A SUPPLEMENTAL BIOACCUMULATION STUDY CONDUCTED ON SEDIMENTS COLLECTED FROM JAMAICA BAY, NEW YORK MAY 2003

Prepared for

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EXECUTIVE SUMMARY

Vittor & Associates collected sediment from Jamaica Bay, New York during May 2003, for bioaccumulation, chemistry, and physical analyses. The purpose of this testing was to supplement the results from the Norton Basin restoration study in 2002 using the U.S. EPA Region II Guidance Manual method detection limits and methods for the chemistry analyses.

The sediments collected from Jamaica Bay (Little Bay and Norton Basin borrow pits, and Grass Hassock Channel and The Raunt reference sites) were analyzed for PAHs, PCBs, dioxin/furan, chlorinated pesticides, SVOCs, TOCs, cadmium, grain size and specific gravity. PAHs, PCBs, furan (2,3,7,8-TCDF), and pesticides were detected in these sediments. PCBs, PAHs and pesticides (chlordane and the sum of DDD, DDE and DDT) measured in the sediments from Little Bay and Norton Basin borrow pits exceeded the Class A Sediment Quality Threshold values. Cadmium was detected in sediments from the Norton Basin borrow pit, the Little Bay borrow pit, the Grass Hassock Channel reference site, and the Raunt reference site. However, the cadmium concentrations measured in Little Bay and Norton Basin borrow pit sediments were not significantly higher than the Class A Sediment Quality Threshold value of 1.2 mg/kg.

In the 28-day bioaccumulation test, *Nereis virens* survivorship in Little Bay and Norton Basin borrow pit sediments was 91% and 89%, respectively. Survivorship in Grass Hassock Channel reference sediment was 97%, and survivorship in the Control sediment was 99%.

At the end of the 28-day bioaccumulation test with Norton Basin and Little Bay borrow pit sediments, and Grass Hassock Channel reference sediments, *Nereis* tissues were analyzed for the following organic constituents: PAHs, PCBs, chlorinated pesticides and dioxin/furan.

Naphthalene was the only PAH detected in the tissues of *Nereis* after the 28-day exposure. Total average naphthalene concentrations measured in *Nereis* exposed to Little Bay and Norton Basin borrow pit sediments were 27.6 and 34.2 ug/kg ww, respectively. Total PAHs detected in *Nereis* exposed to Grass Hassock Channel sediments was 25.8 ug/kg ww. The

concentrations of PAHs measured in *Nereis* tissues from Norton Basin and Little Bay exposures did not exceed the EPA Region 2 guidance levels of 4000 ug/kg ww (Ecological).

PCB concentrations in *Nereis* exposed to Little Bay and Norton Basin borrow pit sediments averaged 27.1 and 9.8 ug/kg ww, respectively (non-detects added). The PCB concentration measured in *Nereis* tissues exposed to Grass Hassock Channel sediment averaged 9.3 ug/kg ww. The concentrations of PCBs detected in the *Nereis* tissues from Norton Basin and Little Bay exposures did not exceed the EPA Region 2 guidance level of 114 ug/kg (ww) for total PCBs.

Dioxin (2,3,7,8-TCDD) was detected in *Nereis* exposed to Little Bay borrow pit sediments, but was not detected in *Nereis* exposed to Norton Basin borrow pit or Grass Hassock Channel sediments. The TCDD concentration measured in *Nereis* exposed to Little Bay borrow pit sediments, was 1.2 pg/g ww. Furan (2,3,7,8-TCDF) was detected in *Nereis* exposed to both Little Bay and Norton Basin borrow pit sediments, at concentrations of 1.6 and 1.5 pg/g ww 2,3,7,8-TCDF, respectively. The furan concentration measured in *Nereis* exposed to Grass Hassock Channel sediments was 1.6 pg/g ww. The TCDD measured in the *Nereis* tissues did not exceed the EPA Region 2 guidance level of 4.5 pg/g ww TCDD.

Heptachlor was the only pesticide detected in the tissues of *Nereis* after a 28-day exposure to the borrow pit sediments. Average heptachlor concentrations measured in *Nereis* tissues exposed to Little Bay and Norton Basin borrow pit sediments were <0.40 ug/kg ww (1.96 ug/kg dw) and 0.58 ug/kg ww (4.1 ug/kg dw), respectively. The average heptachlor concentration measured in *Nereis* exposed to Grass Hassock Channel was 0.56 ug/kg ww (3.9 ug/kg dw). The heptachlor concentrations measured in *Nereis* tissues from Norton Basin and Little Bay exposures did not exceed the Region 2 guidance level of 64 ug/kg ww for heptachlor.

1.0 INTRODUCTION

Barry A. Vittor & Associates, Inc. performed supplemental bioaccumulation testing, chemistry and physical analyses on sediments collected from Jamaica Bay in New York in May 2003. The supplemental evaluation of these sediments is part of an ongoing feasibility analysis of benthic habitat restoration through bathymetric recontouring of borrow pits in Norton Basin and Little Bay, tributary sub-basins of the Jamaica Bay Estuary. In the earlier 2002 sediment study, U.S. Army Corps of Engineers "Green Book" method detection limits (MDLs) were used to determine the presence and concentrations of chemical constituents of concern. The present re-analysis of project site sediments and bioaccumulation potential represents a more precise characterization of contaminant levels, based on U.S. EPA Region 2 MDLs.

This 2003 supplemental report presents additional evaluation of samples from Norton Basin borrow pit (NB), Little Bay borrow pit (LB), Grass Hassock Channel (GH), and The Raunt reference site (R). One sample from each of the following stations was analyzed: NB1, NB2, NB3, NB4, NB5, LB1, LB2, LB3, LB4, GH1, and R1. Several samples from each of these stations were analyzed in the 2002 study (except for LB4 which is an added station in 2003) and are described in the August 2002 report, " Bioassay Analyses Conducted on Sediments Collected from Jamaica Bay, Far Rockaway, New York, by Barry A. Vittor & Associates, Inc.". The 2002 report provides original data on more stations that can be assessed for an overall review of the condition of Norton Basin and Little Bay borrow pits, including tissue heavy metals data. Based on the more stringent chemistry evaluation of sediment samples in this 2003 study, additional bioaccumulation testing and tissue chemical analyses were conducted.

