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Ecological Evaluation of Proposed
Reference Sites in the New York Bight,
Great South Bay, and Ambrose Light,
New York

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Sequim, Washington

October 1996

Prepared for the
U.S. Army Corps of Engineers - New York District
under a Related Services Agreement
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**ECOLOGICAL EVALUATION OF PROPOSED
REFERENCE SITES IN THE NEW YORK BIGHT,
GREAT SOUTH BAY, AND AMBROSE LIGHT,
NEW YORK**

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SUMMARY

The current reference site used in evaluations of dredged material proposed for open water disposal in the New York Bight is the Mud Dump Reference Site. The sediment at this reference site is predominantly sand (approximately 98%). The U.S. Army Corps of Engineers-New York District (USACE-NYD) is considering designation of a new reference site that 1) includes a fine-grained component, believed to be necessary for adequate amphipod survival in laboratory tests, 2) better reflects the physical characteristics of the fine-grained sediment dredged from the New York/New Jersey Harbor and 3) is further removed from the Mud Dump Site than the current Mud Dump Reference Site. Battelle Marine Sciences Laboratory (MSL) was requested to characterize sediment collected from seven candidate reference sites [two in New York Bight (NYB-13 and NYB-15), two in Great South Bay (GSB-1 and GSB-2), and two near the Ambrose Light (Ambrose 1 and 2)] and Site C-2 (IV), during two study phases. The purpose of the Phase I study was to determine the necessity of a fine-grained component for amphipod survival and to identify candidate reference sites which had a fine-grained component. The purpose of Phase II was to identify reference sites that met Environmental Protection Agency (EPA)/USACE reference site selection guidelines. Phase I criterion of limiting site selection to fine-grained material was dropped during Phase II, because grain size appeared to be less critical to amphipod survival than previously thought. During Phase II, reference sites were targeted that featured clean, sandy sediment and that were closer to the entrance to New York Harbor that was north and east of Ambrose Light. This report presents the results of physical, chemical, and toxicological characterizations of sediment from these sites in comparison with those of the original Mud Dump Reference Site.

The objectives of these evaluations were to 1) determine the physical characteristics of six candidate reference sites and the Mud Dump Reference Site, 2) determine the concentrations of chemical contaminants of concern at the NYB and GSB candidate reference sites and the Mud Dump Reference Site, and 3) characterize the biological effects of sediments from the seven candidate reference sites. A total of 78 grab samples was collected from the candidate reference sites and the Mud Dump Reference Site. Sediment from each grab was homogenized, sampled for grain-size analysis, then composited and subsampled for total

organic carbon (TOC). NYB and GSB sediment composites were also subsampled for metals, polychlorinated biphenyl (PCB)/pesticide, dioxin/furan, and polycyclic aromatic hydrocarbon (PAH) analysis. Remaining composites were then used in biological testing.

Sediment grain-size analyses revealed that sediment from both NYB candidate reference sites was silty sand, whereas sediment collected from both GSB sites was sandy silt. Sediment from the Ambrose candidate reference sites, the Mud Dump Reference Site and Site C-2 (IV) was >90% sand. The TOC content of the NYB and GSB candidate reference sites was 1% to 2% by weight, whereas sediment from Ambrose 1 and 2, the Mud Dump Reference Site, and Site C-2 (IV) had lower concentrations of organic carbon (0.01% to 0.23% TOC).

The results of the chemical analyses indicated that some contaminants were present in sediment collected from the NYB and GSB candidate reference sites. Relative to the sandy Mud Dump Reference composite, concentrations of all nine metals were 2 to 93 times higher in sediment from the four finer-grained, candidate reference sites. The highest concentrations were measured in composites GSB-1 and NYB-13. Low levels of dieldrin, heptachlor, and DDT were detected in the NYB-13 and GSB-1 composites. Some PCB congeners were detected in each of the GSB and NYB composites, with total detected PCBs ranging from 0.73 µg/kg (GSB-2) to 19.0 µg/kg dry weight (NYB-15). Both low and high molecular weight PAHs were detected in each of the candidate reference sites and Mud Dump Reference composites. The highest concentrations were measured in the NYB-13 and GSB-1 composites, with total PAH concentrations of 806 µg/kg and 1120 µg/kg dry weight, respectively. The highest detected PAH concentrations were for phenanthrene, fluoranthene, pyrene, and benzo(b)fluoranthene. All contaminant concentrations measured were below New York Department of Environmental Conservation sediment criteria, with the exception of dieldrin, As, Cr, Cu, Hg, and Pb which were above Lowest Effects Levels, but below Severe Effects Levels.

During the Phase I investigations, acute, benthic toxicological tests with amphipods (*Ampelisca abdita*, *Leptocheirus plumulosus* and *Rhepoxynius abronius*) and mysids (*Mysidopsis bahia*) showed no evidence of biologically significant toxicity [statistical significance and >20% reduction in survival (10% for mysids)], relative to the controls. Statistically significant ($\alpha = 0.05$) toxicity was observed in the *A. abdita* benthic test with GSB-1 sediments under both static and modified-static-renewal conditions. Statistically significant toxicity was

also observed in the benthic, modified static-renewal *R. abronius* test conducted with all four candidate reference site composites. However, in each case, survival was >75% and was not >20% reduced, relative to the controls. No statistically significant toxicity was detected in sediment collected from Site C-2 (IV). The results of the Phase I toxicity tests indicated that *A. abdita*, *L. plumulosus*, and *R. abronius* amphipod survival was not significantly reduced when exposed to sediments with >95% sand. Thus, candidate reference sites with >95% sand could be considered acceptable for acute toxicity testing.

Of the candidate reference sites analyzed in Phase II, both Ambrose I and II were acceptable. High amphipod survival was observed in these three sediments and the sandy sediment at these stations is similar to that of the pre-disposal Mud Dump Site. Furthermore, the Ambrose candidate reference sites are located in the New York Bight Apex and are thus exposed to marine influences that are similar to those at the Mud Dump Site. If further chemical analyses indicate that the Ambrose sites are "substantially free of contaminants," these sites would meet the Green Book criteria for a suitable reference site.

Based on Phase I evaluations, both the New York Bight and Great South Bay candidate reference sites may be considered when finer-grained sediment is required. NYB-15 would be the most appropriate silty-sand sediment. It was substantially free of contaminants, had high survival in the biological tests, and had physico-chemical properties that were bracketed by those of the Mud Dump Site and the New York/New Jersey waterways. Additionally, NYB-15 is in the same water body as the Mud Dump Site and receives similar marine influences. However, Site NYB-15 is located 32 nautical miles (nm) from Sandy Hook, New Jersey, and sediment collection from this site could represent substantial costs and logistical problems.

Candidate reference site GSB-2 would be the most appropriate site for evaluations requiring >50% silt/clay. Site GSB-2 was substantially free of chemical contamination, had high survival in the biological tests, and was similar in grain size to many of the New York/New Jersey proposed dredging sites and some of the stations in the 1991 Mud Dump Site. However, because the Great South Bay is isolated from the New York Bight by Fire Island, it is not subject to the same water masses, currents, and sediment sources as the Mud Dump Site.

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1.0 Introduction

1.1 Background

Federal regulations require evaluation of dredged sediment prior to its disposal into ocean waters. To comply with the requirements of these regulations, tiered evaluations are conducted under a testing manual developed by the U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (EPA), called *Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual* (EPA/USACE 1991), and commonly referred to as the "Green Book." The Green Book requires the collection and testing of reference sediment in conjunction with each dredged-material evaluation. According to Section 3.1.2 of the Green Book, a reference site should be "1) substantially free of contaminants, 2) as similar as practical to the grain size of the dredged material and the sediment of the disposal site, and 3) [a site that] reflects conditions that would exist in the vicinity of the disposal site had no dredged-material disposal ever taken place, but had all other influences on sediment condition occurred" (EPA/USACE 1991).

The current reference site used for all dredged-material testing programs in the New York/New Jersey area is the Mud Dump Reference Site. This site is located approximately 2.6 miles southwest of the Mud Dump Site, along the Hudson Shelf Valley. The sediment at this reference site is predominantly sand (approximately 98%).

The USACE-New York District (USACE-NYD) is considering designation of a new reference site that 1) includes a fine-grained component, believed to be necessary for adequate amphipod survival, 2) better reflects the physical characteristics of the fine-grained sediment dredged from the New York/New Jersey Harbor and 3) is further removed from the Mud Dump Site than the current Mud Dump Reference Site. USACE-NYD requested the Battelle/Marine Sciences Laboratory (MSL)^(a) to conduct environmental

^(a) The Battelle Marine Sciences Laboratory is part of the Pacific Northwest National Laboratory, which is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

studies to assist in the reference site designation process. During this evaluation, sediment samples were collected from seven candidate reference sites during two study phases.

The primary purpose of the Phase I study was to identify a fine-grained reference site, based on the presumption that survival in amphipod toxicity tests could be reduced by a lack of fine-grained sediment. The secondary purpose of the Phase I study was to define a reference site which had sediment characteristics similar to those of the proposed dredged material from the New York/New Jersey waterways. In Phase I, two sites were located in New York Bight and two in Great South Bay. Sediment was also collected from a station within Site C-2, an area which has recently been studied as a proposed replacement of the Mud Dump Site disposal site (EPA 1992).

The purpose of Phase II was to identify candidate reference sites that met EPA/USACE Green Book reference site selection criteria. Sediment with >95% sand did not significantly reduce amphipod survival in acute toxicity tests in Phase I; therefore, sites that were >95% sand were included in Phase II analyses. During Phase II, sediment was collected from two sites located immediately northeast of the Ambrose Light. These sites were included because they were less likely to be affected by historic or current dumping and were located closer to the Mud Dump Site than the Phase I sites.

Chemical and biological evaluations were performed under the guidance of the Green Book and a regional manual developed by the USACE-NYD and EPA Region II, *Guidance for Performing Tests on Dredged Material to be Disposed of in Ocean Waters* (USACE-NYD/EPA Region II 1992), hereinafter referred to as the Regional Guidance Manual.

1.2 Program Objectives

The objectives of the Reference Site Selection Project were as follows:

Phase I

- collect sediment samples from two sites in the New York Bight (NYB-13 and NYB-15); from two sites in Great South Bay (GSB-1 and GSB-2); from Site C-2, Station IV.
- process samples and generate sediment composite samples.

- conduct the following biological tests on sediment composite samples:

Benthic Toxicity Evaluations

static, acute tests with amphipods (*Ampelisca abdita* and *Rhepoxynius abronius*) and mysids (*Mysidopsis bahia*); modified static-renewal (MSR), acute tests with *A. abdita* and *R. abronius*. Benthic toxicity tests were conducted on composites GSB-1, GSB-2, NYB-13, NYB-15, and C-2 (IV) (static amphipod tests only), as well as native control sediment.

Bioaccumulation Evaluations

28-day bioaccumulation tests with the deposit-feeding bivalve *Macoma nasuta*, and the deposit-feeding and burrowing polychaete *Nereis virens*. Bioaccumulation tests were conducted with composites from GSB-1, GSB-2, NYB-13, NYB-15, and Mud Dump Reference Site (MDRS), as well as native control sediment. Tissues were archived for possible analyses at a later date.

- perform grain-size and moisture-content analysis on individual grab samples and total organic carbon (TOC) analysis on sediment composites.
- perform metals, pesticide/polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), and dioxins/furans analyses on five sediment composites (GSB-1, GSB-2, NYB-13, NYB-15, and MDRS).

Phase II

- receive sediment samples collected by EPA from two sites northeast of the Ambrose Light (Ambrose 1 and 2).
- process samples and generate sediment composite samples.
- conduct the following biological tests on sediment composite samples:

Benthic Toxicity Evaluations

static, acute toxicity tests with amphipods (*A. abdita*, *R. abronius*, and *Leptocheirus plumulosus*); MSR, acute toxicity tests with *A. abdita*, *R. abronius*, *L. plumulosus*, and *M. bahia*.

Bioaccumulation Evaluations

28-day bioaccumulation tests with the deposit-feeding bivalve *M. nasuta*, and the deposit feeding and burrowing polychaete *N. virens*.

- perform grain-size and moisture-content analysis on individual grab samples and TOC analysis on sediment composites.
- archive sediment and tissues for possible metals, pesticide/PCBs, PAHs, and dioxins/furans analyses at a later date.

Table 1.1 gives an overview of the sampling locations and the types of biological tests and chemical analyses for each site.

TABLE 1.1. Tests and Analyses on Sediment Samples and Composites Collected for the Reference Site Selection Project

Test/Analysis Type	NYB		GSB		Mud Dump Reference	C-2 (IV)	Ambrose	
	13	15	1	2			1	2
Bioassays								
<i>Ampelisca</i> Static	C ^(a)	C	C	C		C	C	C
<i>Ampelisca</i> MSR ^(b)	C	C	C	C			C	C
<i>Rhepoxynius</i> Static	C	C	C	C		C	C	C
<i>Rhepoxynius</i> MSR	C	C	C	C			C	C
<i>Leptocheirus</i> Static							C	C
<i>Leptocheirus</i> MSR							C	C
Mysid Static	C	C	C	C				
Mysid MSR							C	C
<i>Nereis</i> Bioaccumulation	C,A ^(c)	C,A	C,A	C,A	C,A		C,A	C,A
<i>Macoma</i> Bioaccumulation	C,A	C,A	C,A	C,A	C,A		C,A	C,A
Chemistry Parameter-Sediment								
Grain Size	G ^(d)	G	G	G	G	D ^(e)	G	G
Percentage of Moisture	G	G	G	G	G	D	G	G
Percent TOC	C	C	C	C	C	D	C	C
Metals	C	C	C	C	C	D	A	A
Pesticides/PCBs	C	C	C	C	C	D	A	A
PAHs/1,4 Dichlorobenzene	C	C	C	C	C	D	A	A
Dioxins/Furans	C	C	C	C	A	D	A	A

(a) C Analysis/test on one composite sample from each site.

(b) Modified static-renewal.

(c) A All tissues were archived for possible analyses at a later date.

(d) G Analysis/test on each of 10 grab samples collected at each site.

(e) D Data from EPA (1992).

1.3 Study Sites

1.3.1 Candidate Reference Sites

Seven candidate reference sites were selected for evaluation during the Reference Site Selection Project (Figure 1.1). Two sites were located along the Hudson Shelf Valley in the New York Bight (NYB-13 and NYB-15), south and east of the current Mud Dump Reference Site. These stations were selected from National Oceanic and Atmospheric Administration (NOAA) sampling locations (Reid et al. 1991), where our criteria were fine-grained sediments which supported benthic communities relatively unperturbed by anthropogenic input from the New York Bight apex. NYB-13 was located approximately 20 nautical miles (nm) southeast of Sandy Hook, New Jersey, along the 60-m depth contour. NYB-15 was located approximately 32 nm southeast of Sandy Hook, along the 70-m depth contour.

Two stations, GSB-1 and GSB-2 were located in the protected waters of the Great South Bay on the southern shore of Long Island. The Great South Bay is isolated from the New York Bight by Fire Island, therefore it is not subject to the same water masses, currents, and sediment sources as the Mud Dump Site. However, in the New York Bight there are few known sources of fine-grained sediment that are not subject to large scale contaminant influences (i.e. the Hudson-Raritan outflow, the Mud Dump Site, and the Sewage-Sludge Dump Site). The GSB sites were chosen as a fine-grained sediment alternative that most likely contained similar crustal elements, but that were relatively free of anthropogenic influence. Samples from GSB-1 were collected off of Blue Point, near Bayport, New York, off the mouth of the Patchogue River. Station GSB-2 samples were collected off of Howell's Point, near Bellport, New York. Water depths for both GSB stations were 2 m to 3 m.

Site C-2 is an area southeast of the existing Mud Dump Site that has been studied as a possible replacement site for the Mud Dump disposal site. In August 1992, the EPA conducted a benthic bioassessment survey that included sampling at C-2 (EPA 1992). Therefore, some biological and sediment chemistry data have already been collected for this area. If not designated as a disposal area, Site C-2 (IV) could be suitable as a reference site when a

FIGURE 1.1. Approximate Locations of Reference Site Selection Project Sampling Stations

coarser grain size is required. One grab sample was collected at Site C-2 (IV) during the Reference Site Selection Project to provide toxicological data to augment the previously collected benthic and chemistry data. The grab sample was collected from a depth of approximately 36 m.

Two stations, Ambrose 1 and 2, were located north and east of the Ambrose Light, north of the Christiaensen Basin. Previous surveys indicated that sediment near the Ambrose Light had higher amounts of fine-grained material than other regions of the New York Bight (Alex Lecich, personal communication). Depths at the Ambrose stations ranged from 15 m to 24 m.

1.3.2 Mud Dump Reference Site

Reference sediment from the existing Mud Dump Reference Site was collected for use in bioaccumulation tests and chemistry analyses. The Mud Dump Reference Site is located along the southwestern edge of the Christiaensen Basin in approximately 20 m of water. It lies approximately 2.6 nm southwest of the center of the Mud Dump Site at the coordinates 40° 20.217' N, 73° 52.183' W.

2.0 Materials and Methods

2.1 Sediment Collection

The Reference Site Selection Project was performed in two distinct phases: Phase I in 1993 and Phase II in 1994. Sediment samples were collected from six stations in the three Reference Site Selection Project areas. Phase I included two stations in the New York Bight (NYB-13 and NYB-15) and two stations in the Great South Bay (GSB-1 and GSB-2). Additionally, Phase I included a sample collected from Site C-2 (IV). Phase II included two stations near the Ambrose Light (Ambrose 1 and Ambrose 2), in the New York Bight. Station locations were selected by the USACE-NYD. The locations, their coordinates, and water depths are presented in Section 3.0. Reference sediment samples were collected from the Mud Dump Reference Site for use in bioaccumulation testing and chemical analyses. Samples from the New York Bight and Ambrose sites were collected aboard the *M/V Gelberman*. Because of shallow depths in the Great South Bay, the *M/V Hudson* was used to collect samples from stations GSB-1 and GSB-2. Both vessels are owned and operated by USACE-NYD at Caven Point, New Jersey.

2.1.1 Test Sediment Sampling

Stations were located, using a hand-held Magellan Global Positioning System (GPS). The LORAN aboard the *M/V Gelberman* or *M/V Hudson* was available as a backup system. Water depth at the time of sampling was measured by the ship's fathometer. Ten stations were sampled at each of the six sampling sites. Approximately 2-3 gal of sediment from each station was collected for testing and analyses. All sediment was collected with a 0.1-m² van Veen grab sampler. Sediment samples disturbed during retrieval (i.e., partial loss of grab contents) were discarded. Individual grab samples were then placed into separate 5-gal epoxy-lined metal buckets. The buckets were covered, labeled, and stored at approximately 4°C either in a chest freezer (*M/V Gelberman*) or chest cooler with ice packs (*M/V Hudson*) while aboard the ship.

Detailed records of each sediment sample collected were maintained at each station and included information such as the station designation, location (latitude/longitude), replicate number, date, and sampling time. At the end of each sampling day, when the sampling vessel

returned to Caven Point, all sediment samples were loaded into a refrigerated van (approximately 4°C) until shipment to the MSL.

2.1.2 Reference and Control Sediment Sampling

Reference sediment for bioaccumulation tests and chemical analyses was collected from the Mud Dump Reference Site during both Phase I and Phase II. A total of 20 gal of sediment was collected from seven locations within the Mud Dump Reference Site, using the 0.1-m² van Veen grab. Sediment was retained in epoxy-coated 5-gal buckets and stored at approximately 4°C.

The native control sediment used in each toxicity and bioaccumulation test was supplied with the test organisms by their respective suppliers, except for *M. nasuta* and *M. bahia* control sediment. Control sediment for *M. nasuta* and *M. bahia* tests was collected from Sequim Bay, Washington, using a van Veen sampler deployed from an MSL research vessel. Locations of these control sites were determined by reference to known shoreline features. While in transit from the sampling site, all control sediment was stored in coolers at ambient temperature and were stored in a cold room at 4°C±2°C upon arrival at the MSL.

2.2 Sediment Sample Preparation

Sediment for biological testing were used within the 6-week holding period specified in the Green Book for evaluation of dredged sediment for ocean disposal. During this holding time, the sediment samples were received at the MSL; inventoried against chain-of-custody forms; processed and used for benthic toxicity tests and bioaccumulation tests; and subsampled for sediment physical/chemical analyses. This section describes procedures followed for equipment preparation, compositing strategy, and preparation of sediment for biological testing and chemical analyses.

2.2.1 Glassware and Equipment Preparation

All glassware, stainless-steel or titanium utensils, and containers made of polyvinyl chloride (PVC), Nalgene, and Teflon underwent stringent cleaning procedures to avoid contamination of samples. Differences in cleaning procedures were determined by the different material tolerances to cleaning treatments. Glassware (e.g., test containers, aquaria, sediment

transfer dishes) was washed with hot water and detergent, rinsed with deionized water, then soaked in a 5% solution of reagent grade nitric acid for a minimum of 4 h and rinsed again with deionized water before it was allowed to air dry. Glassware, except test chambers, was then rinsed with methylene chloride and allowed to dry under a fume hood. PVC and Nalgene tools were treated in the same manner as glassware, except they received no methylene chloride rinsing. Stainless-steel bowls, spoons, spatulas, and other utensils were washed with hot water and detergent, rinsed with deionized water, and allowed to air dry. They were then solvent-rinsed with methylene chloride and allowed to dry under a fume hood.

Neoprene stoppers and polyethylene sheets or other porous materials were washed with hot water and detergent and rinsed with deionized water. These items were then "seasoned" by continuous soaking in 0.45- μ m filtered seawater for at least 2 days prior to use. Large pieces of laboratory equipment, such as the epoxy-coated sediment mixer, were washed with a dilute solution of detergent, and thoroughly rinsed with tap water followed by deionized water.

Equipment used for determining water quality, including the meters for pH, dissolved oxygen (DO), temperature, salinity, and ammonia were calibrated according to the manufacturers' specifications and internal MSL Standard Operating Procedures (SOPs).

2.2.2 Preparation of Sediment for Toxicity Testing and Bulk Sediment Analyses

All sediment samples were assigned random, unique code numbers to avoid potential bias within the biological and chemical laboratories. Although live native organisms were present upon sample collection, sample storage conditions prior to homogenization for analyses were not conducive to survival. Upon sample receipt, no live organisms were observed and none of the candidate reference site composites were sieved. Native organisms could compete with or prey on test organisms, potentially confounding test results. Sediment was transferred from individual 5-gal buckets into stainless-steel bowls, then was mixed by hand with stainless-steel utensils until the color and consistency appeared homogenous, creating a sample representative of the individual sampling station. Aliquots were then transferred to the appropriate chemistry jar for grain-size analysis. Additionally, 16 oz of sample from each station was archived and frozen (-20°C) for potential analysis at a later time. The remainder of

the homogenized sediment from each station was pooled into a site composite for biological testing and chemical analysis. When all station samples were combined, a composite sample was homogenized in an epoxy-coated mixer, after which aliquots for physical and chemical analysis were removed. The remaining sediment composite was stored in tightly covered epoxy-lined buckets at $4^{\circ}\text{C}\pm 2^{\circ}\text{C}$ until use for benthic toxicity and bioaccumulation tests.

The Mud Dump Reference Site was pressed through a 1-mm mesh to remove live organisms that might have affected the outcome of toxicity tests. Native control sediment was wet-sieved through a 0.5-mm mesh to remove live organisms and hand-homogenized in stainless-steel bowls after sieving. Samples for physical and chemical analyses were taken after sieving and mixing had been completed. All reference and control sediment was stored at $4^{\circ}\text{C}\pm 2^{\circ}\text{C}$ until use in benthic toxicity and bioaccumulation tests.

2.3 Biological Testing Procedures

Six species of test organisms were used to evaluate sediment samples from the Reference Site Selection Project areas: the amphipods *A. abdita*, *L. plumulosus*, *R. abronius*, the mysid *M. bahia*, the bent-nose clam *M. nasuta*, and the polychaete *N. virens*. All test organisms except mysids were wild-captured animals, collected either by a commercial supplier or by MSL personnel.

The amphipods *A. abdita* and *L. plumulosus* were supplied by East Coast Amphipod, Kingston, Rhode Island. *A. abdita* and *L. plumulosus* and their native sediment were collected from Narragansett Bay, Rhode Island, by dragging a large dipnet along the sediment surface. Test organisms were carefully removed from their tubes for counting, and placed in native sediment for overnight transport to the MSL. Upon arrival, the *A. abdita* and *L. plumulosus* were placed in a tub of native sediment and gradually acclimated (at no more than 4°C per day) to $20^{\circ}\text{C}\pm 2^{\circ}\text{C}$ prior to test initiation. During the acclimation period the amphipods were held at $30\text{‰}\pm 2\text{‰}$ salinity. *A. abdita* and *L. plumulosus* were not fed during the 7-day holding period, but were held in flowing, unfiltered Sequim Bay seawater.

The amphipod *R. abronius* and its native control sediment were collected by MSL personnel from West Beach, at Whidbey Island, Washington, using a small anchor-dredge sampler designed specifically for sampling amphipods and their sediment. The amphipods and

sediment were transported to the MSL in clean coolers containing 10 cm of sediment and 5 gal of clean seawater at a temperature approximating natural conditions. At the MSL, *R. abronius* were placed in a tub of native sediment that received a slow seawater exchange. They were received and held at a salinity of 30‰±2‰ and a temperature of 15°C±2°C until testing. *R. abronius* were not fed during the 7-day holding period, but were held in flowing, unfiltered Sequim Bay seawater.

Mysid shrimp were purchased from Aquatic Biosystems, Fort Collins, Colorado. Mysids that were less than 24-h old were shipped via overnight delivery in plastic bags containing oxygen-supersaturated seawater maintained at approximately 15°C. Upon arrival, the *M. bahia* were placed in 10-gal aquaria and gradually acclimated from 15°C, 25‰ seawater to 20°C, 30‰ seawater over a period of 3 days. Mysids were fed concentrated brine shrimp nauplii twice daily prior to testing. Mortality of the *M. bahia* during holding was less than 1%.

Clams (*M. nasuta*) were collected from intertidal zones in Discovery Bay, Washington, by the commercial supplier Johnston and Gunstone, using shovels, buckets, and sieves. The clams were held in large containers filled with sediment from the collection site and supplied with continually flowing, unfiltered seawater at ambient temperatures.

N. virens were purchased through Chesapeake Culture, Incorporated in Hampton, New Hampshire, and were collected from an intertidal region in Newcastle, Maine. The worms were packed in coolers with mats of moist seaweed and shipped to the MSL via overnight delivery. At the MSL, the worms were placed in their native sediment and supplied with continually flowing, 20°C seawater. *N. virens* were not fed prior to testing.

Animals with abnormal behavior or appearance were not used in toxicological tests. Acclimation and animal care records become part of the raw data files for these projects.

2.3.1 Static and Modified Static-Renewal Amphipod Tests

Amphipod tests during Phase I testing were conducted with *A. abdita* and *R. abronius* under static and modified static-renewal conditions. During Phase II testing, *A. abdita*, *R. abronius* and *L. plumulosus* were tested under static and modified static-renewal conditions. All tests were performed in 1-L glass jars. The modified static-renewal chambers were fitted with funneled lids and screened outflow and overflow ports (Figure 2.1). Renewal was performed using a flow-through system, which allowed minimum disturbance during water exchange.

Complete seawater exchanges were performed by turning on flow to each chamber for 30 min, twice daily. The flow-through chambers allowed a subsurface exiting of water, reducing the chance of test organism loss or impingement on the screened discharge.

