1 Wamsutta Street, Suite 8
New Bedford, MA 02740
Telephone 508-441-0999

Memorandum

To: New Bedford Harbor Development Commission

From: Apex Companies, LLC (Apex) Engineering Design Team

Date: February 16, 2012

Re: Lower Harbor CAD Cell (LHCC)
Data Package Summary Memorandum

This Memorandum is submitted by the Lower Harbor CAD Cell Design Team (Apex Companies, LLC), on behalf of the New Bedford Harbor Development Commission, as a companion document to the attached Data Package, in order to clarify the contents and relevance associated with the enclosed items, in association with the design of the Lower Harbor CAD Cell (LHCC).

The data contained within the Data Package includes both historic data and new data generated from pre-design investigations. New data generated from pre-design investigations includes:

- Bathymetric Data;
- Figures;
- Boring logs; and
- Partial Geotechnical Analytical Data.

There are nine figures that have been generated as part of the preparation of this data package. They are:

- *Figure 1 – Bathymetric Data Plan* (Bathymetry Data Section)
- *Figure 2 - Boring Location Plan* (Boring Data Section)
- *Figure 3 - Historic Vibracore Location Plan* (Vibracore Data Section)
- *Figure 4: Conceptual LHCC Location Plan 1* (Conceptual LHCC Siting Plans Section)
- *Figure 5: Conceptual LHCC Location Plan 2* (Conceptual LHCC Siting Plans Section)
- *Figure 6: Conceptual LHCC Location Plan 3* (Conceptual LHCC Siting Plans Section)
- *Figure 7: Conceptual LHCC Location Plan 4* (Conceptual LHCC Siting Plans Section)
- *Figure 8: Conceptual LHCC Location Plan 5* (Conceptual LHCC Siting Plans Section)

- Figure 9: *Conceptual LHCC Location Plan 6* (Conceptual LHCC Siting Plans Section)

The Data Package is organized into multiple categories. These are:

1. **Bathymetry Data**
2. **Boring Data**
3. **Historical Data**
4. **Seismic Data**
5. **Vibracore Data**
6. **Conceptual LHCC Siting Plans**

The following is a brief explanation of each category, the data contained within each, and its relevance to the LHCC design.

1. Bathymetry Data

This information outlines the existing bathymetry, measured in feet below Mean Lower Low Water, of the existing bottom of the harbor within the area anticipated to be utilized to construct the LHCC. It includes the following figure, which is a visual representation of the bathymetry:

a. *Figure 1 – Bathymetric Data Plan, Apex Companies, LLC.* This plan shows existing bathymetry.

2. Boring Data

This information includes both historic and more recent borings, as well as geotechnical analytical data generated from those borings, that have been advanced within the area where the LHCC is being considered to be sited. Geotechnical analytical data is also included that is representative of material to be placed into the LHCC. The data includes the following:

a. *Historic Boring Logs:* Historic boring logs within the vicinity of the area anticipated to be utilized to construct the LHCC.

b. *Historic Geotechnical Analytical Data.* Historic geotechnical analytical data within the vicinity of the area anticipated to be utilized to construct the LHCC. This data is typically associated with samples collected at various depths from Historic Boring Logs.

c. *Historic Organic Silt-Clay Hydraulic Conductivity Data.* This document provides historic hydraulic conductivity analyses shallow, contaminated material that is representative of material that will be placed within the LHCC. The material is a black, organic silt or clay, the upper one to two feet of which has been shown historically by EPA to be impacted by PCBs of varying concentrations. A map showing the locations of the historic samples is included, as well as a calculation of the average hydraulic conductivity of the material.

d. *LHCC Boring Logs:* Boring logs completed in association with design of the LHCC.

e. *Partial LHCC Geotechnical Analytical Data:* Geotechnical analytical data collected from the first six boring logs advanced in association with the design of the LHCC. This data is associated with the LHCC Boring Logs and includes data for bulk density, sieve size, hydraulic conductivity, and total organic carbon.

f. *Figure 2 - Boring Location Plan, Apex Companies, LLC.* Shows location of historic borings as well as the location of borings associated with the LHCC design. Please note that Figure 1 is the *Bathymetric Data Plan*.

3. Historical Data

This is historic information that is relevant to the siting and design of the LHCC. It is organized into a number of sub-categories as follows:

- Historic Air Evaluations;
- Historic New Bedford Harbor Superfund Site Risk Assessments;
- Historic USEPA LHCC Feasibility Assessments;
- Historic Background Material and Literature;
- Historic Remote Sensing Reports;
- Historic Navigational Dredging Water Quality Measurements;
- Historic Suspended Sediment Transport Modeling and Measurement; and
- Historic Toxicity Testing.

Historic Air Evaluations:

This information has been provided (along with the New Bedford Superfund Site Risk Assessments) to address concerns by the public regarding the risks associated with concentrations of PCBs in air. It includes the following reports:

a. *Evaluation of the Impact of Dredging and CAD Cell Disposal on Air Quality, Jacobs Engineering Group, June 2010:* This report was promulgated by Jacobs Engineering on behalf of USACE to evaluate the impact of CAD Cell Disposal and Dredging on air quality.

Historic New Bedford Harbor Superfund Risk Assessments:

This information has been provided to provide a background for the human health and ecological risks associated with PCBs in New Bedford Harbor that drove the 1998 Record of Decision and subsequent Explanations of Significant Differences, including the Lower Harbor CAD Cell. It includes the following reports:

b. *Draft Final Baseline Public Health Risk Assessment, EBASCO, August 1989:* This is the human health risk assessment conducted by EBASCO for USEPA that assesses the risks associated with the PCB impacts to sediment in New Bedford Harbor.

c. *Draft Final Baseline Ecological Risk Assessment, EBASCO, April 1990.* This is the ecological risk assessment conducted by EBASCO for USEPA that assesses the risks to the environment associated with the PCB impacts to sediment in New Bedford Harbor.

Historic USEPA LHCC Feasibility Assessments:

This information has been provided to outline the assessments USEPA conducted prior to implementing the Explanation of Significant Differences associated with the LHCC. It includes the following reports:

d. *Assessment of Contaminant Loss and Sizing for Proposed Lower Harbor Confined Aquatic Disposal (CAD) Cell, USACE Engineer Research and Development Center, May 2010.* This assessment was performed by USACE to estimate how the LHCC would perform geotechnically, and to estimate the potential losses of sediment associated with disposal, capping, and long-term maintenance of the LHCC.

e. *Turbidity Monitoring and Plume Sampling Results for City Dredge Disposal at the New Bedford Harbor CAD Cell #2, Battelle, December, 2009.* This is a report summarizing monitoring of disposal events at CAD Cell #2 during Navigational Dredging, and was utilized by EPA to assess potential loss of sediment when conducting disposal events at a potential future LHCC.

Historic Background Material and Literature:

This information has been provided to outline background information regarding CAD Cells, as well as some background information regarding the mass of PCBs associated with the New Bedford Harbor Superfund Site. It includes the following reports:

f. *Estimate of Mass of PCBs in New Bedford Harbor, EBASCO, April, 1989.* This assessment was part of the 1998 Record of Decision and provides an estimate of the mass of PCBs associated with the New Bedford Superfund Site, as well as the approximate areal distribution of that mass.

g. *USACE Leaching/Pore Water Analysis.* This table summarizes the results of the Sequential Batch Leaching Tests (SBLT) performed by USACE when assessing contaminant loss from the LHCC. The SBLTs are estimates of pore water concentrations once material is placed within the LHCC. The total PCB concentration is indicated for each SBLT pore water result. Massachusetts Contingency Plan Method 1 GW-3 standards are included within the table as a basis of comparison.

h. *Understanding the Physical and Environmental Consequences of Dredged Material*

Disposal: History in New England and Current Perspectives, Fredette and French, 2004. This is a paper written by representatives from USACE, associated with historic use of disposal sites in New England, both open ocean sites and CAD Cells, through the approximately 35 years of the DAMOS program.

i. *Why Confined Aquatic Disposal Cells Often Make Sense, Fredette, 2005.* This is a paper written by a representative from USACE, associated with the issues involved in utilizing CAD Cells.

Historic Remote Sensing Reports:

This information includes remote sensing reports that have been prepared within the area where the LHCC is being considered to be sited:

j. *Underwater Archeological Remote Sensing Survey, Dolan Research, Inc., January 2000 (Revised March 2001).* Remote sensing report prepared in association with the Superfund investigation process.

k. *Underwater Archeological and Hazards Analysis, Remote Sensing Survey, Apex Environmental, Inc., March 2003.* Remote sensing report prepared in association with the Dredge Material Management Plan process.

Historic Navigational Dredging Water Quality Measurements:

This information includes water quality measurements that have been completed associated with the Phase II and Phase III Navigational Dredging program, which included mechanical dredging, and placement of material into CAD Cells. Also see: *Turbidity Monitoring and Plume Sampling Results for City Dredge Disposal at the New Bedford Harbor CAD Cell #2, Battelle, December, 2009,* which includes additional analysis on turbidity generation during CAD Cell disposal events.

l. *Phase II Water Quality Monitoring.* Results of turbidity measurements collected during Phase II of Navigational Dredging. Outlines both mechanical dredging measurements and CAD Cell disposal measurements.

m. *Phase III Water Quality Monitoring.* Results of turbidity measurements collected during Phase III of Navigational Dredging. Outlines both mechanical dredging measurements and CAD Cell disposal measurements.

Historic Suspended Sediment Transport Modeling and Measurement:

This information includes transport modeling associated with CAD Cell planning associated with the Dredge Material Management Plan process as well as a flux analysis conducted by EPA indicating the quantity of contaminated sediment entering Buzzard's Bay under existing conditions.

n. *Dredge Material Transport Modeling Analysis, Maguire Group, July 2003.* Dredge disposal modeling associated with potential sediment re-suspension related to CAD Cell usage associated with the Dredge Material Management Plan process.

o. *New Bedford Harbor PCB Flux Study, Woods Hole Group, Inc., August 2010.* Results of analysis conducted by USEPA associated with determining the quantity of PCB mass that fluxes out of New Bedford Harbor into Buzzard's Bay on a daily basis.

Historic Toxicity Testing:

This information includes toxicity testing associated with suspended sediment anticipated to be generated during placement of contaminated material into CAD Cells.

p. *Task 2A: Suspended Particulate Phase Acute Toxicity Testing with Mysids, Maguire Group, July 2003.* Toxicity testing report instituted to assess potential toxicity associated with re-suspension of sediment associated with CAD Cell usage as part of the Dredge Material Management Plan.

q. *Task 2B: Toxicity Identification Evaluation Testing with Mysids and Sea Urchins, Maguire Group, July 2003.* Additional toxicity testing report instituted to assess potential toxicity associated with re-suspension of sediment associated with CAD Cell usage as part of the Dredge Material Management Plan.

4. Seismic Data

This information includes geophysics reports (seismic and sub-bottom analyses) that have been prepared for the area anticipated to be utilized to construct the LHCC. This information is primarily historic. Information to supplement this data is currently being generated, but is not currently available:

a. *CDF D Geophysics.* Mapped data showing the results of a geophysical investigation conducted in order to assess subsurface sediment and bedrock elevations in the vicinity of the proposed CDF D.

b. *Report of Marine Geophysical Surveys: Seismic Refraction, Sub-Aqueous Disposal Cell Feasibility Studies, Apex Environmental, Inc., 2001.* Geophysics report prepared in association with the Dredge Material Management Plan process.

c. *Addendum To Marine Geophysical Surveys: Seismic Refraction, Sub-Aqueous Disposal Cell Feasibility Studies, Updated Data and Model Revision, Maguire Group, 2003.* Addendum to geophysics report prepared in association with the Dredge Material Management Plan process.

5. Vibracore Data

This information includes vibracores that have been advanced within the area where the LHCC is being considered to be sited. This information is primarily historic. Information to supplement this data is currently being generated, but is not currently available:

a. *Historic Vibracore Logs.* Historic vibracore logs within the area anticipated to be utilized to construct the LHCC.

b. *Figure 3 - Historic Vibracore Location Plan, Apex Companies, LLC.* This plan shows the location of historic vibracores. Please note that Figures 1 and 2 are the *Bathymetric Data Plan and Boring Location Plan.*

6. Conceptual LHCC Siting Plans

These figures have been generated to outline a number of conceptual locations for the proposed LHCC. Once a location has been finalized, final design of the LHCC will begin. Please note that Figures 1 through 3 are the *Bathymetric Data Plan, Boring Location Plan, and Historic Vibracore Location Plan*, respectively:

a. Figure 4: *Conceptual LHCC Location Plan 1:* Shows one potential location for the Lower Harbor CAD Cell.

b. Figure 5: *Conceptual LHCC Location Plan 2:* Shows one potential location for the Lower Harbor CAD Cell.

c. Figure 6: *Conceptual LHCC Location Plan 3:* Shows one potential location for the Lower Harbor CAD Cell.

d. Figure 7: *Conceptual LHCC Location Plan 4:* Shows one potential location for the Lower Harbor CAD Cell.

e. Figure 8: *Conceptual LHCC Location Plan 5:* Shows one potential location for the Lower Harbor CAD Cell.

f. Figure 9: *Conceptual LHCC Location Plan 6:* Shows one potential location for the Lower Harbor CAD Cell. This particular scenario assumes that the LHCC would be combined with a CAD Cell needed for future Navigational Dredging.

APEX

ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA - NEW BEDFORD, MA - HOLYOKE, MA

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

58H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

PROJECT
NEW BEDFORD HARBOR
USEPA LOWER HARBOR CAD CELL
CFDA NO.:66.802

OWNER
NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
52 FISHERMAN'S WHARF
NEW BEDFORD, MA 02745

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	6724
CADD FILE	SAP FIGURE2-6
DESIGNED BY	GCD
DRAWN BY	GCD
CHECKED BY	CMM
DATE	1/24/12
DRAWING SCALE	1"=175'

GRAPHIC SCALE
SCALE: 1"=175'
0 175 350 FEET

SHEET TITLE
BATHMETRIC DATA PLAN

DRAWING NO.
FIG-1

P:\Jobs\6724 EPA CAD Cell\PLANS\SAP FIGURE2-6.dwg

Date: 7/19/2011

APEX

BORING LOG

Project: Phase IV Dredging	Project No: 6690.013	X:	815384
Location: CAD Cell 3 New Bedford Harbor		Y:	2696002
Elevation at mudline: -5.6	Datum: MLLW		
Casing Type: Steel	Boring Depth: -85.6	Boring #:	A-CAD3-2011-B1
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash	Sheet:	1 of 3
Driller: N. Studdard	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
2		24" 6"	WOR, WOR, WOR, WOR	Dark grey, fine to coarse SAND, little organic silt, trace shell hash.	-7.6
4		24" 18"	WOH, WOH, WOH, 1	Dark grey, fine to coarse SAND, some silt.	-9.6
6		24" 19"	No Blow Count Info Available	(Top 12") Dark brown grey, fine to coarse SAND, little silt, organic odor. (Bottom 7") Dark brown grey, fine to coarse SAND, little silt.	-11.6
8		24" 12"	24, 42, 30, 31	Light grey, fine to medium SAND.	-13.6
10		24" 13"	45, 56, 51, 48	Grey, fine to medium SAND, slight organic odor.	-15.6
12		24" 12"	8,10,14,15	Grey, fine to coarse SAND.	-17.6
14		24" 2"	2,5,2,1	Grey, fine to medium SAND, trace fine gravel. (see comments)	-19.6
16		24" 12"	15,14,15,31	(Top 6") Grey, fine to coarse SAND, trace fine gravel. (Bottom 6") Inorganic silt, trace very fine.	-21.6
18		24" 11"	16,10,8,12	Grey inorganic SILT, trace fine sand.	-23.6
20		24" 8"	13,15,16,15	Brown/grey medium to coarse SAND, little fine to coarse gravel, trace silt.	-25.6
22		24" 4"	24,19,15,23	Grey, fine to coarse SAND, little to some fine gravel, trace silt. (see comments)	-27.6
24		24" 8"	15,17,14,25	Grey, fine to coarse SAND, trace silt, trace fine gravel.	-29.6

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 7/19/2011

APEX

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815384
Location: CAD Cell 3 New Bedford Harbor			Y: 2696002
Elevation at mudline: -5.6		Datum: MLLW	
Casing Type: Steel	Boring Depth: -85.6		Boring #: A-CAD3-2011-B1
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 2 of 3
Driller: N. Studdard	Log By: RB		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
26		24" 5"	13,24,19,28	(Top 2")Grey, fine to coarse SAND, little fine gravel, trace silt. (Bottom 3") Tan, Inorganic SILT.	-31.6
28		24" 6"	13,13,14,13	Tan, inorganic SILT.	-33.6
30		24" 12"	19,14,10,10	Tan, inorganic SILT.	-35.6
32		24" 12"	5,3,3,2	(Top 6") Tan/grey inorganic SILT. (Bottom 6") Grey inorganic SILT.	-37.6
34		24" 10"	1,4,4,1	Light grey, inorganic SILT.	-39.6
36		24" 10"	WOH, WOH, WOH, I	Light grey, inorganic SILT, trace fine sand.	-41.6
38		24" 12"	WOH, WOH, 3,5	Inorganic SILT, some sand, some gravel.	-43.6
40		24" 19"	4,10,11	Grey, inorganic SILT.	-45.6
42		24" 18"	2,8,11,8	Grey, inorganic SILT.	-47.6
44		24" 18"	5,6,7,7	Grey, inorganic SILT.	-49.6
46		24" 14"	6,6,10,6	Grey, inorganic SILT.	-51.6
48		24" 16"	11,8,8,9	Grey, inorganic SILT.	-53.6
50		24" 18"	12,8,8,9	Grey, inorganic SILT.	-55.6

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 7/19/2011

APEX

BORING LOG

Project: Phase IV Dredging	Project No: 6690.013	X:	815384
Location: CAD Cell 3 New Bedford Harbor		Y:	2696002
Elevation at mudline: -5.6	Datum: MLLW		
Casing Type: Steel	Boring Depth: -85.6	Boring #:	A-CAD3-2011-B1
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash	Sheet:	3 of 3
Driller: N. Studdard	Log By: RB		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
57		24" 16"	5,15,13,12	Grey, inorganic SILT. (Flush water from casing from milky silt)	-62.6
64		24" 0"	25,18,21,25	(Top 6") Tan/grey fine SAND, some inorganic silt. (Middle 7") Grey fine to medium SAND, trace inorganic silt. (Bottom 7") Grey fine to coarse SAND, trace silt, trace fine gravel. (See comments)	-69.6
73		7" 0"	38, 100/1"	(1" refusal) Fine to Coarse SAND, Some Gravel 1/2"-1", till.	-78.6
75		24" 8"	18,51,22,25	Grey, fine to coarse SAND, some 1/4" to 1/2" gravel, trace grey silt.	-80.6
80			NO BLOW COUNT DATA AVAILABLE	Advanced with roller bit from -80.6 MLLW to -85.6 MLLW through cobbles and nested boulders. End of boring at -85.6 MLLW.	-85.6
				END OF BORING	

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

APEX

Date: 7/20/2011

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815103
Location: CAD Cell 3 New Bedford Harbor			Y: 2696418
Elevation at mudline: -6		Datum: MLLW	
Casing Type: Steel	Boring Depth: -66.55		Boring No: A-CAD3-2011-B2
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 1 of 3
Driller: N. Studdard	Log By: RB		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
2		24" <1"	WOR-> 24"	Black organic SILT, trace fine sand, trace shell hash trace gravel.	-8
4		24' 14'	WOR-> 24"	(Top 7") Black organic SILT, strong organic odor, some shell hash. (Bottom 7") Dark grey, fine to medium SAND, some silt, some shell hash, trace coarse sand, trace gravel, organic odor.	-10
6		24" 13"	WOR-> 24"	Black/dark grey, fine to medium SAND, some silt, organic odor.	-12
8		24" 0"	WOH-18",4	Grey/brown fine to coarse SAND, and SILT. (See comments)	-14
10		24" 15"	10,17,31,23	Brown, fine to medium SAND, some silt. (Washed casing in between intervals, wash water is tan-milky brown)	-16
12		24" 13"	28,25,42,36	Very fine SAND, some inorganic silt.	-18
14		24" 24"	23,20,16,20	Grey, very fine SAND, some inorganic silt.	-20
16		24" 24"	12,14,17,22	Tan/grey very fine SAND.	-22
18		24" 16"	15,10,11,13	Tan/grey very fine SAND.	-24
20		24" 9"	6,10,14,14	Brown/grey fine to very fine SAND.	-26
22		24" 22"	8,10,15,17	Brown/grey fine to very fine SAND.	-28

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 7/20/2011

APEX

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815103
Location: CAD Cell 3 New Bedford Harbor			Y: 2696418
Elevation at mudline: -6		Datum: MLLW	
Casing Type: Steel		Boring Depth: -66.55	Boring No: A-CAD3-2011-B2
Casing Diameter: 4"		Drill Rig: CME 45	
Drill Co: NH Boring		Method: Drill and Wash	Sheet: 2 of 3
Driller: N. Studdard		Log By: RB	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
24		24" 14"	9,8,9,8	Tan/grey, fine to very fine SAND.	-30
26		24" 12"	3,7,10,9	Tan/grey, fine to very fine SAND.	-32
28		24" 14"	4,3,4,8	Tan/grey, fine to very fine SAND.	-34
30		24" No Data	WOR, 6,9,10	Tan/grey, fine to very fine SAND.	-36
32		24" 18"	3,5,6,7	Tan/grey, fine to very fine SAND.	-38
34		24" 18"	1,5,7,10	Tan/brown/grey, fine to very fine SAND.	-40
36		24" 16"	4,5,7,8	Grey, fine to very fine SAND.	-42
38		24" 20"	5,7,8,10	Tan/grey, fine to very fine SAND.	-44
40		24" 17"	4,6,8,7	Tan/grey, fine to very fine SAND.	-46
42		24" 18"	8,10,15,14	Grey, inorganic SILT.	-48
44		24" 15"	11,15,15,18	Grey, fine to coarse SAND, little silt, trace gravel.	-50
46		24" 4"	20,12,12,19	Grey, fine to coarse SAND, trace silt, trace gravel.	-52

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 7/20/2011

APEX

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815103
Location: CAD Cell 3 New Bedford Harbor			Y: 2696418
Elevation at mudline: -6		Datum: MLLW	
Casing Type: Steel		Boring Depth: -66.55	Boring No: A-CAD3-2011-B2
Casing Diameter: 4"		Drill Rig: CME 45	
Drill Co: NH Boring		Method: Drill and Wash	Sheet: 3 of 3
Driller: N. Studdard		Log By: RB	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
46		24" 7"	14,21,18,16	Grey, fine to coarse SAND, trace silt, trace gravel. (see comments)	-52
48		24" 6"	19,14,15,14	Coarse GRAVEL, and fine to coarse SAND, trace silt. (see comments)	-54
50		24" 0"	11,10,10,11	(Top 2") Washed fine gravel from flushing to sample interval. (Bottom 10") Grey, fine to coarse SAND, some fine gravel, trace coarse gravel, Till. (see comments)	-56
55				(See comment)	-61
57		24" 9"	22,16,31,25	Grey, fine to Coarse GRAVEL, trace Silt, Till.	-63
60.55				END OF BORING	-66.55

Comments: Samples with poor recovery were recollected with 3" split spoon sampler. After 50ft below mudline, switched to one split spoon per five feet.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

APEX

Date: 7/27/2011
Time: 8:00 AM

BORING LOG

Project: Phase IV Dredging		Project No: 6690.005	X: 814971
Location: South Terminal Expansion			Y: 2696487
Elevation at mudline: -8.05	Datum: MLLW		
Casing Type: Steel	Boring Depth: -74.05		Boring No: A-CAD3-2011-B3
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 1 of 3
Driller: Todd Pentacost	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
2		24" / 11"	WOR	Black, organic SILT, little shell hash, organic odor.	-10.05
4		24" / 16"	WOR	Black, organic SILT, little shell hash, organic odor.	-12.05
6		24" / 12"	WOR	Black, organic SILT, little shell hash, organic odor.	-14.05
8		24" / 17"	6,1,1,2	Grey, organic SILT, little shell hash.	-16.05
10		24" / 20"	WOR,1,1,1	Grey, organic SILT, little shell hash, organic odor.	-18.05
12		24" / 20"	12,2,3	Grey, organic SILT, little shell hash, trace sand, organic odor.	-20.05
14		24" / 24"	5,25,23,27	Grey/brown, organic SILT, little Sand.	-22.05
16		24" / 20"	30,10,9,20	Dark grey/brown, SILT, little medium sand, organic odor.	-24.05
18		24" / 9"	20,22,26,25	Grey, fine to medium SAND, some silt, trace medium gravel.	-26.05
20		24" / 3"	17,11,10,9	Medium to coarse SAND, trace coarse gravel.	-28.05
22		22" / 22"	23,10,26, 100	Fine to coarse SAND, trace silt.	-30.05
24		NO DATA / NO DATA	12,57,65,62	Light brown, fine to medium SAND, little coarse gravel.	-32.05
26		24" / 24"	6,4,28,30	Light brown, medium to coarse SAND.	-34.05

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 7/27/2011
Time: 8:00 AM

APEX

BORING LOG

Project: Phase IV Dredging		Project No: 6690.005	X: 814971
Location: South Terminal Expansion			Y: 2696487
Elevation at mudline: -8.05	Datum: MLLW		
Casing Type: Steel	Boring Depth: -74.05		Boring No: A-CAD3-2011-B3
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 2 of 3
Driller: Todd Pentacost	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
28		24" 24"	5,17,17,66	Brown, fine to medium SAND, trace silt.	-36.05
30		24" 24"	7,7,20,87	Light brown, fine to medium SAND, trace medium gravel.	-38.05
32		24" 15"	2,2,5,16	Light brown, fine to medium SAND, trace medium gravel.	-40.05
34		24" 10"	5,5,8,10	Light brown, fine to coarse SAND.	-42.05
36		24" 10"	4,5,6,11	Light brown, medium to coarse SAND, trace medium to coarse gravel, trace silt.	-44.05
38		9" 9"	14,121/3"	Light brown, fine to medium SAND, little medium to coarse gravel.	-46.05
40		24" 12"	8,8,17,26	Light brown, fine to medium SAND, trace fine gravel.	-48.05
42		24" 10"	4,5,8,11	Light brown, fine SAND, trace silt,trace fine gravel.	-50.05
44		24" 24"	4,6,17,21	Light grey/brown, Fine to coarse SAND, trace fine gravel.	-52.05
46		24" 13"	13,8,8,11	Grey, SILT/clay and coarse sand, trace fine gravel.	-54.05
48		24" 16"	4,3,8,17	Light grey, fine to coarse SAND, trace fine gravel.	-56.05
50		23" 0	17,9,25,68	Light Grey, Fine to medium SAND.	-58.05
52		24" 22"	9,13,10	Grey/light brown, medium to coarse SAND, some medium to coarse gravel.	-60.05

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes:
1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

	Date:	7/27/2011
APEX	Time:	8:00 AM

BORING LOG

Project: Phase IV Dredging		Project No: 6690.005	X: 814971
Location: South Terminal Expansion			Y: 2696487
Elevation at mudline: -8.05	Datum: MLLW		
Casing Type: Steel	Boring Depth: -74.05		Boring No: A-CAD3-2011-B3
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 3 of 3
Driller: Todd Pentacost	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
54		24" 18"	7,4,6,19	Light brown, medium to coarse SAND, some medium coarse gravel.	-62.05
56		24" 24"	13,52,41, 44	Medium to coarse SAND,some medium to coarse gravel.	-64.05
58		24" 19"	42,30,31, 72	Light brown, coarse SAND, little fine gravel.	-66.05
58.2		2" 0	129/2"	Rock, Gravel in Spoon Nose. Fuel Line Break on rig. Advanced roller bit to -66.25 MLLW.	-66.25
61		0" 0"	120/0"	Obstruction encountered at -68.05 MLLW. Advanced roller bit to -69.05 MLLW.	-69.05
66	65%	5.0' 4.58'	12, 25, 6, 10, 8	Rock Core #1: -69.05 MLLW to -74.05 MLLW - Moderately to intensly fractured light gray to pink gneissic GRANITE with subtle foliation.	-74.05

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

APEX

Date: 8/1/2011

BORING LOG

Project: Phase IV Dredging		Project No: 6690.005	X: 815787
Location: South Terminal Expansion			Y: 2696697
Elevation at mudline: -9.75	Datum: MLLW		
Casing Type: Steel	Boring Depth: -65.75		Boring No: A-CAD3-2011-B4
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 1 of 2
Driller: Todd Pentacost	Log By: ML		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
2		24" 12"	1,1,1,2	Dark grey/black organic SILT, and shell hash, trace sand (see comments).	-11.75
4		24" 21"	4,6,66,2	(Top 10") Dark grey/black organic SILT and shell hash. (Bottom 11") Light brown fine to coarse SAND, some silt.	-13.75
6		24" 29"	22,21,16,26	Tan, SILT, trace very fine sand.	-15.75
8		24" 24"	15,7,22,10	Tan, SILT, trace very fine sand.	-17.75
10		24" 16"	10,9,10,13	Tan, SILT, trace very fine sand.	-19.75
12		24" 8"	WOR,10, 13,12	Light brown SILT, trace fine to coarse sand.	-21.75
14		24" 14"	1,4,5,4	Brown, medium to coarse SAND, some silt, trace very fine sand.	-23.75
16		24" 12"	3,5,6,7	Light brown, SILT, some fine to medium sand.	-25.75
18		24" 12"	1,5,9,10	Light brown, SILT, some fine to medium sand.	-27.75
20		24" 10"	5,2,2,3	Light brown, SILT, little medium gravel.	-29.75
22		24" 12"	5,7,7,11	Light brown, fine to medium SAND, some fine gravel, little silt.	-31.75
24		24" 10"	5,6,9,6	Light brown, SILT, trace medium gravel.	-33.75
26		24" 20"	6,7,10,11	Light brown, SILT, trace fine sand, trace fine gravel.	-35.75

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 8/1/2011

APEX

BORING LOG

Project: Phase IV Dredging		Project No: 6690.005	X: 815787
Location: South Terminal Expansion			Y: 2696697
Elevation at mudline: -9.75	Datum: MLLW		
Casing Type: Steel	Boring Depth: -65.75		Boring No: A-CAD3-2011-B4
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 2 of 2
Driller: Todd Pentacost	Log By: ML		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
28		24" 16"	6,11,14,13	Tan, SILT, and fine to medium SAND.	-37.75
30		24" 20"	1,7,9,8	Brown, SILT, little fine to medium sand, little medium to coarse gravel.	-39.75
32		24" 19"	4,9,11,14	Tan, SILT, and very fine SAND.	-41.75
34		24" 20"	9,10,9,11	(Top 10") Light brown, very fine SAND, some silt. (Bottom 10") Light brown SILT, trace very fine sand.	-43.75
36		24" 10"	6,9,13	Light Brown, SILT.	-45.75
38		24" 0	6,11,23,31	Light brown, SAND, trace silt.(see comments)	-47.75
40		24" 18"	5,5,13,40	Light brown, fine SAND, trace silt. (see comments)	-49.75
42		23" 23"	6,12,69,95	Light brown, fine SAND, little silt.	-51.75
44		24" 20"	9,8,10,13	Light brown/orange, fine SAND, trace of silt.	-53.75
46		24" 12"	8,8,16,25	Light brown/grey, SILT, trace very fine sand.	-55.75
48		24" 0	7,15,43	No Recovery	-57.75
50		19" 10"	14, 31, 66, 86	Light brown, fine SAND.	-59.75
52		24" 20"	5, 8, 14, 24	Ligh grey, fine to medium SAND and silt.	-61.75
54		24" 0"	10, 9, 3, 6	No recovery.	-63.75
56		24" 22"	10, 11, 15, 19	Grey, SILT, medium to coarse sand.	-65.75
				END OF BORING	

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 8/5/2011

APEX

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815574
Location: CAD Cell 3 New Bedford Harbor			Y: 2696726
Elevation at mudline: -5.4		Datum: MLLW	
Casing Type: Steel	Boring Depth: -82.65		Boring No: A-CAD3-2011-B5
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 1 of 3
Driller: N. Studdard	Log By: ML		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
2		24" 6"	WOR, WOR, WOR, WOR	Black/Grey organic SILT, trace shell hash.	-7.4
4		24' 14'	9, 5, 14, 30	(Top 2") Dark grey SILT, trace shell hash. (Bottom 7") Dark grey fine to Coarse SAND, trace silt.	-9.4
6		24" 7"	19, 17, 20, 22	(Top 2") SHELL HASH. (Bottom 5") of Light Brown fine to medium SAND, trace silt.	-11.4
8		24" 14"	11, 25, 24, 27	(Top 12") Light brown fine to medium SAND, trace silt. (Bottom 2") Brown fine to medium SAND, trace silt.	-13.4
10		24" 14"	5, 41, 82, 52	Light brown, fine to medium SAND, trace gravel, trace shell hash.	-15.4
12		24" 18"	18, 11, 13, 12	Light brown, medium to coarse SAND, some brown grey silt.	-17.4
14		24" 14"	20, 16, 15, 16	Light brown, fine to coarse SAND, some brown silt.	-19.4
16		24" 14"	WOR, WOR, 10, 8	Light grey, very fine SAND, trace fine gravel.	-21.4
18		24" 12"	11, 9, 12, 12	Light grey, SILT, some fine to medium sand.	-23.4
20		24" 10"	7, 4, 7, 9	Light grey, very fine SAND, trace gravel.	-25.4
22		24" 13"	2, 17, 5, 6	Light grey, very fine SAND.	-27.4
24		24" 20"	WOR, 7, 4, 5	Light grey, SILT, some very fine sand.	-29.4

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

		Date:	8/5/2011

BORING LOG

Project: Phase IV Dredging	Project No: 6690.013	X: 815574	
Location: CAD Cell 3 New Bedford Harbor		Y: 2696726	
Elevation at mudline: -5.4	Datum: MLLW		
Casing Type: Steel	Boring Depth: -82.65	Boring No:	A-CAD3-2011-B5
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 2 of 3	
Driller: N. Studdard	Log By: ML		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
26		24" 10"	5, 4, 9, 7	Light grey, very fine SAND.	-31.4
28		24" 16"	11, 7, 8, 8	Light grey, SILT, trace very fine sand.	-33.4
30		24" 11"	8, 6, 8, 9	Light grey, fine SAND.	-35.4
32		24" 18"	9, 8, 8, 7	Light grey, SILT, some very fine sand.	-37.4
34		24" 14"	3, 6, 6, 10	Light grey, SILT, some very fine sand.	-39.4
36		24" 18"	9, 6, 10, 11	Grey, fine to very fine SAND.	-41.4
38		24" 14"	14, 10, 12, 16	Light grey, SILT, some very fine sand.	-43.4
40		24" 19"	7, 12, 4, 4	Light grey, SILT, some very fine sand.	-45.4
42		24" 11"	WOR, WOR, 4, 6	Light grey, SILT, some very fine sand.	-47.4
44		24" 11"	10, 12, 9, 17	Light grey, SILT, trace fine to coarse sand.	-49.4
46		24" 7"	24, 38, 39, 37	Light grey, medium to coarse sand, some medium to coarse gravel, some silt, TILL.	-51.4
48		24" 7"	41, 41, 53, 26	Light grey, medium to coarse sand, some medium to coarse gravel, some silt, TILL.	-53.4

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

APEX

Date: 8/8/2011

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815574
Location: CAD Cell 3 New Bedford Harbor			Y: 2696726
Elevation at mudline: -5.4		Datum: MLLW	
Casing Type: Steel		Boring Depth: -82.65	Boring No: A-CAD3-2011-B5
Casing Diameter: 4"		Drill Rig: CME 45	
Drill Co: NH Boring		Method: Drill and Wash	Sheet: 3 of 3
Driller: N. Studdard		Log By: ML	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
50		24" 6"	37, 15, 15, 40	Light grey, medium to coarse sand, some medium to coarse gravel, some silt, TILL	-55.4
52		24" 12"	21, 25, 34, 56	(Top 6") Grey, fine to coarse SAND. (Bottom 6") Grey/tan/pink fine to coarse SAND.	-57.4
54		21" 15"	27, 19, 43, 120/3"	Grey/tan, fine to coarse SAND, trace gravel.	-59.4
56				Obstruction encountered at -59.5 MLLW. Advanced roller bit from -59.5 MLLW to -65.1 MLLW.	
58					
60					
62		24" 5"	42, 29, 31, 30	Grey/tan weathered rock fragments.	-67.4
64		24" 8"	33, 23, 23, 31	White rock fragments w/ trace fine sand.	-69.4
65				Obstruction encountered at -69.4 MLLW. Advanced roller bit from -69.4 MLLW to -70.4 MLLW.	-70.4
67		24" 8"	19, 15, 21, 43	Grey, silty fine to coarse SAND, some gravel	-72.4
69		24" 0"	19, 30, 31, 33	No recovery.	-74.4
71		24" 10"	16, 25, 33, 47	Grey/tan, very fine to coarse SAND, some gravel	-76.4
72.25				Obstruction encountered at -77.1 MLLW. Advanced roller bit to -77.65 MLLW.	-77.65
77.25	62	5.0 5.0		Rock Core #1: -77.65 MLLW to -82.65 MLLW - Intensly to moderately fractured, light gray to pink gneissic GRANITE with slight foliation.	-82.65
				END OF BORING	

Comments: Samples with poor recovery were recollected with 3" split spoon sampler.