The sediment samples from Norton Basin (NB) and Little Bay (LB) borrow pits, and Grass Hassock Channel (GH) and the Raunt reference (R) sites were analyzed by Severn Trent Laboratories (STL) in Mobile, Alabama. The analyses included cadmium, PAHs, PCBs, chlorinated pesticides, dioxin/furan, TOCs, and SVOCs. Physical analyses were performed by Tierra Consulting in Mobile, Alabama. These analyses included grain size distribution, and bulk density. Control sediment for this study was collected by Vittor & Associates from the Mobile District Corps of Engineers-designated control site at Point Aux Pines, Alabama on May 4, 2003.

Bioaccumulation tests (28-day) were conducted May 8 through June 6, 2003 with the polychaete worm *Nereis virens*. After the polychaete worms had been exposed to the test sediments for 28 days, their tissues were analyzed for PAHs, PCBs, chlorinated pesticides, and dioxin/furan by STL in Mobile.

2.0 SEDIMENT COLLECTION PROCEDURES

2.1 COLLECTION SITES

The collection regime consisted of sampling sediments from 4 sites in the Jamaica Bay, New York area: Norton Basin (NB), Little Bay (LB), Grass Hassock Channel (GH), and The Raunt (R). Figure 1 presents the locations of all stations sampled. The borrow pit stations (> 40 ft. depth) are represented by stations LB1, NB2, and NB4. Intermediate depth stations (25-35 ft.) are represented by stations LB2, LB4, NB1, NB3 and NB5. A single shallow reference station (<20 ft. depth) is represented by LB3. A deep reference station is represented by GH1; and a shallow reference station is represented by R1.

2.2 COLLECTION METHODS

Collection of sediments followed the guidelines in "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations "(USEPA, 1995) (EPA 823-B-001) and the U.S. EPA Region II Guidance Manual, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal." Prior to collection of each test sediment, sampling gear and containers were decontaminated. Stainless steel spoons, stainless steel pans, coolers, and brushes were washed with Alconox®, rinsed with distilled water, rinsed with 10% nitric acid, rinsed with methanol and then rinsed with distilled water again. Stainless steel spoons, pans and brushes were wrapped with foil until they were used to collect sediments. Samples from each site were composited to comprise approximately 10 gallons of test material per site. Ten-gallon coolers were lined with sterile plastic bags to hold and store the sediment once it was collected.

A stainless steel Young-modified Van Veen grab was used to collect sediments. This grab was decontaminated prior to use at each site and a new set of pre-cleaned, foil-wrapped spoon and pan was used for each site. Several (4-6) grabs were taken at each station and emptied into a pan. The spoons were used to clear out the grab once its contents were emptied into the pan. The contents from each grab were then inspected for large objects such as rocks and shells. These objects were discarded from the grab samples before the samples were stored in the coolers. Sediment samples were immediately stored on ice until delivered to Vittor & Associate's laboratory in Mobile, Alabama. Chain of Custody sheets for all sediment samples are presented in Appendix A.

2.3 FIELD DATA

A Hypack® GPS/GIS data recorder was used to plot station locations for each site (Figure 1). The salinity and depth at each station were recorded using a YSI SCT meter and Raytheon® L365 depth finder.

3.0 BULK SEDIMENT CHEMISTRY

Bulk sediment chemistry analyses were performed according to the "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations" (USEPA, 1995) (EPA 823-B-001). STL, Mobile performed the following analyses on whole sediment collected from Norton Basin, Little Bay, Grass Hassock Channel reference and The Raunt reference: Cadmium (200.9); Percent Solids; low level PAH (8270C); Chlorinated Pesticides (8081A); Dioxin/Furan (8290); PCB congeners (Aroclors) (8082); Total Organic Carbon (9060); and SVOCs (8270). Complete sediment chemistry data are provided in Appendix B.

3.1 WHOLE SEDIMENT CHEMISTRY RESULTS

Sediment chemistry was performed on four sites within Little Bay, five sites within Norton Basin, one deep reference site in Grass Hassock Channel, and one shallow reference site

in the Raunt. Tables 1 through 6 present summaries of the constituent concentrations for each site. Detection limits were added as half of their value. Values marked with *J in the analytical report were added as whole values.

3.1.1 PAHs

PAHs were detected in the sediments collected from Jamaica Bay, May 2003 (Table 1). Of the Little Bay samples, LB2 (intermediate depth) contained the highest amount of PAHs at 14,556 ug/kg dw. LB3 (shallow station) contained the least amount of PAHs at 536.6 ug/kg dw. The intermediate depths (LB2 and LB4), averaged 9,225 ug/kg dw PAHs. LB1 (deep station) contained 5,306 ug/kg dw PAHs. Average total PAHs measured for all Little Bay samples was 6073.2 ug/kg dw. LB1 and LB2 (and the average for all samples) exceeded the PAH Class A Sediment Quality Threshold Value of 4,000 ug/kg dw.

Of the Norton Basin samples, NB1 (intermediate depth) contained the highest amount of PAHs at 1,439.7 ug/kg dw. The other two intermediate depth samples, NB3 and NB5, contained the lowest levels of PAHs at 546 and 545 ug/kg dw, respectively. The average PAHs measured in the intermediate depth samples was 844 ug/kg dw. Norton Basin deep stations NB2 and NB4, contained 816.8 ug/kg and 1,178.5 ug/kg PAHs, respectively and averaged 998 ug/kg dw. Average total PAHs measured for all Norton Basin sediment samples was 905.2 ug/kg dw. None of the Norton Basin samples exceeded the PAH Class A Sediment Quality Threshold Value of 4000 ug/kg dw.

Total PAHs measured in Grass Hassock Channel and The Raunt reference sediments was 1,319 ug/kg dw and 546 ug/kg dw, respectively. Out of all the samples analyzed, LB2, (intermediate depth) contained the highest amount of PAHs. PAH concentrations measured in LB1 (deep station), LB2 and LB4 (intermediate depth), NB1(intermediate depth), and NB4 (deep station) exceeded the PAHs measured in Grass Hassock Channel and the Raunt reference sediments.