In each test, five replicates of each test and control treatment were used. Each test chamber contained 20 organisms, for a test population of 100 amphipods per sediment treatment. To accurately measure the volume of sediment added, 200 mL of filtered seawater (0.45 μm) was added to the chamber, then 200 mL of sediment was added to displace the seawater to the 400-mL mark. The chamber was then filled with filtered seawater to a volume of 750 mL. The chambers then placed on the water tables, and suspended particles were allowed to settle overnight.

FIGURE 2.1. Modified Static-Renewal and Static Testing Containers for *A. abdita*, *L. plumulosus*, and *R. abronius* Toxicity Tests

Salinity, temperature, DO, pH, and ammonia were measured in all test chambers prior to test initiation. Subsequently, these parameters were measured in at least one replicate daily and in all replicates at test termination. In the modified static-renewal test, exchange flow rates in all chambers were measured at initiation.

In addition to the routine water quality monitoring, estimates of total ammonia levels in the overlying and porewater were made for each sediment treatment under both flow regimes. These measurements were made on four "dummy" containers per treatment that were set up in the same manner as the actual test containers, but without any animals added to them. Two sets of dummy jars were held at 20°C (for the *A. abdita* and *L. plumulosus* test) and two sets were held at 15°C (for the *R. abronius* test). After overnight settling, initial ammonia, pH, and salinity were measured in the first set of dummy containers. After 10 days, ammonia, pH, and salinity were measured in the overlying water and porewater of the second set of containers. After overlying water had been decanted, the porewater was extracted by centrifuging the sediment in a Teflon jar for 20 min at approximately 3000 rpm for a relative force of approximately 1500 g. Ammonia concentrations were measured using a Fischer Accumet Series 1000 meter fitted with a Fisher ammonia-ion-selective probe.

The following were the acceptable ranges for water quality parameters during the *A. abdita*, *L. plumulosus*, and *R. abronius* tests:

	<u><i>A. abdita</i></u> <u><i>L. plumulosus</i></u>	<u><i>R. abronius</i></u>
Temperature	20°C±2°C	15°C±2°C
DO	≥60% saturation	≥60% saturation
	≥4.6 mg/L	≥5.0 mg/L
pH	7.8±0.5	7.8±0.5
Salinity	30‰±2‰	30‰±2‰
Flow Rate (MSR test)	2 exchanges/day	2 exchanges/day.

Gentle aeration was provided throughout both the static and modified static-renewal tests. At the end of the 10-day period, the contents of each chamber were gently sieved through 0.5-mm mesh, and the number of live, dead, and missing amphipods was recorded on termination forms. As a quality control check, a second observer confirmed test organism survival on at least 10% of the termination counts.

Reference toxicant tests with cadmium chloride were performed concurrently with the

A. abdita, *L. plumulosus*, and *R. abronius* tests. The reference toxicant tests were 96-h, water-only exposures that were otherwise conducted following the same procedures as were followed for the static tests with sediment. During Phase I, *A. abdita* and *R. abronius* were exposed to nominal concentrations of 0, 0.25, 0.5, 1, and 2 mg/L cadmium, with three replicates for each. In Phase II, all three amphipod species were exposed to both cadmium and ammonia reference toxicant tests with nominal concentrations of 0, 0.19, 0.38, 0.75, and 1.9 mg/L Cd and 0, 10, 20, 40, and 80 mg/L NH₄Cl.

2.3.2 Static and Modified Static-Renewal Mysid Tests

Mysid tests during Phase I testing were conducted under static conditions. During Phase II testing, mysids were tested under both static and modified static-renewal conditions. The procedures for conducting the 10-day benthic acute toxicity test with *M. bahia* were similar to those used for the static and modified static-renewal amphipod tests. All tests were performed in 1-L glass jars. To accurately measure the volume of sediment added, 200 mL of filtered seawater (0.45 µm) was added to the chamber, then 200 mL of sediment was added to displace the seawater to the 400-mL mark. The chamber was then filled with filtered seawater to a volume of 750 mL, then allowed to settle overnight on the water table. Five replicates of selected test treatments, reference sediment, and control sediment were tested. Each test chamber contained 20 organisms for a test population of 100 mysids per treatment.

Water quality parameters were measured in all replicates prior to test initiation, in at least one replicate daily, and in all replicates at test termination. The following were the acceptable ranges for water quality parameters during the *M. bahia* static, benthic test:

Temperature	20°C±2°C
DO	≥40% saturation (≥3.0 mg/L)
pH	7.8±0.5
Salinity	30‰±2‰
Flow Rate (MSR test)	2 exchanges/day.

Gentle aeration was provided to all test chambers during the test to maintain the DO concentration of ≥3.0 mg/L. At the end of the 10-day period, the overlying water from each chamber was siphoned off, passed through 0.25-mm mesh, and the number of live and dead or missing mysids was recorded on termination forms. As a quality control check, a second observer confirmed surviving test organisms on at least 10% of the termination counts.

A 96-h, water-only reference toxicant test with copper sulfate (0, 108, 180, 300, and 500 $\mu\text{g/L}$ Cu) with three replicates each, was performed concurrently with these tests.

2.3.3 Bioaccumulation Tests with *N. virens* and *M. nasuta*

The polychaete *N. virens* and the bivalve *M. nasuta* were used to evaluate bioaccumulation of contaminants from dredged material. The bioaccumulation tests were 28-day flow-through exposures to sediment. *N. virens* and *M. nasuta* were tested in separate 10-gal flow-through aquaria. Five replicates of each test and reference sediment treatment and three replicates of the native control sediment were analyzed; each chamber contained 25 *M. nasuta* or 25 *N. virens*. Water quality parameters (temperature, DO, pH, and salinity) were measured in all replicates at test initiation, in at least one replicate per treatment daily, and in all replicates at test termination. Flow rates were measured daily in all chambers. Although the Regional Guidance Manual provides an acceptable temperature range of $13^{\circ}\text{C}\pm 1^{\circ}\text{C}$, *M. nasuta* shared a 15°C flow-through water supply with *R. abronius*. This was not expected to affect the outcome of the test, since bioaccumulation tests with *M. nasuta* are typically conducted at $15^{\circ}\text{C}\pm 2^{\circ}\text{C}$ with no adverse effect on the organisms. The following were the acceptable ranges for water quality parameters during the *M. nasuta* and *N. virens* tests:

	<u><i>M. nasuta</i></u>	<u><i>N. virens</i></u>
Temperature	$15^{\circ}\text{C}\pm 2^{\circ}\text{C}$	$20^{\circ}\text{C}\pm 2^{\circ}\text{C}$
DO	$\geq 60\%$ saturation	$\geq 60\%$ saturation
	≥ 5.0 mg/L	≥ 4.6 mg/L
pH	7.8 ± 0.5	7.8 ± 0.5
Salinity	$30\text{‰}\pm 2\text{‰}$	$30\text{‰}\pm 2\text{‰}$
Flow Rate	125 ± 10 mL/min	125 ± 10 mL/min.

Gentle aeration was provided to all test chambers to maintain DO levels above 60% saturation. In addition to water quality monitoring, organism behavior (e.g., burrowing activity, feeding) and mortality were recorded daily. At the end of the 28-day testing period, *M. nasuta* and *N. virens* were placed in clean flowing seawater for a 24-h, water-only depuration period, to allow the test organisms to void their digestive tracts of sediment. After depuration, tissues were transferred into the appropriate chemistry jars for metals, pesticide/PCB, dioxin/furan, and PAH analyses. All tissue samples were frozen immediately and stored at less than -20°C for possible analysis. These samples were not analyzed for this phase of the project.

Water-only, 96-h, reference toxicant tests were also performed using copper sulfate in

five geometrically increasing concentrations with three replicates each. The *M. nasuta* reference toxicant test was run with treatments of 0.25, 0.5, 1, and 2 mg/L Cu plus a seawater-only control; the *N. virens* test was run with treatments of 89, 133, 200, 300 $\mu\text{g/L}$ Cu plus a seawater-only control.

2.4 Physical and Chemical Analytical Procedures

Evaluation of the sediment for the Reference Site Selection Project required analysis of physical and chemical parameters in individual sediment core samples and composited bulk sediment samples. Table 2.1 lists the parameters measured in each sample type, the method used for each analysis, and the target analytical detection limits. The following sections briefly describe the procedures used for physical and chemical analyses. Procedures followed were those required by the Regional Guidance Manual unless otherwise noted.

2.4.1 Sediment Physical Parameters

Physical parameters measured in sediment samples were grain size, percentage of moisture, bulk density and specific gravity. Grain size was measured according to American Society for Testing and Materials (ASTM) Methods D-2217/D-422 (ASTM 1972). Grain size was reported as percentages and volumes within four general size classes:

- Gravel > 2000- μm diameter
- Sand $\leq 2000\text{-}\mu\text{m}$ diameter and > 62.5- μm diameter
- Silt $\leq 62.5\text{-}\mu\text{m}$ diameter and > 0.0039- μm diameter
- Clay $\leq 3.9\text{-}\mu\text{m}$ diameter.

Percentage of moisture was determined according to the Plumb (1981) method.

TABLE 2.1. List of Analytes, Methods, and Target Detection Limits^(a)

Analyte	Method(s)	Sediment Detection Limit
<u>PHYSICAL PARAMETERS</u>		
Grain Size	ASTM D-2217/ASTM D-422 (ASTM 1972, 1985)	1.0%
Percentage of Moisture	Plumb (1981)	1.0 %
<u>METALS</u>		
Arsenic	EPA 200.2, -.8 (EPA 1991)	0.1 µg/g
Cadmium	EPA 200.2, -.8 (EPA 1991)	0.01 µg/g
Chromium	EPA 200.2, -.8 (EPA 1991)	0.02 µg/g
Copper	EPA 200.2, -.8 (EPA 1991)	0.1 µg/g
Lead	EPA 200.2, -.8 (EPA 1991)	0.1 µg/g
Mercury	EPA 245.5 (EPA 1991)	0.02 µg/g
Nickel	EPA 200.2, -.8 (EPA 1991)	0.1 µg/g
Silver	EPA 200.2, -.9 (EPA 1991)	0.1 µg/g
Zinc	EPA 200.2, -.8 (EPA 1991)	0.1 µg/g
<u>ORGANIC COMPOUNDS</u>		
<u>Total Organic Carbon (TOC)</u>	EPA (1986a)	0.01%
<u>Pesticides</u>		
Aldrin	EPA 8080 (EPA 1986b)	1.0 ng/g
gamma BHC (lindane)	EPA 8080 (EPA 1986b)	1.0 ng/g
α-Chlordane	EPA 8080 (EPA 1986b)	1.0 ng/g
trans-Nonachlor	EPA 8080 (EPA 1986b)	1.0 ng/g
Dieldrin	EPA 8080 (EPA 1986b)	1.0 ng/g
4,4'-DDT	EPA 8080 (EPA 1986b)	1.0 ng/g
2,4'-DDT	EPA 8080 (EPA 1986b)	1.0 ng/g
4,4'-DDD	EPA 8080 (EPA 1986b)	1.0 ng/g
2,4'-DDD	EPA 8080 (EPA 1986b)	1.0 ng/g
4,4'-DDE	EPA 8080 (EPA 1986b)	1.0 ng/g
2,4'-DDE	EPA 8080 (EPA 1986b)	1.0 ng/g
Endosulfan I	EPA 8080 (EPA 1986b)	1.0 ng/g
Endosulfan II	EPA 8080 (EPA 1986b)	1.0 ng/g
Endosulfan sulfate	EPA 8080 (EPA 1986b)	1.0 ng/g
Heptachlor	EPA 8080 (EPA 1986b)	1.0 ng/g
Heptachlor epoxide	EPA 8080 (EPA 1986b)	1.0 ng/g

TABLE 2.1. (contd)

Analyte	Method(s)	Sediment Detection Limit
<u>PCBs</u>		
8 (2,4')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
18 (2,2',5)	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
28 (2,4,4')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
44 (2,2',3,5')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
49 (2,2',4,5')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
52 (2,2',5,5')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
66 (2,3',4,4')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
87 (2,2',3,4,5')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
101 (2,2',3,5,5')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
105 (2,3,3',4,4')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
118 (2,3',4,4',5)	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
128 (2,2',3,3',4,4')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
138 (2,2',4,4',5,5')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
153 (2,2',4,4',5,5')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
170 (2,2',3,3',4,4',5)	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
180 (2,2',3,4',5,5',6)	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
183 (2,2',3,4,4',5',6)	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
184 (2,2',3,4,4',6,6')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
187 (2,2',3,4',5,5',6)	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
195 (2,2',3,3',4,4',5,6)	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
206 (2,2',3,3',4,4',5,5',6)	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
209 (2,2',3,3',4,4',5,5',6,6')	NYSDEC (1992), EPA 8080 (EPA 1986b)	1.0 ng/g
<u>Dioxins/Furans</u>		
2,3,7,8-TCDD	EPA 8290 (EPA 1990)	1 pg/g
1,2,3,7,8-PCDD	EPA 8290 (EPA 1990)	1 pg/g
1,2,3,4,7,8-HxCDD	EPA 8290 (EPA 1990)	2.5 pg/g
1,2,3,6,7,8-HxCDD	EPA 8290 (EPA 1990)	2.5 pg/g
1,2,3,7,8,9-HxCDD	EPA 8290 (EPA 1990)	2.5 pg/g
1,2,3,4,6,7,8-HpCDD	EPA 8290 (EPA 1990)	2.5 pg/g
OCDD	EPA 8290 (EPA 1990)	5 pg/g
2,3,7,8-TCDF	EPA 8290 (EPA 1990)	1 pg/g
2,3,4,7,8-PCDF	EPA 8290 (EPA 1990)	1 pg/g
1,2,3,7,8-PCDF	EPA 8290 (EPA 1990)	1 pg/g
1,2,3,4,7,8-HxCDF	EPA 8290 (EPA 1990)	2.5 pg/g
1,2,3,6,7,8-HxCDF	EPA 8290 (EPA 1990)	2.5 pg/g
1,2,3,4,7,8-HxCDF	EPA 8290 (EPA 1990)	2.5 pg/g
2,3,4,6,7,8-HxCDF	EPA 8290 (EPA 1990)	2.5 pg/g
1, 2,3,4,6,7,8-HpCDF	EPA 8290 (EPA 1990)	2.5 pg/g
1, 2,3,4,7,8,9-HpCDF	EPA 8290 (EPA 1990)	2.5 pg/g
OCDF	EPA 8290 (EPA 1990)	5 pg/g

TABLE 2.1. (contd)

Analyte	Method(s)	Sediment Detection Limit
PAHs		
Acenaphthene	NOAA (1993)	10 ng/g
Acenaphthylene	NOAA (1993)	10 ng/g
Anthracene	NOAA (1993)	10 ng/g
Fluorene	NOAA (1993)	10 ng/g
Napthalene	NOAA (1993)	10 ng/g
Phenanthrene	NOAA (1993)	10 ng/g
Benzo[a]ntracene	NOAA (1993)	10 ng/g
Benzo[a]yrene	NOAA (1993)	10 ng/g
Benzo[b]luoranthene	NOAA (1993)	10 ng/g
Benzo[g,h,i]erylene	NOAA (1993)	10 ng/g
Benzo[k]fluoranthene	NOAA (1993)	10 ng/g
Chrysene	NOAA (1993)	10 ng/g
Dibenzo[a,h]anthracene	NOAA (1993)	10 ng/g
Fluoranthene	NOAA (1993)	10 ng/g
Indeno[1,2,3-cd]pyrene	NOAA (1993)	10 ng/g
Pyrene	NOAA (1993)	10 ng/g
Industrial Chemicals/Herbicides		
1,4-Dichlorobenzene	EPA 8270 (EPA 1986b), NOAA (1993)	0.4 ng/g

(a) Detection limits are in dry weight for all sediment parameters, except Hg, which is reported in wet weight, as required by the USACE-NYD Regional Guidance Manual.

2.4.2 Total Organic Carbon (TOC)

Samples were analyzed for TOC according to the EPA Edison, New Jersey, Laboratory Procedure (EPA 1986a). The procedure involved combustion and quantitation of evolved carbon dioxide using a LECO analyzer. TOC was reported as a percentage of the dry weight of the unacidified sample.

2.4.3 Metals

Sediment samples were prepared for analysis of metals according to EPA 200.2 (EPA 1991). Samples were first freeze-dried and blended in a Spex mixer mill. A 0.2-g aliquot of dried homogeneous sample was then digested on a hot plate using nitric acid and hydrogen peroxide. Sediment extracts were analyzed for As, Cd, Cr, Cu, Pb, Ni, and Zn using inductively coupled plasma/mass spectrometry (ICP/MS) (Method 200.8, EPA 1991). For Ag, samples were analyzed by graphite furnace atomic absorption spectroscopy (GFAA) according to a

procedure based on EPA Method 200.9 (EPA 1991). Sediments were analyzed for Hg by cold-vapor spectroscopy (CVAA) according to EPA method 245.5 (EPA 1991).

2.4.4 Chlorinated Pesticides and PCBs

Sediment samples for pesticide and PCB analysis were extracted and analyzed according to an MSL procedure similar to EPA Method 8080 (EPA 1986b) for pesticides and the New York State Department of Environmental Conservation (NYSDEC) Congener-Specific Method 91-11 (NYSDEC 1992) for PCBs. The method also used techniques from the NOAA Mussel Watch procedure. A 20- to 50-g sample of homogenized sediment was first combined with sodium sulfate in a sample jar to remove water. Samples were extracted by adding successive portions of methylene chloride and agitating sample jars at ambient temperature using a roller technique. Extract volumes were reduced and solvent-exchanged to hexane, followed by Florisil column chromatography cleanup. Interferences were removed using high-performance liquid chromatography (HPLC) cleanup. Sample extracts were concentrated and analyzed using GC-ECD by the internal standard technique. The concentration of total estimated PCBs in each sediment was estimated by taking the sum of the 22 congeners (x) and multiplying by 2 (EPA 1996). One-half of the detection limit was used in summation when an analyte was undetected.

2.4.5 Dioxins and Furans

Dioxins and furans were analyzed in GSB and NYB sediment composites but not sediment from the Mud Dump Reference Site. All dioxin analyses followed modified EPA Method 8290 (EPA 1990). A 5- to 10-g aliquot of sediment was spiked with nine isotopically labeled PCDD/PCDF compounds. Sediment samples underwent a toluene Soxhlet extraction. The sample extracts were subjected to an acid/base washing and subsequently dried with sodium sulfate before cleanup by silica/alumina and carbon column chromatography. After a concentration step, the extracts were spiked with internal standards: $^{13}\text{C}_{12}$ -1,2,3,4-TCDD for quantitation of tetra- and pentachlorinated dioxin and furan congeners, and $^{13}\text{C}_{12}$ -1,2,3,4,8,9-HxCDD for quantitation of hexa-, hepta-, and octachlorinated dioxin and furan congeners.

Sample extracts were analyzed by high-resolution gas chromatography/high-resolution mass spectroscopy (HRGC/HRMS) in the selective ion monitoring (SIM) mode.

As an extra measure of quality control, $^{37}\text{C}_{14}$ -2,3,7,8-TCDD was added to sample extracts prior to cleanup to evaluate analyte recovery through cleanup procedures. Procedures similar to EPA Method 1613 were followed for this cleanup recovery standard.

2.4.6 PAHs and 1,4-Dichlorobenzene

Sediment samples were prepared for the analysis of 16 PAHs and 1,4-dichlorobenzene (see Table 2.1) according to an MSL method based on the NOAA Mussel Watch procedure (NOAA 1993). A 20- to 50-g sample of homogenized sediment was first combined with sodium sulfate in a sample jar to remove water. Samples were extracted by adding successive portions of methylene chloride and agitating sample jars at ambient temperature using an ambient shaker technique. Extract volumes were reduced and solvent-exchanged to hexane, followed by column chromatography cleanup. Interferences were removed using HPLC cleanup; tissue sample extracts underwent an additional cleanup by gel-permeation chromatography (GPC). Sample extracts were concentrated and analyzed using gas chromatography with mass spectrometry (GC/MS) in the selective ion monitoring (SIM) mode.

2.5 Data Analysis and Interpretation Procedures

Statistical analyses were conducted to determine the magnitude and statistical significance of toxicity in test treatments relative to the control treatment. Each statistical test was based on a completely random design that allowed unbiased comparison between treatments.

2.5.1 Randomization

All benthic toxicity and bioaccumulation tests were designed as completely random tests. Organisms were randomly allocated to treatments and treatments were randomly positioned on water tables. To determine randomization, a random-number table was generated for each test using the discrete random-number generator in Microsoft *Excel* spreadsheet software.

2.5.2 Statistical Analysis of Benthic Toxicity Tests

Benthic toxicity of all sediment treatments was compared by analysis of variance (ANOVA) on the arcsine square-root of the proportion of organisms surviving the test. The arcsine square-root transformation stabilizes the within-class variances to help meet assumptions of the ANOVA. The Green Book recommends Dunnett's test (Dunnett 1964) for comparing test treatments to a single treatment. All treatments were compared to the control sediment using an experiment-wise error of $\alpha=0.05$. Reference toxicant test results were expressed as an LC_{50} , or median lethal concentration. The LC_{50} is the concentration of toxicant that is lethal to 50% of the individuals tested. The LC_{50} estimation was performed using the Trimmed Spearman-Kärber Method (Finney 1971).

Whereas the ANOVA and Dunnett's analyses identify a statistically significant difference between control and test treatments, these analyses do not evaluate the biological significance of the different responses. The magnitude of the difference in mean survival between each test treatment and its corresponding control was used as a qualitative measure of biological significance. Following Green Book guidance, biologically significant toxicity was interpreted as a statistically significant difference ($\alpha=0.05$) between the candidate reference site and control sediment treatment response, where there was at least 10% greater mortality for mysids or 20% greater mortality for amphipods in the candidate reference site treatment.

2.6 Quality Assurance/Quality Control Procedures

The quality assurance/quality control (QA/QC) procedures for the Reference Site Selection Project were consistent with the Regional Guidance Manual and the Green Book, and were documented in the work/quality assurance project plans, *Reference Site Selection (Phase I and II) and Additional Sampling Sites in the Raritan River and Site C2* (MSL 1994). These documents fully described all QA/QC procedures that were followed for sample collection, sample tracking and storage, biological testing, and chemical analyses. A member of Pacific Northwest National Laboratory's (PNNL) quality assurance staff was present throughout all phases of this program to observe procedures, review and audit data, and ensure that accepted protocols were followed.

3.0 Results

3.1 Sample Collection and Processing

Grab samples for Phase I of the Reference Site Selection Project were collected between September 8 and September 10, 1993, by MSL and USACE-NYD personnel. A total of 48 grab samples was collected from Great South Bay, the New York Bight, the Mud Dump Reference Site, and Site C-2 (IV). Phase I samples were received at the MSL on September 15, 1993, and were processed for chemical and biological analyses between September 20 and 22, 1993, according to the procedures outlined in Section 2.

Phase II grab samples were collected on June 9, 1994 by EPA personnel. A total of 30 grab samples was collected from the Ambrose Light vicinity and the Mud Dump Reference Site. Phase II samples were received at the MSL on June 14, 1994, and were processed on June 16, 1994. Sampling dates, coordinates, and station depths are presented in Table 3.1.

Individual grabs were mixed in a stainless-steel bowl and subsampled for grain-size and percentage of moisture analysis, then composited in a large epoxy-coated cement mixer. Composites representing the six study sites were subsampled for chemical analyses, then held in 5-gal buckets at 4°C prior to biological testing. Only one grab was collected from Site C-2 (IV). It was mixed by hand using stainless steel utensils, and the sediment was used only for amphipod testing.

3.2 Physical and Chemical Analyses of Sediment

This section includes a brief summary of quality control results from chemical analyses and sediment concentrations of analytes. Additional information is available in QA/QC summaries for each group of analytes and data summary tables in Appendix A.

3.2.1 Grain Size and Percentage of Moisture

Individual grabs were analyzed for grain size and percentage of moisture. The results of the grain-size, percentage moisture, and TOC analyses are summarized in Table 3.2.

TABLE 3.1. Sampling Station Locations and Depths

Station and Date	Replicate	Coordinates		Water
		Latitude(°N)	Longitude(°W)	Depth (ft)
<i>Phase I</i>				
New York Bight -13 9/8/93	1	40 09.826	73 41.919	195
	2	40 09.783	73 41.889	194
	3	40 09.813	73 41.788	198
	4	40 09.820	73 41.860	195
	5	40 09.775	73 41.851	195
	6	40 09.789	73 41.896	195
	7	40 09.812	73 41.902	192
	8	40 09.810	73 41.900	193
	9	40 09.828	73 41.932	192
	10	40 09.814	73 41.889	199
New York Bight -15 9/8/93	1	40 01.430	73 25.500	230
	2	40 01.400	73 25.580	223
	3	40 01.460	73 25.540	236
	4	40 01.430	73 25.610	224
	5	40 01.402	73 25.609	225
	6	40 01.372	73 25.605	216
	7	40 01.440	73.25.580	227
	8	40 01.361	73 25.607	218
	9	40 01.038	73 25.620	218
	10	40 01.424	73 25.559	227
Mud Dump Reference 9/8/93	1	40 20.240	73 52.180	69
	2	40 20.280	73 52.140	73
	3	40 20.290	73 52.100	74
	4	40 20.210	73 52.180	68
	5	40 20.230	73 52.150	67
	6	40 20.210	73 52.150	67
	7	40 20.220	73 52.110	67
Great South Bay -1 9/10/93	1	40 43.815	73 01.638	7.2
	2	40 43.797	73 01.596	7.4
	3	40 43.780	73 01.654	7.4
	4	40 43.791	73 01.645	7.5
	5	40 43.745	73 01.635	7.3
	6	40 43.767	73 01.603	7.5
	7	40 43.792	73 01.647	7.4
	8	40 43.776	73 01.669	7.5
	9	40 43.773	73 01.629	7.5
	10	40 43.764	73 01.611	7.8

TABLE 3.1. (contd)

Station and Date	Replicate	Coordinates		Water Depth (ft)
		Latitude(°N)	Longitude(°W)	
Great South Bay -2 9/10/93	1	40 45.057	72 55.398	5.2
	2	40 45.069	72 55.475	5.1
	3	40 45.060	72 55.496	5.2
	4	40 45.043	72 55.457	5.2
	5	40 45.062	72 55.402	5.2
	6	40 45.055	72 55.416	5.4
	7	40 45.070	72 55.434	5.4
	8	40 45.113	72 55.504	5.4
	9	40 45.506	72 55.562	5.2
	10	40 45.020	72 55.542	5.1
C2 (IV) 9/8/93	1	40 11.070	73 35.719	118
<i>Phase II</i>				
Ambrose 1 6/9/94	1	40 31.540	73 47.870	55
	2	40 31.712	73 47.836	54
	3	40 30.992	73 47.886	58
	4	40 31.105	73 47.884	56
	5	40 31.233	73 47.905	57
	6	40 31.394	73 47.908	55
	7	40 31.513	73 47.898	54
	8	40 31.693	73 47.927	54
	9	40 31.621	73 48.117	54
	10	40 31.421	73 48.087	55
Ambrose 2 6/9/94	1	40 30.125	73 45.960	78
	2	40 30.350	73 46.011	ND ^(a)
	3	40 30.490	73 46.032	76
	4	40 30.685	73 46.082	74
	5	40 30.976	73 46.119	72
	6	40 31.002	73 46.102	70
	7	40 31.268	73 46.065	70
	8	40 31.268	73 46.138	68
	9	40 31.503	73 46.203	67
	10	40 31.513	73 46.245	66

(a) ND No depth recorded at this station.

