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**Evaluation of Dredged Material
Proposed for Ocean Disposal from
Gravesend Bay Anchorage, New York**

**E. S. Barrows
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**Battelle Marine Sciences Laboratory
Sequim, Washington**

September 1996

**Prepared for the
U.S. Army Corps of Engineers - New York District
under a Related Services Agreement
with the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest National Laboratory
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**EVALUATION OF DREDGED MATERIAL
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Summary

The Gravesend Bay Anchorage was one of seven waterways that the U. S. Army Corps of Engineers-New York District (USACE-NYD) requested the Battelle Marine Sciences Laboratory (MSL) to sample and evaluate for dredging and disposal in February 1994. Sediment samples were collected from the Gravesend Bay Anchorage, as well as from the Hudson River, Buttermilk Channel, South Brother Island, Port Chester, Eastchester, and Brown's Creek, during a survey conducted from March 7 through 14, 1994. Combining sample collection and evaluation of multiple dredged material projects was more cost-effective for the USACE-NYD because the expense of reference site testing and quality control analyses could be shared among dredging projects.

Tests and analyses were conducted on Gravesend Bay sediment core samples by the MSL according to the manual developed by the USACE and the U.S. Environmental Protection Agency (EPA), *Evaluation of Dredged Material Proposed for Ocean Disposal (Testing Manual)*, commonly referred to as the "Green Book," and the 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*.

The Gravesend Bay Anchorage sediment was expected to meet the exclusionary criteria set forth in 40 CFR §227.13; however, sediment samples were submitted for physical and chemical analyses to provide baseline sediment chemistry data on the Gravesend Bay Anchorage. Individual sediment core samples collected at the Gravesend Bay Anchorage were analyzed for grain size, moisture content, and total organic carbon (TOC). Two samples, one of composited sediment cores representing the southeast corner of the anchorage (COMP GR), and one sediment core representing the northeast corner of the anchorage (Station GR-10), were analyzed for bulk density, specific gravity, metals, chlorinated pesticides, polychlorinated biphenyl (PCB) congeners, polynuclear aromatic hydrocarbons (PAH), and 1,4-dichlorobenzene.

Sediment core samples from Gravesend Bay Stations 1 through 6, located in the southeast corner of the anchorage where most of the shoaling within the anchorage had occurred, had an average grain size distribution of 93% sand and 7% silt and clay. Therefore, the proposed dredging area represented by Stations 1 through 6 met the grain size exclusionary criteria set forth in 40 CFR §227.13.

The TOC concentrations in sediments from Stations 1 through 6 ranged from 0.04% to 0.51% dry weight. Pesticides and PCBs in COMP GR were either undetected or detected at concentrations below or near the method detection limit (MDL). All PAH compounds analyzed in COMP GR were detected at low levels. The compound 1,4-dichlorobenzene was detected at 3.76 $\mu\text{g/kg}$, just above the target detection limit of 1 $\mu\text{g/kg}$.

Sediment from Station GR-10, collected in the northeast corner of the anchorage, was distinctly different, physically and chemically, from the COMP GR sediment. Station GR-10 sediment did not pass the grain size exclusionary criteria, due to a grain size distribution of 45% sand, 31% silt, and 24% clay. The TOC in GR-10 sediment was 2.06% dry weight. Concentrations of all metals found in GR-10 were greater than those found in COMP GR sediment. The dominant pesticides detected were α -chlordane, dieldrin, and the DDT family of compounds. The remaining pesticides were either undetected in GR-10 or detected at concentrations lower than the sample MDL. Station GR-10 sediment contained detectable concentrations of all PCB congeners and PAHs analyzed, as well as 1,4-dichlorobenzene.

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1.0 Introduction

1.1 Project Objectives

The objective of the Gravesend Bay Anchorage Project was to evaluate proposed dredged material from the Gravesend Bay Anchorage to determine its suitability for unconfined ocean disposal at the Mud Dump Site. The Mud Dump Site is the present dredged material disposal site for the Port of New York and New Jersey. It lies in the apex of the New York Bight about 6 miles east of Sandy Hook, New Jersey, and 12 miles south of Rockaway Point, New York.

Tests and analyses were conducted on Gravesend Bay sediment core samples by the Battelle Marine Sciences Laboratory (MSL) according to the manual developed by the U. S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (EPA), *Evaluation of Dredged Material Proposed for Ocean Disposal (Testing Manual)* (EPA/USACE 1991), commonly referred to as the "Green Book," and the regional manual developed by the USACE-New York District (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." The Regional Guidance Manual provides specifications for the use of local or appropriate test species in biological tests and identifies chemical contaminants of concern.

1.2 Project Background

The proposed Gravesend Bay Anchorage project is located just off the southwest end of Brooklyn, New York, in the Lower Bay of New York Harbor, southeast of The Narrows (Figure 1.1). The project requires dredging and disposal of an estimated 40,000 to 50,000 cu yd of sediment. Project depth of the anchorage is -47 ft mean low water (MLW) plus 2 ft of overdepth. Gravesend Bay was one of seven waterways that the USACE-NYD requested the MSL to evaluate in a series of dredged material projects that became known as the New York/New Jersey Federal Projects-2 program. The projects evaluated under the

Figure 1.1. Location of Gravesend Bay Anchorage and Sample Collection Stations

Federal Projects-2 program were the Gravesend Bay Anchorage, the Hudson River, South Brothers Island, Buttermilk Channel, Brown's Creek, Port Chester, and Eastchester. Sediment samples from 12 reaches in these waterways were collected during a survey that took place from March 7 through March 14, 1994. Combining sample collection and evaluation of multiple dredged material projects was more cost-effective for the USACE-NYD because the expense of reference site testing and quality control analyses could be shared among dredging projects.

Based on previous data obtained from sediment grab samples taken in 1989, sediments were expected to be at least 90% sand (L.B. Rosman, personal communication 1994). According to 40 CFR §227.13, if the proposed dredged material is composed predominantly of sand, gravel, rock, or any other naturally occurring bottom material with particle sizes larger than silt, the material is environmentally acceptable for ocean dumping without further testing. Although the Gravesend Bay Anchorage sediment was expected to meet the exclusionary criteria set forth in 40 CFR §227.13, sediment samples were submitted for physical and chemical analyses to provide baseline sediment chemistry data on the Gravesend Bay Anchorage. Individual sediment core samples collected at the Gravesend Bay Anchorage were analyzed for grain size, moisture content, and total organic carbon (TOC). Two samples, one of composited sediment cores representing the southeast corner of the anchorage, and one sediment core representing the northeast corner of the anchorage, were analyzed for bulk density, specific gravity, metals, chlorinated pesticides, polychlorinated biphenyl (PCB) congeners, polynuclear aromatic hydrocarbons (PAH), and 1,4-dichlorobenzene.

1.3 Organization of This Report

Following this introduction, Section 2 presents the methods and materials used for sample collection, sample processing, sediment sample analysis of physical and chemical parameters, and quality assurance. Section 3 presents the results of all physical and chemical analyses and a summary and discussion of the results. Section 4 lists the literature cited in this report. Appendix A contains tables of analytical results, including quality control/quality assurance (QA/QC) summaries and results of all QA/QC sample analyses.

2.0 Materials and Methods

2.1 Sediment Collection

Sediment samples were collected from seven stations within the Gravesend Bay Anchorage. Sampling locations were selected by the USACE-NYD based on recent bathymetric surveys. The locations, their coordinates, and water and core sampling depths are presented with the sampling results in Section 3.0. All samples from the Gravesend Bay Anchorage project area were collected aboard the M/V *Hayward*, a vessel owned and operated by USACE-NYD at Caven Point, New Jersey.

Test sediment core samples were collected using a vibracore sampler deployed from the *Hayward*. The approximate sampling locations were first determined with the aid of reference to landmarks, such as shoreline features or buoys, as well as by water depth. Then, a hand-held Magellan Global Positioning System (GPS) was used to identify and record (within 30 m) each sampling station. The vessel's LORAN was available as a backup system. Water depth at the time of sampling was measured by a fathometer on the *Hayward*. The actual water depth was corrected to MLW depth by correcting to the tide height at the time the depth was recorded. The difference between the MLW depth and the project depth, plus 2 ft overdepth, yields the amount of core required. At some sites, more than one core replicate was required to collect a sufficient volume of sediment for conducting all tests.

Core samples were collected using a vibracore sampler owned and operated by Ocean Surveys, Inc. (OSI), Old Saybrook, Connecticut. The vibracore sampler consisted of a 4-in. outer diameter, steel core barrel attached to an electric vibratory hammer. The vibratory hammer could be fitted to steel core barrels of various lengths, depending on the length of core needed. To collect a core sample, the core barrel was fitted with a 3.125-in. inner diameter, steam-cleaned, Lexan polycarbonate tube. The vibracore was then suspended by the crane on the *Hayward*. Once the coring apparatus was directly above the sampling station, the core was lowered through the water to the sediment surface. At this point, the station coordinates were taken from the Magellan GPS, and water depth was recorded from the ship's fathometer. The vibratory hammer was applied until the corer penetrated through the sediment to the desired project depth. Adequate penetration was determined relative to marks on the outside of the

core barrel and on the cable suspending the vibracore from the crane. The vibracore apparatus was then pulled out of the sediment and lowered onto the *Hayward's* deck. A cutter-head and core-catcher assembly prevented loss of the sediment through the bottom of the core liner. After each core was brought on board, the liner was pulled from the barrel, and the length of cored sediment was measured from the mudline to determine whether the appropriate depth has been reached. If not, the liner was replaced, and a second core sample was attempted. If the core achieved project depth plus 2 ft overdepth, it was capped, sealed with tape, and labeled. While on board the sampling vessel, cores were kept cool ($\sim 4^{\circ}\text{C}$) in a freezer located onboard. If necessary, cores were cut into shorter sections to fit in the freezer.

A log book was maintained containing records of each sediment sample collected, including station designation, coordinates, replicate number, date, sampling time, water depth, core length, and number of core sections per core. At the end of each sampling day, when the *Hayward* returned to Caven Point, all sediment cores were loaded into a refrigerated van, thermostatically controlled to maintain approximately 4°C . Sample identification numbers were logged on chain-of-custody forms daily.

At the conclusion of the sample collection survey, sediment cores were shipped by refrigerated van from Caven Point, New Jersey, to the MSL in Sequim, Washington. The shipment of sediment cores departed from Caven Point on March 14, 1994, and arrived at the MSL on March 18, 1994.

2.2 Sediment Sample Preparation

2.2.1 Laboratory Preparation

All glassware, stainless-steel or titanium utensils, Nalgene or Teflon items, and other laboratory containers and equipment underwent stringent cleaning procedures to avoid contamination of samples. 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. Polyvinyl chloride (PVC), Nalgene, and Teflon tools and equipment were 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 they were allowed to air dry. Teflon tools and equipment were then rinsed with methylene chloride and allowed to dry under a fume hood. Large pieces of laboratory equipment, such as the epoxy-coated cement mixer used for homogenizing sediment, were washed with a dilute solution of detergent, and thoroughly rinsed with tap water followed by deionized water.

2.2.2 Sediment Homogenization and Compositing

Upon arrival at the laboratory, sediment samples were inventoried against chain-of-custody forms. When not in use, all sediment cores were stored in a walk-in refrigerator maintained at approximately 4 °C.

Each Lexan core liner was opened by cutting the core longitudinally. The presence of strata in the cores was noted. The sediment between the mudline and project depth was transferred from the core liner to a clean, stainless-steel bowl. If project depth was not achieved, the entire core sample was used. The sediment from either core or grab samples was mixed using stainless-steel utensils until the color and consistency appeared homogenous, creating a sample representative of the individual sampling station. All sediment samples were assigned random, unique code numbers to ensure that samples were handled without bias. Aliquots were removed from each homogenized core sediment from Stations 1 through 6 and Station 10 and transferred to appropriate containers for analysis of grain size, percentage of moisture, and TOC.

A portion of each homogenized sediment core sample from Stations 1 through 6 was reserved as an archive sample. The remainder of the sediment from Stations 1 through 6 was combined and homogenized in an epoxy-coated cement mixer to create a composite sample representing the southeast area of the Gravesend Bay Anchorage, designated COMP GR. Aliquots of COMP GR and Station GR-10 sediment were transferred to separate, appropriate containers for analysis of bulk density and specific gravity, metals, chlorinated pesticides, PCBs, PAHs and 1,4-dichlorobenzene. An aliquot of COMP GR was also reserved as an archive sample. The archived individual core and composite sediments will be stored frozen for one year in case further chemical analyses are requested by the USACE-NYD.

2.3 Physical and Chemical Analytical Procedures

Gravesend Bay sediment samples were analyzed for selected physical and chemical parameters. Table 2.1 lists the parameters measured, 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 those required by the Regional Guidance Manual unless otherwise noted.

2.3.1 Grain Size and Percentage of Moisture

Grain size was measured following two methods described by Plumb (1981). The wet sieve method was used to determine the size distribution of sand or coarser-grained particles larger than a U.S. No. 230 standard sieve (62.5- μ m mesh). The size distribution of particles smaller than a U.S. No. 230 sieve was determined using the pipet method. Grain size was reported as percentages within three general size classes:

sand $\geq$ 62.5- μ m diameter
silt $<$ 62.5- μ m diameter and $\geq$ 3.9- μ m diameter
clay $\leq$ 3.9- μ m diameter.

