APPENDIX F

CLINTON HARBOR FNP SEDIMENT CHARACTERIZATION AND CORRESPONDENCE

From: Nimeskern, Phillip W NAE
Sent: Wednesday, April 25, 2007 11:55 AM
To: Montoya, Duban NAE
Cc: Cappola, Valerie A NAE
Subject: Clinton Harbor FNP, CT

Hello Dubán,

CENAE is now proposing to hydraulically dredge the sandy material from the 8' main channel in the Clinton Harbor FNP and use this material to nourish the nearby Hammonasset Beach. This project sediment has been previously sampled, tested and found to be suitable for unconfined disposal at Cornfield Shoals Disposal Site (CSDS) in 2003.

Approximately 45,000 cy of sand will be hydraulically dredged and placed directly on the beach. Runback from the dredged material will flow across the beach back into Long Island Sound. The anchorage area will be dredged at a later date and its 2,000 cy of silty material will be disposed of at CSDS.

The sediments in the main channel were characterized by samples G, H, K, L and M. These samples were composited into two composite samples for biological analyses. Both samples are predominately sand (16.0% and 12.1% fines). Based upon the results of the biological analyses, which included Suspended Particulates Bioassays, these sediments were found suitable for unconfined open water disposal at CSDS ("Second Evaluation of Adequacy of Sampling for Clinton Harbor Federal Navigation Project, Clinton, CT, Application #200100849", 22 January 2005).

Based upon my review of the above information, I have no concerns and find the material suitable for beach disposal as proposed.

Phill Nimeskern
US Army, Corps of Engineers
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DRAFT FINAL DATA REPORT

For
VIBRATORY CORE SAMPLING
CLINTON HARBOR, CT

Submitted to

Department of the Army
U.S. Army Corps of Engineers
North Atlantic Division
New England District

Contract No. DACW33-96-D-0005
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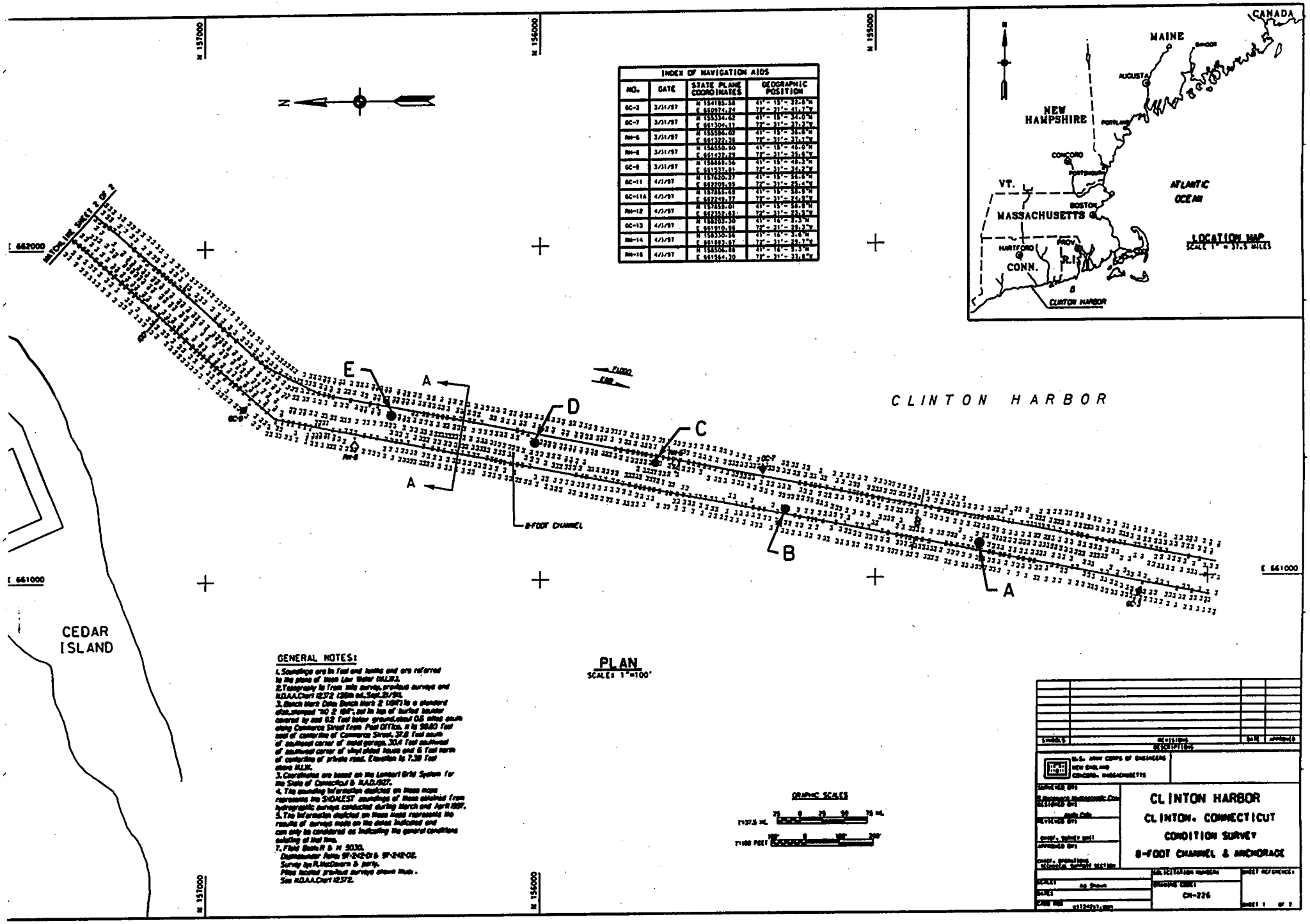
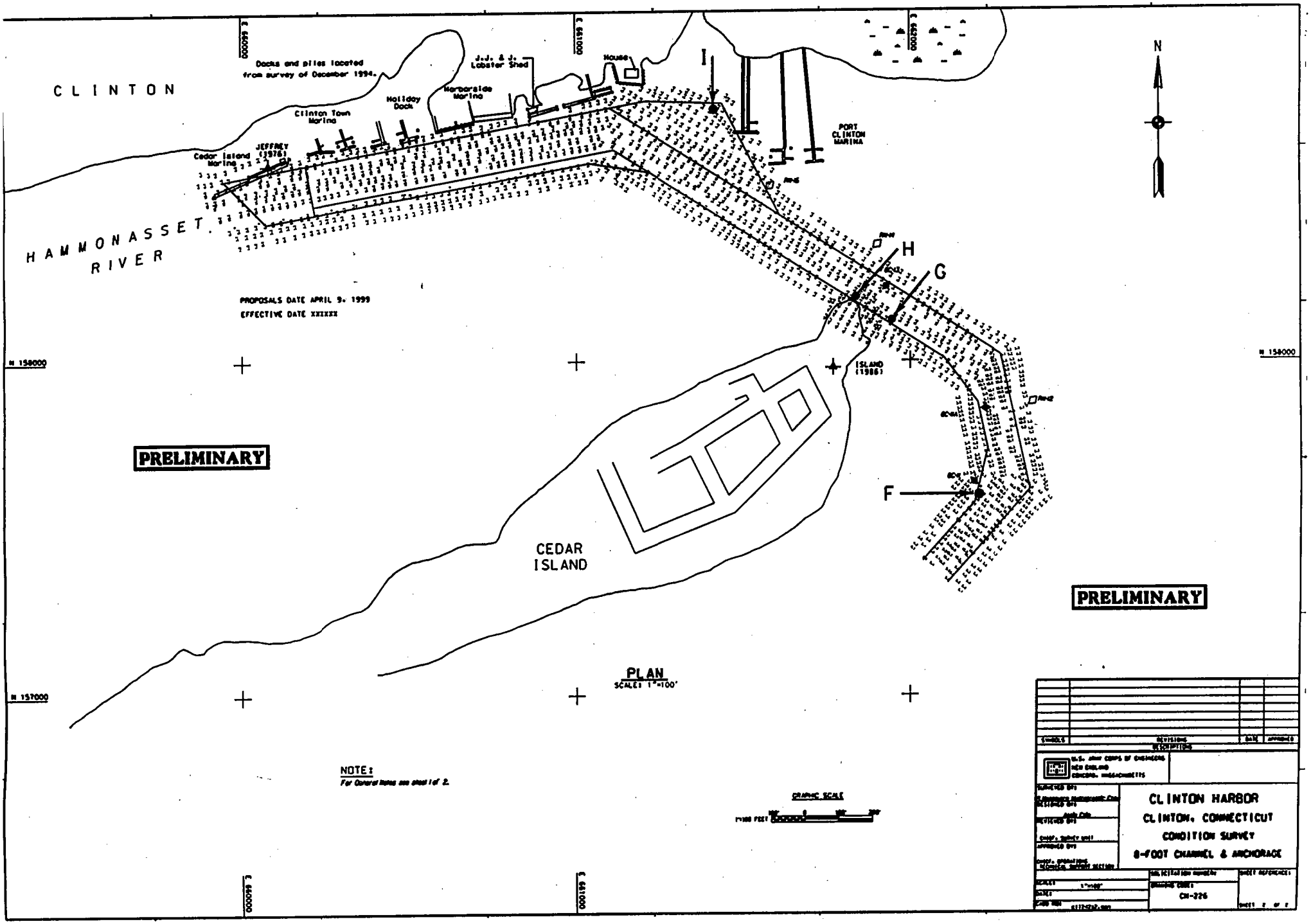
INDEX OF NAVIGATION AIDS			
NO.	DATE	STATE PLANE COORDINATES	GEOGRAPHIC POSITION
GC-3	3/31/97	N 154185.58 E 650974.24	41° - 15' - 37.6" N 72° - 31' - 41.7" W
GC-7	3/31/97	N 155314.62 E 651304.11	41° - 15' - 34.0" N 72° - 31' - 37.3" W
RW-6	3/31/97	N 155586.02 E 651322.36	41° - 15' - 36.6" N 72° - 31' - 37.1" W
RW-8	3/31/97	N 156550.90 E 651332.93	41° - 15' - 46.0" N 72° - 31' - 35.6" W
GC-9	3/31/97	N 156865.56 E 651337.81	41° - 15' - 49.2" N 72° - 31' - 34.7" W
GC-11	4/1/97	N 157630.37 E 652209.95	41° - 15' - 56.6" N 72° - 31' - 23.4" W
GC-11A	4/1/97	N 157855.69 E 652248.37	41° - 15' - 58.9" N 72° - 31' - 24.0" W
RW-12	4/1/97	N 157858.01 E 652332.63	41° - 15' - 58.9" N 72° - 31' - 22.8" W
GC-13	4/1/97	N 158507.30 E 651910.98	41° - 16' - 3.3" N 72° - 31' - 28.3" W
RW-14	4/1/97	N 158530.56 E 651933.67	41° - 16' - 3.0" N 72° - 31' - 28.1" W
RW-16	4/1/97	N 158506.86 E 651954.30	41° - 16' - 3.3" N 72° - 31' - 27.8" W