TABLE 3.2. Mean Grain-Size Distribution, Percentage TOC, and Percentage of Moisture for Reference Site Selection Project Sediment Samples

Sediment Treatment	Percent Gravel > 2000 μm	Percent Sand 62.5-2000 μm	Percent Silt 3.9-62.5 μm	Percent Clay < 3.9 μm	Percent TOC ^(a)	Percentage Moisture
GSB-1 ^(b)	4.5 (1.6) ^(c)	23.7 (1.8)	61.1 (2.6)	10.7 (0.8)	1.79 (0.01)	49
GSB-2 ^(b)	0.0	30.4 (1.5)	58.2 (1.8)	11.3 (1.8)	1.40 (0.02)	44
NYB-13 ^(b)	0.0	67.4 (1.9)	17.6 (0.7)	15.0 (1.3)	1.53 (0.03)	47
NYB-15 ^(b)	0.0	74.3 (2.0)	14.3 (1.4)	11.4 (1.0)	0.94 (0.15)	38
C2 (IV) ^(d)	0.2	98.5	0.2	1.1	0.06	ND
Ambrose 1 ^(b)	2.6 (0.8)	92.4 (1.6)	3.1 (1.0)	1.9 (0.3)	0.23 (0.11)	24
Ambrose 2 ^(b)	0.6 (0.7)	95.3 (2.0)	2.3 (1.2)	1.8 (1.3)	0.21(0.07)	22
Mud Dump Reference ^(e)	0.0	99	0.0	1.0	0.01	20

(a) Mean of triplicate subsamples of the site composite.

(b) Mean of 10 individual grabs.

(c) Sample standard deviation in parentheses.

(d) Data from EPA (1992).

(e) n = 1.

Complete test results and quality control data for grain size and percentage moisture are presented in Appendix A, Table A.1 for Phase I sediments and Appendix C, Table C.1 for Phase II sediments.

Grain-size distribution varied little among the 10 individual sediment samples from each site. Sediment from stations NYB-13 and NYB-15 were dominated by sand, with 67% and 74% of the material represented by this grain size, respectively. The remainder of the material at these stations was silt and clay. No gravel was found in grabs from these stations. Mean percentage of moisture was 47% at NYB-13 and 38% at NYB-15.

Sediments collected at stations GSB-1 and GSB-2 were predominantly silt, with 61% and 58% of sediment in this size class, respectively. Nearly 30% of the material collected in grabs from these stations was sand and gravel. Whereas some gravel was also present in grabs

collected from GSB-1, grabs from GSB-2 contained no gravel. Mean percentage of moisture was 49% in GSB-1 and 44% in GSB-2.

The Ambrose 1 and 2 composites were predominantly sand with 92% and 95% sand, respectively. Gravel, silt, and clay were also present in both composites. Percentage of moisture was lower than in NYB and GSB sediments, with 24% and 22% moisture for Ambrose 1 and 2, respectively. Sediment collected from the Mud Dump Reference Site was 99% sand.

3.2.2. TOC Analysis

TOC analysis was conducted only on sediment composite samples from each site. TOC analysis results are summarized in Table 3.2. Complete test sediment and QC results are presented in Appendix A, Tables A.2 and A.3 for Phase I and Appendix C, Tables C2 and C3 for Phase II. Quality control measures were within QC guidelines and are discussed in Appendix A.

Levels of TOC were similar for the NYB and GSB composites, ranging from 0.94% to 1.79% TOC. Percent TOC was substantially lower in the Ambrose and Mud Dump Reference Site composites, with approximately 0.2% TOC in the Ambrose composites and 0.01% TOC in the Mud Dump Reference Site composite. Three subsamples were analyzed from each site composite to examine composite homogeneity. The coefficients of variation for these samples were generally low, ranging from <1% to 16% for the NYB and GSB sediments, indicating that these composites were well mixed and homogeneous. The CV for the Ambrose sediments were slightly higher (48% and 33% for Ambrose 1 and 2, respectively). While higher CVs may indicate some composite heterogeneity, it is more likely a result of the low TOC (0.15% to 0.36%) at the two locations.

3.2.3. Metals in Sediment Samples

Nine metals were measured in the NYB, GSB, and Mud Dump Reference Site composites (Table 3.3). Complete sediment results and quality control data are presented in Appendix A, Tables A.4 and A.5. Quality control were within acceptable limits, with the exception of the target detection limits and matrix spike and SRM recoveries of some metals. A discussion of quality control results are presented in Appendix A.

All analyzed metals were detected in the NYB and GSB composites, and all analyzed metals except Ag were detected in the Mud Dump Reference Site composite. Concentrations of Ag, Cu, Cd, and Hg in both the NYB and GSB composites were 9 to 83-fold higher, relative to the Mud Dump Reference Site. As, Cr, Ni, Pb, and Zn concentrations were <6-fold higher than concentrations measured in the Mud Dump Reference Site composite. Of the four candidate reference sites, the highest metals concentrations were measured in composite GSB-1 (Cd, Cu, Hg, Ni, Pb, and Zn) and in composite NYB-13 (Ag, As, Cr, and Hg). Composites NYB-15 and GSB-2 had metals concentrations similar to the Mud Dump Reference Site composite, with the exception of Cd and Hg, which were elevated relative to the Mud Dump Reference Site.

For additional comparison, both C-2 (IV) and NYB background concentrations from a previous study (EPA 1992) are presented in Table 3.3. The NYB background concentrations are a mean calculated from 13 sites located within the New York Bight. In general, the NYB background concentrations, as well as those of Site C-2 (IV), were similar or slightly higher than those of the Mud Dump Reference Site. Both NYB-15 and GSB-2 metals concentrations were within one order of magnitude of the NYB background concentrations, with the exception of Cd in the GSB-2 composite. NYB-13 and GSB-1 consistently had the highest metals concentrations.

3.2.4. Pesticides/PCBs in Sediment Samples

Fifteen pesticides and 22 PCB congeners were analyzed in the New York Bight, Great South Bay, and Mud Dump Reference Site composites. Test sediment and QC data are presented in Appendix A, Tables A.6 through A.9 for pesticides and Tables A.10 through A.13 for PCBs. Quality control results were within acceptable guidelines with the exception of matrix spike and surrogate recoveries. These deviations are discussed in the QA/QC narrative in Appendix A.

TABLE 3.3. Metals Concentrations in Reference Site Selection Project Sediments

Metals (mg/kg)	NYB-13 ^(a)	NYB-15	GSB-1	GSB-2	C-2(IV) ^(b)	Mud Dump Reference ^(c)	New York Bight ^(d)
Ag	0.564	0.094	0.323	0.076	0.018	0.01 U ^(e)	0.029
As	7.75	4.58	7.74	6.68	8.38	4.42	5.55
Cd	0.298	0.111	0.549	0.288	0.010	0.015	0.015
Cr	31.1	16.5	26.9	20.5	18.0	7.69	18.6
Cu	19.5	7.51	21.6	9.34	7.60	1.68	5.66
Hg	0.250	0.047	0.237	0.074	0.001	0.003	0.014
Ni	12.0	9.32	12.4	9.64	4.20	2.66	3.78
Pb	38.2	15.8	46.3	19.0	10.4	6.52	5.62
Zn	64.5	35.4	92.2	51.1	23.8	13.7	21.4

(a) Values represent the mean of quadruplicate analysis.

(b) Data from EPA (1992).

(c) Values represent the mean of triplicate analysis.

(d) Concentration presented for each metal is a mean of 13 analyses: 3 stations in Site E1, 3 stations in Site C2, and 7 stations in Site J1. Data from EPA (1992).

(e) Undetected at or above given concentration.

No measurable concentrations of pesticides were found in the Mud Dump Reference Site composite. Measurable concentrations of pesticides in NYB and GSB samples were limited to a few compounds in NYB-13 and GSB-1. Low levels of heptachlor (0.68 µg/kg dry weight), 4,4'-DDT (2.14 µg/kg dry weight), 4,4'-DDE (1.46 µg/kg dry weight), and dieldrin (0.86 µg/kg dry weight) were detected in the NYB-13 composite. Measurable levels of 4,4'-DDD (2.30 µg/kg dry weight) and 4,4'-DDE (1.81 µg/kg dry weight) were detected in the GSB-1 composite. Based on previous data (EPA 1992), Site C-2 (IV) had no detectable concentrations of pesticides.

PCB analyses are summarized in Table 3.4. PCB congeners were detected in each of the four candidate reference site composites; however, no PCBs were detected in the Mud Dump Reference Site composite except PCB 170, which was detected at a concentration less than that observed in the method blank. Total estimated PCBs in GSB-1 and GSB-2 composites were 9.91 µg/kg and 6.07 µg/kg dry weight, respectively. Composites NYB-13 and NYB-15 had total estimated PCB concentrations of 29.9 µg/kg and 42.5 µg/kg dry weight, respectively.

TABLE 3.4. PCB Concentrations in Reference Site Selection Project Sediments

PCBs (µg/kg dry weight)	NYB-13	NYB-15	GSB-1	GSB-2	C2(IV) ^(b)	Mud Dump Reference
PCB 8	0.37 U ^(a)	0.37 U	0.37 U	0.37 U	0.87 U	0.37 U
PCB 18	0.13 U	0.13 U	0.13 U	0.13 U	0.48 U	0.13 U
PCB 28	2.08	3.55	0.73	0.08 U	0.23 U	0.08 U
PCB 44	0.03 U	0.03 U	0.03 U	0.03 U	0.67 U	0.03 U
PCB 49	0.50	0.21 U	0.26 U	0.23 U	NA ^(c)	0.17 U
PCB 52	0.70	6.40	0.28	0.12 U	0.26 U	0.12 U
PCB 66	2.22	0.08 U	0.08 U	0.08 U	0.43 U	0.08 U
PCB 87	0.07 U	0.07 U	0.07 U	0.07 U	NA	0.07 U
PCB 101	1.36	4.81	0.09 U	0.13	0.49 U	0.09 U
PCB 105	0.07 U	0.07 U	0.07 U	0.07 U	0.60 U	0.07 U
PCB 118	2.03	1.19 U	1.19 U	1.19 U	0.45 U	1.19 U
PCB 128	0.08 U	0.08 U	0.08 U	0.08 U	0.34 U	0.08 U
PCB 138	1.34	1.97	0.55	0.19	0.05	0.04 U
PCB 153	1.48	2.30	0.59	0.21	NA	0.06 U
PCB 170	0.51	0.09 U	0.25	0.18	0.67 U	0.16
PCB 180	0.77	0.06 U	0.27	0.06 U	0.49 U	0.06 U
PCB 183	0.25 U	0.21 U	0.26 U	0.23 U	NA	0.17 U
PCB 184	0.25 U	0.21 U	0.26 U	0.23 U	NA	0.17 U
PCB 187	1.52 U	1.52 U	1.52 U	1.52 U	0.58 U	1.52 U
PCB 195	0.06 U	0.06 U	0.06 U	0.06 U	0.61 U	0.06 U
PCB 206	0.49	0.04 U	0.04 U	0.04 U	0.96 U	0.04 U
PCB 209	0.06 U	0.06 U	0.06 U	0.06 U	0.63 U	0.06 U
Total Detected PCBs	13.5	19.0	2.67	0.71	0.05	0.16
Estimated PCBs^(d)	29.9	42.5	9.91	6.07	8.86	4.98

(a) U Undetected at or above given concentration.

(b) Data from EPA (1992).

(c) NA Not analyzed.

(d) Total PCBs: $[2 * (\sum(\text{all PCBs analyzed}))]$, where 1/2 U value was used where U reported (EPA 1996).

Total detected PCB concentrations were lower in GSB composites than in NYB composites. PCB congeners detected above 1 µg/kg included congeners 28, 52, 66, 101, 118, 138, and 153. PCBs were undetected at Site C-2 (IV), with the exception of PCB 138.

3.2.5 Dioxins and Furans in Sediment Samples

Dioxin and furan concentrations and related QC measurements are found in Appendix A, Tables A.14 through A.17. Quality control results (Appendix A) indicate that data are of acceptable accuracy and precision.

Dioxins and furans were detected in the NYB and GSB composites. Sediment from the Mud Dump Reference Site were not analyzed for these compounds. The dioxin congener 2378-TCDD is considered the most toxic congener by EPA (EPA 1990) and was detected in composites GSB-1 (0.66 pg/g dry weight) and NYB-13 (2.38 pg/g dry weight). Two other dioxin/furan congeners considered one-half as toxic, 12378-PeCDD and 23478-PeCDF, were detected in composites GSB-1, NYB-13, and NYB-15 (23478-PeCDF only). Other less toxic congeners were also detected. The highest concentrations of this group of compounds were associated with OCDD, which is considered to have low toxicity and to be ubiquitous (Tondeur 1987). The toxic equivalent concentrations (TEC) of both dioxins and furans, based on the Toxicity Equivalence Factors (TEF) published in Reid et al. (1991), ranged from 1.53 ng/kg at GSB-2 to 9.41 ng/kg at NYB-13 (Table A.14). The TEC was calculated as:

$$TEC = \sum [(TEF) * \text{measured values}], \text{ where undetected values} = (DL/2 * TEF).$$

3.2.6 PAHs in Sediment Samples

All measured PAH concentrations are summarized in Table 3.5. The sediment and QC data are presented in Appendix A, Tables A.18 and A.22. Quality control results were within acceptable ranges, with the exception of matrix spike and surrogate recoveries, which were affected by high concentrations of native PAHs. A discussion of quality control results are presented in Appendix A.

Both low molecular-weight PAH (LPAH) and high molecular-weight PAH (HPAH) compounds were detected in each of the tests and Mud Dump Reference Site composites. Relative to the Mud Dump Reference Site composite, NYB and GSB composite total PAH (t-PAH) concentrations were elevated by 21 to 77 times. The highest concentrations were measured in the NYB-13 and GSB-1 composites, with t-PAH concentrations of 806 µg/kg and 1120 µg/kg dry weight, respectively. The highest detected PAH concentrations at

TABLE 3.5. PAH Concentrations in Reference Site Selection Project Sediments

PAHs (µg/kg dry weight)	NYB-13	NYB-15	GSB-1	GSB-2	C2(IV)	Mud Dump Reference
Naphthalene	28.40	9.60	18.10	5.89	1.15	1.07 U
Acenaphthalene	7.13	2.81	6.83	3.00 ^{*(b)}	1.4 U	1.15 U
Acenaphthene	6.12 *	2.55	5.31	1.99 *	1.0 U	0.55 U
Fluorene	14.9	5.39	12.0	5.36 *	0.83 U	1.63 *
Phenanthrene	75.5	29.3	92.4	19.3	1.07	1.18 *
Anthracene	26.3	8.34	22.9	8.48	0.23	2.90 *
Total LPAH	158	58.0	158	44.0	2.45	5.71
Fluoranthene	127	52.5	207	50.2	1.47	2.69 *
Pyrene	106	39.0	165	41.9	1.30	1.18 U
Benzo[a]anthracene	51.1	18.0	66.0	20.8	0.44	2.03
Chrysene	60.3	22.5	86.4	23.0	0.81 ~	1.09 U
Benzo[b]fluoranthene	102	39.7	166	62.2	0.96	2.68
Benzo[k]fluoranthene	34.3	13.3	56.7	21.0	0.72	1.41 *
Benzo[a]pyrene	57.8	19.4	84.4	28.0	0.51	1.18 U
Indeno[1,2,3-c,d]pyrene	52.6	21.6	71.8	24.0	0.68	2.32 U
Dibenzo[a,h]anthracene	11.1	4.47	13.6	5.02	1.4 U	3.34 U
Benzo[g,h,i]perylene	45.5	18.7	46.1	12.2	0.66	3.64 U
Total HPAH	648	249	963	288	7.55	8.81
Total PAH	806	307	1,120	332	10.0	14.5
1,4 Dichlorobenzene	12.8	10.0 U	22.2	8.26	1.19	10.0 U

(a) U Undetected above given concentration.

(b) * Ion ratio out or confirming ion not found (See QC Summary).

each site generally were phenanthrene, fluoranthene, pyrene, and benzo(b)fluoranthene. In composites NYB-13 and GSB-1, concentrations of these compounds were approximately 1.5 to 2 orders of magnitude above those in the Mud Dump Reference Site composite. Site C-2 (IV) had PAH concentrations that were consistently below Mud Dump Reference Site levels, except for naphthalene and pyrene.

3.3 Biological Testing

Seven test composites were analyzed for benthic effects. Benthic acute toxicity was tested with NYB, GSB, Ambrose, and Site C-2 (IV) (amphipod static only) composites. An appropriate control sediment was included in each of the benthic evaluations. Toxicity was

evaluated for both statistical significance and biological significance. Toxicity was statistically significant if survival in the test treatment was significantly reduced ($\alpha = 0.05$), relative to the control. Toxicity was biologically significant if there was a statistically significant ($\alpha = 0.05$) reduction in survival and >20% reduction in survival, relative to the control (>10% for mysids).

Bioaccumulation testing was performed on GSB, NYB, Ambrose, and Mud Dump Reference Site composites. An appropriate control sediment was included in each of the benthic evaluations.

3.3.1 10-Day Benthic Toxicity Test with *Ampelisca abdita*

Phase I

The 10-day benthic assay with *A. abdita* was performed both as a static and modified static-renewal toxicity test. *A. abdita* survival was greater than 90% in the native control for both flow regimes. Because both the static and modified static-renewal tests were performed with the same population of amphipods, a single reference toxicant test was performed (Tables B.1 and B.2). The cadmium LC_{50} for this population of *A. abdita* was 0.67 mg/L. This value is within the control limits established at the MSL (0.39 mg/L to 0.79 mg/L Cd) and was within one standard deviation from the mean control response, indicating that this population of test organisms were of appropriate sensitivity.

Data from the *A. abdita* static test are presented in Table 3.6 and Appendix B, Tables B.3 and B.4. In the candidate reference site composites, *A. abdita* survival ranged from 76% (GSB-1) to 93% (NYB-13). Survival in the C-2 (IV) composite was 89%. Although the reduction in survival was statistically significant ($\alpha = 0.05$) in GSB-1, relative to the control, no biologically significant reductions in survival were observed in any of the Phase I composites. Water quality parameters were within acceptable ranges throughout this test, except for minor deviations in pH and salinity (Table B.4). These deviations did not appear to have adverse effects. In all treatments, porewater ammonia concentrations were below 15 mg/L at initiation and below 10 mg/L on Day 10. Overlying water ammonia concentrations ranged from <1.00 to 4.05 mg/L for all treatments throughout the static test.

TABLE 3.6. Results of the Benthic Toxicity Tests with *A. abdita*

Sediment Treatment	Mean Proportion Survival ^(a)	SD ^(b)	Statistically Significant ^(c)	Biologically Significant ^(d)
<i>Phase I</i>				
<u>Static</u>				
<i>A. abdita</i> Control	0.94	0.02	NA ^(e)	NA
NYB-13	0.93	0.03	NO	NO
NYB-15	0.87	0.07	NO	NO
GSB-1	0.76	0.07	YES	NO
GSB-2	0.90	0.09	NO	NO
C-2 (IV)	0.89	0.07	NO	NO
<u>MSR</u>				
<i>A. abdita</i> Control	0.92	0.03	NA	NA
NYB-13	0.93	0.06	NO	NO
NYB-15	0.93	0.06	NO	NO
GSB-1	0.77	0.15	YES	NO
GSB-2	0.89	0.04	NO	NO
<i>Phase II</i>				
<u>Static</u>				
<i>A. abdita</i> Control	0.96	0.04	NA	NA
Ambrose 1	0.96	0.04	NO	NO
Ambrose 2	0.92	0.03	NO	NO
<u>MSR</u>				
<i>A. abdita</i> Control	0.88	0.04	NA	NA
Ambrose 1	0.91	0.09	NO	NO
Ambrose 2	0.95	0.07	NO	NO

(a) n = 100
(b) SD Standard deviation.
(c) Significant reduction at $\alpha=0.05$, relative to the controls.
(d) Significant reduction at $\alpha=0.05$ and >20% reduction in survival, relative to the controls.
(e) NA Not applicable.

Results of the *A. abdita* modified static-renewal test are presented in Table 3.6 and in Appendix B, Tables B.5 and B.6. *A. abdita* survival ranged from 77% (GSB-1) to 93% (NYB-13

and 15) in the Phase I composites. Whereas the reduction in survival in the GSB-1 composite was statistically significant ($\alpha = 0.05$), no biologically significant reductions in survival were observed. Water quality parameters were within acceptable ranges, with minor deviations in pH (Table B.3). In all treatments, porewater total ammonia concentrations were below 15 mg/L at initiation and below 10 mg/L on Day 10. Overlying water ammonia concentrations ranged from <1.00 mg/L to 1.48 mg/L total ammonia for all treatment throughout the modified static-renewal test.

Phase II

Survival in the *A. abdita* controls was 88% and 96% in the modified static-renewal and static tests, respectively. The cadmium LC_{50} for the population of *A. abdita* used in Phase II was 0.54 mg/L, within the range of LC_{50} s previously recorded at the MSL and within one standard deviation from the mean control response. Although survival in the modified static-renewal test control was slightly below 90%, this test was considered acceptable because the reference toxicant test was within control limits and survival in the Ambrose test treatments was >90%.

Phase II results are presented in Table 3.6 and Appendix D, Tables D.1. through D.6. *A. abdita* survival was greater than 90% for both Ambrose 1 and 2 composites under both flow conditions. No significant ($\alpha = 0.05$) reductions from control survival, relative to the controls, were observed. Water quality parameters were within acceptable ranges throughout both the static and modified static-renewal tests. For all Phase II treatments, initial porewater ammonia concentrations were approximately 20 mg/L total ammonia. In the static test, Day 10 porewater ammonia concentrations for Ambrose 1 and 2 were 28.4 mg/L and 33.2 mg/L, respectively. Overlying water ammonia concentrations ranged from <1.00 mg/L to 16.6 mg/L total ammonia for both treatments throughout the static test. In the modified static-renewal test, Day 10 total ammonia concentrations were 20.5 mg/L and 23.5 mg/L for Ambrose 1 and 2, respectively. Overlying water ammonia ranged from <1.00 mg/L to 1.78 mg/L total ammonia.

3.3.2. 10-Day Benthic Toxicity Tests with *Leptocheirus plumulosus*

Benthic toxicity tests with *L. plumulosus* were conducted during Phase II under both static and modified static-renewal conditions. *L. plumulosus* survival in the control sediment exceeded 90% with both flow regimes, validating these tests. The cadmium reference toxicant LC₅₀ was 1.58 mg/L cadmium, which was similar to the values of 1.19 mg/L and 2.58 mg/L Cd previously reported by Dewitt et al. (1992). This indicates that the population of *L. plumulosus* used in this test responded to cadmium similarly as those used previously.

Results of the 10-day benthic toxicity test with *L. plumulosus* are presented in Table 3.7 and in Appendix D, Tables D.7 through D.12. Survival in both Ambrose 1 and 2 composites were greater than 90%. No significant ($\alpha = 0.05$) reductions in survival were observed. Water quality parameters were within acceptable ranges throughout the 10-day test for both flow regimes. Porewater ammonia concentrations in the *L. plumulosus* test were shared with *A. abdita* test and are reported in section 3.3.1, Phase II. Overlying water ammonia concentrations ranged from <1.00 mg/L to 19.4 mg/L total ammonia in the static test and from <1.00 mg/L to 4.40 mg/L total ammonia in the modified static-renewal test.

3.3.3. 10-Day Benthic Toxicity Test with *Rhepoxynius abronius*

Phase I

The *R. abronius* tests were conducted under both static and modified static-renewal conditions. *R. abronius* survival in the controls was greater than 90% in both tests, validating the results of these tests. Data for the reference toxicant test are presented on Tables B.7 and B.8. The cadmium LC₅₀ for the population of amphipods used in these tests was 1.10 mg/L Cd, within the control limits established at the MSL (0.49 mg/L to 1.30 mg/L Cd) and within one standard deviation of the mean control response. This indicates that the population of organisms used in these tests was of appropriate sensitivity.

TABLE 3.7. Results of the Benthic Toxicity Tests with *L. plumulosus*

Sediment Treatment	Mean Proportion Survival ^(a)	SD ^(b)	Statistically Significant ^(c)	Biologically Significant ^(d)
<i>Phase II</i>				
<i>Static</i>				
<i>L. plumulosus</i> Control	0.99	0.02	NA ^(e)	NA
Ambrose 1	0.98	0.03	NO	NO
Ambrose 2	0.95	0.06	NO	NO
<i>MSR</i>				
<i>L. plumulosus</i> Control	0.97	0.03	NA	NA
Ambrose 1	0.96	0.04	NO	NO
Ambrose 2	0.96	0.04	NO	NO

(a) n = 100
(b) SD Standard deviation.
(c) Significant reduction in survival at $\alpha=0.05$, relative to the control.
(d) Significant reduction in survival at $\alpha=0.05$, and >20% reduction in survival, relative to the control.
(e) NA Not applicable.

Results of the *R. abronius* static test are presented in Table 3.8 and Appendix B, Tables B.9 through B.10. Survival in the Phase I candidate reference site composites ranged from 88% (GSB-1) to 92% (NYB-15 and GSB-2). Survival in the C-2 (IV) composite was 95%. Survival in both the NYB-13 and GSB-1 composites was significantly ($\alpha = 0.05$) lower than in the control; however, no biologically significant reductions in survival were observed. Water quality parameters were within range throughout the test. The porewater-ammonia was not measured for the *R. abronius* static and modified static-renewal tests in Phase I. Overlying water ammonia concentrations in the static *R. abronius* test ranged from <1.00 mg/L to 3.56 mg/L total ammonia for all sediment treatments.

Data for the *R. abronius* modified static-renewal test are presented in Table 3.8 and Appendix B, Tables B.11 and B.12. Survival in all four candidate reference site composites ranged from 80% (GSB-1) to 86% (NYB-15). Although statistically significant ($\alpha = 0.05$) toxicity was observed in all four test composites, no biologically significant responses were

TABLE 3.8. Results of the Benthic Toxicity Tests with *R. abronius*

Sediment Treatment	Mean Proportion Survival ^(a)	SD ^(b)	Statistically Significant ^(c)	Biologically Significant ^(d)
<i>Phase I</i>				
<u>Static</u>				
<i>R. abronius</i> Control	0.97	0.03	NA ^(e)	NA
NYB-13	0.90	0.04	YES	NO
NYB-15	0.92	0.03	NO	NO
GSB-1	0.88	0.04	YES	NO
GSB-2	0.92	0.06	NO	NO
C-2 (IV)	0.95	0.07	NO	NO
<u>MSR</u>				
<i>R. abronius</i> Control	0.96	0.02	NA	NA
NYB-13	0.83	0.07	YES	NO
NYB-15	0.86	0.07	YES	NO
GSB-1	0.80	0.09	YES	NO
GSB-2	0.85	0.04	YES	NO
<i>Phase II</i>				
<u>Static</u>				
<i>R. abronius</i> Control	0.91	0.12	NA	NA
Ambrose 1	0.98	0.03	NO	NO
Ambrose 2	0.89	0.25	NO	NO
<u>MSR</u>				
<i>R. abronius</i> Control	0.87	0.06	NA	NA
Ambrose 1	0.95	0.05	NO	NO
Ambrose 2	0.92	0.08	NO	NO
<p>(a) n = 100.</p> <p>(b) SD Standard deviation.</p> <p>(c) Significant reduction in survival at $\alpha=0.05$, relative to the control.</p> <p>(d) Significant reduction in survival at $\alpha=0.05$, and >20% reduction in survival, relative to the control.</p> <p>(e) NA Not applicable.</p>				

observed, relative to the controls (96% survival). Water quality parameters were within range throughout the test. Overlying water ammonia concentrations remained below 2.00 mg/L total ammonia for all treatments.