As a quality control measurement of precision, one sample was selected randomly from the batch and analyzed in triplicate. Precision was expressed in terms of relative standard deviation (RSD). The data quality objective for precision grain size analysis was $\leq$ 20% RSD.

Percentage of moisture was obtained using the Plumb (1981) method for determining total solids. The procedure involves drying a sediment sample at 100°C until a constant weight is obtained. Percentage of moisture was calculated by subtracting the percentage of total solids from 100%. One sample from the batch was analyzed in duplicate to assess method precision.

2.3.2 Bulk Density and Specific Gravity

Bulk density, or unit weight, was determined according to EM 111-2-1906 (USACE 1970). Specific gravity, the ratio of the mass of a given volume of material to an equal volume of water at the same temperature, was measured according to ASTM D-854.

Table 2.1. List of Analytes, Methods, and Target Detection Limits

<u>Analyte</u>	<u>Methods</u>	<u>Target Detection Limit ^(a)</u>
<u>PHYSICAL PARAMETERS</u>		
Grain Size	Plumb (1981)	1.0%
Specific Gravity	ASTM D-854	— ^(b)
Bulk Density	EM 1110-2-1906 (USACE 1970)	--
Percent Moisture	Plumb (1981)	1.0 %
<u>METALS</u>		
Arsenic	EPA 200.2, 200.8 ^(c,d)	0.10 mg/kg
Cadmium	EPA 200.2, 200.8 ^(c,d)	0.01 mg/kg
Chromium	EPA 200.2, 200.8 ^(c,d)	0.02 mg/kg
Copper	EPA 200.2, 200.8 ^(c,d)	0.10 mg/kg
Lead	EPA 200.2, 200.8 ^(c,d)	0.10 mg/kg
Mercury	EPA 245.5 ^(c,d)	0.02 mg/kg
Nickel	EPA 200.2, 200.8 ^(c,d)	0.10 mg/kg
Silver	EPA 200.2, 200.8 ^(c,d)	0.10 mg/kg
Zinc	EPA 200.2, 200.8 ^(c,d)	0.10 mg/kg
<u>ORGANIC COMPOUNDS</u>		
TOC	EPA (1986)	0.1%
<u>Pesticides</u>		
Aldrin	EPA 8080 ^(c,e)	1.0 µg/kg
α-Chlordane	EPA 8080 ^(c,e)	1.0 µg/kg
trans-Nonachlor	EPA 8080 ^(c,e)	1.0 µg/kg
Dieldrin	EPA 8080 ^(c,e)	1.0 µg/kg
4,4'-DDT	EPA 8080 ^(c,e)	1.0 µg/kg
2,4'-DDT	EPA 8080 ^(c,e)	1.0 µg/kg
4,4'-DDD	EPA 8080 ^(c,e)	1.0 µg/kg
2,4'-DDD	EPA 8080 ^(c,e)	1.0 µg/kg
4,4'-DDE	EPA 8080 ^(c,e)	1.0 µg/kg
2,4'-DDE	EPA 8080 ^(c,e)	1.0 µg/kg
Endosulfan I	EPA 8080 ^(c,e)	1.0 µg/kg
Endosulfan II	EPA 8080 ^(c,e)	1.0 µg/kg
Endosulfan sulfate	EPA 8080 ^(c,e)	1.0 µg/kg
Heptachlor	EPA 8080 ^(c,e)	1.0 µg/kg
Heptachlor epoxide	EPA 8080 ^(c,e)	1.0 µg/kg
<u>PCBs</u>		
CL 8 (2,4')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 18 (2,2',5)	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 28 (2,4,4')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 44 (2,2',3,5')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 49 (2,2',4,5')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 52 (2,2',5,5')	NYSDEC (1991) ^(d)	1.0 µg/kg

Table 2.1. (contd)

<u>Analyte</u>	<u>Target Methods</u>	<u>Detection Limit ^(a)</u>
CL 66 (2,3',4,4')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 87 (2,2',3,4,5')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 101 (2,2',3,5,5')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 105 (2,3,3',4,4')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 118 (2,3',4,4',5)	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 128 (2,2',3,3',4,4')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 138 (2,2',4,4',5,5')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 153 (2,2',4,4',5,5')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 170 (2,2',3,3',4,4',5)	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 180 (2,2',3,4',5,5',6)	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 183 (2,2',3,4,4',5',6)	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 184 (2,2',3,4,4',6,6')	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 187 (2,2',3,4',5,5',6)	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 195 (2,2',3,3',4,4',5,6)	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 206 (2,2',3,3',4,4',5,5',6)	NYSDEC (1991) ^(d)	1.0 µg/kg
CL 209 (2,2',3,3',4,4',5,5',6,6')	NYSDEC (1991) ^(d)	1.0 µg/kg
PAHs		
Acenaphthene	EPA 8270 ^(d,e)	10 µg/kg
Acenaphthylene	EPA 8270 ^(d,e)	10 µg/kg
Anthracene	EPA 8270 ^(d,e)	10 µg/kg
Fluorene	EPA 8270 ^(d,e)	10 µg/kg
Naphthalene	EPA 8270 ^(d,e)	10 µg/kg
Phenanthrene	EPA 8270 ^(d,e)	10 µg/kg
Benzo[a]anthracene	EPA 8270 ^(d,e)	10 µg/kg
Benzo[a]pyrene	EPA 8270 ^(d,e)	10 µg/kg
Benzo[b]fluoranthene	EPA 8270 ^(d,e)	10 µg/kg
Benzo[g,h,i]perylene	EPA 8270 ^(d,e)	10 µg/kg
Benzo[k]fluoranthene	EPA 8270 ^(d,e)	10 µg/kg
Chrysene	EPA 8270 ^(d,e)	10 µg/kg
Dibenz[a,h]anthracene	EPA 8270 ^(d,e)	10 µg/kg
Fluoranthene	EPA 8270 ^(d,e)	10 µg/kg
Indeno[1,2,3-cd]pyrene	EPA 8270 ^(d,e)	10 µg/kg
Pyrene	EPA 8270 ^(d,e)	10 µg/kg
INDUSTRIAL CHEMICALS		
1,4-Dichlorobenzene	EPA 8270 ^(d,e)	1.0 µg/kg

(a) Detection limits are in dry weight for all sediment parameters except Hg, which is in wet weight.

(b) -- Detection limits not required for this parameter.

(c) EPA (1991).

(d) Equivalent Battelle or MSL standard operating procedures were substituted for the methods cited.

(e) EPA (1990).

2.3.3 TOC

Samples were analyzed for TOC according to the EPA Edison, New Jersey, laboratory procedure (EPA 1986). Inorganic carbon was removed from the sediment sample by acidification. The sample was combusted and the evolved carbon dioxide was quantitated using a carbon-hydrogen-nitrogen (CHN) analyzer. TOC was reported as a percentage of the dry weight of the unacidified sample.

2.3.4 Metals

Sediment samples for analysis of Ag, As, Cd, Cr, Cu, Pb, Ni, and Zn were prepared according to an MSL standard operating procedure (SOP) equivalent to EPA Method 200.2 (EPA 1991). Solid samples were first freeze-dried and blended in a Spex mixer mill. A 0.2- to 0.5-g aliquot of dried homogeneous sample was then digested in sealed Teflon bombs heated in an oven to approximately 130°C using nitric acid. Sediment samples were analyzed for As, Cd, Cr, Cu, Pb, Ni, and Zn using inductively-coupled plasma mass spectrometry (ICP/MS), following an MSL SOP based on EPA Method 200.8 (EPA 1991). Sediments were analyzed for Ag by graphite furnace atomic absorption spectroscopy (GFAA) according to an MSL procedure for Ag determination equivalent to EPA Method 200.9 (EPA 1991). Sediments were analyzed for Hg by cold-vapor atomic absorption spectroscopy (CVAA) according to an MSL procedure for total Hg determination equivalent to EPA Method 245.5 (EPA 1991).

2.3.5 Chlorinated Pesticides, PCBs, and 1,4-Dichlorobenzene

Sediment samples for pesticide, PCB, and 1,4-dichlorobenzene analyses were extracted and analyzed according to a Battelle procedure similar to EPA Method 8080 for pesticides and the New York State Department of Environmental Conservation (NYSDEC) Congener-Specific Method 91-11 (NYSDEC 1991). The method also uses techniques from the National Oceanic and Atmospheric Administration (NOAA) Mussel Watch procedure (NOAA 1989). 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. 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 concentration of total PCBs in sediment was determined by taking the sum of the 22 congeners and multiplying it by 2. For any undetected PCB congeners, one-half of the detection limit was used in the calculation.

2.3.6 PAHs

Sediment samples were prepared for the analysis of 16 PAHs and 1,4-dichlorobenzene (see Table 2.1) according to a Battelle method based on the NOAA Mussel Watch procedure (NOAA 1989). 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. Extract volumes were reduced and solvent-exchanged to hexane, followed by column chromatography cleanup. Interferences were removed using HPLC cleanup. Sample extracts were concentrated and analyzed using gas chromatography with mass spectrometry (GC/MS) in the selective ion monitoring (SIM) mode.

2.4 Quality Assurance/Quality Control Procedures

The QA/QC procedures for the Gravesend Bay Anchorage project were consistent with those prescribed in the Regional Guidance Manual and the Green Book, and were documented in the work/quality assurance project plan, *Evaluation of Dredged Material Proposed for Ocean Disposal from Federal Projects in New York (Part 2)*. (MSL 1994). This document describes all QA/QC procedures that were followed for sample collection, sample tracking and storage, and physical/chemical analyses. A member of the laboratory's quality engineering staff was present throughout all phases of this program to observe procedures, review and audit data, and ensure that accepted protocols were followed. Data accumulation notebooks were assigned to each portion of these studies and served as records of day-to-day project activities.

3.0 Results and Conclusions

This section presents results of sample collection and processing, and of physical and chemical analyses conducted on sediment samples collected from the proposed Gravesend Bay Anchorage dredging area. A summary of these results is also discussed.

3.1 Sample Collection and Processing

Prior to the sample collection survey, 10 sampling stations were established in the Gravesend Bay Anchorage project area. Approximate coordinates for the 10 stations were listed in the project work/quality assurance project plan (MSL 1994). Sediment core samples were collected from the Gravesend Bay Anchorage project area on March 14, 1994. However, during the survey, as sediment core samples were collected from Stations 1 through 6 (GR-1 through GR-6) in the southeast corner of the anchorage where most of the shoaling had occurred, it was noted that the core samples obtained were predominantly sand. It became apparent that sediments in the southeast corner of the anchorage would meet the exclusionary criteria. Therefore, with the approval of the USACE-NYD project manager, samples were collected at only six stations in the southeast corner of the anchorage, Stations 1 through 6. A single sediment core was taken at Station 10 (GR-10) in the northeast corner of the anchorage. Initial observations of Station 10 sediment revealed that this sediment was too silty to pass the exclusionary criteria.

Table 3.1 lists each sampling station, sampling coordinates, collection date, length of core required for testing, and length of core actually collected. (The Gravesend Bay Anchorage project area and locations of the stations where sediment core samples were collected are shown in Figure 1.1.) All Gravesend Bay Anchorage core samples were collected to project depth of -47 ft MLW plus 2 ft of overdepth.

Upon delivery of the sediment core samples to the MSL on March 18, 1994, samples were prepared for the physical and chemical analyses as described in Section 2. Individual sediment core samples collected at GR-1 through GR-6 and GR-10 were analyzed for grain size, moisture content, and TOC. Two samples, one of composited sediment cores representing GR-1 through GR-6 (COMP GR), and one representing station GR-10, were analyzed for bulk density, specific gravity, metals, pesticides, PCBs, PAHs, and 1,4-dichlorobenzene.

Table 3.1. Summary of Sediment Core Sample Data for Gravesend Bay Anchorage

Station	Collection Date	Station Coordinates		Core Length Required (ft)	Core Length Collected (ft)
		Latitude N	Longitude W		
GR-1	3/14/94	40° 34.99' N	74° 01.37' W	3.7	3.7
GR-2	3/14/94	40° 34.99' N	74° 01.39' W	2.5	2.5
GR-3	3/14/94	40° 35.00' N	74° 01.44' W	3.3	3.3
GR-4	3/14/94	40° 34.97' N	74° 01.39' W	3.8	3.8
GR-5	3/14/94	40° 34.95' N	74° 01.46' W	2.0	2.0
GR-6	3/14/94	40° 34.95' N	74° 01.49' W	2.7	2.7
GR-10	3/14/94	40° 35.94' N	74° 01.77' W	3.8	3.8

3.2 Physical and Chemical Analyses

3.2.1 Sediment Core Sample Description

Table 3.2 lists physical characteristics observed as each core sample was cut longitudinally and its contents examined.

3.2.2 Grain Size, Bulk Density, and Specific Gravity

Table 3.3 shows the results of the analysis of Gravesend Bay Anchorage sediment samples for grain size and percentage of moisture. Associated quality control data and a quality control sample summary are provided in Appendix A.

Sediments from Stations 1 through 6 were predominantly sand. The percentages of silt and clay were slightly higher at Station GR-3 than in the other five stations comprising this group (6% and 9%, as opposed to 2% to 3%). Sediment from Station GR-10 was 45% sand, 31% silt, and 24% clay, and was clearly not of the same composition as the sediment from Stations 1 through 6. The moisture content was much lower in the sandier sediments (18% to 27%) than in the GR-10 sediment (46%).

