston and others, 2009). A performance control standard was also evaluated to ensure that the organisms used were healthy and the results were due to the applied amendments. A baseline 28-day toxicity analysis was conducted for each sample, and results from the amended samples were compared to the baseline to evaluate the effectiveness of each of the applied treatments.

Although control performance requirements were met for survival (80 percent) in the *Leptocheirus plumulosus* study, the performance requirement of reproduction in all replicates was not met. One replicate out of the five tested had no reproduction, although survival was high in this replicate (85 percent). Absence of reproduction in a single control replicate may be related to the addition of single sex amphipods (all male or all female) to the test replicate. Amphipods are added randomly to the test replicates without regard to sex, so addition of amphipods of the same sex, although rare, could occur. The high survival in this replicate coupled with the observed reproduction in the remaining four replicates indicates that the absence of reproduction is not indicative of an issue with the performance of the test system.

Sediment pH and Specific Conductance

The pH and specific conductance of the soil was measured by the Academy of Natural Sciences of Drexel University (ANSP) in Philadelphia, Pennsylvania, using Solid Waste-846 Method 9045D and EPA method 120.1, (EPA, 1982, 2004). Results for pH are reported in standard units, and results for specific conductance are reported in millisiemens per centimeter at 22.8 degrees Celsius (mS/cm).

Organic Carbon, Total Nitrogen, and Grain Size

The PFRG laboratory conducted the organic carbon and total nitrogen sediment analyses using EPA Method 440.0 (EPA, 1997). Grain size (sand/silt/clay percentages) analyses were performed by the Rutgers University Soil Testing Laboratory (RUSTL) in New Brunswick, New Jersey. Oven dried sediments were analyzed using standard soil measurement techniques and quality-control practices described in Gee and Bauder (1986). This method was modified to allow for readings at 6 hours and 52 minutes in addition to a reading at 40 seconds to quantify the percentage of clay-sized particles present. Quality assurance was maintained at the RUSTL through their participation in the North American Proficiency Testing program of the Soil Science Society of America. Duplicate testing was performed, and a relative percent difference between duplicate results of less than 20 percent was required for the data to be considered acceptable. The average result of duplicate tests was reported.

Quality Assurance/Quality Control

Stringent quality assurance/quality control (QA/QC) practices were performed at each laboratory where analyses were completed including laboratory duplicates, matrix spikes, matrix spike duplicates, laboratory control spikes, and blanks, and standard reference materials were used. Surrogate compounds were also utilized to help assess bias and variability that can occur during laboratory analyses. Resulting data were reported with the associated environmental data and reviewed by USGS personnel to ensure that the data met the QA/QC standards described in the Quality Assurance Project Plan (QAPP) developed for this project with the participation of the laboratories that conducted the analyses and the NJDEP (appendix 1). All data presented in this report met the quality assurance guidelines described in detail in the QAPP. Values that did not meet all of the quality assurance guidelines outlined in the QAPP were presented in the associated tables as “NR” (not reported).

The only currently-used pesticide detected at greater than the reporting level in laboratory blanks analyzed at the PFRG laboratory was napropamide (4.5 µg/kg). Values of napropamide that were less than 3 times the detection value in the blank were censored. Of the compounds detected above the reporting limit in duplicate estuarine samples, the relative percent differences were carbaryl, 13 percent, and prometon, 21 percent. Of the compounds detected—alachlor, bifenthrin, and metalaxyl—at greater than the reporting limit in duplicate freshwater samples, the relative percent differences were 29, 11, and 15 percent, respectively. Matrix spike recoveries for all estuarine samples ranged from 70 to 117 percent and for all freshwater samples ranged from 47 to 119 percent. Final surrogate compound (^{13}C-cis permethrin, ^{13}C-DDE, and ^{13}C-trifluralin) percent recoveries in sediment ranged from 71 to 80 percent for estuarine samples and 70 to 80 percent for freshwater samples. The mean and standard deviation for percent recoveries for the surrogate ^{13}C-cis permethrin were 79 ±4.9 percent for estuarine samples and 83 ±12.3 percent for freshwater samples. The mean and standard deviation for percent recoveries of the surrogate ^{13}C-DDE were 79 ±5.3 percent for estuarine samples and 81 ±7.2 percent for freshwater samples. The mean and standard deviation for percent recoveries of the surrogate ^{13}C-trifluralin were 88 ±17.4 percent for estuarine samples and 87 ±10.7 percent for freshwater samples.

Table 2. Method detection limits and frequencies of detection for currently-used pesticides in bed-sediment samples collected from 11 estuarine and 11 freshwater sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[Samples were analyzed at the U.S. Geological Survey, Pesticide Fate Research Group, Sacramento, California, using method described in Hladik and McWayne, 2012. µg/kg, micrograms per kilogram]

Compound	Method detection limit (µg/kg)	Frequencies of detection		
		All sites (percent)	Estuarine sites (percent)	Freshwater sites (percent)
3,4-DCA	1.3	0	0	0
3,5-DCA	1.5	5	0	9
Alachlor	0.6	27	0	55
Allethrin	1.7	0	0	0
Atrazine	1.5	0	0	0
Azinphos-methyl	1.7	0	0	0
Azoxystrobin	0.9	0	0	0
Bifenthrin	0.6	18	0	36
Boscalid	1.2	0	0	0
Butylate	1.3	0	0	0
Captan	3.1	0	0	0
Carbaryl	1.2	9	9	9
Carbofuran	1.2	0	0	0
Chlorothalonil	1.1	5	0	9
Chlorpyrifos	0.9	0	0	0
Clomazome	2.0	0	0	0
Cycloate	0.8	0	0	0
Cyfluthrin	1.3	0	0	0
Cypermethrin	1.2	0	0	0
Cyproconazole	1.0	0	0	0
Cyprodinil	1.7	18	0	36
DCPA	1.7	0	0	0
Deltamethrin	1.3	0	0	0
Desulfinylfipronil	1.8	18	0	36
Diazinon	1.6	0	0	0
Difenoconazole	1.0	0	0	0
E- Dimethomorph	1.5	0	0	0
EPTC	0.8	0	0	0
Esfenvalerate	1.0	0	0	0
Ethalfluralin	1.2	0	0	0
Etofenprox	1.0	0	0	0
Famoxadone	1.7	0	0	0
Fenarimol	1.4	0	0	0
Fenbuconazole	1.8	0	0	0
Fenhexamide	2.5	0	0	0
Fenpropathrin	1.0	0	0	0
Fipronil	1.6	0	0	0
Fipronil sulfide	1.5	5	0	9
Fipronil sulfone	1.0	0	0	0
Fluazinam	2.1	0	0	0
Fludioxinil	2.5	0	0	0
Fluoxastrobin	1.2	0	0	0
Flusilazole	2.2	0	0	0
Flutriafol	1.1	0	0	0
Hexazinone	0.9	0	0	0
Imazalil	1.8	0	0	0
Iprodione	0.9	0	0	0
Kresoxim-methyl	0.6	0	0	0
Lambda-Cyhalothrin	0.7	0	0	0
Malathion	1.0	0	0	0
Metalaxyl	1.9	32	18	45
Metconazole	1.2	0	0	0
Methidathion	1.8	0	0	0
Methoprene	1.6	0	0	0
Methyl parathion	1.1	0	0	0
Metolachlor	0.7	0	0	0
Molinate	1.0	0	0	0
Myclobutanil	1.7	0	0	0
Napropamide	0.9	0	0	0
Oxyfluorfen	1.9	5	0	9
Pebulate	0.9	0	0	0
Pendimethalin	0.8	18	0	36
Pentachloroanisole (PCA)	1.1	0	0	0
Pentachloronitrobenzene (PCNB)	1.1	0	0	0
Permethrin	0.9	0	0	0
Phenothrin	0.9	0	0	0
Phosmet	0.9	0	0	0
Piperonyl butoxide	1.2	0	0	0
Prometon	1.3	0	0	0
Prometryn	2.7	18	9	27
Propanil	2.2	0	0	0
Propiconazole	1.1	0	0	0
Propyzamide	1.5	0	0	0
Pyraclostrobin	1.1	9	18	0
Pyrimethanil	1.1	0	0	0
Remethrin	1.3	0	0	0
Simazine	1.3	0	0	0
Tau-Fluvalinate	1.2	0	0	0
Tebuconazole	1.2	0	0	0
Tefluthrin	0.7	0	0	0
Tetraconazole	1.1	0	0	0
Tetramethrin	0.9	0	0	0
Thiobencarb	0.6	0	0	0
Triadimefon	1.5	0	0	0
Triadimenol	1.5	0	0	0
Trifloxystrobin	1	0	0	0
Triflumizole	1.1	0	0	0
Trifluralin	0.9	0	0	0
Triticonazole	1.8	5	0	9
Vinclozolin	1.2	0	0	0
Zoxamide	1.1	0	0	0

Table 3. Method detection limits and frequencies of detection for legacy pesticides in bed-sediment samples collected from 11 estuarine and 11 freshwater sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, using the U.S. Environmental Protection Agency Methods 8081A. µg/kg, micrograms per kilogram; BHC, benzenehexachloride]

Compound	Sediment method detection limit range (µg/kg)	Frequencies of detection		
		All sites (percent)	Estuarine sites (percent)	Freshwater sites (percent)
4,4′-DDE	0.18–1.26	73	73	73
4,4′-DDD	0.18–1.26	91	91	91
4,4′-DDT	0.18–1.26	36	0	73
Aldrin	0.18–1.26	0	0	0
Alpha-BHC	0.18–1.26	0	0	0
Beta-BHC	0.18–1.26	0	0	0
Delta-BHC	0.18–1.26	0	0	0
Gamma-BHC (Lindane)	0.18–1.26	0	0	0
Alpha-Chlordane	0.18–1.26	18	0	36
Gamma-Chlordane	0.18–1.26	0	0	0
Dieldrin	0.18–1.26	14	0	27
Endosulfan I	0.18–1.26	0	0	0
Endosulfan II	0.18–1.26	0	0	0
Endosulfan sulfate	0.18–1.26	0	0	0
Endrin	0.18–1.26	0	0	0
Endrin aldehyde	0.18–1.26	0	0	0
Endrin ketone	0.18–1.26	0	0	0
Heptachlor	0.18–1.26	0	0	0
Heptachlor epoxide	0.18–1.26	9	0	18
Methoxychlor	0.18–1.26	0	0	0
Toxaphene	7.24–50.0	0	0	0

Table 5. Reporting limits and frequencies of detection for polycyclic aromatic hydrocarbons (PAHs) in bed-sediment samples collected from 11 estuarine and 11 freshwater sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, using the U.S. Environmental Protection Agency Methods 8270/8270C. µg/kg, micrograms per kilogram]

Analyte	Reporting limit range (µg/kg)	Frequencies of detection		
		All sites (percent)	Estuarine sites (percent)	Freshwater sites (percent)
Priority PAHs				
Acenaphthene	0.86–5.84	41	9	73
Acenaphthylene	0.86–5.84	14	0	27
Anthracene	0.86–5.84	82	73	91
Benzo(a)anthracene	0.86–5.84	95	91	100
Benzo(a)pyrene	0.86–5.84	86	91	82
Benzo(b)fluoranthene	0.86–5.84	95	91	100
Benzo(g,h,i,)perylene	0.86–5.84	86	91	82
Benzo(k)fluoranthene	0.86–5.84	91	91	91
Chrysene	0.86–5.84	95	91	100
Dibenz(a,h)anthracene	0.86–5.84	54	36	72
Fluoranthene	0.86–5.84	91	91	91
Fluorene	0.86–5.84	45	9	82
Indeno(1,2,3-cd)pyrene	0.86–5.84	91	91	91
Naphthalene	0.86–5.84	73	64	82
Phenanthrene	0.86–5.84	91	82	100
Pyrene	0.86–5.84	95	91	100
Other PAHs				
Benzo(e)pyrene	0.86–5.84	95	91	100
Biphenyl	0.86–5.84	23	9	36
cis-Decalin	0.86–5.84	0	0	0
Dibenzothiophene	0.86–5.84	32	0	64
Perylene	0.86–5.84	91	91	91
trans-Decalin	0.86–5.84	0	0	0
Alkylated PAHs				
1-Methylnaphthalene	0.86–5.84	23	9	36
1-Methylphenanthrene	0.86–5.84	32	0	64
2,3,5-Trimethylnaphthalene	0.86–5.84	14	9	18
2,6-dimethylnaphthalene	0.86–5.84	23	9	36
2-Methylnaphthalene	0.86–5.84	27	18	36
3,6-dimethylphenanthrene	0.86–5.84	23	9	36
C1-Benz(a)anthracene/Chrysene	0.86–5.84	91	91	91
C1-Fluoranthenes/Pyrenes	0.86–5.84	100	100	100
C1-Fluorenes	0.86–5.84	64	55	73
C1-Phenanthrenes/Anthracenes	0.86–5.84	91	91	91
C2-Benz(a)anthracene/Chrysene	0.86–5.84	0	0	0
C2-Fluoranthene/Pyrene	0.86–5.84	73	73	73
C2-Fluorenes	0.86–5.84	0	0	0
C2-Naphthalenes	0.86–5.84	77	64	91
C2-Phenanthrenes/Anthracenes	0.86–5.84	86	100	73
C3-Benz(a)anthracene/Chrysene	0.86–5.84	0	0	0
C3-Naphthalenes	0.86–5.84	73	64	82
C3-Phenanthrenes/Anthracenes	0.86–5.84	55	64	45

Table 6. Reporting limits and frequencies of detection for trace elements in bed-sediment samples collected from 11 estuarine and 11 freshwater sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research Development Center, Vicksburg, Mississippi, using U.S. Environmental Protection Agency Methods SW846/6010 (Target Analyte List Metal) and 7471A (Mercury in Soil Sediment. mg/kg, milligrams per kilogram, dry weight)]

Analyte	Reporting limit (mg/kg)	Frequencies of detection		
		All sites (percent)	Estuarine sites (percent)	Freshwater sites (percent)
Aluminum	4.00	91	91	91
Antimony	0.50	0	0	0
Arsenic	0.50	86	100	73
Barium	0.50	95	100	91
Beryllium	0.50	41	36	45
Cadmium	0.50	18	9	27
Calcium	4.00	95	91	100
Chromium	0.50	100	100	100
Cobalt	0.50	86	91	82
Copper	0.50	90	81	100
Iron	4.00	95	100	91
Lead	0.50	82	73	91
Magnesium	4.00	100	100	100
Manganese	0.50	95	91	100
Mercury	0.004	77	91	64
Molybdenum	0.500	55	73	36
Nickel	0.50	100	100	100
Potassium	4.00	95	91	100
Selenium	0.50	73	73	73
Silver	0.50	9	0	18
Sodium	4.00	95	91	100
Thallium	0.50	5	9	0
Vanadium	0.50	95	91	100
Zinc	0.50	100	100	100

There were no detections in laboratory blanks greater than the reporting limit for legacy pesticides analyzed for at the USACE-ERDC laboratory. Of the compounds detected at greater than the reporting limit in duplicate estuarine samples—4,4′-DDD and 4,4′-DDE—the relative percent differences were 42 and 45 percent, respectively. Of the compounds detected at greater than the reporting limit in duplicate freshwater samples (4,4′-DDD, 4,4′-DDE, and 4,4′-DDT), the relative percent differences ranged from 23 to 53 percent. Laboratory control spike percent recoveries for estuarine samples ranged from 97 to 150 percent and for freshwater samples from 62 to 112 percent. Matrix spike percent recoveries for estuarine samples ranged from 49 to 111 percent, and freshwater matrix spike percent recoveries ranged from 56 to 129 percent. For matrix spike duplicate samples, relative percent difference for estuarine samples ranged from 1.6 to 22 percent and for freshwater samples from 0.03 to 32 percent. Standard reference materials for legacy pesticide percent recoveries ranged from 25 to 92 percent. Two surrogate compounds were used as part of the laboratory QA/QC process for legacy pesticides (2,4,5,6 tetrachloro-m-xylene and decachlorobiphenyl). Percent recoveries associated with estuarine samples for the surrogate 2,4,5,6 tetrachloro-m-xylene ranged from 20 to 55 percent with a mean and standard deviation of 39 ±10 percent, and for decachlorobiphenyl from 34 to 99 percent with a mean and standard deviation of 71 ±19 percent. Percent recoveries associated with freshwater samples for the surrogate 2,4,5,6 tetrachloro-m-xylene ranged from 25 to 100 percent with a mean and standard deviation of 57 ±20 percent and for decachlorobiphenyl from 52 to 124 percent with a mean and standard deviation of 89 ±23 percent.