Phase II

R. abronius control survival was 91% and 87% for the static and modified static-renewal test, respectively. The cadmium reference toxicant test produced an LC₅₀ of 0.54 mg/L cadmium, within the control limits established at the MSL and within one standard deviation of the control-chart mean. Because the reference toxicant LC₅₀ was within established limits and survival in most of the Ambrose test treatments was greater than 90%, the modified static-renewal test was considered valid.

Phase II results are presented in Table 3.8 and Appendix D, Tables D.13 through D.18. *R. abronius* mean survival was equal to or greater than 89% for both Ambrose 1 and 2 composites under both flow regimes. No significant ($\alpha = 0.05$) reductions relative to the control were detected. Water quality parameters were within acceptable ranges throughout both the static and modified static-renewal tests, with the exception of minor deviations in pH (Table D.16). Initial porewater ammonia concentrations were 43.5 mg/L and 31.4 mg/L total ammonia for Ambrose 1 and 2, respectively. In the static test, Day 10 porewater ammonia concentrations were 28.6 mg/L in the Ambrose 1 sediments and 16.4 mg/L in the Ambrose 2 sediment. In the modified static-renewal test Day 10 porewater ammonia concentrations were slightly lower, with 16.4 mg/L and 20.9 mg/L total ammonia in the Ambrose 1 and 2 sediments, respectively. In Ambrose composites, overlying water ammonia concentrations ranged from <1.00 mg/L to 14.2 mg/L total ammonia in the static test and from <1.00 mg/L to 3.70 mg/L total ammonia in the modified static-renewal test.

3.3.4. 10-Day Benthic Toxicity Tests with *Mysidopsis bahia*

Phase I

The Phase I mysid benthic toxicity test was conducted under static conditions. Results are reported as percentage of survival and are presented in Table 3.9 and Appendix B, Tables B.13 through B.16. Control survival was 91%, validating this test.

TABLE 3.9. Results of the Benthic Toxicity Tests with *M. bahia*

Sediment Treatment	Mean Proportion Survival ^(a)	SD ^(b)	Statistically Significant ^(c)	Biologically Significant ^(d)
<i>Phase I</i>				
<u>Static</u>				
<i>M. bahia</i> Control	0.91	0.07	NA ^(e)	NA
NYB-13	0.89	0.06	NO	NO
NYB-15	0.88	0.07	NO	NO
GSB-1	0.90	0.06	NO	NO
GSB-2	0.93	0.03	NO	NO
<i>Phase II</i>				
<u>MSR</u>				
<i>M. bahia</i> Control	0.93	0.06	NA	NA
Ambrose 1	0.96	0.07	NO	NO
Ambrose 2	0.98	0.03	NO	NO

(a) n = 100.

(b) SD Standard deviation.

(c) Significant reduction in survival at $\alpha=0.05$, relative to the control.(d) Significant reduction in survival at $\alpha=0.05$, and >10% reduction in survival, relative to the control.

(e) NA Not applicable.

The reference toxicant test produced a copper LC₅₀ of 269.8 µg/L Cu, within the control limits established at the MSL (132.5 µg/L to 343.1 µg/L Cu) and within one standard deviation of the mean control-chart response. This indicates that the population of mysids used in this test were as sensitive to copper as those previously tested at the MSL.

M. bahia survival in both GSB composites was 90% or above. Percentage of survival for NYB-13 and NYB-15 composites was 89% and 88%, respectively. No statistically significant ($\alpha=0.05$) differences were detected in any of the candidate reference composites, when compared with the control. Water quality parameters were within established limits throughout the test, with the exception of a minor deviation in pH (Table B.16). This deviation was not expected to have had an effect on this test. Porewater and overlying water ammonia concentrations were not monitored.

Phase II

The Phase II mysid tests were conducted under the modified static-renewal flow regime. Results are presented in Table 3.9 and Appendix D, Tables D.19 through D.22. Control survival was 93%, validating this test. The copper reference toxicant test produced an LC_{50} of 273.6 $\mu\text{g/L}$, within the the established control limits and within one standard deviation of the mean control response. Survival in both Ambrose composites was above 90%, and no significant reductions in survival were observed. Water quality parameters were within acceptable ranges throughout the 10-day test. Overlying water ammonia concentrations remained below 1.00 mg/L total ammonia throughout the 10-day test.

4.0 Discussion

This section summarizes the physical, chemical, and biological results of the Reference Site Selection Project. These characteristics of the potential reference sites are also discussed in relation to the reference site criteria listed in the Green Book and the Regional Guidance Manual.

4.1. Physical Characteristics and TOC

The current Mud Dump Reference Site, as defined by the NYD Regional Guidance Manual, is located approximately 2.6 miles southwest of the Mud Dump Site. The reference site lies along the southwestern edge of the Christiaensen Basin in approximately 20 m of water. Samples collected from the Mud Dump Reference Site were dominated (99%) by sand-sized sediments, with nominal amounts of clay. TOC values were quite low; TOC represented 0.01% of the material.

Stations NYB-13 and NYB-15 were located along the Hudson Shelf Valley, in the New York Bight. These stations were based on NOAA Stations 13 and 15 (Reid et al. 1991). NYB-13 was located approximately 20 nm southeast of Sandy Hook, New Jersey, and samples were collected in approximately 60 m of water. NYB-15 sediment was collected approximately 32 nm southeast of Sandy Hook, where samples were collected in approximately 70 m of water. At both stations, the sand-sized fraction of sediment was >67%, by weight. The remainder of the sediments were silt and clay. TOC values were 1.53% and 0.94% for Stations NYB-13 and NYB-15, respectively.

Stations GSB-1 and GSB-2 were located in the protected waters of the Great South Bay on the southern shore of Long Island. Samples from GSB-1 were collected off of Blue Point, near Bayport, New York. Station GSB-2 samples were collected off of Howell's Point, near Bellport, New York. Sampling depths for both stations were approximately 2 m to 3 m. Sediment was approximately 60% silt and 10% clay in both stations. The remainder of the material was sand in GSB-2 samples, whereas GSB-1 had a small amount of gravel (5%), as well as sand. TOC levels were 1.79% and 1.40% in GSB-1 and GSB-2 samples, respectively.

Stations Ambrose 1 and Ambrose 2 were located at the head of the Christiaensen Basin, northeast of the Ambrose Light. Samples for both Ambrose stations were collected at depths of 15 m to 24 m. Ambrose sediment was dominated by sand (>90% sand), with a fine-grained component present at both Ambrose stations (approximately 5%). TOC was 0.2%.

A single grab was collected from the Site C-2 (IV), also located along the Hudson Shelf Valley in 36 m of water. Sediment grain size and TOC characteristics at Site C-2 (IV), measured in a previous study, were similar to those of the Mud Dump Reference Site, with 99% sand and 0.06% TOC (EPA 1992).

4.2. Sediment Chemistry

Chemical parameters were analyzed during Phase I in the NYB, GSB, and Mud Dump Reference Site composites. Sediment from Site C-2 (IV) had been previously analyzed (EPA 1992). Analytes were metals, PAHs, pesticides, PCBs, and dioxins/furans. A chemical analysis of sediments collected at the Ambrose candidate reference sites were not included in this study, however sediment was archived for potential future analysis.

All analyzed metals were detected in all Phase I candidate reference site composites, as well as the Mud Dump Reference Site composite (except Ag). The highest concentrations were consistently found in the GSB-1 and NYB-13 composites. Concentrations of As, Cr, Pb, Ni, and Zn in GSB and NYB composites were less than one order of magnitude higher than those in the Mud Dump Reference Site, whereas concentrations of Ag, Cd, Cu, and Hg were higher by at least one order of magnitude.

PCBs and pesticides were either undetected or at very low levels in all Phase I candidate reference sediments, as well as in the proposed disposal site, Site C-2 (IV) (EPA 1992).

Dioxins and furans were detected in all of the Phase I candidate reference site sediments. Although not analyzed for in this study, the presence of dioxins and furans in the Mud Dump Reference Site sediment has been previously demonstrated (SAIC 1992). Concentrations ranged from less than detection limits to 0.31-2.32 pg/g TCDD and

0.37-2.23 pg/g TCDF dry weight. Several isomers, considered the most toxic by the EPA (1990), were detected in sediments collected from stations GSB-1 and NYB-13. Detected dry weight concentrations ranged from 0.66 pg/g to 2.38 pg/g TCDD; 0.99 pg/g to 1.17 pg/g PeCDD and 2.58 pg/g to 2.61 pg/g PeCDF. TCDD and PeCDD were not detected in NYB-15 or GSB-2 sediments but PeCDF was measured in both of these sediments. At Site C-2 (IV), TCDF was detected at 0.35 pg/g (EPA 1992). Other less toxic congeners were detected in all four candidate reference site composites with the highest levels associated with OCDD, a congener that is considered ubiquitous.

PAH concentrations were elevated in each of the GSB and NYB composites, relative to the Mud Dump Reference Site composite. Site C-2 (IV) had PAH concentrations that were comparable to the Mud Dump Reference Site (EPA 1992). The highest concentrations were again found in the GSB-1 and NYB-13 sediment. Both had over 27 times higher concentrations of total LPAHs and over 73 times higher concentrations total HPAHs than did the reference composite. Phenanthrene, fluoranthene, pyrene, and benzo[b]fluoranthene were the dominant PAH components.

Contaminant concentrations in the candidate reference sediments were compared with effects-based sediment quality criteria published by the New York State Department of Environmental Conservation (NYSDEC 1993) based on the lower of Long et al. (1995) and Persaud et al. 1992 (Table 4.1). For compounds without NYSDEC guidance, effects ranges from Long and Morgan (1993) were used. Most contaminants measured in this study were below concentrations predicted to cause biological effects. PAHs, PCBs, and pesticides (except dieldrin in NYB-13) were below low effect levels (LEL) in all sediments. Metals concentrations were also below LEL, with the exception of As, Cr, Cu, Hg and Pb for NYB-13 and GSB-1 which were above the LEL, but below the Severe Effect Level (SEL).

4.3. Biological Testing

Both static and modified static-renewal tests were performed with the amphipods, *A. abdita*, *L. plumulosus*, and *R. abronius*, and the mysid, *M. bahia*. No biologically significant toxicity (statistical significance [$\alpha = 0.05$] and >20% reduction in survival [>10% for mysids], relative to the control) was observed in any of the candidate reference site sediments with

TABLE 4.1. Sediment Contaminants Detected Above Guidance Levels.

Sediment Treatment	Compound	Concentration Found	Lowest Effect Level	Severe Effect Level
GSB-1	As ^(a)	7.74	6.0	33.0
	Cr ^(a)	26.9	26.0	110.0
	Cu ^(a)	21.6	16.0	110.0
	Hg ^(a)	0.237	0.15	1.3
	Pb ^(a)	46.3	31.0	110.0
GSB-2	As ^(a)	6.68	6.0	33.0
NYB-13	As ^(a)	7.75	6.0	33.0
	Cr ^(a)	31.1	26.0	110.0
	Cu ^(a)	19.5	16.0	110.0
	Hg ^(a)	0.250	0.15	1.3
	Pb ^(a)	38.2	31.0	110.0
	dieldrin ^(b)	0.86	0.02	8.0
C-2 (IV)	As ^(a)	8.38	6.0	33.0

(a) Effect levels from NYSDEC (1993).

(b) Effect levels from Long and Morgan (1990).

either the static or modified static-renewal tests. Statistically significant ($\alpha = 0.05$) toxicity was observed in the GSB-1 composite in tests with *A. abdita*; however, mean percent survival was not >20% lower than the control survival. Statistically significant toxicity ($\alpha = 0.05$) was also observed in all GSB and NYB composites in the modified static-renewal tests with *R. abronius*; however, survival was $\geq 80\%$ in all GSB and NYB composites. No significant reductions ($\alpha = 0.05$) in amphipod or mysid survival were observed in the Ambrose or C-2 (IV) composites and survival was $\geq 89\%$ for all species in both flow-regimes.

No differences in amphipod survival were observed between the static and modified static-renewal flow regimes for any of the candidate reference sites. The finding of no biologically significant toxicity in any of the test treatments was consistent with the relatively low load of contaminants in each of the candidate reference site sediments.

4.4. Reference Site Selection

As defined in Section 1.6 of the Green Book, reference sediment should be "[1] substantially free of contaminants, [2] as similar as practical to the grain size of the dredged material and the sediment of the disposal site, and [3] similar to conditions that would exist in the vicinity of the disposal site had no dredged-material disposal ever taken place, but had all other influences on sediment condition occurred" (EPA/USACE 1991). Contaminant burdens, grain size, TOC, and candidate reference site location are discussed below, relative to these guidelines.

4.4.1. Sediment Contaminant Burdens

Relative to those of the Mud Dump Reference Site composite, the contaminant burdens of the Phase I candidate reference site composites were elevated for metals and PAHs. Metals concentrations were also elevated in candidate reference site composites relative to the background levels seen in the New York Bight (see Table 3.3). Composites GSB-1 and NYB-13 consistently had higher metals and PAH concentrations when compared with composites NYB-15 and GSB-2. This may be due to localized natural and anthropogenic sources or physical sediment properties unique to these sites. Of the candidate reference site sediments analyzed, composites GSB-2 and NYB-15 had the lowest contaminant burdens and more closely met the Green Book criteria of a site substantially free of contaminants. None of the sediments analyzed had contaminant concentrations predicted to elicit biological effects, with the exception of dieldrin, As, Cr, Cu, Hg and Pb in sediments NYB-13 and GSB-1 which were slightly above the LEL but below the SEL (Table 4.1). This finding was supported by the lack of *biologically* significant benthic toxicity using three amphipod species and one mysid shrimp species.

4.4.2. Grain Size

The mean grain size of the current and candidate reference sites were compared with those of sediments collected from 27 proposed dredge sites located in New York/New Jersey waterways and 12 stations within the Mud Dump Site collected after dredged-material disposal activities (Charles and Muramoto 1991). A ternary plot of sediment characteristics (Figure 4.1) reveals that the grain-size at the Mud Dump Reference Site, the Ambrose candidate reference

sites and the proposed disposal site, C-2 (IV), was sand dominated. New York Bight candidate reference site sediments were characterized as silty sand; whereas Great South Bay candidate reference site sediments had sandy-silt sediments. Sediment grain-size at the Mud Dump Site, prior to disposal, is believed to have been predominantly sand (Muramoto and Carey 1991). Currently, the Mud Dump Site is characterized by highly variable sediment grain size, ranging from sand to silty clay (Charles and Muramoto 1991). This may be a result of the disposal of fine-grained dredged-material and coarse-grained capping materials on top of the remaining native sediment. Sediment from the proposed dredged sites included a variety of grain-size classes, ranging from silty sand to silty clay.

Cluster analysis, the grouping of stations with similar grain-size distributions, produced three large dissimilar clusters, Groups A, B, and C. The dendrogram in Figure 4.2 was derived from clustering similarity values estimated by the calculated average distance between pairs of observations, one in each cluster. The largest cluster, termed Group C, could be further divided into subgroups C1 and C2 each consisting of 11 and 10 stations, respectively, and subgroup C3 consisting of 6 stations. These clusters were subsequently superimposed on the ternary grain-size plot (Figure 4.1).

The nine sediments in Group A were those collected from the Mud Dump Reference Site, the Ambrose candidate reference sites, and Site C-2 (IV) and five stations from the southeast and northwest corners of the 1991 Mud Dump Site. Group A was characterized by >85% sand, with little silt or clay. The sandy grain-size characteristics of Group A match the sediment grain size reported to exist at the Mud Dump Site prior to dredged-disposal activities (Muramoto and Carey 1991). None of the 27 proposed sediments from the New York/New Jersey waterways was included in Group A.

Group B contained candidate reference sites NYB-13 and NYB-15, as well as two stations in the northern 1991 Mud Dump Site and the proposed dredge sites Hackensack River (Reach A), Claremont (Reach A), Bay Ridge (Reach B), Red Hook, and Brown's Creek. Group B sediments were loosely linked and were characterized by silty sand or clayey sand. Similarities in this group were driven primarily by the sand fraction, which ranged from 48% to 74% of the total material.

FIGURE 4.1. Grain-Size Distribution of Candidate Reference Sites and Proposed Dredge Sites

FIGURE 4.2. Dendrogram of Similarity Clusters of Candidate Reference Sites and Proposed Dredge Sites

Group C contained candidate reference sites GSB-1 and GSB-2, as well as four of the 1991 Mud Dump Site stations and 20 of the proposed dredge sites. Group C sediments were loosely linked, driven primarily by the silt fraction (45% mean percent silt), with varying amounts of sand and clay. Subgroup C1 included the proposed dredge sites Arthur-Kill (Reaches A and C), Port Elizabeth (Reaches A and B), Raritan River, Claremont (Reach B), Bay Ridge (Reach A), Hudson River (Reach D) and South Brothers Island (Reaches A and B). Subgroup C1 was characterized by silty-clay sediments, with very little coarse material. Subgroup C2 included the proposed dredge sites Arthur-Kill (Reach B), Liberty Island, Hudson River (Reaches A, B and C), Claremont (Reach C), Port Jersey (Reach A and B) and MOTBY (Reach A and B). Sediment in subgroup C2 was characterized by sandy or clayey silt. Subgroup C3 included the candidate reference sites GSB-1 and GSB-2 and four stations in the southern portion of the 1991 Mud Dump Site. This small group was characterized by silty sand with small amounts of clay.

With respect to grain size, the current Mud Dump Reference Site, the Ambrose proposed reference sites, and Site C-2 (IV) were similar to the Mud Dump Site prior to dumping and specific regions of the current Mud Dump Site, but were not similar to sediments collected from the New York/New Jersey waterways. The NYB and GSB candidate reference sediments were similar to many of the proposed dredge sites and specific regions of the current Mud Dump Site, but were dissimilar to the pre-disposal Mud Dump Site.

4.4.3 TOC

Percentage of TOC, the measure of organic material associated with sediments, was similar for all the NYB and GSB candidate reference site sediments, ranging from 1% to 2% of the sediment material, by weight. Both Ambrose stations had approximately 0.2% TOC. There was virtually no organic carbon in the sand-dominated Mud Dump Reference Site and Site C-2 (IV) sediment composites. Sediment at the Mud Dump Site, prior to dredged-material disposal, was presumably low in TOC, typical of sand-dominated sediment. Currently, TOC at the Mud Dump Site ranges from 1% to 34% (Muramoto and Carey 1991). With respect to TOC, the current Mud Dump Reference Site, the Ambrose candidate reference sites, and Site C-2 (IV) were similar to the Mud Dump Site prior to

dumping and specific regions of the 1991 Mud Dump Site. TOC in the NYB and GSB candidate reference site sediments were similar to the TOC of the New York/New Jersey waterways (2% to 10% TOC).

4.4.4 Marine Influences and Reference Site Location

The Mud Dump Site is located in the New York Bight Apex, a subregion of the New York Bight. The New York Bight is bounded by Montauk Point, New York on the northeast and Cape May, New Jersey on the southwest and by the 200-m contour on the shelf edge. Within the Bight, the Hudson Shelf Valley, a submerged river valley, extends southward from the Christiaensen Basin and is the dominant physiographic feature in the region. The Christiaensen Basin is a shallow (25 m to 40 m) amphitheater-shaped feature that forms the head of the Hudson Shelf Valley. The northwest corner of the Bight, known as the New York Bight Apex, extends to the head of the Hudson Shelf Valley and includes the upper Hudson Shelf Valley, the Christiaensen Basin, as well as the Mud Dump Site, de-designated acid-waste 12-mile sewage-sludge and cellar-dirt dumpsites.

Sediment transport in the Apex is driven by both continental shelf and coastal waters. Along-shelf currents move sediment southward across the region, whereas strong seasonal currents and storm surges move up and down the Hudson Shelf Valley and can redistribute fine-grained materials across the entire region or further down the Valley (Muramoto and Carey 1991; Boesch 1982). Regional coastal influences include riverine and estuarine input from the New Jersey and Long Island shores and are dominated by the Hudson-Raritan estuary. However, much of this sediment remains trapped in the estuaries and does not move into the Bight (Muramoto and Carey 1991). Other important sources of fine-grained material within the Apex include the disposal of dredged-material and cellar dirt and the historic disposal of sewage sludge. These dumpsites are located at the head of the Hudson Shelf Valley.

The seabed along the New Jersey and Long Island shores and throughout most of the New York Bight is dominated by clean, sandy sediments (Carriker et al. 1982). The Christiaensen Basin and the Hudson Shelf Valley are considered to be sinks for most of the suspended fine material in the Apex (Boesch 1982). In these areas, concentrations of metals and coprostanol, an indicator of sewage sludge, are higher than the surrounding areas

(Muramoto and Carey 1991). Other areas which feature fine-grained sediments are the Mud Dump Site and the former sewage-sludge dumpsite. Within the Bight, only the Christiaensen Basin and the Mud Dump Site are reported to have sediment with over 50% mud content. In other areas short-term mud patches can develop between sand-ridges, as a result of sediment resuspension (Muramoto and Carey 1991).

The Mud Dump Site, the current Mud Dump Reference Site, Site C-2 (IV) and the Ambrose candidate reference sites are located within the New York Bight Apex. All of these sites would be subject to the same water masses, currents, and sediment sources as the Mud Dump Site; however, Site C-2 (IV) and the Ambrose candidate reference site are further removed from potential influences from the Apex dumpsites than the current Mud Dump Reference site.

Candidate reference sites NYB-13 and NYB-15 were located in the Bight, along the Hudson Shelf Valley approximately 20 nm and 32 nm from the New York/New Jersey Harbor entrance. These sites are likely to receive similar shelf influences; however, they are further removed from the direct influences of the Hudson-Raritan estuary and the Apex dumpsites.

The Christiaensen Basin and upper Hudson Shelf Valley were not considered for a candidate reference site because of their proximity to dredged-material and former sewage-sludge disposal sites. Furthermore, elevated levels of metals and organic contaminants have been observed in these areas (Muramoto and Carey 1991). Since the Christiaensen Basin and the upper Hudson Shelf Valley are the primary sources of fine-grained material in the New York Bight, a clean silt-dominated sediment was not expected to be found in the Bight. Therefore, the Great South Bay candidate reference sites were chosen as a potential fine-grained alternative. These sites would be expected to have similar estuarine influences and sediment characteristics to the dredged-material from the New York/New Jersey Harbor complex. They are not, however, located in the same body of water as the Mud Dump Site and would not be expected to be subject to the same water masses, currents, and sediment sources as the Mud Dump Site or the New York Bight.

4.5. Conclusions

Phase I

The results of the Phase I toxicity tests indicated that *A. abdita*, *L. plumulosus*, and *R. abronius* amphipod survival was not significantly reduced when the organisms were exposed to sediments with >95% sand. Thus, candidate reference sites with >95% sand could be considered acceptable for acute toxicity testing.

Based on Phase I evaluations, both the New York Bight and Great South Bay candidate reference sites were characterized as finer-grained sediments than the current Mud Dump Reference Site. NYB-15 would be the most appropriate silty-sand sediment. It was substantially free of contaminants, had high survival in the biological tests, and had physico-chemical properties that were bracketed by those of the Mud Dump Site and the New York/New Jersey waterways. Additionally, it is in the same water body as the Mud Dump Site and receives similar marine influences. However, NYB-15 is located 32 nm from Sandy Hook, New Jersey and sediment collection from this site could represent substantial costs and logistical problems.

Candidate reference site GSB-2 may be the most appropriate site for evaluations requiring >50% silt/clay. Site GSB-2 was substantially free of chemical contamination, it had high survival in the biological tests, and it was similar in grain size to many of the New York/New Jersey proposed dredging sites. The disadvantages of this site are that its physico-chemical properties are different than those of the the Mud Dump Site prior to commencement of dumping activities and it is not subject to the same water masses, currents, and sediment sources as the Mud Dump Site.

Site C-2 (IV) was a coarse-grained sediment, similar to the Mud Dump Reference Site. Site C-2 (IV) was free of contaminants, had high amphipod and mysid survival, and receives similar marine influences as the Mud Dump Site.

Phase II

Of the Phase II candidate reference sites analyzed, both Ambrose I and II were acceptable. High amphipod survival was observed in these two sediments and the sandy sediment at these stations is similar to that of the pre-disposal Mud Dump Site. Additionally, the Ambrose stations are located in the same water body as the Mud Dump Site, and are exposed to similar marine influences. If further chemical analyses indicate that the Ambrose sites are "substantially free of contaminants," these sites represent a suitable reference site, as defined in the Green Book.

5.0 References

ASTM (American Society for Testing and Materials). 1972. *Standard Method for Particle-Size Analysis of Soils: Procedure D 422*. American Society for Testing and Materials, Philadelphia, Pennsylvania.

ASTM (American Society for Testing and Materials). 1985. *Standard Method for Wet Preparation of Soils Samples for Particle-Size Analysis of Soils: Procedure D 2217*. American Society for Testing and Materials, Philadelphia, Pennsylvania.

Boesch, D.F. 1982. "Ecosystem consequences of alterations of benthic community structure and function in the New York Bight region." In G.F. Mayer, ed., *Ecological Stress and the New York Bight: Science and Management*. University of South Carolina, Columbia, South Carolina.

Blanton, M. L., W. W. Gardiner, and R. L. Dirkes. 1994. *Environmental Monitoring of the Columbia River Near the Hanford Site: Utility of Sediment Characterization*. Presented at the 15th Annual Society of Toxicology and Chemistry (SETAC) meeting in Denver, Colorado (abstract).

Carriker, M.R., J.W. Anderson, W.P. Davis, D.R. Franz, G.F. Mayer, J.B. Pearce, T.K. Sawyer, J.H. Tietjen, J.F. Timony, and D.R. Young. 1982. "Effects of Pollutants on Benthos". In G.F. Mayer, ed., *Ecological Stress and the New York Bight: Science and Management*. University of South Carolina, Columbia, South Carolina.

Dunnett, C. W. 1964. "New Tables for Multiple Comparisons with a Control." *Biometrics* 20:482-491.

Dewitt, T.H., M.S. Redmond, J.E. Sewall, and R.C. Schwartz. 1992. Development of a Chronic Sediment Toxicity Test for Marine Benthic Amphipods. CBP/TRS/89/93. U.S. Environmental Protection Agency, Region II, Office of Research and Development, Washington, D.C.

EPA (U.S. Environmental Protection Agency). 1986a. *Determination of Total Organic Carbon in Sediment*. U.S. Environmental Protection Agency, Region II, Environmental Services Division, Monitoring Management Branch, Edison, New Jersey.

EPA (U.S. Environmental Protection Agency). 1986b (Revised 1990). *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846*. 3rd ed. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency). 1990. *Method 8290 Analytical Procedures and Quality Assurance for Multimedia Analysis of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans by High Resolution Gas Chromatography/High Resolution Mass Spectrometry*. U.S. Environmental Protection Agency, Washington, D.C.

EPA (U.S. Environmental Protection Agency). 1991. *Methods for the Determination of Metals in Environmental Samples*. EPA/600/4-91/010. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

EPA (U.S. Environmental Protection Agency). 1992. *Chemical Analysis of Tissue and Sediment from Potential Disposal Areas in the New York Bight, Summer Survey, August 1992*. Contract No. 68-C8-0105. Report Prepared by Battelle Ocean Sciences under Contract to U.S. Environmental Protection Agency, Oceans and Coastal Protection Division, Washington, D.C.

EPA (U.S. Environmental Protection Agency). 1994. *Methods for Assessing the Toxicity of Sediment-associated Contaminants with Estuarine and Marine Amphipods*. EPA/600/R-94/025. U.S. Environmental Protection Agency, Office of Research and Development, Washington D.C.