The bulk density of the COMP GR sediment was 117 lb/cu ft (determined from the mean of two replicate analyses); the specific gravity of COMP GR was 2.67.

Table 3.2. Gravesend Bay Anchorage Sediment Core Descriptions

<u>Station</u>	<u>Depth Below Mudline (-ft MLW)</u>		<u>Description of Observations</u>
	<u>Core Top</u>	<u>Core Bottom</u>	
GR-1	45.3	49.0	Top of core -- silty-clay mixture. Remainder of core -- gray, silty-sandy mixture. Thin (0.5- to 1-in.wide) bands of black, silty material interspersed throughout length of core. Petroleum-based odor noted.
GR-2	46.5	49.0	Top of core -- gray silty-sandy mixture. At approximately 47.5 ft, bands of black, slippery, silty material (0.5- to 1.5-in wide) interspersed with sandy material. Bottom of core -- gray sand.
GR-3	45.7	49.0	Predominantly gray, silty, sand with thin (0.5- to 1.5-in wide) bands of black, slippery, silty material interspersed throughout length of core. Strong hydrogen sulfide-like odor. Some petroleum-based odor noted.
GR-4	45.2	49.0	Predominantly gray sand. Few thin (approximately 0.5-in wide) bands of black, slippery, silty material. Flecks of shell hash (no distinct bands) throughout length of core. Slight hydrogen sulfide-like odor.
GR-5	47.0	49.0	Fairly uniform gray sand. Some faint, very thin bands of black material (much less compared with other cores). Hydrogen sulfide-like odor noted.
GR-6	46.3	49.0	Gray sand with flecks of shell hash. Several thin (<0.25-in wide) bands of slippery, black material along length of core. Hydrogen sulfide-like odor noted.
GR-10	45.2	49.0	Uniform black, silty-clayey material. Single band of grayish silt-clay (approximately 2-in. wide) near bottom of core (project depth).

3.2.3 TOC

Table 3.4 shows the results of the analysis of Gravesend Bay Anchorage sediment samples for TOC. Associated quality control data and a quality control sample summary are provided in Appendix A.

TOC concentrations were lowest in the sandy sediment samples from Stations GR-1 through GR-6, and highest in Station GR-10, which contained more silt and clay.

Table 3.3. Results of Analysis of Gravesend Bay Anchorage Sediment Samples for Grain Size and Percentage of Moisture

<u>Station</u>	<u>Total Percent (dry weight)</u>				<u>Percentage of Moisture</u>
	<u>Gravel >2000 μm</u>	<u>Sand 62.4-2000 μm</u>	<u>Silt 3.9-62.4 μm</u>	<u>Clay <3.9 μm</u>	
GR-1	0	94	3	3	20
GR-2	0	94	3	3	21
GR-3	0	85	6	9	27
GR-4	1	95	2	2	18
GR-5	0	96	2	2	18
GR-6	0	96	2	2	19
GR-10	0	45	31	24	46

Table 3.4. Results of Analysis of Gravesend Bay Anchorage Sediment Samples for TOC

<u>Station</u>	<u>TOC (% dry weight)</u>
GR-1	0.13
GR-2	0.20
GR-3	0.51
GR-4	0.12
GR-5	0.04
GR-6	0.20
GR-10	2.06

3.2.3 Metals

Table 3.5 shows the results of the analysis of the Gravesend Bay Anchorage sediment samples, COMP GR (Stations 1 through 6) and Station GR-10, for metals. Associated quality control data and a quality control sample summary are provided in Appendix A. All nine metals analyzed were found at detectable concentrations in both samples.

Table 3.5. Results of Analysis of Gravesend Bay Anchorage Sediment Samples for Metals

<u>Analyte</u>	<u>Concentration (mg/kg dry weight)</u>	
	<u>COMP GR</u>	<u>GR-10</u>
Ag	0.292	2.72
As	1.70	11.7
Cd	0.182	1.65
Cr	12.1	76.1
Cu	8.49	80.2
Hg	0.114	1.53
Ni	5.17	25.6
Pb	12.8	112
Zn	16.7	138

The initial analysis of metals in sediment resulted in low spike recoveries for Ag. It was determined that sodium chloride in marine sediments caused an interference during ICP-MS analysis. The sediment digestion was repeated on the Gravesend samples with the addition of aqua regia to the procedure. This step alleviated the sodium chloride interference problem and improved spike recovery. The results of the Ag reanalysis (not the initial analysis) are those presented in Table 3.5. A quality control sample summary and quality control data associated with the metals analysis, including the reanalysis of sediment samples for Ag, are provided in Appendix A.

3.2.4 Chlorinated Pesticides

Table 3.6 shows the results of the analysis of the Gravesend Bay Anchorage sediment samples, COMP GR and Station GR-10, for chlorinated pesticides. Associated quality control data and a quality control sample summary are provided in Appendix A.

Most pesticides were either undetected or detected at concentrations near or below the target detection limit (1.0 $\mu\text{g/kg}$) in sediment from COMP GR. Sediment from Station GR-10 had low concentrations of the DDT family of compounds. The remaining pesticides were either undetected in GR-10 sediment or were estimated concentrations, detected at concentrations below the detection limit.

Table 3.6. Results of Analysis of Gravesend Bay Anchorage Sediment Samples for Chlorinated Pesticides

	<u>Concentration in $\mu\text{g/kg}$ dry weight</u>	
	<u>COMP GR</u>	<u>GR-10^(a)</u>
Sample Dry Weight (g)	12.720	8.478
Percent Moisture (%)	21	46
Aldrin	0.62 U ^(c)	0.93 U
α -Chlordane ^(b)	0.20 J ^(d)	1.17 J
Dieldrin	0.29 J	1.36 J
Endosulfan I/2,4-DDE ^(e)	1.71 U	2.56 U
Endosulfan II	1.27 U	1.37 J
Endosulfan sulfate	1.20 U	0.34 J
Heptachlor	1.40 U	2.10 U
Heptachlor epoxide	0.77 U	1.16 U
<i>trans</i> -Nonachlor	0.09 J	0.58 J
2,4'-DDD	1.22	7.50
2,4'-DDT	0.65 U	0.97 U
4,4'-DDD	0.88 J	5.71
4,4'-DDE	0.75 J	5.04
4,4'-DDT	3.70 U	0.24 J
Total DDT^(f)	5.88	20.3

(a) Sample GR-10 was analyzed in triplicate; values shown are the mean of triplicate analyses.

(b) Two of the triplicate sample concentrations used to calculate the mean concentration for α -Chlordane in GR-10 were flagged with a "J", indicating an estimated value (analyte detected below detection limit).

(c) U Undetected at or above the given concentration.

(d) J Analyte detected is below established method detection limit (MDL).

(e) Endosulfan I and 2,4-DDE coelute; value shown is the detection limit for 2,4-DDE.

(f) Sum of 2,4-DDD, 2,4-DDE, 2,4-DDT, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT; one-half of the detection limit used in summation when analyte was undetected.

3.2.5 PCBs

Table 3.7 shows the results of the analysis of the Gravesend Bay Anchorage sediment samples, COMP GR and Station GR-10, for PCBs. Associated quality control data and a quality control sample summary are provided in Appendix A.

PCBs were either undetected or detected at concentrations near or below the target detection limit ($1.0 \mu\text{g/kg}$) in sediment from COMP GR. All of the 22 PCB congeners analyzed were detected in sediment from Station GR-10, either at low concentrations or at concentrations estimated below the detection limit.

Table 3.7. Results of Analysis of Gravesend Bay Anchorage Sediment Samples for PCBs

	<u>Concentration in $\mu\text{g/kg}$ dry weight</u>	
	<u>COMP GR</u>	<u>GR-10^(a)</u>
Sample Dry Weight (g)	12.72	8.48
Percent Moisture (%)	21	46
CL2(08)	0.61 J ^(b)	2.71 J
CL3(18)	0.72 J	4.13
CL3(28)	2.60	15.0
CL4(44)	1.24 J	5.67
CL4(49)	1.40	6.29
CL4(52)	1.49	7.23
CL4(66)	1.94	10.5
CL5(87)	0.37 J	1.93
CL5(101)	1.13	5.54
CL5(105)	0.40	2.16
CL5(118)	0.94	5.37
CL6(128)	0.43 J	3.20
CL6(138)	1.05	6.23
CL6(153)	0.83 J	4.90 J
CL7(170)	0.41 J	2.41
CL7(180)	0.53 J	3.35
CL7(183)	0.12 J	0.74 J
CL7(184)	0.07 J	0.40 J
CL7(187)	0.31 J	1.79
CL8(195)	0.05 J	0.38 J
CL9(206)	1.36 U ^(c)	0.89 J
CL10(209)	0.14 J	1.42
Total PCB^(d)	34.9	184

(a) Sample GR-10 was analyzed in triplicate; values shown are the mean of triplicate analyses.

(b) J Analyte detected is below established method detection limit (MDL).

(c) U Undetected at or above the given concentration.

(d) Total PCB is two times the sum of all PCB congeners detected; one-half of the detection limit used in summation when analyte was undetected.

3.2.6 PAHs and 1,4-Dichlorobenzene

Table 3.8 shows the results of the analysis of the Gravesend Bay Anchorage sediment samples, COMP GR and Station GR-10, for PAHs and 1,4-dichlorobenzene. Associated quality control data and a quality control sample summary are provided in Appendix A.

All 17 PAHs and 1,4 dichlorobenzene analyzed were detected in COMP GR sediment at low levels. Concentrations of PAH compounds and 1,4 dichlorobenzene were detected in GR-10 at higher concentrations.

Table 3.8. Results of Analysis of Gravesend Bay Anchorage Sediment Samples for PAHs and 1,4-Dichlorobenzene

	<u>Concentration in $\mu\text{g/kg}$ dry weight</u>	
	<u>COMP GR</u>	<u>GR-10^(a)</u>
Percent Moisture (%)	21.38	46.17
Sample Dry Weight (g)	12.72	8.48
Naphthalene	14.21	109
Biphenyl	2.99 J ^(b)	24.3
Acenaphthylene	10.4	80.1
Acenaphthene	3.93 J	33.1
Fluorene	6.96 J	59.9
Phenanthrene	48.2	330
Anthracene	29.0	252
Total LPAH	116	888
Fluoranthene	130	869
Pyrene	136.2	931
Benzo[a]anthracene	69.6	529
Chrysene	70.1	534
Benzo[b]fluoranthene	85.7	619
Benzo[k]fluoranthene	32.2	240
Benzo[a]pyrene	75.8	557
Indeno[1,2,3-c,d]pyrene	42.7	299
Dibenz[a,h]anthracene	10.5	79.3
Benzo[g,h,i]perylene	39.1	267
Total HPAH	692	4920
Total PAH	808	5810
1,4-Dichlorobenzene	3.76	20.9

(a) Sample GR-10 was analyzed in triplicate; values shown are the mean of triplicate analyses.

(b) J Analyte detected is below established method detection limit (MDL).

3.3 Summary and Discussion

Sediment core samples from Gravesend Bay Stations 1 through 6 had an average grain size distribution of 93% sand, 3% silt and 4% clay. Therefore, the proposed dredging area represented by Stations 1 through 6 should meet the exclusionary criteria set forth in 40 CFR §227.13, and this material should be environmentally acceptable for ocean disposal without further testing.

The TOC concentrations in sediments from Stations 1 through 6 ranged from 0.04% to 0.51% dry weight. In COMP GR most pesticides and PCBs were either undetected or detected at concentrations below or near the sample method detection limit (MDL). All PAH compounds analyzed were detected at low levels; the COMP GR total PAH concentration was 808 $\mu\text{g}/\text{kg}$. The compound 1,4-dichlorobenzene was detected at 3.76 $\mu\text{g}/\text{kg}$, just above the target detection limit of 1 $\mu\text{g}/\text{kg}$.

Sediment from Station GR-10 was distinctly different, physically and chemically, from the COMP GR sediment. Station GR-10 sediment did not pass the exclusionary criteria, with a grain size distribution of 45% sand, 31% silt, and 24% clay. The TOC in GR-10 sediment was 2.06% dry weight. The remaining pesticides were either undetected in GR-10 or detected at concentrations lower than the MDL. All PCB congeners were detected in GR-10. All PAHs and 1,4-dichlorobenzene were detected in GR-10.

4.0 References

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Appendix A.

Quality Assurance/Quality Control Data for
Sediment Chemistry
New York/New Jersey Federal Projects-2

QA/QC SUMMARY

PROGRAM: New York/New Jersey Federal Projects-2
PARAMETER: Grain Size, Bulk Density, Specific Gravity and Total Solids
LABORATORY: Soil Technology, Bainbridge Island, 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>
Grain Size	ASTM D-2217 and D-422	N/A	N/A	≤20%	1.0%
Bulk Density	ASTM D-854	N/A	N/A	≤20%	N/A
Specific Gravity	EM 1110-2-1906	N/A	N/A	≤20%	N/A
Total Solids	Plumb 1981	N/A	N/A	N/A	1.0%

METHOD Grain size was measured for four fractions using a combination of sieve and pipet techniques, following ASTM method D-2217 and D-422 for wet sieving. Bulk density was measured in accordance with ASTM method D-854. Specific gravity was measured in accordance with USACE Method EM 1110-2-1906. Total solids were measured gravimetrically following Plumb (1981).

HOLDING TIMES Samples were analyzed within the 6 month holding time.