Notes:
1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

APEX

Date: 7/22/2011

BORING LOG

Project: Phase IV Dredging	Project No: 6690.013	X: 815004	
Location CAD Cell 3 New Bedford Harbor		Y: 2696757	
Elevation at mudline: -5.4'	Datum: MLLW		
Casing Type: Steel	Boring Depth: -69.75	Boring No:	A-CAD3-2011-B6
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 3	
Driller: N. Studdard	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
2		24" 7"	WOH, WOH, WOH, 2	(Top 2") Black organic SILT, little shell hash. (Bottom 5") Dark grey fine SAND, organic silt, little shell hash.	-7.4
4		24" 14"	4,2,5,7	(Top 7") Dark Grey, fine SAND, some organic silt, little shell hash. (Bottom 7") Grey fine SAND, some to little organic silt, little shell hash.	-9.4
6		24" 12"	10,18,23,30	Grey, fine SAND, little organic silt, trace fine gravel.	-11.4
8		24" 17"	17,16,34,29	Grey, very fine SAND, trace silt.	-13.4
10		24" 11"	2,6,10,12	Tan, fine SAND, little inorganic silt.	-15.4
12		24" 7"	13,17,13,17	(Top 3") Tan, fine SAND, little medium to coarse sand, little fine gravel. (Bottom 4") Tan SILT.	-17.4
14		24" 11"	9,9,7,10	(Top 4") Tan, fine to medium SAND, little fine gravel, trace silt. (Middle 3") Tan SILT, little fine gravel. (Bottom 3") Tan, fine to medium SAND, little fine gravel, trace silt	-19.4
16		24" 5"	3,2,4,10	Tan, fine SAND, trace coarse sand, trace gravel.	-21.4
18		24" 4"	4,5,8,12	Tan, fine SAND, little to some medium to coarse sand.	-23.4
20		24" 24"	8,6,27,81	(Top 12") Tan, fine SAND, trace silt. (Bottom 12") Tan, SILT, trace fine to very fine sand.	-25.4
22		24" 15"	4,4,10,6	(Top 5") Tan, fine SAND, trace silt. (Bottom 10") Tan, SILT, some gravel, trace fine sand.	-27.4
24		24" 15"	9,8,6,8	Tan, very fine SAND, and SILT, little fine to coarse sand.	-29.4
26		24" 14"	4,3,4,6	(Top 5") Grey/tan, fine to medium SAND, inorganic silt. (Bottom 9") Tan, SILT, and very fine SAND.	-31.4

Comments: Samples with poor recovery were re collected with a 3" split spoon sampler.Change in sampling intervals after reaching 50' to one sample per five feet.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 7/22/2011

APEX

BORING LOG

Project: Phase IV Dredging	Project No: 6690.013	X: 815004	
Location: CAD Cell 3 New Bedford Harbor		Y: 2696757	
Elevation at mudline: -5.4'	Datum: MLLW		
Casing Type: Steel	Boring Depth: -69.75	Boring No:	A-CAD3-2011-B6
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 2 of 3	
Driller: N. Studdard	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
28		24" 17"	7, 6, 8, 8	Grey, SILT, some fine to coarse sand.	-33.4
30		24" 12"	4,8,26,28	Grey, very fine SAND and silt, brown/tan medium to fine sand in nose of spoon.	-35.4
32		N/A N/A	N/A	Advanced roller bit through interval.	-37.4
34		24" 14"	5,23,25,25	(Top 10") Grey, very fine SAND and SILT. (Bottom 4") Orange/brown, fine to coarse SAND, little silt.	-39.4
36		24" 20"	7,12,13,61	Grey/tan, fine to medium SAND, some silt.	-41.4
38		24" 13"	8,6,10,14	Grey/tan fine SAND, some silt, little fine to coarse gravel, trace fine sand.	-43.4
40		24" 0"	11,12,16,19	No Recovery. Grey Silt in nose of Spoon, Coarse Sand in Cuttings. Possible Till	-45.4
42		24 0"	30,16,10,11	No Recovery	-47.4
44		24" 0"	9,14,15,14	No Recovery	-49.4
46		24 0	35,12,9,13	Grey/tan, coarse SAND, some coarse gravel, little to some fine to medium sand.	-51.4
48		24" 2"	14,13,9,15	Grey,tan fine to coarse SAND, some fine gravel, little coarse gravel, trace silt. (see comments)	-53.4
50		24" 4"	21,11,9,13	Grey/tan, fine to coarse SAND, little fine to coarse gravel, trace silt. (see comments	-55.4
55		24" 0	10,10,12,21	Grey/tan, fine to coarse SAND, some fine to coarse gravel. (see comments)	-60.4

Comments: Samples with poor recovery were re collected with a 3" split spoon sampler.Change in sampling intervals after reaching 50' to one sample per five feet.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

APEX

Date: 7/22/2011

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815004
Location: CAD Cell 3 New Bedford Harbor			Y: 2696757
Elevation at mudline: -5.4		Datum: MLLW	
Casing Type: Steel	Boring Depth: -69.75		Boring No: A-CAD3-2011-B6
Casing Diameter: 4"	Drill Rig:		
Drill Co: NH Boring	Method:		Sheet: 3 of 3
Driller: N. Studdard	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
58.9		11" 4"	13, 118	Grey/tan, fine to coarse SAND, some fine to coarse gravel, little silt.	-64.3
58.9				Obstruction encounctered at -64.3 MLLW, advanced roller bit to -64.75 MLLW.	-64.75
64.35	87%	5.00 4.88	9, 13, 20, 15, 11	Rock Core #1: -64.75 MLLW to -69.75 MLLW - Unfractured to slightly fractured, pink, GRANITE - very subtle gniessic foliation	-69.75
				END OF BORING	

Comments: Samples with poor recovery were re collected with a 3" split spoon sampler.Change in sampling intervals after reaching 50' to one sample per five feet.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 8/9/2011

APEX

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815731
Location: CAD Cell 3 New Bedford Harbor			Y: 2696868
Elevation at mudline: -5.8'	Datum: MLLW		
Casing Type: Steel	Boring Depth: -81.2' MLLW		Boring No: A-CAD3-2011-B7
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 1 of 2
Driller: N. Studdard	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
2		24" 22"	WOR-24"	Black/dark grey, organic SILT, some fine to medium sand, little shell hash, strong organic odor.	-7.8
4		24" 20"	WOR-24"	Black/dark grey, organic SILT, little organic plant matter, little fine to medium sand, strong organic odor.	-9.8
6		24" 14"	WOR-12", WOH, 1	Black/dark grey, organic SILT, trace to little fine to medium sand, trace shell hash, trace organic plant matter, strong odor.	-11.8
8		24" 18"	2, 1, 1, 4	Dark grey, organic SILT with timber at bottom 4" of recovery, little fine sand, strong organic odor.	-13.8
10		24" 14"	WOR, WOR, 6, 15	(Top 10")Grey, very fine to medium SAND, trace silt, strong organic odor. (Bottom 4") Compressed brown, organic plant matter (peat).	-15.8
12		24" 16"	3, 11, 11, 11	(Top 1") Brown oganic plant matter, PEAT. (Bottom 15") Grey, very fine to coarse SAND, strong organic odor.	-17.8
14		24" 12	5, 7, 7, 6	Grey/brown, very fine to coarse SAND, trace silt, strong organic odor.	-19.8
16		24" 12"	11, 6, 11, 39	(Top 6") Grey/tan, fine to coarse SAND, trace silt, organic odor. (Bottom 6") Grey, SILT, organic odor.	-21.8
18		24" 0"	14, 25, 22, 25	Grey, very fine to medium SAND, little sand, organic odor. (see comments)	-23.8
20		24" 12"	4, 6, 13, 18	Grey, fine to coarse SAND, organic odor.	-25.8
22		24" 10"	9, 22, 25, 33	Grey, very fine to fine SAND, slight organic odor.	-27.8
24		24" 24"	17, 19, 29, 40	Grey, medium SAND, little Coarse sand, trace fine sand, slight organic odor.	-29.8
26		24" 5"	17, 17, 21, 26	Coarse SAND, little fine to medium sand.	-31.8
28		24" 8"	5, 11, 35, 40	Coarse SAND, little fine to medium sand.	-33.8

Comments: Samples with poor recovery were re collected with a 3" split spoon sampler.Change in sampling intervals after reaching 50' to one sample per five feet.

Notes:
1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

	Date: 8/10/2011
APEX **BORING LOG**	

Project: Phase IV Dredging	Project No: 6690.013	X: 815731	
Location: CAD Cell 3 New Bedford Harbor		Y: 2696868	
Elevation at mudline: -5.8'	Datum: MLLW		
Casing Type: Steel	Boring Depth: -81.2' MLLW	Boring No:	A-CAD3-2011-B7
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 2 of 2	
Driller: N. Studdard	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
30		24" 24"	12, 18, 15, 18	(Top 20") Grey, very fine to fine SAND. (Bottom 4") Grey, SILT.	-35.8
32		24" 9"	10, 15, 12, 12	Grey, SILT, trace fine to medium sand, trace fine Gravel.	-37.8
34		24" 0		No recovery.	-39.8
36		24" 0"	6, 8, 11, 13	Grey, fine to coarse SAND. (see comments)	-41.8
38		24" 12"	7, 10, 22, 18	Grey, fine to coarse SAND.	-43.8
40		24" 0"	8, 20, 29, 26	Grey, medium to coarse SAND, trace fine sand. (see comments)	-45.8
42		24" 10"	10, 10, 22, 25	Grey, fine to coarse SAND, trace Gravel.	-47.8
44		24" 12"	8, 11, 19, 18	Grey, fine to coarse SAND.	-49.8
46		24" 1"	7, 17, 23, 27	Grey, fine to coarse SAND, trace silt. (see comments)	-51.8
48		24" 12"	10, 13, 18, 27	Grey, fine to coarse SAND.	-53.8
50		24" 12"	11, 14, 20, 18	Grey, fine to coarse SAND, trace silt.	-55.8
52		24" 16"	10, 19, 31, 35	Grey, very fine to fine SAND.	-57.8
54		24" 20"	8, 15, 28, 50	Grey, fine to coarse SAND, trace silt.	-59.8
56		24" 16"	19, 24, 31, 40	Grey, fine to coarse SAND, trace silt.	-61.8
58		24" 4"	15, 31, 28, 26	Grey, fine to coarse SAND, some gravel, trace silt, grey.	-63.8
70.4				Obstruction encounterd at -65.5 MLLW. Advanced roller bit through cobbles and nested boulders to -73.3 MLLW. Cleaned hole and began core run at -76.2 MLLW.	-76.2
75.4	58%	5.0 4.7	6, 12, 9,10, 13	Rock Core #1: -76.2 MLLW to -81.2 MLLW - Moderately fractured, light gray, granitic GNEISS.	-81.2
				END OF BORING	

Comments: Samples with poor recovery were re collected with a 3" split spoon sampler.Change in sampling intervals after reaching 50' to one sample per five feet.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 8/15/2011

APEX

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815532
Location CAD Cell 3 New Bedford Harbor			Y: 2696934
Elevation at mudline: -4.2	Datum: MLLW		
Casing Type: Steel	Boring Depth: -80.3		Boring No: A-CAD3-2011-B8
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 1 of 3
Driller: N. Studdard	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
2		24" 18"	WOR, WOR, WOR, WOR	Black/dark grey/orange SILT, some medium to fine sand, some shell hash.	-6.2
4		24" 8"	6, 6, 11, 17	Light brown fine SAND and SILT.	-8.2
6		24" 10"	9, 11, 21, 29	(Top 7") Light brown, medium to coarse SAND. (Bottom 3") Brown, medium to coarse SAND, some shell hash, trace medium gravel.	-10.2
8		24" 10"	7, 8, 20, 29	Light brown, medium to coarse SAND.	-12.2
10		24" 10"	16, 25, 30, 33	Light brown, medium to coarse SAND, some medium gravel.	-14.2
12		24" 12"	7, 10, 13, 19	Light brown, medium to coarse SAND, some gravel, trace silt.	-16.2
14		24" 11"	12, 12, 19, 21	(Top 7") Light Brown, medium to coarse SAND. (Bottom 3") Light brown/grey, SILT, trace fine sand.	-18.2
16		24" 10"	8, 14, 34, 46	Light Brown, medium to coarse SAND, trace coarse gravel.	-20.2
18		24" 2"	9, 9, 9, 10	Light brown, medium to coarse SAND, some silt. (see comments)	-22.2
20		24" 0	12, 7, 8, 9	Grey, brown SILT, some very fine sand.	-24.2
22		24" 5"	6, 6, 8, 10	Grey, fine SAND, little to some silt.	-26.2
24		24" 20"	4, 4, 8, 6,	Grey, fine to very fine SAND, little to some silt.	-28.2
26		24" 19"	4, 4, 5, 7,	Grey, very fine SAND, grades to grey SILT, little fine sand.	-30.2

Comments: Samples with poor recovery were re collected with a 3" split spoon sampler.Change in sampling intervals after reaching 50' to one sample per five feet.

Notes:
1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Date: 8/15/2011

APEX

BORING LOG

Project: Phase IV Dredging	Project No: 6690.013	X: 815532	
Location: CAD Cell 3 New Bedford Harbor		Y: 2696934	
Elevation at mudline: -4.2	Datum: MLLW		
Casing Type: Steel	Boring Depth: -80.3	Boring No:	A-CAD3-2011-B8
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 2 of 3	
Driller: N. Studdard	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
28		24" 18"	4, 5, 4, 5,	Grey, SILT, some very fine to fine sand.	-32.2
30		24" 18"	3, 6, 7, 8	Grey, very fine SAND, little silt.	-34.2
32		24" 19"	2, 2, 4, 8	Grey, very fine SAND, little to trace silt.	-36.2
34		24" 17"	3, 2, 4, 5	Grey, very fine SAND, grades to silt.	-38.2
36		24" 16"	4, 4, 5, 6	Grey, SILT, some very fine sand.	-40.2
38		24" 16"	6, 7, 6, 8	Grey, very fine SAND, little to some silt.	-42.2
40		24" 16"	3, 4, 9, 9	Grey to blue-grey, very fine SAND, grading to silt, little very fine sand.	-44.2
42		24" 13"	13, 13, 25, 15	(Top 4") Grey, very fine SAND, little to some silt (Bottom 9") Grey, fine to coarse SAND, some silt, little fine grey till.	-46.2
44		24" N/A	15, 16, 14, 12	Grey, fine to coarse SAND, and fine to coarse GRAVEL, trace to little silt.	-48.2
46		24" 6"	25, 19, 22, 40	Grey, fine to coarse SAND, and fine to coarse GRAVEL, trace silt.	-50.2
48		24" 2"	160/4"	Drill wash and 1 piece coarse Gravel, SILT in nose, probable TILL.	-52.2
50		24" n/a	100/0"	Advanced with roller bit through cobble/gravel.	-54.2
52		24" 1"	32, 13, 11, 14	Grey, fine to coarse gravel, some fine to coarse sand, some silt, TILL.	-56.2

Comments: Samples with poor recovery were re collected with a 3" split spoon sampler.Change in sampling intervals after reaching 50' to one sample per five feet.

Notes:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

APEX

Date: 8/15/2011

BORING LOG

Project: Phase IV Dredging		Project No: 6690.013	X: 815532
Location CAD Cell 3 New Bedford Harbor			Y: 2696934
Elevation at mudline: -4.2	Datum: MLLW		
Casing Type: Steel	Boring Depth: -80.3		Boring No: A-CAD3-2011-B8
Casing Diameter: 4"	Drill Rig: CME 45		
Drill Co: NH Boring	Method: Drill and Wash		Sheet: 3 of 3
Driller: N. Studdard	Log By: GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
54		24" 8"	31, 10, 22, 33	Grey, fine to coarse SAND, and fine to coarse GRAVEL, some silt, TILL.	-58.2
58.5		24" n/a	100/2"	Obstruction encountered. Drove casing and advanced with roller bit to -62.7 MLLW.	-62.7
60.5		24" 4"	40, 20, 9, 17	Grey, fine to coarse SAND, and fine to coarse GRAVEL, some silt.	-64.7
62.5		24" 3"	22, 47, 52, 33	Grey, fine to coarse SAND, and GRAVEL, some silt.	-66.7
64.5		24" 4"	15, 16, 25, 18	Grey, fine to coarse SAND, and GRAVEL, some silt.	-68.7
70				Obstructionn encountered. Advanced with roller bit to -74.2 MLLW.	-74.2
70.5		5" 2"	100/5"	Grey, fine to coarse SAND, and GRAVEL, some silt.	-74.7
71.1				Obstruction encounterd at -74.7 MLLW. Advanced roller bit through cobbles and nested boulders. Cleaned hole and began core run at -75.3 MLLW.	-75.3
76.1	89%	5 4.58	N/A	Rock Core #1: -75.3 MLLW to -80.3 MLLW - Slightly to moderately fractured light gray GRANITE	-80.3

Comments: Samples with poor recovery were re collected with a 3" split spoon sampler.Change in sampling intervals after reaching 50' to one sample per five feet.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.

Apex Environmental, Inc. 374 Congress Street, Suite 508, Boston, MA 02210, Phone: 617.728.0070	**PROJECT** NEW BEDFORD HARBOR DREDGE PHASE III, POPE's ISLAND NORTH AREA - CAD CELL 2, NEW BEDFORD HARBOR, NEW BEDFORD, MA	BORING NO.	**B01-CAD-072007**
		SHEET	1 of 4
		FILE NO.	6615.003
		CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696504	Easting 815424	
Driller	Tim Turner	Mudline El.	-5.0	Datum	MLLW
Logged By	GAD, KH, KD	Date Start	7/30/2007	Date End	8/2/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: Rotary wash with mud
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
			24/7	0 - 2	WOR	WOR	Very soft dark grey organic silt, some fine sand, little shells	ORG SILT	
1									
2							Very loose grey silty fine sand, little shells (set casing at 0.5 ft, wash to 2 ft. Casing dropping.)	MARINE SAND	
			24/11	2 - 4	3,2,3,7	5			
3							Loose brown fine to coarse sand, trace silt (pushed casing to 2 ft, washed to 4 ft, casing dropped 2 ft.)		
4									
			24/13	4 - 6	4,6,10,12	16	Medium dense brown fine to coarse sand, trace silt and fine gravel		
5							(washed to 6 ft, hole collapsing. Set casing at 6 ft, wash to 6 ft, sand blowing casing- sampled inside casing at 5.5 ft.)		
6			24/15	5.5 - 7.5	9,14,15,14	29	Medium dense brown fine sand, trace silt		
7							mixed polymer slurry (advanced casing to 8 ft, washed to 8 ft.)		
8									
			24/16	8 - 10	9,14,15,17	29			
9							Medium dense brown silty fine sand		
10							(washed to 10 ft)	GLACIO FLUVIAL	
			24/14	10 - 12	15,18,18,16	36	Brown silt, trace fine to medium sand		
11							(advanced casing to 10 ft, washed to 12 ft)		
12									
			24/14	12 - 14	14,12,8,11	20	Brown silt, trace fine sand		
13							(advanced casing to 12 ft, washed to 14 ft)		
14									
			24/15	14 - 16	17,17,15,11	32	Brown silt, trace fine sand		
15							(washed to 16 ft)		
16									
			24/19	16 - 18	8,7,6,7	13	Brown silt, trace fine sand		
17							(advanced casing to 16 ft, washed to 18 ft)		
18									
			24/20	18 - 20	7,5,5,6	10	Brown silt, trace fine sand		
19									
20									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

	PROJECT	BORING NO.	B01-CAD-072007
374 Congress Street, Suite 508	NEW BEDFORD HARBOR DREDGE PHASE III	SHEET	2 of 4
Boston, MA 02210	POPE's ISLAND NORTH AREA - CAD CELL 2	FILE NO.	6615.003
Phone: 617.728.0070	NEW BEDFORD HARBOR, NEW BEDFORD, MA	CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696504	Easting 815424	
Driller	Tim Turner	Mudline El.	-5.0	Datum	MLLW
Logged By	GAD, KH, KD	Date Start	7/30/2007	Date End	8/2/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: Rotary wash with mud
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
			24/17	20 - 22	10,6,6,6	12	Brown silt, trace fine to medium sand		
21									
							(advanced casing to 18 ft, washed to 22 ft)		
22									
			24/19	22 - 24	8,6,4,3	10	Brown silt, trace fine sand		
23									
24									
			24/18	24 - 26	6,3,3,4	6	Brown silt, trace fine sand		
25									
							(advanced casing to 22 ft, washed to 26 ft)		
26									
			24/18	26 - 28	6,5,9,9	14	Brown silt and fine sand		
27									
							(advanced casing to 24 ft, washed to 28 ft)		
28									
			24/17	28 - 30	11,7,7,8	14	Brown silt, trace fine sand		
29									
30									
			24/16	30 - 32	6,5,5,6	10	Brown silt, little fine sand		
31									
							(advanced casing to 28 ft, washed to 32 ft)		
32									
			24/15	32 - 34	8,8,9,9	17	Brown fine sand and silt		
33									
34									
			24/17	34 - 36	8,5,4,3	9	Grey silt, trace fine sand		
35									
36									
			24/24	36 - 38	9,5,3,2	8	Grey silt, trace fine sand		
37									
38									
			24/16	38 - 40	2,3,3,4	6	Grey silt and fine sand		
39									
40									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

374 Congress Street, Suite 508
Boston, MA 02210
Phone: 617.728.0070

PROJECT
NEW BEDFORD HARBOR DREDGE PHASE III
POPE's ISLAND NORTH AREA - CAD CELL 2
NEW BEDFORD HARBOR, NEW BEDFORD, MA

BORING NO.	**B01-CAD-072007**
SHEET	3 of 4
FILE NO.	6615.003
CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696504	Easting 815424	
Driller	Tim Turner	Mudline El.	-5.0	Datum	MLLW
Logged By	GAD, KH, KD	Date Start	7/30/2007	Date End	8/2/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: Rotary wash with mud
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
			24/19	40 - 42	WOR,1,2,4	3	Grey silt and fine sand		
41									
42			24/19	42 - 44	3,3,3,5	6	Grey fine sand, some silt		
43									
44			24/24	44 - 46	3,2,3,2	5	Grey fine sand and silt		
45									
46			24/13	46 - 48	2,WOR,2	WOR	Grey silt some fine sand		
47									
48			24/15	48 - 50	6,4,3,8	7	Grey silt, little fine sand	GLACIO FLUVIAL	
49									
50			24/17	50 - 52	12.7.8.9	15	Grey silt, little fine sand		
51									
52			24/16	52 - 54	8,2,7,3	9	Grey silt, little fine sand		
53							(advanced casing to 30 ft)		
54			24/18	54 - 56	8,7,7,6	14	Grey silt, little fine sand		
55									
56			24/20	56 - 58	9,2,1,2	3	Grey silt, little fine sand		
57									
58			24/17	58 - 60	8,8,10,9	18	Grey silt, little fine sand		
59									
60									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

374 Congress Street, Suite 508
Boston, MA 02210
Phone: 617.728.0070

PROJECT
NEW BEDFORD HARBOR DREDGE PHASE III
POPE's ISLAND NORTH AREA - CAD CELL 2
NEW BEDFORD HARBOR, NEW BEDFORD, MA

BORING NO.	**B01-CAD-072007**
SHEET	4 of 4
FILE NO.	6615.003
CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696504	Easting 815424	
Driller	Tim Turner	Mudline El.	-5.0	Datum	MLLW
Logged By	GAD, KH, KD	Date Start	7/30/2007	Date End	8/2/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: Rotary wash with mud
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
			24/23	60 - 62	1,10,17,17	27	**Grey silt, little fine sand**	GLACIO FLUVIAL	
61									
62									
			24/24	62 - 64	17,10,48,66	58	**Grey silt, little fine sand**		
63							(advanced casing to 60 ft, washed to 64 ft)		
64									
			24/16	64 - 66	12,7,4,6	11	**Brown fine to coarse sand, trace silt and fine gravel**		
65									
66									
			24/13	66 - 68	9,12,5,9	17	**Brown fine sand, trace medium to coarse sand and silt**		
67							(advanced casing to 66 ft, washed to 68 ft)		
68									
			24/5	68 - 70	8,4,5,15	9	**Brown fine to coarse sand, some fine to coarse gravel, trace silt**		
69							(advanced casing to 68 ft, washed to 72 ft)		
70									
			24/5	70 - 72	21,46,45,24	91	**Brown fine to coarse sand, little fine to coarse gravel and silt**	GLACIAL TILL	
71									
72									
			24/12	72 - 74	19,28,46,95	74	**Brown fine to coarse sand, little fine to coarse gravel and silt**		
73									
74							(roller bit through cobble and sand to 76 ft)		
75									
76							Attempted to sample at 76 ft. Sampler refusal - 50 blows, 0 inches.		
							Set up to core at 76 ft. (see attached rock core log)		
77									
78									
79									
80									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

	PROJECT		
374 Congress Street, Suite 508 Boston, MA 02210 Phone: 617.728.0070	NEW BEDFORD HARBOR DREDGE PHASE III	BORING NO.	B02-CAD-072007
	POPE's ISLAND NORTH AREA - CAD CELL 2	SHEET	1 of 5
		FILE NO.	6615.003
	NEW BEDFORD HARBOR, NEW BEDFORD, MA	CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696111	Easting 815464	
Driller	Tim Turner	Mudline El.	-5.3	Datum	MLLW
Logged By	KD	Date Start	8/6/2007	Date End	8/8/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: Rotary wash with mud
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/0	0 - 2	WOR	WOR		ORGANIC SILT	
1							No Recovery		
2									
3									
4									
5									
		SS	24/12	5 - 7	2,8,9,13	17	0 -3" Brown fine to coarse sand, little fine gravel		
6							3 - 12" Brown silt, little fine sand		
7									
8									
9									
10									
		SS	24/14	10 - 12	9,10,10,8	20	Brown silt, trace fine sand		
11									
12								GLACIO FLUVIAL	
13									
14									
15									
		SS	24/10	15 - 17	6,6,7,6	13	Brown silt, trace fine sand		
16									
17									
18									
19									
20									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

374 Congress Street, Suite 508
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PROJECT
NEW BEDFORD HARBOR DREDGE PHASE III
POPE's ISLAND NORTH AREA - CAD CELL 2
NEW BEDFORD HARBOR, NEW BEDFORD, MA

BORING NO.	**B02-CAD-072007**
SHEET	2 of 5
FILE NO.	6615.003
CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696504	Easting 815424	
Driller	Tim Turner	Mudline El.	-5.3	Datum	MLLW
Logged By	KD	Date Start	7/30/2007	Date End	8/2/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: Rotary wash with mud
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/10	20-22	3,5,8,10	13	Brown silt, trace fine sand		
21									
22									
23									
24									
25									
		SS	24/11	25-27	7,8,11,11	19	Brown silt, some fine sand		
26									
27									
28									
29								GLACIO FLUVIAL	
30									
		SS	24/9	30-32	4,2,3,3	5	Grey silt, trace fine sand		
31									
32									
33									
34									
35									
		SS	24/8	35-37	WOR,4,3,3	7	Grey silt, little fine sand, trace coarse sand		
36									
37									
38									
39									
40									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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PROJECT

NEW BEDFORD HARBOR DREDGE PHASE III

POPE's ISLAND NORTH AREA - CAD CELL 2

NEW BEDFORD HARBOR, NEW BEDFORD, MA

BORING NO.	**B02-CAD-072007**
SHEET	3 of 5
FILE NO.	6615.003
CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696504	Easting 815424	
Driller	Tim Turner	Mudline El.	-5.3	Datum	MLLW
Logged By	KD	Date Start	7/30/2007	Date End	8/2/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: Rotary wash with mud
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/8	40-42	WOR,5,5,4	10	Grey silt, little fine sand		
41									
42									
43									
44									
45									
		SS	24/12	45-47	3/3",6,7,6	13	Grey silt, little fine sand		
46									
47									
48									
49									
50								GLACIO FLUVIAL	
		SS	24/6	50-52	7,6,11,6	17	Medium dense grey fine to coarse sand, some fine to coarse gravel, trace silt		
51									
52									
53									
54									
55									
		SS	24/4	55-57	15,19,8,6	27	Medium dense grey fine gravel, some course gravel, some medium to coarse sand, trace silt		
56									
57									
58									
59									
60									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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PROJECT		
NEW BEDFORD HARBOR DREDGE PHASE III	BORING NO.	B02-CAD-072007
POPE's ISLAND NORTH AREA - CAD CELL 2	SHEET	4 of 5
NEW BEDFORD HARBOR, NEW BEDFORD, MA	FILE NO.	6615.003
	CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696504	Easting 815424	
Driller	Tim Turner	Mudline El.	-5.3	Datum	MLLW
Logged By	KD	Date Start	7/30/2007	Date End	8/2/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: Rotary wash with mud
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/2	60-62	5,6,7,8	13	Medium dense grey fine gravel, some course gravel, some medium to coarse sand, trace silt (rock in spoon drove through sample no sample collected)		
61									
62									
63									
64									
65									
		SS	24/	65-67	17,22,17,18	39	Dense grey medium to coarse sand and fine to coarse gravel, trace fine sand and silt		
66									
67									
68									
69								GLACIO FLUVIAL	
70									
		SS	24/14	70-72	14,14,23,30	37	0-4" Brown fine to coarse sand, little fine to coarse gravel, little silt		
71							4-14" Mottled orange-brown fine sand and silt, trace coarse sand and fine gravel		
72									
73									
74									
75							0 - 4" Dense mottled orange-brown fine sand and silt, trace coarse sand and fine gravel		
		SS	24/9	75-77	13,19,17,16	36			
76							4-9" Dense fine to coarse gravel, some fine to coarse sand		
77									
78								WEATHERED ROCK	
79									
80									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