EPA/USACE (U.S. Environmental Protection Agency/U.S. Army Corps of Engineers). 1991. *Evaluation of Dredged Material Proposed for Ocean Disposal (Testing Manual)*. EPA-503/8-91/001. U.S. Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, D.C.

Finney, D. J. 1971. *Probit Analysis*. 3rd ed. Cambridge University Press, Boston, Massachusetts.

Long E.R. and L.G. Morgan. 1990. *The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the National Status and Trends Program*. National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum NOS OMA 52.

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

MSL (Battelle Marine Sciences Laboratory). 1994. *Work/Quality Assurance Project Plan: Reference Site Selection (Phases I and II) and Additional Sampling at Sites in the Raritan River and Site C2*. Contract DE-AC06-76ARLO 1830. Prepared for the U.S. Army Corps of Engineers, New York District, by Battelle Marine Sciences Laboratory, Pacific Northwest National Laboratory, Richland, Washington.

Muramoto, J. and D.A. Carey. 1991. *A Review of Studies of Metal and Organic Contaminants in Sediments and Biota of the New York Bight Apex and Mud Dump Site*. Prepared by Science Applications International Corporation (SAIC) for the Environmental Protection Agency, SAIC, Newport, Rhode Island.

NOAA (National Oceanic and Atmospheric Administration). 1993. *Sampling and Analytical Methods for the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984-1992. Volume IV. Comprehensive Descriptions of Trace Organic Analytical Methods*. G.G. Lauenstein and A. Y. Cantillo, eds. NOAA Technical Memorandum NOS ORCA 71. National Oceanic and Atmospheric Administration, Coastal Monitoring and Bioeffects Assessment Division, Office of Ocean Resources Conservation and Assessment, Silver Spring, Maryland.

NYSDEC (New York State Department of Environmental Conservation). 1991. *Analytical Method for the Determination of PCB Congeners by Fused Silica Capillary Column Gas Chromatography with Electron Capture Detector (FSCC/GC/EC)*. NYSDEC Method 91-11. New York State Department of Environmental Conservation, New York, New York.

NYSDEC (New York State Department of Environmental Conservation). 1993. *Technical Guidance for Screening Contaminated Sediment*. New York State Department of Environmental Conservation, New York, New York.

Plumb, R. H., Jr. 1981. *Procedure for Handling and Chemical Analysis of Sediment and Water Samples*. Tech. Rep. EPA/USACE-81-1. Prepared by Great Lakes Laboratory, State University College at Buffalo, New York, for the U.S. Environmental Protection Agency/U.S. Army Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Reid, R.N., D.J. Radosh, A.B. Frame, and S.A. Fromme. 1991. *Benthic Macrofauna of the New York Bight, 1979-89*. NOAA Tech. Rep. MNFS 103. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Sandy Hook Laboratory. Highlands, New Jersey.

SAIC (Science Applications International Corporation). 1992. *Sediment/Tissue Baseline Surveys New York Mud Dump Site Dioxin Capping Monitoring Project*. Prepared for the U.S. Corps of Engineers, New York District, by Science Applications International Corporation, Newport, Rhode Island.

Tondeur, Y. 1987. *Method 8290 Analytical Procedures and Quality Assurance for Multimedia Analysis of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans by High-Resolution Gas Chromatography/High Resolution Mass Spectrometry*. Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

USACE-NYD/EPA Region II (U.S. Army Corps of Engineers, New York District/Environmental Protection Agency, Region II). 1992. *Guidance for Performing Tests on Dredged Material Proposed for Ocean Dumping*. Draft. December 1992. U.S. Army Corps of Engineers, New York District, New York.

APPENDIX A

PHASE I SEDIMENT CHEMISTRY DATA AND QUALITY CONTROL DATA

QA/QC SUMMARY

PROGRAM: New York Reference Site Selection Project- Phase I and II
PARAMETER: Grain Size
LABORATORY: Soil Technology, Bainbridge Island, Washington
MATRIX: Sediment

QA/QC DATA QUALITY OBJECTIVES

<u>Reference Method</u>	<u>Range of Recovery</u>	<u>Relative Precision</u>	<u>Detection Limit (dry wt)</u>
Plumb 1981	Not Applicable	Not Applicable	1.0%

METHODS Four grain size fractions were determined by a combination of sieve and pipet techniques. An additional measurement for salt content was performed and each grain size fraction was corrected for this salt measurement.

HOLDING TIMES All samples were analyzed within the specified 6-month holding period.

DETECTION LIMITS The target detection limit of 1.0% was met for all samples.

METHOD BLANKS Not Applicable.

MATRIX SPIKES Not Applicable.

REPLICATES Not Applicable.

SRMs Not Applicable.

REFERENCES

Plumb, R. H., Jr. 1981. *Procedure for Handling and Chemical Analysis of Sediment and Water Samples*. Tech. Rep. EPA/CE-81-1. Prepared by Great Lakes Laboratory, State University College at Buffalo, New York, for the U.S. Environmental Protection Agency/U.S. Army Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

QA/QC SUMMARY

PROGRAM: New York Reference Site Selection Project
PARAMETER: Total Organic Carbon (TOC)
LABORATORY: Battelle/Marine Sciences Laboratory, Sequim, Washington
MATRIX: Sediment

QA/QC DATA QUALITY OBJECTIVES

	<u>Reference Method</u>	<u>Range of Recovery</u>	<u>SRM Accuracy</u>	<u>Relative Precision</u>	<u>Detection Limit (dry wt)</u>
TOC	EPA 1986	NA	≤20%	≤10%	0.1%

HOLDING TIMES All samples were analyzed within the specified 6-month holding period.

DETECTION LIMITS The target detection limit of 0.1% was met for all samples.

METHOD BLANKS The method blanks that were analyzed (n=4) had concentrations ranging from 0.003 to 0.005%. Because these are less than the detection limit, no blank correction was required.

MATRIX SPIKES NA

REPLICATES Precision for triplicate analyes is reported by calculating the relative standard deviation (RSD) between the replicate results. The RSD value was 3%, which was within the QC limits of $\pm 10\%$ and indicates good precision. The relative percent differencd (RPD) for duplicate sample analysis was 5%, less than the QC limits of $\pm 10\%$.

SRMs SRM, MESS-1, obtained from the Natrional Research Council of Canada (NRCC), was analyzed with the sediment samples. The SRM was measured at 2.64% which agrees with the certified value of 2.6%.

REFERENCES

EPA (U.S. Environmental Protection Agency). 1986. *Determination of Total Organic Carbon in Sediment*. U.S. Environmental Protection Agency, Region II, Environmental Services Division, Monitoring Management Branch, Edison, New Jersey.

QA/QC SUMMARY

PROGRAM: New York Reference Site Selection Project
PARAMETER: Metals
LABORATORY: Battelle/Marine Sciences Laboratory, Sequim, Washington
MATRIX: Sediment

QA/QC DATA QUALITY OBJECTIVES

	<u>Reference Method</u>	<u>Range of Recovery</u>	<u>SRM Accuracy</u>	<u>Relative Precision</u>	<u>Detection Limit (dry wt)</u>
Arsenic	ICP/MS	75-125	≤20%	≤20%	0.1
Cadmium	ICP/MS	75-125	≤20%	≤20%	0.01
Chromium	ICP/MS	75-125	≤20%	≤20%	0.02
Copper	ICP/MS	75-125	≤20%	≤20%	0.1
Lead	ICP/MS	75-125	≤20%	≤20%	0.1
Mercury	CVAA	75-125	≤20%	≤20%	0.02
Nickel	ICP/MS	75-125	≤20%	≤20%	0.1
Silver	GFAA	75-125	≤20%	≤20%	0.1
Zinc	ICP/MS	75-125	≤20%	≤20%	0.1

METHOD Nine (9) metals were analyzed for the New York Reference Site project: silver (Ag), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb) and zinc (Zn). Hg was analyzed using cold-vapor atomic absorption spectroscopy (CVAA) according to EPA Method 245.5 (EPA 1991). One metal, Ag, was analyzed using Zeeman Graphite Furnace Atomic Absorption (GFAA) spectrometry following the EPA Method 200.9 (EPA 1991). The remaining metals were analyzed by inductively-coupled plasma mass spectrometry (ICP/MS) following SOP MSL-M-025, Metals and Trace Elements in Sediment and Tissue by ICP/MS which is based on EPA method 200.8 (EPA 1991)

To prepare sediment samples for analysis, samples were freeze-dried and blended in a Spex mixer-mill. Approximately 5 g of mixed sample was ground in a ceramic ball mill. For ICP/MS, GFAA and CVAA analyses, 0.2- to 0.5-g aliquots of dried homogenous sample were digested using a mixture of nitric and hydrochloric acids and hydrogen peroxide following EPA Method 200.2 (EPA 1991).

QA/QC NARRATIVE/ SEDIMENT METALS (continued)

HOLDING TIMES	Sixteen sediment samples (including some from another project) were received on 10/21/93 in good condition. Samples were logged into Battelle's log-in system, frozen to -80°C and subsequently freeze dried within approximately 7 days of sample receipt. Samples were all analyzed within 180 days of collection. Samples were digested on 11/08/93. ICP-MS analysis was performed on 12/15/93, CVAA-Hg analysis was performed on 11/17/93, and GFAA-Ag analysis was performed on 12/02/93.
DETECTION LIMITS	Achieved detection limits from the method detection limit verification study were determined from four replicate analyses of a sample, and they were calculated as the standard deviation times Students' t value ($\alpha=0.99$). Target detection limits were exceeded for some metals, however; metals were detected above the MDLs in all samples.
METHOD BLANKS	One method blank was analyzed. Levels detected were greater than 3 times the target detection limits for As, Cr, Cd, Pb and Zn, however, the levels in the blanks were on the order of 3 to 1000 times lower than the levels in the samples. Therefore, no corrective action was taken and no data were flagged. All data is blank corrected.
MATRIX SPIKES	One sample was spiked with all nine metals. All recoveries were within the QC limits of 75-125% with the exception of Cr. This is most likely due to the digestion method, which uses a relatively weak acid digestion. Recovery of Cr was low and may have resulted in underestimates of actual concentrations in sediment.
REPLICATES	One sample was digested and analyzed in triplicate. Precision for triplicate analyses is reported by calculating the relative standard deviation (RSD) between the replicate results. RSD values ranged from 2 to 15%, all within the QC limits of $\pm 20\%$, indicating good precision.
SRMs	SRM, 1646a (Estuarine sediment from the National Institute of Standards and Technology, NIST), was analyzed for all metals. Results for As, Cd and Cu were within $\pm 20\%$ of mean certified value. Values for the remaining metals were low (except for the Hg value, which was high). This is most likely due to the digestion method which is not as strong as that used to certify the SRM. Therefore, no corrective actions were taken. A second SRM, BEST-1, (sediment obtained from the National Research Council of Canada, NRCC) was analyzed for Hg only. Results were within the control limits.

REFERENCES

EPA (U.S. Environmental Protection Agency). 1991. *Methods for the Determination of Metals in Environmental Samples*. EPA-600/4-91-010. Environmental Services Division, Monitoring Management Branch, Washington, D.C.

QA/QC SUMMARY

PROGRAM: New York Reference Site Selection Project
PARAMETER: Chlorinated Pesticides
LABORATORY: Battelle/Marine Sciences Laboratory, Sequim, Washington
MATRIX: Sediment

QA/QC DATA QUALITY OBJECTIVES

	<u>Reference</u> <u>Method</u>	<u>MS/MSD</u> <u>Recovery</u>	<u>Surrogate</u> <u>Recovery</u>	<u>SRM</u> <u>Accuracy</u>	<u>Relative</u> <u>Precision</u>	<u>Detection</u> <u>Limit (dry wt)</u>
Pesticides	GC/ECD	50-120	30-150%	≤40%	≤30%	1 ng/g

METHOD

A 20 gram (wet wt) aliquot of sediment samples were extracted and analyzed according to a procedure similar to EPA Method 8080 (EPA 1986) for pesticides and the New York State Department of Environmental Conservation (NYSDEC) Congener-Specific Method 91-11 (NYSDEC 1992) for PCB analysis. Sediment was first combined with sodium sulfate in a sample jar to remove water. Samples were extracted by adding successive portions of methylene chloride and agitating sample jars at ambient temperature using a roller technique. Extract volumes were reduced and solvent-exchanged to hexane, followed by Florisil-column chromatography cleanup. Interferences were removed using high-performance liquid chromatography (HPLC) cleanup. Sample extracts were concentrated and analyzed using gas chromatography-electron capture detection (GC-ECD) by the internal standard technique. The column used was a J&W DB-17 and the confirmatory column was a DB-1701, both capillary columns (30m x 0.25mm I.D.).

HOLDING TIMES

Sixteen sediment samples were received on 10/21/93 in good condition. Nine of the samples were archived per instructions from the client; however, one sample intended to be archived was analyzed as the triplicate. Therefore, data for this sample are also reported. A total of 8 samples were analyzed. Samples were logged into Battelle's log-in system, and held frozen until analysis. Samples were extracted on 11/4/93 and analyzed between 11/16/93 and 11/22/93. All sample extracts were analyzed within 40 days of extraction.

DETECTION LIMITS

Target detection limits of 1.0 ng/g dry wt were met for all chlorinated pesticide compounds. A verification of the MDLs was performed by

QA/QC NARRATIVE/ SEDIMENT Pesticides (contd)

analyzing 4 replicates spiked at a low level and multiplying the standard deviation of the results by 3.5. All verification detection limits were below the target detection limit of 1 ng/g dry wt.

METHOD BLANKS

One method blank was extracted with the samples. No pesticides were detected in the method blank. It should be noted that a portion of the blank extract was lost during extraction as indicated by the low surrogate recoveries and therefore, the blank values may be underestimated. Blank spike recoveries, however, were all less than 100%, and if there were significant blank contamination, the spike recoveries calculated based on the blank non-detects reported would be high. Since this is not the case, it is unlikely that there were any significant detections in the method blank. The only compound that had a blank spike recovery of >100% was 4,4'-DDT and in general, this compound was either not detected in the samples or was detected at levels so high the samples had to be diluted.

SURROGATES

Two compounds, PCB congeners 103 and 198 were added to all samples prior to extraction to assess the efficiency of the analysis and to quantify the analytes. Recoveries of all surrogates were within the quality control limits of 30-150% with the exception of the recoveries for the procedural blank. This is because a large portion of the blank sample extract was lost during extraction. The analytes in this sample were quantified by external standard. Although the blank results should be considered estimates and may be underestimated based on the surrogate recoveries, the fact that the blank spike recoveries were all less than 100% indicates that there were not significant levels of pesticides in the blank as described above.

MATRIX SPIKES

One sample was spiked with 11 pesticides and did not include the 2,4' DDT series. Matrix spike recoveries for 4 of the 7 spiked compounds were well below the lower recovery limit (50-120%). This was due to the high native levels of pesticides and PCBs in the authentic sample. Many of the PCB congeners coelute with individual pesticides making the spike recovery calculations at the levels spiked unuseable for QC purposes.

BLANK SPIKES

The method blank from each batch was also spiked in duplicate with a subset of 11 pesticides prior to extraction. Recoveries for all compounds with the exception of 4,4'-DDT and heptachlor, were within the QC limits of 40-120% in at least one of the blank spikes.

QA/QC NARRATIVE/ SEDIMENT Pesticides (contd)

4,4'DDT was recovered only slightly above the upper limit in one of the spikes. Heptachlor epoxide appeared to be affected by the copper used to reduce sulfur contamination in the extract clean-up step and was not recovered at all in the blank spike.

REPLICATES

One sample was extracted in triplicate. Precision was measured by calculating the relative standard deviation (RSD) between the replicate results. No pesticides were detected in any of the replicates, therefore no RSDs were calculated.

REFERENCES

NYSDEC (New York Department of Environmental Conservation). 1992. *Analytical Method for the Determination of PCB congeners by Fused Silica Capillary Column Gas Chromatography with Electron Capture Detector*. NYSDEC Method 91-11. New York State Department of Environmental Conservation, Albany, New York.

EPA (U.S. Environmental Protection Agency). 1986. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*. SW-846. U.S. Document No. 955-001-00000, U.S. Environmental Protection Agency, Washington D. C.

QA/QC SUMMARY

PROGRAM: New York Reference Site Selection Project
PARAMETER: PCB Congeners
LABORATORY: Battelle/Marine Sciences Laboratory, Sequim, Washington
MATRIX: Sediment

QA/QC DATA QUALITY OBJECTIVES

	<u>Reference</u> <u>Method</u>	<u>MS/MSD</u> <u>Recovery</u>	<u>Surrogate</u> <u>Recovery</u>	<u>SRM</u> <u>Accuracy</u>	<u>Relative</u> <u>Precision</u>	<u>Detection</u> <u>Limit (dry wt)</u>
PCBs	GC/ECD	50-120	30-150%	≤40%	≤30%	1 ng/g

METHOD

A 20 gram (wet wt) aliquot of sediment samples were extracted and analyzed according to a procedure similar to EPA Method 8080 for pesticides and the New York State Department of Environmental Conservation (NYSDEC) Congener-Specific Method 91-11 (NYSDEC 1992) for PCB analysis. Sediment was first combined with sodium sulfate in a sample jar to remove water. Samples were extracted by adding successive portions of methylene chloride and agitating sample jars at ambient temperature using a roller technique. Extract volumes were reduced and solvent-exchanged to hexane, followed by Florisil-column chromatography cleanup. Interferences were removed using high-performance liquid chromatography (HPLC) cleanup. Sample extracts were concentrated and analyzed using gas chromatography with electron capture detection (GC-ECD) by the internal standard technique. The column used was a J&W DB-17 and the confirmatory column was a DB-1701, both capillary columns (30m x 0.25mm I.D.).

HOLDING TIMES

Sixteen sediment samples were received on 10/21/93 in good condition. Nine of the samples were archived per instructions from the client, however; one of the samples intended to be archived was analyzed as the triplicate, therefore data for this sample are also reported. A total of 8 samples was analyzed. Samples were logged into Battelle's log-in system, and held frozen until extraction. Samples were extracted on 11/04/93 and analyzed on 11/17/93 and 11/22/93. All sample extracts were analyzed within 40 days of extraction.

QA/QC NARRATIVE/ SEDIMENT PCBs (contd)

DETECTION LIMITS	Target detection limits of 1.0 ng/g dry wt were met for all PCB congeners. A verification of the MDLs was performed by analyzing 4 replicates spiked at a low level and multiplying the standard deviation of the results by 3.5. All verification detection limits were below the target detection limit of 1 ng/g dry wt.
METHOD BLANKS	One method blank was extracted with the samples. Only one PCB (PCB 170) was detected in the method blank. It should be noted that a portion of the blank extract was lost during extraction as indicated by the low surrogate recoveries and therefore, the blank values may be underestimated. Blank spike recoveries, however, were all within 86-112%, and if there were significant blank contamination, the spike recoveries calculated based on the blank non-detects reported would be high. Since this is not the case, it is unlikely that there were any significant detections in the method blank.
SURROGATES	Two compounds, PCB congeners 103 and 198 were added to all samples prior to extraction to assess the efficiency of the analysis and to quantify the analytes. Recoveries of all surrogates were within the quality control limits of 30-150% with the exception of the recoveries for the procedural blank. This is because a large portion of the blank sample extract was lost during extraction. The analytes in this sample were quantified by external standard. Although the blank results should be considered estimates and may be underestimated based on the surrogate recoveries, the fact that the blank spike recoveries were all near 100% indicates that there were not significant levels of PCBs in the blank.
MATRIX SPIKES	One sample was spiked with a subset of 5 PCB congeners. Matrix spike recoveries ranged from 82 to 128%. Two of the recoveries were slightly above the upper recovery limit (50-120%).
BLANK SPIKES	The method blank from each batch was also spiked in duplicate with a subset of 5 PCB congeners prior to extraction. Recoveries ranged from 86 to 112% and were within the QC limits of 40-120%.
REPLICATES	One sample was extracted in triplicate. Precision was measured by calculating the relative standard deviation (RSD) between the replicate results. No PCBs were detected in any of the replicates; therefore, no RSDs were calculated.

REFERENCES

NYSDEC (New York Department of Environmental Conservation). 1992. *Analytical Method for the Determination of PCB congeners by Fused Silica Capillary Column Gas Chromatography with Electron Capture Detector*. NYSDEC Method 91-11. New York State Department of Environmental Conservation, Albany, New York.

EPA (U.S. Environmental Protection Agency). 1986. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*. SW-846. U.S. Document No. 955-001-00000, U.S. Environmental Protection Agency, Washington D. C.

QA/QC SUMMARY

PROGRAM: New York Reference Site Selection Project, Phase I
PARAMETER: Dioxins/Furans
LABORATORY: Battelle/Columbus Operations
MATRIX: Sediment

QA/QC DATA QUALITY OBJECTIVES

<u>Reference Method</u>	<u>MS Recovery</u>	<u>Surrogate Recovery</u>	<u>SRM Accuracy</u>	<u>Relative Precision</u>	<u>Detection Limit (dry wt)</u>
GC/HRMS	50-120%	40-135%	≤30%	≤30%	1, 2.5, and 5 pg/g

METHOD

Sediment samples underwent a toluene Soxhlet extraction. Samples were then cleansed with an acid/base washing and dried with sodium sulfate before cleanup with silica/alumina (5% deactivated) and carbon column chromatography. Extracts were quantified using high-resolution gas chromatography/high resolution mass spectroscopy (HRGC/HRMS) in the selective ion monitoring mode (SIM) following EPA method 8290 (EPA 1990). Second column confirmation of 2378-TCDF levels above 1 pg/g were performed on a DB-Dioxin column.

HOLDING TIMES

Sediment samples were received on 10/29/93 in good condition, extracted on February 22, 1994, and run on the GC/MS on March 22 and 23, 1994. The 30 day holding time prior to extraction was exceeded; the 40 day holding time between extraction and analysis was not exceeded.

DETECTION LIMITS

Target detection limits of 1 pg/g dry wt were met for all dioxin/furan compounds.

METHOD BLANKS

One method blank was extracted with each extraction batch. All dioxin and furan congeners were within acceptable ranges.

MATRIX SPIKES

Matrix spike recoveries for all congeners were within acceptable ranges.

QA/QC NARRATIVE/ SEDIMENT DIOXINS/FURANS (continued)

REPLICATES One sample was extracted in triplicate. Precision was measured by calculating the relative standard deviation (RSD) between the replicate results. The RSDs were within the target precision goal of $\leq 30\%$.

SRMs One SRM was analyzed with the samples. Dioxin/furan congeners were detected within 30% of the certified value.

INTERNAL STANDARDS $^{13}\text{C}_{12}$ -labeled internal standards were analyzed so that each isomer could be related to an internal standard for identification and quantification. Surrogate internal standards were within the data quality objective of 40-135%, with the exception of OCDD in several samples.

REFERENCES

EPA (U.S. Environmental Protection Agency). 1990. Method 8290. *Analytical Procedures and Quality Assurance for Multimedia Analysis of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans by High-Resolution Gas Chromatography/high-Resolution Mass Spectrometry*. EPA, Washington D.C.

QA/QC SUMMARY

PROGRAM: New York Reference Site Selection Project
PARAMETER: PAHs
LABORATORY: Battelle/Marine Sciences Laboratory, Sequim, Washington
MATRIX: Sediment

QA/QC DATA QUALITY OBJECTIVES

	<u>Reference Method</u>	<u>MS/MSD Recovery</u>	<u>Surrogate Recovery</u>	<u>SRM Accuracy</u>	<u>Relative Precision</u>	<u>Detection Limit (dry wt)</u>
PAH	GC/MS/SIM	50-120	30-150%	≤30%	≤30%	5 ng/g

METHOD

Sediment samples were extracted with methylene chloride using a roller under ambient conditions, following a procedure based on methods used by the National Oceanic and Atmospheric Administration for its Status and Trends Program (NOAA 1993). Samples were then cleaned using silica/alumina (5% deactivated) chromatography followed by high performance liquid chromatography (HPLC) cleanup.

Extracts were quantified using gas chromatography/mass spectrometry (GC/MS) in the selected ion mode (SIM) following a procedure based on NOAA (1993).

HOLDING TIMES

Sixteen sediment samples were received on 10/21/93 in good condition. Nine of the samples were archived per instructions from the client, however; one of the samples intended to be archived was analyzed as the triplicate, therefore data for this sample are also reported. A total of 8 samples plus the analytical triplicate were analyzed. Samples were logged into Battelle's log-in system, and held frozen until extraction on 11/04/94. All sample extracts were analyzed on 11/18/93, within 40 days of extraction.

DETECTION LIMITS

Target detection limits of 10 ng/g dry wt were met for all PAH compounds. A verification of the MDLs was performed by analyzing 4 replicates spiked at a low level and multiplying the standard deviation of the results by 3.5. All verification detection limits were below the target detection limit of 10 µg/kg dry wt.

METHOD BLANKS

One method blank was extracted with this sample batch. Six PAH compounds were detected in the blanks. All blank contamination levels are less than one-third of the target detection limits. No data were flagged.

QA/QC NARRATIVE/ SEDIMENT PAHs (contd)

- SURROGATES** Five isotopically labelled compounds were added prior to extraction to assess the efficiency of the method. These were d8-Naphthalene, d10-Acenaphthene, d12-chrysene, d12-perylene and d-4-1,4-dichlorobenzene. Recoveries of all surrogates were within the quality control limits of 30-150% with the exception of d4-1,4-dichlorobenzene in one sample (NYB-13). Recoveries of these surrogates were very low (<8%) due to loss of a large portion of the extract during extraction.
- MATRIX SPIKES** One sample was spiked with all PAH compounds. Matrix spike recoveries for all but 6 of the compounds were above the upper control limit of 120%. This was due to the high but variable native levels of PAHs (primarily high molecular weight compounds) in the authentic sample. Native levels were from 5 to 50 times higher than the levels spiked, thus making the spike recoveries unuseable for QC purposes.
- REPLICATES** One sample was extracted in triplicate. Precision was measured by calculating the relative standard deviation (RSD) between the replicate results. The RSDs ranged from 1 to 7%, within the target precision goal of $\leq 30\%$.
- SRMs** One SRM, HS-4, a marine sediment sample obtained by the National Research Council of Canada (NRCC) was analyzed with the samples. Eleven of the sixteen PAH compounds analyzed are certified at levels above our MDLs. Of these, all compounds with the exception of benzo(b)fluoranthene, benzo(a)pyrene and benzo(g,h,i)perylene were detected within 30% of the certified value. Benzo(b)fluoranthene often coelutes with other benzofluoranthenes which cannot be isolated by GC/MS alone.

REFERENCES

NOAA (National Oceanic and Atmospheric Administration). 1993. *Sampling and Analytical Methods for the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984-1992. Volume IV. Comprehensive Descriptions of Trace Organic Analytical Methods*. G.G. Lauenstein and A. Y. Cantillo, eds. NOAA Technical Memorandum NOS ORCA 71. National Oceanic and Atmospheric Administration, Coastal Monitoring and Bioeffects Assessment Division, Office of Ocean Resources Conservation and Assessment, Silver Spring, Maryland.

EPA (U.S. Environmental Protection Agency). 1986. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*. SW-846. U.S. Document No. 955-001-00000, U.S. Environmental Protection Agency, Washington D.C.

