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Dave Dickerson to Matt Schweisberg
Cc. ElaineT Stanley, Cynthia Catri

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Matt - here is the DRAFT 2009 LTM V report as discussed previously. Since it is draft, please do not distribute outside of the agency.

Dave

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WOODS HOLE GROUP

US Army Corps of Engineers
New England District

DRAFT
SUMMARY REPORT

New Bedford Harbor Long Term Monitoring V

Contract No. W912WJ-09-D-0001-0018

Prepared For:
United States Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

Prepared By:
Woods Hole Group, Inc.
81 Technology Park Drive
East Falmouth, MA 02536

August 2010

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1.0 INTRODUCTION

1.1 SITE NAME, LOCATION, AND DESCRIPTION

The New Bedford Harbor Superfund Site, located in Bristol County, Massachusetts, extends from the shallow northern reaches of the Acushnet River estuary south through the commercial harbor of New Bedford and into 17,000 adjacent areas of Buzzards Bay (Figure 1). Industrial and urban development surrounding the harbor has resulted in sediments becoming contaminated with high concentrations of many pollutants, notably polychlorinated biphenyls (PCBs) and heavy metals, with contaminant gradients decreasing from north to south. From the 1940s into the 1970s two electrical capacitor manufacturing facilities, one located near the northern boundary of the site and one located just south of the New Bedford Harbor hurricane barrier, discharged PCB wastes either directly into the harbor or indirectly via discharges to the City's sewerage system. The Site has been divided into three areas – the upper, lower and outer harbors – consistent with geographical features of the area and gradients of contamination. The Site is also defined by three state-sanctioned fishing closure areas extending approximately 6.8 miles north to south and encompassing approximately 18,000 acres in total.

The City of New Bedford, located along the western shore of the Site, is approximately 55 miles south of Boston. During most of the 1800s, New Bedford was a world renowned center of the whaling industry and attracted a large community of immigrants from Portugal and the Cape Verde islands. Including the neighboring towns of Acushnet, Fairhaven and Dartmouth, the combined 1990 population was approximately 153,000. New Bedford is currently home port to a large offshore fishing fleet and is a densely populated manufacturing and commercial center. By comparison, the eastern shore of New Bedford Harbor is predominantly residential or undeveloped. A large (approximately 70 acre) salt marsh system has formed along almost the entire eastern shore of the upper harbor.

The Acushnet River's 16.5 square mile (43 km^2) drainage basin (VHB, 1996) discharges to New Bedford Harbor in the northern reaches of the Site, contributing on average relatively minor (except during high periods of runoff) volumes of fresh water to the tidally influenced harbor. Numerous storm drains, combined sewer overflows (CSOs) and industrial discharges as well as smaller brooks and creeks also discharge directly to the Site. The upper and lower harbors are areas of net groundwater discharge and are generally described as a shallow, well-mixed estuary.

The upper harbor comprises approximately 187 acres, with current sediment PCB levels ranging from below detection to approximately 4,000 parts per million (ppm). Prior to the removal of the most contaminated hot spot sediments in 1994 and 1995 as part of EPA's first cleanup phase (see Section 1.3), sediment PCB levels were reported higher than 100,000 ppm in the upper harbor. The boundary between the upper and lower harbor is the Coggeshall Street Bridge where the width of the harbor narrows to approximately 100 feet. The lower harbor comprises approximately 750 acres, with

sediment PCB levels ranging from below detection to over 100 ppm. The boundary between the lower and outer harbor is the 150 foot wide opening of the New Bedford hurricane barrier, constructed in the mid-1960s. Sediment PCB levels in the outer harbor are generally low, with only localized areas of PCBs in the 50-100 ppm range near the Cornell-Dubilier plant and the City's sewage treatment plant's outfall pipes. The southern extent of the outer harbor and the Site is an imaginary line drawn from Rock Point (the southern tip of West Island in Fairhaven) southwesterly to Negro Ledge and then southwesterly to Mishaum Point in Dartmouth.

1.2 SITE HISTORY AND ENFORCEMENT ACTIVITY

Identification of PCB-contaminated sediments and seafood in and around New Bedford Harbor was first made in the mid 1970s as a result of EPA region-wide sampling programs. Total PCB usage in New Bedford at this time was around two million pounds per year (Nelson et al., 1996). In 1978, the manufacture and sale of PCBs was banned by the federal Toxic Substance Control Act (TSCA). In 1979, the Massachusetts Department of Public Health promulgated regulations prohibiting fishing and lobstering throughout the Site due to elevated PCB levels in area seafood. Elevated levels of heavy metals in sediments (notably cadmium, chromium, copper and lead) were also identified during this time frame. Due to these concerns, the Site was proposed for the Superfund National Priorities List (the NPL) in 1982, and finalized on the NPL in September 1983. Pursuant to 40 CFR 300.425(c)(2), the Commonwealth of Massachusetts nominated the Site as its priority site for listing on the NPL. In 1982, the U.S. Coast Guard erected signs around the Site warning against fishing and wading. These signs have been maintained or replaced by EPA and the City of New Bedford as needed.

EPA's site-specific investigations began in 1983 and 1984 with the Remedial Action Master Plan (Weston, 1983) and the Acushnet River Estuary Feasibility Study (NUS, 1984). Site investigations continued throughout the rest of the 1980s and early 1990s, including a pilot dredging and disposal study in 1988 and 1989 (Otis et al., 1990), which field tested different dredging and disposal techniques for upper harbor sediments. Site investigations also included extensive physical and chemical computer modeling of the Site (Battelle, 1990). These Site studies are summarized in more detail in the ROD for the hot spot areas of the Site (EPA, 1990) and in the 1990 Feasibility Study for the Site (Ebasco, 1990).

Collectively, these investigations identified the Aerovox facility as the primary source of PCBs to the Site. PCB wastes were discharged from Aerovox's operations directly to the upper harbor through open trenches and discharge pipes, or indirectly throughout the Site via CSOs and the City's sewage treatment plant outfall. Secondary inputs of PCBs were also made from the Cornell-Dubilier Electronics, Inc. (CDE) facility just south of the New Bedford hurricane barrier.