There were no detections in the laboratory blanks greater than the reporting limit for any PCB Arochlor mixtures or congeners analyzed for at the USACE-ERDC laboratories. There were no detections greater than the reporting limit in any of the arochlor or congener duplicate samples. Laboratory control spikes for PCB Arochlor mixtures ranged from 79 to 94 percent. Matrix spike recoveries ranged from 49 to 55 percent, and matrix spike relative percent differences ranged from 18 to 28 percent in the estuarine QA/QC sample. PCB congener laboratory control spike recoveries for estuarine (excluding BB15) samples ranged from 48 to 123 percent, and laboratory spike duplicate recoveries ranged from 42 to 120 percent; for freshwater (and BB15), samples ranged from 49 to 104 percent. Matrix spike recoveries for PCB congeners in freshwater (and BB15) samples ranged from 57 to 144 percent, and matrix spike duplicate recoveries ranged from 46 to 121 percent. The surrogate decachlorobiphenyl was used in the laboratory QA/QC process for PCB Arochlor mixtures. The percent recoveries associated with estuarine samples ranged from 46 to 110 percent and with freshwater samples ranged from 54 to 109 percent. Two surrogate compounds were used as part of the laboratory QA/QC process for PCB congeners—2,4,5,6 tetrachloro-m-xylene and decachlorobiphenyl. Percent recoveries associated with the estuarine samples for 2,4,5,6 tetrachloro-m-xylene ranged from 26 to 93 percent with a mean and standard deviation of 66 ±19 percent and for decachlorobiphenyl, 21 to 80 percent with a mean and standard deviation of 46 ±25 percent. Percent recoveries associated with freshwater samples for 2,4,5,6 tetrachloro-m-xylene ranged from 23 to 104 percent with a mean and standard deviation of 69 ±25 percent and for decachlorobiphenyl, 39 to 81 percent with a mean and standard deviation of 60 ±13 percent.

There were no detections of PAHs at greater than the reporting limit for any of the laboratory blank samples analyzed at the USACE-ERDC laboratory. For PAH compounds detected in freshwater duplicate samples, the relative percent difference ranged from 0.28 to 57 percent. Laboratory control spike recoveries for estuarine samples ranged from 49 to 88 percent. Matrix spikes recoveries ranged from

42 to 183 percent, and matrix spike duplicate relative percent differences ranged from 0.04 to 9 percent. Laboratory control spiked recoveries in freshwater samples ranged from 64 to 114 percent, matrix spike recoveries ranged from 14 to 113 percent, and matrix spike duplicate relative percent differences ranged from 0.0 to 76 percent. Two surrogate compounds were used in the laboratory QA/QC process—2-fluorobiphenyl and terphenyl-dl4. Percent recoveries for 2-fluorobiphenyl associated with estuarine samples ranged from 10 to 60 percent with a mean and standard deviation of 45 ±14 percent, and percent recoveries for terphenyl-dl4 ranged from 56 to 101 percent with a mean and standard deviation of 83 ±13 percent. Percent recoveries for 2-fluorobiphenyl associated with freshwater samples ranged from 30 to 80 percent with a mean and standard deviation of 58 ±15 percent, and percent recoveries for terphenyl-dl4 ranged from 58 to 105 percent with a mean and standard deviation of 84 ±17 percent.

Several trace element compounds (aluminum, barium, calcium, copper, lead, sodium, manganese, potassium, and zinc) were detected at greater than the reporting limit in laboratory blank samples and were censored where appropriate if the detection was greater than 3 times the reported value in the sample. For the trace elements detected at greater than the reporting limit in duplicate estuarine samples, the relative percent difference ranged from 0.07 to 17.2 percent and in freshwater samples from 0.6 to 27 percent. Laboratory control spike recoveries in estuarine samples ranged from 79 to 115 percent. Matrix spike recoveries ranged from 2 to 141 percent, and matrix spike duplicate relative percent differences ranged from 12 to 133 percent. Laboratory control spike recoveries in freshwater samples ranged from 93 to 115 percent. Matrix spike recoveries ranged from 16 to 169 percent, and the matrix spike duplicate relative percent difference (mercury only) was 194 percent. Standard Reference Materials (SRM) 2709a, 2710a, and 2711a were used in the laboratory QA/QC process (National Institute of Standards and Technology, 2009a, b, and c). For SRM 2709a, the recovery was 18 percent. For SRM 2710a, the recoveries ranged from 2 to 103 percent, and for SRM 2711a, the recoveries ranged from 2 to 91 percent.

Sediment pH and Specific Conductance

For pH, check measurements were within allowable limits of standards, ±0.1 pH standard units of 7.0. For specific conductance, check measurements were within 1 percent of the standard solutions used, determined during ambient field conditions. The specific conductance standards used for estuarine samples were 5.0, 24.8, and 100 mS/cm, and for freshwater samples, the standards used were 0.7, 5.0, and 24.8 mS/cm.

Sediment Quality Guidelines

Sediment Quality Guidelines (SQG) used in this report to determine toxicity were assembled by Long and others (1998; table 7). These guidelines are not intended as regulatory policy. The guidelines are used to interpret chemical data and potential toxicity. If a guideline is not available for a specific compound, toxicity may still be possible. Effects Range-Low (ER-L) and Effects Range-Medium (ER-M) guidelines with established concentration levels were used to aid in determining where adverse biological effects are likely. Calculations of SQGs are performed on dry weight samples and do not take into account all potential geochemical effects. Adverse effects are not likely to occur in samples where concentrations are detected at less than the ER-L. In contrast, it is likely that adverse effects will frequently occur when concentrations are detected at greater than the ER-M (Long and others, 1998). Additional information regarding the process used to establish these guidelines and their intended use and limitations are provided in Long and others (1998).

Table 7. Sediment Quality Guidelines with Effects Range-Low and Effects Range-Medium for selected polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and trace elements.

[Sediment quality guidelines are from Long and others, 1995. ER-L, Effects Range-Low; ER-M, Effects Range-Medium; µg/kg, micrograms per kilogram; mg/kg, milligrams per kilogram]

Compound	ER-L	ER-M
PAHs (µg/kg)		
2-Methylnaphthalene	70	670
Acenaphthylene	16	640
Anthracene	85.3	1,100
Benzo (a) anthracene	261	1,600
Benzo (a) pyrene	430	1,600
Chrysene	384	2,800
Dibenz (a,h) anthracene	63.4	260
Fluoranthene	600	5,100
Fluorene	19	540
Naphthalene	160	2,100
Phenanthrene	240	1,500
Pyrene	665	2,600
Total PAHs	4,022	44,792
PCBs (µg/kg)		
Total PCBs	22.7	180
Trace elements (mg/kg)		
Arsenic	8.2	70
Cadmium	1.2	9.6
Chromium	81	370
Copper	34	270
Lead	46.7	218
Mercury	0.15	0.71
Nickel	20.9	51.6
Silver	1	3.7
Zinc	150	410

Bed-Sediment-Bound Organic and Inorganic Contaminants and Toxicity

The results of chemical and toxicological analyses of bed sediment are described in this section.

Organic and Inorganic Constituents

Twenty-two bed-sediment samples were analyzed by the PFRG laboratory for 94 currently-used and legacy pesticides and their degradates (table 2). Results were obtained for 91 of the 94 pesticides. Results for the three legacy compounds analyzed by USACE—4,4′-DDE, 4,4′-DDD, and 4,4′-DDT—are not reported. Of the 91 compounds reported, 14 were detected at or greater than the reporting limit. The two most frequently detected pesticides or degradates were the fungicide metalaxyl (32 percent of samples) and the herbicide alachlor (27 percent). Concentrations of currently-used pesticides ranged from less than the detection limit in most compounds to 115 micrograms per kilogram (µg/kg) (Cyprodinil; table 8, at end of report).

Four currently-used pesticides were detected at or greater than the reporting limit in estuarine bed-sediment samples (table 2). The two most frequently detected currently-used pesticides or degradates in estuarine samples were metalaxyl and pyraclostrobin (both 18 percent). Carbaryl and prometryn were detected at or greater than the reporting limit in 9 percent of the estuarine samples. Concentrations ranged from less than the detection level to 21 µg/kg (carbaryl at BB01). Of the 11 estuarine sites sampled, the sites that had the highest number of compounds detected for currently-used pesticides or degradates were BB01 and BB05A, each with two compounds detected at or greater than the reporting limit (table 8). Eight sites had no detections above the reporting limit (table 8).

Twelve currently-used pesticide compounds were detected at or greater than the reporting limit in freshwater bed-sediment samples. The most frequently detected compounds were alachlor (55 percent), and metalaxyl (45 percent) (table 2). Bifenthrin, desulfinylfipronil, pendimethalin, and cyprodinil were detected in 36 percent of the samples. Concentrations ranged from less than the detection level to 115 µg/kg (cyprodinil at BT05). Of the 11 freshwater sites sampled, the sites with the highest number of currently-used pesticide compounds detected were BT04 (7 compounds), BT01, and BT12 (5 compounds; table 8). The reference site BT17 had no detections.

Twenty-one organochlorine pesticides were analyzed for by the USACE-ERDC laboratory in 22 (11 estuarine and 11 freshwater) bed-sediment samples (table 3). The two most frequently detected compounds were 4,4′-DDD and 4,4′-DDE (91 and 73 percent, respectively). Concentrations ranged from less than the detection level to 326 µg/kg (4,4′-DDD; table 9). In estuarine bed-sediment samples, there were no detections of any organochlorine pesticides other than 4,4′-DDD and 4,4′-DDE, with detections ranging from less than the reporting limit to 0.4 µg/kg (BB07A).

Of the 21 compounds analyzed, 6 compounds were detected at greater than the reporting level in freshwater bed-sediment samples—4,4′-DDD (91 percent), 4,4′-DDE (73 percent), alpha-chlordane (36 percent), 4,4′-DDT (33 percent), dieldrin (27 percent), and heptachlor epoxide (18 percent; table 3). Concentrations of all compounds ranged from less than the detection limit to 326 µg/kg (4,4′-DDD). Of the 11 freshwater sites, only BT17 (reference site) had no detections. The site with the highest total detections was BT05 (6 compounds; table 9). BT12 had the highest total concentration, 719 µg/kg.

Fourteen PCBs as Arochlor mixtures and 145 individual PCB congeners in twenty-two (11 estuarine and 11 freshwater) bed-sediment samples were analyzed for at the USACE-ERDC laboratory (table 4). Only one PCB Arochlor was detected at greater than the reporting level, PCB Arochlor-1254 (99.5 µg/kg) at BT03 (table 10, at end of report). Fifty-seven individual PCB congeners were detected at or greater than the reporting limit (table 4). The most frequently detected congener was 2,3′,4,4′,5-pentachlorobiphenyl (118) (41 percent, table 4). Concentrations of PCB congeners ranged from less than the detection level to 13.9 µg/kg (table 10).

Twenty-four individual PCB congeners were detected at or greater than the reporting limit in estuarine bed-sediment samples. The most frequently detected compounds were 2,4,4′-Trichlorobiphenyl (28) and 2,3′,4,4′,5-Pentachlorobiphenyl (118) (45 percent each, table 4). The site with the most compounds detected was BB15 (15 compounds) (table 10).

Fifty-one individual PCB congeners were detected at or greater than the reporting limit in freshwater bed-sediment samples. The most frequently detected compounds were 2,3,3′,4,4′-pentachlorobiphenyl (105), 2,3′,4,4′,5-pentachlorobiphenyl (118), and 2,2′,3,3′,4,5,6-heptachlorobiphenyl (173) (36 percent each). The site with the most compounds detected was BT03 (48 compounds) (table 10).

Forty PAH and alkylated PAH compounds were analyzed for at the USACE-ERDC laboratory in 22 bed-sediment samples (table 5). Of the 22 PAH compounds, 20 were detected at or greater than the reporting limit (table 11, at end of report). The most frequently detected compounds were benzo(a)anthracene, benzo(b)fluoranthene, benzo(e)pyrene, chrysene, and pyrene (95 percent), and benzo(k)fluoranthene, fluoranthene, indeno(1,2,3-cd)pyrene, perylene, and phenanthrene (91 percent; table 11). Concentrations ranged from less than the detection level to 3,870 µg/kg (fluoranthene). Nine compounds exceeded the SQG ER-L (fluorene, dibenz(a,h) anthracene, anthracene, benzo(a)pyrene, phenanthrene, benzo(a)anthracene, chrysene, pyrene, and fluoranthene). Pyrene also exceeded the ER-M. Fifteen of the 18 alkylated PAHs were detected at greater than the reporting level. Some of the most frequently detected were C1-fluoranthenes/pyrenes (100 percent), C1-phenanthrenes/anthracenes, and C1-benz(a) anthracene/chrysene (91 percent; table 11).

Table 9. Concentration of detected organochlorine pesticides in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[All concentrations are in micrograms per kilogram, dry weight. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; **bold**, indicates maximum concentration; E, estimated value; NR, not reported]

Site name	Date	4,4´-DDD	4,4´-DDE	4,4´-DDT	alpha-Chlordane	Dieldrin	Heptachlor epoxide
BT01	8/20/2012	12.1	11.7	2.59	20.5	**4.03**	nd
BT02	8/20/2012	4.34	3.32	0.63	nd	nd	nd
BT03	8/21/2012	NR	nd	nd	nd	nd	nd
BT04	8/21/2012	3.27	nd	0.44	15.7	1.6	0.74
BT05	8/22/2012	35.7	23.5	6.81	**58.6**	1.9	**0.84**
BT06	8/22/2012	34.4	14.2	4.08	6.83	nd	nd
BT07	8/23/2012	1.53	1.28	E 0.59	nd	nd	nd
BT10	9/11/2012	0.71	0.61	nd	nd	nd	nd
BT12	8/23/2012	**326**	**129**	**264**	nd	nd	nd
BT15	9/1/2012	2.45	1.23	0.83	nd	nd	nd
BT17	9/1/2012	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	E 0.09	nd	nd	nd	nd	nd
BB02	8/30/2012	E 0.19	E 0.18	nd	nd	nd	nd
BB03	8/28/2012	E 0.18	E 0.19	nd	nd	nd	nd
BB05A	8/28/2012	E 0.16	E 0.17	nd	nd	nd	nd
BB06	8/28/2012	E 0.04	nd	nd	nd	nd	nd
BB07A	8/27/2012	0.40	NR	nd	nd	nd	nd
BB09	8/27/2012	E 0.23	0.33	nd	nd	nd	nd
BB10	8/29/2012	E 0.10	E 0.16	nd	nd	nd	nd
BB11	8/29/2012	E 0.06	E 0.08	nd	nd	nd	nd
BB13	8/29/2012	E 0.20	E 0.15	nd	nd	nd	nd
BB15	9/1/2012	nd	nd	nd	nd	nd	nd

Eighteen PAH compounds were detected above the reporting limit in estuarine bed-sediment samples (table 11). Benzo(a)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(e)pyrene, indeno(1,2,3-cd)pyrene, chrysene, fluoranthene, perylene, and pyrene were detected in greater than 90 percent of the samples. Concentrations ranged from less than the detection level to 156 µg/kg (fluoranthene). All 11 estuarine sites had detections of PAH compounds. Total concentrations ranged from 4.54 µg/kg (BB06) to 638 µg/kg (BB07A). Fourteen alkylated PAHs were detected at or greater than the reporting level in estuarine samples with C1-fluoranthenes/pyrenes and C2-phenanthrenes/anthracenes detected in 100 percent of the estuarine bed-sediment samples. All estuarine sites had detections of alkylated PAHs, with total concentrations ranging from estimated 4.53 (BB06) to estimated 177 (BB07A) µg/kg. No alkylated PAH in any estuarine bed-sediment sample exceeded either of the SQGs.