TABLE A.1. Summary of Sediment Grain Size, Percentage of Moisture and Total Percentage of Solids, New York Reference Site Selection Project, Phase I

Sediment Treatment	Analytical Batch	Gravel >2000 μm	Total Percent (Dry)			Percent Moisture	Total Percent Solids
			Sand 62.5 - 2000 μm	Silt 3.9 - 62.5 μm	Clay <3.9 μm		
<u>Great South Bay</u>							
GSB-1-1	1	6	24	60	10	50	50
GSB-1-2	1	6	28	56	10	49	51
GSB-1-3	1	3	21	64	12	50	50
GSB-1-4	1	4	22	63	11	48	52
GSB-1-5	1	3	24	61	12	49	51
GSB-1-6	1	4	24	62	10	46	54
GSB-1-7	1	4	23	63	10	51	49
GSB-1-8	1	7	24	59	10	48	52
GSB-1-9	1	2	23	64	11	52	48
GSB-1-10	1	6	24	59	11	49	51
GSB-2-1	1	0	32	58	10	43	57
GSB-2-2	1	0	28	56	16	44	56
GSB-2-3	1	0	31	58	11	42	58
GSB-2-4	1	0	32	57	11	46	54
GSB-2-5	1	0	31	57	12	45	55
GSB-2-6	1	0	29	60	11	43	57
GSB-2-7	1	1	29	59	11	47	53
GSB-2-8	1	0	31	58	11	45	55
GSB-2-9	1	0	32	57	11	46	54
GSB-2-10	1	0	29	62	9	43	57
<u>New York Bight</u>							
NYB-13-1	1	0	67	18	15	49	51
NYB-13-2	1	0	68	17	15	45	55
NYB-13-3	1	0	70	17	13	46	54
NYB-13-4	1	0	69	17	14	44	56
NYB-13-5	1	0	64	19	17	51	49
NYB-13-6	1	0	65	18	17	51	49
NYB-13-7	1	0	69	17	14	45	55
NYB-13-8	1	0	68	17	15	48	52
NYB-13-9	1	0	66	18	16	49	51
NYB-13-10	1	0	68	18	14	46	54

Table A.1. (cont)

Sediment Treatment	Analytical Batch	Gravel >2000 µm	Total Percent (Dry)			Percent Moisture	Total Percent Solids
			Sand 62.5 - 2000 µm	Silt 3.9 - 62.5 µm	Clay <3.9 µm		
NYB-15-1	1	0	74	15	11	38	62
NYB-15-2	1	0	75	14	11	38	62
NYB-15-3	1	0	71	16	13	39	61
NYB-15-4	1	0	73	15	12	43	57
NYB-15-5	1	0	75	14	11	38	62
NYB-15-6	1	0	77	12	11	36	64
NYB-15-7	1	0	73	16	11	40	60
NYB-15-8	1	0	76	14	10	35	65
NYB-15-9	1	0	77	12	11	36	64
NYB-15-10	1	0	72	15	13	40	60
<u>Reference</u>							
Mud Dump Reference	1	0	99	0	1	20	80

TABLE A.2. Sediment Total Organic Carbon (TOC), New York Reference Site Selection Project, Phase I

Sediment Treatment ^(a)	Composite Replicate	Analytical Replicate	Batch	TOC (% dry weight)
<u>Great South Bay</u>				
GSB-1-A	1		1	1.79
GSB-1-B	2		1	1.79
GSB-1-C	3		1	1.78
GSB-2-A	1	1	1	1.42
GSB-2-A	1	2	1	1.33
GSB-2-A	1	3	1	1.38
GSB-2-B	2		1	1.40
GSB-2-C	3		1	1.42
<u>New York Bight</u>				
NYB-13-A	1		1	1.50
NYB-13-B	2		1	1.53
NYB-13-C	3		1	1.55
NYB-15-A	1	1	1	0.95
NYB-15-A	1	2	1	0.90
NYB-15-B	2		1	1.09
NYB-15-C	3		1	0.79
<u>Reference</u>				
Mud Dump Reference			1	0.03

(a) Three replicate samples from GSB and NYB sites provided to analytical lab.

**TABLE A.3. Quality Control Data for Sediment, Total Organic Carbon (TOC),
New York Reference Site Selection Project, Phase I**

Sediment Treatment	Analytical Replicate	Analytical Batch	TOC (% dry weight)
<u>Method Blanks</u>			
Blank 1	1	1	0.003
Blank 2	1	2	0.005
Blank 3	1	3	0.005
Blank 4	1	4	0.004
<u>Standard Reference Material</u>			
Non-Certified Value			2.6
MESS-1	1	2	2.66
Percent Difference			2%
MESS-1	2	3	2.61
Percent Difference			0%
<u>Analytical Duplicates</u>			
NYB-15-A	1	1	0.95
NYB-15-A	2	1	0.90
RPD			5%
I-Stat			0.03
<u>Analytical Triplicates</u>			
GSB-2-A	1	1	1.42
GSB-2-A	2	1	1.33
GSB-2-A	3	1	1.38
RSD			3%

TABLE A.4. Metals in Sediment, New York Reference Site Selection Project, Phase I

Sediment Treatment	Replicate	Metals (mg/kg dry weight)								
		Ag	As	Cr	Cd	Cu	Hg	Ni	Pb	Zn
Target DL ^(a)		0.1	0.1	0.02	0.01	0.1	0.02	0.1	0.1	0.1
MDL ^(b)		0.01	1.88	0.390	0.010	0.104	0.001	0.218	0.350	0.753
GSB-1	1	0.323	7.74	26.9	0.549	21.6	0.237	12.4	46.3	92.2
GSB-2	1	0.076	6.68	20.5	0.288	9.34	0.074	9.64	19.0	51.1
NYB-13	1	0.551	7.79	31.4	0.294	19.7	0.245	12.1	38.4	62.9
NYB-13	2	0.613	7.78	30.9	0.301	19.3	0.255	11.8	38.8	72.0
NYB-13	3	0.535	7.68	31.2	0.313	19.5	0.254	11.9	38.0	61.7
NYB-13	4	0.557	7.73	31.1	0.284	19.4	0.246	11.9	37.6	61.6
NYB-15	1	0.094	4.58	16.5	0.111	7.51	0.047	9.32	15.8	35.4
A.5 Mud Dump Reference	1	0.01 U ^(c)	4.33	8.89	0.008	1.72	0.004	2.83	6.61	14.4
	2	0.01 U	4.55	7.58	0.028	1.73	0.001 U	2.65	6.56	14.0
	3	0.01 U	4.39	6.59	0.010 U	1.58	0.003	2.49	6.40	12.6

(a) DL Detection limit.

(b) MDL Method detection limit.

(c) U Undetected at or above given concentration.

TABLE A.5. Quality Control Data for Metals in Sediment, New York Reference Site Selection Project, Phase I

Sediment Treatment	Replicate	Metals (mg/kg dry weight)								
		Ag	As	Cr	Cd	Cu	Hg	Ni	Pb	Zn
<u>Method Blank</u>										
Blank	1	0.031	1.88 ^(a)	0.390	0.144 ^(a)	0.104	0.001 U ^(b)	0.218	0.350 ^(a)	0.753
MDL ^(c) verification study		0.119	0.572	0.401	0.020	0.525	0.015	0.849	0.136	2.55
<u>Matrix Spike</u>										
GSB-2	1	0.076	6.68	20.5	0.288	9.34	0.074	9.64	19.0	51.1
GSB-2 , MS		5.13	11.1	23.4	5.14	13.5	2.00	13.6	23.1	55.2
Concentration Recovered		5.05	4.44	2.89	4.85	4.12	1.92	3.93	4.06	4.06
Amount Spiked		5.00	5.00	5.00	5.00	5.00	2.00	5.00	5.00	5.00
Percent Recovery		101%	89%	58% ^(d)	97%	82%	96%	79%	81%	81%
<u>Standard Reference Material</u>										
SRM 1646 Certified value		NC ^(e)	11.6	76.0	0.360	18.0	0.063	32.0	28.2	138
Acceptable Range		NC	±1.30	±3.00	±0.070	±3.00	±0.012	±3.00	±1.80	±6.00
SRM 1646 Measured Value	1	0.048	9.57	35.9 ^(f)	0.329	14.5	0.082 ^(f)	21.6 ^(f)	21.8 ^(f)	107 ^(f)
Percent Difference		NA	17%	53%	9%	20%	30%	33%	23%	22%
SRM BEST-1 Certified value		NA ^(g)	NA	NA	NA	NA	0.092	NA	NA	NA
Acceptable Range		NA	NA	NA	NA	NA	±0.009	NA	NA	NA
SRM BEST-1 Measured Value	1	NA	NA	NA	NA	NA	0.090	NA	NA	NA
Percent Difference		NA	NA	NA	NA	NA	2%	NA	NA	NA
<u>Analytical Replicates</u>										
Mud Dump Reference	1	0.010 U	4.33	8.89	0.008	1.72	0.004	2.83	6.61	14.4
Mud Dump Reference	2	0.010 U	4.55	7.58	0.028	1.73	0.001 U	2.65	6.56	14.0
Mud Dump Reference	3	0.010 U	4.39	6.59	0.010 U	1.58	0.003	2.49	6.40	12.6
RSD		NA	3%	15%	NA	5%	NA	7%	2%	7%

(a) Blank value greater than 3 times verified MDL.

(b) U Undetected at or above given concentration.

(c) MDL Method detection limit.

(d) Outside quality control range (75%-125%) for matrix spike recoveries.

(e) NC Not certified.

(f) Outside quality control criteria (±20%) for SRMs.

(g) NA Not applicable.

TABLE A.6. Chlorinated Pesticides in Sediment (alphabetical: Aldrin - 4,4'-DDT),
New York Reference Site Selection Project, Phase I

Sediment Treatment	Pesticides (µg/kg dry weight)								
	Aldrin	Gamma BHC	alpha- Chlordane	2,4'- DDE	2,4'- DDD	2,4'- DDT	4,4'- DDE	4,4'- DDD	4,4'- DDT
Target DL ^(a)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
GSB-1	0.04 U ^(b)	0.05 U	0.08 U	0.03 U	0.11 U	0.14 U	1.81	2.30	0.30 U
GSB-2	0.04 U	0.04 U	0.08 U	0.03 U	0.11 U	0.14 U	0.04 U	0.10 U	0.30 U
NYB-13	0.04 U	0.05 U	0.08 U	0.03 U	0.11 U	0.14 U	1.46	0.10 U	2.14
NYB-15	0.04 U	0.04 U	0.08 U	0.03 U	0.11 U	0.14 U	0.04 U	0.10 U	0.30 U
Mud Dump Reference	0.04 U	0.03 U	0.08 U	0.03 U	0.11 U	0.14 U	0.04 U	0.10 U	0.30 U

(a) DL Detection limit.

(b) U Undetected at or above given concentration.

TABLE A.7. Chlorinated Pesticides in Sediment (alphabetical: Dieldrin - Transnonachlor),
New York Reference Site Selection Project, Phase I

Sediment Treatment	Pesticides (µg/kg dry weight)						
	Dieldrin	Endo- Sulfan I	Endo- Sulfan II	Endo- Sulfan Sulfate	Hepta- chlor	Hepta chlor- epoxide	Trans- nonachlor
Target DL ^(a)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
GSB-1	0.22 U ^(b)	0.16 U	0.16 U	0.07 U	0.26 U	0.16 U	0.05 U
GSB-2	0.22 U	0.16 U	0.16 U	0.07 U	0.26 U	0.16 U	0.05 U
NYB-13	0.86	0.16 U	0.16 U	0.07 U	0.68	0.16 U	0.05 U
NYB-15	0.22 U	0.16 U	0.16 U	0.07 U	0.26 U	0.16 U	0.05 U
Mud Dump Reference	0.22 U	0.16 U	0.16 U	0.07 U	0.26 U	0.16 U	0.05 U

(a) DL Detection limit.

(b) U Undetected at or above given concentration.

TABLE A.8. Quality Control Summary for Sediment Chlorinated Pesticides (alphabetical: Aldrin - 4,4'-DDT),
New York Reference Site Selection Project, Phase I

Sediment Treatment	Pesticides (µg/kg dry weight)								
	Aldrin	Gamma BHC	alpha- Chlordane	2,4'- DDE	2,4'- DDD	2,4'- DDT	4,4'- DDE	4,4'- DDD	4,4'- DDT
<u>Method Blank</u>									
Blank	0.04 U ^(a)	0.04 U	0.08 U	0.03 U	0.11 U	0.14 U	0.04 U	0.1 U	0.3 U
MDL ^(b) verification study	0.20	0.20	0.22	0.17	0.30	0.21	0.30	0.20	0.28
<u>Matrix Spike</u>									
QC Sample ^(c)	8.18	0.06 U	5.42	NA ^(d)	NA	NA	53.1 ^(e)	14.5	NA
QC Sample, MS	9.38	3.17	6.71	NA	NA	NA	57.9 ^(e)	17.6	NA
Concentration Recovered	1.20	3.17	1.29	NA	NA	NA	4.80	3.11	NA
Amount Spiked	3.85	3.85	3.85	NS ^(f)	NS	NS	3.85	3.85	NS
Percent Recovery	31% ^(g)	82%	34% ^(g)	NA	NA	NA	125% ^(g)	81%	NA
<u>Analytical Replicates</u>									
C-NR, Replicate 1	0.04 U	0.03 U	0.08 U	0.03 U	0.11 U	0.14 U	0.04 U	0.10 U	0.30 U
C-NR, Replicate 2	0.04 U	0.03 U	0.08 U	0.03 U	0.11 U	0.14 U	0.04 U	0.10 U	0.30 U
C-NR, Replicate 3	0.04 U	0.03 U	0.08 U	0.03 U	0.11 U	0.14 U	0.04 U	0.10 U	0.30 U
RSD	NA	NA	NA	NA	NA	NA	NA	NA	NA

(a) U Undetected at or above given concentration.

(b) MDL Method detection limit.

(c) Sample run concurrently with New York Reference Site Selection Project, Phase 1.

(d) NA Not applicable.

(e) Sample diluted (1:5).

(f) NS Not spiked.

(g) Outside quality control range (50% - 120%) for matrix spike recoveries.

TABLE A.9. Quality Control Summary for Sediment Chlorinated Pesticides (alphabetical: Dieldrin - Transnonachlor), New York Reference Site Selection Project, Phase I

Sediment Treatment	Pesticides (µg/kg dry weight)						
	Dieldrin	Endo-Sulfan I	Endo-Sulfan II	Endo-Sulfan Sulfate	Hepta-chlor	Hepta-chlor-epoxide	Trans-nonachlor
<u>Method Blank</u>							
Blank	0.22 U ^(a)	0.16 U	0.16 U	0.07 U	0.26 U	0.16 U	0.05 U
MDL ^(b) verification study	0.21	NA ^(c)	NA	NA	0.24	0.24	0.14
<u>Matrix Spike</u>							
QC Sample ^(d)	6.18	1.41	NA	4.56	10.6	0.16 U	3.59
QC Sample, MS	7.57	4.26	NA	9.40	10.7	3.45	5.68
Concentration Recovered	1.39	2.85	NA	4.84	0.09	3.45	2.09
Amount Spiked	3.85	3.85	NS ^(e)	3.85	3.85	3.85	3.85
Percent Recovery	36% ^(f)	74%	NA	126% ^(f)	2% ^(f)	90%	54%
<u>Analytical Replicates</u>							
C-NR, Replicate 1	0.22 U	0.16 U	0.16 U	0.07 U	0.26 U	0.16 U	0.05 U
C-NR, Replicate 2	0.22 U	0.16 U	0.16 U	0.07 U	0.26 U	0.16 U	0.05 U
C-NR, Replicate 3	0.52 U	0.16 U	0.16 U	0.07 U	0.26 U	0.16 U	0.05 U
RSD	NA	NA	NA	NA	NA	NA	NA

(a) U Undetected at or above given concentration.

(b) MDL Method detection limit.

(c) NA Not applicable.

(d) Sample run concurrently with New York Reference Site project.

(e) NS Not spiked.

(f) Outside quality control range (50% - 120%) for matrix spike recoveries.

TABLE A.10. Sediment Polychlorinated Biphenyls (PCBs), 8 through 66,
New York Reference Site Selection Project, Phase I

Sediment Treatment	PCBs (µg/kg dry weight)						
	CL2 (8)	CL3 (18)	CL3 (28)	CL4 (44)	CL4 (49)	CL4 (52)	CL4 (66)
Target DL ^(a)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
GSB-1	0.37 U ^(b)	0.13 U	0.73	0.03 U	0.26 U	0.28	0.08 U
GSB-2	0.37 U	0.13 U	0.08 U	0.03 U	0.23 U	0.12 U	0.08 U
NYB-13	0.37 U	0.13 U	2.08	0.03 U	0.50	0.70	2.22
NYB-15	0.37 U	0.13 U	3.55	0.03 U	0.21 U	6.40	0.08 U
Mud Dump Reference	0.37 U	0.13 U	0.08 U	0.03 U	0.17 U	0.12 U	0.08 U
<u>Quality Control Data</u>							
MDL ^(c) verification study	0.57	0.30	0.19	0.23	NA	0.16	0.32
Method Blank	0.37 U	0.13 U	0.08 U	0.03 U	0.16 U	0.12 U	0.08 U
<u>Matrix Spike</u>							
QC Sample ^(d)	NA ^(e)	NA	72.2 ^(f)	NA	NA	89.9 ^(f)	NA
QC Sample, MS	NA	NA	76.9 ^(f)	NA	NA	98.2 ^(f)	NA
Concentration Recovered	NA	NA	4.73	NA	NA	8.30	NA
Amount Spiked	NS ^(g)	NS	4.85	NS	NS	10.1	NS
Percent Recovery	NA	NA	98%	NA	NA	82%	NA
<u>Analytical Replicates</u>							
C-NR, Replicate 1	0.37 U	0.13 U	0.38	0.03 U	0.16 U	0.12 U	0.08 U
C-NR, Replicate 2	0.37 U	0.13 U	0.37	0.03 U	0.17 U	0.12 U	0.08 U
C-NR, Replicate 3	0.37 U	0.13 U	0.33	0.03 U	0.17 U	0.12 U	0.08 U
RSD	NA	NA	7%	NA	NA	NA	NA

(a) DL Detection limit.

(b) U Undetected at or above given concentration.

(c) Method detection limit.

(d) Sample run concurrently with New York Reference Site Selection Project, Phase I.

(e) NA Not applicable.

(f) Sample diluted (1:5).

(g) NS Not spiked.

TABLE A.11. Sediment Polychlorinated Biphenyls (PCBs), 87 through 153, New York Reference Site Selection Project, Phase I

Sediment Treatment	PCBs (µg/kg dry weight)						
	CL5 (87)	CL5 (101)	CL5 (105)	CL5 (118)	CL6 (128)	CL6 (138)	CL6 (153)
Target DL ^(a)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
GSB-1	0.07 U ^(b)	0.09 U	0.07 U	1.19 U	0.08 U	0.55	0.59
GSB-2	0.07 U	0.13	0.07 U	1.19 U	0.08 U	0.19	0.21
NYB-13	0.07 U	1.36	0.07 U	2.03	0.08 U	1.34	1.48
NYB-15	0.07 U	4.81	0.07 U	1.19 U	0.08 U	1.97	2.30
Mud Dump Reference	0.07 U	0.09 U	0.07 U	1.19 U	0.08 U	0.04 U	0.06 U
<u>Quality Control Data</u>							
Method Blank	0.07 U	0.09 U	0.07 U	1.19 U	0.08 U	0.04 U	0.06 U
MDL ^(c) verification study	0.33	0.23	0.16	0.27	0.16	0.19	0.19
<u>Matrix Spike</u>							
QC Sample ^(d)	NA ^(e)	56.4 ^(f)	NA	NA	NA	29.6 ^(f)	35.9 ^(f)
QC Sample, MS	NA	62.3 ^(f)	NA	NA	NA	33.4 ^(f)	41.0 ^(f)
Concentration Recovered	NA	5.85	NA	NA	NA	3.80	5.15
Amount Spiked	NS ^(g)	6.86	NS	NS	NS	3.10	4.01
Percent Recovery	NA	85%	NA	NA	NA	123% ^(h)	128% ^(h)
<u>Analytical Replicates</u>							
C-NR, Replicate 1	0.07 U	0.09 U	0.07 U	1.19 U	0.08 U	0.04 U	0.06 U
C-NR, Replicate 2	0.07 U	0.09 U	0.07 U	1.19 U	0.08 U	0.04 U	0.06 U
C-NR, Replicate 3	0.07 U	0.09 U	0.07 U	1.19 U	0.08 U	0.04 U	0.06 U
RSD	NA	NA	NA	NA	NA	NA	NA

(a) DL Detection limit.

(b) U Undetected at or above given concentration.

(c) Method detection limit.

(d) Sample run concurrently with New York Reference Site Selection Project, Phase I.

(e) NA Not applicable.

(f) Sample diluted (1:5).

(g) NS Not spiked.

(h) Outside quality control range (50%-120%) for matrix spike recoveries.

**TABLE A.12. Sediment Polychlorinated Biphenyls (PCBs), 170 through 209,
New York Reference Site Selection Project, Phase I**

Sediment Treatment	PCBs (µg/kg dry weight)							
	CL7 (170)	CL7 (180)	CL7 (183)	CL7 (184)	CL7 (187)	CL8 (195)	CL9 (206)	CL10 (209)
Target DL ^(a)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
GSB-1	0.25	0.27	0.26 U ^(b)	0.26 U	1.52 U	0.06 U	0.04 U	0.06 U
GSB-2	0.18	0.06 U	0.23 U	0.23 U	1.52 U	0.06 U	0.04 U	0.06 U
NYB-13	0.51	0.77	0.25 U	0.25 U	1.52 U	0.06 U	0.49	0.06 U
NYB-15	0.09 U	0.06 U	0.21 U	0.21 U	1.52 U	0.06 U	0.04 U	0.06 U
Mud Dump Reference	0.16	0.06 U	0.17 U	0.17 U	1.52 U	0.06 U	0.04 U	0.06 U
<u>Quality Control Data</u>								
Method Blank	1.20	0.06 U	0.16 U	0.16 U	1.52 U	0.06 U	0.04 U	0.06 U
MDL ^(c) verification study	0.16	0.19	NA	NA	0.16	0.19	0.23	0.29
<u>Matrix Spike</u>								
QC Sample ^(d)	NA ^(e)	NA	NA	NA	NA	NA	NA	NA
QC Sample, MS	NA	NA	NA	NA	NA	NA	NA	NA
Concentration Recovered	NA	NA	NA	NA	NA	NA	NA	NA
Amount Spiked	NS ^(f)	NS	NS	NS	NS	NS	NS	NS
Percent Recovery	NA	NA	NA	NA	NA	NA	NA	NA
<u>Analytical Replicates</u>								
C-NR, Replicate 1	0.10	0.06 U	0.16 U	0.16 U	1.52 U	0.06 U	0.04 U	0.06
C-NR, Replicate 2	0.10	0.06 U	0.17 U	0.17 U	1.52 U	0.06 U	0.04 U	0.06
C-NR, Replicate 3	0.12	0.06 U	0.17 U	0.17 U	1.52 U	0.06 U	0.04 U	0.06
RSD	11%	NA	NA	NA	NA	NA	NA	NA

(a) DL Detection limit.

(b) U Undetected at or above given concentration.

(c) Method detection limit.

(d) Sample run concurrently with New York Reference Site Selection Project, Phase I.

(e) NA Not applicable.

(f) NS Not spiked.

TABLE A.13. Surrogate Percentage Recoveries and Quality Control Data for Chlorinated Pesticides and Polychlorinated Biphenyls (PCBs) in Sediment, New York Reference Site Selection Project, Phase I

<u>Sediment Treatment</u>	<u>Surrogate Percentage Recoveries</u>	
	<u>PCB 103</u>	<u>PCB 198</u>
GSB-1	72	61
GSB-2	60	52
NYB-13	72	60
NYB-15	69	54
Mud Dump Reference	76	66
<u>Quality Control Data</u>		
<u>Method Blank</u>		
Blank	11 ^(a)	7 ^(a)
<u>Matrix Spike</u>		
QC Sample ^(b)	67	71
QC Sample, MS	62	72
<u>Analytical Replicates</u>		
C-NR, Replicate 1	86	74
C-NR, Replicate 2	79	71
C-NR, Replicate 3	78	64

(a) Outside quality control range (40%-120%) for surrogate recoveries.

(b) Sample run concurrently with New York Reference Site Selection Project, Phase I.

TABLE A.14. TCDD/TCDF in Sediment, New York Reference Site Selection Project, Phase I

Analyte	Target DL ^(a)	Achieved DL	MDL ^(b) Verification	TEF ^(c)	Sediment Treatment (pg/g dry weight)			
					GSB-1	GSB-2	NYB-13	NYB-15
2378-TCDD	1	0.2-15.4	1.6	1.0	0.66	0.8 U ^(d)	2.38	2.0 U
12378-PeCDD	1	0.2-42.9	4.2	0.5	1.17	1.1 U	0.99	1.8 U
123478-HxCDD	1	0.2-71.4	8.6	0.1	1.50	0.54	1.53	0.81
123678-HxCDD	1	0.3	6.9	0.1	3.97	1.50	6.13	3.00
123789-HxCDD	1	0.3	5.1	0.1	5.18	2.32	5.10	2.24
1234678-HpCDD	1	<0.37	15.1	0.01	77.2	28.5	78.6	41.5
OCDD	1	<1.58	206	0.001	916	496	756	378
2378-TCDF	1	0.2	3.1	0.1	4.31	1.10	4.66	2.99
12378-PeCDF	1	0.2	2.4	0.05	2.61	0.50	2.58	1.77
23478-PeCDF	1	0.2-1.0	3.1	0.5	1.51	1.0 U	3.24	2.04
123478-HxCDF	1	0.2	3.5	0.1	3.40	0.67	6.20	3.53
123678-HxCDF	1	0.3-0.9	2.4	0.1	1.65	0.9 U	3.41	1.89
123789-HxCDF	1	<0.33	1.0	0.1	1.56	0.76	2.53	1.75
234678-HxCDF	1	0.2-31.7	2.5	0.1	0.9 U	0.3 U	1.1 U	0.4 U
1234678-HpCDF	1	1.0	2.1	0.01	12.2	3.62	24.2	12.0
1234789-HpCDF	1	0.4-51.5	7.5	0.01	2.8 U	0.7 U	5.7 U	1.8 U
OCDF	1	<0.67	52.7	0.001	15.7	3.04	45.8	15.0
Sum TEC ^(e)					6.11	1.53	9.41	3.66

(a) DL Detection limit.

(b) MDL Method detection limit.

(c) TEF Toxicity Equivalence Factor (Reid et. al. 1991).

(d) U Undetected at or above given concentration.

(e) Sum TEC = $\Sigma(\text{TEF} \times \text{measured value})$, where undetected values = $(\text{DL}/2 \times \text{TEF})$

TABLE A.15. Sediment Dioxin Quality Control Summary, New York Reference Site Selection Project, Phase I

Sediment Treatment	Dioxin (pg/g dry weight)						
	2378-TCDD	12378-PeCDD	123478-HxCDD	123678-HxCDD	123789-HxCDD	1234678-HpCDD	OCDD
Method Blank	0.2 U ^(a)	0.2 U	0.2 U	0.3 U	0.3 U	0.37	1.58
<u>Matrix Spike</u>							
GSB1	0.66	1.17	1.50	3.97	5.18	77.2	915
GSB1 MS	32.0	165.1	162.1	144.7	136.0	153.2	169.0
Concentration Recovered	31.3	163.9	160.6	140.7	130.8	76.0	NC ^(b)
Amount Spiked	30.5	152.7	152.7	152.7	152.7	152.7	305.3
Percent Recovery	103%	107%	105%	92%	86%	50%	NC
<u>Standard Reference Material</u>							
Certified Value	500	1000	1000	1000	1000	1500	3500
Fortified Reference Material							
46985-02-18	422	870	867	838	874	1420	2870
Percent Difference	16%	13%	13%	16%	13%	5%	18%
<u>Analytical Replicates</u>							
QC Sample ^(c) , Replicate 1	10.4	4.65	6.57	43.7	27.8	382	6240
QC Sample, Replicate 2	10.3	3.96	4.59	37.0	23.6	339	5570
QC Sample, Replicate 3	9.15	3.26	3.39	32.4	21.3	290	4580
RSD	7%	18%	33%	15%	14%	14%	15%

(a) U Undetected at or above given concentration.