3.1.2 PCBs

PCBs were detected in the sediments collected from Jamaica Bay, May 2003 (Table 2). Of the Little Bay samples, LB2 (intermediate depth) contained the highest amount of total PCBs at 689.1 ug/kg dw. LB4, the other Little Bay intermediate depth sample, contained the least amount of PCBs at 146.9 ug/kg dw. Average total PCB for the intermediate depth (LB2, LB4) was 463.1 ug/kg dw. Total PCB in the Little Bay deep station (LB1) was 385.3 ug/kg dw. Total PCB in the Little Bay shallow site sample (LB3) was 237 ug/kg dw. Average total PCB for all Little Bay samples was 364.6 ug/kg dw. Stations LB1, LB2, LB3, and LB4 exceeded the Class A Sediment Quality Threshold Value of 100 ug/kg dw.

Of the Norton Basin samples, NB3 (intermediate depth) contained the highest amount of PCB at 120.8 ug/kg dw. NB5 (intermediate depth) contained the least amount of PCB at 17.3 ug/kg dw. The average PCB concentration measured in the Norton Basin intermediate depth samples (NB1, NB3, NB5) was 73.5 ug/kg dw. The average PCB concentration measured in the Norton Basin borrow pit (NB2, NB4) was 105.6 ug/kg dw. Average total PCB for all Norton Basin samples was 86.2 ug/kg dw. NB2, and NB3 exceeded the Class A Sediment Quality Threshold Value of 100 ug/kg dw.

Total PCBs in Grass Hassock Channel and the Raunt reference sediments were 66 ug/kg dw and 16.7 ug/kg dw, respectively. Out of all the samples analyzed, LB2 (intermediate depth, contained the highest amount of PCBs. PCB concentrations measured in all of the Little Bay and Norton Basin samples, except for NB5, exceeded the PCB concentration measured in Grass Hassock Channel deep reference. PCB concentrations measured in all of the Little Bay and Norton Basin samples exceeded the PCB concentration measured in the Raunt shallow reference.

3.1.3 Chlorinated Pesticides

Chlorinated pesticides were detected in the sediments collected from Jamaica Bay in May 2003 (Table 3). Of the Little Bay samples, LB1 (deep station) contained the highest amount of

DDD, DDE, DDT at 83 ug/kg dw. The Little Bay intermediate depth samples contained an average of 59 ug/kg dw DDD, DDE, DDT. LB3 (shallow station) contained 32 ug/kg dw DDD, DDE, DDT. The Norton Basin deep station samples contained an average of 16.1 ug/kg DDD, DDE, DDT, and the intermediate depth samples averaged 10.2 ug/kg dw DDD, DDE, DDT. The average, DDD, DDE, DDT measured in all of the Little Bay sediments was 58.2 ug/kg dw, and was 4.6 times that measured in the Norton Basin samples (12.56 ug/kg dw). The sums of DDD, DDE, and DDT in Grass Hassock Channel and The Raunt sediments were 5.8 ug/kg dw and 20.9 ug/kg dw, respectively. All of the Little Bay and Norton Basin samples, except for NB1, exceeded the sum of DDD, DDE, DDT Class A Sediment Quality Threshold value of 3.0 ug/kg dw.

Dieldrin was detected in the sediments from Jamaica Bay (Table 3). Of the Little Bay samples, LB2 (intermediate depth), was the only sample where dieldrin was detected at 1.5 ug/kg dw. Dieldrin was detected in Norton Basin samples, NB2 (deep station) and NB3 (intermediate depth) at 1.2 and 1.1 ug/kg dw, respectively. Dieldrin was not detected in Grass Hassock Channel reference sediments (<1.0 ug/kg dw); however, dieldrin was detected in The Raunt (shallow depth) sediments at 1.1 ug/kg dw. None of the sediment samples exceeded the dieldrin Class A Sediment Quality Threshold value of 110 ug/kg dw.

Chlordane was detected in LB4 (intermediate depth) and was the only sample where it was detected at 9.6 ug/kg dw. Chlordane was not detected in any of the Norton Basin samples. LB4 exceeded the Class A Sediment Quality Threshold value of 0.6 ug/kg dw. Chlordane was not detected in either Grass Hassock Channel or the Raunt sediments (<1.0 ug/kg).

Aldrin was detected in LB2 (intermediate depth) at 4.6 ug/kg dw. Aldrin was not detected in any other Little Bay samples, nor was it detected in any of the Norton Basin or reference samples.

Endosulfan I was detected in LB4 (intermediate depth) at 3.0 ug/kg dw. Endosulfan I was not detected in any of the other Little Bay samples, nor was it detected in any of the Norton Basin or reference samples.

Endosulfan II was detected in LB2 (intermediate depth) at 11.0 ug/kg dw. Endosulfan II was not detected in any other Little Bay samples, nor was it detected in any of the Norton Basin or reference samples.

Endosulfan sulfate was detected in NB2 (deep station) at 1.4 ug/kg dw. Endosulfan sulfate was not detected in any other Norton Basin samples, nor was it detected in any of the Little Bay samples or reference samples.

Heptachlor was detected in LB2 (intermediate depth) at 1.1 ug/kg dw. Heptachlor was not detected in any other Little Bay samples, nor was it detected in any of the Norton Basin or reference samples.

Heptachlor epoxide was detected in LB2 (intermediate depth) at 1.6 ug/kg dw. Heptachlor epoxide was not detected in any other Little Bay sample, nor was it detected in any of the Norton Basin or reference samples.

Trans-nonachlor was detected in LB2 (intermediate depth) and in NB3 (intermediate depth) at 8.3 and 1.5 ug/kg dw, respectively. Trans-nonachlor was not detected in any other Little Bay or Norton Basin samples. Trans nonachlor was not detected in Grass Hassock Channel reference, but was detected in the Raunt reference at 1.5 ug/kg dw.

3.1.4 Dioxin/Furan

Dioxin (2,3,7,8-TCDD) was not detected in either Little Bay or Norton basin sediments (Table 4). However, Furan (2,3,7,8-TCDF) was detected in Little Bay deep station (LB1) and Norton Basin intermediate depth (NB4) sediments, at 32 pg/g dw and 21 pg/g dw, respectively. There are no Sediment Quality Threshold values established for 2,3,7,8-TCDF.