CLINTON
HAMMONASSET RIVER
Docks and piles located from survey of December 1994.
Cedar Island Marina
JEFFREY (1976)
Clinton Town Marina
Holiday Dock
Harborside Marina
J.J. & J. Lobster Shed
House
PORT CLINTON MARINA
PROPOSALS DATE APRIL 9, 1999
EFFECTIVE DATE XXXXXX
PRELIMINARY
CEDAR ISLAND
ISLAND (1986)
I
H
G
F
N
N 158000
N 157000
E 660000
E 661000
E 662000
PLAN
SCALE: 1"=100'
NOTE:
For General Notes see sheet 1 of 2.
GRAPHIC SCALE
PRELIMINARY
U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND
CONCORD, MASSACHUSETTS
CLINTON HARBOR
CLINTON, CONNECTICUT
CONDITION SURVEY
8-FOOT CHANNEL & ANCHORAGE
CH-226

1. Introduction

1.1. Sample Collection

On November 16, 1999 vibratory core sampling was conducted at nine stations at Clinton Harbor, CT. This survey was part of Delivery Order #40 – Laboratory Testing In Support of Environmental Assessment NAE PCS Projects-FY2000. Table 1 provides a summary of the samples collected and the corresponding dates. This report presents the results of the physical and chemical analyses performed on selected sediments. Custody records for all samples collected are provided in Attachment 1. All final data and associated quality control results for grain size, TOC, Metals, PCB/Pest and PAH analyses are provided as attachments to this report. The complete details of the survey operation are provided in the *Final Survey Report, Vibratory Core Sampling in Clinton Harbor, Housatonic River and North Cove, CT,* dated November, 1999.

Table 1 Summary of Individual Sediment Cores Collected at Clinton Harbor, CT

Sample Core ID	Collection Date
CH-A-3-18"	11/16/99
CH-B-9-44"	11/16/99
CH-B-45-58"	11/16/99
CH-C-0-99.5"	11/16/99
CH-D-0-88"	11/16/99
CH-D-89-102"	11/16/99
CH-E-0-71.25	11/16/99
CH-E-71.25-112"	11/16/99
CH-F-0-12"	11/16/99
CH-G-0-38"	11/16/99
CH-G-38-77"	11/16/99
CH-G-77-92"	11/16/99
CH-H-0-62"	11/16/99
CH-H-62-81"	11/16/99
CH-H-81-124"	11/16/99
CH-I-0-60"	11/16/99

1.2. Sample Handling and Custody

Sediment cores were kept cold and transported to Battelle after completion of sampling. Upon receipt of sediment cores at the laboratory, chain of custody was transferred to the Battelle staff member responsible for core descriptions and processing. All cores were stored at 4°C until processing, which occurred within 14 days of sample collection. Once cores were processed (split, characterized, and homogenized), representative portions of the homogenized cores were placed into appropriate containers for physical and chemical analyses. At this point, custody was transferred to Battelle's sample custodian and samples were then logged into Battelle's log-in system and assigned a unique Battelle ID. All samples were frozen until analysis, with the exception of grain size samples, which were sent directly to the laboratory. Samples remained frozen until instructions for

compositing and analyses were provided by NAE (based on results of grain size analyses). Table 2 summarizes the samples selected for further chemical analyses.

Table 2 Selected Cores/Sections for Chemical Analyses from Clinton Harbor, CT

Core	Selected Cores/Sections for Chemical Analyses
Core A	0-1.5'
Core C	0-8.3'
Core E	5.9-9.3'
Core G	0-7.7'
Core I	0-5'

2. Methods

Grain size analyses were performed on all core samples collected from the field. Only selected samples (Table 2) were analyzed for the remaining parameters.

2.1. Grain Size Analyses

Water content and grain size distribution were determined by ASTM D-422. Grain size analyses were performed at Applied Marine Sciences (AMS) of League City, Texas.

2.2. Total Organic Carbon Analyses

Total Organic Carbon (TOC) was analyzed according to EPA Method 9060. TOC analyses were performed at Applied Marine Sciences (AMS) of League City, Texas. All samples were analyzed in duplicate and results are reported in % dry wt.

2.3. Metals Analyses

Eight metals were analyzed: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn). To prepare the sediments for analysis, they were first freeze-dried then blended in a Spex mixer-mill. For both ICP-MS and CVAA analyses, 0.2-g aliquots of dried, homogeneous sample were digested following the EPA Method 200.3 (EPA 1991) procedure, modified by using a different ratio of nitric to hydrochloric acids for digestion. Hg was analyzed using cold-vapor atomic absorption spectrometry (CVAA) following EPA Method 245.5 (EPA 1991). The remaining metals were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) following EPA Method 200.8 (EPA 1991).

2.4. PCB/Pesticide Analyses

PCBs and Pesticides were extracted using methylene chloride. The extract was reduced in volume and cleaned using alumina column chromatography and HPLC. A portion of the extract was exchanged into hexane and analyzed for 22 individual PCB congeners and 19 chlorinated pesticides and toxaphene using gas chromatography/electron capture detection (GC/ECD) following a modified EPA method 8081. Dual column confirmation was performed for all analytes.

2.5. PAH Analyses

PAHs were extracted along with PCB/Pests as described above. Extracts were reduced, cleaned using alumina column chromatography and HPLC, and a portion of the extract analyzed in the selected ion monitoring (SIM) mode using gas chromatography/mass spectrometry (GC/MS) following a modified EPA method 8270.

3. Results

3.1. Grain Size Results

Grain size analysis results, including water content and plots, were furnished by Applied Marine Sciences, Inc. from League City, Texas and are provided in Attachment 2 along with quality control results. The core sediments were generally characterized as fine/clayey sand. Table 3 summarizes the grain size distributions of the individual cores.

Table 3 Summary of Grain Size Results

Core	Gravel (%)	Coarse Sand (%)	Medium Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)
CH-A 3-18"	0.00	0.15	1.13	56.40	29.96	12.35
CH-B 9-44"	0.09	0.15	3.00	91.36	0.40	5.00
CH-B 45-58"	0.13	0.21	2.62	52.04	27.64	17.35
CH-C 0-99.5"	0.26	0.15	5.49	88.20	1.51	4.40
CH-D 0-88"	0.77	1.97	24.47	70.17	0.10	2.52
CH-D 89-102"	0.97	2.24	10.39	69.53	10.46	6.40
CH-I 0-60"	0.00	0.01	0.56	7.05	53.57	38.80
CH-G 0-38"	0.75	0.65	10.06	25.85	36.69	26.00
CH-G 38-77"	11.68	20.25	29.82	16.04	14.01	8.20
CH-G 77-92"	7.09	6.63	18.80	37.51	14.87	15.10
CH-F 0-12"	0.22	3.18	84.67	6.16	1.27	4.50
CH-E 0-71.25"	0.00	0.18	3.53	91.59	0.80	3.90
CH-E 71.25-112"	0.16	0.10	1.25	77.85	12.89	7.75
CH-H 0-62"	26.91	21.91	47.12	2.97	0.30	0.79
CH-H 62-81"	20.54	27.68	44.11	4.66	1.01	2.00
CH-H 81-124"	21.92	16.21	34.47	18.66	5.09	3.65

3.2. Total Organic Carbon Results

TOC results for composited core samples are provided in Attachment 3 and summarized in Table 4.

Table 4 Results of TOC Analyses

Core	TOC [1] (% Dry Wt.)
CH-A	0.64
CH-C	0.15
CH-E	0.71
CH-G	1.31
CH-I	2.68

[1] All TOC analyses were performed in duplicate; replicate results are provided in Attachment 3.

3.3. Metals Results

Metals results are provided in Attachment 4. Low levels of all 8 metals were detected in all samples. The highest concentrations of all metals were found in the sample analyzed from Core I.

3.4. PCB/Pest Results

Results of PCB and chlorinate pesticide analyses for all field samples and quality control samples are provided in Attachment 5. PCBs and pesticides were detected in all of the composited field samples. Core CH-I 0-5' had the highest levels of Total PCB among the five composites tested. All quality control and field samples passed the surrogate recovery criteria. No analytes were detected in the Procedural Blank (PB) at levels above the Target Detection Limit. The Laboratory Control Sample (LCS) had a low recovery of endrin aldehyde (29%). This compound is difficult to recover from the Alumina clean-up column and often exhibits low recoveries. The Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples were within the recovery and Relative Percent Difference (RPD) criteria. The Percent Difference (PD) criteria were exceeded in the Standard Reference Material (SRM) for 2,4 DDE (35%) and Cl7(170%). The Sample Duplicates failed the RPD criteria for 7 PCB congeners due to low levels evaluated which were below the Target Detection Limits.