(b) NC Not calculated, recovery of OCDD could not be calculated.

(c) Sample run concurrently with New York Reference Site Selection Project, Phase I.

TABLE A.16. Sediment Furan Quality Control Summary, New York Reference Site Selection Project, Phase I

Sediment Treatment	Furan (pg/g dry weight)									
	2378-TCDF	12378-PeCDF	23478-PeCDF	123478-HxCDF	123678-HxCDF	123789-HxCDF	234678-HxCDF	1234678-HpCDF	1234789-HpCDF	OCDF
Method Blank	0.2 U ^(a)	0.2 U	0.2 U	0.2 U	0.3 U	0.33	0.2 U	1.0 U	0.4 U	0.67
<u>Matrix Spike</u>										
GSB1	4.31	2.61	1.51	3.40	1.65	1.56	0.9 U	12.2	2.8 U	15.7
GSB1 MS	26.7	150	134	161	152	156	164	135	164	299
Concentration Recovered	22.4	147	132	158	150	155	164	122	164	283
Amount Spiked	30.5	153	153	153	153	153	153	153	153	305
Percent Recovery	73%	96%	86%	103%	98%	101%	107%	80%	107%	93%
<u>Standard Reference Material</u>										
Certified Value	500	1000	1000	1000	1000	1000	1000	1500	1500	2500
<u>Fortified Reference Material</u>										
46985-02-18-Cambridge Isotope	364 ^(b)	835	763 ^(b)	862	848	849	876	1240	1460	2130
Percent Difference	27%	16%	24%	14%	15%	15%	12%	17%	3%	15%
<u>Analytical Replicates</u>										
QC Sample, ^(c) Replicate 1	20.7	11.5	13.3	36.4	12.6	12.0	1.66	122	45.0 U	283
QC Sample, Replicate 2	20.3	10.6	11.7	33.5	12.6	11.0	1.24	114	46.1 U	228
QC Sample, Replicate 3	18.3	10.3	9.88	26.3	11.2	8.67	1.32	96.9	39.6 U	189
RSD	7%	6%	15%	16%	7%	16%	16%	12%	NA ^(d)	20%

(a) U Undetected at or above given concentration.

(b) Outside quality control criteria ($\pm 20\%$) for SRMs.

(c) Sample run concurrently with New York Reference Site Selection Project, Phase I.

(d) NA Not applicable.

TABLE A.17. Internal Standard Recoveries for Sediment TCDD/TCDF and Quality Control Data, New York Reference Site Selection, Phase I

Sediment Treatment:	Internal Standard Recoveries (pg/g dry weight)											
	GSB-1			GSB-2			NYB-13			NYB-15		
	Spike Conc.	Conc. Found	Percent Recovery	Spike Conc.	Conc. Found	Percent Recovery	Spike Conc.	Conc. Found	Percent Recovery	Spike Conc.	Conc. Found	Percent Recovery
2378- TCDD- ¹³ C ₁₂	304	193	63	284	180	63	291	182	63	262	144	55
12378- PeCDD- ¹³ C ₁₂	304	192	63	284	180	63	291	154	53	262	114	44
123478- HxCDD- ¹³ C ₁₂	304	193	63	284	195	69	291	176	60	262	139	53
123678- HxCDD- ¹³ C ₁₂	304	203	67	284	196	69	291	196	67	262	152	58
1234678- HpCDD- ¹³ C ₁₂	304	178	59	284	148	52	291	136	47	262	123	47
OCDD- ¹³ C ₁₂	609	331	54	567	270	48	581	237	41	524	198	38 ^(a)
2378- TCDD- ³⁷ C ₁₄	122	81	66	113	73	65	116	75	65	105	70	67
2378- TCDF- ¹³ C ₁₂	304	201	66	284	176	62	291	174	60	262	145	55
12378- PeCDF- ¹³ C ₁₂	304	184	61	284	159	56	291	151	52	262	119	45
23478- PeCDF- ¹³ C ₁₂	304	193	63	284	164	58	291	152	52	262	110	42
123478- HxCDF- ¹³ C ₁₂	304	206	68	284	187	66	291	185	64	262	154	59
123678- HxCDF- ¹³ C ₁₂	304	227	75	284	208	73	291	210	72	262	163	62
123789- HxCDF- ¹³ C ₁₂	304	216	71	284	207	73	291	206	71	262	153	58
234678- HxCDF- ¹³ C ₁₂	304	203	67	284	193	68	291	193	66	262	142	54
1234678- HpCDF- ¹³ C ₁₂	304	207	68	284	110	39	291	100	34 ^(a)	262	112	43
1234789- HpCDF- ¹³ C ₁₂	304	181	59	284	130	46	291	122	42	262	108	41

TABLE A.17. (contd)

Sediment Treatment:	Quality Control Data (pg/g dry weight)					
	Method Blank			GSB-1, MS		
	Spike Conc.	Conc. Found	% Recovery	Spike Conc.	Conc. Found	% Recovery
2378- TCDD- ¹³ C ₁₂	200	125	63	305	194	64
12378- PeCDD- ¹³ C ₁₂	200	124	62	305	181	59
123478- HxCDD- ¹³ C ₁₂	200	131	66	305	189	62
123678- HxCDD- ¹³ C ₁₂	200	134	67	305	214	70
1234678- HpCDD- ¹³ C ₁₂	200	116	58	305	160	53
OCDD- ¹³ C ₁₂	400	167	42	611	289	47
2378- TCDD- ³⁷ C ₁₄	80	52	65	122	79	65
2378- TCDF- ¹³ C ₁₂	200	121	61	305	188	61
12378- PeCDF- ¹³ C ₁₂	200	115	58	305	173	57
23478- PeCDF- ¹³ C ₁₂	200	117	58	305	161	53
123478- HxCDF- ¹³ C ₁₂	200	139	70	305	198	65
123678- HxCDF- ¹³ C ₁₂	200	146	73	305	222	73
123789- HxCDF- ¹³ C ₁₂	200	146	73	305	207	68
234678- HxCDF- ¹³ C ₁₂	200	132	66	305	194	64
1234678- HpCDF- ¹³ C ₁₂	200	99	49	305	189	62
1234789- HpCDF- ¹³ C ₁₂	200	102	51	305	146	48

TABLE A.17. (contd)

Sediment Treatment:	Quality Control Data (pg/g dry weight)								
	QC Sample, REP 1			QC Sample, REP 2			QC Sample, REP 3		
	Spike Conc.	Conc. Found	Percent Recovery	Spike Conc.	Conc. Found	Percent Recovery	Spike Conc.	Conc. Found	Percent Recovery
2378- TCDD- ¹³ C ₁₂	361	193	53	362	199	55	361	200	56
12378- PeCDD- ¹³ C ₁₂	361	189	52	362	202	56	361	213	59
123478- HxCDD- ¹³ C ₁₂	361	192	53	362	198	59	361	191	53
123678- HxCDD- ¹³ C ₁₂	361	196	54	362	211	58	361	207	57
1234678- HpCDD- ¹³ C ₁₂	361	145	40	362	170	47	361	163	45
OCDD- ¹³ C ₁₂	722	252	35 ^(a)	723	317	44	722	333	46
2378- TCDD- ³⁷ C ₁₄	144	82	57	145	86	60	144	94	65
2378- TCDF- ¹³ C ₁₂	361	213	59	362	206	57	361	226	63
12378- PeCDF- ¹³ C ₁₂	361	170	47	362	184	51	361	197	55
23478- PeCDF- ¹³ C ₁₂	361	197	55	362	216	60	361	225	62
123478- HxCDF- ¹³ C ₁₂	361	203	56	362	216	60	361	218	61
123678- HxCDF- ¹³ C ₁₂	361	195	54	362	216	60	361	219	61
123789- HxCDF- ¹³ C ₁₂	361	191	53	362	212	59	361	214	59
234678- HxCDF- ¹³ C ₁₂	361	188	52	362	202	56	361	209	58
1234678- HpCDF- ¹³ C ₁₂	361	178	49	362	201	56	361	194	54
1234789- HpCDF- ¹³ C ₁₂	361	143	39 ^(a)	362	164	45	361	170	47

(a) Outside QC criteria (40 - 135%) for surrogate recovery.

**TABLE A.18. Low Molecular Weight Polynuclear Aromatic Hydrocarbons (LPAHs)
in Sediment, New York Reference Site Selection Project, Phase I**

Sediment Treatment	LPAHs (µg/kg dry weight)					
	Naphtha- lene	Acenaph- thylene	Acenaph- thene	Fluorene	Phenan- threne	Anthra- cene
Target DL ^(a)	10	10	10	10	10	10
GSB-1	18.1	6.83	5.31	12.0	92.4	22.9
GSB-2	5.89	3.00 ^(b)	1.99 ^(b)	5.36 ^(b)	19.3	8.48
NYB-15	9.60	2.81	2.55	5.39	29.3	8.34
NYB-13	28.4	7.13	6.12 ^(b)	14.9	75.5	26.3
Mud Dump Reference	1.07 U ^(c)	1.15 U	0.55 U	1.63 ^(b)	1.18 ^(b)	2.90 ^(b)

(a) DL Detection limit.

(b) Ion ratio out or confirmation ion not detected.

(c) U Undetected at or above given concentration.

TABLE A.19. High Molecular Weight Polynuclear Aromatic Hydrocarbons (HPAHs) in Sediment, New York
Reference Site Selection Project, Phase I

Sediment Treatment	HPAHs (µg/kg dry weight)										
	Fluor- anthene	Pyrene	Benzo[a]- anthra- cene	Chrysene	Benzo[b]- fluor- anthene	Benzo[k]- fluor- anthene	Benzo[a]- pyrene	Indeno- [1,2,3- cd] pyrene	Dibenzo- [a,h] anthra- cene	Benzo- [g,h,i] perylene	1,4 Dichloro- Benzene
Target DL ^(a)	10	10	10	10	10	10	10	10	10	10	10
GSB-1	207	165	66.0	86.4	166	56.7	84.4	71.8	13.6	46.1	22.2
GSB-2	50.2	41.9	20.8	23.0	62.2	21.0	28.0	24.0	5.02	12.2	8.26
NYB-15	52.5	39.0	18.0	22.5	39.7	13.3	19.4	21.6	4.47	18.7	10.0 U ^(b)
NYB-13	127	106	51.1	60.3	102	34.3	57.8	52.6	11.1	45.5	12.8
Mud Dump Reference	2.69 ^(c)	1.18 U	2.03	1.09 U	2.68	1.41 ^(c)	1.18 U	2.32 U	3.34 U	3.64 U	10.0 U

(a) DL Detection limit.

(b) U Undetected at or above given concentration.

(c) Ion ratio out or confirmation ion not detected.

TABLE A.20. Quality Control Data for Low Molecular Weight Polynuclear Aromatic Hydrocarbons (LPAHs) in Sediment, New York Reference Site Selection Project, Phase I

Sediment Treatment	LPAHs (µg/kg dry weight)					
	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene
Method Blank	1.50	1.93	0.55 U ^(a)	0.84 U	1.74	1.38 U
MDL ^(b) verification study	4.1	4.1	3.7	4.7	6.7	7.4
<u>Matrix Spike</u>						
QC Sample ^(c)	458	95.1	202	256 ^(d)	697	518
QC Sample, MS	493	144	242	317	978	652
Concentration Recovered	35	48.9	40	61	281	134
Amount Spiked	50.4	48.2	52.1	49.9	50.2	38.0
Percent Recovery	69%	101%	77%	122% ^(e)	560% ^(e)	353% ^(e)
<u>Standard Reference Material</u>						
SRM HS-4 Non-certified value	150 ^(f)	150 ^(f)	150 ^(f)	150 ^(f)	680	140
Acceptable range					± 80	± 70
SRM HS-4 Actual values	95.6	77.1	30.9	51.3	671	141
Percent Difference	36%	49%	79%	66%	1%	0%
<u>Analytical Replicates</u>						
C-NR, Replicate 1	2.11 J ^(g)	1.15 U	0.55 U	2.17 J	5.34 J	2.77 J
C-NR, Replicate 2	2.90 J	1.15 U	0.55 U	2.59 J	5.80 J	2.64 J
C-NR, Replicate 3	2.31 J	1.15 U	0.55 U	2.36 J	5.71 J	2.85 J
RSD	NA ^(h)	NA	NA	9%	4%	4%

(a) U Undetected at or above given concentration.

(b) MDL Method detection limit.

(c) Sample run concurrently with New York Reference Site Selection Project, Phase I.

(d) Ion ratio out or confirming ion not detected.

(e) Outside quality control range (50%-120%) for matrix spike recoveries.

(f) Upper limit; amount present is not greater than 150 µg/g.

(g) J Value reported less than LOQ (Limit of Quantitation).

(h) NA Not applicable.

TABLE A.21. Quality Control Data for High Molecular Weight Polynuclear Aromatic Hydrocarbons (HPAHs) in Sediment, New York Reference Site Selection Project, Phase I

Sediment Treatment	HPAHs (µg/kg dry weight)										
	Fluor-anthene	Pyrene	Benzo[a]-anthracene	Chrysene	Benzo[b]-fluor-anthene	Benzo[k]-fluor-anthene	Benzo[a]-pyrene	Indeno-[1,2,3-cd]pyrene	Dibenzo-[a,h]anthracene	Benzo-[g,h,i]perylene	1,4-Dichloro-Benzene
<u>Method Blank</u>											
Blank	3.00	1.18 U ^(a)	0.60 U	1.09 U	0.50 U	1.80 ^(b)	1.60 ^(b)	2.32 U	3.34 U	3.64 U	10.0 U
MDL ^(c) verification study	8.7	7.7	5.3	6.4	8.1	6.5	7.7	5.8	4.1	4.7	9.5
<u>Matrix Spike</u>											
QC Sample ^(d)	2030	2110	867	1020	1230	410	803	547	151	574	203
QC Sample, MS	2300	2340	958	1080	1320	491	901	619	191	635	248
Concentration Recovered	270	230	91	60	90	81	98	72	40	61	45
Amount Spiked	50.4	50.3	43.6	50.5	50.4	49.9	45.3	44.5	37.6	44.8	38.2
Percent Recovery	536% ^(e)	457% ^(e)	209% ^(e)	119%	179% ^(e)	162% ^(e)	216% ^(e)	162% ^(e)	106%	136% ^(e)	118%
<u>Standard Reference Material</u>											
SRM HS-4 Non-certified values	1250 ± 100	940 ± 120	530 ± 50	650 ± 80	700 ± 150	360 ± 50	650 ± 80	580 ± 220	120 ± 50	580 ± 220	NC ^(f)
SRM HS-4 Actual values	1300	956	513	642	1010 ^(g)	352	505 ^(g)	482	110	388 ^(g)	NA ^(h)
Percent Difference	4%	2%	3%	1%	44%	2%	22%	17%	8%	33%	NA

TABLE A.21. (contd)

Sediment Treatment	HPAHs ($\mu\text{g/kg}$ dry weight)										
	Fluor- anthene	Pyrene	Benzo[a]- anthra- cene	Chrysene	Benzo[b]- fluor- anthene	Benzo[k]- fluor- anthene	Benzo[a]- pyrene	Indeno- [1,2,3- cd] pyrene	Dibenzo- [a,h] anthra- cene	Benzo- [g,h,i] perylene	1,4 Dichloro- Benzene
<u>Analytical Replicates</u>											
C-NR, Replicate 1	3.08 J(i)	1.18 U	2.07	1.08	2.63	1.19 ^(b)	1.18 U	2.32 U	3.34 U	3.64 U	10.0 U
C-NR, Replicate 2	3.12 J	1.30 ^(b)	2.09	1.06	2.68	1.17 ^(b)	1.18 U	2.32 U	3.34 U	3.64 U	10.0 U
C-NR, Replicate 3	3.29 J	1.18 U	2.11	1.11	2.98	1.31 ^(b)	1.18 U	2.32 U	3.34 U	3.64 U	10.0 U
RSD	4%	NA	1%	2%	7%	6%	NA	NA	NA	NA	NA

(a) U Undetected at or above given concentration.

(b) Ion ratio out or confirming ion not detected.

(c) MDL Method detection limit.

(d) Sample run concurrently with New York Reference Site Selection Project, Phase I.

(e) Outside quality control range (50% -120%) for matrix spike recoveries.

(f) NC Not certified.

(g) Outside quality control criteria ($\pm 30\%$) for SRMs.

(h) NA Not applicable.

(i) J Value reported less than LOQ (Limit of Quantitation).

TABLE A.22. Surrogate Percentage Recoveries for Polynuclear Aromatic Hydrocarbons (PAHs) in Sediment, New York Reference Site Selection Project, Phase I

Sediment Treatment	Surrogate Percentage Recoveries				
	Naphthalene d8	Acenaphthene d10	Chrysene d12	Perylene d12	1,4 Dichlorobenzene d4
GSB-1	39	54	60	43	33
GSB-2	37	44	49	33	32
NYB-13	37	55	59	46	28 ^(a)
NYB-15	42	54	60	41	34
Mud Dump Reference	51	58	61	40	42
<u>Quality Control Data</u>					
Method Blank	6 ^(a)	7 ^(a)	8 ^(a)	4 ^(a)	5 ^(a)
<u>Matrix Spike</u>					
QC Sample ^(b)	55	74	61	51	33
QC Sample, MS	50	66	58	50	29 ^(a)
<u>Standard Reference Material</u>					
Non-certified values					
SRM HS-4	40	55	62	45	0 ^(a)
<u>Analytical Replicates</u>					
C-NR, Replicate 1	58	67	79	54	44
C-NR, Replicate 2	57	70	73	49	45
C-NR, Replicate 3	52	59	65	45	43

(a) Outside quality control range (30%-150%) for surrogate percentage recoveries.

APPENDIX B

PHASE I TOXICITY TESTING DATA AND QUALITY CONTROL DATA

TABLE B.1. Test Results for 96-Hour *A. abdita* Cadmium Reference Toxicant Test,
New York Reference Site Selection Project, Phase I

Cadmium Concentration (mg/L)	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
0.00	1	18	2	0.90	0.90	0.05
0.00	2	19	1	0.95		
0.00	3	17	3	0.85		
0.25	1	17	3	0.85	0.85	0.00
0.25	2	17	3	0.85		
0.25	3	17	3	0.85		
0.50	1	8	12	0.40	0.55	0.15
0.50	2	14	6	0.70		
0.50	3	11	9	0.55		
1.0	1	3	17	0.15	0.28	0.13
1.0	2	6	14	0.30		
1.0	3	8	12	0.40		
2.0	1	0	20	0.00	0.03	0.06
2.0	2	2	18	0.10		
2.0	3	0	20	0.00		

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE B.2. Water Quality Summary for 96-Hour *A. abdita* Reference Toxicant Test,
New York Reference Site Selection Project, Phase I

Cadmium Concentration (mg/L)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	≥4.6	NA ^(a)	28.0	32.0
0.00	19.2	19.8	7.85	8.04	6.5	7.4	31.5	32.0
0.25	19.3	19.9	7.84	8.05	6.4	7.4	31.5	32.0
0.50	19.2	19.8	7.77	8.07	6.4	7.4	32.0	32.0
1.00	19.2	19.8	7.69	8.04	6.2	7.4	31.5	32.0
2.00	19.3	19.9	7.50	8.02	6.3	7.3	32.0	32.0

(a) NA Not applicable.

TABLE B.3. Test Results for *A. abdita* 10-Day Static Test, New York Reference Site Selection Project, Phase I

Sediment Treatment	Replicate	Live(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
GSB-1	1	17	3	0.85		
GSB-1	2	16	4	0.80		
GSB-1	3	14	6	0.70		
GSB-1	4	15	5	0.75		
GSB-1	5	14	6	0.70	0.76	0.07
GSB-2	1	15	5	0.75		
GSB-2	2	19	1	0.95		
GSB-2	3	18	2	0.90		
GSB-2	4	20	0	1.00		
GSB-2	5	18	2	0.90	0.90	0.09
NYB-13	1	18	2	0.90		
NYB-13	2	19	1	0.95		
NYB-13	3	19	1	0.95		
NYB-13	4	19	1	0.95		
NYB-13	5	18	2	0.90	0.93	0.03
NYB-15	1	18	2	0.90		
NYB-15	2	18	2	0.90		
NYB-15	3	18	2	0.90		
NYB-15	4	18	2	0.90		
NYB-15	5	15	5	0.75	0.87	0.07
C-2(IV)	1	18	2	0.90		
C-2(IV)	2	20	0	1.00		
C-2(IV)	3	18	2	0.90		
C-2(IV)	4	17	3	0.85		
C-2(IV)	5	16	4	0.80	0.89	0.07
<i>A. abdita</i> control	1	19	1	0.95		
<i>A. abdita</i> control	2	19	1	0.95		
<i>A. abdita</i> control	3	19	1	0.95		
<i>A. abdita</i> control	4	19	1	0.95		
<i>A. abdita</i> control	5	19	2	0.90	0.94	0.02

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE B.4. Water Quality Summary for *A. abdita* 10-Day Static Test, New York Reference Site Selection Project, Phase I

Sediment Treatment	Temperature (°C)		^(a) pH		Dissolved Oxygen (mg/L)		Salinity (‰)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	5.0	NA ^(b)	28.0	32.0	NA ^(b)	30 ^(c)
GSB-1	19.1	19.8	7.77	8.60 ^(d)	6.5	7.6	30.5	32.0	0.44	3.28
GSB-2	19.1	19.8	7.74	8.12	6.4	7.8	30.5	32.5 ^(d)	0.09	1.66
NYB-13	19.0	19.8	7.80	8.43 ^(d)	6.6	7.7	31.5	32.0	0.11	4.02
NYB-15	19.1	19.8	7.80	8.21	6.2	7.9	31.0	32.0	0.10	4.05
C-2(IV)	19.1	19.8	7.78	8.14	6.5	7.8	31.0	32.0	0.02	0.27
<i>A. abdita</i> control	19.1	19.8	7.70	8.11	6.3	7.8	31.0	32.5 ^(d)	0.18	2.52

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994.

(d) Data point out of range.

TABLE B.5. Test Results for *A. abdita* Modified Static Renewal Test, New York Reference Site Selection Project, Phase I

Sediment Treatment	Replicate	Live(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
GSB-1	1	19	1	0.95	0.77	0.15
GSB-1	2	11	9	0.55		
GSB-1	3	16	4	0.80		
GSB-1	4	17	3	0.85		
GSB-1	5	14	6	0.70		
GSB-2	1	18	2	0.90	0.89	0.04
GSB-2	2	17	3	0.85		
GSB-2	3	18	2	0.90		
GSB-2	4	19	1	0.95		
GSB-2	5	17	3	0.85		
NYB-13	1	19	1	0.95	0.93	0.06
NYB-13	2	19	1	0.95		
NYB-13	3	18	2	0.90		
NYB-13	4	20	0	1.00		
NYB-13	5	17	3	0.85		
NYB-15	1	19	1	0.95	0.93	0.06
NYB-15	2	20	0	1.00		
NYB-15	3	17	3	0.85		
NYB-15	4	19	1	0.95		
NYB-15	5	18	2	0.90		
<i>A. abdita</i> control	1	18	2	0.90	0.92	0.03
<i>A. abdita</i> control	2	18	2	0.90		
<i>A. abdita</i> control	3	18	2	0.90		
<i>A. abdita</i> control	4	19	1	0.95		
<i>A. abdita</i> control	5	19	1	0.95		

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE B.6. Water Quality Summary for *A. abdita* 10-Day Modified Static-Renewal Test, New York Reference Site Selection Project, Phase I

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	5.0	NA ^(b)	28.0	32.0	NA ^(b)	30 ^(c)
GSB-1	19.1	19.8	7.82	8.74 ^(d)	6.6	7.6	31.5	32.0	0.03	1.13
GSB-2	19.1	19.8	7.77	8.15	6.4	7.8	32.0	32.0	0.04	0.33
NYB-13	19.2	19.8	7.79	8.56 ^(d)	6.4	7.7	32.0	32.0	0.04	1.48
NYB-15	19.2	19.8	7.78	8.18	6.6	7.7	31.0	32.0	0.02	1.41
<i>A. abdita</i> control	19.1	19.8	7.79	8.18	6.5	7.7	32.0	32.0	0.04	1.00

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994.

(d) Data point out of range.

TABLE B.7. Test Results for 96-Hour *R. abronius* Reference Toxicant Test, New York Reference Site Selection Project, Phase I

Cadmium Concentration (mg/L)	Replicate	Live(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
0.00	1	19	1	0.95	0.97	0.03
0.00	2	19	1	0.95		
0.00	3	20	0	1.00		
0.25	1	18	2	0.90	0.65	0.28
0.25	2	14	6	0.70		
0.25	3	7	13	0.35		
0.50	1	12	8	0.60	0.63	0.10
0.50	2	11	9	0.55		
0.50	3	15	5	0.75		
1.00	1	12	8	0.60	0.72	0.13
1.00	2	14	6	0.70		
1.00	3	17	3	0.85		
2.00	1	0	20	0.00	0.12	0.10
2.00	2	3	17	0.15		
2.00	3	4	16	0.20		

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE B.8. Water Quality Summary for 96-Hour *R. abronius* Reference Toxicant Test, New York Reference Site Selection Project, Phase I

Cadmium Concentration (mg/L)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	5.0	NA ^(a)	28.0	32.0
0.00	14.2	15.3	7.88	8.00	7.4	8.8	32.0	32.0
0.25	14.2	15.1	7.87	8.00	7.4	8.8	32.0	32.0
0.50	14.2	15.3	7.75	7.99	7.1	8.8	32.0	32.5 ^(b)
1.00	14.2	15.3	7.82	7.94	7.3	8.8	32.0	32.0
2.00	14.2	15.3	7.86	8.01	7.4	8.7	32.0	32.0

(a) NA Not applicable.

(b) Data point out of range.

TABLE B.9. Test Results for *R. abronius* 10-Day Static Test, New York Reference Site Selection Project, Phase I

Sediment Treatment	Replicate	Live(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
GSB-1	1	17	3	0.85		
GSB-1	2	17	3	0.85		
GSB-1	3	17	3	0.85		
GSB-1	4	19	1	0.95		
GSB-1	5	18	2	0.90	0.88	0.04
GSB-2	1	20	0	1.00		
GSB-2	2	17	3	0.85		
GSB-2	3	18	2	0.90		
GSB-2	4	19	1	0.95		
GSB-2	5	18	2	0.90	0.92	0.06
NYB-13	1	17	3	0.85		
NYB-13	2	18	2	0.90		
NYB-13	3	19	1	0.95		
NYB-13	4	18	2	0.90		
NYB-13	5	18	2	0.90	0.90	0.04
NYB-15	1	19	1	0.95		
NYB-15	2	18	2	0.90		
NYB-15	3	18	2	0.90		
NYB-15	4	19	1	0.95		
NYB-15	5	18	2	0.90	0.92	0.03
C-2(IV)	1	20	0	1.00		
C-2(IV)	2	18	2	0.90		
C-2(IV)	3	20	0	1.00		
C-2(IV)	4	20	0	1.00		
C-2(IV)	5	17	3	0.85	0.95	0.07
<i>R. abronius</i> control	1	20	0	1.00		
<i>R. abronius</i> control	2	19	1	0.95		
<i>R. abronius</i> control	3	20	0	1.00		
<i>R. abronius</i> control	4	19	1	0.95		
<i>R. abronius</i> control	5	19	1	0.95	0.97	0.03

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE B.10. Water Quality Summary for *R. abronius* 10-day Static Test,
New York Reference Site Selection Project, Phase I

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	≥5.0	NA ^(b)	28.0	32.0	NA	60 ^(c)
GSB-1	13.3	15.2	7.77	8.17	6.1	8.0	30.5	32.0	0.17	3.56
GSB-2	13.3	15.2	7.88	7.99	6.0	8.0	30.0	32.0	0.11	1.67
NYB-13	13.3	15.2	7.76	8.10	6.3	8.0	31.0	32.0	0.01	2.81
NYB-15	13.3	15.1	7.83	8.08	6.0	8.0	31.0	32.0	0.03	2.79
C-2(IV)	13.4	15.1	7.76	8.09	6.6	8.0	31.0	32.0	0.01	0.29
<i>R. abronius</i> contro	13.3	15.1	7.75	8.13	6.5	8.0	31.0	32.0	0.04	1.03

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994.