Twenty of the 22 PAH compounds were detected in the 11 freshwater bed-sediment samples. Pyrene, chrysene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(a)anthracene, and phenanthrene were all detected in 100 percent of those samples (table 5). Concentrations of PAHs ranged from less than the detection level to 3,870 µg/kg (fluoranthene). All 11 freshwater samples had detections of PAH compounds with total concentrations ranging from 24.5 µg/kg (BT17) to 15,815 µg/kg (BT05; table 11). Of the 18 alkylated PAH compounds detected at greater than the reporting limit, 10 were found in at least 45 percent of bed-sediment samples; C1-fluoranthenes/pyrenes was detected in 100 percent of the sampled sediments. Concentrations ranged from less than the detection level to 744 (estimated) µg/kg (C1-fluoranthenes/pyrenes). Every freshwater bed-sediment site had at least one alkylated PAH compound detected; BT12 had the most detections (15 compounds). Five freshwater bed-sediment sites had one or more exceedance(s) of the SQG ER-L (BT01, BT02, BT04, BT05, and BT12), and one site had an exceedance of the ER-M for pyrene (BT05) (table 11). Total PAHs (not including alkylated PAH detections) at three sites (BT01, BT04, and BT05) also exceeded the SQG ER-L.

Twenty-four trace elements were analyzed in bed-sediment samples from 22 sites at the USACE-ERDC laboratory (table 6). Antimony was not detected at greater than the reporting level in any sample from any estuarine or freshwater site. Five trace elements were detected in 100 percent of all estuarine and freshwater samples (table 12, at end of report). Concentrations ranged from below the detection limit to 29,800 mg/kg (iron). Of the 9 trace elements analyzed for that have established SQG criteria, 5 had concentrations that exceeded the SQG ER-L (arsenic, cadmium, lead, mercury, and nickel) (table 7).

Concentrations of 23 of the 24 trace elements were greater than the detection limit in the 11 estuarine samples. Eight were detected in 100 percent of the samples (arsenic, barium, calcium, chromium, iron, magnesium, nickel, and zinc). Concentrations ranged from less than the detection level to 29,800 mg/kg (iron) (table 12). Total trace element concentrations ranged from 3,372 mg/kg (BB01) to 45,665 mg/kg (BB15). Three sites had exceedances of the SQG ER-L, BB03 and BB06 for mercury, and BB15 for arsenic, mercury, and nickel; BB06 had an exceedance of the ER-M for mercury.

Twenty-two of the 24 trace elements analyzed for in the freshwater bed-sediment samples were detected at greater than the reporting limit; 11 of them were detected in 100 percent of the samples (barium, calcium, chromium, copper, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc) (table 12). Concentrations ranged from less than the detection level to 10,300 mg/kg (iron). Total trace element concentrations ranged from 1,205 mg/kg (BT17) to 17,444 mg/kg (BT05). Five of the freshwater sites had exceedances of the SGQ ER-L for at least one trace element (cadmium, mercury or lead) (BT01, BT05, BT06, BT07, BT15).

Sediment Toxicity

Twenty-two bed-sediment samples (11 estuarine samples and 11 freshwater samples) were analyzed at the USACE-ERDC laboratory to determine sediment toxicity. The estuarine amphipod *Leptocheirus plumulosus* and the freshwater amphipod *Hyalella azteca* were used to determine the percent survival, difference in biomass, and individual dry weight following a 28-day exposure to sediment samples. Reproductive effects were determined for estuarine samples by calculating the *Leptocheirus plumulosus* survivor/neonate ratio to determine whether any reproductive effects could be observed. Results were compared to control samples analyzed in conjunction with the environmental samples. Endpoint and initial weight results of these analyses are reported in appendixes 2–4.

Results of the sediment toxicity analyses for the 28-day exposure tests indicate no significant differences in the means for the estuarine amphipod for survival when compared to the laboratory control or the reference site (BB15) (table 13). Significant decreases in the means were observed in biomass weight between sediment samples and the reference sample (BB15); however, no significant differences were observed when compared to the laboratory control. Analyses of individual dry weight indicated significant decreases in the means in 80 percent of samples when compared to the mean for BB15 (no significant differences were noted at BB01 and BB07A), but no differences were observed when compared to the laboratory control sample (table 13). A significant decrease in reproductive endpoints was observed at four estuarine sites—BB01, BB07A, BB09, and BB10—when compared to the reference site sample (BB15) and the laboratory control sample (table 13). On the basis of these results, these four sites were selected for further toxicity analysis by Phase I Toxicology Identification Evaluation (TIE).

The Phase I TIE results showed no statistical difference in the means between the amended sediment samples and the baseline samples for survival, reproduction, or individual dry weight for 3 of the 4 sites analyzed (BB01, BB07A, and BB09) (table 14). For BB10, there were statistically significant differences between the means of the baseline sample and the means of the sediment samples amended with SIR-300 or sediment samples amended with a mixture of activated carbon and SIR-300 for individual dry weight and survival, and the reduction of temperature for survival (table 14).

Results of the sediment toxicity analyses for the 28-day exposure tests showed no significant differences in the means for the freshwater amphipod *Hyalella azteca* for survival or biomass when compared to the control sample or reference sample (BT17) (table 15). Significant differences were seen in the individual dry weight between the reference sample (BT17) and BT07 and BT15, whereas no significant differences were noted between any sample from any site and the control sample (table 15).

Sediment pH and Specific Conductance

Estuarine and freshwater bed-sediment samples were also analyzed for pH and specific conductance (table 16). The pH in the estuarine samples ranged from 5.9 to 7.5 (standard units) and in freshwater samples from 3.4 to 4.5 (standard units). The highest measurements of pH in estuarine and freshwater bed-sediment samples were at sites BB06 and BT01, respectively. Specific conductance values in estuarine samples ranged from 8.24 to 98.0 mS/cm, and in the freshwater samples, from 0.08 to 3.11 mS/cm. The highest measurements of specific conductance in estuarine and freshwater samples were at BB15 (98.0 mS/cm) and BT02 (3.11 mS/cm), respectively.

Organic Carbon, Total Nitrogen, and Grain Size

Percent organic carbon and total nitrogen (table 16), as well as grain size, analyses (table 17) were performed on all sediment samples. The organic carbon found in estuarine samples ranged from 0.18 to 4.10 percent and from 0.14 to 55.1 percent in freshwater samples. The highest percentages of organic carbon in estuarine and freshwater samples were at BB15 and BT07, respectively. The total nitrogen found in estuarine samples ranged from 0.06 to 0.47 percent and in freshwater samples from 0.07 to 1.17 percent. The highest percentages of total nitrogen in estuarine and freshwater samples were at BB15 and BT07, respectively. Grain size analysis determined that the estuarine samples ranged from silty clay loam to sand, and freshwater samples ranged from sandy clay loam to sand (table 17).

Table 13. Statistical summary for the control and environmental bed-sediment samples collected from sites within the Barnegat Bay, New Jersey, August–September, 2012, and analyzed for the estuarine amphipod, *Leptocheirus plumulosus*, by *A*, percent survival rate, *B*, biomass, *C*, individual dry weight, and *D*, reproduction rate used in the 28-day chronic toxicology study.

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. BB, Barnegat Bay; n, sample size; --, not applicable; NS, no significant difference; *, significantly different from BB15 reference sample; #, significantly different from control sample]

Site name	Remark	Mean	Standard deviation	Standard error	Coefficient of variance (percent)	n
A. Leptocheirus plumulosus percent survival rate (percent) following 28-day exposure						
Control	--	80.0	8.66	3.54	10.8	5
BB01	NS	63.0	23.6	9.64	37.5	5
BB02	NS	87.0	8.37	3.42	9.62	5
BB03	NS	77.0	18.9	7.72	24.6	5
BB05A	NS	93.0	9.75	3.98	10.5	5
BB06	NS	76.0	23.8	9.73	31.3	5
BB07A	NS	68.0	25.9	10.6	38.1	5
BB09	NS	78.0	11.5	4.70	14.8	5
BB10	NS	66.0	26.1	10.6	39.5	5
BB11	NS	82.0	16.8	6.86	20.5	5
BB13	NS	72.0	16.0	6.55	22.3	5
BB15	--	92.0	6.71	2.74	7.29	5
B. Leptocheirus plumulosus biomass (milligrams) following 28-day exposure						
Control	--	9.11	3.67	1.50	40.2	5
BB01	*	9.32	4.86	1.98	52.1	5
BB02	*	14.5	5.74	2.34	39.6	5
BB03	*	12.2	8.81	3.60	72.4	5
BB05A	*	20.3	3.62	1.48	17.8	5
BB06	*	10.7	7.97	3.25	74.5	5
BB07A	*	18.0	8.91	3.64	49.6	5
BB09	*	10.9	3.43	1.40	31.5	5
BB10	*	8.77	5.11	2.09	58.3	5
BB11	*	11.4	1.81	0.738	15.9	5
BB13	*	10.1	1.51	0.615	14.9	5
BB15	--	35.8	4.55	1.86	12.7	5
C. Leptocheirus plumulosus individual dry weight (milligrams) following 28-day exposure						
Control	--	0.566	0.215	0.088	38.0	5
BB01	NS	0.814	0.531	0.217	65.3	5
BB02	*	0.824	0.314	0.128	38.1	5
BB03	*	0.746	0.404	0.165	54.2	5
BB05A	*	1.09	0.136	0.056	12.5	5
BB06	*	0.696	0.461	0.188	66.2	5
BB07A	NS	1.22	0.410	0.167	33.5	5
BB09	*	0.686	0.133	0.054	19.4	5
BB10	*	0.629	0.142	0.058	22.6	5
BB11	*	0.726	0.213	0.087	29.3	5
BB13	*	0.723	0.134	0.055	18.5	5
BB15	--	1.96	0.345	0.141	17.6	5
D. Leptocheirus plumulosus reproduction (neonates/survivor) following 28-day exposure						
Control	--	1.28	0.887	0.362	69.4	5
BB01	# *	0.11	0.157	0.064	148	5
BB02	NS	0.73	0.511	0.209	69.6	5
BB03	NS	0.97	1.10	0.461	116	5
BB05A	NS	0.72	0.398	0.162	55.4	5
BB06	NS	1.18	0.821	0.335	69.7	5
BB07A	# *	0.13	0.185	0.076	140	5
BB09	# *	0.20	0.198	0.081	98.5	5
BB10	# *	0.17	0.227	0.093	137	5
BB11	NS	1.29	0.883	0.360	68.6	5
BB13	NS	1.13	0.430	0.175	38.1	5
BB15	--	2.98	1.41	0.580	47.5	4

Table 14. Statistical summary for the Phase I Toxicity Identification Evaluation using the estuarine amphipod, *Leptocheirus plumulosus*, analyzed in bed-sediment samples collected from sites within the Barnegat Bay, New Jersey, August–September, 2012.

[Samples were anlayzed at the U.S. Army Corps of Engineers, Research and Development Center, Vicksburg, Mississippi, and archived in a project database. BB, Barnegat Bay; n, number of samples; AC, activated carbon; **bold**, significantly different from control sample; NA, not analyzed]

Sediment identification	28-day survival (percent)					28-day reproduction (number of neonates/survivor)					10-day individual dry weight (milligrams)				
	Mean	Standard deviation	Standard error mean	Coefficient of variance	n	Mean	Standard deviation	Standard error mean	Coefficient of variance (percent)	n	Mean	Standard deviation	Standard error mean	Coefficient of variance (percent)	n
Performance Control	80	24.5	11.0	30.6	5	1.0	1.0	0.4	101	5	0.95	0.50	0.22	52.8	5
SIR-300 Control[1]	65	30.8	13.8	47.4	5	0.4	0.6	0.3	137	5	0.88	0.18	0.08	20.5	5
AC Control	85	12.7	5.70	15.0	5	1.3	1.3	0.6	101	5	1.30	0.14	0.06	10.4	5
Sand Control	77	25.6	11.5	33.3	5	1.6	1.8	0.8	114	5	0.84	0.40	0.18	48.4	5
Temperature Control	90	10.0	4.47	11.1	5	0.0	0.0	0.0	NA	5	0.56	0.36	0.16	63.9	5
BB01 Baseline	86	9.62	4.30	11.2	5	2.0	2.6	1.1	129	5	1.35	0.38	0.17	28.3	5
BB01 Sand	85	11.2	5.00	13.2	5	0.2	0.1	0.1	63.9	5	1.10	0.19	0.09	17.5	5
BB01 SIR-300	95	6.12	2.74	6.45	5	1.4	1.2	0.5	86.4	5	1.59	0.11	0.05	6.65	5
BB01 AC	92	5.70	2.55	6.20	5	0.3	0.3	0.1	84.3	5	1.12	0.29	0.13	26.2	5
BB01 MIX	93	5.70	2.55	6.13	5	1.4	1.5	0.7	NA	5	1.38	0.35	0.16	25.5	5
BB01 Temperature	92	4.47	2.00	4.86	5	0.0	0.0	0.0	NA	5	1.04	0.23	0.10	22.0	5
BB07A Baseline	82	15.7	7.00	19.1	5	0.2	0.2	0.1	NA	5	0.87	0.21	0.09	23.7	5
BB07A Sand	79	16.4	7.31	20.7	5	0.2	0.2	0.1	NA	5	0.79	0.39	0.17	48.5	5
BB07A SIR-300	78	28.4	12.7	36.4	5	0.3	0.4	0.2	NA	5	0.80	0.30	0.14	38.0	5
BB07A AC	85	11.7	5.24	13.8	5	0.3	0.4	0.2	NA	5	0.57	0.28	0.13	49.8	5
BB07A MIX	69	31.7	14.2	45.9	5	0.3	0.6	0.3	NA	5	0.82	0.38	0.17	46.7	5
BB07A Temperature	79	13.4	6.00	17.0	5	0.0	0.0	0.0	NA	5	0.54	0.44	0.20	81.1	5
BB09 Baseline	79	25.1	11.2	31.8	5	0.6	1.0	0.4	155	5	0.83	0.33	0.15	39.0	5
BB09 Sand	76	16.4	7.31	21.5	5	0.3	0.4	0.2	129	5	0.71	0.33	0.15	46.1	5
BB09 SIR-300	84	19.2	8.57	22.8	5	1.1	1.0	0.4	85.3	5	1.14	0.06	0.03	5.02	5
BB09 AC	79	18.5	8.28	23.4	5	0.2	0.3	0.1	145	5	0.47	0.07	0.03	15.1	5
BB09 MIX	76	14.7	6.60	19.4	5	0.3	0.4	0.2	NA	5	0.80	0.16	0.07	20.4	5
BB09 Temperature	85	10.0	4.47	11.8	5	0.0	0.0	0.0	NA	5	0.44	0.29	0.13	67.1	5
BB10 Baseline	63	10.4	4.64	16.5	5	0.2	0.4	0.2	184	5	0.57	0.18	0.08	31.9	5
BB10 Sand	53	11.5	5.15	21.7	5	0.2	0.3	0.1	NA	5	0.42	0.24	0.11	56.2	5
BB10 SIR-300	**87**	7.58	3.39	8.72	5	0.8	0.8	0.3	NA	5	**1.24**	0.20	0.09	16.0	5
BB10 AC	75	13.7	6.12	18.3	5	0.1	0.1	0.1	NA	5	0.44	0.13	0.06	30.1	5
BB10 MIX	**96**	2.24	1.00	2.33	5	0.6	0.5	0.2	NA	5	**1.15**	0.30	0.13	26.3	5
BB10 Temperature	**85**	7.91	3.54	9.30	5	0.0	0.0	0.0	NA	5	0.50	0.17	0.07	32.9	5

[1]Cation exchange resin (Resin Tech, Inc.).

Table 15. Statistical summary for the control and environmental bed-sediment samples collected from selected tributaries to the Barnegat Bay, New Jersey, August–September, 2012, and analyzed for the freshwater amphipod, *Hyalella azteca*, by *A*, percent survival rate, *B*, biomass, and *C*, individual dry weight used in the 28-day chronic toxicology study.