3.5. PAH Results

Results of PAH analyses for all field samples and quality control samples are provided in Attachment 6. PAHs were detected in all of the composited sediment samples, except for CH-C (0-8.3'). CH-A, CH-E, and CH-G all had low recoveries of naphthalene-d8 (39, 37, and 37%, respectively). No analytes were detected in the PB. The LCS, MS/MSD, and SRM were within recovery and RPD/PD criteria. The Sample Duplicates passes the RPD criteria but had low recoveries for naphthalene-d8 (39 and 29%). Method detection limits (MDLs) for naphthalene are approximately 10 times lower that the reported Target Detection limits and naphthalene was not detected at those levels, therefore, reporting naphthalene as not detected below the Target Detection limit, even with the low naphthalene-d8 surrogate recoveries is accurate.

4. References

Battelle 1999. *Vibratory Core Sampling in Clinton Harbor, Housatonic River and North Cove, CT,* November, 1999.

Battelle 1999. Sampling and Analysis Plan for O&M. May 4, 1999.

EPA. 1991. *Methods for the Determination of Metals in Environmental Samples.* EPA-600/4-91-010.

Statement of Work. Laboratory Testing in Support of Environmental Assessment. NAE PCS Projects-FY2000, October 6, 1999

FINAL DATA REPORT

for

Laboratory Testing in Support of Environmental Assessment, Biological Sampling and Testing – Three Projects in Connecticut Clinton Harbor, CT

Submitted to

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U.S. Army Corps of Engineers
North Atlantic Division
New England District

Contract No. DACW33-01-D-0004
Delivery Order No. 10

April 8, 2002

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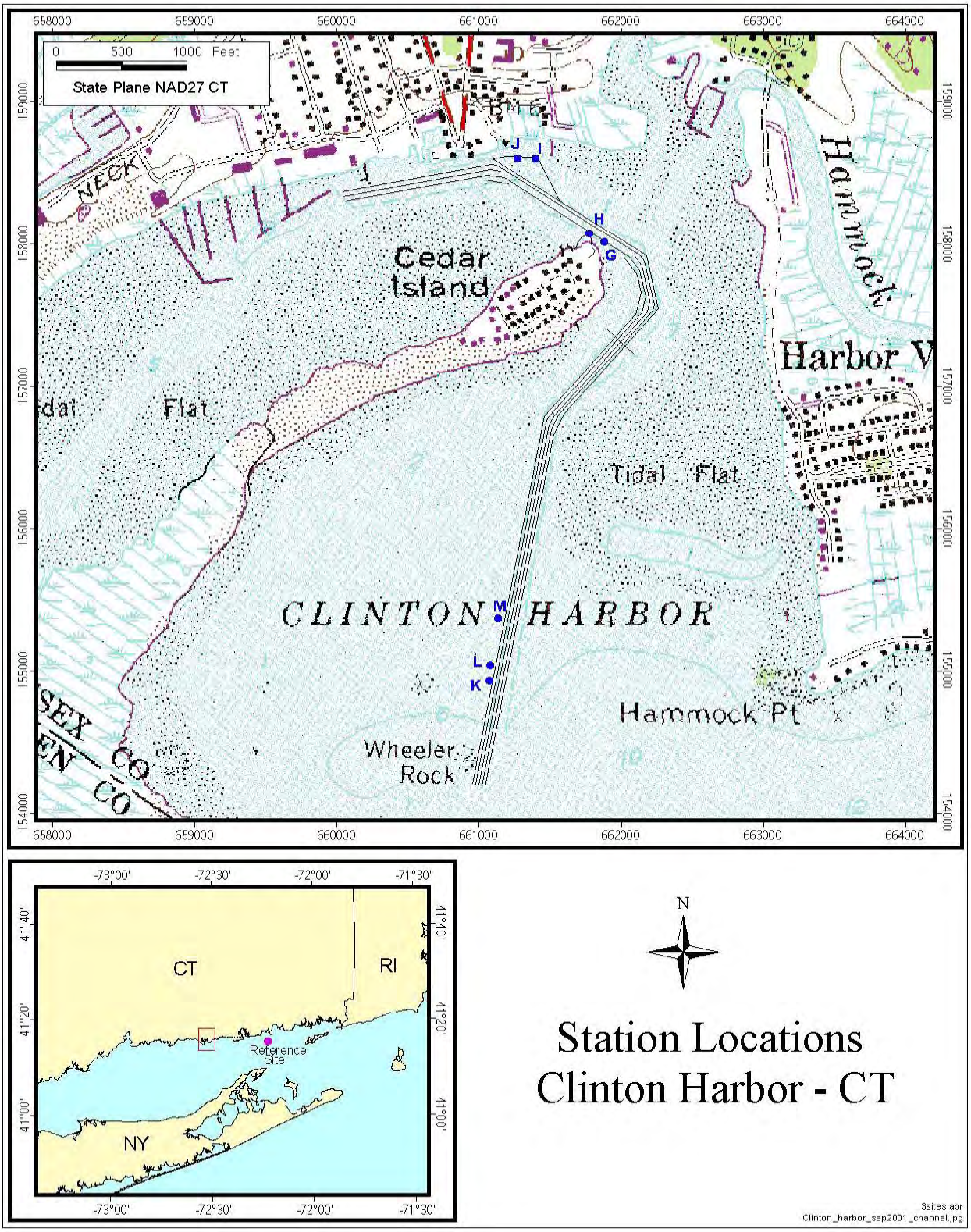
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State Plane NAD27 CT
Cedar Island
Tidal Flat
CLINTON HARBOR
Hammock Pt
Wheeler Rock
Hammock
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NECK
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K
658000
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662000
663000
664000
154000
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159000
-73°00'
-72°30'
-72°00'
-71°30'
41°40'
41°20'
41°00'
CT
RI
NY
Reference Site
N
Station Locations
Clinton Harbor - CT
3sites.apr
Clinton_harbor_sep2001_channel.jpg

Table 0-1. Compositing Scheme for Sediment Cores from Clinton Harbor, Connecticut.

Site ID	Composite Designation	Composite ID	Sampling Location	Core ID	Collection Date
Clinton Harbor	COMP G/H	AAM-076	G	AAM-034	9/20/01 and 9/21/01
			H	AAM-033	9/20/01
	COMP I/J	AAM-073	I	AAM-031	9/19/01
			J	AAM-032	9/19/01
	COMP K/L/M	AAM-070	K	AAM-036	9/22/01
			L	AAM-035	9/22/01
			M	AAM-030	9/21/01

1. RESULTS

With one exception, organic and metal contaminant data were evaluated against the laboratory based method detection limits (MDL) and reporting limits (RL) such that:

- Contaminants not-detected or detected at levels below the MDL were reported as the MDL and U flagged
- Contaminants detected at levels above the MDL and below the RL were J flagged

The one exception pertained to PCB/pesticide water data, which were only evaluated against laboratory RLs.

1.1 Sediment Testing

This section summarizes results obtained from the chemical analysis of the CSDS reference sediment and the three Clinton Harbor sediment composites. Complete results, along with quality control details and achieved laboratory reporting limits, are provided as Appendix A. Results from the chemical analysis of rinsate blank samples associated with sediment sampling are reported in Appendix B.

Grain size results for this study are summarized in Table 3-1; PCB, PAH, metals and TOC results are summarized in Table 3-2. PCB and PAH results are presented as total concentrations. Total PCB concentrations reported in Table 3-2 were determined as 2 times the summation of the 18 NS&T congeners and total PAH concentrations were determined as the summation of the individual target PAHs defined in Table 2-1. In cases where an individual PCB congener or PAH compound was not detected, a value of one half the laboratory achieved MDL was used in the summation. Sample results are presented on a dry weight basis to three significant figures.

1.1.1 Grain Size

Grain size analysis results, including water content and plots, were furnished by AMS and are provided in Appendix B along with quality control results. Note that one sample was analyzed in replicate and the relative percent difference between replicate values for all grain size fractions was less than eight percent.

1.1.2 Total Organic Carbon

Concentrations of TOC ranged from 0.22 to 2.54 % dry weight (Table 3-2). Sediment from Clinton Harbor Composite sample K/L/M and the reference site (CSDS) contained the lowest concentrations of TOC; whereas sediment from Clinton Harbor Comp I/J contained the highest concentrations of TOC.

Table 1-1. Summary of Sediment Grain Size Results.

Sample Description		Gravel (%)	Coarse Sand (%)	Medium Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)
CSDS	Reference	8.61	11.8	32.9	34.9	5.81	6
Clinton Harbor	COMP G/H	6.84	21.8	44.2	11.2	9.52	6.5
	COMP I/J	0	0.15	0.73	6.66	54.5	38
	COMP K/L/M	0	1.48	13.7	72.8	7.63	4.5

Table 1-2. Summary of Sediment Contaminant Results.