374 Congress Street, Suite 508 Boston, MA 02210 Phone: 617.728.0070	**PROJECT** NEW BEDFORD HARBOR DREDGE PHASE III POPE's ISLAND NORTH AREA - CAD CELL 2 NEW BEDFORD HARBOR, NEW BEDFORD, MA	BORING NO. **B02-CAD-072007** SHEET 5 of 5 FILE NO. 6615.003 CHKD. BY KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696504	Easting 815424	
Driller	Tim Turner	Mudline El.	-5.3	Datum	MLLW
Logged By	KD	Date Start	7/30/2007	Date End	8/2/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: Rotary wash with mud
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	7/7	80-82	66,100/1"	100/1"	Very dense orange brown fine to coarse sand, some fine to coarse gravel, trace silt	WEATHERED ROCK	
81									
82							Set up to core at 82.5 ft.		
83							(Top of rock at depth of 82.5 ft)		
84									
85									
86									
87									
88									
89									
90									
91									
92									
93									
94									
95									
96									
97									
98									
99									
100									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex environmental, inc.
374 Congress Street, Suite 508
Boston, MA 02210
Phone: 617.728.0070

PROJECT
NEW BEDFORD HARBOR DREDGE PHASE III
POPE's ISLAND NORTH AREA - CAD CELL 2
NEW BEDFORD HARBOR, NEW BEDFORD, MA

BORING NO.	B03-CAD-072007
SHEET	1 of 4
FILE NO.	6615.003
CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696733	Easting 815841	
Driller	TIM TURNER	Mudline El.	-6.6	Datum	MLLW
Logged By	KTD, WB	Date Start	8/3/2007	Date End	8/6/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/20	0-2	WOR	WOR	Very soft black organic silt, some fine sand	ORGANIC SILT	
1							mild odor		
2									
		SS	24/10	2 - 4	WOR	WOR	Very soft black organic silt, some fine sand		
3							mild odor		
4									
5									
		SS	24/11	5 - 7	WOR	WOR	Very soft black organic silt, some fine sand		
6							shells in wash		
7									
8									
9									
10									
		SS	24/1	10-12	WOR	WOR	Very soft black organic silt, some fine sand		
11							(sample was mishandled, no sample collected)		
12									
13									
14									
15									
		SS	24/14	15-17	WOR, WOR, 2,1	2	Soft black organic silt, some fine sand		
16							(brown sandy silt in tip, Peat)		
17								PEAT	
18									
19									
20									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex Environmental, Inc.
374 Congress Street, Suite 508
Boston, MA 02210
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PROJECT
NEW BEDFORD HARBOR DREDGE PHASE III
POPE's ISLAND NORTH AREA - CAD CELL 2
NEW BEDFORD HARBOR, NEW BEDFORD, MA

BORING NO. **B03-CAD-072007**

FILE NO. 6615.003
CHKD. BY KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696733	Easting 815841	
Driller	TIM TURNER	Mudline El.	-6.6	Datum	MLLW
Logged By	KTD, WB	Date Start	8/3/2007	Date End	8/6/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
			24/18	20-22	WOR,WOR,2,1	2	Soft brown silt, some fine sand and organic material (Peat)	PEAT	
21									
22									
23									
24									
25									
			24/15	25-27	2,3,3,4	6	Loose grey fine sand and silt shells in wash	GLACIO FLUVIAL	
26									
27									
28									
29									
30									
			24/	30-32	1,2,2,1	4	Loose gray fine sand, trace medium sand and silt Shell layer at 31 ft.		
31									
32									
33									
34									
35									
			24/23	35-37	6,5,5,6	10	Loose gray fine to medium sand, trace coarse sand, trace fine gravel, trace silt sample contains gravel at 14"		
36									
37									
38									
39									
40									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex Environmental, Inc.	PROJECT	BORING NO.	B03-CAD-072007
374 Congress Street, Suite 508	NEW BEDFORD HARBOR DREDGE PHASE III	SHEET	3 of 4
Boston, MA 02210	POPE's ISLAND NORTH AREA - CAD CELL 2	FILE NO.	6615.003
Phone: 617.728.0070	NEW BEDFORD HARBOR, NEW BEDFORD, MA	CHKD. BY	KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696733	Easting 815841	
Driller	TIM TURNER	Mudline El.	-6.6	Datum	MLLW
Logged By	KTD, WB	Date Start	8/3/2007	Date End	8/6/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/	40-42	WOR,WOR,2,2	2	Loose gray fine sand, some silt		
41									
42									
43									
44									
45									
		SS	24/15	45-47	WOR, 1,3, 1	4	Loose gray fine sand, some silt		
46									
47									
48								GLACIO FLUVIAL	
49									
50									
		SS	24/13	50-52	5,4,5,8	9	Gray silt, little fine sand		
51									
52									
53									
54									
55									
		SS	24/12	55-57	5,5,7,9	12	Medium dense gray fine to coarse sand, little fine to coarse gravel, trace silt		
56									
57									
58									
59									
60									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex Environmental, Inc.
374 Congress Street, Suite 508
Boston, MA 02210
Phone: 617.728.0070

PROJECT
NEW BEDFORD HARBOR DREDGE PHASE III
POPE's ISLAND NORTH AREA - CAD CELL 2
NEW BEDFORD HARBOR, NEW BEDFORD, MA

BORING NO. **B03-CAD-072007**

FILE NO. 6615.003
CHKD. BY KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2696733 / Easting 815841
Driller	TIM TURNER	Mudline El.	-6.6 / Datum MLLW
Logged By	KTD, WB	Date Start	8/3/2007 / Date End 8/6/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/9	60-62	17,16,21,41	37	Dense gray-brown mottled silty fine sand, little medium to coarse sand and fine to coarse gravel (Glacial Till)		
61									
62							(roller bit through cobble or boulder at 62 ft)	GLACIAL TILL	
63									
64									
65			9/6	65-67	4,100/3"	100/3"	Very dense orange-brown fine to medium sand, some silt, trace coarse sand and fine gravel		
66									
67									
68									
69									
70							set up to core at 70ft.		
71							Top of rock at 70 ft. (see attached rock core log)		
72									
73									
74									
75									
76									
77									
78									
79									
80									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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374 Congress Street, Suite 508
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PROJECT
NEW BEDFORD HARBOR DREDGE PHASE III
POPE's ISLAND NORTH AREA - CAD CELL 2
NEW BEDFORD HARBOR, NEW BEDFORD, MA

BORING NO. **B04-CAD-072007**
SHEET 1 of 4
FILE NO. 6615.003
CHKD. BY KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2690765 / Easting 815163
Driller	RAY	Mudline El.	-4.1 / Datum MLLW
Logged By	KTD, WB, GD, KVN	Date Start	8/16/2007 / Date End 8/20/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/10.5	0-2	2,1/12",1	1	0-3" Very loose black fine sand, little coarse sand, shells		
1							3-10.5" Very loose dark gray fine sand, some silt, trace shells		
2								MARINE SAND	
3									
4									
5							Very loose gray fine sand, little silt		
		SS	24/11	5-7	WOR,7,9,7	16			
6							(layer of coarse gravel at 5.2 ft)		
							Brown silt, some fine sand		
7									
8									
9									
		SS	24/16	9-11	4,2,4,7	6	Brown silt and fine sand		
10								GLACIO FLUVIAL	
11									
12									
13									
14									
15									
		SS	24/24	15-17	7,10,9,10	19	Medium dense brown to orange fine sand, trace silt and fine gravel		
16									
17									
18									
19									
20									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex Environmental, Inc. 374 Congress Street, Suite 508 Boston, MA 02210 Phone: 617.728.0070	PROJECT NEW BEDFORD HARBOR DREDGE PHASE III POPE's ISLAND NORTH AREA - CAD CELL 2 NEW BEDFORD HARBOR, NEW BEDFORD, MA	BORING NO. B04-CAD-072007 SHEET 2 of 4 FILE NO. 6615.003 CHKD. BY KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2690765	Easting 815163	
Driller	RAY	Mudline El.	-4.1	Datum	MLLW
Logged By	KTD, WB, GD, KVN	Date Start	8/16/2007	Date End	8/20/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/14	20-22	3,4,4,5	8	Brown silt, trace fine sand		
21									
22									
23									
24									
25									
		SS	24/17	25-27	4,5,10,10	15	Brown silt, trace fine sand layer of orange-brown silt and fine sand at 26 ft		
26									
27									
28									
29									
30								GLACIO FLUVIAL	
		SS	24/24	30-32	1,1,2,4	3	Brown fine sand, some silt, trace medium sand		
31									
32									
33									
34									
35									
		SS	24/23	35-37	4,4,5,6	9	Brown silt, trace fine sand		
36									
37									
38									
39									
40									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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374 Congress Street, Suite 508
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PROJECT
NEW BEDFORD HARBOR DREDGE PHASE III
POPE's ISLAND NORTH AREA - CAD CELL 2
NEW BEDFORD HARBOR, NEW BEDFORD, MA

BORING NO. **B03-CAD-072007**

FILE NO. 6615.003
CHKD. BY KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2690765 / Easting 815163
Driller	TIM TURNER	Mudline El.	-4.1 / Datum MLLW
Logged By	KTD, WB, GD, KVN	Date Start	8/16/2007 / Date End 8/20/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		SS	24/19	40-42	1,4,5,8	9	Brown silt, trace fine sand		
41									
42									
43									
44									
45									
		SS	24/17	45-47	WOR	WOR	Gray fine sand and silt		
46									
47									
48									
49								GLACIO FLUVIAL	
50									
		SS	24/24	50-52	WOR,4,11,16	15	0 - 13": Brown silt and fine sand		
51							13 - 24" Gray silt, trace fine sand		
52									
53									
54									
55									
		SS	24/12	55-57	23,12,10,12	22	Gray silt, trace fine sand		
56									
57									
58									
59									
60									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex Environmental, Inc. 374 Congress Street, Suite 508 Boston, MA 02210 Phone: 617.728.0070	PROJECT NEW BEDFORD HARBOR DREDGE PHASE III POPE's ISLAND NORTH AREA - CAD CELL 2 NEW BEDFORD HARBOR, NEW BEDFORD, MA	BORING NO. B04-CAD-072007 SHEET 4 of 4 FILE NO. 6615.003 CHKD. BY KH

Boring Co.	Geologic, Inc.	Boring Location	Northing 2690765	Easting 815163	
Driller	TIM TURNER	Mudline El.	-4.1	Datum	MLLW
Logged By	KTD, WB, GD, KVN	Date Start	8/16/2007	Date End	8/20/2007

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted ATV
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
61							roller bit through boulder at 60 ft. sand blew in, hole collapsed. (No sample at 60 ft)		
62									
63		SS	24/8	63-65	5,6,7,11	13	Medium dense gray fine to coarse sand, little fine gravel	GLACIO FLUVIAL	
64									
65									
66							telescoped 3" casing down to 68 ft. boulder encountered from 65 to 66.5 ft.		
67									
68							cleaned out casing to 70 ft, driller thinks rock encountered, set up to core rock.		
69									
70							top of rock at 70 ft.		
71							(see rock core log, next page)		
72									
73									
74									
75									
76									
77									
78									
79									
80									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex environmental, inc.
374 Congress Street, Suite 508
Boston, MA 02210
Phone: 617.728.0070

PROJECT

New Bedford Harbor Dredge - Phase II
New Bedford, Massachusetts

BORING NO. CAD-1

FILE NO. 6542.003
CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2696013.2	Easting 815159.3	
Driller	Barry Wordell	Mudline El.	-30.6	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/20/2004	Date End	9/20/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1								ORGANIC SILT	
2									
3									
4									
5		S1	24/24	4-6	3-9-7-5	16	Sandy organic silt and clay (OL/OH); Black, very stiff, organic odor; Grades to well-graded sand (SW) with trace organics that is dark gray and medium dense; Fine sand: 25%, medium sand: 40%, coarse sand: 25%, organics: <10%.		
6								GLACIO-FLUVIAL	
7									
8									
9		S2	24/17	8-10	2-2-3-3	5	Poorly-graded sand with trace silt and gravel (SP); Olive gray, loose; Silt: 5%, fine sand: 40%, medium sand: 35%, coarse sand: 15% gravel: 5%.		
10									
11									
12									
13									
14									
15		S3	24/8	14-16	2-2-2-3	4	Poorly-graded sand (SP) similar to S2.		
16									
17									
18									
19									
20		S4	24/7	19-21	2-3-8-14	11	Poorly-graded sand and silt (SM); Silt: 30%, fine sand: 50%, medium sand: 10%, coarse sand: 10%.		

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

	PROJECT	
Apex environmental, inc. 374 Congress Street, Suite 508 Boston, MA 02210 Phone: 617.728.0070	New Bedford Harbor Dredge - Phase II New Bedford, Massachusetts	BORING NO. CAD-1 SHEET 2 of 3 FILE NO. 6542.003 CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2696013.2	Easting 815159.3	
Driller	Barry Wordell	Mudline El.	-30.6	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/20/2004	Date End	9/20/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
21							(cont.) Poorly-graded sand and silt (SM); Silt: 30%, fine sand: 50%, medium sand: 10%, coarse sand: 10%.		
22								GLACIO-FLUVIAL	
23									
24									
25		S5	24/12	24-26	9-9-6-10	15	Poorly-graded sand with gravel (SP); Possible wash sample; Olive gray, medium density; Fine sand: 10%, medium sand: 15%, coarse sand: 50%, gravel: 25%.		
26									
27									
28									
29									
30		S6	23/7	29-31	10-8-24-100/5"	32	Well-graded sand and gravel (SW); Brown, dense; Fine sand: 15%, medium sand: 20%, coarse sand: 40%, gravel: 25%; Gravel is fine to medium , sub-rounded to sub-angular and composed of quartz, K-feldspar, and granite. Advance casing to 34 feet.		
31									
32									
33									
34									
35		S7	24/7	34-36	16-9-12-38	21	Well-graded sand and gravel (SW) similar to S6 with increasing gravel content and trace silt.		
36									
37									
38									
39									
40		S8	24/10	39-41	6-3-7-19	10	Well-graded gravel and sand (GW); Brownish gray, medium density; Silt: 5%, fine sand: 10%, medium sand: 10%, coarse sand: 20%, gravel: 55%.		

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex environmental, inc.

374 Congress Street, Suite 508
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Phone: 617.728.0070

PROJECT

New Bedford Harbor Dredge - Phase II
New Bedford, Massachusetts

BORING NO.	CAD-1
SHEET	3 of 3
FILE NO.	6542.003
CHKD. BY	K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2696013.2	Easting 815159.3	
Driller	Barry Wordell	Mudline El.	-30.6	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/20/2004	Date End	9/20/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
41							(cont.) Well-graded gravel and sand (GW); Brownish gray, medium density; Silt: 5%, fine sand: 10%, medium sand: 10%, coarse sand: 20%, gravel: 55%.	GLACIO-FLUVIAL	
42									
43									
44									
45		S9	24/8	44-46	4-3-3-7	6	Well-graded gravel and sand (GW) similar to S8.		
46									
47									
48									
49									
50									
51									
52									
53									
54									
55		S10	5/5	54-54.4	100/5"		Well-graded gravel and sand (GW) similar to S8. Iron staining observed. Bottom of Exploration at 54.4 ft.		
56									
57									
58									
59									
60									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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PROJECT
New Bedford Harbor Drege - Phase II
New Bedford, Massachusetts

BORING NO. CAD-2
SHEET 1 of 3
FILE NO. 6542.003
CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695565.3	Easting 814905.3	
Driller	Barry Wordell	Mudline El.	-30.6	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/23/2004	Date End	9/24/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1								ORGANIC SILT	
2		S1	24/12	1-3	WOR		Organic silt and clay (OL/OH); black, organic odor.		
3									
4		S2	24/10	3-5	6-3-3-1	6	Poorly-graded sand and silt with trace organics (SM); Brownish-black, loose, slight organic odor; Fine sand: 50%, medium sand: 10%, silt: 35%, organics:25%.		
5									
6		S3	1/1	5-5.1	100/1"		Refusal; Brownish-black, fine to medium sand with some silt. Pulled casing, set spuds, readvance casing to 6'. Windy conditions moving barge.		
7		S4	24/11	6-8	13-9-13-14	22	Well-graded gravel and sand (GW); Brown , medium dense; Fine sand: 10%, medium sand: 10%, coarse sand: 25%, gravel: 15%; Gravel is composed of quartz, K and Na feldspar, granite, olivine, and is subrounded to subangular.	GLACIO-FLUVIAL	
8									
9		S5	24/8	8-10	13-11-9-23	20	Well-graded gravel and sand (GW); Reddish-brown, medium dense, similar to S4.		
10									
11									
12		S6	24/9	11-13	100-21-14-14	35	Poorly-graded sand and gravel with trace silt (SP); Brownish-gray, dense: Fine sand: 10%, medium sand: 15%, coarse sand: 30%, gravel: 30%, silt: 15%.		
13									
14		S7	24/7	13-15	17-8-3-2	11	Well-graded sand and gravel with trace silt (SW); Brownish-gray, medium dense; Fine sand: 15%, medium sand: 15%, coarse sand: 30%, gravel: 35%, silt: 5%.		
15									
16									
17		S8	19/12	16-18	1-1-1-100/1		Poorly-graded sand with some gravel (SP); Olive gray, very loose; Fine sand: 40%, medium sand: 20%, coarse sand: 15%, gravel: 25%.		
18									
19							Advance (drive) casing to 18.5. Roller bit refusal at 18.5. Core rock from 18.5 to 21.5 - boulder. (see rock core log, page 3).		
20									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex environmental, inc.

374 Congress Street, Suite 508
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Phone: 617.728.0070

PROJECT

New Bedford Harbor Drege - Phase II
New Bedford, Massachusetts

BORING NO.	CAD-2
SHEET	2 of 3
FILE NO.	6542.003
CHKD. BY	K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695565.3	Easting 814905.3	
Driller	Barry Wordell	Mudline El.	-30.6	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/23/2004	Date End	9/24/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION: Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
21							end of boulder encountered at 21.5 ft.		
							Telescope 3" casing inside 4" casing; advance casing to 22 ft.		
22									
		S8	24/7	22-24	5-7-10-11	17	Poorly-graded sand and gravel (SP); Light brown., medium dense: Fine sand: 5%,		
23							medium sand: 15%, coarse sand: 40%, gravel: 40%; Gravel is composed of quartz,		
							K feldspar, granite, gneiss, fine to coarse grained, and subrounded to subangular,		
24									
		S9	24/9	24-26	10-8-30-33	38	Well-graded gravel and sand (GW); Light brown, dense; Fine sand: 5%, medium sand:		
25							10%, coarse sand: 35%, gravel 50%; Composition of gravel is similar to S8.		
26									
		S10	17/10	26-27.4	16-21-100/5"	-	Well-graded gravel and sand with trace silt (GW); Brownish-gray.		
27							Split spoon refusal at 27.4 ft.		
							See page 3 for log of rock core.		
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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PROJECT
New Bedford Harbor Drege - Phase II
New Bedford, Massachusetts

BORING NO. CAD-2

FILE NO. 6542.003
CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695565.3 Easting 814905.3
Driller	Barry Wordell	Mudline El.	-30.6 Datum MLLW
Logged By	Joe Kraycik	Date Start	9/23/2004 Date End 9/24/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
18						
		C1	18.5-19.5	5	Begin C1 at 18.5 ft.	
19						
			19.5-20.5	2.5	White to pink, fine to medium grained granitic gneiss recovered.	
20					Out of rock (boulder) at 21.5 ft.	
			20.5-21.5	3		
21					End C1 at 21.5 ft.	
					REC=88% RQD=45%	
22						
23					(See page 2 for drilling and sampling data from 21.5 ft to 27.4 ft.)	
24						
25						
26						
27					Begin C2 at 27.4 ft.	
		C2	27.4-28.4	4.5	White to pink, fine to medium grained granitic gneiss; No breaks.	
28						
			28.4-29.4	4	No breaks	
29						
			29.4-30.4	3	Highly fractured with horizontal and vertical breaks; Iron staining; Sand present.	
30						
			30.4-31.4	2	Horizontal break present; Iron staining and sand at breaks.	
31						
			31.4-32.4	4.5	End C2 at 32.4 ft.	
32					REC=82% RQD=75%	
			32.4-33.4	3	Begin C3 at 32.4 ft.	
33					White to pink, fine to medium grained granitic gneiss.	
			33.4-34.4	2	One low-angle break.	
34						
			34.4-35.4	3	Three low-ang;e breaks; Iron staining and sand in breaks.	
35						
			35.4-36.4	4	Highly fractured with horizontal and vertical breaks.	
36					One horizontal break.	
			36.4-37.4	4	End C3 at 37.4 ft. REC=88% RQD=45%	
37					Bottom of Exploration at 37.4 ft.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
2)
3)
4)

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PROJECT

New Bedford Harbor Dredge - Phase II
New Bedford, Massachusetts

BORING NO. CAD-3
SHEET 1 of 2
FILE NO. 6542.003
CHKD. BY K. Hartel

Boring Co. New Hampshire Boring
Driller Barry Wordell
Logged By Tom Stolworthy
Boring Location Northing 2695904.6 Easting 814775
Mudline El. -32.5 Datum MLLW
Date Start 9/2/2004 Date End 9/3/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
1							No Samples Taken to depth of 11.5 ft		
2							See log of boring 3A		
3									
4									
5									
6									
7									
8									
9									
10									
11									
12		S1	24/19	11.5-13.5	6-12-29-15	41	SM; Olive gray, fine sand and silt, little medium sand, organic odor.	GLACIO-FLUVIAL	
13									
14		S2	24/19	13.5-15.5	5-4-10-13	14	SM; Olive gray, fine sand and silt, organic odor.		
15									
16		S3	24/16	15.5-17.5	8-9-8-8	17	SM; Light gray, fine sand sand and silt with trace amounts of corase sand; slight organic odor.		
17									
18		S4	24/22	17.5-19.5	1-4-33-20	37	SM; Light gray, fine sand and slit, slight organic odor.		
19									
20		S5	24/24	19.5-21.5	3-6-8-6	14	SP; Gray, corse and medium sand with some fine sand, poorly sorted to 21 feet,		

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex environmental, inc. 374 Congress Street, Suite 508 Boston, MA 02210 Phone: 617.728.0070	**PROJECT** New Bedford Harbor Dredge - Phase II New Bedford, Massachusetts	BORING NO. CAD-3 SHEET 2 of 2 FILE NO. 6542.003 CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695904.6	Easting 814775	
Driller	Barry Wordell	Mudline El.	-32.5	Datum	MLLW
Logged By	Tom Stolworthy	Date Start	9/2/2004	Date End	9/3/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
21							(cont.) SP; Gray, corse and medium sand with some fine sand, poorly sorted to 21 feet, slight clay stringer to 21.5 feet.	GLACIO-FLUVIAL	
22		S6	24/10	21.5-23.5	14-20-8-8	28	SP; Gray/brown, coarse sand with little fine sand and trace amounts of fine gravel, poorly sorted.		
23									
24		S7	24/19	23.5-25.5	20-16-14-22	30	SP; Gray/brown, coarse sand with little fine sand and gravel, poorly sorted.		
25									
26		S8	24/12	25.5-27.5	8-13-21-3	34	SP; Brown, coarse sand with little fine gravel and trace fine to medium sand, poorly sorted.		
27									
28		S9	24/10	27.5-29.5	14-11-6-17	17	SP; Borwn, coarse sand with some fine gravel and little fine to medium sand with trace cobbles, poorly sorted.		
29									
30		S10	18/13.5	29.5-31	12-49-130	179	SP; Brown, coarse sand with some fine gravel and little fine to medium sand, poorly sorted to 31 feet.		
31							Gray, fine sand with clasts of granitic gneiss.		
32							Unable to core rock due to mechanical problems with drill rig. Bottom of exploration at 31 ft.		
33									
34									
35									
36									
37									
38									
39									
40									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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PROJECT

New Bedford Harbor Dredge - Phase II

New Bedford, Massachusetts

BORING NO.	CAD-3A
SHEET	1 of 3
FILE NO.	6542.003
CHKD. BY	K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695897.9	Easting 814773.3	
Driller	Barry Wordell	Mudline El.	-32.5	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/13/2004	Date End	9/14/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1			24/0	0-2	WOR	WOR	No Recovery	ORGANIC SILT	
2									
3		S1	24/24	2-4	WOR	WOR	Organic silt and clay (OL/OH); Black, soft, strong odor; Coarsens downwards, bottom 2 inches composed of gray, fine to medium sand and silt (SM) ; Silt: 30%, fine sand: 45%, medium sand: 25%.		
4									
5		S2	24/18	4-6	16-12-15-17	27	Fine to medium sand and silt with trace clay and organics (SM); Gray, medium dense, organic odor; Clay: <5%, silt: 35%, fine sand: 45%, medium sand: 10-15%, organics: <5%.	GLACIO-FLUVIAL	
6									
7		S3	24/15	6-8	6-5-4-3	9	Poorly-graded sand with some silt (SP-SM); Olive gray, loose; Silt: 5-10%, fine sand: 50%, medium sand: 30-40%, coarse sand: 5-10%.		
8									
9		S4	24/17	8-10	2-2-2-3	4	Same as above (SP-SM). Casing sank under own weight. Advanced boring to 24 ft. (See log of boring CAD-3 for stratigraphy).		
10									
11									
12									
13									
14									
15									
16									
17									
18							Note: from approximately 18 to 24 ft depth, spinning casing became difficult and it was necessary to drive the casing.		
19									
20									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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PROJECT

New Bedford Harbor Dredge - Phase II

New Bedford, Massachusetts

BORING NO.	CAD-3A
SHEET	2 of 3
FILE NO.	6542.003
CHKD. BY	K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695897.9	Easting 814773.3	
Driller	Barry Wordell	Mudline El.	-32.5	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/13/2004	Date End	9/14/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
21									
22									
23									
24									
25		S5	24/13	24-26	9-3-5-4	8	Well-graded sand with trace silt and gravel (SW); Olive grey, loose; Silt: <5%, fine sand: 45%, medium sand: 30%, coarse sand: 10%, gravel: <5%.	GLACIO-FLUVIAL	
26									
27		S6	24/17	26-28	7-3-3-4	6	Well-graded sand and gravel with trace silt (SW); Olive gray, loose, coarsens at 27.5 feet; Silt: <5%, fine sand: 35%, medium sand: 20%, coarse sand: 25%, gravel: 10-15%.		
28									
29		S7	24/	28-30	3-4-4-9	8	Well-graded sand and gravel with trace silt (SW); Light brown, loose; Silt: <5%, fine gravel is fine to medium grained.		
30								GLACIAL TILL	
31		S8	9/	30-30.75	9-100/3"	-	Well-graded sand and gravel (SW); Gray, very dense, some coarse gravel present; Silt: <5%, fine sand: 30%, medium sand: 15%, coarse sand: 20%, gravel: 30%.		
32							Spoon hit refusal at 30.75 feet. Begin rock core at 30.75 ft. Boring log continued on next page.		
33									
34									
35									
36									
37									
38									
39									
40									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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PROJECT

New Bedford Harbor Dredge - Phase II

New Bedford, Massachusetts

BORING NO.	CAD-3A
SHEET	3 of 3
FILE NO.	6542.003
CHKD. BY	K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695897.9	Easting 814773.3	
Driller	Barry Wordell	Mudline El.	-32.5	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/13/2004	Date End	9/14/2004

Sampler 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig Barge Mounted Diedrich D50 ATV
Drilling Method 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		C1			Begin C1 at 30.75 ft.	
31			30.75-31.75	7	Fine to medium grained, highly weathered, gray/pink granitic gneiss; Horizontal fractures.	
32			31.75-32.75	5	Approximate 4" drop at 32.7 ft.	
33			32.75-33.75	3	Quartz pegmatite intrusions, higlhy weathered with gravel and cobbles; Horizontal fractures.	
34			33.75-34.75	2	Approximate 1 ft drop at 34.1 ft.	
35			34.75-35.75	3	End C1 at 35.75 ft. REC=62% RQD=44%	
					Begin C2 at 35.75 ft.	
36		C2	35.75-36.75	6	Fine to medium grained, light gray/pink granitic gneiss; Horizontally fractured with sand in fractures.	
37			36.75-37.75	3	Low angle fracture (10-20°) with sand in fracture, weathered.	
38			37.75-38.75	5	Medium to high angle fracture with silt in fracture, weathered.	
39			38.75-39.75	6	Slightly darker with more foliation and banding.	
40			39.75-40.75	7	End C2 at 40.75 ft.	
					REC=78% RQD=91%	
41						
					Bottom of exploration at 40.75 ft.	
42						
43						
44						
45						
46						
47						
48						
49						
50						

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
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Boston, MA 02210
Phone: 617.728.0070

PROJECT
New Bedford Harbor Dredge - Phase II
New Bedford, Massachusetts

BORING NO.	CAD-4
SHEET	1 of 3
FILE NO.	6542.003
CHKD. BY	K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695138.5	Easting 814853.4	
Driller	Barry Wordell	Mudline El.	-29.5	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/16/2004	Date End	9/16/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1								ORGANIC SILT	
2		S1	24/24	1.5-3.5	6-12-16-18	28	Sandy organic soil (OL/OH); Black, very stiff; Organic silt/clay: 65%, fine sand: 25%, medium sand: 10%.		
3							At 3 ft: Poorly graded sand and silt (SP-SM); gray, medium dense; fine sand 65%, medium sand 20%, silt 10 - 15%.		
4								GLACIO-FLUVIAL	
5									
6									
7		S2	24/15	6.5-8.5	5-8-6-4	14	Poorly-graded sand (SP); Olive gray, medium dense; Fine sand: 50%, medium sand: 40%, coarse sand: 10%, trace shell fragments.		
8									
9									
10									
11									
12		S3	24/17	11.5-13.5	9-5-8-9	13	Poorly graded sand with silt (SP-SM); Olive gray, medium dense; Fine sand: >60%, medium sand: 20%, silt: 10-15%, clay: <5%.		
13									
14									
15									
16									
17		S4	24/12	16.5-18.5	3-3-3-5	6	Well-graded sand with some gravel (SW); Olive gray, loose; Fine sand: 25%, medium sand: 45%, coarse sand: 20%, gravel: 5-10%.		
18									
19									
20									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex environmental, inc. 374 Congress Street, Suite 508 Boston, MA 02210 Phone: 617.728.0070	PROJECT New Bedford Harbor Dredge - Phase II New Bedford, Massachusetts	BORING NO. CAD-4 SHEET 2 of 3 FILE NO. 6542.003 CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695138.5	Easting 814853.4	
Driller	Barry Wordell	Mudline El.	-31.9	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/16/2004	Date End	9/16/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21									
22		S5	24/12	21.5-23.5	9-10-19-16	29	Well-graded sand and gravel (SW); Brownish-gray, medium dense; Fine sand: 10%, medium sand: 15%, coarse sand: 40%, gravel: 35%; Fine to coarse, subrounded to subangular; Quartz, K-feldspar, olivine, granite, gneiss.		
23									
24									
25									
26									
27		S6	24/9	26.5-28.5	16-18-19-30	37	Well-graded gravel with sand (GW); Brown, dense; Fine sand: <5%, medium sand: 10%, coarse sand: 25%, gravel: 60%; Fine to coarse, coarse gravel on top; Mineral content similar to above.		
28									
29									
30									
31									
32									
33		S7		32-34	28-13-34-83	47	Gravel with silt and sand (GW); Gray, dense; Silt: 30%, fine sand: 10%, medium sand: 10%, coarse sand: 10%, gravel: 45%.		
34									
35									
36									
37									
38									
39									
40		S8	24/9	39-41	43-13-19-9	32	Well-graded gravel with silt and sand (GW); Gray, dense; Silt: 20%, fine sand: 10%, medium sand: 15%, coarse sand: 15%, gravel: 40%.		