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. BT, Barnegat tributary; n, sample size; --, no data; NS, no significant difference; *, significantly different from BT17 reference sediment]

Station name	Remark	Mean	Standard deviation	Standard error	Coefficient of variance (percent)	n
A. Hyalella azteca percent survival (percent) following 28-day exposure						
Control	--	81.3	26.4	10.8	32.5	8
BT01	NS	87.5	14.9	6.07	17.0	8
BT02	NS	88.8	14.6	5.95	16.4	8
BT03	NS	86.3	7.44	3.04	8.63	8
BT04	NS	97.5	4.63	1.89	4.75	8
BT05	NS	90.0	9.26	3.78	10.3	8
BT06	NS	73.8	23.3	9.50	31.5	8
BT07	NS	91.3	9.91	4.05	10.9	8
BT10	NS	92.5	8.86	3.62	9.58	8
BT12	NS	93.8	10.6	4.33	11.3	8
BT15	NS	91.3	13.6	5.54	14.9	8
BT17	--	71.3	37.2	15.2	52.2	8
B. Hyalella azteca biomass (milligrams) following 28-day exposure						
Control	--	1.30	0.265	0.11	20.4	8
BT01	NS	2.80	0.625	0.26	22.4	8
BT02	NS	3.42	0.598	0.24	17.5	8
BT03	NS	3.91	0.530	0.22	13.5	8
BT04	NS	3.92	0.770	0.31	19.7	8
BT05	NS	3.09	0.767	0.31	24.8	8
BT06	NS	3.14	1.06	0.43	33.7	8
BT07	NS	1.39	0.212	0.09	15.2	8
BT10	NS	3.01	0.562	0.23	18.7	8
BT12	NS	2.90	1.02	0.41	34.9	8
BT15	NS	1.75	0.354	0.14	20.2	8
BT17	--	1.92	1.04	0.43	54.5	8
C. Hyalella azteca individual dry weight (milligrams) following 28-day exposure						
Control	--	0.175	0.058	0.024	33.2	8
BT01	NS	0.320	0.051	0.021	16.0	8
BT02	NS	0.401	0.133	0.054	33.1	8
BT03	NS	0.458	0.083	0.034	18.2	8
BT04	NS	0.402	0.082	0.034	20.5	8
BT05	NS	0.342	0.072	0.030	21.2	8
BT06	NS	0.430	0.059	0.024	13.7	8
BT07	*	0.152	0.012	0.005	8.02	8
BT10	NS	0.324	0.044	0.018	13.7	8
BT12	NS	0.308	0.092	0.038	29.9	8
BT15	*	0.195	0.042	0.017	21.4	8
BT17	--	0.269	0.039	0.016	14.6	7

Table 16. Specific conductance, pH, organic carbon, total nitrogen, and percent solids in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[Specific Conductance and pH were measured at the Academy of Natural Sciences of Drexel University, Philadelphia, Pennsylvania. Organic carbon and total nitrogen were analyzed by the U.S. Geological Survey, Pesticide Fate Research Group, Sacramento, California, and percent solids were measured at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi. All data archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; mS/cm, milliseimens per centimeter at 22.8 degrees Celsius]

Site name	Date	pH (standard units)	Specific conductivity (mS/cm)	Organic carbon (percent, dry weight)	Total nitrogen (percent, dry weight)
BT01	8/20/2012	4.5	2.03	9.61	0.54
BT02	8/20/2012	4.5	3.11	3.08	0.21
BT03	8/21/2012	4.3	0.44	1.44	0.09
BT04	8/21/2012	4.0	0.68	1.52	0.12
BT05	8/22/2012	3.9	1.80	15.5	0.70
BT06	8/22/2012	3.9	1.64	11.6	0.53
BT07	8/23/2012	3.4	0.99	55.1	1.17
BT10	9/11/2012	3.4	1.57	1.86	0.13
BT12	8/23/2012	4.1	1.22	4.48	0.30
BT15	9/1/2012	4.4	1.99	12.6	0.37
BT17	9/1/2012	4.1	0.08	0.14	0.07
BB01	8/30/2012	7.5	8.24	0.18	0.07
BB02	8/30/2012	6.4	16.4	0.85	0.13
BB03	8/28/2012	6.0	25.1	1.26	0.17
BB05A	8/28/2012	7.2	9.40	0.89	0.14
BB06	8/28/2012	7.5	14.2	0.21	0.06
BB07A	8/27/2012	7.1	28.9	0.66	0.09
BB09	8/27/2012	6.8	40.6	1.83	0.17
BB10	8/29/2012	7.1	23.8	1.05	0.14
BB11	8/29/2012	6.9	20.9	0.56	0.10
BB13	8/29/2012	7.2	29.9	1.14	0.13
BB15	9/1/2012	5.3	98.0	4.10	0.47

Table 17. Sediment grain size, sand/silt/clay break, results for estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[Samples were analyzed at the Rutgers Soil Testing Laboratory, New Brunswick, New Jersey, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay]

Site name	Sand (percent)	Silt (percent)	Clay (percent)	Texture
BT01	69.4	28.5	2.10	Sandy loam
BT02	74.7	20.8	4.50	Loamy sand
BT03	96.5	1.60	1.90	Sand
BT04	92.6	4.00	3.40	Sand
BT05	74.5	14.8	10.7	Sandy loam
BT06	69.4	30.6	0.00	Sandy loam
BT07	65.7	14.3	20.0	Sandy clay loam
BT10	90.2	5.40	4.40	Sand
BT12	88.1	5.80	6.10	Sand
BT15	78.0	14.4	7.70	Loamy sand
BT17	98.2	1.30	0.500	Sand
BB01	94.9	0.300	4.80	Sand
BB02	82.4	8.00	9.60	Loamy sand
BB03	62.8	25.4	11.8	Sandy loam
BB05A	89.8	3.40	6.80	Sand
BB06	93.6	1.60	4.80	Sand
BB07A	62.8	22.4	14.8	Sandy loam
BB09	48.8	30.4	20.8	Loam
BB10	69.8	15.4	14.8	Sandy loam
BB11	75.8	13.4	10.7	Sandy loam
BB13	38.2	40.4	21.4	Loam
BB15	18.9	47.7	33.5	Silty clay loam

Summary

During August–September 2012, the U. S. Geological Survey, in cooperation with the New Jersey Department of Environmental Protection, conducted a study to collect and analyze samples of bed sediment from 11 freshwater and 11 estuarine sites in the Barnegat Bay watershed, New Jersey. A suite of organic and inorganic contaminants were selected for chemical analyses on the basis of their potential to affect sediment quality and the results of previous studies. Compounds selected for inclusion in this study were currently-used and legacy pesticides, trace elements, polychlorinated biphenyls (Arochlor mixtures and individual congeners), polycyclic aromatic hydrocarbons, and selected alkylated polycyclic aromatic hydrocarbons. Sediment toxicity was evaluated in sediment samples from sites within Barnegat Bay and selected major tributaries using standard organisms appropriate for estuarine (*Leptocheirus plumulosus)* and freshwater (*Hyalella azteca)* toxicity testing. Survival and growth endpoints were evaluated for all sampled sites, and reproductive effects were evaluated for estuarine sites. Four estuarine sites were subjected to additional toxicity testing (Phase I Toxicology Identification Evaluation) in an attempt to determine the source(s) of observed reproductive effects. Sediment carbon and nitrogen, pH, specific conductance, and grain size were measured in the 22 samples collected from the bay and selected tributaries.

A total of 20 different pesticides were detected in estuarine and freshwater samples collected from the Barnegat Bay watershed, August–September 2012, 14 of which were currently-used pesticides with concentrations ranging from 0.3 µg/kg (estimated) (desulfinylfipronil) to 115 µg/kg (cyprodinil), and six legacy pesticides with concentrations ranging from 0.08 µg/kg (estimated) (4,4′-DDE) to 326 µg/kg (4,4′-DDD). One PCB Arochlor mixture, Arochlor-1254 (99.5 µg/kg), and 57 PCB congeners, were detected above the reporting limit with concentrations ranging from 0.08 µg/kg (2,3′,4,4′,5-Pentachlorobiphenyl) to 13.9 µg/kg (2,3,3′,4′,6-Pentachlorobiphenyl). Thirty-five PAH compounds were detected above the reporting limit, with concentrations ranging from estimated 1.44 µg/kg (several compounds) to 3,870 µg/kg (fluoranthene). Twenty-three of the 24 trace elements that were analyzed for, were detected above the reporting limit, antimony being the only one not detected.

Results of the sediment toxicity analyses for the 28-day exposure tests showed significant decreases in the means of biomass weight between sediment samples and the reference sample (BB15) but not with the laboratory control sample. Analyses of individual dry weight indicated significant decreases in the means in 80 percent of samples when compared to the mean for BB15, but no differences were observed when compared to the laboratory control sample. A significant decrease in reproductive endpoints was observed at four estuarine sites—BB01, BB07A, BB09, and BB10—when compared to the reference site sample (BB15) and the laboratory control sample.

The Phase I TIE results showed no statistical difference in the means between the amended sediment samples and the baseline samples for survival, reproduction, or individual dry weight for 3 of the 4 sites analyzed (BB01, BB07A, and BB09). For BB10, there were statistically significant differences between the means of the baseline sample and the means of the sediment samples amended with SIR-300 or sediment samples amended with a mixture of activated carbon and SIR-300 for individual dry weight and survival, and the reduction of temperature for survival.

Results of pH, specific conductance, percent of organic carbon, percent of total nitrogen, and grain size classification were also reported. Measurements of pH (standard units) ranged from 3.37 (BT10) to 7.49 (BB06). Measurements of specific conductance ranged from 0.078 (BT17) to 98.0 (BB15) millisiemens per centimeter at 22.8 degrees Celsius. Measurements of organic carbon ranged from 0.14 (BT17) to 55.1 (BT07) percent (dry weight), and total nitrogen ranged from 0.06 (BB06) to 1.17 (BT07) percent (dry weight). Grain size classification results ranged from silty clay loam to sand.

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Table 4. Detection levels and frequencies of detection for polychlorinated biphenyl arochlors and congeners in bed-sediment samples collected from 11 estaurine and 11 freshwater sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, using the U.S. Environmental Protection Agency Method 8082. µg/kg, micrograms per kilogram; --, no data]

Compound	Sediment detection levels (µg/kg)	Congener sequence number	Frequencies of Detection		
			All sites (percent)	Estuarine sites (percent)	Freshwater sites (percent)
Arochlor-1016	2.23–16.4	--	0	0	0
Arochlor-1221	2.33–16.2	--	0	0	0
Arochlor-1232	2.33–16.2	--	0	0	0
Arochlor-1242	2.33–16.2	--	0	0	0
Arochlor-1248	2.33–16.2	--	0	0	0
Arochlor-1254	2.33–16.2	--	5	0	9
Arochlor-1260	2.31–16.6	--	0	0	0
2-Chlorobiphenyl	0.05–0.37	1	0	0	0
4-Chlorobiphenyl	0.05–0.37	3	0	0	0
2,2′-Dichlorobiphenyl	0.05–0.37	4	0	0	0
2,3-Dichlorobiphenyl	0.05–0.37	5	0	0	0
2,3′-Dichlorobiphenyl	0.05–0.37	6	0	0	0
2,4-Dichlorobiphenyl	0.05–0.37	7	0	0	0
2,4′-Dichlorobiphenyl	0.05–0.37	8	0	0	0
2,5-Dichlorobiphenyl	0.05–0.37	9	0	0	0
2,6-Dichlorobiphenyl	0.05–0.37	10	0	0	0
3,4-Dichlorobiphenyl	0.05–0.37	12	0	0	0
3,4′-Dichlorobiphenyl	0.05–0.37	13	0	0	0
3,5-Dichlorobiphenyl	0.05–0.37	14	9	18	0
4,4′-Dichlorobiphenyl	0.05–0.37	15	0	0	0
2,2′,3-Trichlorobiphenyl	0.05–0.37	16	0	0	0
2,2′,4-Trichlorobiphenyl	0.05–0.37	17	0	0	0
2,2′,5-Trichlorobiphenyl	0.05–0.37	18	5	0	9
2,2′,6-Trichlorobiphenyl	0.05–0.37	19	0	0	0
2,3,3′-Trichlorobiphenyl	0.05–0.37	20	9	18	0
2,3,4′-Trichlorobiphenyl	0.05–0.37	22	5	9	0
2,3,6-Trichlorobiphenyl	0.05–0.37	24	0	0	0
2,3′,4-Trichlorobiphenyl	0.05–0.37	25	0	0	0
2,3′,5-Trichlorobiphenyl	0.05–0.37	26	0	0	0
2,3′,6-Trichlorobiphenyl	0.05–0.37	27	0	0	0
2,4,4′-Trichlorobiphenyl	0.05–0.37	28	23	45	0
2,4,5-Trichlorobiphenyl	0.05–0.37	29	0	0	0
2,4′,5-Trichlorobiphenyl	0.05–0.37	31	0	0	0
2,4′,6-Trichlorobiphenyl	0.05–0.37	32	0	0	0
2,3′,4′-Trichlorobiphenyl	0.05–0.37	33	0	0	0
2,3′,5′-Trichlorobiphenyl	0.05–0.37	34	0	0	0
3,3′,4-Trichlorobiphenyl	0.05–0.37	35	0	0	0
3,4,4′-Trichlorobiphenyl	0.05–0.37	37	0	0	0

Table 4. Detection levels and frequencies of detection for polychlorinated biphenyl arochlors and congeners in bed-sediment samples collected from 11 estaurine and 11 freshwater sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, using the U.S. Environmental Protection Agency Method 8082. µg/kg, micrograms per kilogram; --, no data]

Compound	Sediment detection levels (µg/kg)	Congener sequence number	Frequencies of Detection		
			All sites (percent)	Estuarine sites (percent)	Freshwater sites (percent)
2,2′,3,3′-Tetrachlorobiphenyl	0.05–0.37	40	0	0	0
2,2′,3,4-Tetrachlorobiphenyl	0.05–0.37	41	0	0	0
2,2′,3,4′-Tetrachlorobiphenyl	0.05–0.37	42	0	0	0
2,2′,3,5′-Tetrachlorobiphenyl	0.05–0.37	44	5	0	9
2,2′,3,6-Tetrachlorobiphenyl	0.05–0.37	45	0	0	0
2,2′,3,6′-Tetrachlorobiphenyl	0.05–0.37	46	0	0	0
2,2′,4,4′-Tetrachlorobiphenyl	0.05–0.37	47	0	0	0
2,2′,4,5-Tetrachlorobiphenyl	0.05–0.37	48	0	0	0
2,2′,4,5′-Tetrachlorobiphenyl	0.05–0.37	49	0	0	0
2,2′,4,6′-Tetrachlorobiphenyl	0.05–0.37	51	0	0	0
2,2′,5,5′-Tetrachlorobiphenyl	0.05–0.37	52	5	0	9
2,2′,5,6′-Tetrachlorobiphenyl	0.05–0.37	53	0	0	0
2,2′,6,6′-Tetrachlorobiphenyl	0.05–0.37	54	0	0	0
2,3,3′,4′-Tetrachlorobiphenyl	0.05–0.37	56	32	36	27
2,3,3′,6-Tetrachlorobiphenyl	0.05–0.37	59	0	0	0
2,3,4,4′-Tetrachlorobiphenyl	0.05–0.37	60	18	9	27
2,3,4′,5-Tetrachlorobiphenyl	0.05–0.37	63	0	0	0
2,3,4′,6-Tetrachlorobiphenyl	0.05–0.37	64	0	0	0
2,3′,4,4′-Tetrachlorobiphenyl	0.05–0.37	66	18	27	9
2,3′,4,5-Tetrachlorobiphenyl	0.05–0.37	67	0	0	0
2,3′,4,6-Tetrachlorobiphenyl	0.05–0.37	69	0	0	0
2,3′,4′,5-Tetrachlorobiphenyl	0.05–0.37	70	23	27	18
2,3′,4′,6-Tetrachlorobiphenyl	0.05–0.37	71	0	0	0
2,3′,5′,6-Tetrachlorobiphenyl	0.05–0.37	73	0	0	0
2,4,4′,5-Tetrachlorobiphenyl	0.05–0.37	74	0	0	0
2,4,4′,6-Tetrachlorobiphenyl	0.05–0.37	75	0	0	0
3,3′,4,4′-Tetrachlorobiphenyl	0.05–0.37	77	0	0	0
3,4,4′,5-Tetrachlorobiphenyl/2,2′,3,4,5′-Pentachlorobiphenyl	0.05–0.37	81/87	18	27	9
2,2′,3,3′,4-Pentachlorobiphenyl	0.05–0.37	82	5	0	9
2,2′,3,3′,5-Pentachlorobiphenyl	0.05–0.37	83	5	0	9
2,2′,3,3′,6-Pentachlorobiphenyl	0.05–0.37	84	5	0	9
2,2′,3,4,4′-Pentachlorobiphenyl	0.05–0.37	85	5	0	9
2,2′,3,4,5′-Pentachlorobiphenyl	0.05–0.37	87	0	0	0
2,2′,3,4′,5-Pentachlorobiphenyl	0.05–0.37	90	0	0	0
2,2′,3,4′,5-Pentachlorobiphenyl/2,2′,4,5,5′-Pentachlorobiphenyl	0.05–0.37	90/101	0	0	0
2,2′,3,4′,6-Pentachlorobiphenyl	0.05–0.37	91	9	9	9
2,2′,3,5,5′-Pentachlorobiphenyl	0.05–0.37	92	5	0	9
2,2′,3,5,6-Pentachlorobiphenyl	0.05–0.37	93	5	0	9