DETECTION LIMITS Target detection limits of 1.0% by weight for each fraction were met for all samples.

METHOD BLANKS Not applicable.

MATRIX SPIKES Not applicable.

REPLICATES Six samples were analyzed in triplicate for grain size for the entire set of NY/NJ Federal Projects-2 program. Precision was measured by calculating the relative standard deviation (RSD) among triplicate results. The RSD's ranged from 0% to 10%, indicating acceptable precision. Two samples were analyzed in duplicate for bulk density and specific gravity. Precision was measured by calculating the relative percent difference (RPD) between the replicate results. The RPDs for bulk density were 0% and 2% while the RPDs for specific gravity were both 1%, indicating acceptable precision of the methods.

For total solids, three samples were analyzed in duplicate and four samples were analyzed in triplicate. All RSDs and RPDs were 0%.

**QA/QC SUMMARY/GRAIN SIZE, BULK DENSITY, SPECIFIC GRAVITY and
TOTAL SOLIDS (continued)**

SRMs

Not applicable.

REFERENCES

ASTM D-2217. Standard Method for Wet Preparation of Soil Samples for Particle-size Analysis and Determination of Soil Constants.

ASTM D-422. Standard Method for Particle-Size Analysis of Soils.

ASTM D-854. Standard Method for Specific Gravity

EM 1110-2-1906. USACE (U.S. Army Corps of Engineers). 1970. Engineering and Design Laboratory Soils Testing.

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QA/QC SUMMARY

PROGRAM: New York/New Jersey Federal Projects-2
PARAMETER: Total Organic Carbon (TOC)
LABORATORY: Global Geochemistry, Canoga Park, California
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>
EPA 1986	N/A	≤20%	≤10%	0.1%

METHOD TOC was analyzed in accordance with EPA (1986). Analysis was performed by combustion and quantitation of evolved carbon dioxide using a LECO analyzer.

HOLDING TIMES Samples were analyzed within the 6 month holding time.

DETECTION LIMITS Target detection limits of 0.1% was met for all samples.

METHOD BLANKS Thirty-four method blanks were analyzed with the entire set of NY/NJ Federal Projects-2 program sediment samples. TOC levels detected in blanks ranged from 0.001% to 0.008% which were less than the established detection limit.

MATRIX SPIKES Not applicable.

REPLICATES Four samples were analyzed in triplicate and three samples were analyzed in duplicate. Precision was measured by calculating the relative standard deviation (RSD) or relative percent difference (RPD) between the replicate results. All RSDs and RPDs were between 1% and 10% indicating acceptable precision of the method.

SRMs Standard reference material MESS-1, obtained from the National Research Council of Canada, was analyzed at least once per batch of sediment samples. Although MESS-1 is not certified for TOC, accuracy was measured by calculating the percent difference (PD) from the in-house consensus value. PD values reported ranged from 1% to 8%.

REFERENCES

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

QA/QC SUMMARY

PROGRAM: New York/New Jersey Federal Projects-2
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>Achieved Detection Limit (mg/kg dry wt)</u>
Arsenic	ICP/MS	75-125%	≤20%	≤20%	0.572
Cadmium	ICP/MS	75-125%	≤20%	≤20%	0.020
Chromium	ICP/MS	75-125%	≤20%	≤20%	0.401
Copper	ICP/MS	75-125%	≤20%	≤20%	0.525
Lead	ICP/MS	75-125%	≤20%	≤20%	0.136
Mercury	CVAA	75-125%	≤20%	≤20%	0.001
Nickel	ICP/MS	75-125%	≤20%	≤20%	0.849
Silver	ICP/MS	75-125%	≤20%	≤20%	0.119
Zinc	ICP/MS	75-125%	≤20%	≤20%	2.55

METHOD

A total of nine metals was analyzed: 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 the method of Bloom and Crecelius (1983). The remaining metals were analyzed by inductively coupled plasma mass spectrometry (ICP/MS) following 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 and CVAA analyses, 0.2- to 0.5-g aliquots of dried homogenous sample were digested using nitric acid following modified EPA Method 200.2 (EPA 1991). Sediment samples initially showed poor matrix spike recovery for Ag. (Refer to Matrix Spike section of this QA/QC Summary.) EPA Method 200.2 was modified by the addition of aqua regia to the digestion procedure and all samples were reanalyzed for Ag.

HOLDING TIMES

Samples were received on 3/30/94 and were logged into Battelle's log-in system. Samples were frozen to -80°C and subsequently freeze dried. Samples were all analyzed within 180 days of collection. The following list summarizes all analysis dates:

<u>Task</u>	<u>Date Performed</u>
Sample Digestion	5/5/94
ICP-MS	5/20/94
CVAA-Hg	5/9/94

QA/QC SUMMARY/METALS (continued)

DETECTION LIMITS	Target detection limits were exceeded for some metals; however, metals were detected above the MDLs in all samples with the exception of Ag in one sample. MDLs were determined by multiplying the standard deviation of the mean of four replicate low level sediment spikes by 3.5.
METHOD BLANKS	Two method blanks were analyzed. No metals were detected above the MDL in either blank with the exception of Pb in Blank-2. The value was less than three times the MDL and all sample values were detected at levels greater than five times the blank concentration, so no data were flagged. All data were blank corrected.
MATRIX SPIKES	Two samples were spiked with all nine metals. In the original set of matrix spikes, recoveries of all metals, with the exception of Ag, were within the QC limits of 75% to 125%. Recoveries of Ag in the original spikes were low (3% and 10%). After reanalysis of the matrix spikes with the addition of aqua regia to the digestion procedure (see Methods section of this QA/QC Summary), matrix spike recoveries improved (93%) and concentrations of Ag in the dredging site sediments increased slightly. The low recovery of Ag appears to occur in analysis of marine sediment samples having high (in excess of approximately 5 µg/g) Ag concentrations. During the EPA Method 200.2 digestion procedure, a precipitate of AgCl can form with the Ag in the sediment and the Cl in the seawater.
REPLICATES	Two samples were digested and analyzed in triplicate. Precision of triplicate analyses is reported by calculating the relative standard deviation (RSD) between the replicate results. RSD values ranged from 1% to 5%, within the QC limits of $\pm 20\%$, indicating acceptable precision.
SRM	Standard Reference Material (SRM) 1646 (estuarine sediment from the National Institute of Standards and Technology [NIST]), was analyzed for all metals. Only results for Cd, Cu and Hg were within $\pm 20\%$ of the certified value (Ag is not certified). Results for As, Ni, and Pb were between 20 and 30% of the certified values. The poorest result was with Cr, where the mean was 46% of the certified value. Values for the remaining metals were low because the digestion method used is not as strong as the method (perchloric acid) used to certify the SRM; thus, the results of this analysis should not be expected to match the SRM certified values. Therefore, no corrective actions were taken.

REFERENCES

Bloom, N. S., and E.A. Crecelius. 1983. "Determination of Mercury in Seawater at Sub-Nanogram per Liter Levels." *Mar. Chem.* 14:49-59.

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/New Jersey Federal Projects-2
PARAMETER: Chlorinated Pesticides, PCB Congeners, and 1,4-Dichlorobenzene
LABORATORY: Battelle Ocean Sciences, Duxbury, Massachusetts
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/ECD	50-120%	30-150%	≤30%	≤30%	1.0 - 20 ng/g

METHOD Sediment samples were extracted with methylene chloride according to a modified version of EPA Method 8080 and the National Oceanic and Atmospheric Administration (NOAA) Status and Trends cleanup procedure (Krahn et al. 1988). Extracts were analyzed using gas chromatography with electron capture detection (GC/ECD) following a modified version of EPA Method 8270. Pesticide detections were qualitatively confirmed on a secondary column.

HOLDING TIMES Samples were collected from 3/22/94 through 3/25/94, and after compositing, were held frozen at -20°C until shipment to the analytical laboratory. Sediment samples were received by Battelle Ocean Sciences on 4/22/94. Samples were held frozen at -20°C until extraction and analysis. Samples were extracted by 5/6/94 and analyzed from 6/2/94 to 6/29/94.

DETECTION LIMITS Target detection limits were exceeded for most of the analytes. Actual detection limits were determined by the Method Detection Limit (MDL) verification study. Four sediment samples with very low background concentrations of contaminants were spiked with target compounds. For each analyte, the standard deviation of the four spiked replicates was multiplied by 3.5.

METHOD BLANKS One method blank was extracted with batch of samples. No pesticides or PCB congeners were detected in the blank.

SURROGATES Two compounds, DBOFB and PCB congener 112, were added to all samples prior to extraction to assess the efficiency of the analysis. The mean recoveries of DBOFB and PCB 112 were 71% and 60%, respectively. Recoveries of these compounds were within the QC guidelines of 30% -150% for all samples analyzed.

MATRIX SPIKES One sample in each batch was spiked with pesticides and PCB congeners. Recoveries for PCB congener CL₂ (25% and 47%) fell below the acceptable criteria of 50% to 120%. The reason for this low recovery is probably that the PCB congener CL₂ coeluted with alpha-BHC. All other PCB congener recoveries ranged from 54% to 121%. Recoveries for all pesticides and 1,4-dichlorobenzene ranged from 57% to 115%. Since >80% of all analytes were between 50% and 120%, no corrective action was taken.

QA/QC SUMMARY/CHLORINATED PESTICIDES and PCB CONGENERS (continued)

REPLICATES

One sample from each batch was extracted in triplicate. Precision was measured by calculating the relative standard deviation (RSD) between the replicate results. RSDs were evaluated only when pesticides or PCB congeners were detected in all three replicates. RSDs ranged from 5% to 114%. Six of the RSDs were greater than 30% but of those six, only three were for analytes that were >10 times the MDL. These three were 31% for CL₃(18), 114% for CL₅(105) and 52% for CL₆(138).

SRMs

One SRM, 1941a, a marine sediment sample obtained from the National Institute of Science and Technology (NIST) was analyzed with each batch. Many of the values exceeded the acceptable criteria of $\leq 30\%$; however all were <10 times the MDL. Percent differences were calculated using SRM concentrations that were corrected for surrogate recovery.

REFERENCES

Krahn, M.M., C.A. Wigren, R.W. Pearce, L.K. Moore, R.G. Bogar, W.D. MacLeod, Jr., S-L Chan, and D.W. Brown. 1988. *New HPLC Cleanup and Revised Extraction Procedures for Organic Contaminants*. NOAA Technical Memorandum NMFS F/NWC-153. National Oceanic and Atmospheric Administration, National Marine Fisheries, Seattle, Washington.

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/New Jersey Federal Projects-2
PARAMETER: Polynuclear Aromatic Hydrocarbons (PAH)
LABORATORY: Battelle Ocean Sciences, Duxbury, Massachusetts
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>
GC/MS/SIM	50-120%	30-150%	≤30%	≤30%	10 ng/g
METHOD	Sediment samples were extracted according to a modified version of EPA Method 8080 and the NOAA Status and Trends cleanup procedure (Krahn et al. 1988). Extracts were analyzed using gas chromatography/mass spectrometry (GC/MS) in the selected ion mode (SIM) following a modified version of EPA Method 8270.				
HOLDING TIMES	Samples were collected from 3/22/94 through 3/25/94, and after compositing, were held frozen at -20°C until shipment to the analytical laboratory. Sediment samples were received by Battelle Ocean Sciences, Duxbury, Massachusetts, on 4/22/94. Samples were held frozen at approximately -20°C until extraction and analysis. Samples were extracted by 5/6/94 and analyzed from 5/16/94 to 6/28/94.				
DETECTION LIMITS	Target detection limits of 10 ng/g dry weight were met for most of the PAH compounds. Actual detection limits were determined by the Method Detection Limit (MDL) verification study. Four sediment samples with very low background concentrations of contaminants were spiked with target compounds. For each analyte, the standard deviation of the four spiked replicates was multiplied by 3.5. Actual detection limits ranged from 7.18 to 20.84 µg/kg.				
METHOD BLANKS	One method blank was extracted with each batch of samples. No PAH compounds were detected above the MDL; however, 2 of the 17 compounds were detected below the MDL and are flagged with a "J" to indicate the values are estimates. They are pyrene in Batch 1 and naphthalene in Batch 2.				
SURROGATES	Three isotopically labelled compounds were added prior to extraction to assess the efficiency of the method. These were naphthalene-d ₈ , acenaphthene-d ₁₀ , and chrysene-d ₁₂ . Recoveries of surrogates were within the quality control limits of 30% -150% with one exception. For Batch 1, mean recoveries of naphthalene-d ₈ , acenaphthene-d ₁₀ , and chrysene-d ₁₂ were 52%, 59%, and 48%, respectively. In one sample, recovery of chrysene-d ₁₂ was 28%. For Batch 2, mean recoveries of naphthalene-d ₈ , acenaphthene-d ₁₀ , and chrysene-d ₁₂ were 62%, 64%, and 57%, respectively.				

QA/QC SUMMARY/PAHs (continued)

MATRIX SPIKES

One sample was spiked with all PAH compounds for each batch. Matrix spike recoveries for all analytes in Batch 2 ranged from 57% to 67%. Matrix spike recoveries for all analytes in Batch 1 ranged from 26% to 73%. Six of the analytes in Batch 1 fell outside the acceptable ranges of 50% to 120%. They are 48% for fluoranthene; 47% for pyrene; 44% for benzo[a]anthracene; 38% for chrysene; 26% for benzo[b]fluoranthene; and 32% for benzo[a]pyrene. These PAHs were present at naturally elevated levels in the background sample. A blank spike was prepared with this batch and had acceptable recoveries for all target PAHs. As a result, it appears that the failure of selected PAHs to meet the recovery criteria is related to the sediment sample. The recoveries of PAHs in the MS sample for Batch 2 met the acceptance criteria.