3.1.5 Cadmium

Cadmium was detected in the sediments collected from Jamaica Bay (Table 5.) Of the Little Bay samples, LB2 (intermediate depth) contained the highest amount of cadmium at 3.2 mg/kg dw. LB3 (shallow station) contained the least amount of cadmium at 0.22 mg/kg dw. LB1 (deep station) contained 0.24 mg/kg dw cadmium. The average cadmium concentration at the intermediate depth was 2.35 mg/kg. The average cadmium concentration for all of the Little Bay samples was 1.29 mg.kg. On average, the intermediate depths contained the most cadmium.

Of the Norton Basin samples, NB3 (intermediate depth) contained the highest amount of cadmium at 2.0 mg/kg dw. NB5 (intermediate depth) contained the least amount of cadmium at 0.65 mg/kg dw. The average cadmium concentration for the deep stations (NB2, NB4) was 1.55 mg/kg dw. The average cadmium concentration for the intermediate depths (NB1, NB3, NB5) was 1.38 mg/kg dw. The average concentration of cadmium for all Norton Basin samples was 1.45 mg/kg dw. On average, deep stations contained the most cadmium.

Cadmium concentrations in LB2, LB4, NB1, NB2, NB3, and NB4 were only slightly higher than that found in the Grass Hassock Channel sediments (1.2 mg/kg dw). The cadmium concentration at LB3 shallow depth (0.22 mg/kg dw) was less than the cadmium found at The Raunt shallow reference station (0.31 mg/kg). LB2, LB4, NB1, NB2, NB3, and NB4 exceeded the cadmium Class A Sediment Quality Threshold value of 1.2 mg/kg dw.

3.1.6 SVOCs

SVOC (1,4 Dichlorobenzene) was not detected at levels above the reporting limits in any of the sediments collected from Jamaica Bay. However, *J values were given for some of the reported values (Table 6).

3.1.7 TOCs

TOCs are summarized in Table 7. Of the Little Bay samples, LB1 (deep station) contained the highest amount of TOC at 58000 mg/kg dw. LB3 (shallow depth) contained the least amount of TOC at 5400 mg/kg dw. The average TOC for the intermediate depths (LB2, LB4) was 46000 mg/kg dw. The average TOC for all of the Little Bay samples was 38850 mg/kg dw.

Of the Norton Basin samples, NB4 (deep station) contained the highest amount of TOC at 53000 mg/kg dw. NB5 (intermediate depth) contained the least amount of TOC at 15000 mg/kg dw. The average TOC for the deep stations (NB2, NB4) was 52500 mg/kg dw. The average TOC for the intermediate depths was 31667 mg/kg dw. The average TOC for all of the Norton Basin samples was 40000 mg/kg dw.

Grass Hassock Channel and The Raunt reference sites contained 46000 mg/kg dw and 6400 mg/kg dw TOC, respectively. The deep stations in Little Bay and Norton Basin contained similar TOC levels as the Grass Hassock deep reference station. The Little Bay shallow station (LB3) contained similar levels of TOC as The Raunt shallow reference station. Generally, TOC levels increased with depth.

4.0 PHYSICAL ANALYSES

Description, grain size distribution, weight and specific gravity for the sediments collected from Jamaica Bay are summarized in Table 7. Complete sediment physical data are presented in Appendix C.

5.0 BIOACCUMULATION TESTING

Bioaccumulation tests were performed to determine if organisms would bioaccumulate significant amounts of PAHs, PCBs, dioxin/furan and chlorinated pesticides when exposed to Norton Basin (NB2) and Little Bay (LB1) sediments during a 28-day period. Test organisms

were also exposed to Control and Grass Hassock Channel reference sediments. The levels of organic constituents found in the test sediment-exposed organism tissues were compared to those levels found in Grass Hassock Channel reference sediment-exposed test organisms. Additionally, EPA Region 2 guidance levels were used to evaluate the concentrations of organic compounds found in the test organism tissues. The polychaete *Nereis virens* was used for this test and was obtained from Aquatic Research Organisms in Hampton, New Hampshire. Bioaccumulation testing with *Nereis* began May 8, 2003, and was terminated June 6, 2003.

5.1 Bioaccumulation Test Methods

The test chambers consisted of 10-gallon glass aquaria with 5 replicates per test sediment and three replicates for the Control. An average of 5 cm of sediment was placed in each aquarium, which was then filled to volume with filtered seawater at a salinity of 29 ± 1 ‰. Water quality was recorded before test organisms were introduced to the test chambers (30 *Nereis* per chamber).

Test temperature (20±1 ˚C) was maintained by means of ambient temperature control, and averaged 19.13 ˚C for *Nereis* test chambers. Aeration was supplied to all test chambers for the duration of the test by two 1-inch air stones at a rate of approximately 50 cm^3/min.

Water quality parameters measured daily during the 28-day bioaccumulation tests were dissolved oxygen, pH, temperature, and salinity. Dissolved oxygen was measured with a YSI Model 55 DO meter, pH and temperature were measured with an Oakton meter with pH/temperature probe, and salinity was measured with an Aquafauna® temperature-compensated refractometer. All instruments were calibrated daily.

At test termination, 28 days after initiation, *Nereis* were removed from their test chambers and counted. On June 6, 2003 the test organisms from each sediment replicate were placed in trays of clean sand and filtered seawater and allowed to depurate (void their gut of digested material) for approximately 24 hrs. On June 7, 2003 the test animals were rinsed with deionized water to remove any external debris from their bodies. Animals from each replicate

were composited into a single sample (for a total of 18 samples) and placed in pre-cleaned, pre-labeled glass jars and stored frozen until analyzed.

5.2 Bioaccumulation Survivorship

Nereis survivorship in all test sediments was not significantly lower than survivorship in the Control and Grass Hassock Channel reference sediments (Tables 8 and 9). Survivorship for *Nereis* was 89% and 91% in Norton Bay and Little Bay sediments, respectively. Control and Grass Hassock Reference sediments exhibited 99% and 97% survivorship, respectively. Complete laboratory and statistical data for *Nereis* are presented in Appendix D.

5.3 Tissue Chemistry Results

Frozen *Nereis* tissues from 28-day exposure to Norton Basin, Little Bay, and Grass Hassock Channel reference sediments, and pre-exposed tissues (Day-0) were transported on ice to STL Mobile, Alabama for the following analyses: PAHs (8270C), PCBs (8082), and Chlorinated Pesticides (8081A), dioxin/furan (8290), moisture (EPA 1986a, 1987); and lipids content (Lee et al, 1989). Summary tables 1-13 include added and averaged detection limits as half of their value. *J values were added as whole values. Complete tissue chemistry data are presented in Appendix E.