Table 4. Detection levels and frequencies of detection for polychlorinated biphenyl arochlors and congeners in bed-sediment samples collected from 11 estaurine and 11 freshwater sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, using the U.S. Environmental Protection Agency Method 8082. µg/kg, micrograms per kilogram; --, no data]

Compound	Sediment detection levels (µg/kg)	Congener sequence number	Frequencies of Detection		
			All sites (percent)	Estuarine sites (percent)	Freshwater sites (percent)
2,2′,3,5′,6-Pentachlorobiphenyl	0.05–0.37	95	14	18	9
2,2′,3,4′,5′-Pentachlorobiphenyl	0.05–0.37	97	5	0	9
2,2′,4,4′,5-Pentachlorobiphenyl	0.05–0.37	99	14	18	9
2,2′,4,4′,6-Pentachlorobiphenyl	0.05–0.37	100	5	0	9
2,2′,4,5,5′-Pentachlorobiphenyl	0.05–0.37	101	0	0	0
2,2′,4,5′,6-Pentachlorobiphenyl	0.05–0.37	103	0	0	0
2,2′,4,6,6′-Pentachlorobiphenyl	0.05–0.37	104	0	0	0
2,3,3′,4,4′-Pentachlorobiphenyl	0.05–0.37	105	27	18	36
2,3,3′,4′,5-Pentachlorobiphenyl	0.05–0.37	107	19	27	9
2,3,3′,4′,6-Pentachlorobiphenyl	0.05–0.37	110	18	27	9
2,3,4,4′,5-Pentachlorobiphenyl	0.05–0.37	114	5	0	9
2,3,4,4′,6-Pentachlorobiphenyl	0.05–0.37	115	5	0	9
2,3,4′,5,6-Pentachlorobiphenyl	0.05–0.37	117	0	0	0
2,3′,4,4′,5-Pentachlorobiphenyl	0.05–0.37	118	41	45	36
2,3′,4,4′,6-Pentachlorobiphenyl	0.05–0.37	119	0	0	0
2,3,3′,4′,5′-Pentachlorobiphenyl	0.05–0.37	122	0	0	0
2,3′,4,4′,5′-Pentachlorobiphenyl	0.05–0.37	123	5	0	9
2,3′,4′,5,5′-Pentachlorobiphenyl	0.05–0.37	124	5	0	9
2,2′,3,3′,4,4′-Hexachlorobiphenyl	0.05–0.37	128	9	9	9
2,2′,3,3′,4,5-Hexachlorobiphenyl	0.05–0.37	129	5	0	9
2,2′,3,3′,4,5′-Hexachlorobiphenyl	0.05–0.37	130	9	9	9
2,2′,3,3′,4,6-Hexachlorobiphenyl	0.05–0.37	131	5	0	9
2,2′,3,3′,4,6′-Hexachlorobiphenyl	0.05–0.37	132	0	0	0
2,2′,3,3′,5,6-Hexachlorobiphenyl	0.05–0.37	134	0	0	0
2,2′,3,3′,5,6′-Hexachlorobiphenyl	0.05–0.37	135	5	0	9
2,2′,3,3′,6,6′-Hexachlorobiphenyl	0.05–0.37	136	5	0	9
2,2′,3,4,4′,5-Hexachlorobiphenyl	0.05–0.37	137	5	0	9
2,2′,3,4,4′,5′-Hexachlorobiphenyl	0.05–0.37	138	14	18	9
2,2′,3,4,5,5′-Hexachlorobiphenyl	0.05–0.37	141	0	0	0
2,2′,3,4,5′,6-Hexachlorobiphenyl	0.05–0.37	144	5	0	9
2,2′,3,4′,5,5′-Hexachlorobiphenyl	0.05–0.37	146	9	9	9
2,2′,3,4′,5,6-Hexachlorobiphenyl	0.05–0.37	147	5	0	9
2,2′,3,4′,5′,6-Hexachlorobiphenyl	0.05–0.37	149	18	27	9
2,2′,3,5,5′,6-Hexachlorobiphenyl	0.05–0.37	151	5	0	9
2,2′,4,4′,5,5′-Hexachlorobiphenyl	0.05–0.37	153	5	9	0
2,2′,4,4′,5,6′-Hexachlorobiphenyl	0.05–0.37	154	0	0	0
2,3,3′,4,4′,5-Hexachlorobiphenyl	0.05–0.37	156	9	0	18
2,3,3′,4,4′,5′-Hexachlorobiphenyl	0.05–0.37	157	5	0	9

Table 4. Detection levels and frequencies of detection for polychlorinated biphenyl arochlors and congeners in bed-sediment samples collected from 11 estaurine and 11 freshwater sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, using the U.S. Environmental Protection Agency Method 8082. µg/kg, micrograms per kilogram; --, no data]

Compound	Sediment detection levels (µg/kg)	Congener sequence number	Frequencies of Detection		
			All sites (percent)	Estuarine sites (percent)	Freshwater sites (percent)
2,3,3′,4,4′,6-Hexachlorobiphenyl	0.05–0.37	158	5	0	9
2,3,3′,4′,5,6-Hexachlorobiphenyl	0.05–0.37	163	9	18	0
2,3,3′,4′,5,6-Hexachlorobiphenyl/2,3,3′,4′,5′,6-Hexachlorobiphenyl	0.05–0.37	163/164	5	0	9
2,3,3′,4′,5′,6-Hexachlorobiphenyl	0.05–0.37	164	0	0	0
2,3,3′,5,5′,6-Hexachlorobiphenyl	0.05–0.37	165	0	0	0
2,3′,4,4′,5,5′-Hexachlorobiphenyl	0.05–0.37	167	5	0	9
2,2′,3,3′,4,4′,5-Heptachlorobiphenyl	0.05–0.37	170	5	0	9
2,2′,3,3′,4,4′,6-Heptachlorobiphenyl	0.05–0.37	171	0	0	0
2,2′,3,3′,4,5,5′-Heptachlorobiphenyl	0.05–0.37	172	5	0	9
2,2′,3,3′,4,5,6-Heptachlorobiphenyl	0.05–0.37	173	18	0	36
2,2′,3,3′,4,5,6′-Heptachlorobiphenyl	0.05–0.37	174	0	0	0
2,2′,3,3′,4,5′,6-Heptachlorobiphenyl	0.05–0.37	175	0	0	0
2,2′,3,3′,4,6,6′-Heptachlorobiphenyl	0.05–0.37	176	0	0	0
2,2′,3,3′,4,5′,6′-Heptachlorobiphenyl	0.05–0.37	177	0	0	0
2,2′,3,3′,5,5′,6-Heptachlorobiphenyl	0.05–0.37	178	0	0	0
2,2′,3,3′,5,6,6′-Heptachlorobiphenyl	0.05–0.37	179	0	0	0
2,2′,3,4,4′,5,5′-Heptachlorobiphenyl	0.05–0.37	180	0	0	0
2,2′,3,4,4′,5,5′-Heptachlorobiphenyl/2,3,3′,4′,5,5′,6-Heptachlorobiphenyl	0.05–0.37	180/193	5	0	9
2,2′,3,4,4′,5′,6-Heptachlorobiphenyl	0.05–0.37	183	0	0	0
2,2′,3,4,5,5′,6-Heptachlorobiphenyl	0.05–0.37	185	5	0	9
2,2′,3,4′,5,5′,6-Heptachlorobiphenyl	0.05–0.37	187	9	9	9
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl	0.05–0.37	189	0	0	0
2,3,3′,4,4′,5,6-Heptachlorobiphenyl	0.05–0.37	190	0	0	0
2,3,3′,4,4′,5′,6-Heptachlorobiphenyl	0.05–0.37	191	0	0	0
2,3,3′,4′,5,5′,6-Heptachlorobiphenyl	0.05–0.37	193	0	0	0
2,2′,3,3′,4,4′,5,5′-Octachlorobiphenyl	0.05–0.37	194	0	0	0
2,2′,3,3′,4,4′,5,6-Octachlorobiphenyl	0.05–0.37	195	0	0	0
2,2′,3,3′,4,4′,5,6′-Octachlorobiphenyl	0.05–0.37	196	0	0	0
2,2′,3,3′,4,4′,6,6′-Octachlorobiphenyl	0.05–0.37	197	0	0	0
2,2′,3,3′,4,5,5′,6′-Octachlorobiphenyl	0.05–0.37	199	0	0	0
2,2′,3,3′,4,5,6,6′-Octachlorobiphenyl	0.05–0.37	200	0	0	0
2,2′,3,3′,4,5′,6,6′-Octachlorobiphenyl	0.05–0.37	201	0	0	0
2,2′,3,3′,5,5′,6,6′-Octachlorobiphenyl	0.05–0.37	202	0	0	0
2,2′,3,4,4′,5,5′,6-Octachlorobiphenyl	0.05–0.37	203	0	0	0
2,3,3′,4,4′,5,5′,6-Octachlorobiphenyl	0.05–0.37	205	0	0	0
2,2′,3,3′,4,4′,5,5′,6-Nonachlorobiphenyl	0.05–0.37	206	0	0	0
2,2′,3,3′,4,4′,5,6,6′-Nonachlorobiphenyl	0.05–0.37	207	0	0	0
2,2′,3,3′,4,5,5′,6,6′-Nonachlorobiphenyl	0.05–0.37	208	0	0	0

Table 8. Concentrations of detected currently-used pesticides in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[All concentrations are in micrograms per kilogram, dry weight. Samples were analyzed at the U.S. Geological Survey Pesticide Fate Research Group, Sacramento, California, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; **bold,** indicates maximum concentration; E, estimated value below the detection limit]

Site name	Sampling date	3,5-Dichloroaniline	Alachlor	Bifenthrin	Carbaryl	Chlorothalonil	Cyprodinil	Desulfinylfipronil
BT01	8/20/2012	nd	nd	**9.8**	nd	nd	nd	E 0.9
BT02	8/20/2012	nd	nd	nd	nd	nd	nd	nd
BT03	8/21/2012	nd	nd	1.9	nd	nd	E 1.5	E 0.3
BT04	8/21/2012	nd	3.5	7.6	nd	nd	2.9	nd
BT05	8/22/2012	nd	nd	nd	nd	nd	**115**	E 1.0
BT06	8/22/2012	nd	7.2	nd	nd	**1.2**	4.2	nd
BT07	8/23/2012	nd	8.8	nd	nd	nd	nd	nd
BT10	9/11/2012	nd	3.1	5.2	nd	nd	nd	nd
BT12	8/23/2012	**39.4**	5.5	nd	3.3	nd	nd	nd
BT15	9/1/2012	nd	**31.7**	nd	nd	nd	nd	**2.7**
BT17	9/1/2012	nd	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	nd	nd	nd	**21.0**	nd	nd	nd
BB02	8/30/2012	nd	nd	nd	nd	nd	nd	nd
BB03	8/28/2012	nd	nd	nd	nd	nd	nd	nd
BB05A	8/28/2012	nd	nd	nd	nd	nd	nd	nd
BB06	8/28/2012	nd	nd	nd	nd	nd	nd	nd
BB07A	8/27/2012	nd	nd	nd	nd	nd	nd	nd
BB09	8/27/2012	nd	nd	nd	nd	nd	nd	nd
BB10	8/29/2012	nd	nd	nd	nd	nd	nd	nd
BB11	8/29/2012	nd	nd	nd	nd	nd	nd	nd
BB13	8/29/2012	nd	nd	nd	nd	nd	nd	nd
BB15	9/1/2012	nd	nd	nd	nd	nd	nd	nd

Table 8. Concentrations of detected currently-used pesticides in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram, dry weight. Samples were analyzed at the U.S. Geological Survey Pesticide Fate Research Group, Sacramento, California, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; **bold,** indicates maximum concentration; E, estimated value below the detection limit]

Site name	Sampling date	Fipronil sulfide	Metalaxyl	Oxyfluorfen	Pendimethalin	Prometryn	Pyraclostrobin	Triticonazole
BT01	8/20/2012	**2.2**	10.2	nd	**22.6**	nd	nd	nd
BT02	8/20/2012	nd	nd	nd	nd	2.90	nd	**23.1**
BT03	8/21/2012	nd	nd	nd	3.2	nd	nd	nd
BT04	8/21/2012	nd	4.6	**22.9**	17.0	2.7	nd	nd
BT05	8/22/2012	nd	**28.6**	nd	nd	nd	nd	nd
BT06	8/22/2012	nd	nd	nd	14.3	nd	nd	nd
BT07	8/23/2012	nd	nd	nd	nd	nd	nd	nd
BT10	9/11/2012	nd	6.7	nd	nd	nd	nd	nd
BT12	8/23/2012	nd	15.3	nd	nd	**6.8**	nd	nd
BT15	9/1/2012	nd	nd	nd	nd	nd	nd	nd
BT17	9/1/2012	nd	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	nd	nd	nd	nd	E 1.1	nd	nd
BB02	8/30/2012	nd	nd	nd	nd	nd	nd	nd
BB03	8/28/2012	nd	nd	nd	nd	nd	nd	nd
BB05A	8/28/2012	nd	E 1.5	nd	nd	nd	7.20	nd
BB06	8/28/2012	nd	nd	nd	nd	nd	nd	nd
BB07A	8/27/2012	nd	nd	nd	nd	nd	nd	nd
BB09	8/27/2012	nd	nd	nd	nd	nd	nd	nd
BB10	8/29/2012	nd	nd	nd	nd	nd	nd	nd
BB11	8/29/2012	nd	2.7	nd	nd	nd	nd	nd
BB13	8/29/2012	nd	nd	nd	nd	nd	nd	nd
BB15	9/1/2012	nd	nd	nd	nd	nd	**8.0**	nd

Table 10. Concentrations of detected polychlorinated biphenyl arochlors and congeners in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[All concentrations are in micrograms per kilogram. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. (), congener sequence number; BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, not reported; --. no data; **bold**, indicates maximum concentration]

Site name	Date	Arochlor-1254	3,5-Dichlorobiphenyl (14)	2,2′,5-Trichlorobiphenyl (18)	2,3,3′-Trichlorobiphenyl (20)	2,3,4′-Trichlorobiphenyl (22)	2,4,4′-Trichlorobiphenyl (28)	2,2′,3,5′-Tetrachlorobiphenyl (44)	2,2′,5,5′-Tetrachlorobiphenyl (52)
BT01	8/20/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT02	8/20/2012	nd	nd	**1.7**	nd	nd	nd	nd	nd
BT03	8/21/2012	**99.5**	nd	nd	nd	nd	nd	**2.4**	**3.4**
BT04	8/21/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT05	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT06	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT07	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT10	9/11/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT12	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT15	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT17	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB02	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB03	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB05A	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB06	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB07A	8/27/2012	nd	nd	nd	**0.25**	nd	nd	nd	nd
BB09	8/27/2012	nd	nd	nd	0.22	**0.17**	0.93	nd	nd
BB10	8/29/2012	nd	nd	nd	nd	nd	0.31	nd	nd
BB11	8/29/2012	nd	**0.37**	nd	nd	nd	0.28	nd	nd
BB13	8/29/2012	nd	0.37	nd	nd	nd	0.61	nd	nd
BB15	9/1/2012	nd	nd	nd	nd	nd	**1.6**	nd	nd