REPLICATES

One sample was extracted in triplicate for each batch. Precision was measured by calculating the relative standard deviation (RSD) between the replicate results. The RSDs ranged from 1% to 20%, within the target precision goal of $\leq 30\%$.

SRMs

One SRM, 1941a, a marine sediment sample obtained from the National Institute of Standards and Technology, was analyzed with each batch of samples. Twelve of the 17 PAH compounds analyzed are certified at levels above the MDLs. Of these, all compounds were detected within 30% of the certified mean, with the exception of chrysene (58% and 73%), benzo[b]fluoranthene (32% and 45%), and dibenz[a,h]anthracene (63% and 40%) in both batches. Percent differences were calculated using SRM concentrations that were corrected for surrogate recovery.

REFERENCES

Krahn, M.M., C.A. Wigren, R.W. Pearce, L.K. Moore, R.G. Bogar, W.D. MacLeod, Jr., S-L Chan, and D.W. Brown. 1988. *New HPLC Cleanup and Revised Extraction Procedures for Organic Contaminants*. NOAA Technical Memorandum NMFS F/NWC-153. National Oceanic and Atmospheric Administration, National Marine Fisheries, Seattle, Washington.

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. Quality Assurance/Quality Control Data for Grain Size Analysis

Sediment Treatment	Gravimetric Water Content (%)	Batch No.	Total Percent (dry weight)			
			Gravel >2000 μm	Sand 62.4- 2000 μm	Silt 3.9- 62.4 μm	Clay <3.9 μm
R-CLIS, Replicate 1	109	1	0	6	59	35
R-CLIS, Replicate 2	109	1	0	6	60	34
R-CLIS, Replicate 3	109	1	0	6	60	34
RSD			NA ^(a)	0%	1%	2%
EC-8, Replicate 1	151	2	0	21	39	40
EC-8, Replicate 2	151	2	0	20	40	40
EC-8, Replicate 3	151	2	1	21	38	40
RSD			NA	3%	3%	0%
HU-2, Replicate 1	124	3	1	18	47	34
HU-2, Replicate 2	124	3	0	19	47	34
HU-2, Replicate 3	124	3	2	18	47	33
RSD			NA	3%	0%	2%
HU-22, Replicate 1	139	4	0	16	48	36
HU-22, Replicate 2	139	4	0	16	48	36
HU-22, Replicate 3	139	4	0	15	47	38
RSD			NA	4%	1%	3%
BU-2, Replicate 1	171	5	0	13	42	45
BU-2, Replicate 2	171	5	0	13	40	47
BU-2, Replicate 3	171	5	0	14	41	45
RSD			NA	4%	2%	3%
BC-4, Replicate 1	222	6	0	15	55	30
BC-4, Replicate 2	222	6	0	14	56	30
BC-4, Replicate 3	222	6	0	17	55	28
RSD			NA	10%	1%	4%

(a) NA Not applicable.

TABLE A.2. Quality Assurance/Quality Control Data for Analysis of Specific Gravity and Bulk Density

Sediment Treatment	Replicate	Sample ID	Batch	Bulk Density		Specific Gravity
				Wet lbs/cu ft	Dry lbs/cu ft	
COMP HU-C	1	NY2-GRA-17	1	92	45	2.61
COMP HU-C	2	NY2-GRA-17	1	ND ^(a)	ND	2.64
RPD				NA ^(b)	NA	1%
I-Stat				NA	NA	0.01
COMP SB-A	1	NY2-GRA-1	1	83	30	2.58
COMP SB-A	2	NY2-GRA-1	1	83	30	2.56
RPD				0%	0%	1%
I-Stat				0.00	0.00	0.00
COMP GR	1	NY2-GRA-9	1	116	94	2.67
COMP GR	2	NY2-GRA-9	1	118	96	ND
RPD				2%	2%	NA
I-Stat				0.01	0.01	NA

(a) ND No data; not tested.

(b) NA Not applicable.

TABLE A.3. Quality Assurance/Quality Control Data for Analysis of TOC and Percentage of Moisture

Sediment Treatment	Batch No.	TOC (% dry wt.)
<u>Method Blanks</u>		
Blank-1	1	0.003
Blank-2	1	0.001
Blank-1	2	0.003
Blank-2	2	0.003
Blank-1	3	0.003
Blank-2	3	0.002
Blank-3	3	0.003
Blank-4	3	0.003
Blank-5	3	0.002
Blank-1	4	0.005
Blank-2	4	0.008
Blank-3	4	0.002
Blank-4	4	0.002
Blank-5	4	0.004
Blank-6	4	0.004
Blank-1	5	0.003
Blank-2	5	0.002
Blank-3	5	0.002
Blank-4	5	0.004
Blank-5	5	0.004
Blank-1	6	0.001
Blank-2	6	0.002
Blank-3	6	0.002
Blank-4	6	0.002
Blank-5	6	0.002
Blank-6	6	0.005
Blank-7	6	0.004
Blank-8	6	0.004
Blank-9	6	0.004
Blank-10	6	0.006
Blank-11	6	0.004
Blank-12	6	0.002
Blank-13	6	0.002
Blank-14	6	0.002

TABLE A.3. (contd)

Sediment Treatment	Batch No.	TOC (% dry wt.)	Percent Difference ^(a)
<u>Standard Reference Material</u>			
Non-certified Value		2.6	
SRM MESS-1	1	2.49	4%
SRM MESS-1	2	2.44	6%
SRM MESS-1	2	2.62	1%
SRM MESS-1	3	2.56	2%
SRM MESS-1	4	2.42	7%
SRM MESS-1	5	2.40	8%
SRM MESS-1	6	2.40	8%
SRM MESS-1	6	2.39	8%
SRM MESS-1	6	2.45	6%
MESS-1Y	6	2.47	
MESS-1Y, Duplicate	6	2.48	
RPD			0%

TABLE A.3. (contd)

Sediment Treatment	Batch No.	TOC (% dry wt.)	Total Percent Solids
<u>Analytical Replicates</u>			
EC-2, Replicate 1	1	1.02	66
EC-2, Replicate 2	1	1.13	66
RPD		10%	0%
GR-1, Replicate 1	1	0.12	80
GR-1, Replicate 2	1	0.13	80
RPD		8%	0%
EC-3, Replicate 1	2	1.26	75
EC-3, Replicate 2	2	1.23	75
EC-3, Replicate 3	2	1.31	75
RSD		3%	0%
HU-1, Replicate 1	3	3.17	53
HU-1, Replicate 2	3	3.13	53
HU-1, Replicate 3	3	3.30	53
RSD		3%	0%
HU-21, Replicate 1	4	3.26	44
HU-21, Replicate 2	4	3.19	44
HU-21, Replicate 3	4	3.15	44
RSD		2%	0%
HU-39, Replicate 1	5	1.95	52
HU-39, Replicate 2	5	1.95	52
HU-39, Replicate 3	5	1.88	52
RSD		2%	0%
BU-4, Replicate 1	6	3.42	37
BU-4, Replicate 2	6	3.44	37
RPD		1%	0%

(a) Percent Difference between results obtained from analysis of SRM MESS-1 and non-certified value of 2.6%. SRM MESS-1 is not certified for TOC, but according to historical analyses from Battelle's records, the estimated value is 2.6% TOC.

TABLE A.4. Quality Assurance/Quality Control Data for Metals in Sediment

Sediment Treatment	Batch	Ag (ICP/MS)	Ag (ICP/Aqua)	As	Metals (µg/g dry wt)							
					Cd	Cr	Cu	Hg	Ni	Pb	Zn	
Method Blanks												
Blank-1	1	0.119 U ^(a)	0.131	0.572 U	0.020	0.401 U	0.525 U	0.001 U	0.849 U	0.14 U	2.55 U	
Blank-2	1	0.119 U	0.119 U	0.572 U	0.020	0.401 U	0.525 U	0.001 U	0.849 U	0.41	2.55 U	
Blank-3	1	NA ^(b)	NA	NA	NA	NA	NA	0.001 U	NA	NA	NA	
Mean blank		NA	NA	NA	NA	NA	NA	NA	NA	0.2	NA	
Standard Reference Material												
Certified value		NC ^(c)	NC	11.6	0.36	76	18	0.063	32	28.2	138	
Range		NC	NC	±1.3	±0.07	±3	±3	±0.012	±3	±1.8	±6	
SRM 1646	1	0.119 U	0.275	8.72	0.331	42.7	16.4	0.074	25.4	22.7	93.6	
SRM 1646	1	0.119 U	0.136	8.89	0.350	39.9	16.1	0.079	23.5	22.4	90.6	
SRM 1646	1	NA	NA	NA	NA	NA	NA	0.077	NA	NA	NA	
SRM 1646	1	NA	NA	NA	NA	NA	NA	0.070	NA	NA	NA	
Percent Difference		NA	NA	25% ^(d)	8%	44% ^(d)	9%	17%	21% ^(d)	20%	32% ^(d)	
Percent Difference		NA	NA	23% ^(d)	3%	48% ^(d)	11%	25% ^(d)	27% ^(d)	21% ^(d)	34% ^(d)	
Percent Difference		NA	NA	NA	NA	NA	NA	22% ^(d)	NA	NA	NA	
Percent Difference		NA	NA	NA	NA	NA	NA	11%	NA	NA	NA	
Matrix Spike Results												
EC-11/CT COMP EC-B-II	1	2.91	3.38	11.1	4.15	104	250	1.21	44.1	322	379	
EC-11/CT COMP EC-B-II MS	1	4.85	22.0	192	21.4	589	696	11.4	135	840	1140	
Concentration Recovered		1.94	18.6	181	17.3	485	446	10.2	90.9	518	761	
Amount Spiked		20.0	20.0	200	20.0	500	500	10.0	100	500	1000	
Percent Recovery		10% ^(e)	93%	90%	86%	97%	89%	102%	91%	104%	76%	

TABLE A.4. (contd)

Sediment Treatment	Batch	Metals (µg/g dry wt)									
		Ag (ICP/MS)	Ag (ICP/Aqua)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
COMP HU-C	1	6.22	7.02	15.2	4.06	169	174	2.55	40.0	194	252
COMP HU-C, MS	1	6.85	25.6	193	21.4	656	612	12.1	125	715	1010
Concentration Recovered		0.63	18.6	178	17.3	487	438	9.55	85.0	521	758
Amount Spiked		20.0	20.0	200	20.0	500	500	10.0	100	500	1000
Percent Recovery		3% ^(e)	93%	89%	87%	97%	88%	96%	85%	104%	76%
<u>Analytical Replicates</u>											
EC-11/CT COMP EC-B-II, Re	1	2.78	3.36	10.9	4.26	102	248	1.27	44.6	322	375
EC-11/CT COMP EC-B-II, Re	1	3.05	3.44	11.3	4.04	107	254	1.18	44.6	333	383
EC-11/CT COMP EC-B-II, Re	1	2.91	3.33	11.1	4.15	103	248	1.19	43.1	312	378
RSD		5%	2%	2%	3%	3%	1%	4%	2%	3%	1%
COMP HU-C, Replicate 1	1	6.10	7.05	15.2	4.05	171	174	2.57	40.3	196	247
COMP HU-C, Replicate 2	1	6.05	7.03	15.5	4.11	167	173	2.66	39.4	193	253
COMP HU-C, Replicate 3	1	6.51	6.98	15.0	4.02	170	175	2.42	40.3	194	257
RSD		4%	1%	2%	1%	1%	1%	5%	1%	1%	2%

(a) U Undetected at or above given concentration.

(b) NA Not applicable.

(c) NC Not certified.

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

(e) Outside quality control criteria (75-125%) for matrix spike recoveries.

**TABLE A.5. Quality Assurance/Quality Control Data for Additional
Metals in Sediment**

Sediment Treatment	Metals (µg/g dry wt)			
	Be ICP/MS	Sb ICP/MS	Se GFAA	Tl ICP/MS
<u>Method Blanks</u>				
Blank-1	0.5 U ^(a)	0.124	0.13 U	0.024 U
Blank-2	0.5 U	0.030 U	0.13 U	0.024 U
<u>Standard Reference Material</u>				
Certified Value	NC ^(b)	NC	NC	NC
Range	NA ^(c)	NA	NA	NA
Non Certified Value	1.5	0.4	0.6	0.5
1646	1.02	0.300	0.41	0.305
1646	0.912	0.200	0.42	0.322
Percent Difference from Certified value	NA	NA	NA	NA
Percent Difference from Certified value	NA	NA	NA	NA
<u>Matrix Spike Results</u>				
EC-11/CT COMP EC-B-II	NA	0.15	0.21	NA
EC-11/CT COMP EC-B-II MS	NA	2.43	2.89	NA
Amount Recovered	NA	2.28	2.68	NA
Amount Spiked	NS ^(d)	1.00	2.50	NS
Percent Recovery	NA	228% ^(e)	107%	NA
EC-11/CT COMP EC-B-II	0.953	NA	NA	0.461
EC-11/CT COMP EC-B-II MS	4.99	NA	NA	4.68
Amount Recovered	4.04	NA	NA	4.68
Amount Spiked	5.00	NS	NS	5.00
Percent Recovery	81%	NA	NA	94%
<u>Analytical Replicates</u>				
EC-11/CT COMP EC-B-II, Rep 1	0.959	1.52	0.70	0.423
EC-11/CT COMP EC-B-II, Rep 2	0.955	1.46	0.83	0.440
EC-11/CT COMP EC-B-II, Rep 3	0.903	1.48	0.89	0.445
RSD	3%	2%	12%	3%

(a) U Undetected at or above given concentration.