Sample Description		Total PCB (a)	Total PAH (b)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	TOC (c)
	Target DL	1	20	0.50	0.1	1.0	1.0	0.02	1.0	1.0	1.0	0.01
	Achieved RL	0.20 (d)	5.1 (d)	0.569	0.166	0.110	0.070	0.00299	0.117	0.073	0.0709	0.01
CSDS	Reference	4.68	399	3.05	0.0669 J	20.0	6.15	0.000941 U	7.34	8.72	34.8	0.24
Clinton Harbor	COMP G/H	8.11	782	5.42	0.238	44.2	29.7	0.0890	15.8	23.5	105	0.65
	COMP I/J	79.6	4,070	9.49	0.481	86.2	66.5	0.314	27.1	57.9	178	2.54
	COMP K/L/M	7.77	384	2.05	0.0955 J	15.6	8.67	0.0030	5.18	6.87	34.4	0.22

(a) Total PCB = 2 X 3* denoted PCBs (in case of non-detects, use a value of ½ laboratory MDL in the summation)
(b) Total PAH = 3target PAHs (in case of non-detects, use a value of ½ laboratory MDL in the summation)
(c) All TOC analyses performed in duplicate; replicate 1 value reported.
(d) Achieved RLs varied from sample to sample; highest RL among study samples reported.
J, Detected at a concentration above the MDL and below the RL.
U, Not detected or detected at a concentration below the laboratory MDL; MDL reported.

1.1.3 Polychlorinated Biphenyl Congeners and Chlorinated Pesticides

Concentrations of total PCB ranged from 4.68 to 79.6 micrograms per gram dry-weight (Table 3-2). Sediment from the reference site (CSDS) contained the lowest concentrations of total PCB; whereas sediment from Clinton Harbor sample I/J contained the highest concentrations of total PCB.

QC Summary – Detailed QA/QC narratives are included with the analytical data in Appendix A. Results from the analyses of QC samples generally met MQOs (Table 2-9); notable exceptions included:

- The PCB surrogate compound PCB103 was over-recovered in all but two study samples (PCB extracts only). The recovery of PCB103 from the confirmation column was acceptable, suggesting that the over-recovery on the primary column was due to a matrix/sample interference isolated to that column.
- The relative percent difference (RPD) between concentrations of several PCBs in the laboratory replicate analysis exceeded the MQOs. The poor precision between laboratory replicates does not appear to be method related given that the precision between the MS/MSD samples was very good. Rather, the poor precision is likely because PCBs were present in the sample replicates at low-levels (<TDL).

1.1.4 Polynuclear Aromatic Hydrocarbons

Concentrations of total PAH ranged from 384 to 4,070 micrograms per kilogram dry-weight (Table 3-2). Sediment from Clinton Harbor Comp K/L/M and the reference site (CSDS) contained the lowest concentrations of total PAH; whereas sediment from Clinton Harbor Comp I/J contained the highest concentrations of total PAH.

QC Summary – Detailed QA/QC narratives are included with the analytical data in Appendix A. Results from the analyses of QC samples generally met MQOs; notable exceptions included:

- The laboratory blank contained selected PAHs (e.g., Naphthalene) at concentrations less than the laboratory MDL. Sample concentrations were compared to blank values and data were B flagged wherever the sample concentration was less than ten times the blank value.
- As was observed with PCBs, the RPD between concentrations of several PAHs in the laboratory replicate analysis exceeded the MQOs.

1.1.5 Trace Metals

Concentrations of trace metals are summarized in Table 3-2. Sediment from Clinton Harbor Comp I/J consistently contained higher concentrations of trace metals; whereas sediment from the reference site and Clinton Harbor Comp K/L/M contained the lowest concentrations of trace metals.

QC Summary – Detailed QA/QC narratives are included with the analytical data in Appendix A. Results from the analyses of QC samples generally met MQOs; notable exceptions included:

- The achieved laboratory RL for As and Cd did not meet required TDLs (As: RL = 0.569, TDL = 0.50; Cd: RL = 0.166, TDL = 0.10). Concentrations of As and Cd in most of the study samples were present at levels well above target and achieved RLs, suggesting that impact on data quality by not meeting the TDL is minimal.
- Sediment samples were analyzed for Hg 56 days from collection of the first sediment samples. Because samples were held frozen at -58 °C ± 20 °C until processing, it is unlikely that exceeding the holding time had any effect on the concentrations of Hg measured in the samples.

1.2 Water Chemistry

This section summarizes results obtained from the chemical analysis of the CSDS reference site water and elutriate/elutriate blanks prepared from composite sediment and site water from the three Clinton Harbor sampling sites. Note that elutriates and elutriate blanks were analyzed for PCBs, pesticides and metals. PAHs were only analyzed in the rinsate blanks. Results for all samples and associated quality control results are provided in Appendix B.

1.2.1 Polychlorinated Biphenyl Congeners and Chlorinated Pesticides

The results, and QA/QC narratives, of the PCB and pesticide analyses for elutriate samples and their associated quality control samples are provided in Appendix B. With few exceptions, PCBs and pesticides were undetected in the water/elutriate samples at concentrations above the TDL.

Detailed QA/QC narratives are included with the analytical data in Appendix B. Results from the analyses of QC samples were very good.

1.2.2 Polynuclear Aromatic Hydrocarbons

The results, and QA/QC narratives, of the PAH analyses for rinsate blanks and their associated quality control samples are provided in Appendix B. With the exception of Naphthalene, 1-Methylnaphthalene, and 2-Methylnaphthalene, PAHs were undetected in the rinsate blanks at concentrations above the laboratory achieved RLs.

Detailed QA/QC narratives are included with the analytical data in Appendix B. Results from the analyses of QC samples were very good.

1.2.3 Trace Metals

The results, and QA/QC narratives, of the metals analyses for elutriate samples and their associated quality control samples are provided in Appendix B. Eight metals (As, Cd, Cr, Cu, Hg, Pb, Ni and Zn) were analyzed in the elutriate and elutriate blanks. With some exceptions (*e.g.*, As, Cu, and Zn), metals were undetected in the water/elutriate samples at concentrations above the TDL.

QC Summary – Detailed QA/QC narratives are included with the analytical data in Appendix B. Results from the analyses of QC samples generally met MQOs; notable exceptions included:

- Some water samples were analyzed for Hg beyond the 28-day holding time by several days. It is unlikely that exceeding the holding time affected the results. EPA Method 1631, Revision D (draft) states that acid-preserved water samples are stable for 90 days from collection.
- Cr was detected in the blank associated with the rinsate blank samples at approximately two times the TDL. The blank value and corresponding sample results were B flagged on the final report tables.

1.3 Tissue Chemistry

Based on the results of the 10-day acute toxicity testing, it was determined by USACE NED that only selected tissue samples generated through the 28-day bioaccumulation testing would be analyzed for lipids, selected metals, PCB congeners, and PAHs (Table 3-3).

Results for all tissue replicates exposed to site and reference sediments as well as background tissues as well as detailed QA/QC narratives are presented in Appendix F; study samples are presented on a wet-weight basis and QC samples are presented on a dry-weight basis. Summaries of wet weight means are provided in Section 4.

Table 1-3. Summary of Bioaccumulation Samples Analyzed for Chemical Parameters.

Sample Description		Analysis Performed at the Direction of NED (Y/N)			
		PCB Congeners	PAH	Metals (a)	Lipid
Cornfield Shoals Disposal Site	Reference	Yes	Yes	Yes	Yes
Clinton Harbor	COMP G/H	No	No	No	No
	COMP I/J	Yes	Yes	Yes (b)	Yes
	COMP K/L/M	No	No	No	No
Pre-test	Pre-test	Yes	Yes	Yes	Yes

(a) Metals analyzed are As, Cd, Cr, Cu, Hg, Pb, Ni and Zn.
(b) Only Cd and Pb required.

1.3.1 Polychlorinated Biphenyl Congeners

The results, and the QA/QC summaries, of the PCB analyses for tissue samples and their associated quality control samples are provided in Appendix F.

The majority of PCB in *N. virens* were detected below the TDL (0.5 µg/Kg wet). However, PCB49, PCB52, PCB101, PCB118, PCB138, PCB153, PCB180, and PCB187 were usually detected at levels

above the TDL in tissue samples from the Clinton Harbor treatment. In comparison, only PCB138, PCB153, PCB180, and PCB187 were consistently detected above the TDL at CSDS treatment.

The majority of PCB in *M. nasuta* were detected below the TDL (0.5 µg/Kg wet). However, PCB28, PCB49, PCB52, PCB66, PCB101, PCB118, PCB138 and PCB153 were usually detected above the TDL in tissue samples from the Clinton Harbor treatment. PCB concentrations were lower at the CSDS site with only PCB 52 and PCB 153 detected consistently above the TDL.

Within each test, for both *N. virens* and *M. nasuta*, concentrations of individual PCB were relatively consistent between the replicate organisms. Exceptions were usually associated with PCB detected at very low concentrations.

Concentrations of individual PCBs in the clams and worms were similar within each treatment, with slightly higher concentrations overall of the more chlorinated PCBs (e.g., PCB138, PCB153) found on average in worm samples.

QC Summary — Detailed QA/QC narratives are included with the analytical data in Appendix F, as described above. The results from the analyses of QC samples met MQOs (Table 2-9).

1.3.2 Polynuclear Aromatic Hydrocarbons

The results, and the QA/QC summaries, of the PAH analyses for tissue samples and their associated quality control samples are provided in Appendix F.

With the exception of Fluoranthene and Pyrene, most individual PAH were detected at concentrations below the TDL (2 µg/Kg wet) in all *N. virens* treatment samples. In contrast, the majority of PAH (4-, 5- and 6-ring compounds) detected in the *M. nasuta* samples were at concentrations above the TDL (2 µg/Kg wet).

Within each test, for both *N. virens* and *M. nasuta*, concentrations of individual PAH were relatively consistent between the replicate organisms. Exceptions were usually a result of PAH detected at lower concentrations.

Tissue samples from the CSDS treatment consistently contained lower concentrations of PAHs relative to the Clinton Harbor Comp I/J; this trend was most notable for high molecular weight PAHs. Further, concentrations of high molecular weight PAHs were generally at least one order of magnitude higher in *M. nasuta* than in *N. virens* samples.