Table 10. Concentrations of detected polychlorinated biphenyl arochlors and congeners in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. (), congener sequence number; BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, not reported; --. no data; **bold**, indicates maximum concentration]

Site name	Date	2,3,3′,4′-Tetrachlorobiphenyl (56)	2,3,4,4′-Tetrachlorobiphenyl (60)	2,3′,4,4′-Tetrachlorobiphenyl (66)	2,3′,4′,5-Tetrachlorobiphenyl (70)	3,4,4′,5-Tetrachlorobiphenyl/ 2,2′,3,4,5′-Pentachlorobiphenyl (81/87)	2,2′,3,3′,4-Pentachlorobiphenyl (82)	2,2′,3,3′,5-Pentachlorobiphenyl (83)	2,2′,3,3′,6-Pentachlorobiphenyl (84)
BT01	8/20/2012	**1.2**	**10.6**	nd	2.3	nd	nd	nd	nd
BT02	8/20/2012	0.47	2.3	nd	nd	nd	nd	nd	nd
BT03	8/21/2012	0.77	2.2	**1.5**	**4.8**	**7.9**	**1.9**	**0.74**	**4.8**
BT04	8/21/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT05	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT06	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT07	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT10	9/11/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT12	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT15	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT17	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB02	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB03	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB05A	8/28/2012	nd	nd	nd	nd	0.20	nd	nd	nd
BB06	8/28/2012	nd	nd	nd	nd	0.10	nd	nd	nd
BB07A	8/27/2012	0.29	nd	0.40	0.45	0.29	nd	nd	nd
BB09	8/27/2012	0.25	nd	0.30	0.25	nd	nd	nd	nd
BB10	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB11	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB13	8/29/2012	0.39	nd	0.11	nd	nd	nd	nd	nd
BB15	9/1/2012	1.1	1.1	nd	0.90	nd	nd	nd	nd

Table 10. Concentrations of detected polychlorinated biphenyl arochlors and congeners in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. (), congener sequence number; BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, not reported; --. no data; **bold**, indicates maximum concentration]

Site name	Date	2,2′,3,4,4′-Pentachlorobiphenyl (85)	2,2′,3,4′,6-Pentachlorobiphenyl (91)	2,2′,3,5,5′-Pentachlorobiphenyl (92)	2,2′,3,5,6-Pentachlorobiphenyl (93)	2,2′,3,5′,6-Pentachlorobiphenyl (95)	2,2′,3,4′,5′-Pentachlorobiphenyl (97)	2,2′,4,4′,5-Pentachlorobiphenyl (99)	2,2′,4,4′,6-Pentachlorobiphenyl (100)
BT01	8/20/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT02	8/20/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT03	8/21/2012	**2.2**	**1.6**	**2.6**	**0.14**	**8.9**	**4.0**	**5.7**	**2.1**
BT04	8/21/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT05	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT06	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT07	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT10	9/11/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT12	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT15	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT17	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB02	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB03	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB05A	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB06	8/28/2012	nd	nd	nd	nd	0.09	nd	nd	nd
BB07A	8/27/2012	nd	0.10	nd	nd	0.31	nd	0.33	nd
BB09	8/27/2012	nd	nd	nd	nd	nd	nd	0.17	nd
BB10	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB11	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB13	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB15	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd

Table 10. Concentrations of detected polychlorinated biphenyl arochlors and congeners in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. (), congener sequence number; BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, not reported; --. no data; **bold**, indicates maximum concentration]

Site name	Date	2,3,3′,4,4′-Pentachlorobiphenyl (105)	2,3,3′,4′,5-Pentachlorobiphenyl (107)	2,3,3′,4′,6-Pentachlorobiphenyl (110)	2,3,4,4′,5-Pentachlorobiphenyl (114)	2,3,4,4′,6-Pentachlorobiphenyl (115)	2,3′,4,4′,5-Pentachlorobiphenyl (118)	2,3′,4,4′,5′-Pentachlorobiphenyl (123)	2,3′,4′,5,5′-Pentachlorobiphenyl (124)
BT01	8/20/2012	0.31	nd	nd	nd	nd	2.4	nd	nd
BT02	8/20/2012	1.0	nd	nd	nd	nd	0.92	nd	nd
BT03	8/21/2012	**5.1**	NR	**14.0**	**0.28**	**0.27**	**11.2**	**2.4**	**0.58**
BT04	8/21/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT05	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT06	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT07	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT10	9/11/2012	1.5	0.50	nd	nd	nd	3.4	nd	nd
BT12	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT15	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT17	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB02	8/30/2012	nd	nd	nd	nd	nd	0.12	nd	nd
BB03	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB05A	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB06	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB07A	8/27/2012	0.18	0.11	0.62	nd	nd	0.48	nd	nd
BB09	8/27/2012	nd	0.13	0.19	nd	nd	0.20	nd	nd
BB10	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB11	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB13	8/29/2012	0.11	nd	nd	nd	nd	0.08	nd	nd
BB15	9/1/2012	nd	**1.9**	1.1	nd	nd	0.5	nd	nd

Table 10. Concentrations of detected polychlorinated biphenyl arochlors and congeners in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. (), congener sequence number; BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, not reported; --. no data; **bold**, indicates maximum concentration]

Site name	Date	2,2′,3,3′,4,4′-Hexachlorobiphenyl (128)	2,2′,3,3′,4,5-Hexachlorobiphenyl (129)	2,2′,3,3′,4,5′-Hexachlorobiphenyl (130)	2,2′,3,3′,4,6-Hexachlorobiphenyl (131)	2,2′,3,3′,5,6′-Hexachlorobiphenyl (135)	2,2′,3,3′,6,6′-Hexachlorobiphenyl (136)	2,2′,3,4,4′,5-Hexachlorobiphenyl (137)	2,2′,3,4,4′,5′-Hexachlorobiphenyl (138)
BT01	8/20/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT02	8/20/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT03	8/21/2012	**2.5**	**0.58**	**3.0**	**2.4**	**1.3**	**2.6**	**0.84**	**10.4**
BT04	8/21/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT05	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT06	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT07	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT10	9/11/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT12	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT15	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT17	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB02	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB03	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB05A	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB06	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB07A	8/27/2012	nd	nd	nd	nd	nd	nd	nd	NR
BB09	8/27/2012	nd	nd	nd	nd	nd	nd	nd	0.16
BB10	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB11	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB13	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB15	9/1/2012	0.16	nd	1.3	nd	nd	nd	nd	0.43

Table 10. Concentrations of detected polychlorinated biphenyl arochlors and congeners in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. (), congener sequence number; BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, not reported; --. no data; **bold**, indicates maximum concentration]

Site name	Date	2,2′,3,4,5′,6-Hexachlorobiphenyl (144)	2,2′,3,4′,5,5′-Hexachlorobiphenyl (146)	2,2′,3,4′,5,6-Hexachlorobiphenyl (147)	2,2′,3,4′,5′,6-Hexachlorobiphenyl (149)	2,2′,3,5,5′,6-Hexachlorobiphenyl (151)	2,2′,4,4′,5,5′-Hexachlorobiphenyl (153)	2,3,3′,4,4′,5-Hexachlorobiphenyl (156)	2,3,3′,4,4′,5′-Hexachlorobiphenyl (157)
BT01	8/20/2012	nd	nd	nd	nd	nd	NR	nd	nd
BT02	8/20/2012	nd	nd	nd	nd	nd	NR	nd	nd
BT03	8/21/2012	**0.60**	**1.2**	**0.22**	**6.1**	**1.4**	NR	2.0	**0.21**
BT04	8/21/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT05	8/22/2012	nd	nd	nd	nd	nd	nd	**2.2**	nd
BT06	8/22/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT07	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT10	9/11/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT12	8/23/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT15	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT17	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB02	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB03	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB05A	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB06	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB07A	8/27/2012	nd	nd	nd	0.29	nd	NR	nd	nd
BB09	8/27/2012	nd	nd	nd	0.13	nd	NR	nd	nd
BB10	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB11	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB13	8/29/2012	nd	nd	nd	nd	nd	NR	nd	nd
BB15	9/1/2012	nd	0.24	nd	0.17	nd	**0.43**	nd	nd

Table 10. Concentrations of detected polychlorinated biphenyl arochlors and congeners in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. (), congener sequence number; BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, not reported; --. no data; **bold**, indicates maximum concentration]

Site name	Date	2,3,3′,4,4′,6-Hexachlorobiphenyl (158)	2,3,3′,4′,5,6-Hexachlorobiphenyl (163)	2,3,3′,4′,5,6-Hexachlorobiphenyl/ 2,3,3′,4′,5′,6-Hexachlorobiphenyl (163/164)	2,3′,4,4′,5,5′-Hexachlorobiphenyl (167)	2,2′,3,3′,4,4′,5-Heptachlorobiphenyl (170)	2,2′,3,3′,4,5,5′-Heptachlorobiphenyl (172)	2,2′,3,3′,4,5,6-Heptachlorobiphenyl (173)	2,2′,3,4,4′,5,5′-Heptachlorobiphenyl/ 2,3,3′,4′,5,5′,6-Heptachlorobiphenyl (180/193)
BT01	8/20/2012	nd	--	nd	nd	nd	nd	4.7	nd
BT02	8/20/2012	nd	--	nd	nd	nd	nd	nd	nd
BT03	8/21/2012	**1.8**	--	**2.4**	**0.65**	**2.8**	nd	1.1	**1.2**
BT04	8/21/2012	nd	--	nd	nd	nd	nd	1.6	nd
BT05	8/22/2012	nd	--	nd	nd	nd	**6.0**	**8.1**	nd
BT06	8/22/2012	nd	--	nd	nd	nd	nd	nd	nd
BT07	8/23/2012	nd	--	nd	nd	nd	nd	nd	nd
BT10	9/11/2012	nd	nd	--	nd	nd	nd	nd	--
BT12	8/23/2012	nd	--	nd	nd	nd	nd	nd	nd
BT15	9/1/2012	nd	nd	--	nd	nd	nd	nd	--
BT17	9/1/2012	nd	nd	--	nd	nd	nd	nd	--
BB01	8/30/2012	nd	nd	--	nd	nd	nd	nd	--
BB02	8/30/2012	nd	nd	--	nd	nd	nd	nd	--
BB03	8/28/2012	nd	nd	--	nd	nd	nd	nd	--
BB05A	8/28/2012	nd	nd	--	nd	nd	nd	nd	--
BB06	8/28/2012	nd	nd	--	nd	nd	nd	nd	--
BB07A	8/27/2012	nd	0.1	--	nd	nd	nd	nd	--
BB09	8/27/2012	nd	nd	--	nd	nd	nd	nd	--
BB10	8/29/2012	nd	nd	--	nd	nd	nd	nd	--
BB11	8/29/2012	nd	nd	--	nd	nd	nd	nd	--
BB13	8/29/2012	nd	nd	--	nd	nd	nd	nd	--
BB15	9/1/2012	nd	**0.16**	--	nd	nd	nd	nd	--

Table 10. Concentrations of detected polychlorinated biphenyl arochlors and congeners in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. (), congener sequence number; BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, not reported; --. no data; **bold**, indicates maximum concentration]

Site name	Date	2,2′,3,4,5,5′,6-Heptachlorobiphenyl (185)	2,2′,3,4′,5,5′,6-Heptachlorobiphenyl (187)
BT01	8/20/2012	nd	nd
BT02	8/20/2012	nd	nd
BT03	8/21/2012	**0.60**	**0.44**
BT04	8/21/2012	nd	nd
BT05	8/22/2012	nd	nd
BT06	8/22/2012	nd	nd
BT07	8/23/2012	nd	nd
BT10	9/11/2012	nd	nd
BT12	8/23/2012	nd	nd
BT15	9/1/2012	nd	nd
BT17	9/1/2012	nd	nd
BB01	8/30/2012	nd	nd
BB02	8/30/2012	nd	nd
BB03	8/28/2012	nd	nd
BB05A	8/28/2012	nd	nd
BB06	8/28/2012	nd	nd
BB07A	8/27/2012	nd	nd
BB09	8/27/2012	nd	nd
BB10	8/29/2012	nd	nd
BB11	8/29/2012	nd	nd
BB13	8/29/2012	nd	nd
BB15	9/1/2012	nd	0.36

Table 11. Concentrations of detected polycyclic aromatic hydrocarbons in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[All concentrations are in micrograms per kilogram, dry weight. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, results not reported due to quality assurance/quality control issues; **bold**, indicates maximum concentration; E, estimated value; *, value exceeds Sediment Quality Guideline Effects Range-Low; **, value exceeds Sediment Quality Guideline Effects Range-Medium]

Site name	Date	1-Methylnaphthalene	1-Methylphenanthrene	2,3,5-Trimethylnaphthalene	2,6-dimethylnaphthalene	2-Methylnaphthalene	3,6-dimethylphenanthrene	Acenaphthene	Acenaphthylene
BT01	8/20/2012	nd	19.0	nd	nd	nd	**19.0**	14.3	nd
BT02	8/20/2012	nd	12.5	nd	nd	nd	17.5	10.0	**7.52**
BT03	8/21/2012	nd	nd	nd	nd	nd	nd	nd	nd
BT04	8/21/2012	nd	nd	nd	nd	nd	nd	12.6	nd
BT05	8/22/2012	**21.1**	NR	**12.7**	nd	**25.4**	nd	59.2	E 3.79
BT06	8/22/2012	nd	20.6	nd	E 10.3	nd	nd	E 5.15	nd
BT07	8/23/2012	E 19.5	**146**	nd	E 9.74	E 19.5	nd	38.9	nd
BT10	9/11/2012	E 3.7	37.0	nd	E 3.70	E 3.70	E 7.4	E 3.70	nd
BT12	8/23/2012	13.2	23.1	E 6.60	**29.7**	23.1	E 6.6	**95.7**	E 6.60
BT15	9/1/2012	nd	87.9	nd	nd	nd	nd	nd	NR
BT17	9/1/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB01	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB02	8/30/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB03	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB05A	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB06	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB07A	8/27/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB09	8/27/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB10	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB11	8/29/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB13	8/29/2012	nd	nd	nd	nd	E 1.92	nd	nd	nd
BB15	9/1/2012	E 3.67	nd	E 3.67	E 3.67	E 3.67	E 3.67	E 3.67	nd

Table 11. Concentrations of detected polycyclic aromatic hydrocarbons in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram, dry weight. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, results not reported due to quality assurance/quality control issues; **bold**, indicates maximum concentration; E, estimated value; *, value exceeds Sediment Quality Guideline Effects Range-Low; **, value exceeds Sediment Quality Guideline Effects Range-Medium]