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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PROJECT
New Bedford Harbor Dredge - Phase II
New Bedford, Massachusetts

BORING NO. CAD-4
SHEET 3 of 3
FILE NO. 6542.003
CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695138.5 Easting 814853.4
Driller	Barry Wordell	Mudline El.	-31.9 Datum MLLW
Logged By	Joe Kraycik	Date Start	9/16/2004 Date End 9/16/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hc hammer free falling from a height of 30 inche
Drill Rig Barge Mounted Diedrich D50 ATV
Drilling Method 4-inch (PW) flush joint drill casin(
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inch

Groundwater Readings Not Applicable for Offshore Boring:

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
41							(cont.) Well-graded gravel with silt and sand (GW); Gray, dense; Silt: 20%, fine sand: 10%, medium sand: 15%, coarse sand: 15%, gravel: 40%.		
42									
43									
44									
45		S9	17/	44-45.4	43-82-100/5"	-	Well-graded gravel with sand (GW) some silt and clay; Gray, very dense; Silt: 20%, fine sand: 10%, medium sand: 15%, coarse sand: 10%, gravel: 40%, clay: <5%. Split spoon refusal at 45.4 ft.		
46									
47							Bottom of exploration at 45.4 ft.		
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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PROJECT
New Bedford Harbor Dredge - Phase II
New Bedford, Massachusetts

BORING NO. CAD-5
SHEET 1 of 2
FILE NO. 6542.003
CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695179.3	Easting 814434.5	
Driller	Barry Wordell	Mudline El.	-31.3	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/15/2004	Date End	9/15/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S1	24/0	0-2			No recovery	ORGANIC SILT	
1									
2									
		S2	24/24	2-4	9-12-15-10	27	2 to 3.25 feet: Organic silt and clay (OL/OH); Black, organic odor; 3.25 to 4 feet: Fine sand and silt (SM); Gray; Coarsens with depth to a well-graded sand and gravel (SW); Light brown, medium dense; Some organic odor; Silt: 5-10%, fine sand: 30%, medium sand: 25%, coarse sand: 30%, gravel: 15%.		
3									
4									
		S3	24/14	4-6	11-7-9-14	16	Well-graded sand and gravel with trace silt (SW); Brown, medium dense; Possible wash; Silt: 5%, fine sand: 20%, medium sand: 35%, coarse sand: 25%, gravel: 15%.	GLACIO FLUVIAL	
5									
6									
7									
8									
9									
10									
		S4	24/9	10-12	22-28-25-8	53	Well-graded sand and gravel with silt (SW-SM); Light brown, very dense; Silt: 15%, fine sand: 15%, medium sand: 20%, coarse sand: 30%, gravel: 20%; Gravel is fine to coarse grained, rounded to sub-angular, and composed of quartz, K and Na feldspar, and granite.		
11									
12									
13									
14									
15									
		S5	24/14	15-17	21-24-9-12	33	Similar to S4 (SW-SM); Silt: 10%.		
16									
17									
18									
19							Well-graded gravel with sand (GW); Medium sand: 35%, coarse sand: 35%, gravel: 40%; Gravel is fine to coarse grained, rounded to subangular, and composed of quartz, K and Na feldspar, and granite. Prepare to core rock at 20.4 ft.		
20		S6	5/3	20-20.4	100/5"	-			

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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PROJECT
New Bedford Harbor Dredge - Phase II
New Bedford, Massachusetts

BORING NO.	CAD-5
SHEET	2 of 2
FILE NO.	6542.003
CHKD. BY	K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695179.3	Easting 814434.5	
Driller	Barry Wordell	Mudline El.	-31.3	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/15/2204	Date End	9/15/2004

Sampler 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig Barge Mounted Diedrich D50 ATV
Drilling Method 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE INFORMATION: CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		C1	20.4-21.4	5	Reddish, highly weathered and fractured pegmatite, 70% quartz veins, 30% granite, sand and silt	
21					present in fractures.	
			21.4-22.4	3.5	Pink/white/black medium coarse granite, weathered, horizontal and vertical fractures.	
22						
			22.2-23.4	3	Similar to 21.4-22.4, horizontal breaks, vertical fracture over entire interval; grading into	
23					granitic gneiss.	
			23.4-24.4	3	Pink/white granitic gneiss, horizontal banding, no fractures.	
24						
			24.4-25.4	3	Similar to 23.4-24.4, weathered horizontal break at 24.7', high angle healed fracture last 3".	
25					End of C1 at 25.4 ft. REC=93% RQD=65%	
		C2	25.4-26.4	3	Granitic gneiss similar to 23.4-24.4, horizontal fracture (mechanical) at 26.8', fracture	
26					(weathered) at 26 ft.	
			26.4-27.4	4	Horizontal and vertical fractures.	
27						
			27.4-28.4	3	Horizontal fractures, iron staining, sand in fractures, slightly weathered.	
28						
			28.4-29.4	3	Highly fractured, sand in fractures, iron staining.	
29						
			29.4-30.4	4	Horizontal and vertical fractures.	
30						
31					End of C2 at 30.4 ft.	
					REC= 95% RQD=80%	
32					Bottom of exploration at 30.4 ft.	
33						
34						
35						
36						
37						
38						
39						
40						

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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PROJECT

New Bedford Harbor Dredge - Phase II

New Bedford, Massachusetts

BORING NO. CAD-6
SHEET 1 of 2
FILE NO. 6542.003
CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695343.5	Easting 814674.3	
Driller	Barry Wordell	Mudline El.	-31.3	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/8/2004	Date End	9/10/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1								ORGANIC SILT	
		S1	24/24	1-3	WOR-7-8	7	Black organic silt/clay (OL/OH); Organic odor; Coarsening downwards at bottom; Advance casing and roller bit to a depth of 2 feet.		
2									
		S2	24/21	2-4	6-7-10-14	17	Light brown, poorly-graded sand with some silt and trace coarse sand (SP-SM); medium dense; Trace OL/OH in top 6"; Silt: 15%, fine sand: 40%, medium sand: 35%, coarse sand: 5%, OL/OH: 5%; Some minor iron staining.	GLACIO-FLUVIAL	
3									
4									
		S3	24/18	4-6	9-7-5-5	12	Light brown, medium dense, well-graded sand with trace gravel and silt (SW); shell fragments, top 6" is primarily sand and silt, Silt: 5-10%, fine sand: 30%, med. sand: 30%, coarse sand: 25-30%, gravel: 5%.		
5									
6									
		S4	24/6	6-8	13-23-16-20	39	Reddish brown, dense, poorly-graded sand and gravel with trace silt (SP); Silt: 5%, medium sand:20%, coarse sand: 40%, gravel:35%; The gravel is rounded to sun-angular and composed of quartz, K and Na feldspar, granite, and gneiss; Note poor recovery.		
7									
8									
		S5	24/12	8-10	22-13-11-12	24	Reddish brown, medium dense well-graded gravel with sand (GW); Fine sand: 10%, medium sand: 15%, fine gravel: 25%, medium gravel: 35%, coarse gravel: 15%; Rock and mineral content same as 6-8 feet; Note poor recovery.		
9									
10									
		S6	24/10	10-12	16-16-11-10	27	Same as S5 (GW).		
11									
12									
		S7	24/10	12-14	16-13-12-16	25	Same as S5 with trace amounts of silt (<5%) (GW). Possible wash.		
13									
14									
		S8	24/11	14-16	12-27-19-9	46	Well-graded gravel (GW), possible wash; The bottom 4" is medium dense fine to medium sand with trace amounts of gravel; Fine sand: 50%, medium sand: 40%, gravel: 5%.		
15									
16									
		S9	3/3	16-16.25	100/3"	-	Well-graded sand and gravel with trace silt (SW); Fine sand: 15%, medium sand: 25%, coarse sand: 40%, gravel: 15%, silt: <5%. Refusal at 16.25 ft. Set up to core rock.		
17									
18									
19									
20									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

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Boring Co.		Boring Location	Northing 2695343.5	Easting 814674.3	
Driller		Mudline El.	-31.3	Datum	MLLW
Logged By		Date Start	9/8/2004	Date End	9/10/2004

Sample 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Ri(Barge Mounted Diedrich D50 ATV
Drilling Metho(4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		C1	16.3-17.3	9	Begin C1 at 16.3 ft.	
17			17.3-18.3	7	Granite. Possible boulder.	
18			18.3-19.3	9	Core dropped at 19.3 ft, approximate 4" void.	
19					Out of rock at approximately 20 ft.	
20					Pulled 3" casing from boring.	
					Advanced roller bit through core run, to approximately 21 ft.	
21					Hit rock at 21 ft.	
					Advanced roller bit through rock (possible boulder) to 24 ft.	
22						
23					possible boulder from 21 to 24 ft.	
24						
					driller advanced roller bit without sampling to 26 ft.	
25					Attempted split spoon sample at 26 ft. Drove spoon 100 blows for 2 inches. very coarse sand and gravel in tip.	
26					Set up to core rock. Begin C2 at 26 ft.	
		C2	26-27	8	Fine to medium grained, slightly weatherd, light gray/pink granitic gneiss; Fractures at 42" and 44", likely mechanical; High angle fracture joints at 24-27".	
27			27-28	4		
28			28-29	5		
29			29-30	4		
30			30-31	7		
31					end of C2 at 31 ft. REC=78% RQD=89%	
		C3	31-32	3	begin C3 at 31 ft.	
32					Fine to medium grained, slightly weatherd, light gray/pink granitic gneiss	
			32-33	1.5	31.42': Horizontal break, staining, weathered, 4' fracture zone; Pegmatite vein.	
33					32.7': Pegmatite vein.	
			33-34	2	33.75': Medium angle mechanical break, possibly along a fracture; 34'.	
34			34-35	1.5	34': Horizontal break, weathered, clay along pegmatite intrusion.	
35					34.4-35': Horizontal and medium angle breaks, weathered, staining; Break at 34.4; at pegmatite	
			35-36	2	intrusion.	
36					End of C3 at 36 ft.	
37					REC=97% RQD=80%	
					Bottom of exploration at 36 ft.	
38						
39						
40						

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
2)
3)
4)

Apex environmental, inc.
374 Congress Street, Suite 508
Boston, MA 02210
Phone: 617.728.0070

PROJECT

New Bedford Harbor Dredge - Phase II
New Bedford, Massachusetts

BORING NO. CAD-8
SHEET 1 of 2
FILE NO. 6542.003
CHKD. BY K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695624.7	Easting 814477.1	
Driller	Barry Wordell	Mudline El.	-33.2	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/21/2004	Date End	9/21/2004

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Barge Mounted Diedrich D50 ATV
Drilling Method: 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1								ORGANIC SILT	
2									
3									
4									
5		S1	24/24	4-6	7-9-8-5	17	4 to 5 feet: Organic silt and clay with some sand (OL/OH); Black, very stiff, organic odor; Coarsens with depth; 5 to 6 feet: Well-graded sand with some organics (SW); Grayish-black, medium density, slight organic odor; Fine sand: 35%, medium sand: 25%, coarse sand: 20%, organics: 20%.		
6									
7								GLACIO-FLUVIAL	
8									
9									
10		S2	24/13	9-11	15-16-15-29	31	Well-graded sand with little gravel (SW); Brown, dense; Silt: 5-10%, fine sand: 15-20%, medium sand: 30%, coarse sand: 30%, gravel 15%.		
11									
12									
13									
14									
15		S3	24/	14-16	31-20-15-27	35	Well-graded sand and gravel (SW); Brown, dense; Fine sand: 25%, medium sand: 30%, coarse sand: 15%, gravel: 40%; The gravel is subrounded to subangular and composed of quartz and granite.		
16									
17									
18							Advanced roller bit and casing to refusal at 18 ft.		
19							Set up to core rock at 18 ft. See next page for rock core log.		
20									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

Apex environmental, inc.
374 Congress Street, Suite 508
Boston, MA 02210
Phone: 617.728.0070

PROJECT

New Bedford Harbor Dredge - Phase II

New Bedford, Massachusetts

BORING NO.	CAD-8
SHEET	2 of 2
FILE NO.	6542.003
CHKD. BY	K. Hartel

Boring Co.	New Hampshire Boring	Boring Location	Northing 2695624.7	Easting 814477.1	
Driller	Barry Wordell	Mudline El.	-33.2	Datum	MLLW
Logged By	Joe Kraycik	Date Start	9/21/2004	Date End	9/21/2004

Sampler 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig Barge Mounted Diedrich D50 ATV
Drilling Method 4-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE INFORMATION: CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
					Begin C1 at 18 ft.	
18						
		C1	18-19	3	White to pink, fine to coarse grained granitic gneiss; Iron staining at top; One horizontal break;	
19					Slightly weathered.	
			19-20	6	No breaks, uniform texture.	
20						
			20-21	6	One horizontal, low-angle break; Slightly weathered.	
21						
			21-220	4	No breaks, uniform texture.	
22						
			22-23	5	One horizontal break, appears mechanical.	
23					End of C1 at 23 ft.	
					REC= 90% RQD=100%	
24						
					Bottom of exploration at 23 ft.	
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
2)
3)
4)

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 3

TO Maguire Group, Inc.	ADDRESS Foxborough, MA	HOLE NO. NBH-1	
PROJECT NAME Harbor Aquatic Disposal Cell	LOCATION New Bedford, MA	PROJ. NO. 16421	
REPORT SENT TO above / Feasibility Study	OUR JOB NO. 02-011	SURF. ELEV. -6.2' MSL	

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		DATE
At ____ after ____ Hours	Type	HW-NW	S/S	NV-II	Start	6/20/01
	Size I.D.	4" 3"	1-3/8"		Complete	6/27/01
At ____ after ____ Hours	Hammer Wt.	300#	140#	BIT	Boring Foreman	J. Medeiros
	Hammer Fall	24"	30"	Dia.	Inspector/Engr.	R. SHARPNACK

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		0.0-2.0	D	Wt.	of	Rods			Dark Gray Organic SILT, trace shells	1	24	12
5												
		7.0-9.0	D	Wt.	of	Rods				2	24	24
10												
		12.0-14.0	D	Wt.	of	Rods				3	24	24
15												
		17.0-19.0	D	Wt.	of	Rods				4	24	24
20												
		22.0-24.0	D	Wt.	of	Rods				5	24	24
25												
		27.0-29.0	D	Wt.	of	Rods				6	24	18
								28.0	Dark Brown PEAT, little silt			
30												
		32.0-34.0	D	Wt.	of	Rods				7	24	12
		34.0-36.0	D	3	4	4		34.0	Gray SILT and fine Sand, trace dark brown peat	8	24	12
35						5						
		38.5-40.5	D	6	10	10		38.5	Gray fine SAND and Silt	9	24	1

GROUND SURFACE TO ________ USED ________ CASING: THEN ________

Sample Type	Proportions Used		140 lb. Wt x 30" fall on 2" O.D. Sampler					SUMMARY:
D=Drive C=Cored W=Washed	trace	0 to 10%	Cohesionless	Density	Cohesive	Consistency		Earth Boring 87.5'
UP=Fixed Piston UT=Shelby Tube	little	10 to 20%	0-10	Loose	0-4	Soft	30 + Hard	Rock Coring 15'
TP=Test Pit A=Auger	some	20 to 35%	10-30	Med. Dense	4-8	M./Stiff		Samples 17
OE = Open End Rod	and	35 to 50%	30-50	Dense	8-15	Stiff		
* 300# hammer			50+	Very Dense	15-30	V-Stiff		HOLE NO. NBH-1

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 2 OF 3

TO Maguire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-1
PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO. 16421
REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -6.2' MSL.

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
						9			Gray fine SAND and Silt			
		43.5-45.5 (struck through on form)	D	5	4	5				10	24	12
45						9		44.0	Gray fine to medium SAND, some silt, trace fine gravel & coarse sand			
		49.0-51.0	D	4	5	6		49.0	Gray fine to coarse SAND and fine to medium Gravel, little silt	11	24	8
50						7						
		54.0-56.0	D	9	12	18		54.0	Dark Gray & Brown coarse to fine SAND and fine to medium Gravel, little silt (Odor Noted)	12	24	12
55						20						
		59.0-61.0	D	9	4	7		59.0	Grayish Brown medium to coarse SAND, some fine gravel, little silt	13	24	18
60						21						
		64.0-66.0	D	3	4	4				14	24	8
65						9						
70												
		71.0-73.0	D	3	3	9				15	24	18
						11						
75								75.0				
		76.0-78.0	D	53	29	17			Yellow Brown & Gray silty fine to coarse SAND and Gravel	16	24	12
						20						
80									(80' to 81' - Boulder)			
		82.0-82.5	D	100					" some weathered rock	17	6	4
								84.0				
85												

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
OE = Open End Rod
* 300# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 87.5'
Rock Coring 15'
Samples 17

HOLE NO. NBH-1

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

TO **Maguire Group, Inc.** ADDRESS **Foxborough, MA** HOLE NO. **NBH-1**

PROJECT NAME **Harbor Aquatic Disposal Cell** LOCATION **New Bedford, MA** PROJ. NO. 16421

REPORT SENT TO **above / Feasibility Study** OUR JOB NO. **02-011** SURF. ELEV. -6.2' MSL

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		87.5-92.5	C						Gray GRANITE	C1	60	36
		RQD = 0%										60%
90												
		92.5-97.5	C							C2	60	30
		RQD = 0%										50%
95												
		97.5-102.5	C							C3	60	40
		RQD = 0%										66.7%
100												
								102.5	Bottom of Boring 102.5'			

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type	Proportions Used		140 lb. Wt x 30" fall on 2" O.D. Sampler					SUMMARY:
D=Drive C=Cored W=Washed	trace	0 to 10%	Cohesionless	Density	Cohesive	Consistency		Earth Boring 87.5'
UP=Fixed Piston UT=Shelby Tube	little	10 to 20%	0-10	Loose	0-4	Soft	30 + Hard	Rock Coring 15'
TP=Test Pit A=Auger	some	20 to 35%	10-30	Med. Dense	4-8	M./Stiff		Samples 17
OE = Open End Rod	and	35 to 50%	30-50	Dense	8-15	Stiff		
* 300# hammer			50+	Very Dense	15-30	V-Stiff		HOLE NO. NBH-1

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

TO Maguire Group, Inc. ADDRESS Foxborough, MA HOLE NO. NBH-2
PROJECT NAME Harbor Aquatic Disposal Cell LOCATION New Bedford, MA PROJ. NO. 16421
REPORT SENT TO above / Feasibility Study OUR JOB NO. 02-011 SURF. ELEV. -7.8' MSL

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		DATE
At ____ after ____ Hours	Type	HW-NW	S/S	NV-II	Start	6/29/01
	Size I.D.	4" 3"	1-3/8"		Complete	7/2/01
At ____ after ____ Hours	Hammer Wt.	300#	140#	BIT	Boring Foreman	J. Medeiros
	Hammer Fall	24"	30"	Dia.	Inspector/Engr.	R. SHARPNACK

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION (Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.)	Sample No.	Pen"	Rec."
		0.0-2.0	D	Wt.	of	Rods			Black Organic SILT, trace shells	1	24	8
		~~3.5-5.5~~	~~D~~	~~Wt.~~	~~of~~	~~Rods~~				~~2~~	~~24~~	~~20~~
5												
		9.0-11.0	D	Wt.	of	Rods				3	24	24
10						11		10.0	Gray Brown fine SAND, little silt & medium sand			
		14.0-16.0	D	WOR	3	3		14.0	Brown fine to medium SAND, trace silt	4	24	10
15						5						
20												
		22.0-24.0	D	Wt.	Rods	3		22.0	Gray silty fine SAND	5	24	15
						3						
25												
		27.0-29.0	D	3	4	4				6	24	22
						3						
30												
		32.0-34.0	D	5	9	13		32.0	Gray medium to fine SAND, trace silt, coarse sand & fine gravel	7	24	10
						12						
35												
								36.0				
		38.0-40.0	D	11	7	7			Gray fine to coarse SAND, some fine to medium gravel, little silt	8	24	6
						10						

GROUND SURFACE TO ________ USED ________ CASING: THEN ________

Sample Type	Proportions Used		140 lb. Wt x 30" fall on 2" O.D. Sampler					SUMMARY:
D=Drive C=Cored W=Washed	trace	0 to 10%	Cohesionless	Density	Cohesive	Consistency		Earth Boring 59'
UP=Fixed Piston UT=Shelby Tube	little	10 to 20%	0-10	Loose	0-4	Soft	30 + Hard	Rock Coring 10'
TP=Test Pit A=Auger	some	20 to 35%	10-30	Med. Dense	4-8	M./Stiff		Samples 11
OE = Open End Rod	and	35 to 50%	30-50	Dense	8-15	Stiff		HOLE NO. NBH-2
* 300# hammer			50+	Very Dense	15-30	V-Stiff		

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 2 OF 2

TO Maguire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-2
PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO. 16421
REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -7.8' MSL

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	Soil or Rock Identification (Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.)	Sample No.	Pen"	Rec."
		43.0-45.0	D	6	9	15 / 14			Gray Brown silty fine SAND (compact), trace fine gravel	9	24	10
45								46.0				
		48.0-50.0	D	8	5	9 / 7			Gray silty very fine SAND	10	24	12
50								52.0				
		53.5-55.5	D	34	15	11 / 11			TILL	11	24	0
55								56.0				
							Min/Ft					
		59.0-64.0	C				5		Gray GRANITE	C1	60	54
60		RQD = 78%					7					90%
							7					
							5					
							7					
		64.0-69.0	C				6			C2	60	54
65		RQD = 99%					6					90%
							5					
							5					
							6					
								69.0	Bottom of Boring 69'			

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
OE = Open End Rod
* 300# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 59'
Rock Coring 10'
Samples 11

HOLE NO. NBH-2

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 2

TO Maguire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-3A
PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO. 16421
REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -7.2' MSL

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		DATE
At ____ after ____ Hours	Type	HW-NW	S/S	NV-II	Start	7/12/01
	Size I.D.	4" 3"	1-3/8"		Complete	7/13/01
At ____ after ____ Hours	Hammer Wt.	300#	140#	BIT	Boring Foreman	J. Medeiros
	Hammer Fall	24"	30"	Dia.	Inspector/Engr.	R. SHARPNACK

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	Sample No.	Pen"	Rec."
		0.0-2.0	D	Wt.	of	Rods			Black Organic SILT	1	24	6
5		4.0-6.0	D	Wt.	of	Rods			" color change to Gray	2	24	24
10		9.0-11.0	D	Wt.	of	Rods				3	24	24
								11.0	PEAT, some organic silt			
15												
		16.5-18.5	D	8	8	20 / 22		16.0	Brown fine to coarse SAND, some fine to medium gravel, trace silt & shells	4	24	2
20												
		21.5-23.5	D	2	3	3 / 8		21.5	Gray fine to coarse SAND, some silt & fine to coarse gravel	5	24	5
25												
		26.0-28.0	D	3	2	3 / 5		26.0	Brown coarse to fine SAND, some fine gravel, little silt	6	24	4
30												
		31.0-33.0	D	3	3	4 / 5		31.0	Light Brown fine SAND, some silt, little fine gravel	7	24	1
35												
		37.0-39.0	D	5	5	6 / 8				8	24	0

GROUND SURFACE TO ____ USED ____ CASING: THEN ____

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
OE = Open End Rod
* 300# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 57.5'
Rock Coring 10'
Samples 12

HOLE NO. NBH-3A

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 2 OF 2

TO Maguire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-3A
PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO. 16421
REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -7.2' MSL

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		41.0-43.0	D	2	3	3			Brown fine SAND, little silt	9	24	8
						2						
45												
		46.0-48.0	D	1	1	2				10	24	12
						3						
50		50.0-52.0	D	26	30	33		50.0	Brown weathered GRANITE and silty Sand	11	24	12
						33						
		54.0-54.5	D	100					" color change to Gray with little sand	12	6	4
55												
							Min/Ft					
		~~57.5-62.5~~	~~C~~				5	57.5		~~C1~~	~~60~~	~~52~~
		RQD = 90%					5		GRANITE			86.7%
60							6					
							6					
							5					
		~~62.5-67.5~~	~~C~~				5			~~C2~~	~~60~~	~~58~~
		RQD = 85%					5					96.7%
65							5					
							5					
							5					
								67.5	Bottom of Boring 67.5'			

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type	Proportions Used		140 lb. Wt x 30" fall on 2" O.D. Sampler					SUMMARY:
D=Drive C=Cored W=Washed	trace	0 to 10%	Cohesionless	Density	Cohesive	Consistency		Earth Boring 57.5'
UP=Fixed Piston UT=Shelby Tube	little	10 to 20%	0-10	Loose	0-4	Soft	30 + Hard	Rock Coring 10'
TP=Test Pit A=Auger	some	20 to 35%	10-30	Med. Dense	4-8	M./Stiff		Samples 12
OE = Open End Rod	and	35 to 50%	30-50	Dense	8-15	Stiff		
* 300# hammer			50+	Very Dense	15-30	V-Stiff		HOLE NO. NBH-3A

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 3

TO Maguire Group, Inc.	ADDRESS Foxborough, MA	HOLE NO. NBH-8
PROJECT NAME Aquatic Disposal Project	LOCATION New Bedford, MA	PROJ. NO. 16421
REPORT SENT TO above	OUR JOB NO. 03-100	SURF. ELEV. -7.5'

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		DATE
At ____ after ____ Hours	Type	HW-NW	S/S	NV-II	Start	10/15/02
	Size I.D.	4" 3"	1-3/8"		Complete	10/18/02
At ____ after ____ Hours	Hammer Wt.	300#	140#	BIT	Boring Foreman	G. Brouillette
	Hammer Fall	24"	30"	Dia.	Inspector/Engr.	R. SHARPNACK

LOCATION OF BORING On Water

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION (Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.)	Sample No.	Pen"	Rec."
		0.0-2.0	D		Pushed				MUCK	1	24	24
5		5.0-7.0	UP						Dark Brown to Gray fine SAND and Silt	UP1	24	22
		7.0-9.0	D	10	21	16 / 9		7.0	Gray Brown fine to medium SAND, little silt, coarse sand & fine to medium gravel	2	24	22
								9.0				
10		10.0-12.0	D	4	5	5 / 12			Gray fine to coarse SAND, trace silt & fine to coarse gravel,	3	24	3
								14.0				
15		15.0-17.0	D	22	25	30 / 13			Gray fine to coarse SAND and Gravel, trace silt	4	24	5
20		20.0-22.0	D	16	17	16 / 14				5	24	7
25		25.0-27.0	D	9	6	6 / 4				6	24	3
30		30.0-30.3	D	75/3"					(@ 30' - Boulder)	7	3	0
35												

GROUND SURFACE TO ________ USED ________ CASING: THEN ________

Sample Type	Proportions Used		140 lb. Wt x 30" fall on 2" O.D. Sampler					SUMMARY:
D=Drive C=Cored W=Washed			Cohesionless	Density	Cohesive	Consistency		Earth Boring 86'
UP=Fixed Piston UT=Shelby Tube	trace	0 to 10%	0-10	Loose	0-4	Soft	30 + Hard	Rock Coring 11'
TP=Test Pit A=Auger	little	10 to 20%	10-30	Med. Dense	4-8	M./Stiff		Samples 16
OE = Open End Rod	some	20 to 35%	30-50	Dense	8-15	Stiff		
* 300# hammer	and	35 to 50%	50+	Very Dense	15-30	V-Stiff		HOLE NO. NBH-8

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 2 OF 3

TO Maguire Group, Inc. ADDRESS Foxborough, MA HOLE NO. NBH-8
PROJECT NAME Aquatic Disposal Project LOCATION New Bedford, MA PROJ. NO. 16421
REPORT SENT TO above OUR JOB NO. 03-100 SURF. ELEV. -7.5

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	Sample No.	Pen"	Rec."
		41.5-43.5	D	27	35	38 / 40			Grayish Brown fine to coarse SAND, little fine gravel, trace silt	8	24	4
45												
		47.5-49.5	D	11	6	7 / 9		47.5	Gray coarse to fine SAND, some fine to medium gravel, trace silt	9	24	2
50												
		52.5-54.5	D	37	41	47 / 47		52.5	Gray Brown fine SAND, trace silt	10	24	24
55								56.0				
		57.5-59.5	D	7	4	4 / 7			Gray fine to coarse SAND, some fine to coarse gravel, trace silt	11	24	3
60												
		62.5-64.5	D	16	13	7 / 7			" little fine gravel	12	24	2
65												
		67.5-69.5	D	23	20	12 / 14		67.5	Gray fine SAND, little silt	13	24	1
70												
75												
		75.5-77.5	D	19	8	9 / 10		75.5	Gray fine to coarse SAND, little fine to medium gravel, trace silt	14	24	4
80												
		80.5-82.5	D	21	10	12 / 10		80.5	Grayish Brown coarse to fine SAND, trace silt & fine gravel	15	24	18
								84.0	Gray fine to coarse SAND and Gravel, some silt & weathered rock			
85		85.0-85.3	D	120/3"						16	3	3
		86.0-91.0	C	(RQD=30%)				85.3	Gray GRANITE	C1	60	60

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type	Proportions Used		140 lb. Wt x 30" fall on 2" O.D. Sampler					SUMMARY:
D=Drive C=Cored W=Washed	trace	0 to 10%	Cohesionless	Density	Cohesive	Consistency		Earth Boring 86'
UP=Fixed Piston UT=Shelby Tube	little	10 to 20%	0-10	Loose	0-4	Soft	30 + Hard	Rock Coring 11'
TP=Test Pit A=Auger	some	20 to 35%	10-30	Med. Dense	4-8	M./Stiff		Samples 16
OE = Open End Rod	and	35 to 50%	30-50	Dense	8-15	Stiff		
* 300# hammer			50+	Very Dense	15-30	V-Stiff		HOLE NO. NBH-8

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FM-1
SHEET 1 of 5
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2698554	easting 815021	
Driller	E. Thomas	Mudline El.	-15.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/11/01	Date End	1/12/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	WOC							ORGANIC CLAY 2.0 ft.	
		S-1	24/4	2-4	6-4-1-1	5	Clayey sand (SC); medium stiff, 40% organic clay/silt, 30% fine sand, 15% medium sand, 5% coarse sand, 5% gravel, 5% shells and shell fragments, slight organic odor, dark gray.		
							Advance PW drill casing to 8 ft. Difficult drilling.		
3	27						Advance 4-7/8 in. roller bit ahead of casing.	MARINE SAND	
							Several cobbles/boulders noted.		
							Estimated strata break at 5 ft.		
4	96								
5	138							5.0 ft.	
6	96								
7	75							GLACIAL TILL	
8	109								
		S-2	24/15	8-10	25-46-74-30	120	Silty sand with gravel (SM); very dense, 40% fine sand, 25% medium sand, 5% coarse sand, 15% gravel, 15% silt, subangular to angular gravel, brown. (Glacial Till) (2 jars)		
							Advance 3-7/8 in. roller bit to 11.5 ft. Very difficult drilling, probable cobbles.		
9									
10									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FM-1
SHEET 2 of 5
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2698554	easting 815021	
Driller	E. Thomas	Mudline El.	-15.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/11/01	Date End	1/12/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Telescope HW drill casing to 11.6 ft.		
							Begin NX rock core at 11.5 ft.	GLACIAL TILL	
11							(boring log continued on next page)	11.0 ft.	
								BEDROCK	
12									
13									
14									
15									
16									
17									
18									
19									
20									

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FM-1 SHEET 3 of 5 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2698554	easting 815021	
Driller	E. Thomas	Mudline El.	-15.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/11/01	Date End	1/12/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R1	11.5-12.5	6 min.	Begin R1 at 11.5 ft. Fresh, hard, gray, fine to medium grained GNEISS. Low angle foliation (approx. 20 to 30 degrees). REC. = 52%; RQD = 50% (poor/fair). No water return noted during coring activities.	1
12.0						
12.5					12.3 ft.: Mechanical break in rock core.	
			12.5-13.5	6 min.		
13.0					12.9 to 13.3 ft.: Secondary joint: high angle, rough, planar, discolored, and tight. 13.0 ft.: Mechanical break in rock core.	
13.5						
			13.5-14.5	6 min.	13.7 ft.: Mechanical break in rock core. 13.8 to 14.1 ft.: Secondary joint: high angle, smooth, planar, discolored, and open.	
14.0					14.1 to 16.5 ft.: Core not recovered due to faulty core lifter in core barrel.	
14.5	CORE NOT RECOVERED		14.5-15.5	5.5 min.		
15.0						
15.5			15.5-16.5	7 min.		
16.0						
16.5					End of R1 at 16.5 ft. Bottom of exploration at 16.5 ft; boring terminated in bedrock. Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.45.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FM-1 SHEET 4 of 5 FILE NO. 48138.27 CHKD. BY J. Trottier

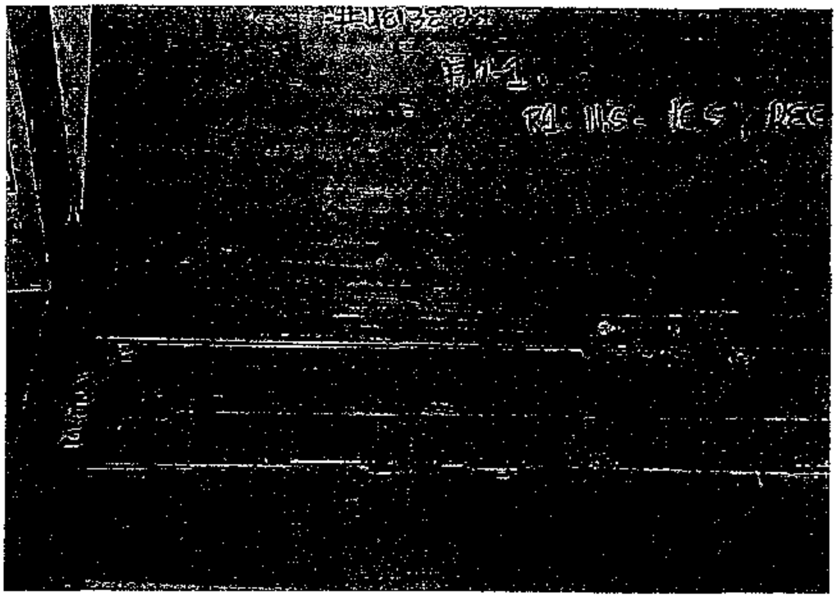
Boring Co.	Warren George, Inc.	Boring Location	northing 2698554	easting 815021	
Driller	E. Thomas	Mudline El.	-15.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/11/01	Date End	1/12/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