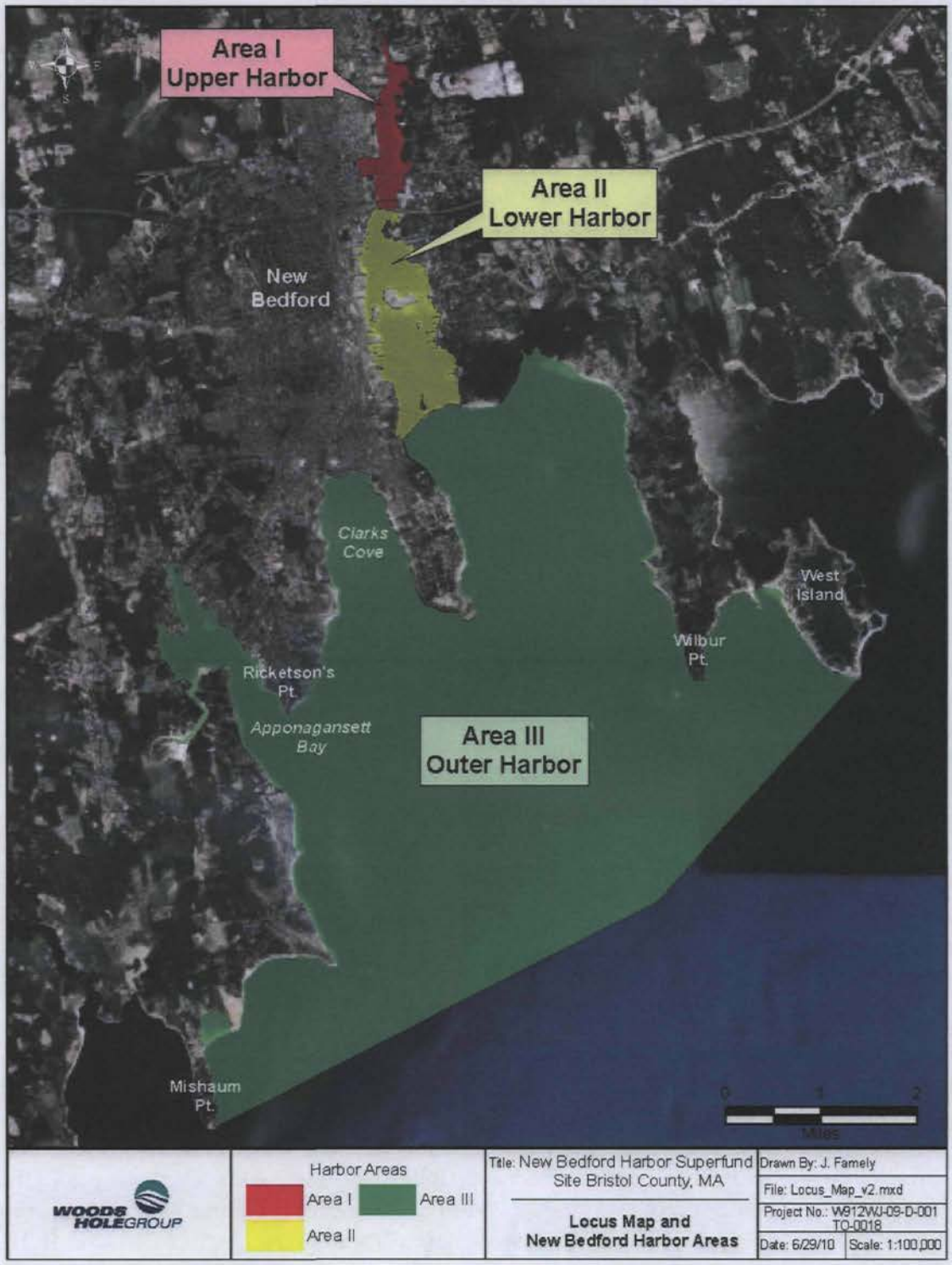

Figure 1. Site Map

In May 1982, Aerovox Incorporated signed an administrative consent order pursuant to section 106 of CERCLA regarding contamination on its property adjacent to the upper harbor. This order called for a cut-off wall and cap system to isolate contaminated soil, and for groundwater monitoring and maintenance. This containment system was completed in June 1984.

Also in May 1982, CDE and EPA signed an administrative consent agreement and final order under TSCA. This agreement addressed PCB handling procedures, discharges, releases to the municipal sewer system and surrounding areas, and groundwater monitoring requirements. Subsequently, in September 1983, EPA issued an administrative order to CDE under section 106 of CERCLA requiring CDE to remove PCB-contaminated sediments from portions of the municipal sewer system downstream of the CDE plant. The removal and disposal of these sediments took place in the fall of 1984 (CDE, 1985). EPA also issued an administrative order to the City of New Bedford under section 106 of CERCLA in September 1983 requiring the City to assist CDE in the sewer line clean-up and to monitor PCB levels from the City's municipal wastewater treatment plant.

On December 9, 1983, the United States filed a complaint on behalf of the National Oceanic and Atmospheric Administration (NOAA) under section 107 of CERCLA seeking damages for injury to natural resources at and near the Site caused by releases of PCBs. The next day, the Commonwealth of Massachusetts (the Commonwealth) filed its own section 107 action. The cases were subsequently consolidated. In February 1984, the complaint was amended to include claims on behalf of EPA for recovery of response costs incurred, or to be incurred, under section 107, and for injunctive relief under section 106 of CERCLA and other environmental statutes. The United States brought this action against six companies which, at various times, owned and/or operated either of the two capacitor manufacturing facilities at the Site.

On December 31, 1985, the Commonwealth issued a notification of responsibility to the City of New Bedford pursuant to the state's hazardous waste regulations regarding the build-up of PCB-contaminated grit in one of the main interceptors of the City's sewerage system. Severe amounts of PCB-contaminated grit had accumulated within the interceptor especially in the area between Coffin Avenue and Campbell Street; PCB levels in this grit averaged 265 ppm on a dry weight basis (CDM, 1987). The City subsequently encased and abandoned approximately one and one-half mile of the sewer interceptor that ran from Hathaway Street to Pearl Street.

In 1991 and 1992, the Unites States, the Commonwealth and five defendants in the litigation – Aerovox Incorporated, Belleville Industries, Inc., AVX Corporation, CDE, and Federal Pacific Electric Company (FPE) – reached settlement regarding the governments' claims. The governments' claims against the sixth defendant, RTE Corporation, were dismissed on jurisdictional grounds. The federal and state governments recovered a total of $99.6 million plus interest from the five settling defendants.

The terms of the settlements are set forth in three separate consent decrees. Under the first consent decree, Aerovox Incorporated and Belleville Industries, Inc. were required to pay a total of $12.6 million, plus interest, to the United States and the Commonwealth for damages to natural resources and for past and future Site response costs. The court approved and entered this consent decree in July 1991. Under the second consent decree, AVX Corporation was required to pay $66 million, plus interest, to the governments for natural resource damages and for past and future Site response costs. This decree was approved and entered by the court in February 1992. Under the third consent decree, CDE and FPE paid $21 million, plus interest, to the governments for natural resource damages and for past and future Site response costs. This decree was approved and entered by the Court in November 1992.