5.3.1 PAHs

A summary of PAHs detected in the *Nereis virens* tissues is presented in Table 10. Napthalene was the only PAH detected in the tissues of *Nereis* after a 28-day exposure to the sediments collected from Jamaica Bay. Average total napthalene levels measured in *Nereis* exposed to Little Bay and Norton Basin borrow pit sediments were 27.6 ug/kg ww and 34.2 ug/kg ww, respectively. Napthalene concentration measured in *Nereis* tissues exposed to Grass Hassock Channel reference sediments was 25.8 ug/kg ww. The napthalene concentration measured in *Nereis* exposed to Little Bay and Norton Basin borrow pit sediments did not exceed

the EPA Region 2 guidance level of 4000 ug/kg ww (Ecological) and 2000 ug/kg ww (Human Health). There are no FDA action levels established for this compound.

5.3.2 PCBs

A summary of mean total PCB congeners measured in the tissues of *Nereis* is presented in Table 11. After a 28-day exposure to Little Bay and Norton Basin sediments, *Nereis* tissues contained an average of 27.1 and 9.8 ug/kg ww PCBs, respectively. Average total PCB measured in *Nereis* exposed to Grass Hassock Channel sediments was 9.3 ug/kg ww. The concentrations of PCBs measured in *Nereis* tissues from Norton Basin and Little Bay exposures did not exceed the Region 2 EPA guidance level of 114 ppb (ug/kg) ww for total PCBs.

5.3.3 Dioxin/Furan

A summary of dioxin/furan content in *Nereis* tissues is presented in Table 12. After a 28-day exposure to Little Bay and Norton Basin borrow pit sediments, *Nereis* tissues contained 1.2 and <0.52 pg/g ww 2,3,7,8-TCDD, respectively. Furan (2,3,7,8-TCDF) was detected in *Nereis* exposed to both Little Bay and Norton Basin sediments. These tissues contained 1.6 and 1.5 pg/g ww 2,3,7,8-TCDF, respectively. The Furan concentration measured in *Nereis* exposed to Grass Hassock Channel sediment was 1.6 pg/g ww. The TCDD measured in the *Nereis* tissues did not exceed the EPA Region 2 guidance level of 4.5 parts per trillion (pg/g ww) for TCDD.

5.3.4 Chlorinated Pesticides

Heptachlor was the only pesticide detected in the tissues of *Nereis* after a 28-day exposure to the borrow pit sediments. Average heptachlor concentrations measured in *Nereis* tissues exposed to Little Bay and Norton Basin borrow pit sediments were <0.40 ug/kg ww (1.96 ug/kg dw) and 0.58 ug/kg ww (4.1 ug/kg dw), respectively. Average heptachlor concentrations measured in *Nereis* exposed to Grass Hassock Channel was 0.56 ug/kg ww (3.9 ug/kg dw). The heptachlor concentrations measured in *Nereis* tissues from Norton Basin and Little Bay exposures did not exceed the Region 2 guidance level of 64 ug/kg ww for heptachlor.

5.4 Tissue Chemistry Quality Assurance /Quality Control

Replicate analyses were performed for every 10 samples analyzed. Matrix spikes and matrix duplicates (MS/MSD) were performed for every 20 samples analyzed. In addition, procedural blanks were run for the different analyses, and triplicate analyses were performed on 10% of all samples tested. QA/QC data can be found in Appendix E.

6.0 SUMMARY

The results of the supplemental bioaccumulation study of sediment collected from borrow pits in Norton Basin and Little Bay can be summarized as follows:

1. The results from the 28-day bioaccumulation test revealed that none of the project sediments were acutely toxic to *Nereis*. *Nereis* survivorship was 97% in Grass Hassock Channel reference, 91% in Little Bay borrow pit, and 89% in Norton Basin borrow pit sediments.

2. PCBs, napthalene, dioxin/furan, and heptachlor were detected in the *Nereis* tissues after a 28- day exposure to the Little Bay and Norton Basin borrow pit sediments.

3. Levels of PCBs, napthalene, dioxin, and heptachlor detected in *Nereis* tissues did not exceed the EPA Region 2 guidance levels.

4. The average napthalene concentration measured in *Nereis* exposed to Norton Basin borrow pit sediments was 1.3 times higher than in *Nereis* exposed to Grass Hassock Channel reference sediments. Average napthalene concentrations measured in *Nereis* exposed to Little Bay borrow pit sediments were not significantly greater than *Nereis* exposed to Grass Hassock Channel reference sediments.

5. The average total PCB concentration measured in *Nereis* exposed to Norton Basin borrow pit sediments was approximately the same as that found in the *Nereis* exposed to the Grass Hassock Channel reference sediments. However, the average PCB concentration measured in *Nereis* exposed to Little Bay borrow pit sediments was 2.9 times higher than in *Nereis* exposed to Grass Hassock Channel reference sediments.

6. The average heptachlor concentration measured in *Nereis* exposed to Little Bay borrow pit sediments was less than in *Nereis* exposed to Grass Hassock Channel reference sediments. The average heptachlor concentration measured in *Nereis* exposed to Norton

Basin borrow pit sediments was only slightly higher than in *Nereis* exposed to Grass Hassock Channel reference sediments.

7. *Nereis* exposed to Little Bay borrow pit, Norton Basin borrow pit and Grass Hassock Channel sediments contained similar amounts of furan. Dioxin was detected in *Nereis* exposed to Little Bay borrow pit sediments, but not in *Nereis* exposed to Norton Basin borrow pit or Grass Hassock Channel sediments.

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TABLES

Table 1. Low Level PAHs (ug/kg dw) in sediments collected from Jamaica Bay, N.Y. in May 2003.
(Non-detects added as half of the detection limit.)