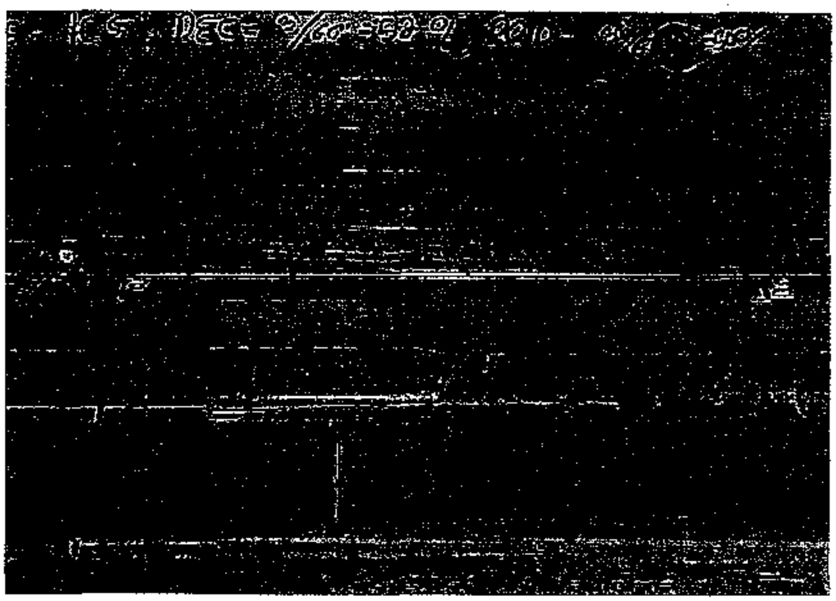
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Run R1



Core Run R1

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

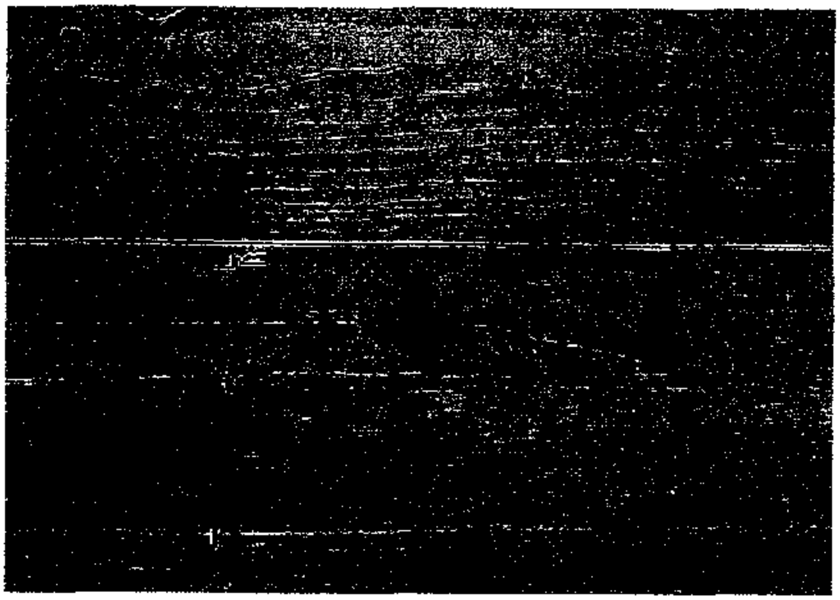
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FM-1 SHEET 5 of 5 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2698554	easting 815021	
Driller	E. Thomas	Mudline El.	-15.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/11/01	Date End	1/12/01

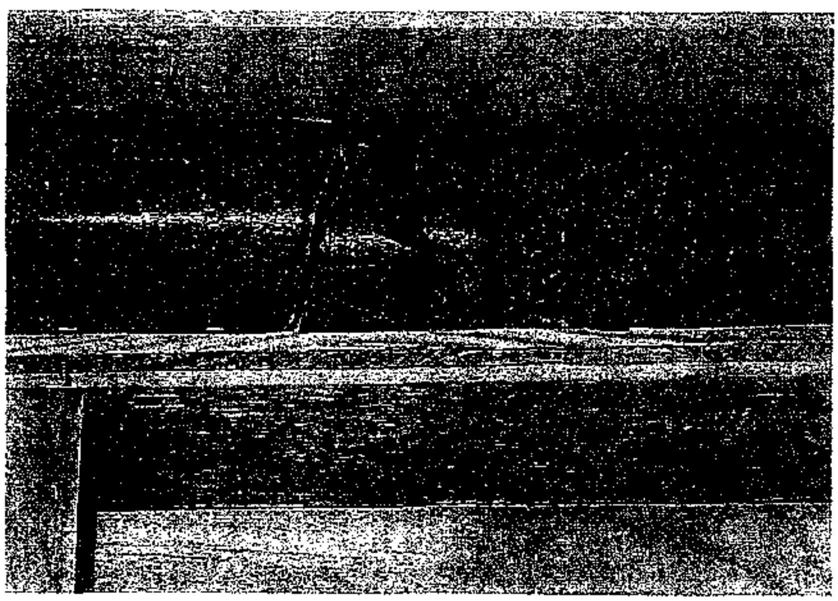
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Run R1



Secondary Joint noted in R1

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FM-2
SHEET 1 of 3
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2698516 easting 815070
Driller	S. Laurenza	Mudline El.	-8.80 Datum NGVD
Logged By	S. Bonis	Date Start	1/11/01 Date End 1/12/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing, 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
1	WOC								
2	WOC								
		S-1	24/16	2-4	WOR	—	Clayey sand (SC); 40% organic clay/silt, 60% fine sand, organic odor, black to olive gray. Interbedded medium sands noted. Advance PW drill casing to 7 ft. Advance 3-7/8 in. roller bit to 7 ft.	CLAYEY SAND	
3	WOC								
4	WOC								
5	WOC								
6	WOC								
7	10							7.0 ft.	
		S-2	24/0	7-9	WOR-1-3-9	4	Washed sample. Advance PW drill casing to 10 ft. Advance 3-7/8 in. roller bit to 10 ft.	GLACIAL TILL	
8	18								
9	18								
10	50								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
2)
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FM-2
SHEET 2 of 3
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2698516	easting 815070	
Driller	S. Laurenza	Mudline El.	-8.80	Datum	NGVD
Logged By	S. Bonis	Date Start	1/11/01	Date End	1/12/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-3	24/6	10-12	13-26-12-13	38	Poorly graded sand with gravel (SP); dense, 30% fine sand, 40% medium sand, 30% gravel, brown, angular to subangular sand and gravel. (GLACIAL TILL)		
							Advance PW drill casing to 15 ft.		
11	13						Advance 3-7/8 in. roller bit to 15 ft.		
12	86								
13	192								
14	140								
15	153							GLACIAL TILL	
		S-4	24/7	15-17	10-30-7-7	37	Poorly graded sand with gravel (SP); dense, 40% fine sand, 30% medium sand, 10% coarse sand, 15% gravel, 5% silt, brown, angular to subangular sand and gravel. (GLACIAL TILL)		
16							Advance 3-7/8 in. roller bit to 21 ft.		
17									
18									
19									
20									

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
2)
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FM-2
New Bedford Harbor Superfund Site	SHEET 3 of 3
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2698516	easting 815070	
Driller	S. Laurenza	Mudline El.	-8.80	Datum	NGVD
Logged By	S. Bonis	Date Start	1/11/01	Date End	1/12/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21								GLACIAL TILL 21.0 ft.	
							Top of bedrock at 21.0 ft. Bottom of exploration at 21.0 ft. Boring terminated on probable bedrock. Grout completed borehole to mudline with cement/bentonite grout, specific gravity = 1.40.	PROBABLE BEDROCK	
22									
23									
24									
25									
26									
27									
28									
29									
30									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
2)
3)
4)

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PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-1
SHEET 1 of 4
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697662	easting 815001	
Driller	S. Laurenza	Mudline El.	-7.81	Datum	NGVD
Logged By	S. Bonis	Date Start	1/11/01	Date End	1/11/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1	WOC								
2	WOC								
		S-1	24/2	2-4	WOR/24"	—	Organic soil with sand (OH); 80% organic clay/silt, 20% fine sand, organic odor, shells, black. Slight sheen noted on sample. Advance PW drill casing to 7 ft. Advance 3-7/8 in. roller bit to 7 ft.		
3	WOC								
4	WOC								
5	WOC							ORGANIC CLAY	
6	WOC								
7	WOC								
		S-2	24/10	7-9	WOR/24"	—	Sandy organic soil (OH); 60% organic clay/silt, 40% fine sand, organic odor, shells, gray. Advance PW drill casing to 12 ft. Advance 3-7/8 in. roller bit to 12 ft.		
8	WOC								
9	WOC								
10	WOC								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) * 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2)
3)
4)

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-1
SHEET 2 of 4
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697662	easting 815001	
Driller	S. Laurenza	Mudline El.	-7.81	Datum	NGVD
Logged By	S. Bonis	Date Start	1/11/01	Date End	1/11/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	WOC								
12	WOC								
		S-3	24/24	12-14	WOR/24"	—	Sandy organic soil (OH); 60% organic clay/silt, 40% fine sand, organic odor, shells, gray.		
							Advance PW drill casing to 17 ft.		
							Advance 3-7/8 in. roller bit to 17 ft.		
13	WOC								
14	4								
15	4							ORGANIC CLAY	
16	3								
17	6								
		S-4	24/10	17-19	WOR/24"	—	Similar to S-3.		
							Advance PW drill casing to 22 ft.		
							Advance 3-7/8 in. roller bit to 22 ft.		
18	8								
19	8							19.0 ft.	
							Estimated strata change at 19 ft.	GLACIO FLUVIAL	
20	27								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) * 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2)
3)
4)

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PROJECT	
Remedial Design For Operable Unit 01	BORING NO. BP-D-1
New Bedford Harbor Superfund Site	SHEET 3 of 4
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697662	easting 815001	
Driller	S. Laurenza	Mudline El.	-7.81	Datum	NGVD
Logged By	S. Bonis	Date Start	1/11/01	Date End	1/11/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	25								
22	27								
		S-5	24/4	22-24	20-21-24-25	45	Poorly graded sand with gravel (SP); dense, 65% fine sand, 15% medium sand, 15% gravel, 5% silt, subangular gravel, gray. Cobble noted in tip of spoon. Advance PW drill casing to 27 ft. Advance 3-7/8 in. roller bit to 27 ft.		
23	40								
24	56								
25	92								
26	37							GLACIO FLUVIAL	
		S-6	24/9	26-28	8-9-10-7	19*	Poorly graded gravel with silt and sand (GP-GM); medium dense, 20% fine sand, 20% medium sand, 50% subangular gravel, 10% silt, gray.		1
27	36								
28							Boring continued as 2-15/16 in. roller bit probe at 28 ft.		
29									
30									

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) * 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2)
3)
4)

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-1
SHEET 4 of 4
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697662	easting 815001	
Driller	S. Laurenza	Mudline El.	-7.81	Datum	NGVD
Logged By	S. Bonis	Date Start	1/11/01	Date End	1/11/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as 2-15/16 in. roller bit probe at 28 ft.		
31								GLACIO FLUVIAL	
32								32.0 ft.	
		S-7	0/0	32-32	25/0"	—	Attempt to advance split-barrel sampler. Bottom of exploration at 32.0 ft. Boring terminated on probable bedrock. Grout completed borehole to mudline with cement/bentonite grout, specific gravity = 1.40.	PROBABLE BEDROCK	
33									
34									
35									
36									
37									
38									
39									
40									

GRANULAR SOILS	COHESIVE SOILS	SYMBOLS KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) * 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2)
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. BP-D-2 SHEET 1 of 5 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697683 easting 815274
Driller	E. Thomas	Mudline El.	-7.11 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/10/01 Date End 1/10/01

Sampler: No sampling performed.

Drill Rig: Acker AD II Truck Rig
Drilling Method: NW rod probe.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Boring performed as NW rod probe with 2-inch O.D. split-barrel sampler, from mudline to refusal. Probe driven with a 300 lb. center hole hammer free falling from a height of 24 inches.		
1	WOR								
2	WOR								
3	WOR								
4	WOR								
5	WOR							ORGANIC CLAY	
6	WOR								
7	WOR								
8	WOR								
9	WOR							9.0 ft.	
							Estimated strata change at 9 ft. based upon NW rod probe no longer falling under the weight of the rod.	GLACIO FLUVIAL	
10	4***						Blows shown in casing blows column beyond 9 ft. are probe blows.		

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *** Blows shown in casing blows column beyond 9 ft. are probe blows.
2)
3)
4)

Nobis Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01, New Bedford Harbor Superfund Site, New Bedford, Massachusetts	BORING NO.	BP-D-2
		SHEET	2 of 5
		FILE NO.	48138.27
		CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697683		easting 815274
Driller	E. Thomas	Mudline El.	-7.11	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/10/01	Date End	1/10/01

Sampler: No sampling performed.

Drill Rig: Acker AD II Truck Rig

Drilling Method: NW rod probe.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Boring performed as NW rod probe with 2-inch O.D. split-barrel sampler, from mudline to refusal. Probe driven with a 300 lb. center hole hammer free falling from a height of 24 inches. Blows shown in casing blows column beyond 9 ft. are probe blows.		
11	4***								
12	8***								
13	12***								
14	19***								
15	21***							GLACIO FLUVIAL	
16	28***								
17	30***								
18	28***								
19	27***								
20	24***								

GRANULAR SOILS	COHESIVE SOILS	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) *** Blows shown in casing blows column beyond 9 ft. are probe blows.

2)

3)

4)

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PROJECT	
Remedial Design For Operable Unit 01	BORING NO. BP-D-2
New Bedford Harbor Superfund Site	SHEET 3 of 5
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2697683 easting 815274
Driller E. Thomas | Mudline El. -7.11 | Datum NGVD
Logged By E. Thibodeau | Date Start 1/10/01 | Date End 1/10/01

Sampler: No sampling performed.
Drill Rig: Acker AD II Truck Rig
Drilling Method: NW rod probe.

Groundwater Readings Not Applicable for Offshore Borings.

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring performed as NW rod probe with 2-inch O.D. split-barrel sampler, from mudline to refusal. Probe driven with a 300 lb. center hole hammer free falling from a height of 24 inches. Blows shown in casing blows column beyond 9 ft. are probe blows.		
21	21***								
22	31***								
23	31***								
24	32***								
25	33***							GLACIO FLUVIAL	
26	40***								
27	50***								
28	54***								
29	49***								
30	54***								

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *** Blows shown in casing blows column beyond 9 ft. are probe blows.
2)
3)
4)

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Boring Co.	Warren George, Inc.	Boring Location	northing 2697683		easting 815274
Driller	E. Thomas	Mudline El.	-7.11	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/10/01	Date End	1/10/01

Sampler: No sampling performed.

Drill Rig: Acker AD II Truck Rig
Drilling Method: NW rod probe.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring performed as NW rod probe with 2-inch O.D. split-barrel sampler, from mudline to refusal. Probe driven with a 300 lb. center hole hammer free falling from a height of 24 inches. Blows shown in casing blows column beyond 9 ft. are probe blows.		
31	52***								
32	36***								
33	40***								
34	51***							GLACIO FLUVIAL	
35	51***								
36	55***								
37	56***								
38	70***								
39	56***								
40	56***								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) *** Blows shown in casing blows column beyond 9 ft. are probe blows.
2)
3)
4)

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	BP-D-2
SHEET	5 of 5
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697683 easting 815274
Driller	E. Thomas	Mudline El.	-7.11 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/10/01 Date End 1/10/01

Sampler: No sampling performed.
Drill Rig: Acker AD II Truck Rig
Drilling Method: NW rod probe.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring performed as NW rod probe with 2-inch O.D. split-barrel sampler, from mudline to refusal. Probe driven with a 300 lb. center hole hammer free falling from a height of 24 inches. Blows shown in casing blows column beyond 9 ft. are probe blows.		
41	49***								
42	42***								
43	51***							GLACIO FLUVIAL	
44	53***								
45	61***								
46	72***								
	51***/3"							46.3 ft.	
	25***/0"						Bottom of exploration at 46.3 ft.; probe refusal on probable bedrock.	PROBABLE BEDROCK	
47									
48									
49									
50									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *** Blows shown in casing blows column beyond 9 ft. are probe blows.
2)
3)
4)

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-3
SHEET 1 of 6
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697360 easting 815190
Driller	E. Thomas	Mudline El.	-7.17 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/11/01 Date End 1/11/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	WOC								
		S-1	24/2	2-4	WOR/24"	—	Organic soil (OH); 90% organic clay/silt, 10% fine sand, strong organic odor, black to dark gray. Slight sheen noted on sample.		
							Advance PW drill casing to 7 ft.		
3	WOC						Advance 3-7/8 in. roller bit to 7 ft.	ORGANIC CLAY	
4	WOC								
5	WOC								
6	WOC							6.0 ft.	
7	HYD PUSH								
		S-2	24/10	7-9	2-2-2-3	4	Poorly graded sand with silt (SP-SM); very loose, 60% fine sand, 25% medium sand, 5% coarse sand, 10% silt, moderate organic odor, black to gray.	MARINE SAND	
							Advance PW drill casing to 12 ft.		
8	24						Advance 3-7/8 in. roller bit to 12 ft.		
9	38								
10	44								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with a 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 29 ft. are probe blows.
2) *** Blows shown in casing blows column beyond 29 ft. are probe blows.
3)
4)

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Concord, New Hampshire 03301

PROJECT	BORING NO.	BP-D-3
Remedial Design For Operable Unit 01	SHEET	2 of 6
New Bedford Harbor Superfund Site	FILE NO.	48138.27
New Bedford, Massachusetts	CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697360	easting 815190	
Driller	E. Thomas	Mudline El.	-7.17	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/11/01	Date End	1/11/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	44								
12	68								
		S-3	24/10	12-14	3-4-7-7	11	Poorly graded sand (SP); medium dense, 45% fine sand, 40% medium sand, 5% coarse sand, 5% gravel, 5% silt, rounded to subrounded gravel, gray-brown. Advance PW drill casing to 17 ft. Advance 3-7/8 in. roller bit to 17 ft.	MARINE SAND	
13	29								
14	44								
15	76								
16	95								
17	110								
		S-4	24/10	17-19	4-4-4-7	8	Poorly graded sand (SP); loose, 35% fine sand, 60% medium sand, 5% silt, gray-brown to brown. Advance PW drill casing to 22 ft. Advance 3-7/8 in. roller bit to 22 ft.		
18	57								
19	68								
20	109								

GRANULAR SOILS (SPT N-Values)	COHESIVE SOILS (SPT N-Values)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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2) *** Blows shown in casing blows column beyond 29 ft. are probe blows.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-3
SHEET 3 of 6
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2697360 easting 815190
Driller E. Thomas | Mudline El. -7.17 | Datum NGVD
Logged By E. Thibodeau | Date Start 1/11/01 | Date End 1/11/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
21	107								
22	101								
		S-5	24/10	22-24	6-6-5-6	11	Sandy silt (ML); stiff, 30% fine sand, 70% silt, olive brown.		
							Advance HW drill casing to 27 ft.		
							Advance 3-7/8 in. roller bit to 27 ft.		
23	90							MARINE SAND	
24	96								
25	97								
26	83								
27	119								
		S-6	24/13	27-29	2-2-2-4	4	Poorly graded sand (SP); loose, 55% fine sand, 40% medium sand, 5% silt, brown.		
28	NR								
29	NR								
							Boring continued as NW rod probe at 29 ft. with 2-inch O.D. split-barrel sampler.		1
							Blows shown in casing blows column beyond 29 ft. are probe blows.		
30	3***								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-3
SHEET 4 of 6
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697360 easting 815190
Driller	E. Thomas	Mudline El.	-7.17 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/11/01 Date End 1/11/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 29 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 29 ft. are probe blows.		
31	4***								
32	4***								
33	5***								
34	6***								
35	10***								
36	11***								
37	14***								
38	14***								
39	18***								
40	15***								

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-3
SHEET 5 of 6
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.	Boring Location northing 2697360	easting 815190	
Driller E. Thomas	Mudline El. -7.17	Datum NGVD	
Logged By E. Thibodeau	Date Start 1/11/01	Date End 1/11/01	

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 29 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 29 ft. are probe blows.		
41	15***								
42	14***								
43	15***								
44	14***								
45	13***								
46	13***								
47	12***								
48	22***								
49	26***								
50	26***								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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PROJECT
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New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	BP-D-3
SHEET	6 of 6
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697360	easting 815190	
Driller	E. Thomas	Mudline El.	-7.17	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/11/01	Date End	1/11/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Boring continued as NW rod probe at 29 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 29 ft. are probe blows.		
51	27***								
52	43***								
53	35***								
54	37***								
55	50***							55.0 ft.	
	25***/0"						Bottom of exploration at 55.5 ft.; probe refusal on probable bedrock. Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.39.	PROBABLE BEDROCK	
56									
57									
58									
59									
60									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	BP-D-4
SHEET	1 of 7
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697053	easting 815006	
Driller	E. Thomas	Mudline El.	-6.60	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/2/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	WOC							ORGANIC CLAY	
		S-1	24/3	2-4	WOR/24"	—	Organic soil with sand (OH); 75% organic clay/silt, 20% fine sand, 5% shells and shell fragments, strong organic odor, black to dark gray. Slight sheen noted on sample.		
							Advance PW drill casing to 7 ft.		
3	WOC						Advance 3-7/8 in. roller bit to 7 ft.		
4	WOC								
5	WOC							5.0 ft.	
							Estimated strata change at 5 ft.		
6	HYD PUSH								
7	HYD PUSH							MARINE SAND	
		S-2	24/18	7-9	2-2-3-2	5	Silty sand (SM); loose, 10% medium sand, 75% fine sand, 15% silt, gray. Some iron staining noted in bottom 4 in. of sample.		
							Advance PW drill casing to 12 ft.		
8	19						Advance 3-7/8 in. roller bit to 12 ft.		
9	14								
10	28								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches. casing blows beyond 29 ft. are probe blows.
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PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO.	BP-D-4
SHEET	2 of 7
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697053	easting 815006	
Driller	E. Thomas	Mudline El.	-6.60	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/2/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
11	43								
12	55								
		S-3	24/16	12-14	2-2-2-3	4	Poorly graded sand with silt (SP-SM); loose, 80% fine sand, 10% medium sand, 10% silt, subangular. Some iron staining noted. Advance PW drill casing to 17 ft. Advance 3-7/8 in. roller bit to 17 ft.		
13	34								
14	27								
15	39							MARINE SAND	
16	42								
17	50								
		S-4	24/13	17-19	2-1-2-1	3	Sandy silt (ML); soft, 65% silt, 35% fine sand, gray. Advance PW drill casing to 22 ft. Advance 3-7/8 in. roller bit to 22 ft.		
18	54								
19	28								
20	28								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-4
SHEET 3 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller E. Thomas
Logged By E. Thibodeau

Boring Location northing 2697053 easting 815006
Mudline El. -6.60 Datum NGVD
Date Start 1/2/01 Date End 1/2/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows 1 (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	21								
22	20								
		S-5	24/24	22-24	6-6-5-7	11	S-5A: Lean clay with sand (CL); stiff, 75% clay/silt, 25% fine sand, olive-gray. (12 in.)		
							S-5B: Poorly graded sand (SP); medium dense, 55% fine sand, 40% medium sand, 5% silt, brown. Some iron staining noted. (12 in.)		
23	31						Advance PW drill casing to 27 ft.		
							Advance 3-7/8 in. roller bit to 27 ft.		
24	28								
25	29							MARINE SAND	
26	33								
27	26								
		S-6	24/13	27-29	4-4-5-7	9	Sandy silt (ML); stiff, 70% silt, 30% fine sand, gray.		
							Boring continued as NW rod probe at 29 ft. with 2-inch O.D. split-barrel sampler.		1
28	NR								
29	NR								
30	14***								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-4
SHEET 4 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697053 easting 815006
Driller	E. Thomas	Mudline El.	-6.60 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/2/01 Date End 1/2/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 29 ft. with 2-inch O.D. split-barrel sampler.		
31	15***								
32	17***								
33	19***								
34	18***								
35	21***								
36	19***								
37	25***								
38	22***								
39	24***								
40	28***								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 29 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 29 ft. are probe blows.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-4
SHEET 5 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2697053 easting 815006
Driller E. Thomas | Mudline El. -6.60 | Datum NGVD
Logged By E. Thibodeau | Date Start 1/2/01 | Date End 1/2/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Boring continued as NW rod probe at 29 ft. with 2-inch O.D. split-barrel sampler.		
41	29***								
42	30***								
43	28***								
44	30***								
45	25***								
46	23***								
47	24***								
48	23***								
49	24***								
50	24***								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 29 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 29 ft. are probe blows.
3)
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Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-4
SHEET 6 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.	Boring Location northing 2697053	easting 815006	
Driller E. Thomas	Mudline El. -6.60	Datum NGVD	
Logged By E. Thibodeau	Date Start 1/2/01	Date End 1/2/01	

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 29 ft. with 2-inch O.D. split-barrel sampler.		
51	30***								
52	30***								
53	37***								
54	34***								
55	36***								
56	37***								
57	31***								
58	34***								
59	33***								
60	33***								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLOGY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 29 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 29 ft. are probe blows.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-4

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697053	easting 815006	
Driller	E. Thomas	Mudline El.	-6.60	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/2/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 29 ft. with 2-inch O.D. split-barrel sampler.		
61	27***								
62	26***								
63	29***								
	26***/6"							63.5 ft.	
	50***/0"						Bottom of exploration at 63.5 ft.; probe refusal on probable bedrock.		
64							Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.41.	PROBABLE BEDROCK	
65									
66									
67									
68									
69									
70									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 29 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 29 ft. are probe blows.
3)
4)

	PROJECT	
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. BP-D-5 SHEET 1 of 6 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696823 easting 815010
Driller	E. Thomas	Mudline El.	-5.85 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/29/00 Date End 12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	HYD PUSH							CLAYEY SAND	
		S-1	24/10	2-4	WOR/12"-3-3	—	Clayey sand (SC); 30% organic clay/silt, 40% fine sand, 25% medium sand, 5% shells and shell fragments, strong organic odor, black to dark gray.		
3	HYD PUSH						Advance PW drill casing to 4 ft. Advance 3-7/8 in. roller bit to 4 ft.		
4	HYD PUSH							4.0 ft.	
		S-2	24/6	4-6	3-2-2-4	4	Poorly graded sand (SP); loose, 30% medium sand, 65% fine sand, 5% silt, gray-brown.		
5	12						Advance PW drill casing to 9 ft. Advance 3-7/8 in. roller bit to 9 ft.	MARINE SAND	
6	16								
7	23								
8	41								
9	48								
		S-3	24/8	9-11	3-2-3-3	5	Poorly graded sand (SP); loose, 30% medium sand, 65% fine sand, 5% silt, gray-brown.		
10	33						Advance PW drill casing to 14 ft. Advance 3-7/8 in. roller bit to 14 ft.		

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 32 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 32 ft. are probe blows.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	BP-D-5
SHEET	2 of 6
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696823	easting 815010	
Driller	E. Thomas	Mudline El.	-5.85	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/29/00	Date End	12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	29								
12	36								
13	56								
14	105								
		S-4	24/12	14-16	3-3-4-3	7	S-4A: Poorly graded sand with gravel (SP); loose, 45% medium sand, 40% fine sand, 5% coarse sand, 5% gravel, 5% silt, subrounded to subangular sand and gravel, brown. (6 in.)		
15	41						S-4B: Silt with sand (ML); loose, 75% silt, 25% fine sand, brown. (6 in.) Advance PW drill casing to 19 ft. Advance 3-7/8 in. roller bit to 19 ft.	MARINE SAND	
16	48								
17	56								
18	61								
19	95								
		S-5	24/8	19-21	2-3-2-4	5	Poorly graded sand (SP); loose, 30% medium sand, 55% fine sand, 5% coarse sand, 5% gravel, 5% silt, subrounded to subangular sand and gravel, brown.		
20	90						Advance PW drill casing to 24 ft. Advance 3-7/8 in. roller bit to 24 ft.		

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 32 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 32 ft. are probe blows.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-5
SHEET 3 of 6
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller E. Thomas
Logged By E. Thibodeau

Boring Location northing 2696823 easting 815010
Mudline El. -5.85 Datum NGVD
Date Start 12/29/00 Date End 12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	99								
22	110								
23	121								
24	98								
		S-6	24/14	24-26	2-2-4-2	6	Sandy silt (ML); medium stiff, 60% silt, 5% medium sand, 35% fine sand, brown.		
							Advance PW drill casing to 30 ft.		
							Advance 3-7/8 in. roller bit to 30 ft.		
25	58								
26	129								
27	117								
28	112								
29	121								
30	120								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. BP-D-5
New Bedford Harbor Superfund Site	SHEET 4 of 6
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696823	easting 815010	
Driller	E. Thomas	Mudline El.	-5.85	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/29/00	Date End	12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-7	24/10	30-32	2-1-2-1	3	Silt with sand (ML); loose, 15% fine sand, 85% silt, gray-brown.		
31	NR								
32	NR								
							Boring continued as NW rod probe at 32 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 32 ft. are probe blows.		1
33	5***								
34	3***								
35	8***								
36	10***								
37	12***								
38	18***								
39	19***								
40	21***								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	STANDARD KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 32 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 32 ft. are probe blows.
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18 Chenell Drive
Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. BP-D-5
New Bedford Harbor Superfund Site	SHEET 5 of 6
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696823	easting 815010	
Driller	E. Thomas	Mudline El.	-5.85	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/29/00	Date End	12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 32 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 32 ft. are probe blows.		
41	21***								
42	27***								
43	23***								
44	16***								
45	16***								
46	18***								
47	14***								
48	16***								
49	12***								
50	12***								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 32 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 32 ft. are probe blows.
3)
4)

Nobis *Nobis Engineering* *18 Chenell Drive* *Concord, New Hampshire 03301*	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. BP-D-5 SHEET 6 of 6 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696823	easting 815010	
Driller	E. Thomas	Mudline El.	-5.85	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/29/00	Date End	12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 32 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 32 ft. are probe blows.		
51	14***								
52	21***								
53	28***								
54	33***								
55	37***								
56	35***								
57	33***								
58	48***								
59	55***								
	20***/6"								
	50***/0"							59.5 ft.	
60							Bottom of exploration at 59.5 ft.; probe refusal on probable bedrock. Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.50.	PROBABLE BEDROCK	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 32 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 32 ft. are probe blows.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-6
SHEET 1 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696505 easting 814990
Driller	E. Thomas	Mudline El.	-8.55
		Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/28/00
		Date End	12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	WOC								
		S-1	24/18	2-4	WOR/24"	—	Organic soil (OH); 95% organic clay/silt, 5% fine sand, strong organic odor, black to dark gray. Trace of shell fragments noted.		
							Advance PW drill casing to 5 ft.		
3	WOC						Advance 3-7/8 in. roller bit to 5 ft.		
4	WOC								
5	WOC							ORGANIC CLAY	
		S-2	24/6	5-7	WOR/24"	—	Similar to S-1; except dark gray.		
							Advance PW drill casing to 10 ft.		
							Advance 3-7/8 in roller bit to 10 ft.		
6	WOC								
7	WOC								
8	WOC								
9	WOC								
10	WOC								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 32 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 32 ft. are probe blows.
3)
4)

Nobis Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. BP-D-6 SHEET 2 of 7 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696505 easting 814990
Driller	E. Thomas	Mudline El.	-8.55 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/28/00 Date End 12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-3	24/15	10-12	WOR/24"	—	Organic soil with sand (OH); 85% organic clay/silt, 15% fine sand, strong organic odor, dark gray. Traces of shell fragments noted in sample.		
							Advance PW drill casing to 15 ft.		
11	WOC						Advance 3-7/8 in. roller bit to 15 ft.	ORGANIC CLAY	
12	WOC								
13	WOC								
14	WOC								
15	WOC							15.0 ft.	
		S-4	24/18	15-17	WOR/6"-5-4-4	9	S-4A: Mixture of organic soil (OH) and peat (Pt). Shell fragments noted. (6 in.)		
							S-4B: Poorly graded sand (SP); loose, 35% medium sand, 60% fine sand, 5% silt, moderate organic odor, gray. (12 in.)		
16	29						Advance PW drill casing to 20 ft.		
							Advance 3-7/8 in. roller bit to 20 ft.		
17	36							MARINE SAND	
18	34								
19	39								
20	35								

GRANULAR SOILS [illegible]	COHESIVE SOILS [illegible]	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 32 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 32 ft. are probe blows.
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Nobis Engineering
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Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-6
SHEET 3 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2696505 easting 814990
Driller E. Thomas | Mudline El. -8.55 | Datum NGVD
Logged By E. Thibodeau | Date Start 12/28/00 | Date End 12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (6")	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/1	20-22	3-3-3-4	6	Poor recovery.		
							Advance PW drill casing to 25 ft.		
							Advance 3-7/8 in. roller bit to 25 ft.		
21	23							MARINE SAND	
22	24								
23	26								
24	30								
25	33							25.0 ft.	
		S-6	24/9	25-27	3-3-2-3	5	Poorly graded sand (SP); loose, 40% medium sand, 40% fine sand, 10% coarse sand, 5% gravel, 5% silt, subrounded to subangular sand and gravel, brown.	GLACIO FLUVIAL	
26	33						Advance PW drill casing to 30 ft.		
							Advance 3-7/8 in. roller bit to 30 ft.		
27	25								
28	28								
29	29								
30	62								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLOGY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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2) ***Blows shown in casing blows column beyond 32 ft. are probe blows.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-6
SHEET 4 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller E. Thomas
Logged By E. Thibodeau