(b) NC Non-certified value.

(c) NA Not applicable.

(d) NS Not spiked.

(e) Outside quality control criteria (75-125%) for matrix spike recoveries.

TABLE A.6. Quality Control Data for 1,4-Dichlorobenzene, Pesticides, and PCB Congeners in Sediment

	Batch: 1 Treatment: Blank	MATRIX SPIKE					
		1 EC-10	1 EC-10, MS	1 Concentration Recovered	1 Amount Spiked	1 Concentration Spiked	1 Percent Recovery
Sample Size (g)	9.076 ^(a)	6.689	2.289	NA ^(b)	NA	NA	
Units (dry wt) : $\mu\text{g/kg}$		$\mu\text{g/kg}$	$\mu\text{g/kg}$	$\mu\text{g/kg}$	ng	$\mu\text{g/kg}$	
1,4-Dichlorobenzene	1.19 U ^(c)	84.46	510.36	425.91	1425	623	68
2,4-DDD	0.97 U	16.57	18.72	2.15	NS ^(d)	NS	NA
2,4-DDT	0.91 U	NA	NA	NA	NS	NS	NA
4,4-DDD	1.56 U	53.31	154.73	101.42	201.0	88	115
4,4-DDE	2.29 U	38.55	117.11	78.56	200.5	88	90
4,4-DDT	5.19 U	2.19 J ^(e)	74.76	72.56	200.5	88	83
Aldrin	0.87 U	1.18 U	58.05	58.05	200.5	88	66
alpha-Chlordane	1.27 U	14.46	85.02	70.56	200.0	87	81
Dieldrin	1.85 U	8.52	66.86	58.34	200.5	88	67
Endosulfan I /2,4-DDE	2.39 U	3.24 U	73.57	73.57	200.5	88	84
Endosulfan II	1.78 U	2.42 U	72.03	72.03	200.5	88	82
Endosulfan Sulfate	1.68 U	2.28 U	86.48	86.48	200.5	88	99
Endrin ^(f)	3.24 U	4.40 U	78.26	78.26	200.0	87	90
Endrin Aldehyde ^(f)	1.93 U	2.62 U	66.18	66.18	200.5	88	76
Heptachlor	1.96 U	2.65 U	87.96	87.96	200.5	88	100
Heptachlor Epoxide	1.09 U	1.47 U	81.04	81.04	200.5	88	93
alpha-BHC ^(f)	1.21 U	0.28 J	69.22	68.94	200.5	88	79
beta-BHC ^(f)	0.09 J	2.42 U	64.97	64.97	200.5	88	74
delta-BHC ^(f)	1.20 J	2.20 U	68.21	68.21	200.5	88	78
Lindane ^(f)	0.33 J	1.92 U	72.05	72.05	200.5	88	82
Methoxychlor ^(f)	2.03 U	2.75 U	94.68	94.68	200.0	87	108
Toxaphene ^(f)	61.41 U	83.32 U	NA	NA	NS	NS	NA
trans-Nonachlor	1.86 U	7.45	5.57	5.57	NS	NS	NA
CL2(08)	4.38 U	6.47	28.20	21.74	200.00	87	25 ^(g)
CL3(18)	2.78 U	26.86	98.05	71.18	200.00	87	81
CL3(28)	1.83 U	42.91	148.46	105.55	200.00	87	121 ^(g)
CL4(44)	2.65 U	43.52	118.73	75.21	200.00	87	86
CL4(49)	1.66 U	34.91	44.50	9.60	NS	NS	NA
CL4(52)	1.54 U	51.61	122.53	70.92	200.00	87	81
CL4(66)	1.45 U	59.60	158.19	98.58	200.00	87	113
CL5(87)	0.88 U	13.96	15.20	1.24	NS	NS	NA
CL5(101)	0.74 U	33.21	98.14	64.93	200.00	87	74
CL5(105)	0.49 U	12.92	85.99	73.07	200.00	87	84
CL5(118)	1.30 U	28.18	87.87	59.69	200.00	87	68
CL6(128)	1.38 U	5.45	82.99	77.54	200.00	87	89
CL6(138)	1.19 U	31.64	101.08	69.45	200.00	87	79
CL6(153)	5.77 U	26.37	91.20	64.83	200.00	87	74
CL7(170)	1.46 U	17.20	88.02	70.82	200.00	87	81
CL7(180)	0.98 U	31.37	96.83	65.45	200.00	87	75
CL7(183)	1.09 U	4.97	NA	NA	NS	NS	NA
CL7(184)	1.09 U	0.49 J	NA	NA	NS	NS	NA
CL7(187)	0.82 U	15.44	70.69	55.25	200.00	87	63
CL8(195)	1.24 U	6.36	76.77	70.41	200.00	87	81
CL9(206)	1.90 U	14.96	90.94	75.98	200.00	87	87
CL10(209)	1.18 U	9.42	90.27	80.85	200.00	87	93
<u>Surrogate Recoveries (%)</u>							
DBOFB	73	82	86	NA	NA	NA	NA
CL5(112)	64	55	67	NA	NA	NA	NA

TABLE A.6. (contd)

		MATRIX SPIKE					
Batch: 2		2	2	2	2	2	2
Treatment: Blank		R-MUD	R-MUD, MS	Concentration Recovered	Amount Spiked	Concentration Spiked	Percent Recovery
Sample Size (g)	8.542 ^(a)	13.660	13.220	NA	NA	NA	
Units (dry wt) :	µg/kg	µg/kg	µg/kg	µg/kg	ng	µg/kg	
1,4-Dichlorobenzene	1.27 U	0.79 U	61.78	61.78	1425.00	108	57
2,4-DDD	1.04 U	0.01 J	NA	NA	NS	NS	NA
2,4-DDT	0.97 U	0.60 U	NA	NA	NS	NS	NA
4,4-DDD	1.65 U	0.06 J	11.72	11.66	201.00	15	77
4,4-DDE	2.43 U	0.01 J	10.08	10.07	200.50	15	66
4,4-DDT	5.51 U	3.45 U	10.99	10.99	200.50	15	72
Aldrin	0.93 U	0.58 U	11.35	11.35	200.50	15	75
alpha-Chlordane	1.35 U	0.01 J	11.39	11.39	200.00	15	75
Dieldrin	1.97 U	0.21 J	11.34	11.13	200.50	15	73
Endosulfan I /2,4-DDE	2.54 U	1.59 U	13.52	13.52	200.50	15	89
Endosulfan II	1.89 U	0.05 J	13.24	13.19	200.50	15	87
Endosulfan Sulfate	1.79 U	1.12 U	10.86	10.86	200.50	15	72
Endrin ^(f)	NA	NA	NA	NA	NS	NS	NA
Endrin Aldehyde ^(f)	NA	NA	NA	NA	NS	NS	NA
Heptachlor	2.08 U	1.30 U	10.27	10.27	200.50	15	68
Heptachlor Epoxide	1.15 U	0.72 U	10.60	10.60	200.50	15	70
alpha-BHC ^(f)	NA	NA	NA	NA	NS	NS	NA
beta-BHC ^(f)	NA	NA	NA	NA	NS	NS	NA
delta-BHC ^(f)	NA	NA	NA	NA	NS	NS	NA
Lindane ^(f)	NA	NA	NA	NA	NS	NS	NA
Methoxychlor ^(f)	NA	NA	NA	NA	NS	NS	NA
Toxaphene ^(f)	NA	NA	NA	NA	NS	NS	NA
trans-Nonachlor	1.98 U	0.00 J	NA	NA	NS	NS	NA
CL2(08)	4.65 U	2.91 U	7.05	7.05	200.00	15	47 ^(g)
CL3(18)	2.95 U	1.85 U	8.12	8.12	200.00	15	54
CL3(28)	1.94 U	1.21 U	10.03	10.03	200.00	15	66
CL4(44)	2.82 U	0.22 J	10.29	10.07	200.00	15	67
CL4(49)	1.76 U	0.04 J	NA	NA	NS	NS	NA
CL4(52)	1.63 U	0.06 J	9.91	9.85	200.00	15	65
CL4(66)	1.54 U	0.04 J	10.43	10.39	200.00	15	69
CL5(87)	0.93 U	0.05 J	NA	NA	NS	NS	NA
CL5(101)	0.78 U	0.04 J	10.27	10.23	200.00	15	68
CL5(105)	0.52 U	0.03 J	9.12	9.09	200.00	15	60
CL5(118)	1.38 U	0.02 J	9.25	9.23	200.00	15	61
CL6(128)	1.46 U	0.92 U	9.42	9.42	200.00	15	62
CL6(138)	1.26 U	0.07 J	9.36	9.29	200.00	15	61
CL6(153)	6.13 U	0.03 J	8.56	8.53	200.00	15	56
CL7(170)	1.55 U	0.97 U	9.26	9.26	200.00	15	61
CL7(180)	1.04 U	0.65 U	9.32	9.32	200.00	15	62
CL7(183)	1.15 U	0.72 U	NA	NA	NS	NS	NA
CL7(184)	1.15 U	0.01 J	NA	NA	NS	NS	NA
CL7(187)	0.87 U	0.01 J	9.28	9.27	200.00	15	61
CL8(195)	1.32 U	0.83 U	9.35	9.35	200.00	15	62
CL9(206)	2.02 U	1.26 U	9.13	9.13	200.00	15	60
CL10(209)	1.26 U	0.79 U	9.41	9.41	200.00	15	62
<u>Surrogate Recoveries (%)</u>							
DBOFB	66	65	69	NA	NA	NA	
CL5(112)	72	49	64	NA	NA	NA	

TABLE A.6. (contd)

	STANDARD REFERENCE MATERIAL					
	Batch: 1	1	1	2	2	2
	Treatment: SRM			SRM		
	NIST 1941a	Certified	Percent	NIST 1941a	Certified	Percent
Sample Size (g)	5.133	Value	Difference ^(h)	5.057	Value	Difference
Units (dry wt) :	µg/kg	µg/kg		µg/kg	µg/kg	
1,4-Dichlorobenzene	NA	NC ^(f)	NA	NA	NC	NA
2,4-DDD	NA	NC	NA	NA	NC	NA
2,4-DDT	NA	NC	NA	NA	NC	NA
4,4-DDD	2.56 J	5.06	4	4.86	5.06	103
4,4-DDE	3.46 J	6.59	8	3.16 J	6.59	1
4,4-DDT	NA	NC	NA	NA	NC	NA
Aldrin	NA	NC	NA	NA	NC	NA
alpha-Chlordane	1.01 J	2.33	44	1.06 J	2.33	14
Dieldrin	NA	NC	NA	NA	NC	NA
Endosulfan I /2,4-DDE	C ^(f)	0.73	NA	ND	0.73	NA
Endosulfan II	NA	NC	NA	NA	NC	NA
Endosulfan Sulfate	NA	NC	NA	NA	NC	NA
Endrin ^(f)	NA	NC	NA	NA	NC	NA
Endrin Aldehyde ^(f)	NA	NC	NA	NA	NC	NA
Heptachlor	NA	NC	NA	NA	NC	NA
Heptachlor Epoxide	NA	NC	NA	NA	NC	NA
alpha-BHC ^(f)	NA	NC	NA	NA	NC	NA
beta-BHC ^(f)	NA	NC	NA	NA	NC	NA
delta-BHC ^(f)	NA	NC	NA	NA	NC	NA
Lindane ^(f)	NA	NC	NA	NA	NC	NA
Methoxychlor ^(f)	NA	NC	NA	NA	NC	NA
Toxaphene ^(f)	NA	NC	NA	NA	NC	NA
trans-Nonachlor	0.39 J	1.26	61	0.60 J	1.26	10
CL2(08)	NA	NC	NA	NA	NC	NA
CL3(18)	NA	NC	NA	NA	NC	NA
CL3(28)	NA	NC	NA	NA	NC	NA
CL4(44)	3.88 J	4.80	4	3.92 J	4.80	54
CL4(49)	3.03	9.50	59	3.14 J	9.50	38
CL4(52)	3.20	6.89	40	3.89	6.89	6
CL4(66)	7.11	6.80	34	6.07	6.80	68
CL5(87)	1.45 J	6.70	55	1.72	6.70	46
CL5(101)	9.02	11.00	5	6.94	11.00	19
CL5(105)	1.18	3.65	33	1.05	3.65	39
CL5(118)	3.29	10.00	32	3.55	10.00	25
CL6(128)	3.07	1.87	238	1.82 J	1.87	106
CL6(138)	4.96	13.38	24	6.05	13.38	4
CL6(153)	5.21 J	17.60	39	5.21 J	17.60	37
CL7(170)	4.82	3.00	230	C	3.00	NA
CL7(180)	5.47	5.83	93	5.10	5.83	85
CL7(183)	NA	NC	NA	NA	NC	NA
CL7(184)	NA	NC	NA	NA	NC	NA
CL7(187)	NA	NC	NA	NA	NC	NA
CL8(195)	NA	NC	NA	NA	NC	NA
CL9(206)	C	3.67	NA	2.93 J	3.67	69
CL10(209)	7.52	8.34	85	5.26	8.34	33
<u>Surrogate Recoveries (%)</u>						
DBOFB	78	NA	NA	53	NA	NA
CL5(112)	49	NA	NA	47	NA	NA