QC Summary — Detailed QA/QC narratives are included with the analytical data in Appendix F, as described above. The results from the analyses of QC samples generally met MQOs, notable exceptions included:

- Naphthalene, 2- Methylnaphthalene and 1-Methylnaphthalene, and Biphenyl were detected in the procedural blanks prepared with the samples at concentrations generally below the laboratory MDL. Sample data were evaluated against the associated laboratory blanks and results were B flagged in all cases where the sample result was less than 10× blank values.
- Anthracene was over-recovered in the tissue SRMs. Detected values for Anthracene have historically been high compared to the certified value. The impact on sample data should be minimal given that Anthracene was recovered within the control limits in associated LCS, MS and MSD samples.

1.3.3 Trace Metals

The results, and the QA/QC summaries, of the trace metals analyses for tissue samples and their associated quality control samples are provided in Appendix F.

Concentrations of Cd and Pb were below the TDLs (Cd = 0.1 and Pb = 0.5 µg/g wet) in the Clinton Harbor and CSDS samples for *N. virens*. Concentrations of Cd were also below the TDL (0.1 µg/g wet) in all *M. nasuta* samples; whereas concentrations of Pb were detected at levels slightly above the TDL (0.5 µg/g wet) in most *M. nasuta* samples.

In general, concentrations of Pb were detected at higher concentrations in the *M. nasuta* samples than in *N. virens* samples; whereas concentrations of Cd were very similar between the test organisms in all treatments.

QC Summary — Detailed QA/QC narratives are included with the analytical data in Appendix F, as described above. The results from the analyses of QC samples generally met MQOs, notable exceptions included:

- Three method blanks were analyzed with the set of samples. With few exceptions, metals were undetected or detected at concentrations less than the laboratory RL in the blanks. Exceptions included:
    - Arsenic (As) was detected in one blank at a concentration just above the RL, however, sample concentrations of As were all greater than 10 times the blank concentration.
    - Zinc (Zn) was detected in one blank at a concentration just above the RL, however, sample concentrations of Zn were all greater than 10 times the blank concentration.
    - Lead (Pb) was detected in all three blanks at concentrations approximately 1.5 times greater than the RL. The presence of Pb in the blanks is most likely due to laboratory contamination of one of the reagents used in sample processing. Although most sample concentrations of Pb were greater than 10 times the concentration of Pb in the blank, the samples were flagged with a “B” to indicate that they are biased high.
- Lead was over-recovered in all of the tissue SRMs prepared in the laboratory. The over-recovery of Pb is most likely due to laboratory contamination (discussed above), rather than an indication of poor accuracy of the method. Had the Pb data been blank corrected, then the percent difference between detected and certified values for Pb would be acceptable.

1.3.4 Lipids

Bligh and Dyer lipid content results are reported in Appendix F. The lipid contents overall were similar, ranging from 1.08 to 1.57 % wet weight for *N. virens* and 1.05 to 1.51 % wet weight for *M. nasuta*.

QC Summary — Four samples were analyzed in replicate for lipid content. The RPD between lipid content values in the sample replicates were acceptable (1.12 % and 4.94% RPD for *N. virens* and 12.5% and 0.8% RPD for *M. nasuta*).

1.4 Suspended Phase Acute Toxicity Tests

Results of SPP testing are summarized below. Additional water quality characteristics and other supporting data are presented in Appendix C. A reference toxicant (copper) was analyzed along with each batch of tests for each organism.

1.4.1 Americamysis bahia

Mean percent survivals for each of the three Clinton Harbor test sediments and the Hampton Estuary control sediment are summarized in Table 3-4. Survivals are based on the 96-hour exposure period. Mean survival in the laboratory control exposure was 100% for Test #2, which met the minimum test acceptability criterion of 90% survival and indicated that test organisms were healthy and not stressed by handling. The mean survival in the CSDS diluent ranged from 98% to 100%. These results indicate that water from the disposal site used to dilute the suspended particulate phase solutions had no adverse impact on the outcome of the assays.

Table 1-4. Summary of Acute SPP Assays: *A. bahia*.

Percent Survival of *A. bahia* after 96 Hours Exposure – Test #2			
Treatment	**Clinton Harbor Comp G/H**	**Clinton Harbor Comp I/J**	**Clinton Harbor Comp K/L/M**
CSDS Diluent	100%	100%	98%
Laboratory Control	100%	100%	100%
10% SPP	98%	100%	100%
50% SPP	98%	98%	100%
100% SPP	100%	98%	98%
LC-50	>100%	>100%	>100%
NOEC	100%	100%	100%

COMMENTS:
* Survival significantly different from Diluent Control.
95% confidence limits are in parentheses.

1.4.2 Acute Toxicity Test – *Menidia beryllina*

Mean percent survivals for each of the three Clinton Harbor test sediment and the Hampton Estuary control are summarized in Tables 3-5. Survivals are based on the 96-hour exposure period. Mean survival in the control exposure was 90% for Test #2, which meets the minimum test acceptability criterion of 90% survival and indicated that test organisms were healthy and not stressed by handling. The mean survival in the CSDS water ranged from 94 to 96%. These values indicated that water from the disposal site used to dilute the suspended particulate phase solutions had no adverse impact on the outcome of the assays.

Table 1-5. Summary of Acute SPP Assays: *M. beryllina*.

Percent Survival of *M. beryllina* after 96 Hours Exposure – Test #2			
Treatment	**Clinton Harbor Comp G/H**	**Clinton Harbor Comp I/J**	**Clinton Harbor Comp K/L/M**
CSDS Diluent	96%	96%	94%
Laboratory Control	90%	90%	90%
10% SPP	94%	98%	94%
50% SPP	92%	100%	96%
100% SPP	82%	94%	94%
LC-50	>100%	>100%	>100%
NOEC	100%	100%	100%

COMMENTS:
* Survival significantly different from Diluent Control.
95% confidence limits are in parentheses.

1.4.3 Embryo Development Test – *A. punctulata*

Mean percent survival and normal development for each of the three Clinton Harbor test sediments and the Hampton Estuary control are summarized in Tables 3-6 and 3-7, respectively. Survivals and development are based on the 72-hour exposure period. Survivals and development in the Hampton Estuary control exposures were well above the minimum acceptability criteria of 70% embryo survival and 70% normal development with the exception of Clinton Harbor Comp I/J. This was the second attempt at testing this composite (see Section 2.4.1.8). While the survival and development of *A. punctulata* in the Hampton Estuary controls did not meet passing criteria for the Clinton Harbor Comp I/J assay, holding times for the site and overlying water used to prepare the SPP solutions exceeded protocol criteria. The decision was made that this would not have an impact on the outcome of the assay, and results from this test were approved by USACE NED.

Counts made at the start of the *A. punctulata* assay in the surrogate test vessels indicate an average initial embryo concentration of 26.4 embryos/mL (132 embryos/5 mL aliquot) for Test #2. The majority of the larvae reached the pluteus stage 72 hours after the start of the assay. The initial embryo concentration for the Clinton Harbor Comp I/J retest was 23 embryos/mL (115 embryos/5mL aliquot). The majority of the larvae for Clinton Harbor Comp I/J reached the pluteus stage 96 hours after the start of the assay.

Counts in the CSDS diluent for Test #2 ranged from 77.3 to 93.5%, and the mean normal development of the original embryos ranged from 75.2% to 92.1%. Counts in the CSDS diluent for the Clinton Harbor Comp I/J retest showed that 88.5% of the embryos survived and 87.0% were normally developed pluteus larvae. This indicates that the CSDS reference site water, used as the diluent for the both Test #2 and the Clinton Harbor Comp I/J retest SPP solutions, did not have a negative impact on the assays.

Table 1-6. Summary of Acute SPP Assays, Percent Survival: *A. punctulata*.

Percent Survival of *A. punctulata* after 72 Hours Exposure – Test #2			
Treatment	**Clinton Harbor Comp G/H**	**Clinton Harbor Comp I/J**	**Clinton Harbor Comp K/L/M**
CSDS Diluent	85.2%	88.5%	77.3%
Laboratory Control	85.9%	58.4%	85.9%
10% SPP	85.8%	100.7%	65.5%
50% SPP	2.7%	27.5%	79.5%
100% SPP	0.0%	47.0%	69.8%
LC-50	17.7% (15.4-20.6)	47.8% (39.9-57.9)	>100.0%
NOEC	10.0%	10.0%	100.0%

COMMENTS:
95% confidence limits are given in parentheses.

Table 1-7. Summary of Acute SPP Assays, Percent Normal Development: *A. punctulata.*

Percent Normal Development for *A. punctulata* after 72 Hours Exposure – Test #2			
Treatment	**Clinton Harbor Comp G/H**	**Clinton Harbor Comp I/J**	**Clinton Harbor Comp K/L/M**
CSDS Diluent	84.8%	87.0%	75.2%
Laboratory Control	84.1%	57.6%	84.1%
10% SPP	85.2%	97.9%	63.0%
50% SPP	0.6%	0.9%	73.8%
100% SPP	0.0%	0.0%	5.2%
EC-50	16.0% (14.0-19.2)	21.0% (17.8-25.2)	62.0% (57.8-65.9)
NOEC	10.0%	10.0%	<10.0%

COMMENTS:
95% confidence limits are given in parentheses.

1.5 10-day Amphipod and Mysid Tests

Results from the amphipod and mysid acute toxicity tests are summarized below. Complete test results by replicate for the amphipod and mysid tests along with additional water quality data are presented in Appendix D.