In April 1990, EPA issued the ROD for the hot spot operable unit of the Site. The hot spot ROD called for dredging and on-site incineration of the Site's most highly PCB-contaminated sediments located adjacent to the Aerovox facility. The ROD specified a 4,000 ppm PCB level to define the sediments to be dredged (sediments below this 4,000 ppm threshold were to be left in place). Dredging of these sediments – about 14,000 cubic yards (cy) in volume and 5 acres in area – began in April 1994 and was completed in September 1995. However, due to a vehement and congressionally-supported reversal in local support for on-site incineration during the initial mobilization stage, EPA suspended the incineration component of the hot spot remedy (EPA, 1995). The dredged hot spot sediments were therefore placed in interim storage in a shoreline confined disposal facility (CDF) near Sawyer Street in New Bedford.

In 1997 and 1998, additional investigations of the Aerovox and CDE facilities revealed elevated levels of PCBs on various work surfaces and areas of these facilities.

In September 1998, EPA issued ROD 2, the ROD for the upper and lower harbor operable unit (EPA, 1998). Although the hot spot sediments were removed from the harbor in 1994 and 1995, PCB contaminated sediment below 4,000 ppm PCBs remains in these areas by definition of the hot spot cleanup objectives (i.e., only those sediments contaminated above 4,000 ppm PCBs were removed). In addition, one of the hot spot areas (Area B, see USACE, 1991) was not dredged during the hot spot dredging operations due to its proximity to submerged high voltage power lines serving the City of New Bedford. The remedy for the upper and lower harbor therefore included these former hot spot areas in order to meet the more stringent target cleanup levels (TCLs) and remedial objectives of ROD 2.

Two localized areas of PCB-contaminated sediment located just south of the hurricane barrier were also included in ROD 2. While geographically just seaward of the operable unit and lower harbor boundary, these areas were included in the remedy to the extent that they contained sediment above the 50 ppm TCL for the lower harbor. Further investigation of the outer harbor area of the Site will be undertaken as part of operable unit three (OU-3), also planned to begin in mid-September 2009, to determine whether additional remediation is appropriate for this area.

On August 15, 2002 EPA issued a change to the 1998 harbor cleanup plan using a process known as an Explanation of Significant Difference (ESD) (EPA 2002). This ESD, which follows an earlier ESD issued in September 2001, eliminates CDF "D", the largest of the four CDFs (confined disposal facilities), and instead sends the dredged sediment slated for it to an offsite landfill. This ESD as well as other site information is available for review at the New Bedford Free Public Library (reference section) and at EPA's Boston records center. Both ESDs are also available online at the New Bedford Harbor web site (www.epa.gov/ne/nbh) under "Technical Documents."

EPA believes ROD 2 to be consistent with the remaining remedy selections envisioned for the Site, namely the hot spot ROD amendment and the outer harbor ROD, since it removes sediments that act as a continuing source of PCBs to surrounding areas, and since it can be implemented in a way that will not interfere with remedial activities for these other areas.

1.3 PURPOSE OF STUDY

In order to assess the effectiveness of the New Bedford Superfund remediation efforts, a long term environmental monitoring plan has been developed by the US Environmental Protection Agency's Research Laboratory, Atlantic Ecology Division in Narragansett, Rhode Island (AED). The plan incorporates an intensive sampling and analysis effort for the purpose of quantifying the long-term environmental effects of reduced PCB levels in the sediments and water column of the New Bedford Harbor estuary as a result of remediation efforts. The four previous sampling rounds for this program include the "baseline" sampling event conducted in October 1993 (LTM I), a second event (LTM II) conducted immediately after removal of the "hot spot" sediments in OU#2 during October of 1995, a third event conducted in 1999 (LTM III), and a fourth event conducted in 2004 by Battelle (LTM IV). The fifth event was conducted in 2009 (LTM V). This Summary Report describes the field and laboratory components of the LTM V program, and presents the LTM V data. Sample collection was completed by Woods Hole Group, Inc. was the prime contractor for this work, which was initiated in September of 2009.

The overall objective of LTM V was to gather chemical, biological, and physical data on sediments to document the spatial and temporal changes in the sediments and biota associated with the New Bedford Harbor Superfund remediation work.

2.0 METHODS

2.1 QUALITY ASSURANCE

Quality Assurance (QA) for this project is presented in detail in the Quality Assurance Project Plan (QAPP) developed for the LTM V survey (Woods Hole Group, 2009a).

2.2 FIELD METHODS

Detailed accounts of field sampling events and methods are provided in the NBH LTM V Field Sampling Report (Woods Hole Group, 2009b).

The field sampling program followed the guidelines and protocols developed for the Environmental Monitoring and Assessment Program (EMAP). Sampling was conducted at 79 separate stations located in three distinct geographical areas of New Bedford Harbor.

- **Area I:** Woods Street to the Coggeshall Street Bridge (27 stations)
- **Area II:** Coggeshall Street Bridge to the Hurricane Barrier (29 stations)
- **Area III:** Hurricane Barrier to the edge of Fishing Closure Area 3 (23 stations)

A hexagonal sampling grid was established by EPA AED within each of the three sampling areas (Figure 2). In order to obtain representative samples, the hexagonal sampling grid was proportionally adjusted to scale with the progressively larger sampling areas. The hexagons in Area I (Upper Harbor) have a radius (center to side mid-point) of 88m; the hexagons in Area II (Lower Harbor) have a radius of 175m; the hexagons in Area III (Outer Harbor) have a radius of 793m.