Boring Location northing 2696505 easting 814990
Mudline El. -8.55 Datum NGVD
Date Start 12/28/00 Date End 12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-7	24/8	30-32	4-3-3-4	6	Poorly graded sand with gravel (SP); loose, 40% medium sand, 30% fine sand, 10% coarse sand, 15% gravel, 5% silt, subrounded to subangular sand and gravel, brown.	GLACIO FLUVIAL	
31	NR								
32	NR								
							Boring continued as NW rod probe at 32 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 32 ft. are probe blows.		1
33	14***								
34	13***								
35	12***								
36	12***								
37	13***								
38	16***								
39	21***								
40	19***								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. BP-D-6 SHEET 5 of 7 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696505	easting 814990	
Driller	E. Thomas	Mudline El.	-8.55	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/28/00	Date End	12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Boring continued as NW rod probe at 32 ft. with 2-inch O.D. split-barrel sampler.		
							Blows shown in casing blows column beyond 32 ft. are probe blows.		
41	21***								
42	20***								
43	19***								
44	22***								
45	21***								
46	23***								
47	28***								
48	26***								
49	26***								
50	26***								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-6

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696505	easting 814990	
Driller	E. Thomas	Mudline El.	-8.55	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/28/00	Date End	12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Boring continued as NW rod probe at 32 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 32 ft. are probe blows.		
51	27***								
52	23***								
53	25***								
54	28***								
55	26***								
56	25***								
57	27***								
58	24***								
59	24***								
60	27***								

GRANULAR SOILS (BLOWS)	COHESIVE SOILS (BLOWS)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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2) ***Blows shown in casing blows column beyond 32 ft. are probe blows.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-6
SHEET 7 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696505 easting 814990
Driller	E. Thomas	Mudline El.	-8.55 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/28/00 Date End 12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
	22***/5"						Boring continued as NW rod probe at 32 ft. with 2-inch O.D. split-barrel sampler.		
	50***/0"						Blows shown in casing blows column beyond 32 ft. are probe blows.	60.4 ft.	
							Bottom of exploration at 60.4 ft.; probe refusal on probable bedrock.		
61							Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.34.	PROBABLE BEDROCK	
62									
63									
64									
65									
66									
67									
68									
69									
70									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. center hole hammer free falling from a height of 24 inches, casing blows beyond 32 ft. are probe blows.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-7
SHEET 1 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696314 easting 814992
Driller	E. Thomas	Mudline El.	-8.46 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/28/00 Date End 12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	WOC								
		S-1	24/6	2-4	WOR/24"	—	Organic soil (OH); 90% organic clay/silt, 5% fine sand, 5% shells and shell fragments, strong organic odor, dark gray.		
							Advance PW drill casing to 7 ft.		
3	WOC						Advance 3-7/8 in. roller bit to 7 ft.		
4	WOC								
5	WOC							ORGANIC CLAY	
6	WOC								
7	WOC								
		S-2	24/18	7-9	WOR/24"	—	Similar to S-1.		
							Advance PW drill casing to 11 ft.		
							Advance 3-7/8 in roller bit to 11 ft.		
8	WOC								
9	WOC								
10	HYD PUSH								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. Center hole hammer free falling from a height of 24 inches, casing blows beyond 26 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 26 ft. are probe blows.
3)
4)

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. BP-D-7
New Bedford Harbor Superfund Site	SHEET 2 of 7
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

Boring Co.	Warren George, Inc.	Boring Location	northing 2696314		easting 814992
Driller	E. Thomas	Mudline El.	-8.46	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/28/00	Date End	12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	HYD PUSH							ORGANIC CLAY	
		S-3	24/10	11-13	WOR/24"	—	Organic soil with sand (OH); 75% organic clay/silt, 20% fine sand, 5% shells and shell fragments, strong organic odor, dark gray. Traces of peat noted in tip of sampler.		
12	HYD PUSH						Estimated strata change at 13 ft. Advance PW drill casing to 17 ft. Advance 3-7/8 in. roller bit to 17 ft.		
13	HYD PUSH							13.0 ft.	
14	HYD PUSH							PEAT	
15	HYD PUSH						Estimated strata change at 15 ft.	15.0 ft.	
16	40								
17	58								
		S-4	24/13	17-19	6-10-10-10	20	Poorly graded sand with silt (SP-SM); medium dense, 45% medium sand, 30% fine sand, 10% coarse sand, 5% gravel, 10% silt, slight organic odor, subrounded sand and gravel, gray. Traces of shells and shell fragments noted.	MARINE SAND	
18	22						Advance PW drill casing to 22 ft. Advance 3-7/8 in. roller bit to 22 ft.		
19	34								
20	48								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. Center hole hammer free falling from a height of 24 inches, casing blows beyond 26 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 26 ft. are probe blows.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-7
SHEET 3 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.	Boring Location	northing 2696314	easting 814992
Driller E. Thomas	Mudline El.	-8.46	Datum NGVD
Logged By E. Thibodeau	Date Start	12/28/00	Date End 12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-5	24/3	20-22	6-2-2-2	4	Poorly graded sand (SP); very loose, 30% medium sand, 65% fine sand, 5% silt, brown.		
							Some iron staining noted.		
							Advance PW drill casing to 22 ft.		
21	44						Advance 3-7/8 in. roller bit to 22 ft.		
22	58								
		S-6	24/18	22-24	5-5-6-9	11	Poorly graded sand (SP); medium dense, 40% medium sand, 55% fine sand, 5% silt, gray.		
							Advance PW drill casing to 26 ft.		
							Advance 3-7/8 in. roller bit to 26 ft.		
23	36								
24	57								
25	112							MARINE SAND	
26	123								
		S-7	24/8	26-28	5-4-4-5	8	Poorly graded sand (SP); loose, 30% medium sand, 65% fine sand, 5% silt, gray.		
							Boring continued as NW rod probe at 26 ft. with 2-inch O.D. split-barrel sampler.		1
							Blows shown in casing blows column beyond 26 ft. are probe blows.		
27	12***								
28	10***								
29	17***								
30	29***								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. Center hole hammer free falling from a height of 24 inches, casing blows beyond 26 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 26 ft. are probe blows.
3)
4)

Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	PROJECT: Remedial Design For Operable Unit 01, New Bedford Harbor Superfund Site, New Bedford, Massachusetts	BORING NO. BP-D-7
		SHEET 4 of 7
		FILE NO. 48138.27
		CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696314 easting 814992
Driller	E. Thomas	Mudline El.	-8.46 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/28/00 Date End 12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 26 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 26 ft. are probe blows.		
31	28***								
32	28***								
33	25***								
34	25***								
35	23***								
36	25***								
37	25***								
38	24***								
39	24***								
40	26***								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. Center hole hammer free falling from a height of 24 inches, casing blows beyond 26 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 26 ft. are probe blows.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. BP-D-7
New Bedford Harbor Superfund Site	SHEET 5 of 7
	FILE NO. 48138.27
New Bedford, Massachusetts	CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696314 easting 814992
Driller	E. Thomas	Mudline El.	-8.46 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/28/00 Date End 12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 26 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 26 ft. are probe blows.		
41	32***								
42	28***								
43	27***								
44	31***								
45	25***								
46	27***								
47	29***								
48	29***								
49	26***								
50	29***								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
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11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. Center hole hammer free falling from a height of 24 inches, casing blows beyond 26 ft. are probe blows.
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PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-7
SHEET 6 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696314	easting 814992	
Driller	E. Thomas	Mudline El.	-8.46	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/28/00	Date End	12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 26 ft. with 2-inch O.D. split-barrel sampler. Blows shown in casing blows column beyond 26 ft. are probe blows.		
51	31***								
52	40***								
53	38***								
54	37***								
55	30***								
56	35***								
57	39***								
58	43***								
59	36***								
60	35***								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Probe driven with 300 lb. Center hole hammer free falling from a height of 24 inches, casing blows beyond 26 ft. are probe blows.
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18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. BP-D-7
SHEET 7 of 7
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696314 easting 814992
Driller	E. Thomas	Mudline El.	-8.46 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/28/00 Date End 12/28/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Boring continued as NW rod probe at 26 ft. with 2-inch O.D. split-barrel sampler.		
							Blows shown in casing blows column beyond 26 ft. are probe blows.		
61	45***								
62	49***								
	13***/4"						Bottom of exploration at 62.3 ft.; probe refusal on probable bedrock.	62.3 ft.	
	50***/0"						Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.41.	PROBABLE BEDROCK	
63									
64									
65									
66									
67									
68									
69									
70									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
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REMARKS:
1) Probe driven with 300 lb. Center hole hammer free falling from a height of 24 inches, casing blows beyond 26 ft. are probe blows.
2) ***Blows shown in casing blows column beyond 26 ft. are probe blows.
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 1 SHEET 1 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697818.1 easting 814178.0		
Driller	A. Carter	Mudline El.	-8.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	9/22/99	Date End	9/27/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. roller bit from 0 to 1 ft.		
	Hyd.	S-1	24/18	1-3	WOR/24"	0	Organic soil (OH); very soft, 90% organic clay/silt, 5% medium sand, 5% fine sand,	OH	
2	Push						strong organic odor, noticeable sheen, black.		
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
3	Push						Advance 3-7/8 in. roller bit from 1 to 3 ft.		
	0						Pull casing back to 2 ft. and perform borehole permeability test at 2 ft. Casing		
4	Hyd.	S-2	24/3	3.5-5.5	WOR/24"	0	advanced to 3.5 ft. during test due to the effects of falling tide.	SM	
	Push						Advance 3-7/8 in. roller bit from 3 to 3.5 ft. (remove wick media)	(Possible	
5	Hyd.						S-2: Silty sand (SM); very loose, 62% medium sand, 20% fine sand, 3% coarse sand,	wick media)	1
	Push						2% gravel, 13% silt/clay, brown to black. (possible wick media)		
6	Hyd.	S-3	24/10	5.5-7.5	WOR/24"	0	Advance HW drill casing to 5.5 ft. (hydraulic push)	OH	
	Push						Advance 3-7/8 in. roller bit from 3.5 to 5.5 ft.		
7	Hyd.						S-3A: Sandy organic soil (OH); very soft, 50% organic clay /silt, 30% medium sand,		
	Push						20% fine sand, strong organic odor, black. (8 in.)		
8		S-4	24/2	7.5-9.5	WOR/24"	0	S-3B: Organic soil with sand (OH); very soft, 80% organic clay/silt, 20% fine sand,	OH	
	WOH						strong organic odor, noticeable sheen, black. (2 in.)		
9							Advance HW drill casing to 7.5 ft; difficult push at 7 ft. (hydraulic push)		
	WOH						Advance 3-7/8 in. roller bit from 5.5 to 7.5 ft.		
10		S-5	24/14	9.5-11.5	1/18"-3	0	S-4: Sandy organic soil (OH); very soft, 90% organic clay/silt, 10% fine sand, strong	OH	
	11						organic odor, noticeable sheen, black. (poor recovery)		
11							Advance HW drill casing to 9.5 ft. Advance 3-7/8 in. roller bit from 7.5 to 9.5 ft.		
	6						Perform borehole permeability test at 9.5 ft.		
12		S-6	24/8	11.5-13.5	2-8-7-8	15	S-5A: Organic soil with sand (OH); very soft, 75% organic clay/silt, 25% fine sand,	SM	
	9						strong organic odor, noticeable sheen, black. (3 in.)	SP-SM	
13							S-5B: Silty sand (SM); very loose, 40% medium sand, 15% fine sand, 5% coarse		
	16						sand, 30% silt, strong organic odor, gray to black. (10 in.)		
14		S-7	24/6	13.5-15.5	21-9-8-6	17	S-5C: cinder fragments; probable sediments. (1 in.)	SP-SM	
	17						Advance HW drill casing to 11.5 ft. Advance 3-7/8 in. roller bit from 9.5 to 11.5 ft.		
15							S-6A: cinder fragments; probable sediments. (5 in.)		
	22						S-6B: Poorly graded sand with silt and gravel (SP-SM); medium dense, 25% medium		
16		S-8	24/1	15.5-17.5	5-5-7-8	12	sand, 15% coarse sand, 10% fine sand, 40% gravel, 10% silt, slight organic odor, gray.		
	23						Advance HW drill casing to 13.5 ft. Advance 3-7/8 in. roller bit from 11.5 to 13.5 ft.		
17							S-7: Poorly graded sand with silt (SP-SM); medium dense, 30% medium sand, 25%		
	24						coarse sand, 25% fine sand, 10% gravel, 10% silt, brown.		
18	12	S-9	24/7	17.5-19.5	17-6-5-5	11	Advance HW drill casing to 15.5 ft. Advance 3-7/8 in. roller bit from 13.5 to 15.5 ft.	SP-SM	
							Perform borehole permeability test at 15.5 ft.		
19	13						S-8: Poor recovery; piece of gravel lodged in tip of sampler.		
							Advance HW drill casing to 17.5 ft. Advance 3-7/8 in. roller bit from 15.5 to 17.5 ft.		
20	13						S-9: Poorly graded sand with silt and gravel (SP-SM); medium dense, 30% medium		1

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 1 SHEET 2 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697618.1 easting 814178.0
Driller	A. Carter	Mudline El.	-8.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/22/99 Date End 9/27/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-10	24/10	20-22	4-3-4-4	7	sand, 29% fine sand, 10% coarse sand, 25% gravel, 6% silt, brown.	SP	1
21	10						Advance HW drill casing to 20 ft.		
							Advance 3-7/8 in. roller bit from 17.5 to 20 ft.		
22	17						S-10: Poorly graded sand with gravel (SP); loose, 40% medium sand, 25% fine sand,		
							10% coarse sand, 20% gravel, 5% silt, brown.		
23	16						Advance HW drill casing to 25 ft.		
							Advance 3-7/8 in. roller bit from 20 to 25 ft.		
24	18								
25	30								
		S-11	24/11	25-27	5-6-10-5	16	Poorly graded sand with gravel (SP); medium dense, 30% medium sand, 30% fine	SP	
26	13						sand, 10% coarse sand, 25% gravel, 5% brown.		
							Advance HW drill casing to 30 ft.		
27	27						Advance 3-7/8 in. roller bit from 25 to 30 ft.		
28	39								
29	40								
30	66								
		S-12	24/6	30-32	17-14-9-8	23	Poorly graded sand with gravel (SP); medium dense, 30% medium sand, 20% fine	SP	
31	57						sand, 20% coarse sand, 25% gravel, 5% silt, brown.		
							Advance HW drill casing to 35 ft.		
32	47						Advance 3-7/8 in. roller bit from 30 to 35 ft.		
33	52								
34	57								
35	72								
		S-13	24/3	35-37	16-17-10-8	27	Poorly graded sand with gravel (SP); medium dense, 20% coarse sand, 15% medium	SP	
36	71						sand, 15% fine sand, 45% gravel, 5% silt, brown.		
							Advance HW drill casing to 37 ft. Advance 3-7/8 in. roller bit from 35 to 37 ft.		
37	62						Attempt borehole permeability test at 37 ft. Unable to keep bottom of borehole		
		S-14	24/0	37-39	12-7-8-7	15	stabilized; approximately 10 in. of run-in sands. Four attempts to remove material were		
38	60						made. Permeability test not performed.		
							Add bentonite to drilling fluid.		
39	56						S-14: No recovery.		
							Advance HW drill casing to 40 ft. Advance 3-7/8 in. roller bit from 37 to 40 ft.		
40	73								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:

1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesting Express, dated November 29, 1999.
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Nobis Nobis Engineering, PO Box 2890, Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 / New Bedford Harbor Superfund Site / New Bedford, Massachusetts	BORING NO. FD-1 / SHEET 3 of 8 / FILE NO. 48138.07 / CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697618.1 easting 814178.0
Driller	A. Carter	Mudline El.	-8.1 / Datum NGVD
Logged By	E. Thibodeau	Date Start	9/22/99 / Date End 9/27/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	150/	S-15	5/4	40-40.4	100/5"	—	Poorly graded sand with silt and gravel (SP-SM); 25% coarse sand, 25% medium	SP-SM	
41	6"						sand, 20% fine sand, 20% gravel, 10% silt, brown.		
							Advance HW drill casing to 40.5 ft. Advance 3-7/8 in. roller bit from 40 to 40.5 ft.		
							Top of bedrock at 40.5 ft.	BEDROCK	
							Telescope and advance NW inner drill casing to 41 ft. for coring. (spin)		
							Begin NV rock core at 41.0 ft.		
							(boring log continued on next page)		

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD - 1
SHEET	4 of 8
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697618.1 easting 814178.0
Driller	A. Carter	Mudline El.	-8.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/22/99 Date End 9/27/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
41.5 42.0		R1	41.0 - 42.0	7 mins.	Begin R1 at 41.0 ft. Fresh to slightly weathered, medium, gray, fine grained GNEISS. Low angle foliation (25 degrees). REC = 85%; RQD = 50% (poor/fair) 41.0 to 41.3 ft: fractured zone, some discoloration present. 41.3 ft: Primary joint: low angle, close to moderately spaced, rough, undulating, discolored, and partly open.	
42.5 43.0			42.0 - 43.0	4 mins.	42.2 ft: Secondary joint: horizontal, very close to moderately spaced, rough, planar, discolored, and open. 42.4 ft: Secondary joint; horizontal, very close to moderately spaced, rough, planar, discolored, and open. 42.4 to 42.6 ft: Primary joint: moderately dipping, close to moderately spaced, rough, planar, slightly discolored, and partly open. 42.9 to 43.1 ft: Primary joint: moderately dipping, close to moderately spaced, smooth, planar, discolored, and open.	
43.5 44.0			43.0 - 44.0	2 mins.	43.1 to 43.3 ft: healed primary joint with some discoloration. 43.8 ft: Secondary joint: horizontal, very close to moderately spaced, rough, planar, slightly discolored, and partly open.	
44.5 45.0			44.0 - 45.2	0 mins.	43.9 to 44.4 ft: fractured zone, some discoloration noted. 44.4 to 45.2 ft: core barrel dropped; core run terminated. Obtain split-barrel sample of void material; 5 blows, 2.5 in. of recovery. S-16A: Sandy silt (ML); moist to wet, 60% silt, 10% clay, 30% fine sand, gray. Some discoloration/iron staining noted. (top) S-16B: Silty sand with gravel (SM); wet, 25% fine sand,10% coarse sand, 10% medium sand, 15% gravel, 40% silt, reddish-brown. (bottom) End R1 at 45.2 ft.	
45.5 46.0		R2	45.2 - 46.2	5.5 mins.	Begin R2 at 45.2 ft. Fresh to slightly weathered, medium, gray, fine grained GNEISS. Low angle foliation (30 degrees). REC = 95%; RQD = 63% (fair) No water return noted during coring activities. 45.4 ft: Primary joint: low angle, very close to moderately spaced, rough, planar, discolored, and open. 45.6 to 45.9 ft: Secondary joint: high angle, extremely close to widely spaced, rough, planar, discolored, and open.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 1 SHEET 5 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697618.1	easting 814178.0	
Driller	A. Carter	Mudline El.	-8.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	9/22/99	Date End	9/27/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2 (cont.)	46.2 - 47.2	3 mins.	45.9 to 46.8 ft: Secondary joint: high angle to vertical, extremely close to widely spaced, rough, undulating, discolored, and partly open. 45.8 ft: mechanical break in rock core.	
46.5						
47.0					46.8 to 46.9 ft: Primary joint: low angle, very close to moderately spaced, smooth, planar, discolored, and open. Traces of filling material noted along joint.	
			47.2 - 48.2	4 mins.	46.9 ft: healed primary joint. Some discoloration noted. 47.0 ft: mechanical break in rock core. Minor discoloration noted; possible healed joint.	
47.5					47.6 ft: healed primary joint. 47.7 ft: mechanical break in rock core. Minor discoloration noted; possible healed joint.	
48.0						
			48.2 - 49.2	4.5 mins.	48.2 ft: Primary joint: low angle, very close to moderately spaced, rough, undulating, discolored, and partly open.	
48.5					48.3 ft: quartz inclusion, pink in color. Approximately 1 in. thick. 48.4 to 48.5 ft: Secondary joint: high angle, extremely close to widely spaced, rough, undulating, slightly discolored, and partly open.	
49.0					48.9 ft: healed joint.	
			49.2 - 50.2	4 mins.	49.0 to 49.1 ft: series of healed joints. Slight discoloration noted. 49.1 to 49.3 ft: Secondary joint: high angle, extremely close to widely spaced, smooth, planar, slightly discolored, and partly open. Possible healed joint.	
49.5					49.3 to 49.8 ft: Secondary joint: high angle, extremely close to widely spaced, rough, undulating, discolored, and open. 49.3 to 49.8 ft: series of healed joints. Some discoloration noted along joints. 49.8 ft: Primary joint: low angle, very close to moderately spaced, rough, planar, discolored and open.	
50.0					Perform single packer water pressure test from 42.2 to 50.2 ft. End R2 at 50.2 ft.	
		R3	50.2 - 51.2	4 mins.	Begin R3 at 50.2 ft. Fresh to slightly weathered, medium to moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 20 degrees.	
50.5					REC = 100%; RQD = 52% (fair) 50.2 ft: Primary joint: low angle, very close to moderately spaced, smooth, planar, discolored and open.	
51.0					50.2 ft to 50.9 ft: Secondary joint: high angle to vertical, extremely close to widely spaced, rough,	

Granular Soils	Cohesive Soils	Notes	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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	PROJECT		
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01	BORING NO.	FD - 1
	New Bedford Harbor Superfund Site	SHEET	6 of 8
	New Bedford, Massachusetts	FILE NO.	48138.07
		CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697618.1	easting 814178.0	
Driller	A. Carter	Mudline El.	-8.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	9/22/99	Date End	9/27/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION
	R3 (cont.)	51.2 - 52.2	4 mins.	undulating, discolored, and open. 50.3 ft: mechanical break in rock core. 50.6 ft: Primary joint: low angle, very close to moderately spaced, rough, planar, discolored, and open.
51.5				50.9 ft: Primary joint: low angle, very close to moderately spaced, rough, planar, discolored, and open. 51.0 ft: healed joint. 51.1 ft: mechanical break in rock core. 51.3 and 51.4 ft: Primary joints: low angle, very close to moderately spaced, smooth, planar,
52.0				discolored, and partly open. 51.5 and 51.7 ft: mechanical breaks in rock core.
		52.2 - 53.2	3.5 mins.	52.0 and 52.1 ft: Primary joints: low angle, very close to moderately spaced, smooth, planar, discolored, and partly open.
52.5				52.4 and 52.5 ft: Primary joints: low angle, very close to moderately spaced, smooth to rough, planar, discolored, and open. 52.6 to 53.0 ft: series of joints. Some discoloration and slight weathering noted.
53.0				
		53.2 - 54.2	4 mins.	53.0 to 53.6 ft: change in rock core. Possible secondary mineralization. Fresh, very soft to soft, dark gray, and aphanitic. Several mechanical breaks noted.
53.5				53.4 to 53.6 ft: Secondary joints: high angle, extremely close to widely spaced, smooth, planar, discolored, slightly decomposed, and open. Traces of slickensides noted along joint surface. 53.6 to 53.7 ft: Primary joint: low angle to moderately dipping, very close to moderately spaced, slickensides, planar, discolored, and tight.
54.0				53.9 ft: Primary joint: low angle, very close to moderately spaced, rough, planar, discolored, and open. 54.0 to 54.1 ft: Primary joint: moderately dipping, very close to moderately spaced, smooth, planar,
		54.2 - 55.2	3.5 mins.	discolored, and partly open.
54.5				54.5 to 54.6 ft: series of healed joints. 54.6 ft: mechanical break in rock core. Possible healed joint. 55.0 to 55.1 ft: Secondary joint: high angle, extremely close to widely spaced, smooth, planar, discolored and partly open.
55.0				55.1 ft: Primary joint: low angle, very close to moderately spaced, rough, planar, discolored, and open. End R3 at 55.2 ft.
	R4	55.2 - 56.2	3.5 mins.	Begin R4 at 55.2 ft. Fresh to slightly weathered, moderately hard, gray, fine grained GNEISS. Low angle foliation;
55.5				approximately 20 degrees. REC = 100%; RQD = 62% (fair) 55.3 to 55.4 ft: series of healed joints. 55.8 to 56.6 ft: Secondary joint: vertical, extremely close to widely spaced, smooth, undulating, slightly
56.0				discolored, and tight. Possible healed joint.

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 1 SHEET 7 of 8 FILE NO. 46138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697618.1	easting 814178.0	
Driller	A. Carter	Mudline El.	-8.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	9/22/99	Date End	9/27/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4 (cont.)	56.2 - 57.2	3.5 mins.	56.0 and 56.2 ft: mechanical breaks in rock core.	
56.5					56.6 to 56.8 ft: Secondary joint: moderately dipping, extremely close to widely spaced, smooth, planar, discolored, and open. 56.7 to 56.8 ft: mechanical break in rock core. Possible healed joint. 57.1 to 57.6 ft: series of healed joints. Some discoloration noted.	
57.0			57.2 - 58.2	2.5 mins.		
57.5					57.5 ft: Primary joint: low angle, very close to moderately spaced, rough, undulating, discolored, and partly open. 57.9 to 58.9 ft: series of healed joints. Some discoloration noted. 58.1 ft: Primary joint: low angle, very close to moderately spaced, rough, planar, and discolored. Possible healed joint.	
58.0			58.2 - 59.2	4 mins.	58.0 to 58.7 ft: Secondary joint: high angle to vertical, extremely close to widely spaced, rough, undulating, discolored, and partly open. Possible healed joint. 58.3 ft: mechanical break in rock core. Possible healed joint.	
58.5					58.8 ft: Primary joint: low angle to moderately dipping, very close to moderately spaced, rough, undulating, discolored, and partly open.	
59.0			59.2 - 60.2	4 mins.	58.8 to 58.9 ft: Secondary joint: moderately dipping, extremely close to widely spaced, rough, undulating, discolored, and open. 58.9 ft: Primary joint: low angle, very close to moderately spaced, rough, planar, slightly discolored, and open. Possible healed joint. 59.0 to 60.2 ft: change in rock core. Possible inclusion or secondary mineralization. Fresh to slightly weathered, soft, dark gray, and aphanitic. Several mechanical breaks noted.	
59.5						
60.0		R5	60.2 - 61.2	12 mins.	End R4 at 60.2 ft. Begin R5 at 60.2 ft. Fresh, medium hard, gray, fine grained GNEISS. Low angle foliation; approximately 30 degrees. REC = 100%; RQD = 53% (fair) 60.2 to 61.6 ft: change in rock core. Possible inclusion or secondary mineralization. (continued from R4) Fresh, very soft to soft, dark gray, and aphanitic. Highly fractured near bottom of zone.	
60.5						
61.0						

[illegible]	[illegible]	[illegible]	
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11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 1 SHEET 8 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697618.1 easting 814178.0
Driller	A. Carter	Mudline El.	-8.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/22/99 Date End 9/27/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION
	R5 (cont.)	61.2 - 62.2	8.5 mins.	
61.5				61.4 to 62.2 ft: series of healed joints. Slight discoloration noted.
				61.7 ft: mechanical break in rock core. Possible healed joint; slight discoloration noted.
62.0				61.9 ft: mechanical break in rock core. Possible healed joint; slight discoloration noted.
		62.2 - 63.2	4 mins.	62.1 ft: mechanical break in rock core. Possible healed joint; slight discoloration noted.
62.5				62.5 and 62.6 ft: Primary joints: low angle, very close to moderately spaced, smooth, undulating, discolored, and partly open.
				62.8 ft: mechanical break in rock core. Possible healed joint; slight discoloration noted.
63.0				63.0 ft: Primary joint: low angle, very close to moderately spaced, smooth, planar, slightly discolored, and partly open.
		63.2 - 64.2	3.5 mins.	63.1 ft: mechanical break in rock core. Possible healed joint; slight discoloration noted.
63.5				63.3 to 64.2 ft: series of healed joints. Slight discoloration noted.
				63.8 ft: mechanical break in rock core. Possible healed joint.
64.0				
		64.2 - 65.2	4 mins.	64.3 ft: Primary joint: low angle, very close to moderately spaced, rough, planar, discolored, and partly open.
64.5				64.4 ft: Primary joint: horizontal, very close to moderately spaced, smooth, planar, discolored, and partly open.
				64.6 to 64.8 ft: Secondary joint: high angle, extremely close to widely spaced, smooth, planar, slightly discolored, and partly open.
65.0				64.8 to 65.2 ft: series of mechanical breaks in rock core. Some grinding of the core noted. End R5 at 65.2 ft.
				Bottom of exploration at 65.2 ft.; boring terminated in bedrock.

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-2 SHEET 1 of 2 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697607.5 easting 814288.8
Driller	A. Carter	Mudline El.	-10.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/13/99 Date End 8/16/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 3 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.	UO-1	24/22	3-5	———	—	Sandy organic silt (OH); 59% organic silt, 33% fine sand, 6% medium sand, 2% coarse	OH	1
4	Push						sand, slightly glossy sheen appearance, strong organic odor, black.		
	Hyd.						Advance HW drill casing to 6 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 6 ft.		
	Hyd.								
6	Push								
	Hyd.	UO-2	24/15	6-8	———	—	Top: Organic clay with sand (OH); 74% organic clay, 23% fine sand, 3% medium sand,	OH	1
7	Push						slight glossy sheen appearance, strong organic odor, black.		
	Hyd.						Bottom: Silty sand (SM); 10% medium sand, 75% fine sand, 15% silt, gray.		
8	Push						Advance HW drill casing to 9 ft. (hydraulic push)	SM	
	Hyd.						Advance 3-7/8 in. button bit from 6 to 9 ft.		
9	Push								
		S-1	24/10	9-11	6-6-6-6	12	Silty sand (SM); medium dense, 5% coarse sand, 5% medium sand, 70% fine sand,	SM	
10	5						20% silt, strong organic odor, gray to black.		
							Advance HW drill casing to 15 ft.		
11	8						Add bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 9 to 15 ft.		
12	10								
13	12								
14	11								
15	11								
		S-2	24/18	15-17	WOH/6"-7-7-6	14	S-2A: Sandy lean clay (CL); 50% clay, 20% silt, 30% fine sand, brown. (12 in.)	CL	
16	29						S-2B: Poorly graded sand with silt and gravel (SP-SM); medium dense, 30% medium		
							sand, 20% fine sand, 15% coarse sand, 20% gravel, 15% silt, oxidized, reddish	SP-SM	
17	35						brown. (6 in.)		
							Advance HW drill casing to19 ft.		
18	27						Casing refusal at 19 ft.		
			[illegible]		[illegible]		Advance 3-7/8 in. button bit from 15 to 19.5 ft.		2
19	82						Top of bedrock at 19 ft.		
	50/						Telescope and advance NW inner drill casing to 19.8 ft for coring. (spin)		
20	0"	R1	19.8-20.8		4 mins.		Begin NX rock core at 19.8 ft.	BEDROCK	

[illegible]

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	5. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Loss of drilling fluid noted during advancement of button bit.
3)
4)