1.5.1 Ammonia Measurements

Bulk sediment ammonia measurements showed that ammonia thresholds were exceeded for the amphipod test species, therefore, purging was required to reduce porewater ammonia prior to testing with *A. abdita*. Ammonia purging began on sediments with the highest porewater ammonia concentrations. The layering of the Connecticut River Harbors sediments for use in the *Ampelisca* test was staggered from October 11, 2001 to October 21, 2001, according to the estimated time needed to purge ammonia. After layering, sediments were purged twice daily with water exchanges (EPA 1994a). Porewater ammonia measurements were made at several intervals after initial layering. This information is presented in

Tables 3-8 and 3-9, including the measured ammonia levels. The *Ampelisca* control and CSDS Reference sediments were layered on October 22, 2001, the day before the test was initiated.

Table 1-8. Pre-initiation Ammonia Monitoring Data for the 10-d Solid-Phase Acute Toxicity Test with *Ampelisca abdita*.

Treatment	Bulk Porewater Ammonia (mg/L)	Date Layered	Ammonia in Porewater During Purge Period (mg/L)			
			12 Oct	16 Oct	18 Oct	22 Oct
A. abdita Control	NA[1]	10/22/01	NL[2]	NL	NL	NL
CSDS Reference	12.6	10/22/01	NL	NL	NL	NL
Clinton Harbor						
Composite G/H	91	10/15/01	NL	33.3	28.9	17
Composite I/J	36.8	10/17/01	NL	NL	26.6	17
Composite K/L/M	36.3	10/17/01	NL	NL	NPE[3]	NPE

[1] NA, Not applicable
[2] NL, Not layered
[3] NPE, No porewater extractable from sample

Table 1-9. Post-initiation Ammonia Monitoring Data for the 10-d Solid-Phase Acute Toxicity Test with *Ampelisca abdita*.

Treatment	Date Layered	Ammonia in Porewater During Test Period (mg/L)		
		Day 0 23-Oct	Day 3 26-Oct	Day 10 2-Nov
A. abdita Control	10/22/01	12	12	2.4
CSDS Reference	10/22/01	5.4	2.2	1.3
Clinton Harbor				
Composite G/H	10/15/01	10	7.9	2.4
Composite I/J	10/17/01	11	7.8	1.9
Composite K/L/M	10/17/01	11	11	2.1

[1] Italicized numbers indicate measurement is an estimate that was below the instrument calibration range.

The ammonia toxicity threshold for *A. bahia* is expressed in terms of unionized ammonia present in the water column, rather than total ammonia in porewater. Total ammonia concentrations in overlying waters were converted to unionized concentrations by using the total ammonia measurement and temperature, with pH and salinity measurements from daily water quality monitoring. Table 3-10 shows the results of overlying water unionized ammonia concentrations, and the total ammonia measurements from which they were calculated, before and during the *A. bahia* 10-d test. Unionized ammonia concentrations were below the guideline for the duration of the test.

Table 1-10. Unionized and Total Ammonia Concentrations in Overlying Waters during the 10-d Solid-Phase Acute Toxicity Test with *Americamysis bahia*.

Treatment	Bulk	Unionized Ammonia (mg/L)	Total Ammonia (mg/L)

	Sediment Porewater Ammonia (mg/L)	Day 0	Day 3	Day 5	Day 7	Day 10	Day 0	Day 3	Day 5	Day 7	Day 10
		19-Oct	22-Oct	24-Oct	26-Oct	29-Oct	19-Oct	22-Oct	24-Oct	26-Oct	29-Oct
Mysid Control	NA[1]	*0.01* [2]	0.04	0.05	0.17	0.16	*0.23*[2]	3.7	3.3	6.1	7.3
CSDS Reference	12.6	*0.00*	0.03	0.03	0.13	0.16	*0.24*	4.3	4.2	6.9	9.1
Clinton Harbor											
Composite G/H	91	0.02	0.14	0.09	0.18	0.32	1.2	11	5.9	9.4	14
Composite I/J	36.8	*0.01*	0.03	0.04	0.15	0.23	*0.81*	7.6	5	7.9	9.9
Composite K/L/M	36.3	*0.01*	0.03	0.02	0.14	0.18	*0.31*	4.3	4.8	6	9.9

[1] NA, Not applicable.
[2] Italicized numbers indicate that the measurement (or subsequent calculation) is an estimate that was below the instrument calibration range.

1.5.2 Ampelisca Abdita 10-Day Solid-Phase Test

Results of the solid-phase test with *A. abdita* are summarized in Table 3-11. The complete test results by replicate are presented in Appendix D. Data presented within this section are mean survival only. Mean survival in the *A. abdita* control sediments was 97%, which validates the test. *A. abdita* mean survival in the CSDS reference sediments was 97%.

Table 1-11. Mean and standard deviation (sd) survival in the 10-d Solid-Phase *Ampelisca abdita* Acute Toxicity Test.

Treatment	Survival		Absolute Difference from CSDS (%)	Statistically Significant Difference from CSDS [1]
	Mean (%)	sd		
Control	97	3	NA	NA
CSDS Reference	97	7	NA	NA
Clinton Harbor				
Composite G/H [2]	**68**	**31**	**–29**	**Yes**
Composite I/J	93	4	–4	No
Composite K/L/M	96	4	–1	No

[1] Determined by Fisher's LSD
[2] Composites shown in boldface type were acutely toxic to *Ampelisca abdita*.

Water quality parameters (Appendix D) were within the acceptable ranges during the test except for minor deviations in salinity (greater than the upper limit by < 1 ‰). These deviations had no apparent effect on test results.

The cadmium reference toxicant results (Appendix D) showed that the test population was as sensitive as typical *A. abdita* populations that have been tested at Battelle MSL. The LC_{50} (0.57 mg/L) was within the control range of 0.36–1.24 mg/L (mean = 0.80 mg/L) as determined for the previous 20 tests of this species conducted at Battelle MSL.
Among the three Clinton Harbor test sediments, *A. abdita* mean survival ranged from 68% to 96% (Table 3-11). *Ampelisca* survival in Clinton Harbor Comp G/H was significantly different from that in the CSDS reference sediment (Fisher's LSD, $p > 0.05$). The absolute difference between survival in any

test sediment versus that in the reference sediment was > 20% for Clinton Harbor Comp G/H. Therefore, only Clinton Harbor Comp G/H was acutely toxic to *Ampelisca abdita.*

1.5.3 Americamysis bahia 10-Day Solid-Phase Test

Results of the solid-phase test with *A. bahia* are summarized in Table 3-12. Complete test results by replicate are presented in Appendix D. Mean survival in the test containers designated as the Connecticut Harbors control sediments was 87%, which is slightly lower than the 90% needed to validate the test. However, the mysid survival in the concurrently-run control test for the Bridgeport Harbor Environmental Assessment was 90%. Because the Bridgeport control samples were run at the same time and under the same test set up and conditions as those from Connecticut Harbors, and involved animals from the same culture batch and sediment from the same collection batch, the Bridgeport mysid control survival can be used to validate the Connecticut Harbors mysid test. *A. bahia* mean survival in the CSDS reference sediments was 95%.

Table 1-12. Mean and standard deviation (sd) survival in the 10-d Solid-Phase *Americamysis bahia* Acute Toxicity Test.

Treatment	Percent Survival		Absolute Difference from CSDS (%)	Statistically Significant Difference from CSDS [1]
	Mean (%)	sd		
A. bahia Control [2]	90	8	NA	NA
CSDS Reference	95	4	NA	NA
Clinton Harbor				
Composite G/H	94	4	–1	No
Composite I/J	90	6	–5	No
Composite K/L/M [3]	**76**	**11**	**–19**	**Yes**

[1] Determined by Fisher's LSD
[2] Data from replicates designated as control jars for the concurrent Bridgeport Harbor test.
[3] Composite shown in boldface type was acutely toxic to *Americamysis bahia*.

Water quality parameters (Appendix D) were within the acceptable ranges during the test except for minor deviations in salinity (greater than the upper limit by < 1 ‰) and one deviation in DO content (3.2 mg/L recorded on Day 5 for one replicate container of Clinton Harbor Comp K/L/M).

The copper reference toxicant results (Appendix D) showed that the test population was about as sensitive as typical *A. bahia* populations that have been tested at Battelle MSL. The LC_{50} (275 μg /L) was within the control range of 170–420 μg /L (mean = 295 μg/L) as determined for the previous 20 tests of this species conducted at Battelle MSL.

A. bahia mean survival in the three Clinton Harbors test sediments ranged from 76% to 94% (Table 3-12). The absolute difference in survival between any test sediment versus the reference sediment exceeded 10 % only for Clinton Harbor Comp K/L/M. *A. bahia* survival in test sediment Clinton Harbor Comp K/L/M was significantly different from that in the CSDS reference sediment (Fisher's LSD, $p > 0.05$). Therefore, the Clinton Harbor Comp K/L/M was acutely toxic to *Americamysis bahia.*

1.6 Bioaccumulation Tests

1.6.1 *Macoma nasuta* Bioaccumulation Test

The *M. nasuta* bioaccumulation test was conducted from October 22, 2001 to November 19, 2001. Mean survival in the *M. nasuta* control sediments was 95%. *M. nasuta* mean survival in the CSDS reference sediments was 95%. Mean survival in the three Clinton Harbor test sediments were all 97%. Complete test results by replicate are presented in Appendix E. Enough tissue was collected to permit chemical analyses.

Water quality parameters (Appendix E) were within the acceptable ranges during the test except for minor deviations in salinity (greater than the upper limit by < 1 ‰) and pH (lower than the lower limit by 0.3 unit). These deviations had no apparent effect on test results.