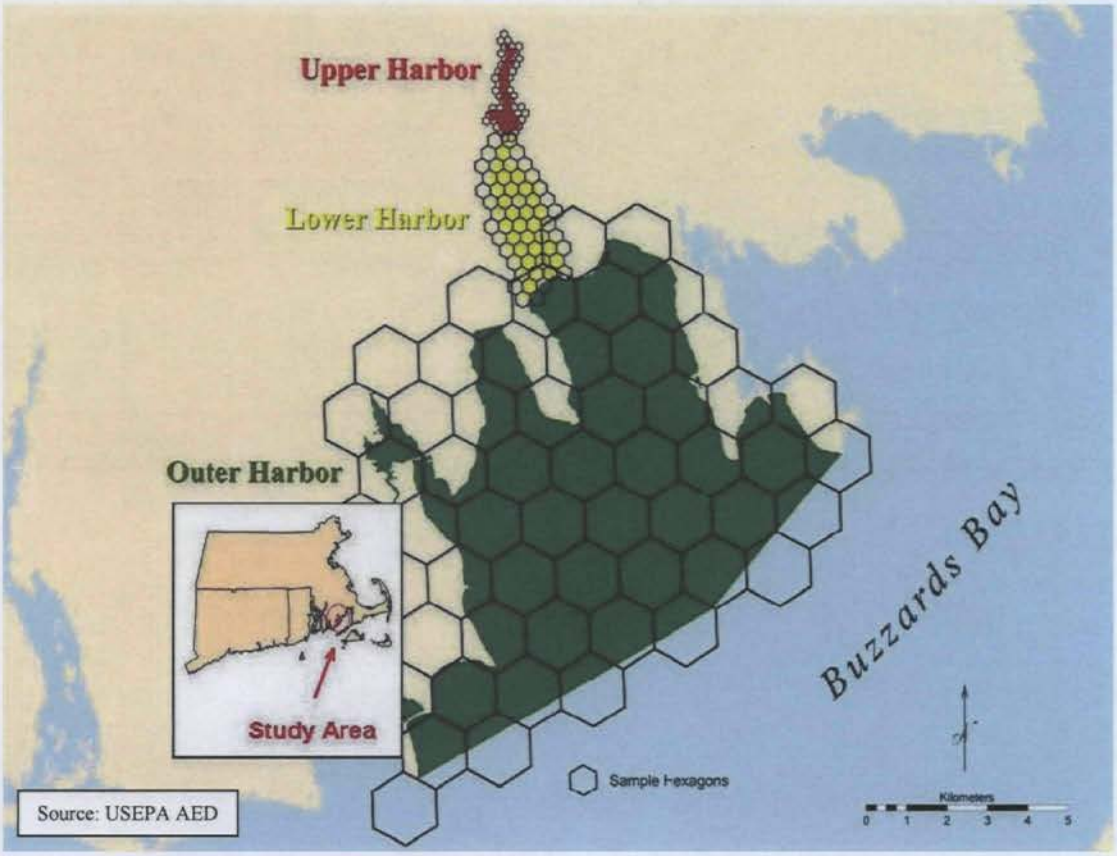

Figure 2. LTM Sampling Areas and Sampling Hexagons

The target sampling stations and as-sampled stations are shown in Figures 3 through 5. As-sampled stations are displayed in green and mostly overlap target stations (yellow).

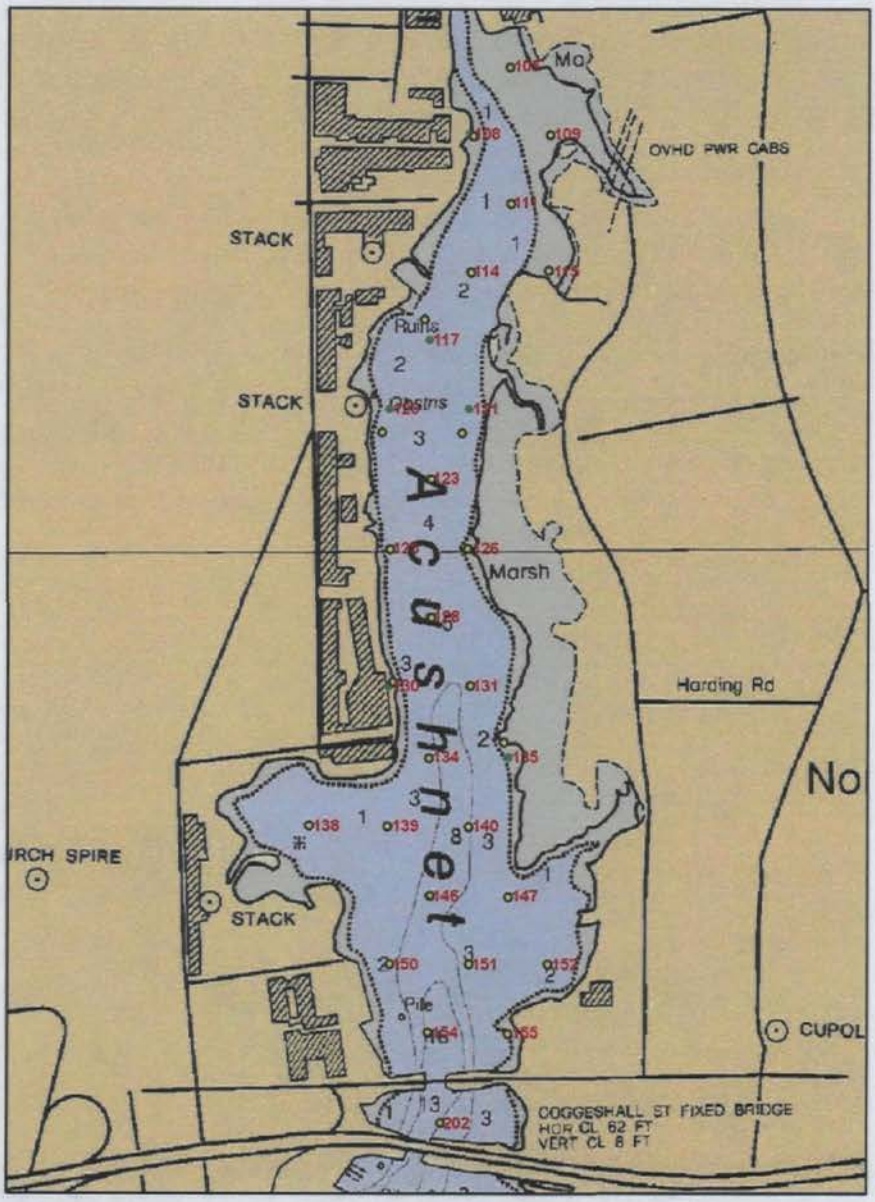

Figure 3. Area I Sampling Stations (Stations 105 – 202)