**TABLE B.11. Test Results for *R. abronius* 10-Day Modified Static-Renewal Test,
New York Reference Site Selection Project, Phase I**

Sediment Treatment	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
GSB-1	1	18	2	0.90		
GSB-1	2	17	3	0.85		
GSB-1	3	17	3	0.85		
GSB-1	4	14	6	0.70		
GSB-1	5	14	6	0.70	0.80	0.09
GSB-2	1	17	3	0.85		
GSB-2	2	18	2	0.90		
GSB-2	3	17	3	0.85		
GSB-2	4	16	4	0.80		
GSB-2	5	17	3	0.85	0.85	0.04
NYB-13	1	18	2	0.90		
NYB-13	2	16	4	0.80		
NYB-13	3	15	5	0.75		
NYB-13	4	16	4	0.80		
NYB-13	5	18	2	0.90	0.83	0.07
NYB-15	1	15	5	0.75		
NYB-15	2	18	2	0.90		
NYB-15	3	18	2	0.90		
NYB-15	4	18	2	0.90		
NYB-15	5	17	3	0.85	0.86	0.07
<i>R. abronius</i> control	1	19	1	0.95		
<i>R. abronius</i> control	2	19	1	0.95		
<i>R. abronius</i> control	3	19	1	0.95		
<i>R. abronius</i> control	4	20	0	1.00		
<i>R. abronius</i> control	5	19	1	0.95	0.96	0.02

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE B.12. Water Quality Summary for *R. abronius* 10-Day Modified Static-Renewal Test, New York Reference Site Selection Project, Phase I

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	≥5.0	NA ^(b)	28.0	32.0	NA	60 ^(c)
GSB-1	13.1	15.0	7.74	8.01	6.5	8.0	31.0	32.0	0.04	0.38
GSB-2	13.1	15.1	7.69	7.99	6.8	7.9	31.0	32.0	<0.01	0.72
NYB-13	13.1	15.3	7.67	8.03	6.5	7.9	30.5	32.0	0.02	1.32
NYB-15	13.1	15.2	7.77	7.98	6.7	8.0	31.0	32.0	0.01	0.98
<i>R. abronius</i> control	13.1	15.0	7.71	8.02	6.4	8.0	31.0	32.0	0.01	0.26

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994.

TABLE B.13. Test Results for 96-Hour *M. bahia* Reference Toxicant Test, New York
Reference Site Selection Project, Phase I

Copper Concentration (µg/L)	Replicate	Live(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
0	1	10	0	1.00		
0	2	10	0	1.00		
0	3	9	1	0.90	0.97	0.06
108	1	9	1	0.90		
108	2	9	1	0.90		
108	3	10	0	1.00	0.93	0.06
180	1	8	2	0.80		
180	2	7	3	0.70		
180	3	8	2	0.80	0.77	0.06
300	1	4	6	0.40		
300	2	5	5	0.50		
300	3	4	6	0.40	0.43	0.06
500	1	0	10	0.00		
500	2	0	10	0.00		
500	3	0	10	0.00	0.00	0.00

(a) Survival based on initial exposure of 10 organisms per replicate.

TABLE B.14. Water Quality Summary for 96-Hour *M. bahia* Reference Toxicant Test, New York Reference Site Selection Project, Phase I

Copper Concentration (µg/L)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	4.0	NA ^(a)	28.0	32.0
0	19.3	19.6	7.47	7.91	3.9 ^(b)	8.0	32.0	32.0
108	19.2	19.7	7.58	7.91	4.6	8.0	31.5	32.0
180	19.3	19.7	7.54	7.92	5.1	8.0	31.5	32.0
300	19.3	19.6	7.57	7.91	5.5	8.0	31.5	32.0
500	19.2	19.6	7.69	8.02	6.0	8.0	31.5	32.0

(a) NA Not applicable.

(b) Data point out of range.

TABLE B.15. Test Results for *M. bahia* 10-Day Static Test, New York Reference Site Selection Project, Phase I

Sediment Treatment	Replicate	Live(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
GSB-1	1	18	2	0.90	0.90	0.06
GSB-1	2	19	1	0.95		
GSB-1	3	16	4	0.80		
GSB-1	4	19	1	0.95		
GSB-1	5	18	2	0.90		
GSB-2	1	19	1	0.95	0.93	0.03
GSB-2	2	18	2	0.90		
GSB-2	3	19	1	0.95		
GSB-2	4	19	1	0.95		
GSB-2	5	18	2	0.90		
NYB-13	1	18	2	0.90	0.89	0.06
NYB-13	2	19	1	0.95		
NYB-13	3	18	2	0.90		
NYB-13	4	18	2	0.90		
NYB-13	5	16	4	0.80		
NYB-15	1	19	1	0.95	0.88	0.07
NYB-15	2	17	3	0.85		
NYB-15	3	17	3	0.85		
NYB-15	4	19	1	0.95		
NYB-15	5	16	4	0.80		
<i>M. bahia</i> control	1	17	3	0.85	0.91	0.07
<i>M. bahia</i> control	2	18	2	0.90		
<i>M. bahia</i> control	3	17	3	0.85		
<i>M. bahia</i> control	4	19	1	0.95		
<i>M. bahia</i> control	5	20	0	1.00		

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE B.16. Water Quality Summary for *M. bahia* 10-Day Static Test, New York Reference Site Selection Project, Phase I

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	4.0	NA ^(a)	28.0	32.0
GSB-1	19.2	20.0	7.65	8.28	6.1	7.6	30.0	31.5
GSB-2	19.2	20.1	7.57	7.88	6.1	7.5	30.0	31.5
NYB-13	19.2	20.0	7.59	8.03	6.1	7.6	31.5	32.0
NYB-15	19.2	20.0	7.58	7.99	6.4	7.6	31.0	32.0
<i>M. bahia</i> control	19.2	20.0	7.22	8.34 ^(b)	6.0	7.6	31.0	32.0

(a) NA Not applicable.

(b) Data point out of range.

APPENDIX C

PHASE II: SEDIMENT CHEMISTRY DATA AND QUALITY CONTROL DATA

Table C.1. Summary of Sediment Grain Size, Percentage of Moisture and Total Percentage of Solids, New York Reference Site Selection Project, Phase II

Sediment Treatment	Analytical Batch	Total Percent (Dry)				Percent Moisture	Total Percent Solids
		Gravel >2000 μm	Sand 62.5- 2000 μm	Silt 3.9- 62.5μm	Clay < 3.9 μm		
<u>Ambrose 1</u>							
Ambrose 1-1	1	2	94	2	2	26	74
Ambrose 1-2	1	2	93	4	1	22	78
Ambrose 1-3	1	2	94	2	2	26	74
Ambrose 1-4	1	2	92	4	2	26	74
Ambrose 1-5	1	3	92	3	2	23	77
Ambrose 1-6	1	2	94	2	2	22	78
Ambrose 1-7 ^(a)	1	3	92	3	2	24	76
Ambrose 1-8	1	2	93	3	2	19	81
Ambrose 1-9	1	4	91	3	2	25	75
Ambrose 1-10	1	4	89	5	2	23	77
<u>Ambrose 2</u>							
Ambrose 2-1	1	0	91	4	5	26	74
Ambrose 2-2	1	1	97	1	1	22	78
Ambrose 2-3	1	2	96	1	1	17	83
Ambrose 2-4	1	1	97	1	1	20	80
Ambrose 2-5	1	1	95	2	2	21	79
Ambrose 2-6	1	1	96	2	1	20	80
Ambrose 2-7	1	0	95	3	2	25	75
Ambrose 2-8	1	0	96	3	1	19	81
Ambrose 2-9	1	0	97	2	1	22	78
Ambrose 2-10	1	0	93	4	3	23	77
<u>Reference</u>							
Mud Dump Reference	1	1	98	0	1	17	83
<u>Control</u>							
Lepto Control	1	1	70	17	12	85	15
Ampelisca Control	1	0	6	69	25	71	29
Mysid Control	1	1	15	53	31	72	28
Rhepox Control	1	0	97	2	1	25	75
<u>Quality Control Data</u>							
Ambrose 1-7 Rep 1	1	3	92	3	2	24	76
Ambrose 1-7 Rep 1	1	3	91	4	2	24	76
Ambrose 1-7 Rep 1	1	3	92	3	2	24	76
RSD		0%	1%	17%	0%	0%	0%

(a) Value represents a mean of 3 replicate analyses.

**TABLE C.2. Sediment Total Organic Carbon (TOC), New
York Reference Site Selection Project, Phase II**

Sediment Treatment	Replicate	Batch	TOC (% dry weight)
Ambrose 1	1	1	0.19
Ambrose 1	2	1	0.36
Ambrose 1	3	1	0.15
Ambrose 2	1	1	0.29
Ambrose 2	2	1	0.19
Ambrose 2	3	1	0.15
<u>Reference</u>			
Mud Dump Reference		1	0.006
<u>Control</u>			
Ampelisca Control		1	3.10
Lepto Control		1	1.50
Mysid Control		1	2.42
Rhepox Control		1	0.09
<u>Quality Control Data</u>			
<u>Standard Reference Material</u>			
Certified Value			4.80 ±1.2%
NIST 1941a		1	4.74
Percent Difference			1%
NIST 1941a		2	4.66
Percent Difference			3%
<u>Triplicate Analysis</u>			
QC Sample	1	1	2.01
QC Sample	2	1	2.00
QC Sample	3	1	1.99
RSD ^(a)			0%
QC Sample (LI-3)	1	2	3.11
QC Sample (LI-3)	2	2	3.17
QC Sample (LI-3)	3	2	3.11
RSD			1%

(a) RSD Relative standard deviation.

APPENDIX D

PHASE II: TOXICITY TESTING DATA AND QUALITY CONTROL DATA

TABLE D.1. Results of 96-Hour Cadmium Reference Toxicant Test with *A. abdita*,
New York Reference Site Selection Project, Phase II

Cadmium Concentration (mg/L)	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
0.00	1	20	0	1.00		
0.00	2	18	2	0.90		
0.00	3	19	1	0.95	0.95	0.05
0.19	1	16	4	0.80		
0.19	2	17	3	0.85		
0.19	3	17	3	0.85	0.83	0.03
0.38	1	12	8	0.60		
0.38	2	11	9	0.55		
0.38	3	15	5	0.75	0.63	0.10
0.75	1	5	15	0.25		
0.75	2	8	12	0.40		
0.75	3	8	12	0.40	0.35	0.09
1.50	1	0	20	0.00		
1.50	2	0	20	0.00		
1.50	3	2	18	0.10	0.03	0.06

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE D.2. Water Quality Summary for 96-Hour Cadmium Reference Toxicant Test with *A. abdita*, New York Reference Site Selection Project, Phase II

Cadmium Concentration mg/L	Temperature °C		pH		Dissolved Oxygen (mg/L)		Salinity (‰)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	≥ 4.6	NA ^(a)	28.0	32.0
0.00	19.3	20.5	7.93	8.11	6.6	7.6	30.0	30.5
0.19	19.5	20.3	7.90	8.17	7.0	7.6	30.0	30.5
0.38	19.3	20.3	7.85	8.14	6.7	7.5	30.5	31.0
0.75	19.3	20.4	7.66	8.06	6.9	7.6	30.5	31.0
1.50	19.5	20.3	7.50	8.07	6.8	7.6	30.0	31.0

(a) NA Not applicable

TABLE D.3. Results of 10-Day Benthic, Static Test with *A. abdita*,
New York Reference Site Selection Project, Phase II

Sediment Treatment	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
Ambrose 1	1	20	0	1.00		
Ambrose 1	2	18	2	0.90		
Ambrose 1	3	20	0	1.00		
Ambrose 1	4	19	1	0.95		
Ambrose 1	5	19	1	0.95	0.96	0.04
Ambrose 2	1	19	1	0.95		
Ambrose 2	2	18	2	0.90		
Ambrose 2	3	19	1	0.95		
Ambrose 2	4	18	2	0.90		
Ambrose 2	5	18	2	0.90	0.92	0.03
<i>A. abdita</i> Control	1	20	0	1.00		
<i>A. abdita</i> Control	2	19	1	0.95		
<i>A. abdita</i> Control	3	18	2	0.90		
<i>A. abdita</i> Control	4	20	0	1.00		
<i>A. abdita</i> Control	5	19	1	0.95	0.96	0.04

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE D.4. Water Quality Summary for 10-Day Benthic, Static Test with *A. abdita*,
New York Reference Site Selection Project, Phase II

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	≥4.6	NA ^(b)	28.0	32.0	NA	30 ^(c)
Ambrose 1	19.5	20.3	7.79	8.23	6.9	7.9	30.5	32.0	<1.00	15.2
Ambrose 2	19.5	20.3	7.17	8.28	7.3	8.1	30.5	32.0	<1.00	16.6
<i>A. abdita</i> Control	19.4	20.4	7.90	8.26	7.2	8.0	30.5	32.0	<1.00	5.40

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994

TABLE D.5. Results of 10-Day Benthic, Modified Static-Renewal Test with *A. abdita*,
New York Reference Site Selection Project, Phase II

Sediment Treatment	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
Ambrose 1	1	20	0	1.00		
Ambrose 1	2	16	4	0.80		
Ambrose 1	3	17	3	0.85		
Ambrose 1	4	18	2	0.90		
Ambrose 1	5	20	0	1.00	0.91	0.09
Ambrose 2	1	18	2	0.90		
Ambrose 2	2	20	0	1.00		
Ambrose 2	3	20	0	1.00		
Ambrose 2	4	20	0	1.00		
Ambrose 2	5	17	3	0.85	0.95	0.07
<i>A. abdita</i> Control	1	18	2	0.90		
<i>A. abdita</i> Control	2	18	2	0.90		
<i>A. abdita</i> Control	3	18	2	0.90		
<i>A. abdita</i> Control	4	18	2	0.90		
<i>A. abdita</i> Control	5	16	4	0.80	0.88	0.04

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE D.6. Water Quality Summary for 10-Day Benthic, Modified Static-Renewal Test with *A. abdita*, New York Reference Site Selection Project, Phase II

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	≥4.6	NA ^(b)	28.0	32.0	NA ^(b)	30 ^(c)
Ambrose 1	19.1	20.3	7.88	8.14	6.7	8.2	30.0	30.5	<1.00	3.09
Ambrose 2	19.4	20.1	7.75	8.09	7.4	8.1	30.0	31.0	<1.00	3.15
<i>A.abdita</i> Control	19.5	20.1	7.82	8.11	7.3	8.4	30.0	30.5	<1.00	1.78

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994.

TABLE D.7. Test Results for 96-Hour Cadmium Reference Toxicant Test with *L. plumulosus*, New York Reference Site Selection Project, Phase II

Cadmium Concentration (mg/L)	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
0.00	1	20	0	1.00	1.00	0.00
0.00	2	20	0	1.00		
0.00	3	20	0	1.00		
0.38	1	18	2	0.90	0.93	0.03
0.38	2	19	1	0.95		
0.38	3	19	1	0.95		
0.75	1	16	4	0.80	0.82	0.03
0.75	2	16	4	0.80		
0.75	3	17	3	0.85		
1.50	1	10	10	0.50	0.50	0.15
1.50	2	7	13	0.35		
1.50	3	13	7	0.65		
3.0	1	5	15	0.25	0.28	0.06
3.0	2	7	13	0.35		
3.0	3	5	15	0.25		

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE D.8. Water Quality Summary for 96-Hour Cadmium Reference Toxicant Test with *L. plumulosus*, New York Reference Site Selection Project, Phase II

Cadmium Concentration (mg/L)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	≥4.6	NA ^(a)	28.0	32.0
0.00	19.4	20.4	7.95	8.16	6.9	7.6	30.5	31.5
0.38	19.3	20.2	7.80	8.13	7.0	7.8	30.0	31.0
0.75	19.4	20.4	7.67	8.10	6.8	7.5	30.0	31.0
1.50	19.4	20.3	7.42	8.03	6.8	7.6	30.0	31.0
3.00	19.4	20.3	7.50	7.99	6.7	7.5	30.5	31.0

(a) NA Not applicable

TABLE D.9. Results of 10-Day Benthic, Static Test with *L. plumulosus*,
New York Reference Site Selection Project, Phase II

Sediment Treatment	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
Ambrose 1	1	19	1	0.95		
Ambrose 1	2	20	0	1.00		
Ambrose 1	3	19	1	0.95		
Ambrose 1	4	20	0	1.00		
Ambrose 1	5	20	0	1.00	0.98	0.03
Ambrose 2	1	19	1	0.95		
Ambrose 2	2	20	0	1.00		
Ambrose 2	3	19	1	0.95		
Ambrose 2	4	17	3	0.85		
Ambrose 2	5	20	0	1.00	0.95	0.06
<i>L. plumulosus</i> Control	1	20	0	1.00		
<i>L. plumulosus</i> Control	2	20	0	1.00		
<i>L. plumulosus</i> Control	3	20	0	1.00		
<i>L. plumulosus</i> Control	4	19	1	0.95		
<i>L. plumulosus</i> Control	5	20	0	1.00	0.99	0.02

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE D.10. Water Quality Summary for 10-Day *Benthic*, Static Test with *L. plumulosus*,
New York Reference Site Selection Project, Phase II

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	≥5.0	NA ^(b)	28.0	32.0	NA	60 ^(c)
Ambrose 1	19.3	20.3	7.94	8.27	7.1	8.0	30.5	32.0	<1.00	17.8
Ambrose 2	19.5	20.3	7.97	8.28	7.3	8.0	30.5	33.5	<1.00	19.4
<i>L. plumulosus</i> Control	19.4	20.2	7.94	8.15	7.1	7.9	28.5	31.0	<1.00	17.2

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994.

TABLE D.11. Results for 10-Day Benthic, Modified Static-Renewal Test with *L. plumulosus*, New York Reference Site Selection Project, Phase II

Sediment Treatment	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
Ambrose 1	1	19	1	0.95		
Ambrose 1	2	20	0	1.00		
Ambrose 1	3	18	2	0.90		
Ambrose 1	4	19	1	0.95		
Ambrose 1	5	20	0	1.00	0.96	0.04
Ambrose 2	1	19	1	0.95		
Ambrose 2	2	20	0	1.00		
Ambrose 2	3	19	1	0.95		
Ambrose 2	4	18	2	0.90		
Ambrose 2	5	20	0	1.00	0.96	0.04
<i>L. plumulosus</i> Control	1	19	1	0.95		
<i>L. plumulosus</i> Control	2	20	0	1.00		
<i>L. plumulosus</i> Control	3	20	0	1.00		
<i>L. plumulosus</i> Control	4	19	1	0.95		
<i>L. plumulosus</i> Control	5	19	1	0.95	0.97	0.03

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE D.12. Water Quality Summary for 10-Day Benthic, Modified Static-Renewal Test with *L. plumulosus*, New York Reference Site Selection Project, Phase II

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	≥4.6	NA ^(b)	28.0	32.0	NA	60 ^(c)
Ambrose 1	19.4	20.0	8.00	8.16	7.1	8.1	30.5	32.0	<1.00	2.06
Ambrose 2	19.5	20.0	7.94	8.10	7.1	8.1	30.0	32.0	<1.00	4.4
<i>L. plumulosus</i> Control	19.5	20.1	7.51	8.10	6.6	8.1	29.0	31.0	<1.00	2.28

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994

TABLE D.13. Results of 96-Hour Cadmium Reference Toxicant Test with *R. abronius*,
New York Reference Site Selection Project, Phase II

Cadmium Concentration (mg/L)	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
0.00	1	16	4	0.80		
0.00	2	20	0	1.00		
0.00	3	19	1	0.95	0.92	0.10
0.38	1	18	2	0.90		
0.38	2	17	3	0.85		
0.38	3	13	7	0.65	0.80	0.13
0.75	1	6	14	0.30		
0.75	2	0	20	0.00		
0.75	3	2	18	0.10	0.13	0.15
1.50	1	0	20	0.00		
1.50	2	0	20	0.00		
1.50	3	0	20	0.00	0.00	0.00
3.00	1	0	20	0.00		
3.00	2	0	20	0.00		
3.00	3	0	20	0.00	0.00	0.00

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE D.14. Water Quality Summary for 96-Hour Cadmium Reference Toxicant Test with *R. abronius*, New York Reference Site Selection Project, Phase II

Cadmium Concentration (mg/L)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	≥5.0	NA ^(a)	28.0	32.0
0.00	15.0	15.9	7.90	8.12	7.3	8.1	30.0	31.0
0.38	15.0	15.9	7.85	8.09	7.4	7.8	30.0	30.5
0.75	15.0	15.4	7.91	8.07	7.4	7.8	30.0	31.5
1.50	15.0	15.9	7.86	8.09	7.2	7.8	30.5	31.0
3.00	15.1	15.8	7.83	7.99	7.4	7.9	30.5	31.5

(a) NA Not applicable

TABLE D.15. Results of 10-Day Benthic, Static Test with *R. abronius*,
New York Reference Site Selection Project, Phase II

Sediment Treatment	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
Ambrose 1	1	20	0	1.00		
Ambrose 1	2	20	0	1.00		
Ambrose 1	3	19	1	0.95		
Ambrose 1	4	20	0	1.00		
Ambrose 1	5	19	1	0.95	0.98	0.03
Ambrose 2	1	20	0	1.00		
Ambrose 2	2	20	0	1.00		
Ambrose 2	3	9	11	0.45		
Ambrose 2	4	20	0	1.00		
Ambrose 2	5	20	0	1.00	0.89	0.25
<i>R. abronius</i> Control	1	19	1	0.95		
<i>R. abronius</i> Control	2	19	1	0.95		
<i>R. abronius</i> Control	3	14	6	0.70		
<i>R. abronius</i> Control	4	20	0	1.00		
<i>R. abronius</i> Control	5	19	1	0.95	0.91	0.12

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE D.16. Water Quality Summary for 10-Day Benthic, Static Test with *R. abronius*,
New York Reference Site Selection Project, Phase II

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	≥5.0	NA ^(b)	28.0	32.0	NA	60 ^(c)
Ambrose 1	14.8	15.5	7.82	8.18	7.5	8.2	30.5	31.5	<1.00	11.6
Ambrose 2	14.8	15.7	7.75	8.21	5.9	8.3	30.5	32.0	<1.00	14.2
<i>R. abronius</i> Control	14.0	15.7	7.60	8.36 ^(d)	6.9	8.6	30.0	32.0	<1.00	16.2

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994.

(d) Data point out of range.

TABLE D.17. Results for 10-Day Benthic, Modified Static-Renewal Test with *R. abronius*, New York Reference Site Selection Project, Phase II

Sediment Treatment	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
Ambrose 1	1	20	0	1.00		
Ambrose 1	2	18	2	0.90		
Ambrose 1	3	18	2	0.90		
Ambrose 1	4	20	0	1.00		
Ambrose 1	5	19	1	0.95	0.95	0.05
Ambrose 2	1	19	1	0.95		
Ambrose 2	2	20	0	1.00		
Ambrose 2	3	19	1	0.95		
Ambrose 2	4	18	2	0.90		
Ambrose 2	5	16	4	0.80	0.92	0.08
<i>R. abronius</i> Control	1	19	1	0.95		
<i>R. abronius</i> Control	2	18	2	0.90		
<i>R. abronius</i> Control	3	17	3	0.85		
<i>R. abronius</i> Control	4	17	3	0.85		
<i>R. abronius</i> Control	5	16	4	0.80	0.87	0.06

(a) Survival based on initial exposure of 20 organisms per replicate.

TABLE D.18. Water Quality Summary for 10-Day Benthic, Modified Static-Renewal Test with *R. abronius*, New York Reference Site Selection Project, Phase II

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (‰)		Total Ammonia ^(a) (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	≥5.0	NA ^(a)	28.0	32.0	NA ^(a)	60 ^(b)
Ambrose 1	14.8	15.7	7.81	8.03	7.3	8.2	30.0	32.0	<1.00	2.50
Ambrose 2	14.6	15.9	7.75	8.08	7.3	8.6	30.5	32.0	<1.00	3.70
<i>R. abronius</i> Control	14.8	15.3	7.25	8.12	1.7	8.2	30.0	32.0	<1.00	5.90

(a) Ammonia is measured in overlying water.

(b) NA Not applicable.

(c) EPA 1994.

TABLE D.19. Results of 96-Hour Copper Reference Toxicant Test with *M. bahia*,
New York Reference Site Selection Project, Phase II

Copper Concentration (µg/L)	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
0	1	10	0	1.00		
0	2	10	0	1.00	1.00	0.00
100	1	10	0	1.00		
100	2	9	1	0.90	0.95	0.07
150	1	10	0	1.00		
150	2	10	0	1.00	1.00	0.00
200	1	8	2	0.80		
200	2	9	1	0.90	0.85	0.07
300	1	4	6	0.40		
300	2	3	7	0.30	0.35	0.07

(a) Survival based on initial exposure of 10 organisms per replicate.

TABLE D.20. Water Quality Summary for 96-Hour Copper Reference Toxicant Test with *M. bahia*, New York Reference Site Selection Project, Phase II

Copper Concentration (µg/L)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	18.0	22.0	7.30	8.30	≥4.6	NA ^(b)	28.0	32.0
0	19.2	19.6	7.53	7.94	5.9	8.1	30.5	31.0
100	19.3	19.7	7.57	7.89	6.1	8.0	30.5	31.5
150	19.2	19.6	7.55	7.92	7.0	7.9	30.5	31.5
200	19.3	19.6	7.73	7.91	7.0	7.9	31.0	31.0
300	19.2	19.6	7.57	7.93	7.1	8.1	30.5	31.0

(a) NA Not applicable.

TABLE D.21. Results of 10-Day Benthic, Modified Static-Renewal Test with *M. bahia*
New York Reference Site Selection Project, Phase II

Sediment Treatment	Replicate	Live ^(a)	Dead or Missing	Proportion Surviving	Mean Proportion Surviving	Standard Deviation
Ambrose 1	1	20	0	1.00		
Ambrose 1	2	17	3	0.85		
Ambrose 1	3	19	1	0.95		
Ambrose 1	4	20	0	1.00		
Ambrose 1	5	20	0	1.00	0.96	0.07
Ambrose 2	1	20	0	1.00		
Ambrose 2	2	19	1	0.95		
Ambrose 2	3	20	0	1.00		
Ambrose 2	4	19	1	0.95		
Ambrose 2	5	20	0	1.00	0.98	0.03
<i>M. bahia</i> Control	1	19	1	0.95		
<i>M. bahia</i> Control	2	19	1	0.95		
<i>M. bahia</i> Control	3	18	2	0.90		
<i>M. bahia</i> Control	4	20	0	1.00		
<i>M. bahia</i> Control	5	17	3	0.85	0.93	0.06

(a) Survival based on initial exposure of 20 organisms per replicate.