PAH (8270c)	LB1	LB2	LB3	LB4	LB Ave*	NB1	NB2	NB3	NB4	NB5	NB Ave*	GH	R
Acenapthene	<47	<10*	<5.7	<10*	11.6	<10*	<14*	<9.1*	<18*	<8.0*	11.82	<10*	<9.1*
Acenapthylene	110	150	13	56	82.3	20	<8*	<5.2*	<10	<4.6*	9.56	<5.7*	<5.2*
Anthracene	100	230	12	48	97.5	28	<18*	<11*	<22*	<10*	17.8	32	<11*
Benzo (a) anthracene	520	1300	48	320	547	120	68	52	110	50	80	120	52
Benzo (b) fluoranthene	580	1200	48	420	562	140	74	54	120	50	93.6	120	54
Benzo (k) flouranthene	400	970	28	300	424.5	100	54	40	86	36	63.2	96	40
Benzo (g,h,I) perylene	360	740	32	280	353	98	56	32	70	32	57.6	72	32
Benzo (a) pyrene	520	1000	44	400	491	130	76	52	100	52	86	120	52
Chrysene	700	1500	54	360	653.5	140	84	60	120	60	92.8	160	60
Dibenzo (a,h,) anthracene	110	260	11	96	119.3	38	<6.8*	<4.4*	<8.5*	<3.9*	12.32	19	<4.4*
Flouranthene	100	2400	80	560	785	240	130	78	200	86	146.8	220	78
Flourene	52	66	<5.7	24	36.2	8	<12*	<7.5*	<14*	<6.7*	9.64	<8.3*	<7.5*
Indeno (1,2,3-cd) pyrene	360	740	36	300	359	100	48	28	64	34	54.8	68	28
Naphthalene	50	<10*	<5.7	20	20.7	9.7	<14*	<8.8*	<17*	<7.8*	11.46	<9.7*	<8.8*
Phenanthrene	400	780	44	160	308.5	58	44	24	54	26	41.2	68	24
Pyrene	920	3200	78	540	1184.5	200	110	80	170	78	127.6	190	80
Total PAH	**5306**	**14556**	**536.6**	**3894**	**6073.2**	**1439.7**	**816.8**	**546**	**1178.5**	**545**	**905.2**	**1318.7**	**546**

LB= Little Bay NB= Norton Basin GH= Grass Hassock R= The Raunt

GH and R values are based on one sample.

*J values are reported and added as whole values.

Class A Sediment Quality Threshold Values for Total PAH = 4000 ug/kg

Table 2. Summary of total PCB congeners (ug/kg dw) in sediments collected from Jamaica Bay, N.Y. May 2003.
(Non-detects added as half of the detection limit.)

SW 8082	**LB1**	**LB2**	**LB3**	**LB4**	**LB Ave**	**NB1**	**NB2***	**NB3**	**NB4**	**NB5**	**NB Ave**	**GH**	**R**
Total PCBs	385.3	689.1	237.1	146.9	364.6	82.35	113.93	120.8	97.3	17.25	86.2	66	16.7

LB= Little Bay NB= Norton Basin GH= Grass Hassock R= The Raunt

*NB2 value was taken from an average of NB2 and a duplicate.

Class A Sediment Quality Threshold Value for total PCBs = **100 ug/kg dw**

Table 3.Summary of chlorinated pesticides (ug/kg dw) in sediments collected from Jamaica Bay, N.Y. May 2003. (*Non-detects added as half of the detection limit.)

Chlorinated Pesticide (8081A)	LB1	LB2	LB3	LB4	LB Ave	NB1	NB2	NB3	NB4	NB5	NB Ave	GH	R
Aldrin	<1	4.6	<1	<1	1.5	<1	<1	<1	<1	<1	<1	<1	<1
Alpha Chlordane	<1	<1	<1	9.6	2.8	<1	<1	<1	<1	<1	<1	<1	<1
4,4'-DDD	<1	4.2	4.5	18	6.8	<1	5	<1	<1	<1	1.4	<1	<1
4,4'-DDE	<1	19	2.4	26	11.98	<1	4.8	8.1	5.2	<1	3.8	<1	8.1
4,4'-DDT	<1	2.1	<1	<1	0.9	<1	<1	<1	<1	<1	<1	<1	<1
O,P-DDD	67	24	22	10	30.8	<1	6.2	8.1	3.9	1.5	4.04	<1	8.1
O,P-DDE	14	9.9	2.1	3.2	7.3	<1	2	3.2	<1	3.2	1.8	3.3	3.2
O,P-DDT	<1	<1	<1	<1	<1	<1	<1	1	2.6	<1	0.92	<1	<1
Mean* Total DDD,DDE,DDT	**83**	**59.7**	**32**	**58.1**	**58.2**	**3**	**19**	**20.9**	**13.2**	**6.7**	**12.56**	**5.8**	**20.9**
Dieldrin	<1	1.5	<1	<1	0.75	<1	1.2	1.1	<1	<1	0.76	<1	1.1
Endosulfan I	<1	<1	<1	3	1.13	<1	<1	<1	<1	<1	<1	<1	<1
Endosulfan II	<1	11	<1	<1	3.13	<1	<1	<1	<1	<1	<1	<1	<1
Endosulfan Sulfate	<1	<1	<1	<1	<1	<1	1.4	<1	<1	<1	0.68	<1	<1
Heptachlor	<1	1.1	<1	<1	0.65	<1	<1	<1	<1	<1	<1	<1	<1
Heptachlor Epoxide	<1	1.6	<1	<1	0.78	<1	<1	<1	<1	<1	<1	<1	<1
Trans-Nonachlor	<1	8.3	<1	<1	2.45	<1	<1	1.5	<1	<1	0.7	<1	1.5

Class A Sediment Quality Threshold Value for Total DDD, DDE, and DDT = **3 ug/kg dw**
Class A Sediment Threshold Value for Chlordane = **0.6 ug/kg dw**
Class A Sediment Threshold Value for Dieldrin = **110.0 ug/kg dw**

Table 4. Summary dioxin/furan(pg/g dw) as measured in sediments collected from Jamaica Bay, N.Y. May 2003.

8290	LB1	NB4
2,3,7,8-TCDD	<13	<8.2
2,3,7,8-TCDF	32	21

Class A Sediment Quality Threshold Value for 2,3,7,8-TCDD = **4.5** parts per trillion

Table 5. Summary of cadmium (mg/kg dw) in sediments collected from Jamaica Bay, N.Y. May 2003.