1.6.2 *Nereis virens* Bioaccumulation Test

The *N. virens* bioaccumulation test was originally initiated on October 11, 2001. By Day 8 of the test (October 19, 2001) worm mortality for the overall test was high (19%) and increasing. Therefore, a decision to terminate the test was made. A new batch of worms was obtained from ARO and the test was reinitiated on October 30, 2001. The test terminated on November 27, 2001.

Mean survival in the *N. virens* control sediments was 81%, however survival in one replicate was poor indicating that it may have been an outlier. If this replicate is excluded, the mean survival for the remaining four replicates is 95%. *N. virens* mean survival in the CSDS reference sediments was 79%, however one replicate had poor survival indicating that it may have been an outlier. If this replicate is excluded, the mean survival for the remaining four replicates is 91%. Mean survival in the three Clinton Harbor test sediments ranged from 82% to 96%. Complete test results by replicate are presented in Appendix E. Enough tissue was collected to permit chemical analyses.

Water quality parameters (Appendix E) were within the acceptable ranges during the test except for minor deviations in salinity (greater than the upper limit by < 1 ‰) and pH (lower than the lower limit by 0.1 unit). These deviations had no apparent effect on test results.

2. DISCUSSION AND CONCLUSIONS

2.1 Benthic Effects

The *Green Book* states that, for the amphipod test, test material does not meet the limiting permissible concentration (LPC) for benthic toxicity when organism survival in the test sediment and the reference site sediment is statistically significantly different, and when the decrease in survival observed exceeds 20% for *A abdita* in the test treatment relative to the reference treatments and 10% for A. *bahia*. Based on this definition, one sediment composite (Clinton Harbor Comp G/H) exhibited acute toxicity to *A. abdita* and one sediment composite (Clinton Harbor Comp K/L/M) exhibited acute toxicity to *A. bahia*. A summary of the test results is provided in Table 4-1. **This test was repeated by Woods Hole Group Oct 2003 – Data following this report.**

Table 2-1. Statistical Significance of 10-Day Acute Solid Phase Tests for Clinton Harbor Samples.

Treatment	Statistically Significant Difference from CSDS [1]	
	A abdita	*A. bahia*
Clinton Harbor		
Composite G/H [2]	**Yes**	No
Composite I/J	No	No
Composite KLM [2]	No	**Yes**

[1] Determined by Fisher's LSD
[2] For treatments shown in boldface type, the difference in mean survival between the treatment and the reference sediment was statistically significant and >20% for A. *abdita* or > 10% for A. *bahia*.

2.2 Water-Column Effects

Three water column tests were conducted in support of the Connecticut projects; two 96-hour exposures using a vertebrate (*Menidia beryllina*) and a crustacean (*Americamysis bahia*) and a 72 hour using larvae of the Eastern purple urchin (*Arbacia punctulata).* If mortalities were greater than 50% in any of the dilutions, LC_{50} values were estimated. The significance of these estimates is based on the likelihood of 0.01 of these concentrations existing at the edge of the mixing zone after disposal operations, after allowance of 4 hours for initial mixing. Numerical models are available to NED if required, to determine whether these acutely toxic concentrations present a disposal problem.

Results of all three SPP tests are summarized below and presented in Table 4-2. Based on the survival and development data, a synopsis of adverse effects is presented in Table 4-3.

The SPP solutions prepared from the Clinton Harbor composites G/H, I/J, and K/L/M did not have an impact on the inland silverside, *Menidia beryllina*, or the mysid shrimp, *Americamysis bahia*, but did have an impact on the sea urchin, *Arbacia punctulata*.

Table 2-2. Summary of SPP LC-50 and EC-50 Values.

Treatment	***Americamysis bahia***	***Menidia beryllina***	***Arbacia punctulata***	
	LC-50 Endpoint	LC-50 Endpoint	LC-50 Endpoint	EC-50 Endpoint
Clinton Harbor Comp G/H	>100.0%	>100.0%	17.7%	16.0%
Clinton Harbor Comp I/J	>100.0%	>100.0%	47.8%	21.0%
Clinton Harbor Comp K/L/M	>100.0%	>100.0%	>100.0%	62.0%

Table 2-3. Summary of Adverse Effects of SPP Assays.

Treatment	Adverse Effect	Adverse Effect	Adverse Effect
	Americamysis bahia	*Menidia beryllina*	*Arbacia punctulata*
Clinton Harbor Comp G/H	No	No	Yes
Clinton Harbor Comp I/J	No	No	Yes
Clinton Harbor Comp K/L/M	No	No	Yes

COMMENTS:
An "Adverse Effect" was considered to have occurred when there was a significant (p=<0.05) difference in survival between the undiluted SPP and the CSDS reference site dilution water.

2.3 Bioaccumulation Potential

This section summarizes the mean concentrations of the chemical analyses of five individual replicates of tissue composites of *M. nasuta* and *N. virens* samples exposed to sediment composites from the one Clinton Harbor Comp I/J statistically compared to results from the CSDS reference site. Tissue samples were analyzed for lipids, metals, PCBs, and PAHs (Table 3-3). Complete analytical data for all replicate samples for all parameters, along with quality control data, are reported in Appendix F.

2.3.1 Bioaccumulation of Metals

Eight metals (As, Cd, Cr, Cu, Hg, Pb, Ni, Zn) were analyzed in tissues from *Macoma nasuta* and *Nereis virens* exposed to sediments from the CSDS reference site and replicate one (1) of Clinton Harbor Comp I/J. Tissues exposed to sediments in replicates 2–5 of Clinton Harbor Comp I/J were only analyzed for Cd and Pb. *Note that all replicates from Clinton Harbor Comp I/J only required Cd and Pb analysis. However all eight metals were analyzed in replicate 1 of this treatment because this replicate was used as a laboratory QC sample (i.e., laboratory sample duplicate).*

Neither Cd nor Pb concentrations in clams (Table 4-4) or worms (Table 4-5) exposed to Clinton Harbor Composite I/J were statistically greater than those in tissues of clams exposed to the reference sediment (Table 4-4).

Table 2-4. Mean, Standard Deviation (SD), and Data Qualifiers (Q) for Concentrations of Metals Detected in *Macoma nasuta* Tissues Exposed to Sediments from the Clinton Harbor Composite I/J and the Cornfield Shoals Disposal Site. Values are μg/g wet weight.

Analyte	CSDS Reference			Clinton Harbor Composite I/J		
	Mean	SD	Q	Mean	SD	Q
As	3.84	0.225		NA	NA	
Cd	0.05	0.007		0.04	0.007	
Cr	4.87	1.410		NA	NA	
Cu	2.01	0.184		NA	NA	
Hg	0.02	0.001		NA	NA	
Pb	0.43	0.024		0.46	0.191	
Ni	2.69	0.618		NA	NA	
Zn	15.34	1.020		NA	NA	

NA, not analyzed.
S, treatment mean is statistically greater than reference mean (Fisher's LSD test).

Table 2-5. Mean, Standard Deviation (SD), and Data Qualifiers (Q) for Concentrations of Metals Detected in *Nereis virens* Tissues Exposed to Sediments from the Clinton Harbor Composite I/J and the Cornfield Shoals Disposal Site. Values are μg/g wet weight.

Analyte	CSDS Reference			Clinton Harbor Composite I/J		
	Mean	SD	Q	Mean	SD	Q
As	1.90	0.866		NA	NA	
Cd	0.04	0.017		0.04	0.003	
Cr	0.18	0.069	B	NA	NA	
Cu	0.83	0.349		NA	NA	
Hg	0.02	0.005		NA	NA	
Pb	0.14	0.066	B	0.20	0.028	B
Ni	0.13	0.051		NA	NA	
Zn	10.20	7.438		NA	NA	

NA, not analyzed.
B, treatment mean is less than ten times the blank concentration.

2.3.2 Bioaccumulation of PCBs

Twenty-two PCB congeners were analyzed in tissues from *Macoma nasuta* and *Nereis virens* exposed to sediments from the CSDS reference site and to Clinton Harbor Comp I/J. Concentrations of four PCB congeners (PCB08, PCB128, PCB184, PCB195) in tissues of *Macoma nasuta* exposed to all sediments were lower than the method detection limits (Table 4-6). Concentrations of two additional PCB congeners (PCB105, PCB206) in tissues of clams exposed to the CSDS reference sediment were lower than the method detection limits (Table 4-6). Among the remaining 16 congeners, concentrations of 15 congeners in tissues of clams exposed to Clinton Harbor Composite I/J was significantly greater than those in tissues of clams exposed to the reference sediment (Table 4-6).

Table 2-6. Mean, Standard Deviation (SD), and Data Qualifiers (Q) for Concentrations of PCBs Detected in *Macoma nasuta* Tissues Exposed to Sediments from the Clinton Harbor Composite I/J and the Cornfield Shoals Disposal Site. Values are µg/kg wet weight.