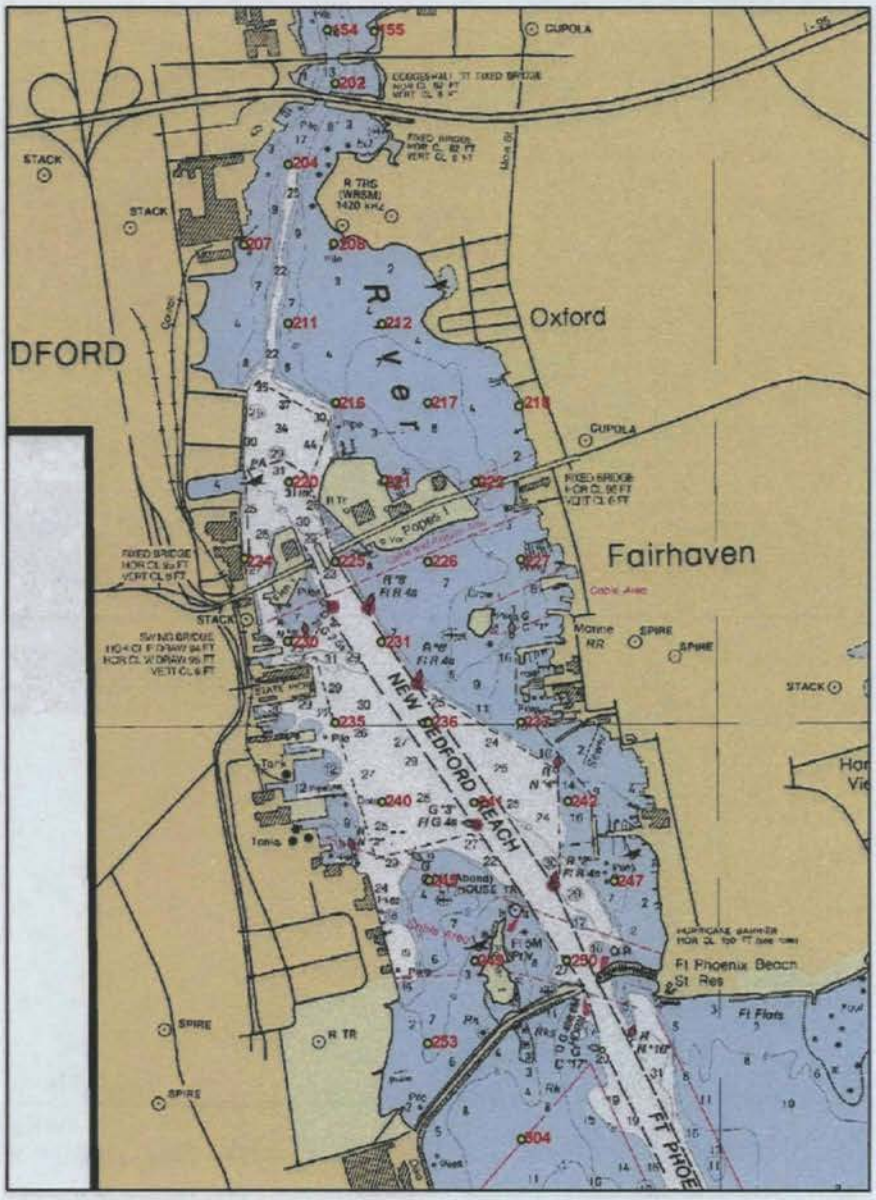

Figure 4. Area II Sampling Stations (Stations 204 – 253)

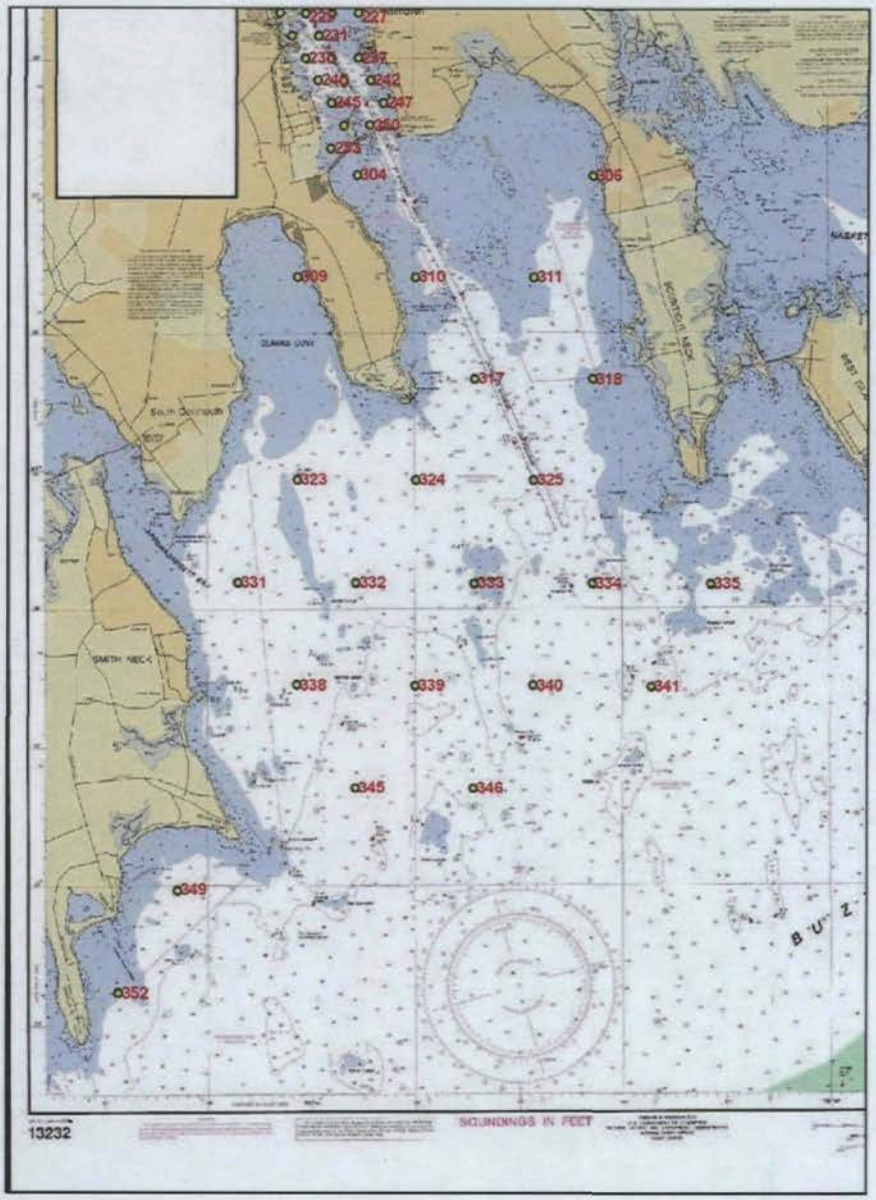

Figure 5. Area III Sampling Stations (Stations 304 – 352)

Navigation was performed using a Differential Global Positioning System (DGPS). Stations were initially located using the target coordinates established during the 1993 and 1995 surveys (Appendix A of the QAPP). In general, the targets were achieved. However, where the target coordinates were either inshore of navigable waters, or were inside the no-spud areas in the dredge area, the sample was relocated to the nearest acceptable location. All as-sampled locations were within the bounds of the associated station hexagon.

At each station, in situ water quality measurements were taken prior to the collection of sediment samples. Measured parameters included salinity, temperature, and dissolved oxygen. YSIs were used to collect water quality data. Sediment samples at each station were collected for the analysis of PCBs (18 NOAA Congeners), total organic carbon (TOC), and grainsize. Three benthic biology samples were collected at each station: two for community analysis and one for archiving. A summary of sampling and analysis activities is presented in Table 1.