Site name	Date	Anthracene	Benzo (a) anthracene	Benzo (a) pyrene	Benzo (b) fluoranthene	Benzo (e) pyrene	Benzo (g,h,i) perylene	Benzo (k) fluoranthene	Biphenyl
BT01	8/20/2012	61.8	337*	356	642	561	276	513	nd
BT02	8/20/2012	15.0	205	203	301	283	160	233	nd
BT03	8/21/2012	13.1	27.9	29.5	41.0	36.1	21.3	29.5	nd
BT04	8/21/2012	28.7	285*	240	262	214	131	228	nd
BT05	8/22/2012	**131***	**1,220***	**923***	**854**	**677**	**547**	**744**	21.1
BT06	8/22/2012	E 10.3	61.8	30.9	41.2	30.9	20.6	30.9	nd
BT07	8/23/2012	E 9.74	E 9.74	nd	E 9.74	E 9.74	nd	E 9.74	E 9.74
BT10	9/11/2012	11.1	88.7	14.8	33.3	22.2	11.1	29.6	E 3.70
BT12	8/23/2012	75.9	251	59.4	106	85.8	23.1	92.4	**16.5**
BT15	9/1/2012	59.8	NR	E 7.03	17.6	14.1	NR	nd	nd
BT17	9/1/2012	nd	E 1.44	E 1.44	E 2.88	E 1.44	E 1.44	E 1.44	nd
BB01	8/30/2012	E 2.89	13.0	10.1	11.6	10.1	5.78	8.67	nd
BB02	8/30/2012	E 3.49	12.2	8.73	14.0	10.5	6.98	8.73	nd
BB03	8/28/2012	E 1.98	15.8	7.92	13.9	9.9	5.94	9.90	nd
BB05A	8/28/2012	nd	4.37	4.37	4.37	4.37	E 2.91	5.83	nd
BB06	8/28/2012	nd	nd	nd	nd	nd	nd	nd	nd
BB07A	8/27/2012	8.89	48.0	46.2	39.1	37.3	26.7	37.3	nd
BB09	8/27/2012	E 4.08	30.6	26.5	24.5	24.5	14.3	22.4	nd
BB10	8/29/2012	nd	10.6	8.85	14.2	8.85	7.08	7.08	nd
BB11	8/29/2012	E 1.59	4.76	6.34	6.34	6.34	4.76	4.76	nd
BB13	8/29/2012	E 3.83	15.3	13.4	15.3	13.4	7.66	13.4	nd
BB15	9/1/2012	11.0	33.0	14.7	22.0	22.0	11	14.7	E 3.67

Table 11. Concentrations of detected polycyclic aromatic hydrocarbons in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram, dry weight. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, results not reported due to quality assurance/quality control issues; **bold**, indicates maximum concentration; E, estimated value; *, value exceeds Sediment Quality Guideline Effects Range-Low; **, value exceeds Sediment Quality Guideline Effects Range-Medium]

Site name	Date	Chrysene	Dibenz (a,h) anthracene	Dibenzothiophene	Fluoranthene	Fluorene	Indeno (1,2,3-cd) pyrene	Naphthalene	Perylene
BT01	8/20/2012	784*	38.0	23.8	1,650*	23.8*	371	E 9.50	152
BT02	8/20/2012	348	25.1	12.5	699*	12.5	233	E 5.01	133
BT03	8/21/2012	80.3	4.92	nd	77.0	nd	27.9	nd	13.1
BT04	8/21/2012	411	23.3	17.9	1050*	14.4	251	5.38	66.4
BT05	8/22/2012	**1,570***	**95.3***	**88.8**	**3,870***	101*	**766**	**21.1**	216
BT06	8/22/2012	87.6	E 5.15	E 10.3	227	15.5	30.9	E 10.3	119
BT07	8/23/2012	E 19.5	nd	nd	29.2	E 9.74	E 9.74	E 9.74	**243**
BT10	9/11/2012	88.7	E 3.70	E 7.4	192	14.8	11.1	E 3.70	48.1
BT12	8/23/2012	472*	E 6.60	33.0	732*	**122***	39.6	16.5	42.9
BT15	9/1/2012	28.1	NR	nd	NR	E 3.51	10.5	E 3.51	77.3
BT17	9/1/2012	4.32	nd	nd	4.32	nd	nd	nd	nd
BB01	8/30/2012	15.9	nd	nd	65.0	nd	7.22	nd	5.78
BB02	8/30/2012	14.0	nd	nd	64.6	nd	10.5	E 1.75	14.0
BB03	8/28/2012	13.9	nd	nd	63.4	nd	7.92	nd	9.90
BB05A	8/28/2012	5.83	nd	nd	18.9	nd	4.37	nd	4.37
BB06	8/28/2012	nd	nd	nd	4.54	nd	nd	nd	nd
BB07A	8/27/2012	48.0	5.33	nd	156	nd	32.0	5.33	44.4
BB09	8/27/2012	32.6	nd	nd	NR	nd	16.3	E 4.08	22.4
BB10	8/29/2012	12.4	7.08	nd	53.1	nd	8.85	E 3.54	15.9
BB11	8/29/2012	6.34	nd	nd	22.2	nd	4.76	E 1.59	12.7
BB13	8/29/2012	19.2	E 1.92	nd	74.7	nd	9.58	E 3.83	28.7
BB15	9/1/2012	33.0	E 3.67	nd	73.3	E 3.67	14.7	E 7.33	36.7

Table 11. Concentrations of detected polycyclic aromatic hydrocarbons in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram, dry weight. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, results not reported due to quality assurance/quality control issues; **bold**, indicates maximum concentration; E, estimated value; *, value exceeds Sediment Quality Guideline Effects Range-Low; **, value exceeds Sediment Quality Guideline Effects Range-Medium]

Site name	Date	Phenanthrene	Pyrene	C1-Benz(a)anthracene/ Chrysene	C1-Fluoranthenes/ Pyrenes	C1-Fluorenes	C1-Phenanthrenes/ Anthracenes	C2-Fluoranthene/ Pyrene	C2-Naphthalenes
BT01	8/20/2012	423*	1,210*	E 143	E 242	E 9.50	E 90.3	E 23.8	E 4.75
BT02	8/20/2012	143	471	E 140	E 125	E 5.01	E 32.6	E 22.6	E 5.01
BT03	8/21/2012	31.1	70.5	E 8.20	E 24.6	nd	E 6.56	E 1.64	E 1.64
BT04	8/21/2012	319	732*	E 59.2	E 140	E 3.59	E 66.4	E 14.4	E 3.59
BT05	8/22/2012	**1,210***	**2,670****	E 279	**E 744**	**E 33.8**	**E 338**	**E 80.3**	E 16.9
BT06	8/22/2012	92.8	165	E 61.8	E 72.1	E 5.15	E 36.1	E 5.15	E 15.5
BT07	8/23/2012	58.4	E 19.5	E 48.7	E 29.2	E 9.74	E 77.9	nd	**E 38.9**
BT10	9/11/2012	77.7	144	**E 414**	E 48.1	E 3.70	E 37.0	E 3.70	E 7.40
BT12	8/23/2012	211	726*	E 49.5	E 195	E 16.5	E 59.4	E 19.8	E 26.4
BT15	9/1/2012	31.6	38.7	E 7.03	E 24.6	nd	E 49.2	nd	E 28.1
BT17	9/1/2012	E 1.44	4.32	nd	E 1.44	nd	nd	nd	nd
BB01	8/30/2012	E 2.89	31.8	E 2.89	E 13.0	nd	E 4.33	E 1.44	nd
BB02	8/30/2012	5.24	20.9	E 5.24	E 14.0	E 1.75	E 5.24	E 1.75	E 1.75
BB03	8/28/2012	E 3.96	29.7	E 5.94	E 15.8	nd	E 5.94	E 1.98	nd
BB05A	8/28/2012	nd	7.28	E 1.46	E 4.37	nd	E 1.46	nd	nd
BB06	8/28/2012	nd	nd	nd	E 1.51	nd	E 1.51	nd	nd
BB07A	8/27/2012	24.9	78.2	E 28.4	E 58.6	E 3.55	E 23.1	E 10.7	E 3.55
BB09	8/27/2012	16.3	53.0	E 18.3	E 42.8	E 2.04	E 16.3	E 8.15	E 2.04
BB10	8/29/2012	7.08	23.0	E 5.31	E 10.6	E 1.77	E 5.31	E 1.77	E 1.77
BB11	8/29/2012	4.76	9.52	E 1.59	E 6.34	nd	E 3.17	nd	E 1.59
BB13	8/29/2012	11.5	30.7	E 5.75	E 19.2	E 1.92	E 7.66	E 3.83	E 1.92
BB15	9/1/2012	22.0	62.3	E 7.33	E 14.7	E 3.67	nd	E 7.33	E 3.67

Table 11. Concentrations of detected polycyclic aromatic hydrocarbons in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in micrograms per kilogram, dry weight. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, results not reported due to quality assurance/quality control issues; **bold**, indicates maximum concentration; E, estimated value; *, value exceeds Sediment Quality Guideline Effects Range-Low; **, value exceeds Sediment Quality Guideline Effects Range-Medium]

Site name	Date	C2-Phenanthrenes/ Anthracenes	C3-Naphthalenes	C3-Phenanthrenes/ Anthracenes
BT01	8/20/2012	E 61.8	E 4.75	E 19.0
BT02	8/20/2012	E 12.5	E 5.01	E 15.0
BT03	8/21/2012	E 3.28	nd	nd
BT04	8/21/2012	E 30.5	E 5.38	nd
BT05	8/22/2012	**E 216**	**E 29.6**	**E 63.4**
BT06	8/22/2012	E 25.8	E 10.3	E 5.15
BT07	8/23/2012	nd	E 29.2	nd
BT10	9/11/2012	E 29.6	E 3.70	nd
BT12	8/23/2012	E 33.0	E 13.2	E 13.2
BT15	9/1/2012	nd	E 3.51	nd
BT17	9/1/2012	nd	nd	nd
BB01	8/30/2012	E 5.78	nd	E 1.44
BB02	8/30/2012	E 10.5	E 1.75	E 1.75
BB03	8/28/2012	E 11.9	nd	nd
BB05A	8/28/2012	E 2.91	nd	E 1.46
BB06	8/28/2012	E 1.51	nd	nd
BB07A	8/27/2012	E 37.3	E 3.55	E 8.89
BB09	8/27/2012	E 28.5	E 4.08	nd
BB10	8/29/2012	E 8.85	E 1.77	E 1.77
BB11	8/29/2012	E 4.76	E 1.59	E 1.59
BB13	8/29/2012	E 13.4	E 1.92	E 1.92
BB15	9/1/2012	E 14.7	E 3.67	nd

Table 12. Concentrations of detected trace elements in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.

[All concentrations are in milligrams per kilogram, dry weight. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksbury, Mississippi, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, value not reported due to quality assurance/quality control issue; **bold**, indicates maximum concentration; E, estimated value; *, value exceeds Sediment Quality Guideline, Effects Range-Low; **, value exceeds Sediment Quality Guideline, Effects Range-Medium]

Site name	Date	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium
BT01	8/20/2012	NR	3.49	NR	**0.843**	**1.85***	3,110	16.7	**10.8**	24.4	NR	NR	583
BT02	8/20/2012	1,960	0.778	29.2	0.307	0.512	697	6.25	2.06	7.52	7,010	24.5	136
BT03	8/21/2012	413	nd	7.72	nd	nd	136	2.70	0.543	1.76	1,620	8.12	29.6
BT04	8/21/2012	551	nd	5.58	nd	nd	124	2.50	nd	1.98	1,040	9.12	47.6
BT05	8/22/2012	4,750	3.34	32.2	nd	0.308	1,220	17.9	0.941	**29.9**	10,300	**77.5***	531
BT06	8/22/2012	4,010	1.81	37.2	nd	nd	1,200	6.83	0.822	8.28	5,360	44.0	193
BT07	8/23/2012	4,140	2.02	74.1	0.464	nd	925	3.83	2.69	4.15	3,430	77.2*	683
BT10	9/11/2012	1,390	1.07	13.6	nd	nd	104	4.94	0.585	2.19	6,490	11.3	60.2
BT12	8/23/2012	2,220	0.884	48.3	0.281	nd	308	5.14	0.646	14.3	2,440	40.1	199
BT15	9/1/2012	3,780	1.27	47.8	0.827	nd	989	6.46	1.56	3.54	7,820	10.9	197
BT17	9/1/2012	528	nd	2.17	nd	nd	82.2	1.95	nd	0.628	476	1.59	35.3
BB01	8/30/2012	297	E 0.354	1.69	nd	nd	198	2.40	nd	NR	712	NR	329
BB02	8/30/2012	2,370	1.55	6.09	nd	nd	1,130	7.48	1.70	7.23	4,770	9.67	1,330
BB03	8/28/2012	4,910	3.96	11.6	E 0.293	nd	1,730	16.5	3.50	16.9	10,700	24.5	2,850
BB05A	8/28/2012	1,440	1.19	4.34	nd	nd	1,140	5.66	1.06	5.50	3,390	6.68	961
BB06	8/28/2012	682	E 0.434	2.48	nd	nd	348	2.72	0.460	NR	1,260	NR	545
BB07A	8/27/2012	4,920	2.43	13.5	nd	nd	3,330	17.7	2.89	9.28	9,680	NR	3,420
BB09	8/27/2012	**8,440**	5.01	22.0	E 0.408	nd	3,040	28.4	4.60	16.6	15,600	20.4	5,380
BB10	8/29/2012	5,270	2.80	14.7	nd	nd	1,980	16.9	2.91	9.43	9,460	14.4	3,110
BB11	8/29/2012	3,910	2.24	10.4	nd	nd	1,630	11.8	2.24	5.07	7,050	7.40	2,320
BB13	8/29/2012	7,140	3.56	20.1	E 0.283	nd	3,630	22.8	3.89	9.82	13,100	12.7	4,480
BB15	9/1/2012	NR	**10.7***	**48.4**	0.718	E 0.494	**15,200**	**62.3**	8.73	28.0	**29,800**	40.5	**10,400**

Table 12. Concentrations of detected trace elements in estuarine and freshwater bed-sediment samples collected from sites within the Barnegat Bay watershed, New Jersey, August–September, 2012.—Continued

[All concentrations are in milligrams per kilogram, dry weight. Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksbury, Mississippi, and archived in a project database. BT, Barnegat Tributary; BB, Barnegat Bay; nd, not detected above reporting limit; NR, value not reported due to quality assurance/quality control issue; **bold**, indicates maximum concentration; E, estimated value; *, value exceeds Sediment Quality Guideline, Effects Range-Low; **, value exceeds Sediment Quality Guideline, Effects Range-Medium]

Site name	Date	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
BT01	8/20/2012	**286**	0.309*	0.799	11.2	273	1.11	**0.286**	188	nd	19.3	**125**
BT02	8/20/2012	44.9	NR	nd	3.26	66.7	0.317	0.253	167	nd	5.36	41.2
BT03	8/21/2012	15.4	0.112	nd	0.500	17.3	nd	nd	35.4	nd	2.38	4.33
BT04	8/21/2012	2.79	0.081	nd	0.601	23.3	nd	nd	34.3	nd	2.96	5.55
BT05	8/22/2012	20.4	0.195*	0.901	5.87	233	0.884	nd	133	nd	22.9	64.3
BT06	8/22/2012	9.39	0.225*	0.512	3.33	102	1.42	nd	143	nd	11.3	15.6
BT07	8/23/2012	13.1	nd	0.302	13.2	66.2	1.69	nd	201	nd	4.19	6.84
BT10	9/11/2012	2.12	nd	nd	2.04	95.5	0.539	nd	78.0	nd	8.30	20.0
BT12	8/23/2012	5.62	0.097	nd	2.78	73.2	0.682	nd	103	nd	7.14	9.52
BT15	9/1/2012	20.9	0.171*	nd	3.46	101	1.49	nd	500	nd	5.78	8.92
BT17	9/1/2012	1.64	nd	nd	0.734	34.3	nd	nd	38.0	nd	1.00	1.47
BB01	8/30/2012	4.38	nd	nd	0.573	148	nd	nd	1,670	nd	1.26	7.25
BB02	8/30/2012	48.3	0.0426	E 0.432	3.65	575	0.303	nd	2,150	nd	7.42	28.7
BB03	8/28/2012	92.9	0.150*	1.02	7.16	1,310	0.414	nd	4,330	nd	15.5	69.3
BB05A	8/28/2012	23.8	0.040	E 0.267	2.06	463	nd	nd	2,240	nd	5.69	20.0
BB06	8/28/2012	11.6	**6.54****	nd	1.15	203	nd	nd	1,600	nd	2.47	7.03
BB07A	8/27/2012	NR	0.087	E 0.350	8.12	NR	E 0.363	nd	4,240	nd	NR	46.1
BB09	8/27/2012	127	0.147	**1.11**	13.3	2,400	0.616	nd	**7,410**	nd	25.9	63.0
BB10	8/29/2012	84.3	0.041	0.527	7.83	1,340	E 0.365	nd	4,180	nd	16.3	35.2
BB11	8/29/2012	68.5	0.012	E 0.399	5.66	994	E 0.320	nd	2,770	nd	11.8	25.0
BB13	8/29/2012	120	0.069	E 0.485	10.6	1,840	E 0.461	nd	5,270	nd	20.7	44.1
BB15	9/1/2012	256	0.339*	NR	26.6*	**4,820**	1.42	NR	NR	**E 0.252**	**51.4**	109

Appendixes

Appendix 1. Quality Assurance Project Plan.