Nobis Engineering
PO Box 1890
Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-2
New Bedford Harbor Superfund Site	SHEET 2 of 2
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited — Boring Location northing 2697607.5 easting 814288.8
Driller A. Carter — Mudline El. -10.9 — Datum NGVD
Logged By E. Thibodeau — Date Start 8/13/99 — Date End 8/16/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							R1: 19.8 to 24.8 ft.		
21		R1	20.8-21.8		4 mins.		Fresh, moderately hard, gray, aphanitic GNEISS with low angle to moderately		
		cont.					dipping, very close to close, rough, stepped, discolored, tight to moderately wide		
22			21.8-22.8		4 mins.		joints.		
							REC = 88%, RQD = 75% (good)		
23			22.8-23.8		5 mins.		Loss of water return noted at 22.8 ft.		
24			23.8-24.8		4 mins.				
							Perform constant head permeability test from 19.8 to 24.8 ft. (R1)		
25		R2	24.8-25.8		5 mins.		R2: 24.8 to 29.8 ft.	BEDROCK	
							From 24.8 to 27.5 ft: Highly fractured discolored material; poor recovery.		
26			25.8-26.8		0 mins.		From 27.5 to 29.8 ft: Fresh, medium hard, gray, GNEISS with high angle to vertical,		
							smooth to rough, planar, discolored joints.		
27			26.8-27.8		1 min.		REC = 67%, RQD = 10% (very poor)		
							No water return noted during coring activities.		
28			27.8-28.8		6 mins.		Core barrel dropped a total of approximately 22 inches from 25.8 feet to 27.8 feet.		
							Attempt constant head permeability test at completion of R2; unable to maintain		
29			28.8-29.8		9 mins.		a constant water level in casing. Water level did not rise in casing.		
30									
							Bottom of exploration at 29.8 ft.; boring terminated in bedrock.		
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Loss of drilling fluid noted during advancement of button bit.
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO.	FD-3
SHEET	1 of 6
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697572.5 easting 814475.8
Driller	A. Carter	Mudline El.	-20.32 Datum NGVD
Logged By	E. Paddleford	Date Start	9/27/99 Date End 9/28/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
		S-1	24/15	1-3	WOR/9"-1-3	0	S-1A: Organic soil (OH); 75% organic clay, 20% organic silt, 5% fine sand, dark gray	OH	
2	4						to black. (3 in.)	Pt	
							S-1B: Peat (Pt) (9 in.)	SP	
3	8						S-1C: Poorly graded sand (SP); 50% medium sand, 45% fine sand, 5% silt, gray. (3 in.)		
							All three samples had a strong organic odor.		
4	16						Advance HW drill casing to 5 ft.		
							Advance 3-7/8 in. button bit from 1 to 5 ft.		
5	42								
		S-2	24/16	5-7	9-7-9-8	16	Sandy silt (ML); very stiff, 50% silt, 50% fine sand, gray.	ML	
6	14						Advance HW drill casing to 10 ft.		
							Advance 3-7/8 in. button bit from 5 to 10 ft.		
7	25								
8	26								
9	16								
10	19								
		S-3	24/18	10-12	3-5-11-13	16	Sandy silt (ML); very stiff, 54% silt, 45% fine sand, 1% medium sand, dark gray.	ML	1
11	24						Advance HW drill casing to 15 ft.		
							Advance 3-7/8 in. button bit from 10 to 15 ft.		
12	22								
13	24								
14	23								
15	22								
		S-4	24/16	15-17	4-6-5-7	16	S-4A: Silt (ML); very stiff, 95% silt, 5% fine sand, gray. (8 in.)	ML	
16	20						S-4B: Poorly graded sand with silt (SP-SM); medium dense, 45% medium sand, 40%		
							fine sand, 5% coarse sand, 10% silt, gray. (8 in.)	SP-SM	
17	31						Advance HW drill casing to 20 ft.		
							Advance 3-7/8 in. button bit from 15 to 20 ft.		
18	30						Mix drilling mud.		
19	26								
20	28								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-3 SHEET 2 of 6 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697572.5 easting 814475.8
Driller	A. Carter	Mudline El.	-20.32 Datum NGVD
Logged By	E. Paddleford	Date Start	9/27/99 Date End 9/28/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHE	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/0	20-22	4-6-7-7	13	No recovery. Change in drilling effort noted; probable gravel and sand.		
21	12						Advance HW drill casing to 22 ft.		
							Advance 3-7/8 in. button bit from 20 to 22 ft.		
22	26								
		S-6	24/4	22-24	13-25-10-12	35	Poorly graded sand with gravel (SP); dense, 50% coarse sand, 20% medium sand,	SP	
23	26						10% fine sand, 15% gravel, 5% silt, brown. Rock fragments in tip of sampler.		
							Advance HW drill casing to 25.9 ft.		
24	28						Advance 3-7/8 in. button bit from 22 to 22.9 ft. Some water loss noted during		
							advancement of roller bit.		
25	72						Casing refusal at 25.9 ft. 100 blows recorded for last 2 in.		
	205/								
26	11"	S-7	1/1	25.9 -	100/1"	—	Poorly graded sand (SP); 55% medium sand, 30% coarse sand, 10% fine sand,	SP	
				25.9			5% gravel, brown. (1 in.)		
							Bedrock disc noted in tip of sampler; quartz.		
							Top of bedorck at 25.9 ft.	BEDROCK	
							Telescope and advance NW inner drill casing to 26 ft. for rock coring. (spin)		
							Was only able to advance NW inner drill casing 1.5 in into bedrock; competent rock.		
							Begin NV rock core at 25.9 ft.		
							(boring log continued on next page)		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UD denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4 PEN denotes penetration length of sampler	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6 SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-3 SHEET 3 of 6 FILE NO. 48136.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697572.5 easting 814475.8
Driller	A. Carter	Mudline El.	-20.32 Datum NGVD
Logged By	E. Paddleford	Date Start	9/27/99 Date End 9/28/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
Unless noted, all casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	25.9'	R1	25.9-26.9	4 mins.	Begin R1 at 25.9 ft. Top 9 in: Fresh, hard, gray with pink and green, aphanitic with fine grained minerals also present. Some pitting noted on surface. REC = 84%; RQD = 60%	
26.5	26.7' void				Void spaces occur from 26.7 to 27 ft. where a small amount (3) cobbles were cored then another void from 27.2 to 27.7 ft. Void/softer material from 26.7 to 27 ft. and 27.2 to 27.7 ft. Minimal water return noted during coring activities.	
27.0	27' cobble		26.9-27.9	4 mins.	Attempted to note changes in water return color and catch in sieve; nothing found.	
27.5	27.7'				Lower 3.3 ft: Fresh, medium hard, gray, aphanitic GNEISS with low angle, moderately spaced, rough, planar, fresh, tight, jointing. Foliation roughly horizontal with jointing not following foliation plane.	
28.0			27.9-28.9	4 mins.		
28.5	Joint					
29.0			28.9-29.9	4.5 mins.		
29.5						
30.0	mechanical break		29.9-30.9	5 mins.		
30.5					Perform falling head permeability test for 6 mins. Filled NW inner drill casing. Some overflow noticed in the HW outer drill casing. Water level in HW outer drill casing returns to harbor level. Take readings from NW drill casing. Advance NW inner drill casing to 26.4 ft. (6 in.)	
31.0	30.9 R1 BOT				End R1 at 30.9 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

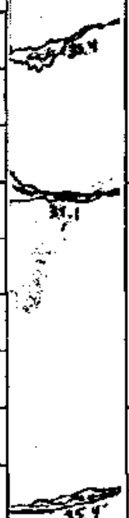
REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-3 SHEET 4 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697572.5 easting 814475.8
Driller	A. Carter	Mudline El.	-20.32 Datum NGVD
Logged By	E. Paddleford	Date Start	9/27/99 Date End 9/28/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
Unless noted, all casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time



DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION
	R2	30.9-31.9	5 mins.	Begin R2 at 30.9 ft. Fresh, moderately hard, light gray, aphanitic GNEISS with low angle, moderately spaced, rough, undulating, fresh, partly open joints.
31.5				REC = 93%; RQD = 93% Minimal water return noted during coring activities; approximately 1/4 to 1/2 of normal.
32.0		31.9-32.9	6.5 mins.	
32.5				
33.0		32.9-33.9	7 mins.	32.9 ft: further reduction in water return noted.
33.5				
34.0		33.9-34.9	8 mins.	33.9 ft: almost total water return observed.
34.5				
35.0		34.9-35.4	4 mins.	35 ft: no water return observed. Core barrel full at 35.4 ft. Probably filled with material from advancing NW inner drill casing. Material was preserved in sample jars. End R2 at 35.4 ft.
35.5	R3	35.4-36.4	4 mins.	Begin R3 at 35.4 ft. Fresh, moderately hard, gray, aphanitic GNEISS with low angle, widely spaced, rough, undulating, discolored, moderately wide joints.
36.0				REC = 100%; RQD = 96%

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-3 SHEET 5 of 6 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697572.5 easting 814475.8
Driller	A. Carter	Mudline El.	-20.32 Datum NGVD
Logged By	E. Paddleford	Date Start	9/27/99 Date End 9/28/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
Unless noted, all casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
					No water return noted for the first two feet of coring.	
36.5		R3 (cont.)	36.4-37.4	4 mins.		
37.0						
37.5			37.4-38.4	5 mins.	37.4 ft: almost total water return observed.	
38.0						
38.5			38.4-39.0	2 mins.	Core barrel full/clogged at 38.9 ft. Attempt to remove core barrel; core barrel caught in hole. Difficult to remove. Core barrel full with broken rock fragments. Jar rock fragments. (wash) Cored a total of 3.6 ft; the rest of core barrel was filled with rock fragments. End R3 at 39.0 ft.	
39.0	14°	R4	39.0-40.0	3.5 mins.	Advance NW inner drill casing another 1.5 ft to 27.9 ft. to seal off void area. Clean out rock core hole with 2-7/8 in. roller bit. Having trouble getting core barrel back down core hole. Spin roller bit a few times to at least 15 ft. Begin R4 at 39.0 ft. Fresh, moderately hard, gray, aphanitic GNEISS with low angle, widely spaced, rough, undulating, discolored, moderately wide joints. REC = 100%, RQD =100% No water return noted during coring activities.	
39.5						
40.0			40.0-41.0	4 mins.		
40.5						
41.0						

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
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Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-3
SHEET 6 of 6
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697572.5 easting 814475.8
Driller	A. Carter	Mudline El.	-20.32 Datum NGVD
Logged By	E. Paddleford	Date Start	9/27/99 Date End 9/28/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
Unless noted, all casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4 (cont.)	41.0-42.0	5.5 mins.		
41.5						
42.0			42.0-43.0	6 mins.		
42.5						
43.0			43.0-44.0	6 mins.		
43.5					Filled NW inner drill casing with water at completion of coring to perform permeability test. Some water noted overtopping the HW drill casing. Advance NW inner drill casing 12 in. to 28.9 ft. to achieve a better seal. Still water noted overtopping HW drill casing.	
44.0					End R4 at 44.0 ft.	
					Bottom of exploration at 44.0 ft; boring terminated in bedrock.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-4 SHEET 1 of 6 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697615.7 easting 814602.1
Driller	A. Carter	Mudline El.	-15.4 Datum NGVD
Logged By	E. Paddleford	Date Start	9/20/99 Date End 9/21/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
	Hyd.	S-1	24/6	1-3	WOR/24"	0	Organic soil (OH); very soft, 75% organic clay, 10% organic silt, 10% fine sand, 5%	OH	
2	Push						shell fragments, strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
3	Push						Advance 3-7/8 in. button bit from 1 to 3 ft.		
	Hyd.	S-2	24/4	3-5	WOR/24"	0	Poorly graded sand (SP); very loose, 50% medium sand, 20% fine sand, 30% shell	SP	
4	Push						fragments, gray.		
	Hyd.						Advance HW drill casing to 5 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 5 ft.		
	Hyd.	S-3	24/16	5-7	WOR/18"- 3	0	S-3A: Organic soil (OH); very soft, 75% organic clay, 10% organic silt, 10% fine sand,	OH	
6	Push						5% shell fragments. (12 in.)		
	Hyd.						S-3B: Mixture of Peat (Pt) and sand in tip of sampler. (4 in.)		
7	Push						Advance HW drill casing to 7 ft. (hydraulic push)	Pt	
		S-4	24/16	7-9	2-6-9-11	15	Advance 3-7/8 in. button bit from 5 to 7 ft.	SP-SM	
8	15						S-4: Poorly graded sand with silt (SP-SM); medium dense, 40% medium sand, 35%		
							fine sand, 10% coarse sand, 10% silt, 5% gravel, gray-brown.		
9	24						Advance HW drill casing to 11 ft.		
							Advance 3-7/8 in. button bit from 7 to 11 ft.		
10	24						Mix drilling mud.		
11	22								
		S-5	24/10	11-13	13-61-22-20	83	Silty sand (SM); very dense, 60% fine sand, 20% medium sand, 20% silt, gray.	SM	
12	16						Advance HW drill casing to 16 ft.		
							Advance 3-7/8 in. button bit from 11 to 16 ft.		
13	19						Mix drilling mud.		
14	18								
15	19								
16	24								
		S-6	24/20	16-18	2-8-9-10	17	S-6A: Silty sand (SM); medium dense, 65% fine sand, 15% medium sand, 20% silt,	SM	
17	27						gray. (14 in.)		
							S-6B: Poorly graded sand (SP); medium dense, 15% coarse sand, 50% medium sand,	SP	
18	23						30% fine sand, 5% silt, brown. (6 in.)		
							Advance HW drill casing to 21 ft.		
19	28						Advance 3-7/8 in. button bit from 16 to 21 ft.		
20	23								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Changed rig geologist from E. Paddleford to E. Thibodeau at 36 ft.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-4
New Bedford Harbor Superfund Site	SHEET 4 of 6
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697615.7 easting 814602.1
Driller	A. Carter	Mudline El.	-15.4 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/20/99 Date End 9/21/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	41.0 - 42.0	10 mins.	Begin R2 at 41.0 ft. Fresh, moderately hard, gray, fine grained GNEISS. Low angle, foliation (30 degrees). REC = 100%; RQD = 97% (excellent) 41.1 ft. Primary joint: low angle, wide to very widely spaced, rough, undulating, fresh, and open. Loss of water noted during coring activities.	
41.5						
42.0			42.0 - 43.0	8 mins.		
42.5						
43.0			43.0 - 44.0	7 mins.		
43.5						
44.0			44.0 - 45.0	6.5 mins.	44.2 to 44.7 ft. pink- orange zone; possible quartz inclusion.	
44.5						
45.0			45.0 - 46.0	8 mins	45.2 to 45.3 ft. mechanical breaks in core.	
45.5						
46.0					Approximately 225 gallons of water loss noted during coring activities. End R2 at 46.0 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Changed rig geologist from E. Paddleford to E. Thibodeau at 36 ft.
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PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-4
New Bedford Harbor Superfund Site	SHEET 5 of 6
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited — Boring Location northing 2697615.7 easting 814602.1
Driller A. Carter — Mudline El. -15.4 — Datum NGVD
Logged By E. Thibodeau — Date Start 9/20/99 — Date End 9/21/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	46.0 - 47.0	10 mins.	Begin R3 at 46.0 ft. Fresh, moderately hard, gray, medium to fine grained GNEISS. Low angle foliation (30 degrees). REC = 98%; RQD = 98% (excellent) Loss of water noted during coring activities. 46.2 to 46.9 ft. Secondary joint: high angle, very widely spaced, smooth, planar, slightly discolored, and open. Possible mechanical break.	
46.5						
47.0					46.9 ft. mechanical break in core.	
			47.0 - 48.0	10 mins.	46.3 to 47.3 ft. Healed joint: vertical, very widely spaced, smooth, planar, and discolored. Missing core from 46.9 to 47.3 ft.	
47.5						
48.0						
			48.0 - 49.0	11 mins.		
48.5						
49.0						
			49.0 - 50.0	11 mins.		
49.5						
50.0						
			50.0 - 51.0	11.5 mins.	50.3 to 50.5 ft. pink zone; possible quartz inclusion.	
50.5					50.7 ft. mechanical break in core. 50.7 to 51.0 ft. black/pink mica and quartz inclusion. (continued in R4) Approximately 400 gallons of water loss noted during coring activities.	
51.0					End R3 at 51.0 ft.	

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) Changed rig geologist from E. Paddleford to E. Thibodeau at 36 ft.
2)
3)
4)

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PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-4
New Bedford Harbor Superfund Site	SHEET 6 of 8
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited — Boring Location northing 2697615.7 easting 814602.1
Driller A. Carter — Mudline El. -15.4 — Datum NGVD
Logged By E. Thibodeau — Date Start 9/20/99 — Date End 9/21/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4	51.0 - 52.0	5 mins.	Begin R4 at 51.0 ft. Fresh, moderately hard, gray, fine grained GNEISS. Low angle foliation (20 degrees). REC = 100%; RQD = 100% (excellent) Loss of water noted during coring activities. 51.0 to 51.4 ft. black/pink mica and quartz inclusion. (continued from R3)	
51.5						
52.0			52.0 - 53.0	3.5 mins.		
52.5						
53.0			53.0 - 54.0	4.5 mins.		
53.5					53.6 ft. mechanical break in core.	
54.0			54.0 - 55.0	4 mins.		
54.5						
55.0			55.0 - 56.0	5 mins.		
55.5					55.5 ft. mechanical break in core. Filled NW inner casing with water at completion of coring activities; water level dropped at a constant rate. Approximately 5 ft. of head was noted. End R4 at 56.0 ft.	
56.0					Bottom of exploration at 56.0 ft; boring terminated in bedrock.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Changed rig geologist from E. Paddleford to E. Thibodeau at 38 ft.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-5 SHEET 1 of 2 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697671.3 easting 814761.0
Driller	A. Carter	Mudline El.	-22.5 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/17/99 Date End 8/18/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 3 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.	UO-1	24/24	3-5	————	——	Organic clay (OH); 94% organic clay,4% fine sand, 2% medium sand, black.	OH	1
4	Push						Advance HW drill casing to 6 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 3 to 6 ft.		
5	Push								
	Hyd.								
6	Push								
	Hyd.	UO-2	24/21	6-8	————	——	Top : Sandy organic clay (OL); 54% organic clay, 35% fine sand, 8% medium sand, 1%	OL	1
7	Push						coarse sand, 2% gravel, black.		
	Hyd.						Bottom : Poorly graded sand with silt (SP-SM); 50% medium sand, 35% fine sand,		
8	Push						15% silt, gray to brown. Bottom of tube damaged from sand and gravel.	SP-SM	
	Hyd.						Advance HW drill casing to 9 ft. (hydraulic push)		
9	Push						Advance 3-7/8 in. button bit from 6 to 9 ft.		
		S-1	24/13	9-11	9-8-8-11	16	Poorly graded sand (SP); medium dense, 50% medium sand, 35% fine sand, 5%	SP	
10	14						coarse sand, 5% gravel, 5% silt, brown to red.		
							Advance HW drill casing to 15 ft.		
11	16						Add bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 9 to 15 ft.		
12	17								
13	23								
14	18								
15	25								
		S-2	24/13	15-17	11-7-8-11	15	Poorly graded sand with silt and gravel (SP-SM); medium dense, 56% fine sand, 17%	SP-SM	1
16	15						medium sand, 2% coarse sand, 15% gravel, 10% silt, brown.		
							Advance HW drill casing to 20 ft.		
17	21						Advance 3-7/8 in. button bit from 15 to 20 ft.		
18	55								
19	56								
20	46								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
3)
4)

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PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-5
SHEET 2 of 2
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697671.3 easting 814761.0
Driller	A. Carter	Mudline El.	-22.5 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/17/99 Date End 8/18/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-3	24/12	20-22	5-4-5-4	9	Poorly graded sand with silt and gravel (SP-SM); loose, 37% medium sand, 27% fine	SP-SM	2
21	31						sand, 14% coarse sand, 16% gravel, 6% silt, brown.		
							Advance HW drill casing to 25 ft.		
22	30						Advance 3-7/8 in. button bit from 20 to 25 ft.		
23	25								
24	30								
25	32								
		S-4	24/12	25-27	11-8-5-30	13	Silty sand with gravel (SM); medium dense, 24% medium sand, 21% fine sand, 8%	SM	2
26	27						coarse sand, 30% gravel, 17% silt, brown.		
							Advance HW drill casing to 27 ft.		
27	44						Advance 3-7/8 in. button bit from 25 to 27 ft.		
	25/						Top of bedrock at 27 ft.		
28	0"						Advance 3-7/8 in. button bit from 27 to 28 ft.		
		R1	28.0-29.0		8.5 mins.		Begin NX rock core at 28 ft.	BEDROCK	
29							R1: 28.0 to 33.0 ft.		
			29.0-30.0		5.5 mins.		Fresh, moderately hard, gray, aphanitic GNEISS with horizontal to high angle, close		
30							to moderately spaced, rough, planar, fresh to discolored, open joints.		
			30.0-31.0		30 sec.		REC = 72%; RQD = 55% (fair)		
31							Core barrel dropped from 30 to 30.9 ft; probable cavity or void.		
			31.0-32.0		8.5 mins.		Loss of water return at 31 ft.		
32							Core barrel dropped from 32 to 32.6 ft; probable cavity or void.		
			32.0-33.0		4.5 mins.				
33									
		R2	33.0-34.0		8 mins.		R2: 33.0 to 36.0 ft.		
34							Fresh, moderately hard, gray, aphanitic GNEISS with horizontal to low angle, close to		
			34.0-35.0		7 mins.		moderately spaced, smooth, planar, fresh to discolored, partly open joints.		
35							REC = 100%; RQD = 78% (good)		
			35.0-36.0		13.5 mins.		Core barrel dropped from 33.4 to 33.8 ft.		
36							Reddish discoloration noted on core from 34.9 to 35.1 ft.		
		R3	36.0-37.0		5.5 mins.		No water return noted during coring activities for R2.		
37							R3: 36.0 to 38.0 ft.		
			37.0-38.0		7 mins.		Fresh, moderately hard, gray, aphanitic GNEISS. No joints noted.		
38							REC = 100%; RQD = 100% (excellent)		
							Approximately 12 in. of cave in material noted at beginning of core run.		
39							No water return noted during coring activities for R3.		
							Bottom exploration at 38.0 ft; boring terminated in bedrock.		
40									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated February 2, 2000.
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 6 SHEET 1 of 6 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697527.4 easting 814695.2
Driller	A. Carter	Mudline El.	-21.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/22/99 Date End 10/26/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4 inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
	Hyd.	UO-1	24/24	1-3	———	—	Organic clay with sand (OH); 75% organic clay, 13% fine sand, 3% medium sand, 2%	OH	1
2	Push						coarse sand, 7% gravel, strong organic odor, slight sheen, black to gray.		
	Hyd.						Advance HW drill casing to 4 ft. (hydraulic push)		
3	Push						Advance 3-7/8 in. button bit from 1 to 4 ft.		
	Hyd.								
4	Push								2
	Hyd.	UO-2	24/24	4-6	———	—	Clayey sand with gravel (SC); 23% fine sand, 13% medium sand, 3% coarse sand,	SC	1
5	Push						15% gravel, 46% organic clay, strong organic odor, slight sheen, black to dark gray.		
	Hyd.						Shells and shell fragments noted in sample.		
6	Push						Advance HW drill casing to 7 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 4 to 7 ft.		
7	Push								3
		UO-3	24/24	7-9	———	—	Silty sand (SM); 62% fine sand, 1% medium sand, 37% non-plastic silt, strong organic	SM	1
8	Spin						odor, dark gray.		
							Advance HW drill casing to 10 ft.		
9	Spin						Advance 3-7/8 in. button bit from 7 to 10 ft.		
10	Spin						Sandy Silt (ML)	ML	
		S-1	24/15	10-12	13-15-11-10	26	~~Silty sand (SM)~~; medium dense, 49% fine sand, 1% medium sand, 50% silt, gray.	~~SM~~	4
11	Spin						Advance HW drill casing to 15 ft.		
							Approximately 10 in. of material in bottom of casing prior to sampling; advance		
12	Spin						3-7/8 in. button bit to remove material.		
13	Spin								
14	Spin								
15	Spin								
		S-2	24/6	15-17	6-4-3-7	7	Poorly graded sand with silt (SP-SM); loose, 40% coarse sand, 20% medium sand,	SP-SM	
16	Spin						20% fine sand, 10% gravel, 10% silt, brown. Approximately 1 in. fine sand/silt lense		
							noted in sample.		
17	Spin						Advance HW drill casing to 17 ft.		
		S-3	24/13	17-19	7-6-8-4	14	S-3A: Clayey sand (SC); medium dense, 55% fine sand, 45% clay, reddish brown to	SC	
18	Spin						brown. (5 in.)		
							S-3B: Silty sand (SM); medium dense, 45% fine sand, 10% medium sand, 5% coarse	SM	
19	Spin						sand, 30% silt, 10% clay, reddish brown. (8 in.)		
							Advance HW drill casing to 20 ft.		
20	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 8.5 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Strata break changed from 8.5 ft. (shown on the field log) to 7 ft. based on the laboratory test data.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 6 SHEET 2 of 6 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2697527.4 easting 814695.2
Mudline El. -21.1 Datum NGVD
Date Start 10/22/99 Date End 10/26/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4 Inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-4	24/9	20-22	14-6-5-6	11	Poorly graded sand with gravel (SP); medium dense, 33% medium sand, 21% fine	SP	5
21	Spin						sand, 13% coarse sand, 30% gravel, 3% silt, brown.		
							Advance HW drill casing to 25 ft.		
22	Spin								
23	Spin								
24	Spin								
25	Spin								
		S-5	24/7	25-27	13-6-6-10	12	Poorly graded sand with silt and gravel (SP-SM); medium dense, 40% medium sand,	SP-SM	
26	Spin						25% fine sand, 10% coarse sand, 15% gravel, 10% silt, brown.		
							Advance HW drill casing to 30 ft.		
27	Spin								
28	Spin						Change in drilling resistance at 28 ft; probable cobble.		
29	Spin								
							Approximately 6 in. of material in bottom of casing prior to taking sample; advance		
30	Spin						3-7/8 in. button bit to remove material.		
		S-6	24/7	30-32	11-6-3-6	9	Silty sand with gravel (SM); loose, 40% fine sand, 10% medium sand, 10% coarse	SM	
31	Spin						sand, 20% gravel, 20% silt, brown.		
							Advance HW drill casing to 32 ft.		
32	Spin								
		S-7	4/4	32-	15/4" - 50/0"	—	Silty sand with gravel (SM); 41% fine sand, 16% medium sand, 3% coarse sand, 17%	SM	1
				32.3			gravel, 23% silt, brown.		
							Spoon refusal at 32.3 ft.	BEDROCK	
							Top of bedrock at 32.3 ft.		
							Advance HW drill casing from 32 to 32.5 ft. for rock coring. (spin)		
							Begin HV rock core at 32.3 ft.		
							(boring log continued on next page)		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 8.5 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Strata break changed from 8.5 ft. (shown on the field log) to 7 ft. based on the laboratory test data.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 6 SHEET 3 of 6 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697527.4	easting 814695.2	
Driller	A. Carter	Mudline El.	-21.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	10/22/99	Date End	10/26/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4 inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
32.5	R1	32.3 - 33.3	10 mins.	Check casing seal; water level dropped slowly. Begin R1 at 32.3 ft. (3rd gear) Fresh, moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 25 degrees. REC = 100%; RQD = 97% (excellent) 32.3 to 32.6 ft: discoloration/weathering noted.	
33.0					
33.5		33.3 - 34.3	6 mins.		
34.0				33.8 ft: Primary joint: low angle, very widely spaced, smooth, planar, discolored, and open. 34.0 to 34.4 ft: mechanical break in rock core.	
34.5		34.3 - 35.3	6 mins.		
35.0					
35.5		35.3 - 36.3	6 mins.	35.5 ft: mechanical break in rock core.	
36.0					
36.5		36.3 - 37.3	6 mins.		
37.0				Perform constant head permeability test from 32.8 to 37.3 ft. End R1 at 37.3 ft.	

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 8.5 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Strata break changed from 8.5 ft. (shown on the field log) to 7 ft. based on the laboratory test data.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD - 6

FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697527.4 easting 814695.2
Driller	A. Carter	Mudline El.	-21.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/22/99 Date End 10/26/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4 inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	37.3 - 38.3	10	Begin R2 at 37.3 ft. (3rd gear)	
37.5				mins.	Fresh, moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 20 degrees.	
					REC = 100%; RQD = 100% (excellent)	
					Water return color: milky white.	
38.0						
			38.3 - 39.3	6		
38.5				mins.		
39.0						
			39.3 - 40.3	5	39.3 ft: mechanical break in rock core.	
39.5				mins.		
40.0						
			40.3 - 41.3	6.5		
40.5				mins.		
41.0						
			41.3 - 42.3	5.5		
41.5				mins.		
					41.8 ft: mechanical break in rock core.	
42.0						
					End R2 at 42.3 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 8.5 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Strata break changed from 8.5 ft. (shown on the field log) to 7 ft. based on the laboratory test data.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD - 6
New Bedford Harbor Superfund Site	SHEET	5 of 6
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697527.4	easting 814695.2	
Driller	A. Carter	Mudline El.	-21.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	10/22/99	Date End	10/26/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4 inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	42.3 - 43.3	8 mins.	Begin R1 at 42.3 ft. (3rd gear)	
42.5					Fresh, moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 15-20 degrees. REC = 98%; RQD = 98% (excellent)	
43.0						
			43.3 - 44.3	8.5 mins.		
43.5						
44.0					43.8 to 44.1 ft: Quartz or feldspar inclusion; pink in color. 43.9 ft: mechanical break in rock core.	
			44.3 - 45.3	7.5 mins.		
44.5						
45.0					45.2 ft: mechanical break in rock core.	
			45.3 - 46.3	7.5 mins.		
45.5						
46.0					46.2 ft: mechanical break in rock core.	
			46.3 - 47.3	7.5 mins.		
46.5						
47.0					End R3 at 47.3 ft.	

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 8.5 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Strata break changed from 8.5 ft. (shown on the field log) to 7 ft. based on the laboratory test data.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 6 SHEET 6 of 6 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697527.4	easting 814695.2	
Driller	A. Carter	Mudline El.	-21.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	10/22/99	Date End	10/26/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4 inch I.D. (HW) flush joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4	47.3 - 48.3	13.5	Begin R4 at 47.3 ft. (3rd gear)	
47.5				mins.	Fresh, moderately hard to hard, gray, fine grained GNEISS. Low angle foliation; approximately 20 degrees. REC = 98%; RQD = 98% (excellent) Water return color: milky white.	
48.0						
			48.3 - 49.3	11		
48.5				mins.		
49.0						
					49.2 ft: mechanical break in rock core.	
			49.3 - 50.3	10.5		
49.5				mins.		
					49.8 to 50.1 ft: Secondary joint: moderately dipping, very widely spaced, smooth, planar, discolored, and partly open.	
50.0						
			50.3 - 51.3	23	50.3 ft: mechanical break in rock core.	
50.5				mins.		
51.0						
					Switch to coring in 4th gear at 51.3 ft.	
			51.3 - 52.3	18.5	51.3 ft: mechanical break in rock core.	
51.5				mins.		
52.0						
					End of R4 at 52.3 ft. Bottom of exploration at 52.3 ft.; boring terminated in bedrock.	