Previous LTM assessments collected sediments for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium) analysis, AVS analysis, and sediment toxicity testing. These analyses were not pursued in LTM V.

Grab samples for chemistry analysis were collected at all of the stations using a Kynar® coated 0.1 m^2 Young modified Van Veen grab sampler. Each grab was inspected for acceptability. If the grab was deemed unacceptable (grab was not full; sediment was slumped or washed out) it was discarded over the opposite side of the vessel to avoid contaminating subsequent samples. The equipment was washed with site water before collecting the next sample. Once the grab was deemed acceptable, samples were collected for chemistry (PCBs and total organic carbon), grain size, and an archive from the top 2 cm. Each sample was contained in an 8-oz glass jar with a Teflon-lined lid, and labeled with pre-printed and bar-coded labels. Samples were stored in coolers on ice until being transferred to the sample custodian.

Grab samples for infauna analysis and associated grain size were collected concurrently with the samples described above. The infauna grab samples were collected using a 0.04-m^2 Young-modified Van Veen grab sampler. Triplicate grabs were taken at each station. Once the grab was deemed acceptable, a grain size sample was collected by inserting an open-ended syringe through the entire depth of the core and drawing the sediment out, thereby capturing a known volume of sample representing the entire depth of the grab. The remaining material was transferred to a sieving station and passed through a 0.5 mm sieve by washing with low pressure site water. All material remaining in the sieve was transferred to a clean plastic jar, preserved with buffered solution of 10% formalin and Rose Bengal stain, and identified with pre-printed labels. Grain size samples were also labeled and stored on ice. All benthic samples were transferred to sample custodians at the end of the sampling day.

For both sediment and infauna grabs, the vessel was moved slightly while on station to avoid re-sampling the same location. After each station was completed, the grabs were decontaminated with Alconox water solution then rinsed with site water.

Table 1. Summary of Sampling and Analysis Program

Field Collection	Sample Type	Analyses	No. Samples/ Station	Field QC Samples (FDs)	Total No. Field Samples Collected	Lab QC Samples	Total Samples
Sediment sampling at 79 stations within Segments 1, 2, 3 Plus one field duplicate (FD) within each Segment (3 total FDs) for each type of analysis.	Chemistry	PCBs	1	3 FDs	82	5 MS 5 MSD 5 SRM	97
		TOC	1	3 FDs	82	5 MS 5 MD	92
	Chemistry Archive	Organics & Metals	1	NA	79	NA	79
	Physical	Grain size	1/chemistry 1/ea of 3 benthic (4 total)	3 FDs /chemistry	319	4 MD	323
	Biological	Benthic Community analysis (species enumeration)	2	NA	158	NA	158
	Biological Archive	Benthic Community analysis (species enumeration)	1	NA	79	NA	79
Water Column testing at 79 stations (total) within Segments 1, 2, 3	Field measurement	Temperature	1	NA	79	NA	79
		Dissolved oxygen	1	NA	79	NA	79
		Salinity	1	NA	79	NA	79

FD = Field duplicate
MS = Matrix spike
MSD = Matrix spike duplicate
MD = Matrix (lab) duplicate
SRM = Standard Reference Material
NA = Not Applicable

2.3 LABORATORY METHODS

2.3.1 Chemical and Physical Analyses

PCB, TOC, and Grain size analysis were performed by Alpha Analytical in Mansfield, Massachusetts. Table 2 summarizes the analytical methods. Standard operating procedures (SOPs) employed by Alpha Analytical are referenced below and in Table 2, and are provided in Appendix D of the QAPP (Woods Hole Group, 2009a).

Table 2. Analytical Methods

Analyte Group	Laboratory SOP No.	Equivalent EPA or other Agency Method No.
PCBs	Alpha SOP OP-013 (extraction) Alpha SOP OP-014 (silica gel cleanup) Alpha SOP OP-010 (sulfuric acid cleanup) Alpha SOP O-015 (GC/MS-SIM analysis)	Shaker table extraction: performance-based method (NOAA Status and Trends (NOAA 1993) Extract Cleanup: EPA Method 3630C Extract Cleanup: EPA Method 3665A Analysis: SW-846 8270C, modified (EPA, 1996) & EPA 680, modified (EPA, 1985)
TOC	Alpha SOP W-028	SW-846 9060, modified (EPA, 1996)
Grain Size	Alpha SOP W-029 (Grain Size/ Particle-Size with Hydrometer)	ASTM D422-63 (ASTM, 1998)
Percent Solids	Alpha SOP W-001	EPA Method 2540G

2.3.1.1 PCBs

All sediment samples were analyzed for percent solids prior to extraction for PCB analysis. Any sample with less than 50% solids was air-dried and re-analyzed until percent solids exceeded 50%. PCB congener results on sediment samples was reported on a dry-weight basis. (based on the after air-drying percent solids result). Alpha Analytical extracted the sediments using the shaker table extraction procedure (Alpha SOP #OP-013) followed by silica gel cleanup (Alpha SOP #OP-014) and then sulfuric acid cleanup (Alpha SOP #OP-010). Extracts were analyzed using gas chromatography/mass spectrometry (GC/MS) in the Selected Ion Monitoring (SIM) mode of operation for the 18 NOAA PCB Congeners (Alpha SOP #O-015). Sample data was quantified by the method of internal standards. PCB congener results were reported on a dry-weight basis. Data from Alpha was not surrogate recovery corrected. This correction, as required by USACE and performed historically for LTM PCB results, was performed during the data validation process.

2.3.1.2 TOC

Total Organic Carbon (TOC) analysis was performed by Alpha Analytical following EPA SW-846 method 9060 modified for replicate analyses (Alpha SOP #W-028). The replicate results were averaged and the average value was reported.

2.3.1.3 Grain Size

Grain size analysis was performed by Alpha Analytical following ASTM D422-63 (Alpha SOP #W-029). Sediment grain-size was determined with phi-classes for sands using wet sieve analysis based on the methods outlined in ASTM D422-63 (particle-size analysis with hydrometer, ASTM 1998). Wet sieving yielded the following phi-classes:

Gravel (>2.00 mm), Very Coarse Sand (1.00-2.00 mm), Coarse Sand (0.50-1.00 mm), Medium Sand (0.25-0.50 mm), Fine Sand (0.125-0.25 mm), Very Fine Sand (0.0625-0.125 mm), and Silt and Clay (<0.0625 mm). Pipette analysis resulted in percents of silt (0.0039-0.0625 mm) and clay (<0.0039 mm).

2.3.2 Benthic Biology Analysis

Benthic biology sorting, enumeration, and identification was performed by Normandeau Associates in Bedford, New Hampshire. Sample processing was performed as described in Appendix E (EMAP Near-Coastal Laboratory Procedures Macrobenthic Community Assessment) of the QAPP (Woods Hole Group, 2009a), with the exception that sample biomass determinations were not performed. At each station, three replicate samples were collected: two for species enumeration, and one for archiving.