TABLE A.6. (contd)

Batch: Treatment: Sample Size (g) Units (dry wt) :	TRIPLICATE ANALYSES							
	1	1	1	RSD(%)	2	2	2	RSD(%)
	EC-15	EC-15	EC-15		GR-10	GR-10	GR-10	
	Replicate 1	Replicate 2	Replicate 3		Replicate 1	Replicate 2	Replicate 3	
	9.854	9.442	9.339		8.182	8.594	8.657	
	µg/kg	µg/kg	µg/kg		µg/kg	µg/kg	µg/kg	
1,4-Dichlorobenzene	10.65	8.00	7.52	19	17.73	25.25	19.82	19
2,4-DDD	10.32	13.52	10.13	17	6.58	9.27	6.64	21
2,4-DDT	0.84 U	0.87 U	0.88 U	NA	1.01 U	0.96 U	0.95 U	NA
4,4-DDD	41.51	47.84	42.18	8	5.56	6.05	5.52	5
4,4-DDE	13.20	12.90	10.14	14	4.58	5.53	5.01	9
4,4-DDT	2.35 J	4.25 J	2.57 J	34	0.38 J	0.19 J	0.16 J	48
Aldrin	0.80 U	0.84 U	0.85 U	NA	0.97 U	0.92 U	0.91 U	NA
alpha-Chlordane	18.62	23.16	22.52	11	1.02 J	1.41	1.09 J	18
Dieldrin	7.09	7.58	6.22	10	1.27 J	1.35 J	1.46 J	7
Endosulfan I /2,4-DDE	2.20 U	2.30 U	2.32 U	NA	2.65 U	2.52 U	2.51 U	NA
Endosulfan II	1.64 U	1.71 U	1.73 U	NA	1.38 J	1.77 J	0.97 J	29
Endosulfan Sulfate	1.55 U	1.62 U	1.64 U	NA	0.31 J	0.44 J	0.28 J	25
Endrin ^(f)	2.98 U	3.11 U	3.15 U	NA	NA	NA	NA	NA
Endrin Aldehyde ^(f)	1.78 U	1.86 U	1.88 U	NA	NA	NA	NA	NA
Heptachlor	1.80 U	1.88 U	1.90 U	NA	2.17 U	2.07 U	2.05 U	NA
Heptachlor Epoxide	1.00 U	1.04 U	1.05 U	NA	1.20 U	1.15 U	1.14 U	NA
alpha-BHC ^(f)	1.11 U	1.16 U	1.17 U	NA	NA	NA	NA	NA
beta-BHC ^(f)	1.64 U	1.71 U	1.73 U	NA	NA	NA	NA	NA
delta-BHC ^(f)	1.49 U	1.56 U	1.58 U	NA	NA	NA	NA	NA
Lindane ^(f)	1.30 U	1.36 U	1.37 U	NA	NA	NA	NA	NA
Methoxychlor ^(f)	1.87 U	1.95 U	1.97 U	NA	NA	NA	NA	NA
Toxaphene ^(f)	56.56 U	59.03 U	59.68 U	NA	NA	NA	NA	NA
trans-Nonachlor	11.31	14.64	14.13	13	0.54 J	0.66 J	0.53 J	12
CL2(08)	7.98	8.19	6.21	15	2.53 J	2.95 J	2.64 J	8
CL3(18)	19.18	23.08	22.08	9	3.81	4.43	4.15	7
CL3(28)	51.14	30.02	31.95	31 ^(k)	13.08	17.79	14.05	17
CL4(44)	24.24	31.36	29.22	13	5.15	6.44	5.42	12
CL4(49)	23.21	27.19	24.75	8	5.38	7.00	6.50	13
CL4(52)	29.20	41.52	36.00	17	6.66	8.07	6.98	10
CL4(66)	88.09	103.82	92.36	9	10.53	11.61	9.40	10
CL5(87)	5.33	7.44	6.83	17	1.78	2.11	1.90	8
CL5(101)	24.93	29.25	28.42	8	5.15	6.22	5.24	11
CL5(105)	4.86	41.07	7.37	114 ^(k)	2.29	2.35	1.85	13
CL5(118)	13.11	16.42	15.16	11	4.74	6.11	5.26	13
CL6(128)	4.50	6.23	7.30	24	2.96	3.47	3.17	8
CL6(138)	67.37	36.36	24.29	52 ^(k)	5.60	7.00	6.08	11
CL6(153)	12.25	10.68	12.57	9	4.21 J	5.46 J	5.04 J	13
CL7(170)	9.06	9.86	8.44	8	2.11	2.81	2.31	15
CL7(180)	9.43	12.62	10.25	15	3.04	3.82	3.20	12
CL7(183)	1.45	2.28	2.07	22	0.60 J	0.89 J	0.73 J	19
CL7(184)	1.19	0.79 J	0.42 J	48	0.38 J	0.36 J	0.45 J	11
CL7(187)	3.29	4.79	3.73	20	1.61	2.04	1.72	12
CL8(195)	1.57	2.03	1.59	15	0.35 J	0.41 J	0.37 J	8
CL9(206)	4.73	5.62	4.95	9	0.74 J	1.07 J	0.86 J	19
CL10(209)	4.10	5.87	4.75	18	1.27 J	1.49	1.49	9
<u>Surrogate Recoveries (%)</u>								
DBOFB	84	94	85	NA	50	63	58	NA
CL5(112)	34	43	34	NA	39	50	44	NA

TABLE A.6. (contd)

Qualifiers

- (a) Sample concentration of the procedural blank adjusted for the average sample size of the batch.
- (b) NA Not applicable.
- (c) U Undetected at or above given concentration.
- (d) NS Not spiked.
- (e) J Concentration estimated; analyte detected below method detection limit (MDL), but above instrument detection limit (IDL).
- (f) Analyte required only in samples designated for Central Long Island Disposal Testing Site.
- (g) Outside quality control criteria (50-120%) for matrix spike recoveries.
- (h) Percent Difference from certified
= absolute value [(certified value, $\mu\text{g/kg}$ - value detected corrected for surrogate recovery, $\mu\text{g/kg}$) / certified value, $\mu\text{g/kg}$].
- (i) NC No certified value available.
- (j) C Analyte not determined due to co-eluting peak.
- (k) Outside quality control criteria ($\pm 30\%$) for replicates.

TABLE A.7. MDL Verification Study for Analysis of Pesticides and PCBs in Sediment

Battelle ID:	OG99	OH01	OH02	OH03	OH04	OH05	OH06	OH07	Standard Deviation STD (n-1)	Method Detection Limit MDL ^(a) µg/kg	Method Detection Limit MDL (ng)
Sample Size (g): Units (dry wt):	20.919 µg/kg	19.455 µg/kg	19.201 µg/kg	18.645 µg/kg	19.087 µg/kg	19.434 µg/kg	18.896 µg/kg	18.612 µg/kg			
1,4-Dichlorobenzene	1.934	1.589	1.642	1.966	1.820	1.483	1.965	2.685	0.372	1.114	21.485
2,4-DDD	NS ^(a)	NS	NS	NS	NS	NS	NS	NS	NA ^(a)	NA	NA
2,4-DDT	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA	NA
4,4-DDD	0.494	0.516	0.533	0.637	0.526	0.570	0.453	0.503	0.055	0.165	3.180
4,4-DDE	0.380	0.433	0.422	0.477	0.464	0.462	0.451	0.456	0.031	0.093	1.791
4,4-DDT	0.853	0.455	0.487	0.474	0.515	0.546	0.498	0.499	0.129	0.387	7.460
Aldrin	0.379	0.460	0.443	0.502	0.459	0.431	0.450	0.477	0.036	0.108	2.077
Alpha-chlordane	0.344	0.427	0.375	0.471	0.435	0.413	0.438	0.440	0.040	0.121	2.328
Dieldrin	0.400	0.451	0.478	0.493	0.456	0.499	0.465	0.441	0.032	0.095	1.836
Endosulfan I	0.423	0.556	0.480	0.562	0.531	0.506	0.517	0.540	0.045	0.136	2.628
Endosulfan II	0.500	0.538	0.544	0.575	0.552	0.558	0.529	0.526	0.023	0.068	1.319
Endosulfan Sulfate	0.416	0.426	0.448	0.476	0.463	0.489	0.473	0.462	0.025	0.076	1.458
Endrin ^(a)	0.381	0.490	0.512	0.557	0.552	0.550	0.540	0.549	0.059	0.178	3.439
Endrin Aldehyde ^(a)	0.425	0.534	0.532	0.619	0.568	0.526	0.558	0.578	0.056	0.169	3.256
Heptachlor	0.445	0.516	0.476	0.561	0.527	0.480	0.528	0.549	0.040	0.119	2.296
Heptachlor epoxide	0.442	0.542	0.495	0.572	0.549	0.514	0.543	0.560	0.042	0.127	2.444
A-BHC ^(a)	0.342	0.415	0.428	0.450	0.433	0.384	0.415	0.433	0.034	0.103	1.985
B-BHC ^(a)	0.442	0.547	0.539	0.541	0.495	0.493	0.513	0.504	0.035	0.104	1.996
D-BHC ^(a)	0.429	0.537	0.489	0.510	0.532	0.473	0.491	0.485	0.034	0.103	1.989
Lindane ^(a)	0.386	0.477	0.457	0.482	0.458	0.431	0.452	0.460	0.030	0.091	1.745
Methoxychlor ^(a)	0.319	0.446	0.497	0.489	0.530	0.553	0.561	0.554	0.081	0.242	4.673
Toxaphene ^(a)	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA	NA
Trans-nonachlor	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA	NA

TABLE A.7. (contd)

Battelle ID:	OG99	OH01	OH02	OH03	OH04	OH05	OH06	OH07	Standard Deviation STD (n-1)	Method Detection Limit MDL ^(a) μg/kg	Method Detection Limit MDL (ng)
Sample Size (g): Units (dry wt):	20.919 μg/kg	19.455 μg/kg	19.201 μg/kg	18.645 μg/kg	19.087 μg/kg	19.434 μg/kg	18.896 μg/kg	18.612 μg/kg			
CL2(08)	0.273	0.302	0.289	0.319	0.244	0.312	0.319	0.378	0.039	0.117	2.265
CL3(18)	0.376	0.447	0.416	0.489	0.452	0.415	0.423	0.445	0.034	0.100	1.937
CL3(28)	0.376	0.491	0.465	0.482	0.439	0.463	0.459	0.486	0.037	0.112	2.155
CL4(44)	0.425	0.529	0.478	0.551	0.506	0.470	0.489	0.511	0.039	0.116	2.243
CL4(49)	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA	NA
CL4(52)	0.418	0.491	0.442	0.522	0.471	0.426	0.450	0.473	0.035	0.104	2.000
CL4(66)	0.423	0.526	0.487	0.519	0.493	0.436	0.477	0.490	0.036	0.108	2.087
CL5(87)	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA	NA
CL5(101)	0.459	0.587	0.530	0.597	0.551	0.501	0.519	0.532	0.045	0.134	2.581
CL5(105)	0.373	0.381	0.416	0.459	0.405	0.435	0.423	0.421	0.028	0.084	1.618
CL5(118)	0.399	0.479	0.454	0.486	0.463	0.469	0.460	0.467	0.027	0.080	1.534
CL6(128)	0.363	0.414	0.401	0.394	0.400	0.404	0.385	0.401	0.015	0.046	0.887
CL6(138)	0.379	0.422	0.411	0.421	0.418	0.410	0.407	0.417	0.014	0.042	0.806
CL6(153)	0.359	0.416	0.418	0.437	0.430	0.414	0.402	0.414	0.024	0.071	1.378
CL7(170)	0.343	0.402	0.376	0.407	0.394	0.384	0.378	0.380	0.020	0.060	1.149
CL7(180)	0.341	0.384	0.380	0.430	0.426	0.397	0.395	0.390	0.028	0.084	1.622
CL7(183)	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA	NA
CL7(184)	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA	NA
CL7(187)	0.329	0.384	0.358	0.421	0.400	0.403	0.391	0.378	0.029	0.086	1.654
CL8(195)	0.328	0.367	0.364	0.397	0.390	0.382	0.381	0.371	0.021	0.064	1.227
CL9(206)	0.267	0.303	0.314	0.326	0.328	0.305	0.277	0.299	0.022	0.065	1.256
CL10(209)	0.359	0.399	0.402	0.448	0.447	0.430	0.437	0.425	0.030	0.090	1.738
<u>Surrogate Recoveries (%)</u>											
DBOFB	55	67	58	66	64	61	63	65			
CL5(112)	58	63	61	67	64	67	62	61			

(a) MDL The Method Detection Limit (2.998 x standard deviation).

(b) NS Not spiked.

(c) NA Not applicable.

(d) Analyte required only in samples designated for Central Long Island Disposal Testing Site.