	LB1	LB2	LB3	LB4	LB Ave	NB1	NB2	NB3	NB4	NB5	NB Ave	GH	TR
Cadmium (200.9)	0.24	3.2	0.22	1.5	1.29	1.5	1.5	2	1.6	0.65	1.45	1.2	0.31

LB= Little Bay NB= Norton Basin GH= Grass Hassock R= The Raunt

Class A Sediment Quality Threshold Value for cadmium = **<1.2 mg/kg**

Table 6. Summary of SVOC (1,4 Dichlorobenzene ug/kg dw) measured in sediments collected from Jamaica Bay, N.Y. May 2003.

	LB1	LB2	LB3	LB4	LB Ave.	
1,4, Dichlorobenzene	<47	<12*J	<5.7	<12*J	<12.6	
	NB1	NB2	NB3	NB4	NB5	NB Ave
1,4 Dichlorobenzene	<12*J	<16*J	<10*J	<20*J	<10*J	<13.6*J
	GH	TR				
1,4, Dichlorobenzene	<12*J	<10*J				

*J values were added and averaged as whole values.

Table 7. Physical data for the sediments collected from Jamaica Bay, May 2003.

	NB1	NB2	NB3	NB4	NB5	NB Ave.	
Wt	26.67	25.41	25.74	25.6	32.45	27.17	
Spec. Grav.	2.65	2.65	2.65	2.65			
Description	SiltyCly	SiltyCly	SiltyCly	SiltyCly	Sand		
%Gravel	0	0	0	0	1.08		
%Sand	19.76	11.89	20.4	26.25	94.51		
%Silt	37.58	50.26	38.85	28.73	*4.41		
%Clay	42.66	37.86	40.75	45.02	*		
TOC mg/kg	46000	52000	34000	53000	15000	40000	
	LB1	LB2	LB3	LB4	LB Ave.	GH	TR
Wt.	26.05	27.6	32.38	31.62	29.41	26.24	25.17
Spec. Grav.	26.5	2.65		2.65		2.65	
Description	SiltyCly	SandyCly	Sand	SiltyCly		SiltyCly	Sand
%Gravel	0	0	0	0		0	0
%Sand	8.71	34.31	88.85	17.68		16.31	95.03
%Silt	51.97	29.02	*11.15	48.33		45.18	3.26
%Clay	39.32	36.67	*	33.99		38.51	*1.71
TOC mg/kg dw	58000	46000	5400	46000	38850	46000	6400

*Silt and Clay was not differentiated

Table 8. *Nereis virens* survival data for the 28-day bioaccumualtion test with sediments collected from Jamaica Bay, N.Y. in May 2003. The bioaccumulation test was conducted from May 8, 2003 to June 6, 2003.

Sample ID	No. of Replicates	Initial Load Per Rep.	Ave. No. Survived Per Rep.	Percent Survivorship
Control (Cont050503)	3	30	29.7	99
Grass Hassock (GH050203-A GH050203-B)	5	30	29	97
Norton Basin (NB050203-A NB050203-B)	5	30	26.6	89
Little Bay (LB050203-A LB050203-B)	5	30	27.2	91

Table 9. Summary of ANOVA and Bonferroni t-Test for differences in *Nereis virens* survivorship in the 28-day Norton Basin bioaccumulation study conducted May 8, 2003 to June 6, 2003.

ANOVA for Differences between Means

Source of Variation	df	Sum of Squares	Mean Squares	F
Between Means	3	26.278	8.759	2.520
Within	14	48.667	3.476	
Total	17	74.944		

Critical F Value = 3.34 (0.05, 3, 14)
Since F < Critical F ; Fail to reject Ho : All Equal

Bonferroni t-Test for Differences between Sediments

[a]Reference vs. Test Sediment

Test Condition	t	Conclusion	Mean Survivorship
Grass Hassock	--------	--------	29.000
Control	-0.490	Not >	29.667
Norton Basin	2.035	Not >	26.600
Little Bay	1.526	Not >	27.200

[a]Bonferroni t table value = 2.36 (1 Tailed value, P = 0.05, df = 14, 3)

Table 10. Average PAHs (ug/kg ww) in *Nereis virens* tissues from a 28-day bioaccumulation study conducted May 8 through June 5, 2003 on sediments collected from Jamaica Bay, N.Y. in May 2003.

PAH (8270c)	LB	NB	GH	Day-0
Acenapthene	<4.0	<4.0	<4.0	<4.0
Acenapthylene	<4.0	<4.0	<4.0	<4.0
Anthracene	<4.0	<4.0	<4.0	<4.0
Benzo (a) anthracene	<4.0	<4.0	<4.0	<4.0
Benzo (b) fluoranthene	<4.0	<4.0	<4.0	<4.0
Benzo (k) flouranthene	<4.0	<4.0	<4.0	<4.0
Benzo (g,h,I) perylene	<4.0	<4.0	<4.0	<4.0
Benzo (a) pyrene	<4.0	<4.0	<4.0	<4.0
Chrysene	<4.0	<4.0	<4.0	<4.0
Dibenzo (a,h,) anthracene	<4.0	<4.0	<4.0	<4.0
Flouranthene	<4.0	<4.0	<4.0	<4.0
Flourene	<4.0	<4.0	<4.0	<4.0
Indeno (1,2,3-cd) pyrene	<4.0	<4.0	<4.0	<4.0
Napthalene	**27.6**	**34.2**	**25.8**	**15**
Phenanthrene	<4.0	<4.0	<4.0	<4.0
Pyrene	<4.0	<4.0	<4.0	<4.0
Total Ave. PAHs (Zero added for non-detects)	27.6	34.2	25.4	15
Total Ave PAHs (Detection Limit added)	57.6	64.2	55.8	45
% Average Moisture	86.8	85.4	85.6	84

EPA Region 2 Guidance Level = 4000 ppm ww (Ecological) ; 2000 ppm ww (Human Health)

Table 11. Summary of mean total PCB congeners (ug/kg ww) in *Nereis virens* tissues exposed to sediments collected from Jamaica Bay, N.Y. May 2003. (Non-detects added)

SW8082	**LB**	**NB**	**GH**	**Day-0**
Mean Total PCBs	27.1	9.8	9.3	10.4

EPA Region 2 Gudance Level for Sum of PCBs = 114 ppb ww

Table 12. Summary of Dioxin/Furan (pg/g ww) in *Nereis virens* tissues exposed to sediments collected from Jamica Bay, May 2003.