2.4 DATA VALIDATION METHODS

New Environmental Horizons, Inc. (NEH) performed an independent validation of the chemical data for PCB congeners and TOC generated during the LTM V. The basis for the validation was the EPA Region I validation guidelines, modified to include project-specific and method-specific criteria as discussed in the QAPP (Woods Hole Group, 2009a), consistent with validation protocols performed historically for LTM data. The data validation reports are provided in Appendix A.

Based on the Tier 1+ validation of the 18 NOAA PCB Congeners and TOC, all results are considered usable for project decisions based on a comparison to the NBH LTMV QAPP requirements. The validation reports (Appendix A) provide an understanding of the potential uncertainty (bias) in the qualified results.

Surrogate recovery correction of PCB data was also performed during data validation, which is different from previous LTM procedures. A technical memorandum was produced by NEH to document LTM IV surrogate recovery correction procedures and to present the recommended procedure for LTM V. The technical memorandum is presented in Appendix B. Surrogate-recovery correction was applied for twelve samples (502425, 502625, 503125, 503225, 503525, 503925, 504425, 504625, 504825, 505025, 505325, and 505625). The results of these samples were surrogate-recovery corrected following the methodology outlined in the technical memorandum, and qualified as estimated due to conflicting surrogate recovery results.

3.0 RESULTS

Sediment samples and water quality parameters were collected from 79 stations in the New Bedford Harbor study area between September 22, 2009 and September 28, 2009. Three field duplicate samples were also collected. Sample collection dates, times, coordinates and total water depths are presented in Appendix C.

3.1 WATER QUALITY

In situ water quality parameters were measured at all 79 stations in the New Bedford Harbor study area (Upper Harbor, Lower Harbor, and Outer Harbor). Water quality parameters were also taken for the three field duplicates. Salinity, temperature, and dissolved oxygen were measured prior to the collection of sediment samples. Water quality measurement depths and data are presented in Appendix D. Water quality data was not recorded at five field stations and for one of the field duplicates because the YSI exceeded available memory, thereby disabling the continuous data collection function.

Based on the data collected during field sampling, the water quality conditions can be characterized as follows:

- In the Upper Harbor, salinity ranged from 21.43 to 31.33 ppt with a median of 27.04 ppt. Temperature ranged from 18.76 to 21.64 °C with a median of 20.57 °C. Dissolved oxygen ranged from 6.40 to 10.60 mg/L with a median of 8.16 mg/L.

- In the Lower Harbor, salinity ranged from 23.40 to 27.97 ppt with a median of 26.85 ppt. Temperature ranged from 18.14 to 20.05 °C with a median of 19.77 °C. Dissolved oxygen ranged from 5.51 to 10.41 mg/L with a median of 7.07 mg/L.

- In the Outer Harbor, salinity ranged from 26.89 to 33.37 ppt with a median of 29.84 ppt. Temperature ranged from 18.12 to 19.79 °C with a median of 18.90 °C. Dissolved oxygen ranged from 6.69 to 8.06 mg/L with a median of 7.21 mg/L.

In general, salinity was higher in the Outer Harbor than in the Upper and Lower Harbors. This is a result of the seawater from Buzzards Bay in the Outer Harbor mixing with the freshwater inflow to the Upper Harbor. Temperature decreased slightly with increasing depth from the Upper Harbor to the Outer Harbor. This is likely because the sampling was conducted in September, when the shallow water remains relatively warm due to waning summer climatological influences. The temperature gradient from the Upper to Outer Harbor was mild, though, likely due to the onset of cooler fall weather. Mean dissolved oxygen was slightly higher in the Upper Harbor than in the Lower or Outer Harbors, but the low-to-high ranges overlapped substantially, and there was no strong trend. No anoxic conditions were observed, likely because of the early fall conditions during sampling, which tend to be characteristic of increasing dissolved oxygen conditions in the region.

3.2 CHEMICAL ANALYSES

Sediment samples were collected at all 79 stations in the New Bedford Harbor study area (Upper Harbor, Lower Harbor, and Outer Harbor). Three field duplicate samples were also collected. Sediments were analyzed by Alpha Analytical for the 18 NOAA PCB congeners and TOC. The laboratory data was validated by NEH.

3.2.1 Polychlorinated Biphenyls

At each of the 79 stations, plus the three field duplicate stations, sediment samples were collected for PCB analysis. Surrogate recovery correction of the PCB data was performed by NEH during data validation. Some of the sediment samples, mostly those collected from the Upper Harbor (Area 1), were highly contaminated, necessitating dilution in the laboratory. The surrogates that had initially been spiked into the sample were diluted out in these instances, and consequently no surrogate recovery correction could be performed. Final validated results of PCB analysis are presented in Appendix E.

Calculations of Total PCBs were performed on the validated results. This calculation summed the 18 NOAA PCB congeners, using a zero value for all non-detected results. The Total PCBs calculation did not utilize a multiplier, and any samples in which surrogate recovery correction was performed for some of the congeners were given a "K" qualifier for the summed result (Appendix E).

Throughout all three study areas, Total PCBs ranged between 3 parts per billion (ppb) and 329,936 ppb. The lowest Total PCB value was at Station 306 in the Outer Harbor; the highest Total PCB value was at Station 125 in the Upper Harbor. Results display a trend of decreasing Total PCBs from the Upper Harbor to the Outer Harbor. Some details include:

- Upper Harbor Total PCB levels were between 569 ppb (Station 202) and 329,936 ppb (Station 125) with a median of 29,781 ppb (Station 138).
- In the Lower Harbor, Total PCB was between 524 ppb (Station 250) and 18,725 ppb (Station 217) with a median of 4,412 ppb (Station 236).
- Outer Harbor Total PCB levels were between 3 ppb (Station 306) and 1,130 ppb (Station 304) with a median of 117 ppb (Stations 333 and 335).

This trend of substantial decreases in Total PCBs from the Upper to the Lower and into the Outer Harbor is consistent with prior LTM sampling events. High levels in the Upper Harbor are a result of the historical PCB source to the Upper Harbor from the Aerovox facility as discussed in Section 1.2.

3.2.2 Total Organic Carbon

At each of the 79 stations, plus the three field duplicate stations, sediment samples were collected for TOC analysis. In the laboratory, a replicate analysis was performed. The TOC data, presented in Appendix F, are the averages of the laboratory replicates for each sample.