TABLE A.8. Quality Control Data for Polynuclear Aromatic Hydrocarbons (PAH) in Sediment

	BLANKS		MATRIX SPIKE							
	1	2	1	1	2	2	2	2	2	2
Batch:	Blank	Blank	EC-10	EC-10, MS	Concentration	Concentration	R-MUD	R-MUD, MS	Concentration	Concentration
Treatment:	NA ^(a)	NA	56.369	19.842	Spiked	Percent	13.655	13.216	Spiked	Percent
Percent Moisture:	NA ^(a)	NA	56.369	19.842	Spiked	Percent	13.655	13.216	Spiked	Percent
Dry Weight (g)	9.076 ^(b)	8.542	6.689	2.289	µg/kg	Recovery	µg/kg	µg/kg	µg/kg	Recovery
Units (dry wt):	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	Recovery	µg/kg	µg/kg	µg/kg	Recovery
naphthalene	12.36 U ^(c)	0.73 J ^(d)	293.40	1949.96	2595.02	64	1.13 J	280.30	449	62
1-methylnaphthalene ^(e)	13.00 U	NA	95.73	1781.30	2575.36	65	NA	NA	NS ^(h)	NA
2-methylnaphthalene ^(e)	10.96 U	NA	190.08	1754.99	NS	NA	NA	NA	NS	NA
biphenyl	10.45 U	11.10 U	64.14	1699.62	2588.69	63	6.94 U	285.69	448	64
2,6-dimethylnaphthalene ^(e)	10.21 U	NA	89.93	1798.88	2579.29	66	NA	NA	NS	NA
acenaphthylene	9.94 U	10.57 U	392.81	2109.65	2484.93	69	6.61 U	275.33	430	64
acenaphthene	12.93 U	13.74 U	199.96	1884.07	2681.52	63	8.59 U	299.51	464	64
fluorene	10.69 U	11.36 U	234.41	1876.21	2570.55	64	7.11 U	271.59	445	61
phenanthrene	10.78 U	11.45 U	1129.33	2727.93	2584.10	62	0.72 J	285.68	448	64
anthracene	10.46 U	11.12 U	839.49	2036.08	1956.09	61	6.96 U	211.15	339	62
1-methylphenanthrene ^(e)	9.57 U	NA	343.98	2220.41	2555.70	73	NA	NA	NS	NA
fluoranthene	9.72 U	10.32 U	4118.64	5351.78	2594.15	48 ^(g)	0.53 J	288.99	449	64
pyrene	2.83 J	12.46 U	4171.38	5396.57	2590.65	47 ^(g)	0.55 J	286.47	449	64
benzo[a]anthracene	11.56 U	12.29 U	2017.45	3005.59	2245.09	44 ^(g)	0.62 J	230.70	389	59
chrysene	14.17 U	15.06 U	2535.99	3529.16	2602.88	38 ^(g)	9.42 U	291.13	451	65
benzo[b]fluoranthene	10.68 U	11.34 U	3396.16	4074.64	2582.35	26 ^(g)	0.50 J	277.16	447	62
benzo[k]fluoranthene	12.66 U	13.46 U	780.34	2498.31	2572.30	67	8.42 U	296.83	446	67
benzo[e]pyrene ^(e)	7.98 U	NA	1244.09	2852.72	2582.79	62	NA	NA	NS	NA
benzo[a]pyrene	9.90 U	10.52 U	2397.66	3136.38	2332.46	32 ^(g)	6.58 U	231.13	404	57
perylene ^(e)	20.84 U	NA	381.92	1587.57	1953.69	62	NA	NA	NS	NA
indeno[1,2,3-c,d]pyrene	8.55 U	9.08 U	1408.83	2781.05	2292.27	60	5.68 U	239.58	397	60
dibenz[a,h]anthracene	8.68 U	9.22 U	355.49	1583.39	1938.40	63	5.77 U	205.26	336	61
benzo[g,h,i]perylene	7.18 U	7.63 U	1349.43	2656.07	2307.99	57	4.77 U	231.76	400	58
<u>Surrogate Recoveries (%)</u>										
naphthalene-d8	59	69	53	55	NA	NA	54	66	NA	NA
acenaphthene-d10	63	66	60	59	NA	NA	56	63	NA	NA
chrysene-d12	65	63	52	55	NA	NA	58	64	NA	NA

TABLE A.8. (contd)

Batch: Treatment: Dry Weight (g) Units (dry wt):	STANDARD REFERENCE MATERIAL					
	1	1	Percent Difference ^(h)	2	2	Percent Difference ^(h)
	NIST 1941a	NIST 1941a		NIST 1941a	NIST 1941a	
	Certified Value µg/kg	Certified Value µg/kg		Certified Value µg/kg	Certified Value µg/kg	
naphthalene	1010	446.35	2	1010	461.60	10
1-methylnaphthalene ^(e)	NC ⁽ⁱ⁾	69.83	NA	NA	NA	NA
2-methylnaphthalene ^(e)	NC	149.85	NA	NA	NA	NA
biphenyl	NC	45.65	NA	NC	45.92	NA
2,6-dimethylnaphthalene ^(e)	NC	33.39	NA	NA	NA	NA
acenaphthylene	NC	50.40	NA	NC	43.38	NA
acenaphthene	NC	23.36	NA	NC	24.71	NA
fluorene	97.3	49.71	18	97	47.87	3
phenanthrene	489	274.57	12	489	275.27	6
anthracene	184	115.14	24	184	114.23	17
1-methylphenanthrene ^(e)	NC	59.14	NA	NA	NA	NA
fluoranthene	981	558.33	13	981	523.89	1
pyrene	811	465.23	14	811	439.33	2
benz[a]anthracene	427	228.99	7	427	208.24	8
chrysene	380	330.74	73 ^(j)	380	318.66	58 ^(j)
benzo[b]fluoranthene	740	540.68	45 ^(j)	740	519.11	32 ^(j)
benzo[k]fluoranthene	361	186.68	3	361	192.57	1
benzo[e]pyrene ^(e)	553	291.70	5	NA	NA	NA
benzo[a]pyrene	628	277.29	12	628	291.97	12
perylene ^(e)	452	202.39	11	NA	NA	NA
indeno[1,2,3-c,d]pyrene	501	264.41	5	501	248.25	6
dibenz[a,h]anthracene	73.9	60.42	63 ^(j)	74	54.65	40 ^(j)
benzo[g,h,i]perylene	525	249.44	6	525	233.31	16
<u>Surrogate Recoveries (%)</u>						
naphthalene-d8	NA	43	NA	NA	51	NA
acenaphthene-d10	NA	50	NA	NA	53	NA
chrysene-d12	NA	51	NA	NA	55	NA

TABLE A.8. (contd)

Batch: Treatment:	ANALYTICAL REPLICATES							
	1 EC-15 Replicate 1	1 EC-15 Replicate 2	1 EC-15 Replicate 3	RSD(%)	2 GR-10 Replicate 1	2 GR-10 Dup. Replicate 2	2 GR-10 Trip. Replicate 3	RSD(%)
Dry Weight (g)	9.854	9.442	9.339		8.182	8.594	8.657	
Units (dry wt):	µg/kg	µg/kg	µg/kg		µg/kg	µg/kg	µg/kg	
naphthalene	413.07	383.64	346.57	9	97.15	122.54	106.28	12
1-methylnaphthalene ^(e)	230.13	293.43	294.48	14	NA	NA	NA	NA
2-methylnaphthalene ^(e)	220.96	269.92	256.05	10	NA	NA	NA	NA
biphenyl	67.60	81.01	101.32	20	21.24	27.72	23.89	13
2,6-dimethylnaphthalene ^(e)	141.18	161.94	151.86	7	ND	ND	ND	NA
acenaphthylene	350.59	356.12	360.45	1	72.16	85.43	82.68	9
acenaphthene	393.29	494.18	516.99	14	27.42	37.65	34.18	16
fluorene	496.91	588.49	564.89	9	51.78	69.28	58.58	15
phenanthrene	2775.86	3308.85	2624.88	12	293.40	391.80	305.88	16
anthracene	784.75	917.38	820.41	8	228.03	286.56	241.40	12
1-methylphenanthrene ^(e)	480.83	521.03	513.57	4	NA	NA	NA	NA
fluoranthene	4967.01	5744.20	5225.88	7	809.42	996.86	801.60	13
pyrene	4698.65	5597.13	5124.00	9	877.93	1063.72	851.74	12
benz[a]anthracene	2158.28	2538.62	2480.41	9	492.12	601.96	493.70	12
chrysene	2530.60	2939.22	2913.86	8	502.85	603.94	493.96	11
benzo[b]fluoranthene	2953.82	3554.01	3284.14	9	572.66	705.11	577.73	12
benzo[k]fluoranthene	678.98	661.98	723.19	5	221.94	269.23	228.73	11
benzo[e]pyrene ^(e)	1586.76	1869.29	1743.18	8	NA	NA	NA	NA
benzo[a]pyrene	2154.13	2586.21	2437.45	9	518.39	627.31	524.96	11
perylene ^(e)	380.77	395.37	445.44	8	NA	NA	NA	NA
indeno[1,2,3-c,d]pyrene	1507.35	1811.51	1634.00	9	276.94	335.32	284.94	11
dibenz[a,h]anthracene	371.68	394.28	398.09	4	71.13	90.76	75.94	13
benzo[g,h,i]perylene	1365.92	1673.81	1530.19	10	249.71	298.49	254.12	10
Surrogate Recoveries (%)								
naphthalene-d8	52	61	55	NA	41	52	46	NA
acenaphthene-d10	57	68	59	NA	47	58	51	NA
chrysene-d12	39	44	41	NA	46	56	49	NA

TABLE A.8. (contd)

Qualifiers

- (a) NA Not applicable.
- (b) Sample concentration of the procedural blank adjusted for the average sample size of the batch.
- (c) U Undetected at or above given concentration.
- (d) J Concentration estimated; analyte detected below method detection limit (MDL), but above instrument detection limit (IDL).
- (e) Analyte required only in samples designated for Central Long Island Disposal Testing Site.
- (f) NS Not spiked.
- (g) Outside quality control criteria (50-120%) for matrix spike recoveries.
- (h) Percent Difference from certified
= absolute value [(certified value $\mu\text{g/kg}$ - value detected corrected for surrogate recovery, $\mu\text{g/kg}$) / certified value, $\mu\text{g/kg}$].
- (i) NC No certified value available.
- (j) Outside SRM quality control acceptable criteria ($\leq 30\%$).

TABLE A.9. MDL Verification Study for Analysis of Polynuclear Aromatic Hydrocarbons (PAH) in Sediment

A.20

Sample Number:	OG99	OH01	OH02	OH03	OH04	OH05	OH06	OH07		Method Detection	Method Detection
Percent Moisture (%):	38.233	38.160	38.160	38.160	38.098	38.160	38.160	38.161	Standard	Limit	Limit
Sample Dry Weight (g):	20.919	19.455	19.201	18.645	19.087	19.434	18.896	18.612	Deviation	MDL ^(a)	MDL
Units (dry wt):	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	STD	(µg/kg)	(ng)
naphthalene	1.61	1.85	1.88	1.86	1.66	1.72	1.75	1.97	0.12	0.36	7.03
biphenyl	1.30	1.55	1.49	1.61	1.56	1.50	1.57	1.67	0.11	0.33	6.35
acenaphthylene	0.93	1.06	1.09	1.15	1.01	1.18	1.09	1.16	0.08	0.25	4.87
acenaphthene	1.12	1.41	1.16	1.41	1.38	1.21	1.34	1.56	0.15	0.44	8.55
fluorene	1.07	1.31	1.12	1.17	1.09	0.99	1.27	1.25	0.11	0.34	6.48
phenanthrene	1.25	1.41	1.35	1.58	1.42	1.38	1.43	1.59	0.11	0.34	6.52
anthracene	0.73	0.87	0.78	0.88	0.87	0.78	0.77	0.99	0.08	0.25	4.80
fluoranthene	1.10	1.24	1.08	1.24	1.11	1.13	1.13	1.11	0.06	0.19	3.64
pyrene	1.16	1.34	1.21	1.21	1.14	1.15	1.19	1.19	0.06	0.19	3.64
benz[a]anthracene	0.82	1.08	0.94	0.96	0.92	0.89	0.88	0.95	0.08	0.23	4.38
chrysene	0.95	1.12	0.98	1.14	1.01	1.16	0.95	1.02	0.09	0.26	4.98
benzo[b]fluoranthene	0.97	1.02	0.93	1.03	0.89	0.88	0.85	0.86	0.07	0.21	4.03
benzo[k]fluoranthene	0.93	0.92	0.93	1.01	0.89	0.92	1.01	0.69	0.10	0.30	5.72
benzo[a]pyrene	0.67	0.77	0.61	0.79	0.81	0.70	0.71	0.60	0.08	0.24	4.54
indeno[1,2,3-c,d]pyrene	0.85	0.84	0.70	0.75	0.75	0.58	0.66	0.61	0.10	0.30	5.79
dibenz[a,h]anthracene	0.70	0.71	0.53	0.62	0.45	0.53	0.44	0.40	0.12	0.36	6.90
benzo[g,h,i]perylene	0.95	0.87	0.86	0.99	0.73	0.84	0.85	0.76	0.09	0.26	4.99
<u>Surrogate Recoveries (%)</u>											
naphthalene-d8	66	74	69	74	68	74	70	71			
acenaphthene-d10	65	71	69	73	68	73	71	70			
chrysene-d12	58	65	61	65	61	64	62	58			

(a) MDL = STD * 2.998, Average Sample Dry Weight (g) = 19.281.