SW846 8290	**LB**	**NB**	**GH**	**Day-0**
2,3,7,8-TCDD	1.2	<0.52	<0.50	<0.50
2,3,7,8-TCDF	1.6	1.5	1.6	0.74

EPA Region 2 Guidance Level for Sum of 2,3,7,8-TCDD = **4.5** parts per trillion ww

LB= Little Bay NB= Norton Basin GH= Grass Hassock

Day-0 = Pre-exposed *Nereis virens*

Table 13. Summary of average chlorinated pesticides (ug/kg ww) in *Nereis virens* tissues from a 28-day bioaccumulation test with sediments collected from Jamaica Bay, N.Y. May 2003

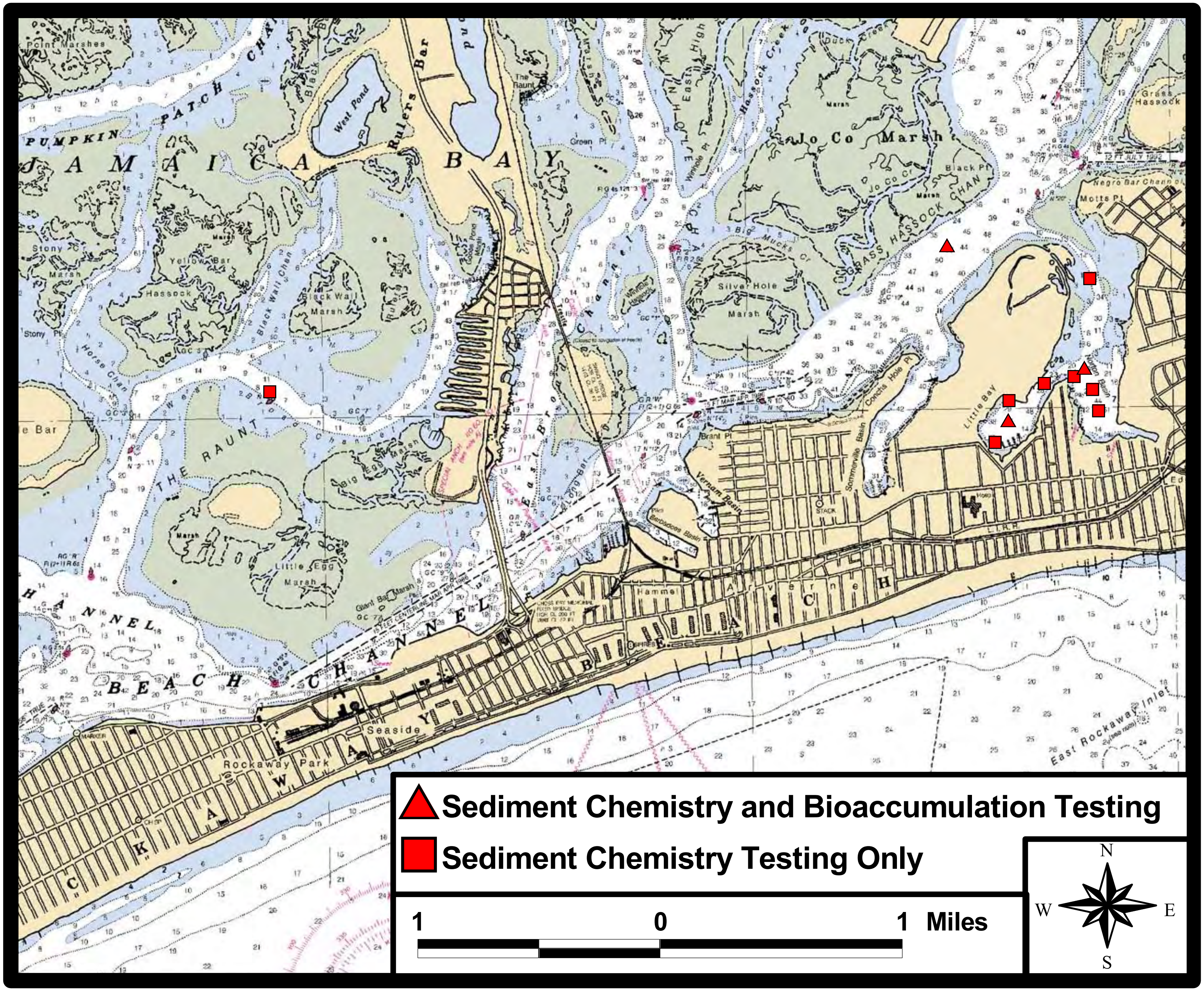
Chlorinated Pesticides (8081A)	**LB**	**NB**	**GH**	**Day-0**
Aldrin	<0.40	<0.40	<0.40	<0.40
Alpha Chlordane	<0.40	<0.40	<0.40	<0.40
4,4'-DDD	<0.40	<0.40	<0.40	<0.40
4,4'-DDE	<0.40	<0.40	<0.40	<0.40
4,4'-DDT	<0.40	<0.40	<0.40	<0.40
O,P-DDD	<0.40	<0.40	<0.40	<0.40
O,P-DDE	<0.40	<0.40	<0.40	<0.40
O,P-DDT	<0.40	<0.40	<0.40	<0.40
Dieldrin	<0.40	<0.40	<0.40	<0.40
Endosulfan I	<0.40	<0.40	<0.40	<0.40
Endosulfan II	<0.40	<0.40	<0.40	<0.40
Endosulfan Sulfate	<0.40	<0.40	<0.40	<0.40
Heptachlor*****	<0.40	0.58	0.56	<0.40
Heptachlor Epoxide	<0.40	<0.40	<0.40	<0.40
Trans-Nonachlor	<0.40	<0.40	<0.40	<0.40

EPA Region 2 EPA Guidance Level for DDD + DDE= DDT = 40.0 ppm ww
EPA Region 2 Guidance Level for Chlordane = 64 ppm ww
EPA Region 2 Guidance Level for Aldrin = 33.0 ppm ww
EPA Region 2 Guidance Level for Dieldrin = 4.4 ppm ww

* Non- detection Limits were averaged

LB= Little Bay NB= Norton Basin GH= Grass Hassock Channel

FIGURES


Sediment Chemistry and Bioaccumulation Testing
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THE RAUNT
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East Rockaway Inlet