Throughout all three study areas, TOC ranged between 0.05% and 5.15%. The lowest TOC value was recorded at Station 306 in the Outer Harbor; the highest TOC value was recorded at Station 125 in the Upper Harbor. That the lowest and highest levels of TOC corresponded to the lowest and highest Total PCB concentrations, respectively, is Consistent with prior analysis that demonstrated a relationship between TOC and PCB

levels in New Bedford Harbor. Results display an overall trend of decreasing TOC from the Upper Harbor to the Outer Harbor, also indicative of the Total PCB trend.

In the Upper Harbor, TOC was between 0.10% and 5.15% with a median of 2.52%. In the Lower Harbor, TOC was between 0.33% and 4.06% with a median of 1.81%. In the Outer Harbor, TOC was between 0.05% and 3.28% with a median of 0.97%.

3.3 PHYSICAL ANALYSIS

Sediment samples were collected at all 79 stations in the New Bedford Harbor study area (Upper Harbor, Lower Harbor, and Outer Harbor). Three field duplicate samples were also collected. Sediments were analyzed by Alpha Analytical for grain size.

At each of the 79 stations, plus the three field duplicate stations, four replicate sediment samples were collected for grain size analysis. One grain size replicate sample originated from the composited grab samples (top 2cm of the grab as specified in the field operations manual (Strobel, 2000)) collected for chemical analyses. The other three replicates were sub-sampled from the three sediment grab samples collected for benthic infauna analysis. An additional three field duplicates were collected in association with the chemistry analyses. The grain size data associated with the chemistry samples are presented in Appendix G. A brief summary of these grain size samples follows.

Total Percent Fines (sum of silt and clay) were highly variable throughout the study area:

- Upper Harbor: Fines ranged from 1% to 86%
- Lower Harbor: Fines ranged from 2% to 84%
- Outer Harbor: Fines ranged from 1% to 83%

Throughout all three study areas, the median grain size (d_{50}) was between 0.0236mm and 1.0943mm, ranging between silt and very coarse sand. The finest median sediment sample was at Station 123 in the Upper Harbor; the coarsest sample was at Station 236 in the Lower Harbor.

In the Upper Harbor, d_{50} was between 0.0236mm and 0.6992mm, ranging from silt to coarse sand. The Lower Harbor d_{50} was between 0.0325mm and 1.0943mm, ranging from silt to very coarse sand. And, in the Outer Harbor, d_{50} was between 0.0270mm and 0.7155mm, ranging from silt to coarse sand.

Grain size data from the benthic community replicate sampling is presented in Appendix H. Grain size distribution curves for all (chemistry and benthic community) analyses are presented in the laboratory reports included in Appendix I. Sample locations ending in "11", "12", or "13" are associated with benthic replicates, while samples locations ending in "26" or "36" are associated with chemistry samples.

3.4 BENTHIC FAUNA

At each of the 79 stations, three replicate sediment samples were collected for benthic community analysis. Two of the replicates were sorted and enumerated, while the third replicate was archived. Benthic community abundance data in the format specified by EPA is attached to the Normandeau report, which is included in Appendix J. Replicate 1 results are summarized as follows.

A total of 96 species and 19,688 organisms were enumerated from 27 samples in the Upper Harbor. The number of species encountered per station in the Upper Harbor ranged from 5 to 43, and the median in Upper Harbor samples was 14 species. Abundance per station in the Upper Harbor ranged from 17 to 4,137, and the median was 441 individuals. The station with the highest abundance (4,137) of any station sampled in LTM V was Station 108 in the Upper Harbor. The dominant species in the Upper Harbor was *Streblospio benedicti*. The total abundance of *Streblospio benedicti* in all Upper Harbor samples was 12,996. The next two most abundant organisms throughout the Upper Harbor were *Oligochaeta* (1,727) and *Polydora cornuta* (1,597).

A total of 136 species and 10,226 organisms were enumerated from 29 samples in the Lower Harbor. The number of species encountered per station in the Lower Harbor ranged from 4 to 59, and the median was 19 species. The station with the lowest species richness (4) of any station sampled in LTMV was Station 231 in the Lower Harbor. Abundance per station in the Lower Harbor ranged from 10 to 1,123, and the median was 318 individuals. The station with the lowest abundance (10) of any station sampled in LTM V was Station 240 in the Lower Harbor. As with the Upper Harbor, the dominant species in the Lower Harbor was *Streblospio benedicti*. The abundance of *Streblospio benedicti* was 1,822. By comparison to the strong dominance of this species in the Upper Harbor, the *Streblospio benedicti* abundance in the Lower Harbor was much closer to the next two most abundant organisms throughout the Lower Harbor [*Tharyx acutus* (1,052) and *Leitoscoloplos sp.* (880)].

A total of 233 species and 10,687 organisms were enumerated from the 23 samples in the Outer Harbor. The number of species encountered per station in the Outer Harbor ranged from 19 to 82, and the median was 43 species. The station with the highest species richness (82) of any station sampled in LTM V was Station 352 in the Outer Harbor. Abundance per station in the Outer Harbor ranged from 70 to 1,488, and the median was 439 individuals. The dominant species in the Outer Harbor was *Tharyx acutus*. The abundance of *Tharyx acutus* was 1,128. The next two most abundant organisms throughout the Outer Harbor were *Macoma tenta* (1,126) and *Cylichna oryza* (902).

Although formal statistics were not computed, the data indicate an increase in benthic community diversity from the Upper to the Lower and into the Outer Harbor. Lists of all species encountered in the Upper, Lower, and Outer Harbors (for Replicate 1 benthic samples) are provided in Appendix K.

4.0 DISCUSSION

The LTM V survey for New Bedford Harbor was completed in September 2009. Sediments were collected for physical, chemical and benthic biology analyses. Water quality parameters were also collected at each station. A total of 79 stations were sampled, and the appropriate field and laboratory QC was conducted.

This LTM V Summary Report presents the data. Provided in the appendices are station locations, water quality measurements, PCB (NOAA 18 Congeners) data, discussion of previous (LTM IV) and current (LTM V) approaches to PCB surrogate recovery correction, total organic carbon data, data validation reports, grain size data, and benthic infaunal community abundance data.

The resulting data were uploaded into the New Bedford Harbor Database and are available for querying and downloading. Because surrogate recovery correction was performed during data validation, and not by the laboratory, PCB congener data are maintained in the database in two forms: "Laboratory Results", which are the original data as analyzed and reported by the laboratory, and "Data Validation Results", which are the surrogate recovery corrected data.

Although no formal analysis of the data is included in this report, summary observations are provided in Section 3. The results of the LTM V will be used by EPA to assess spatial trends in contaminated sediments. In conjunction with previous LTM data, the information will be used to assess temporal trends in contaminated sediments, and to assess the effectiveness of the New Bedford Harbor Superfund remediation efforts. LTM data also are planned for inclusion in the OU #3 Remedial Investigation.

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