Analyte	CSDS Reference			Clinton Harbor Composite I/J		
	Mean	sd	Q	Mean	sd	Q
PCB08	0.28	0.142	U	0.21	0.000	U
PCB18	0.07	0.030	a	0.19	0.054	J, S
PCB28	0.15	0.071	a	0.89	0.135	S
PCB44	0.06	0.082	a	0.18	0.043	J, S
PCB49	0.24	0.023		1.18	0.194	S
PCB52	0.62	0.054		1.20	0.212	S
PCB66	0.23	0.119	a	1.24	0.225	S
PCB87	0.10	0.073	a	0.16	0.034	J, S
PCB101	0.48	0.042		1.34	0.240	S
PCB105	0.04	0.019	U	0.18	0.043	J, b
PCB118	0.22	0.112	a	0.97	0.170	S
PCB128	0.08	0.039	U	0.06	0.000	U
PCB138	0.37	0.205	a	0.81	0.147	S
PCB153	0.63	0.079		1.40	0.215	S
PCB170	0.04	0.021	a	0.12	0.026	J, S
PCB180	0.12	0.092	a	0.32	0.056	S
PCB183	0.04	0.021	a	0.09	0.046	a, S
PCB184	0.04	0.022	U	0.03	0.000	U
PCB187	0.20	0.040		0.39	0.065	S
PCB195	0.03	0.016	U	0.02	0.000	U
PCB206	0.03	0.015	U	0.05	0.028	a, b
PCB209	0.04	0.018	a	0.05	0.019	a

U, analyte undetected in all replicates; value is mean of 1/2 reported detection limits.
J, analyte detected above the batch-specific method detection limit in all 5 replicates, but below the batch-specific reporting limit.
S, treatment mean is statistically greater than reference mean (Fisher's LSD test).
a, analyte undetected in at least one replicate. Statistical analysis was conducted using ½ reported detection limit for undetected replicates.
b, analyte was detected in the treatment at a higher mean concentration than reference; statistical analyses not conducted because analyte was not detected in any replicate of the reference.

Concentrations of two PCB congeners (PCB08, PCB184) in tissues of *Nereis virens* exposed to the Clinton Harbor Comp I/J was lower than the method detection limits (Table 4-7). Among the remaining 20 congeners, concentrations of 16 congeners in tissues of worms exposed to the Clinton Harbor Comp I/J was significantly greater than those in tissues of worms exposed to the reference sediment (Table 4-7).

Table 2-7. Mean, Standard Deviation (SD), and Data Qualifiers (Q) for Concentrations of PCBs Detected in *Nereis virens* Tissues Exposed to Sediments from the Clinton Harbor Composite I/J and the Cornfield Shoals Disposal Site. Values are μg/kg wet weight.

Analyte	CSDS Reference			Clinton Harbor Composite I/J		
	Mean	sd	Q	Mean	sd	Q
PCB08	0.21	0.000	U	0.21	0.000	U
PCB18	0.15	0.123	a	0.36	0.046	S
PCB28	0.09	0.033	J	0.44	0.046	S
PCB44	0.07	0.034	a	0.29	0.046	J, S
PCB49	0.36	0.193		0.80	0.073	S
PCB52	0.46	0.211		1.03	0.158	S
PCB66	0.10	0.044	J	0.51	0.040	S
PCB87	0.10	0.049	J	0.11	0.010	J
PCB101	0.55	0.205		1.12	0.125	S
PCB105	0.18	0.063	J	0.27	0.046	J, S
PCB118	0.29	0.169		0.62	0.097	S
PCB128	0.14	0.054	a	0.19	0.024	J
PCB138	1.21	0.246		1.65	0.137	S
PCB153	1.61	0.302		2.35	0.164	S
PCB170	0.24	0.048	J	0.34	0.032	S
PCB180	0.66	0.104		0.90	0.061	S
PCB183	0.27	0.047	J	0.32	0.033	
PCB184	0.03	0.000	U	0.03	0.000	U
PCB187	0.58	0.074		0.81	0.035	S
PCB195	0.13	0.018	J	0.16	0.008	J, S
PCB206	0.13	0.102	a	0.03	0.016	a
PCB209	0.19	0.024	J	0.23	0.025	J, S

U, analyte undetected in all replicates; value is mean of 1/2 reported detection limits.
S, treatment mean is statistically greater than reference mean (Fisher's LSD test).
J, Analyte detected above the batch-specific method detection limit in all 5 replicates, but below the batch-specific reporting limit.
a, analyte undetected in at least one replicate. Statistical analysis was conducted using ½ reported detection limit for undetected replicates.

2.3.3 Bioaccumulation of PAHs

Twenty-three PAH compounds were analyzed in tissues of *Macoma nasuta* and *Nereis virens* exposed to sediments from the CSDS reference site and the Clinton Harbor Comp I/J. The concentrations of all PAH analytes in tissues of *Macoma nasuta* exposed to the CSDS reference sediment were greater than the method detection limits (Table 4-8). Tissue concentrations of 18 analytes were statistically greater in clams exposed to the Clinton Harbor Composite I/J than they were in clams exposed to the CSDS reference sediment (Table 4-8).

The concentrations of all PAH analytes, except indeno(1,2,3-c,d)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene, in tissues of *Nereis virens* exposed to the CSDS reference sediment were greater than the method detection limits (Table 4-9). Among the remaining 20 PAH analytes, the concentrations of 15 PAHs were statistically greater in the Clinton Harbor Composite I/J than they were in tissues of worms exposed to the CSDS reference sediment (Table 4-9).

Table 2-8. Mean, Standard Deviation (SD), and Data Qualifiers (Q) for Concentrations of PAHs Detected in *Macoma nasuta* Tissues Exposed to Sediments from the Clinton Harbor Composite I/J and the Cornfield Shoals Disposal Site. Values are µg/kg wet weight.

Analyte	CSDS Reference			Clinton Harbor Composite I/J		
	Mean	sd	Q	Mean	sd	Q
Naphthalene	1.37	0.428	B	1.34	0.229	B
2-Methylnaphthalene	0.45	0.094	B, J	0.45	0.083	B, J
1-Methylnaphthalene	0.28	0.071	B, J	0.26	0.037	B, J
2,6-Dimethylnaphthalene	0.24	0.042	J	0.41	0.042	J, S
Biphenyl	0.55	0.222	B	0.63	0.135	B, J
Acenaphthylene	0.33	0.044	J	1.19	0.194	S
Acenaphthene	0.21	0.038	J	0.95	0.163	S
Fluorene	0.18	0.016	J	1.50	0.211	S
Phenanthrene	1.15	0.036	B	11.58	1.819	S
Anthracene	0.36	0.032	J	4.16	0.526	S
1-Methylphenanthrene	0.37	0.042	J	2.07	0.336	S
Fluoranthene	5.60	0.742		62.66	9.719	S
Pyrene	9.05	1.265		52.40	6.566	S
Benzo(a)anthracene	1.91	0.231		10.85	1.912	S
Chrysene	3.49	0.326		17.16	2.892	S
Benzo(b)fluoranthene	4.10	0.523		13.06	1.702	S
Benzo(k)fluoranthene	3.87	0.496		11.46	2.228	S
Benzo(e)pyrene	3.89	0.419		11.40	1.655	S
Benzo(a)pyrene	2.79	0.285		8.29	1.270	S
Perylene	2.52	0.701		21.68	3.189	S
Indeno(1,2,3-c,d)pyrene	1.66	0.221		4.63	0.881	S
Dibenz(a,h)anthracene	0.36	0.084	J	1.05	0.172	
Benzo(g,h,i)perylene	1.99	0.240		4.59	0.612	S

B, treatment mean is less than ten times the blank concentration.
J, reported value is less than the sample specific detection limit.
S, treatment mean is statistically greater than reference mean (Fisher's LSD test).

Table 2-9. Mean, Standard Deviation (SD), and Data Qualifiers (Q) for Concentrations of PAHs Detected in *Nereis virens* Tissues Exposed to Sediments from the Clinton Harbor Composite I/J and the Cornfield Shoals Disposal Site. Values are μg/kg wet weight.

Analyte	CSDS Reference			Clinton Harbor Composite I/J		
	Mean	sd	Q	Mean	sd	Q
Naphthalene	0.59	0.352	B, a	0.64	0.040	B, J
2-Methylnaphthalene	0.25	0.072	B, J	0.22	0.016	B, J
1-Methylnaphthalene	0.19	0.054	B, J	0.21	0.014	B, J
2,6-Dimethylnaphthalene	0.10	0.040	J	0.10	0.047	a
Biphenyl	0.27	0.119	B, J	0.31	0.052	B, J
Acenaphthylene	0.16	0.034	J	0.32	0.068	J, S
Acenaphthene	0.25	0.105	J	0.83	0.149	S
Fluorene	0.19	0.077	J	0.31	0.056	J, S
Phenanthrene	0.23	0.121	B, a	0.87	0.184	B, S
Anthracene	0.10	0.016	J	0.28	0.048	J, S
1-Methylphenanthrene	0.12	0.171	a	0.53	0.098	J, S
Fluoranthene	0.77	0.154		8.47	1.704	S
Pyrene	0.93	0.179		6.99	1.200	S
Benzo(a)anthracene	0.05	0.008	J	0.37	0.080	J, S
Chrysene	0.45	0.113		2.00	0.493	S
Benzo(b)fluoranthene	0.06	0.062	a	0.40	0.071	J, S
Benzo(k)fluoranthene	0.06	0.066	a	0.52	0.095	J, S
Benzo(e)pyrene	0.16	0.104	a	0.61	0.089	J, S
Benzo(a)pyrene	0.03	0.029	a	0.26	0.058	J, S
Perylene	0.16	0.140	J	0.66	0.167	J, S
Indeno(1,2,3-c,d)pyrene	0.01	0.000	U	0.07	0.065	a, b
Dibenz(a,h)anthracene	0.01	0.000	U	0.05	0.025	a
Benzo(g,h,i)perylene	0.01	0.000	U	0.18	0.035	J, b

B, treatment mean is less than ten times the blank concentration.
J, reported value is less than the sample specific detection limit.
S, treatment mean is statistically greater than reference mean (Fisher's LSD test).
a, analyte undetected in at least one replicate. Statistical analysis and mean calculation was conducted using 1/2 reported detection limit for undetected replicates.
b, analyte was detected in the treatment at a higher mean concentration than reference; statistical analyses not conducted because analyte was not detected in any replicate of the reference.

Attachments for this appendix were omitted for brevity and are available upon request.