The plan is presented as developed for, and accepted by, the U.S. Geological Survey and the New Jersey Department of Environmental Protection for their cooperative study titled "Characterization of selected contaminants and determination of toxicity of bed sediments—Barnegat Bay and tributaries."

Site names in tables 2–3 have minor differences when compared with table 1 in the main report. The final site names as established for the U.S. Geological Survey National Water Information System are as presented in table 1 in the main report.

Available for download at *http://dx.doi.org/10.3133/ds/867*.

Appendix 2. Initial weight data for the estuarine amphipod, *Leptocheirus plumulosus*, and the freshwater amphipod, *Hyalella azteca*, in bed-sediment samples from the Barnegat Bay and tributaries, August–September, 2012.

[mg, milligrams]

Pan number	Number of animals on pan	Pan weight (mg)	Pan and animal dry weight (mg)	Individual dry weight (mg)
		Leptocheirus plumulosus		
1	20	82.3	82.7	0.024
2	20	89.5	89.8	0.015
3	20	91.5	92.1	0.028
4	20	96.6	97.0	0.020
			Mean:	**0.021**
			Standard deviation:	**0.005**
		Hyalella azteca		
1	10	71.3	71.5	0.025
2	10	73.5	73.7	0.026
3	10	60.6	61.0	0.034
4	10	67.8	68.1	0.038
5	10	68.0	68.3	0.031
6	10	71.3	71.5	0.028
7	10	71.9	72.3	0.032
8	10	69.4	69.7	0.029
			Mean:	**0.030**
			Standard deviation:	**0.004**

Appendix 3. Endpoint data for the 28-day sediment chronic toxicology study (percent survival, reproduction (neonate/survivor), biomass, and individual dry weight) for the estuarine amphipod *Leptocheirus plumulosus* in bed-sediment samples collected from sites within Barnegat Bay, New Jersey, August–September, 2012.

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi. mg, milligrams; BB, Barnegat Bay]

Site name	Replicate	Survival	Survival (percent)	Number of neonates	Ratio of number of neonates to number of survival	Number of animals weighed	Pan weight (mg)	Pan and animal dry weight (mg)	Replicate biomass (mg)	Mean animal individual dry weight (mg)
Control	A	17	85	32	1.9	17	112	118	6.59	0.388
Control	B	17	85	0	0.0	17	103	114	10.5	0.619
Control	C	16	80	25	1.6	16	93.2	108	14.6	0.913
Control	D	13	65	10	0.8	13	98.0	103	5.25	0.404
Control	E	17	85	37	2.2	17	103	111	8.60	0.506
BB01	A	7	35	0	0.0	7	103	115	11.9	1.69
BB01	B	11	55	2	0.2	11	108	113	5.47	0.497
BB01	C	20	100	7	0.4	20	109	125	16.1	0.804
BB01	D	12	60	0	0.0	12	118	128	9.12	0.760
BB01	E	13	65	0	0.0	13	115	119	4.08	0.314
BB02	A	20	100	22	1.1	20	103	122	18.8	0.939
BB02	B	16	80	10	0.6	16	108	126	17.6	1.10
BB02	C	17	85	24	1.4	17	99.6	115	15.1	0.888
BB02	D	18	90	4	0.2	18	99.3	116	16.4	0.912
BB02	E	16	80	5	0.3	16	102	106	4.50	0.282
BB03	A	12	60	0	0.0	12	110	116	5.56	0.464
BB03	B	20	100	37	1.9	20	99.2	112	12.5	0.624
BB03	C	13	65	0	0.0	13	108	114	5.53	0.426
BB03	D	19	95	47	2.5	19	106	133	27.0	1.42
BB03	E	13	65	7	0.5	13	117	128	10.3	0.795
BB05A	A	20	100	23	1.2	20	94.4	121	26.1	1.30
BB05A	B	20	100	10	0.5	20	106	125	18.5	0.927
BB05A	C	20	100	23	1.2	20	96.8	118	21.3	1.07
BB05A	D	16	80	7	0.4	16	94.8	112	16.9	1.06
BB05A	E	17	85	6	0.4	17	100	119	18.5	1.09
BB06	A	16	80	27	1.7	16	101	108	6.71	0.419
BB06	B	16	80	33	2.1	16	104	128	24.1	1.51
BB06	C	7	35	0	0.0	7	105	109	3.64	0.520
BB06	D	19	95	27	1.4	19	116	123	7.82	0.412
BB06	E	18	90	13	0.7	18	101	112	11.2	0.622

Appendix 3. Endpoint data for the 28-day sediment chronic toxicology study (percent survival, reproduction (neonate/survivor), biomass, and individual dry weight) for the estuarine amphipod *Leptocheirus plumulosus* in bed-sediment samples collected from sites within Barnegat Bay, New Jersey, August–September, 2012.—Continued

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi. mg, milligrams; BB, Barnegat Bay]

Site name	Replicate	Survival	Survival (percent)	Number of neonates	Ratio of number of neonates to number of survival	Number of animals weighed	Pan weight (mg)	Pan and animal dry weight (mg)	Replicate biomass (mg)	Mean animal individual dry weight (mg)
BB07A	A	15	75	0	0.0	15	108	133	24.7	1.64
BB07A	B	18	90	5	0.3	18	121	145	23.9	1.33
BB07A	C	5	25	0	0.0	5	124	127	2.75	0.551
BB07A	D	13	65	5	0.4	13	99.4	118	18.2	1.40
BB07A	E	17	85	0	0.0	17	99.9	120	20.3	1.20
BB09	A	13	65	2	0.2	13	104	111	6.46	0.497
BB09	B	18	90	9	0.5	18	102	117	15.3	0.851
BB09	C	15	75	1	0.1	15	102	113	11.3	0.751
BB09	D	14	70	4	0.3	14	105	114	8.76	0.626
BB09	E	18	90	0	0.0	18	81.9	94.6	12.7	0.703
BB10	A	15	75	0	0.0	15	83.8	95.1	11.4	0.758
BB10	B	9	45	0	0.0	9	98.8	103	4.55	0.506
BB10	C	7	35	3	0.4	7	102	105	3.77	0.539
BB10	D	20	100	8	0.4	20	96.3	112	16.2	0.807
BB10	E	15	75	0	0.0	15	97.1	105	8.03	0.535
BB11	A	20	100	14	0.7	20	95.9	107	11.6	0.578
BB11	B	15	75	26	1.7	15	104	116	12.3	0.822
BB11	C	14	70	36	2.6	14	102	116	13.6	0.973
BB11	D	20	100	7	0.4	20	111	119	8.83	0.442
BB11	E	13	65	14	1.1	13	113	124	10.6	0.814
BB13	A	12	60	16	1.3	12	120	129	8.79	0.733
BB13	B	10	50	4	0.4	10	108	117	9.09	0.909
BB13	C	17	85	22	1.3	17	107	118	10.7	0.632
BB13	D	17	85	19	1.1	17	97.8	107	9.56	0.562
BB13	E	16	80	24	1.5	16	106	119	12.5	0.780
BB15	A	19	95	19	1.0	19	108	142	33.9	1.78
BB15	B	19	95	61	3.2	19	132	160	28.8	1.51
BB15	C	17	85	57	3.4	17	105	146	40.2	2.36
BB15	D	17	85	74	4.4	17	97.7	136	38.1	2.24
BB15	E	20	100	178	8.9	20	106	144	38.1	1.90

Appendix 4. Endpoint data for the 28-day sediment chronic toxicology study (percent survival, reproduction (neonate/survivor), biomass, and individual dry weight) for the freshwater amphipod *Hyalella azteca* in bed-sediment samples collected from selected tributaries to Barnegat Bay, New Jersey, August–September, 2012.

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi. mg, milligrams; BT, Barnegat Tributary]

Site name	Replicate	Survival	Survival (percent)	Number of animals weighed	Pan weight (mg)	Pan and animal dry weight (mg)	Replicate biomass (mg)	Mean animal individual dry weight (mg)
Control	A	8	80	8	63.0	64.2	1.28	0.160
Control	B	4	40	4	68.4	69.4	1.06	0.265
Control	C	10	100	10	76.0	77.6	1.58	0.158
Control	D	4	40	4	74.0	75.0	1.02	0.255
Control	E	10	100	10	67.3	68.2	0.952	0.095
Control	F	10	100	10	72.8	74.2	1.48	0.148
Control	G	10	100	10	68.8	70.2	1.36	0.136
Control	H	9	90	9	57.5	59.2	1.64	0.183
BT01	A	10	100	10	60.5	63.4	2.87	0.287
BT01	B	8	80	8	65.7	68.7	2.99	0.374
BT01	C	10	100	10	63.0	66.7	3.69	0.369
BT01	D	10	100	10	69.8	72.7	2.89	0.289
BT01	E	8	80	8	62.2	64.1	1.88	0.234
BT01	F	8	80	8	67.7	70.7	3.04	0.380
BT01	G	6	60	6	67.8	69.6	1.87	0.312
BT01	H	10	100	10	56.4	59.5	3.15	0.315
BT02	A	10	100	10	68.1	71.4	3.27	0.327
BT02	B	10	100	10	69.5	73.4	3.85	0.385
BT02	C	9	90	9	64.7	66.9	2.21	0.246
BT02	D	6	60	6	55.7	59.8	4.01	0.669
BT02	E	8	80	8	60.7	64.8	4.03	0.504
BT02	F	10	100	10	67.9	71.0	3.10	0.310
BT02	G	10	100	10	69.6	73.1	3.47	0.347
BT02	H	8	80	8	56.5	59.9	3.37	0.421
BT03	A	10	100	10	54.9	58.6	3.77	0.377
BT03	B	8	80	8	63.7	67.6	3.88	0.485
BT03	C	9	90	9	65.6	68.9	3.28	0.364
BT03	D	9	90	9	60.2	63.3	3.10	0.344
BT03	E	8	80	8	56.9	61.2	4.31	0.539
BT03	F	8	80	8	65.9	70.3	4.40	0.550
BT03	G	9	90	9	76.6	81.2	4.60	0.511
BT03	H	8	80	8	60.8	64.8	3.98	0.497
BT04	A	9	90	9	56.8	61.7	4.85	0.539
BT04	B	9	90	9	75.5	78.3	2.80	0.312
BT04	C	10	100	10	55.1	59.0	3.94	0.394
BT04	D	10	100	10	69.5	73.8	4.40	0.440
BT04	E	10	100	10	75.9	79.9	4.03	0.403
BT04	F	10	100	10	66.8	71.6	4.83	0.483
BT04	G	10	100	10	57.4	60.8	3.40	0.340
BT04	H	10	100	10	64.2	67.3	3.08	0.308

Appendix 4. Endpoint data for the 28-day sediment chronic toxicology study (percent survival, reproduction (neonate/survivor), biomass, and individual dry weight) for the freshwater amphipod *Hyalella azteca* in bed-sediment samples collected from selected tributaries to Barnegat Bay, New Jersey, August–September, 2012.—Continued

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi. mg, milligrams; BT, Barnegat Tributary]

Site name	Replicate	Survival	Survival (percent)	Number of animals weighed	Pan weight (mg)	Pan and animal dry weight (mg)	Replicate biomass (mg)	Mean animal individual dry weight (mg)
BT05	A	9	90	9	72.5	74.7	2.22	0.247
BT05	B	10	100	10	71.1	74.5	3.41	0.341
BT05	C	8	80	8	57.3	59.3	2.00	0.250
BT05	D	10	100	10	69.3	73.3	3.99	0.399
BT05	E	8	80	8	56.9	60.4	3.51	0.439
BT05	F	9	90	9	64.6	68.2	3.63	0.403
BT05	G	10	100	10	62.6	66.2	3.59	0.359
BT05	H	8	80	8	78.4	80.8	2.36	0.295
BT06	A	5	50	5	71.7	73.7	2.03	0.405
BT06	B	3	30	3	66.6	68.0	1.47	0.490
BT06	C	9	90	9	65.7	68.8	3.10	0.344
BT06	D	10	100	10	63.5	68.3	4.79	0.479
BT06	E	8	80	8	64.2	67.9	3.75	0.469
BT06	F	7	70	7	58.1	60.9	2.82	0.403
BT06	G	8	80	8	58.0	61.9	3.91	0.489
BT06	H	9	90	9	68.5	71.7	3.26	0.362
BT07	A	10	100	10	59.5	60.9	1.42	0.142
BT07	B	8	80	8	65.1	66.2	1.10	0.138
BT07	C	8	80	8	66.3	67.6	1.34	0.168
BT07	D	10	100	10	63.2	64.8	1.59	0.159
BT07	E	8	80	8	60.7	61.7	1.08	0.136
BT07	F	10	100	10	62.9	64.6	1.64	0.164
BT07	G	9	90	9	73.5	74.9	1.39	0.154
BT07	H	10	100	10	68.1	69.7	1.57	0.157
BT10	A	9	90	9	68.8	72.2	3.46	0.385
BT10	B	10	100	10	71.7	74.9	3.20	0.320
BT10	C	8	80	8	65.5	68.1	2.61	0.327
BT10	D	9	90	9	62.2	64.6	2.48	0.276
BT10	E	8	80	8	59.5	61.7	2.22	0.277
BT10	F	10	100	10	71.2	74.0	2.80	0.280
BT10	G	10	100	10	65.3	68.9	3.57	0.357
BT10	H	10	100	10	64.6	68.3	3.75	0.375
BT12	A	10	100	10	71.9	74.9	3.00	0.300
BT12	B	9	90	9	68.9	70.9	2.01	0.223
BT12	C	10	100	10	68.0	70.7	2.76	0.276
BT12	D	10	100	10	64.4	66.9	2.48	0.248
BT12	E	10	100	10	70.3	75.5	5.23	0.523
BT12	F	9	90	9	73.1	76.0	2.89	0.322
BT12	G	7	70	7	71.8	73.9	2.02	0.289
BT12	H	10	100	10	69.1	71.9	2.84	0.284

Appendix 4. Endpoint data for the 28-day sediment chronic toxicology study (percent survival, reproduction (neonate/survivor), biomass, and individual dry weight) for the freshwater amphipod *Hyalella azteca* in bed-sediment samples collected from selected tributaries to Barnegat Bay, New Jersey, August–September, 2012.—Continued

[Samples were analyzed at the U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi. mg, milligrams; BT, Barnegat Tributary]

Site name	Replicate	Survival	Survival (percent)	Number of animals weighed	Pan weight (mg)	Pan and animal dry weight (mg)	Replicate biomass (mg)	Mean animal individual dry weight (mg)
BT15	A	10	100	10	66.8	68.2	1.42	0.142
BT15	B	6	60	6	65.7	67.1	1.38	0.230
BT15	C	9	90	9	66.5	68.4	1.90	0.211
BT15	D	10	100	10	57.2	59.3	2.16	0.216
BT15	E	10	100	10	65.7	67.0	1.28	0.128
BT15	F	10	100	10	61.6	63.3	1.74	0.174
BT15	G	9	90	9	51.3	53.4	2.03	0.226
BT15	H	9	90	9	69.3	71.4	2.12	0.236
BT17	A	9	90	9	58.3	60.2	1.86	0.207
BT17	B	10	100	10	50.4	53.1	2.70	0.270
BT17	C	4	40	4	47.9	48.9	0.978	0.245
BT17	D	10	100	10	56.4	59.2	2.81	0.281
BT17	E	0	0	0	58.1	0.0	0.000	0.000
BT17	F	9	90	9	59.2	61.4	2.26	0.251
BT17	G	10	100	10	60.3	63.4	3.11	0.311
BT17	H	5	50	5	60.1	61.7	1.60	0.319

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