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 8.5 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Strata break changed from 8.5 ft. (shown on the field log) to 7 ft. based on the laboratory test data.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-7 SHEET 1 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697361.2 easting 814759.4
Driller	A. Carter	Mudline El.	-20.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	11/1/99 Date End 11/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
	Hyd.	UO-1	24/24	1-3	———	—	Organic clay with sand (OH); 81% organic clay, 14% fine sand, 4% medium sand, 1%	OH	1
2	Push						coarse sand, strong organic odor, black to dark gray. Traces of shells noted.		
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
3	Push						Advance 3-7/8 in. button bit from 1 to 3 ft.		
	Hyd.	UO-2	24/24	3-5	———	—	Organic clay (OH); 91% organic clay, 6% fine sand, 3% medium sand, strong organic	OH	1
4	Push						odor, black.		
	Hyd.						Advance HW drill casing to 5 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 5 ft.		2
	Hyd.	UO-3	24/24	5-7	———	—	Pull casing back to 4 ft. and perform borehole permeability test at 4 ft.	SC	
6	Push						UO-3: Clayey sand (SC); 38% fine sand, 12% medium sand, 2% coarse sand, 1%		1
	Hyd.						gravel, 49% organic clay, strong organic odor, dark gray.		
7	Push						Advance HW drill casing to 7 ft. (hydraulic push)		
	Hyd.	UO-4	24/20	7-9	———	—	Advance 3-7/8 in. button bit from 5 to 7 ft.	SC	
8	Push						UO-4: Clayey sand (SC); 31% fine sand, 21% medium sand, 6% coarse sand, 10%		1
	Hyd.						gravel, 32% organic clay, strong organic odor, dark gray. Bottom 4 in. of sample		
9	Push						missing; presumed to be clayey sand/silty sand interface.		
	Hyd.	S-1	24/13	9-11	4-4-5-4	9	Advance HW drill casing to 9 ft. (hydraulic push)	SM	
10	Push						Advance 3-7/8 in. button bit from 7 to 9 ft.		
	Hyd.						S-1: Silty sand (SM); loose, 60% fine sand, 40% silt , gray		
11	Push						Advance HW drill casing to 11 ft. (hydraulic push)		
		S-2	24/7	11-13	10-8-8-5	16	Advance 3-7/8 in. button bit from 9 to 11 ft.	ML	
12	9						Perform borehole permeability test at 11 ft.		
							S-2: Sandy silt (ML); very stiff, 62% silt, 32% fine sand, 5% medium sand, 1% coarse		3
13	10						sand, gray.		
		S-3	24/6	13-15	2-2-4-4	6	Advance HW drill casing to 13 ft. Advance 3-7/8 in. button bit from 11 to 13 ft.	CL	
14	8						Perform borehole permeability test at 13 ft.		
							S-3: Lean clay with sand (CL); medium stiff, 82% clay/silt, 14% fine sand, 2% medium		3
15	17						sand, 1% coarse sand, 1% gravel, olive brown. Some iron staining noted in sample.		
		S-4	24/0	15-17	7-5-6-6	11	Advance HW drill casing to 15 ft. Advance 3-7/8 in. button bit from 13 to 15 ft.		
16	16						No recovery. Piece of fractured rock lodged in tip of sampler. Appears to be a		
							coarse grained granite; possible cobble.		
17	18						Advance HW drill casing to 17 ft.		
		S-5	24/0	17-19	7-6-7-8	13	Add bentonite to drilling fluid. Advance 3-7/8 in. button bit from 15 to 17 ft.	SP	
18	23						No recovery. Attempt to resample material with 2 in. split-barrel. 6 in. of recovery		
							achieved. Poorly graded sand with gravel (SP); medium dense, 40% fine sand, 20%		
19	20						medium sand, 10% coarse sand, 25% gravel, 5% silt, brown.		
							Advance HW drill casing to 20 ft.		
20	20						Advance 3-7/8 in. button bit from 17 to 20 ft. (No bentonite drilling mud)		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 8.5 ft. (shown on the field log) to 7 ft. based on the laboratory test data.
3) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-7 SHEET 2 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697361.2 easting 814759.4
Driller	A. Carter	Mudline El.	-20.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	11/1/99 Date End 11/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/6	20-22	4-5-7-8	12	Perform borehole permeability test at 20 ft.	SP	
21	23						S-6: Poorly graded sand with gravel (SP); medium dense, 26% medium sand, 15%		3
							coarse sand, 14% fine sand, 41% gravel, 4% silt, reddish brown.		
22	31						Advance HW drill casing to 25 ft.		
							Add bentonite to drilling fluid.		
23	39						Advance 3-7/8 in. button bit from 20 to 25 ft.		
24	38								
25	31						well (SW)		
		S-7	24/9	25-27	6-3-4-5	7	~~Poorly~~ graded sand with gravel ~~(SP)~~; loose, 30% medium sand, 22% coarse sand,	SW ~~SP~~	3
26	19						9% fine sand, 36% gravel, 3% silt, brown.		
							Advance HW drill casing to 27 ft.		
27	23						Advance 3-7/8 in. button bit from 25 to 27 ft.		
		S-8	24/10	27-29	8-4-4-4	8	Silty sand with gravel (SM); loose, 10% coarse sand, 10% fine sand, 5% medium sand,	SM	
28	15						45% gravel, 20% silt, gray.		
							Advance HW drill casing to 30 ft.		
29	21						Advance 3-7/8 in. button bit from 27 to 30 ft. (No bentonite drilling mud)		
30	18						Perform borehole permeability test at 30 ft.		
		S-9	24/10	30-32	3-5-4-4	9	Poorly graded sand with gravel (SP); loose, 43% fine sand, 34% medium sand, 5%	SP	3
31	18						coarse sand, 15% gravel, 3% silt, gray-brown.		
							Advance HW drill casing to 32 ft.		
32	23						Advance 3-7/8 in. button bit from 30 to 32 ft.		
		S-10	24/6	32-34	4-4-2-3	6	Poorly graded sand with silt (SP-SM); loose, 70% fine sand, 10% medium sand, 5%	SP-SM	
33	27						coarse sand, 5% gravel, 10% silt, gray-brown.		
							Advance HW drill casing to 34 ft.		
34	31						Advance 3-7/8 in. button bit from 32 to 34 ft.		
		S-11	24/2	34-36	21-8-7-8	15	Poor recovery. Mostly rock fragments and button bit cuttings; possible cobbles.		
35	18						Advance HW drill casing to 36 ft.		
							Advance 3-7/8 in. button bit from 34 to 36 ft.		
36	37								
		S-12	24/3	36-38	14-13-13-9	26	Poor recovery. Mostly rock fragments and button bit cuttings; possible cobbles.		
37	48						Advance HW drill casing to 38 ft.		
							Advance 3-7/8 in. button bit from 36 to 38 ft. (No bentonite drilling mud)		
38	85						Perform borehole permeability test at 38 ft.		
		S-13	23/6	38-39.9	23-27-16-	43	S-13A: rock fragments and button bit cuttings. (top)	GP-GM	
39	99				18/4"-50/1"		S-13B: Poorly graded gravel with silt and sand (GP-GM); dense, 53% gravel, 18%		3
							medium sand, 17% fine sand, 7% coarse sand, 5% silt, gray. (6 in.) Bedrock fragments		
40	112						noted in tip of sampler. Minor feldspar/quartz inclusion noted in one of the fragments.	BEDROCK	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 8.5 ft. (shown on the field log) to 7 ft. based on the laboratory test data.
3) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
4)

	PROJECT	
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 7 SHEET 3 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697361.2 easting 814759.4
Driller	A. Carter	Mudline El.	-20.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	11/1/99 Date End 11/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance HW drill casing to 40 ft.		
41							Approximately one foot of material in bottom of casing; advance 3-7/8 in. button bit to remove material.		
42							Top of bedrock at 40 feet.		
							Telescope NW drill casing to 40 ft. for coring.		
43							Boring terminated at 40 ft. due to a severe overnight wind event causing the loss of the HW and NW drill casings.		
44									
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 8.5 ft. (shown on the field log) to 7 ft. based on the laboratory test data.
3) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
4)

	PROJECT	
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-8 SHEET 1 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2697223.2 easting 814705.6
Mudline El. -23.5 Datum NGVD
Date Start 8/9/99 Date End 8/11/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush joint outer casing and 4-inch I.D. (HW) flush-joint inner casing.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Boring

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance PW outer drill casing to 4 ft. (hydraulic push)		
1	Push						Advance 4-7/8 in. roller bit from 0 to 4 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.								
4	Push								
	Hyd.	UO-1	24/0	4-6	——	——	No recovery. No soil trimmings on inside or outside of tube. Probable very soft sediments.		
5	Push						Advance PW outer drill casing to 6 ft. (hydraulic push)		
	Hyd.						Advance 4-7/8 in. roller bit from 4 to 6 ft.		
6	Push								
	Hyd.	UO-2	24/23	6-8	——	——	Clayey sand (SC); 28% fine sand, 17% medium sand, 6% coarse sand, 13% gravel, 36% organic	SC	1
7	Push						clay, organic odor, drak gray to black. Traces of shells and shell fragments noted in sample.		
	Hyd.						Advance PW outer drill casing to 9 ft. (hydraulic push)		
8	Push						Very difficult push at 8.5 ft.		
	Hyd.						Advance 4-7/8 in. roller bit from 6 to 9 ft.		
9	Push								
		S-1	24/18	9-11	3-3-3-4	6	Silty sand (SM); loose, 60% fine sand, 20% medium sand, 20% silt, strong organic odor, gray.	SM	
10	16						Telescope HW inner drill casing to 11 ft.		
							Advance 3-7/8 in. button bit from 9 to 11 ft.		
11	9								
		S-2	24/12	11-13	8-8-7-6	15	Similar to S-1, except medium dense.	SM	
12	8						Advance HW inner drill casing to 15 ft.		
							Advance 3-7/8 in. button bit from 11 to 15 ft.		
13	13								
14	13								
15	10								
		S-3	24/12	15-17	6-3-3-2	6	Sandy silt (ML); medium stiff, 66% silt/clay, 32% fine sand, 1% medium sand, 1% coarse sand,	ML	1
16	0						slight organic odor, gray.		
	0						Advance HW inner drill casing to 17 ft. Casing advanced by self-weight from 15 to 16.5 ft.		
17	9						Advance 3-7/8 in. button bit from 15 to 17 ft.		
	0	S-4	24/8	17-19	5-1-WOH/12"	1	S-4A: Silty sand (SM); 50% fine sand, 30% medium sand, 5% coarse sand, 15% silt, gray. (6 in.)	SM	
18	9						S-4B: Lean clay with sand (CL); very soft, 50% clay, 30% silt, 20% fine sand, brown to gray. (2 in.)		
							Advance HW inner drill casing to 20 ft. Casing advanced by self-weight from 17 to 17.5 ft.	CL	
19	17						Advance 3-7/8 in. button bit from 17 to 20 ft.		
20	22								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2)
3)
4)

M:/Reports/Active/48138.07/Logs/CDFC/FD-8.xls/FD8

Nobis

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-8
SHEET	2 of 4
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697223.2 easting 814705.6
Driller	A. Carter	Mudline El.	-23.5 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/9/99 Date End 8/11/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush joint outer casing and 4-inch I.D. (HW) flush-joint inner casing.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Boring

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/2	20-22	8-5-6-8	11	Poorly graded sand with silt (SP-SM); medium dense, 35% coarse sand, 30% medium sand,	SP-SM	
21	15						20% fine sand, 5% gravel, 10% silt, brown.		
							Advance HW inner drill casing to 25 ft.		
22	26						Add bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 20 to 25 ft.		
23	21								
24	27								
25	30								
		S-6	24/6	25-27	6-5-5-2	10	Poorly graded sand with silt and gravel (SP-SM); loose, 22% medium sand, 21% fine sand,	SP-SM	1
26	20						17% coarse sand, 34% gravel, 6% silt, brown.		
							Advance HW inner drill casing to 30 ft.		
27	26						Add more bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 25 to 30 ft.		
28	32								
29	37								
30	39								
		S-7	24/2	30-32	5-4-4-6	8	Poorly graded sand with gravel (SP); loose, 30% medium sand, 20% coarse sand, 5% fine	SP	
31	31						sand, 40% gravel, 5% silt, brown. (possible washed sample)		
							Advance HW inner drill casing to 32 ft.		
32	29						Advance 3-7/8 in. button bit from 30 to 32 ft.		
		S-8	24/2	32-34	8-10-12-12	22	Poorly graded sand with gravel (SP); medium dense, 50% coarse sand, 20% medium sand,	SP	
33	40						5% fine sand, 20% gravel, 5% silt, brown. (possible washed sample)		
	70/						Advance HW inner drill casing to 33.6 ft.		
34	7"						Advance 3-7/8 in. button bit from 32 to 33.6 ft.		
							Top of bedrock at 33.6 ft.		
							Advance 3-7/8 in. button bit from 33.6 to 34.6 ft.	BEDROCK	
							Telescope and advance NW drill casing to 35.1 ft. for coring. (spin)		
							Begin NX rock core at 34.6 ft.		
							(boring log continued on next page)		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 29, 1999.
2)
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. SHEET FILE NO. CHKD. BY	FD-6 3 of 4 48138.07 J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697223.2	easting 814705.6	
Driller	A. Carter	Mudline El.	-23.5	Datum	NGVD
Logged By	E. Thibodeau	Date Start	8/9/99	Date End	8/11/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush joint outer casing and 4-inch I.D. (HW) flush-joint inner casing. All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Boring

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
35.0 35.5	R1	34.6 - 35.6	8.5 mins.	Begin R1 at 34.6 ft. Fresh, moderately hard, gray, fine grained GNEISS. Moderately dipping foliation; approximately 45 degrees. REC = 68%; RQD = 54% (fair) 34.7 to 34.9 ft: Primary joint: moderately dipping, moderate to widely spaced, smooth, planar, fresh to slightly discolored, and partly open. 35.2 ft: mechanical break in rock core.	
36.0 36.5		35.6 - 36.6	11.5 mins.		
37.0 37.5		36.6 - 37.6	11.5 mins.	36.5 and 36.8 ft: Secondary joints: low angle, very closely spaced, smooth, planar, fresh to slightly discolored, and partly open. 36.8 to 37.1 ft: Primary joint: high angle, moderate to widely spaced, rough, planar, fresh, and tight. Possible mechanical break; goes against foliation. 36.6 to 36.8 ft: mechanical break in rock core.	
38.0 38.5		37.6 - 38.6	3 mins.	37.7 to 38.6 ft: core barrel dropped. Possible void in bedrock; no void material recovered.	
39.0 39.5		38.6 - 39.6	6 mins.	38.6 ft: appears to be a change in foliation from moderately dipping to high angle. Possible cobble or boulder. 38.7 ft: mechanical break in rock core. 39.1 to 39.6 ft: core barrel dropped. Possible void in bedrock; no void material recovered.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-8
New Bedford Harbor Superfund Site	SHEET 4 of 4
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697223.2 easting 814705.6
Driller	A. Carter	Mudline El.	-23.5 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/9/99 Date End 8/11/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush joint outer casing and 4-inch I.D. (HW) flush-joint inner casing. All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Boring				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1 (cont.)	39.6 - 40.6	3 mins.		
40.0					39.9, 40.2, and 40.3 ft: appear to be mechanical breaks in the rock core. Slight discoloration noted.	
40.5					40.3 to 41.1 ft: Quartz vein; dark gray. Appears to be a mechanical break in rock core along quartz/GNEISS interface.	
			40.6 - 41.6	3 mins.	40.7 ft: mechanical break in rock core.	
41.0					41.1 to 41.6 ft: core barrel dropped. Possible void in quartz vein or possible quartz/GNEISS interface.	
41.5						
			41.6 - 42.6	3.5 mins.	41.6 to 42.6 ft: Quartz vein; dark gray. Some discoloration noted on quartz; possible natural fractures. Did not achieve full recovery of rock core for this interval. Core very fractured; probable mixture of mechanical breaks and natural fractures.	
42.0						
42.5	No core					
			42.6 - 43.6	5.5 mins.	42.6 to 43.3 ft: Fresh, moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 20 degrees. 42.6 to 42.7 ft: discoloration/weathering noted on rock core.	
43.0					43.3 to 43.8 ft: Quartz vein; dark gray. Some discoloration noted.	
43.5						
			43.6 - 44.6	4.5 mins.	43.8 to 44.6 ft: rock core not recovered.	
44.0	No Rock Core					
44.5					Perform single packer water pressure test at 44.6 ft. End R1 at 44.6 ft. Bottom of exploration at 44.6 ft.; boring terminated in bedrock.	

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT	
	Remedial Design For Operable Unit 01	BORING NO. FD-9
	New Bedford Harbor Superfund Site	SHEET 1 of 4
	New Bedford, Massachusetts	FILE NO. 48138.07
		CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697056.5 easting 814763.5
Driller	A. Carter	Mudline El.	-18.7 Datum NGVD
Logged By	E. Paddleford	Date Start	9/28/99 Date End 10/5/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft. Wash water clear upon return.		
	Hyd.	S-1	24/0	1-3	WOR/24"	0	No recovery.		
2	Push						Advance HW drill casing to 3 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 1 to 3 ft. Wash water black to gray upon return.		
3	Push								
	Hyd.	S-2	24/8	3-5	WOR/24"	0	Organic soil (OH); very soft, 80% organic clay, 10% organic silt, 5% fine sand, 5% shell	OH	
4	Push						fragments, dark gray. Large shell noted in sample.		
	Hyd.						Advance HW drill casing to 5 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 5 ft.		
	Hyd.	S-3	24/20	5-7	WOR/24"	0	Organic soil (OH); very soft, 80% organic clay, 10% organic silt, 10% fine sand, dark gray.	OH	
6	Push						Advance HW drill casing to 7 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 5 to 7 ft.		
7	Push								
	Hyd.	S-4	24/0	7-9	WOR/24"	0	No recovery.		
8	Push						Advance HW drill casing to 9 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 7 to 9 ft.		
9	Push								
	Hyd.	S-5	24/12	9-11	4-4-4-6	8	Poorly graded sand (SP); loose, 76% fine sand, 9% medium sand, 4% coarse sand, 7%	SP	1
10	Push						gravel, 4% silt, gray. Shell fragments noted in sample.		
	Hyd.						Advance HW drill casing to 11 ft. (hydraulic push)		
11	Push						Advance 3-7/8 in button bit from 9 to 11 ft.		
		S-6	24/10	11-13	5-9-10-12	19	Poorly graded sand (SP); medium dense, 60% fine sand, 30% medium sand, 5% silt, 5%	SP	
12	9						shell fragments, gray.		
							Advance HW drill casing to 16 ft.		
13	13						Mix bentonite drilling mud.		
							Advance 3-7/8 in. button bit from 11 to 16 ft.		
14	13								
15	12								
16	10								
		S-7	24/10	16-18	3-4-3-2	7	Silty sand (SM); loose, 68% fine sand, 3% medium sand, 29% silt, gray.	SM	1
17	9						Advance HW drill casing to 18 ft.		
							Advance 3-7/8 in. button bit from 16 to 18 ft.		
18	10								
		S-8	24/16	18-20	2-3-1-2	4	Silt with sand (ML); soft, 80% silt, 20% fine sand, gray.	ML	
19	7						Advance HW drill casing to 23 ft.		
							Advance 3-7/8 in. button bit from 18 to 23 ft.		
20	8								

[illegible]

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
3)
4)

Nobis Engineering
PO Box 1890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-9
SHEET	2 of 4
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697056.5	easting 814763.5	
Driller	A. Carter	Mudline El.	-18.7	Datum	NGVD
Logged By	E. Paddleford	Date Start	9/28/99	Date End	10/5/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
21	11								
22	15								
23	17								
		S-9	24/21	23-25	6-3-2-3	5	Similar to S-8, except medium stiff.	ML	
24	23						Advance HW drill casing to 28 ft.		
							Advance 3-7/8 in. button bit from 23 to 28 ft.		
25	27								
26	29								
27	27								
28	28								
		S-10	24/20	28-30	6-3-3-3	6	Silt with sand (ML); medium stiff, 80% silt, 20% fine sand, gray.	ML	
29	43						Advance HW drill casing to 33 ft		
							Advance 3-7/8 in. button bit from 28 to 33 ft.		
30	41						Seemed to be cobbly when washing out casing.		
31	43								
32	44								
33	50								
		S-11	24/12	33-35	48-26-6-8	32	Poorly graded sand with silt (SP-SM); dense, 40% medium sand, 30% fine sand, 15%	SP-SM	
34	19						coarse sand, 10% silt, 5% gravel, brown.		
							Probable cobble from 33 to 33.5 ft.; hard driving spoon.		
35	35						Advance HW drill casing to 38 ft.		
							Advance 3-7/8 in. button bit from 33 to 38 ft.		
36	48								
37	69								
38	126								
		S-12	24/10	38-40	7-13-23-18	36	Poorly graded sand (SP); dense, 75% fine sand, 20% medium sand, 5% coarse sand,	SP	
39	150						brown, iron stained layers.		
							Advance HW drill casing to 43 ft.		
40	113						Advance 3-7/8 in. button bit from 38 to 43 ft.		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-9
New Bedford Harbor Superfund Site	SHEET 3 of 4
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697056.5 easting 814763.5
Driller	A. Carter	Mudline El.	-18.7 Datum NGVD
Logged By	E. Paddleford	Date Start	9/28/99 Date End 10/5/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	155								
42	125								
43	152								
		S-13	24/0	43-45	11-10-19-17	29	No recovery.		
44	200						Advance HW drill casing to 45 ft. Hard driving but still seems to be cobbly/sand material.		
							Advance 3-7/8 in. button bit from 43 to 45 ft. Drilling mud thickness equals 70 pcf. as per		
45	160						mud scale. Poorly graded sand with gravel (SP)	SP	
		S-14	24/8	45-47	11-10-4-5	14	~~Silty sand with gravel (SM)~~; medium dense, ~~46%~~ 20 fine sand, ~~15%~~ 25 medium sand, ~~9%~~ 11 coarse	~~SM~~	2
46	206						sand, ~~17%~~ 42 gravel, ~~20%~~ 7 silt/clay, gray.		
							Due to high casing blow count, will advance 3-7/8 in. roller bit ahead of drill casing to		
47	168						establish pilot hole.		
							Advance 3-7/8 in. button bit from 45 to 50 ft. Losing drilling mud to borehole. Difficult		
48	124						roller bitting; possible cobles.		
							Advance HW drill casing to 50 ft. Difficult to advance casing.		
49	83						Due to the falling tide cycle and the time it took to advance the drill casing; casing depth		
							actually 50.7 ft. Mix additional bentonite drilling mud.		
50	146			50.7-			Advance 3-7/8 in. button bit to clean out casing; 8 in. of fill in at bottom of casing.		
		S-15	9/8	51.5	26-100/4"	—	Poorly graded sand with silt (SP-SM); 35% medium sand, 25% coarse sand, 20% fine	SP-SM	
51			[illegible]				sand, 10% gravel, 10% silt, gray.		
							Top of bedrock at 51.5 ft.		
52		R1	51.5-52.5		4.5 mins.		Telescope and advance NW drill casing to 52.0 ft. for coring. (spin)		
							Begin NV rock core at 51.5 ft.		
53			52.5-53.5		4.5 mins.		R1: 51.5 to 56.5 ft.	BEDROCK	
							Fresh, moderately hard, gray, aphanitic GNEISS with horizontal to low angle, closely		
54			53.5-54.5		4.5 mins.		spaced, rough, undulating, fresh, tight joints. Jointing is along foliation. However		
							foliation is not distinct.		
55			54.5-55.5		5.5 mins.		REC = 100%; RQD = 100%		
56			55.5-56.5		7 mins.				
57		R2	56.5-57.5		6 mins.		R2: 56.5 to 61.5 ft.		
							Fresh, moderately hard, gray, aphanitic GNEISS with primary horizontal to low angle,		
58			57.5-58.5		4.5 mins.		closely spaced, rough, undulating, fresh, tight joints. Secondary jointing is high angle,		
							widely spaced, rough, stepped, discolored, and partly open. Discoloration due to		
59			58.5-59.5		7 mins.		secondary mineralization/filling material noted in the joint.		
							REC = 100%; RQD = 100%		
60			59.5-60.5		11 mins.				

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

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Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-9
New Bedford Harbor Superfund Site	SHEET 4 of 4
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697056.5 easting 814763.5
Driller	A. Carter	Mudline El.	-18.7 Datum NGVD
Logged By	E. Paddleford	Date Start	9/28/99 Date End 10/5/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
61			60.5-61.5		13 mins.				
62		R3	61.5-62.5		12 mins.		R3: 61.5 to 65.5 ft. Fresh, moderately hard, gray, aphanitic GNEISS. No jointing. However, surface of core shows signs of weakness that are high angle. REC = 100%; RQD = 100%	BEDROCK	
63			62.5-63.5		12 mins.				
64			63.5-64.5		11 mins.				
65			64.5-65.5		15 mins.				
66		R4	65.5-66.5		24.25 mins.		R4: 65.5 to 70.5 ft. Fresh, moderately hard, gray, aphanitic GNEISS with primary low angle, closely spaced, rough, stepped, fresh to slightly discolored, partly open joints. Secondary high angle, moderately spaced, rough, planar, fresh, partly open joints. Quartz and feldspar mineralization noted in last foot of core (layer of weakness). Surface jointing in bottom 2 ft. Solution cavities. REC = 99%; RQD = 70%		
67			66.5-67.5		16 mins.				
68			67.5-68.5		11.75 mins.				
69			68.5-69.5		9.5 mins.				
70			69.5-70.5		13.25 mins.				
71							Bottom of exploration at 70.5 ft.; boring terminated in bedrock.		
72									
73									
74									
75									
76									
77									
78									
79									
80									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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PROJECT		
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-10 SHEET 1 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited — Boring Location northing 2696917.0 easting 814709.0
Driller A. Carter — Mudline El. -23.3 — Datum NGVD
Logged By E. Thibodeau — Date Start 8/19/99 — Date End 8/23/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 3 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.	S-1	24/24	3-5	WOR/24"	0	Organic soil (OH); very soft, 60% organic clay, 30% organic silt, 10% fine sand, strong	OH	
4	Push						organic odor, black. Traces of peat noted in sample.		
	Hyd.						Advance HW drill casing to 5 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 5 ft.		
	Hyd.	S-2	24/12	5-7	WOR/24"	0	S-2A: Similar to S-1. (11 in.)	OH	
6	Push						S-2B: Peat (Pt); very soft, fibrous, strong organic odor, dark brown. (1 in.)		
	Hyd.						Advance HW drill casing to 8 ft. (hydraulic push)		
7	Push						Very difficult push at 8 ft. Drive casing to 10 ft.		
	Hyd.						Advance 3-7/8 in button bit from 5 to 10 ft.	Pt	
8	Push								
9	23								
10	18								
		S-3	24/5	10-12	8-8-6-8	14	Silty sand (SM); medium dense, 55% fine sand, 20% medium sand, 5% coarse sand,	SM	
11	11						20% silt, gray.		
							Advance HW drill casing to 15 ft.		
12	12						Add bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 10 to 15 ft.		
13	16								
14	11								
15	19								
		S-4	24/2	15-17	14-17-12-10	29	Fractured rock; probable cobbles.		
16	22						Advance HW drill casing to 17 ft.		
							Advance 3-7/8 in button bit from 15 to 17 ft.		
17	52								
		S-5	24/4	17-19	8-7-9-6	16	Silty sand with gravel (SM); medium dense, 30% medium sand, 15% coarse sand, 15%	SM	
18	16						fine sand, 20% gravel, 20% silt, brown.		
							Advance HW drill casing to 20 ft.		
19	30						Advance 3-7/8 in button bit from 17 to 20 ft.		
20	28								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-10 SHEET 2 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696917.0 easting 814709.0
Driller	A. Carter	Mudline El.	-23.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/19/99 Date End 8/23/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/0	20-22	5-6-6-6	12	No recovery.		
21	22						Advance HW drill casing to 22 ft.		
							Advance 3-7/8 in. button bit from 20 to 22 ft.		
22	35								
		S-7	24/5	22-24	9-10-4-3	14	Poorly graded sand with gravel (SP); medium dense, 30% coarse sand, 20% medium	SP	
23	36						sand, 20% fine sand, 25% gravel, 5% silt, gray.		
							Advance HW drill casing to 25 ft.		
24	33						Advance 3-7/8 in. button bit from 22 to 25 ft.		
25	33								
		S-8	24/0	25-27	4-8-7-10	12	No recovery.		
26	20						Advance HW drill casing to 27 ft.		
							Advance 3-7/8 in. button bit from 25 to 27 ft.		
27	48								
	100/	S-9	4/1	27-27.3	100/4"	—	Poor recovery. Button bit cuttings and piece of fractured bedrock.		
28	2"						Advance HW drill casing to 27.2 ft. Advance 3-7/8 in. button bit from 27 to 27.2 ft.		
							Top of bedrock at 27.2 ft.		
29		R1		28.2-29.2	1.5 mins.		Advance 3-7/8 in. button bit from 27.2 to 28.2 ft.		
							Telescope and advance NW drill casing to 29.7 ft. for coring. (spin)	BEDROCK	
30				29.2-30.2	1.5 mins.		NW drill casing dropped and readily advanced to 29.7 ft.		
							Begin NX rock core at 28.2 ft.		
31				30.2-31.2	5 mins.		R1: 28.2 to 33.2 ft.		
							Fresh, medium hard, gray, aphanitic GNEISS with moderately dipping, close to widely		
32				31.2-32.2	6 mins.		spaced, rough, planar, discolored, open joints.		
							REC = 77%; RQD = 53% (fair)		
33				32.2-33.2	6 mins.		Core barrel dropped from 28.5 to 29.7 feet.		
							Water return noted in HW drill casing; NW drill casing seal compromised.		
34		R2		33.2-34.2	2.5 mins.		Minimal water loss noted during coring activities; water return via HW drill casing.		
							R2: 33.2 to 43.2 ft.		
35				34.2-35.2	30 secs.		NW drill casing advanced approximately 3 in. upon core barrel insertion. Core barrel		
							lodged in NW drill casing. Remove core barrel and advance NW drill casing from		
36				35.2-36.2	11.5 mins.		30 to 30.5 ft. (spin)		
							Fresh, moderately hard, gray, aphanitic GNEISS with close to moderately spaced,		
37				36.2-37.2	5.5 mins.		rough, undulating, slightly discolored, open joints. High angle, close, smooth, planar,		
							discolored, partially healed and sand filled joint set noted from 42.5 to 43.2 ft.		
38				37.2-38.2	6 mins.		REC = 82%; RQD = 73% (fair)		
							Core barrel dropped from 33.2 to 35 ft.		
39				38.2-39.2	7.5 mins		Minimal water loss noted during coring activities; water return via NW drill casing.		
40				39.2-40.2	8 mins.				

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1)
2)
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4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-10 SHEET 3 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696917.0 easting 814709.0
Driller	A. Carter	Mudline El.	-23.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/19/99 Date End 8/23/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
41		R2		40.2-41.2	7.5 mins.				
		cont.						BEDROCK	
42				41.2-42.2	9 mins.				
43				42.2-43.2	9 mins.				
44							Bottom of exploration at 43.2 ft.; boring terminated in bedrock.		
45							Note: Pumped approximately 70 gallons of grout to grout completed hole to top of HW drill casing.		
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. SHEET FILE NO. CHKD. BY	FD - 11 1 of 7 48138.07 J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696789.5 easting 814755.4
Driller	A. Carter	Mudline El.	-13.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/5/99 Date End 10/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
	Hyd.	S-1	24/16	1-3	2-1-4-2	5	Well-graded sand with silt (SW-SM); loose, 38% fine sand, 30% medium sand, 10%	SW-SM	1
2	Push						coarse sand, 13% gravel, 9% silt, slight organic odor, gray. Traces of shells and		
	Hyd.						shell fragments noted in sample.		
3	Push						Advance HW drill casing to 3 ft. (hydraulic push)		
	Hyd.	S-2	24/12	3-5	3-4-2-3	6	Advance 3-7/8 in. button bit from 1 to 3 ft.	SM	
4	Push						S-2: Silty sand with gravel (SM); loose, 30% fine sand, 20% coarse sand, 10% medium		
	Hyd.						sand, 20% gravel, 20% silt, 5% shells and shell fragments, gray.		
5	Push						Advance HW drill casing to 5 ft. (hydraulic push)		
		S-3	24/6	5-7	3-2-2-3	4	Advance 3-7/8 in. button bit from 3 to 5 ft.	CL	
6	Spin						Perform borehole permeability test at 5 ft.		
							S-3: Lean clay with sand (CL); soft, 73% clay, 22% fine sand, 4% medium sand, 1%		1
7	Spin						coarse sand, gray. Traces of iron staining noted in bottom of sample.		
							Advance HW drill casing to 10 ft.		
8	Spin								
9	Spin								
10	Spin								
		S-4	24/7	10-12	14-10-9-11	19	Poorly graded sand with gravel (SP); medium dense, 30% medium sand, 30% fine	SP	
11	Spin						sand, 10% coarse sand, 25% gravel, 5% silt, brown.		
							Advance HW drill casing to 15 ft.		
12	Spin								
13	Spin								
14	Spin								
15	Spin								
		S-5	24/0	15-17	15-11-9-13	20	No recovery. Piece of gravel lodged in tip of sampler.		
16	Spin						Advance HW drill casing to 17 ft.		
17	Spin								
		S-6	24/7	17-19	18-16-12-15	28	Poorly graded sand with gravel (SP); medium dense, 30% medium sand, 20% fine	SP	2
18	Spin						sand, 15% coarse sand, 30% gravel, 5% silt, brown.		
							Advance HW drill casing to 20 ft.		
19	Spin								
20	Spin								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Fractured rock noted in top of sample. May have been pushing cobble with sampler; therefore, N-valve may be biased high.
3) Button bit cuttings sample obtained utilizing an 8-in. diameter #100 U.S. sieve.
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 11 SHEET 2 of 7 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696789.5 easting 814755.4
Driller	A. Carter	Mudline El.	-13.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/5/99 Date End 10/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing, spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-7	24/10	20-22	32-23-19-13	42	S-7A: Fractured pieces of gravel/rock. (1 in.)	SM	2
21	Spin						S-7B: Silty sand with gravel (SM); dense, 20% medium sand, 20% fine sand, 10% coarse sand, 30% gravel, 20% silt, reddish-brown. (9 in.)		
22	Spin						Advance HW drill casing to 25 ft.		
23	Spin								
24	Spin								
25	Spin								
		S-8	24/8	25-27	30-30-20-24	50	S-8A: Fractured pieces of gravel/rock. (1 in.)	SP-SM	2
26	Spin						S-8B: Poorly graded sand with silt and gravel (SP-SM); dense, 27% medium sand, 21% fine sand, 14% coarse sand, 29% gravel, 9% silt, brown. (7 in.)		1
27	Spin						Advance HW drill casing to 30 ft. Very difficult drilling from approximately 29 to 30 ft. Possible cobble/boulder or weathered bedrock.		
28	Spin						Sound borehole; approximately 12 in. of material in bottom of casing. Advance		
29	Spin						3-7/8 in button bit from 29 to 30 ft. Button bit cuttings preserved in two sample jars.		3
30	Spin								
		S-9	6/3	30-30.5	10-75/0"	—	Silty sand with gravel (SM); 30% fine sand, 15% medium sand, 5% coarse sand, 15% gravel, 35% silt, brown.	SM	
							Advance HW drill casing to 30.5 ft.		
							Top of bedrock at 30.5 ft.	BEDROCK	
							Attempt to advance HW drill casing to 31.0 ft. for coring. Very hard formation, only able to advance to 30.7 ft.		
							Begin HV rock core at 30.5 ft.		
							(boring log continued on next page)		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Fractured rock noted in top of sample. May have been pushing cobble with sampler; therefore, N-valve may be biased high.
3) Button bit cuttings sample obtained utilizing an 6-in. diameter #100 U.S. sieve.
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT		
	Remedial Design For Operable Unit 01	BORING NO.	FD - 11
	New Bedford Harbor Superfund Site	SHEET	3 of 7
	New Bedford, Massachusetts	FILE NO.	48138.07
		CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696789.5	easting 814755.4	
Driller	A. Carter	Mudline El.	-13.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	10/5/99	Date End	10/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	30.5 - 31.5	3.5 mins.	Begin R1 at 30.5 ft. (4th gear) Fresh to slightly weathered, medium hard, gray, fine grained GNEISS. Low angle foliation; approximately 10 degrees. REC = 95%; RQD = 82% (good)	
31.0					30.9 ft: Primary joint: horizontal, very close to very widely spaced, rough, planar, slightly discolored, and open.	
31.5			31.5 - 32.5	3 mins.		
32.0					31.8 ft: Primary joint: horizontal, very close to very widely spaced, rough, planar, discolored, and open. 31.8 to 32.0 ft: Fractured zone. Discoloration noted. 32.0 ft: Primary joint: low angle, very close to very widely spaced, rough, planar, slightly discolored, and open.	
32.5			32.5 - 33.5	8 mins.	32.5 ft: shift drill rig to lower gear; approximately 200 rpm. (3rd gear)	
33.0					32.9 ft: mechanical break in rock core.	
33.5			33.5 - 34.5	6 mins.	33.5 ft: shift drill rig to higher gear. (4th gear)	
34.0					34.0 ft: shift drill rig to lower gear. (3rd gear) 34.2 ft: mechanical break in rock core.	
34.5			34.5 - 35.5	4 mins.	34.7 ft: minimal water return noted. 34.7 ft: mechanical break in rock core.	
35.0					35.4 ft: Primary joint: low angle, very close to very widely spaced, rough, undulating, discolored, and open.	
35.5					End R1 at 35.5 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Fractured rock noted in top of sample. May have been pushing cobble with sampler; therefore, N-valve may be biased high.
3) Button bil cuttings sample obtained utilizing an 8-in. diameter #100 U.S. sieve.
4)

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Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-11
New Bedford Harbor Superfund Site	SHEET 4 of 7
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited — Boring Location northing 2696789.5 easting 814755.4
Driller A. Carter — Mudline El. -13.1 Datum NGVD
Logged By E. Thibodeau — Date Start 10/5/99 Date End 10/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings.

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R2	35.5 - 36.5	3.5 mins.	Begin R2 at 35.5 ft. Fresh to slightly weathered, medium hard, gray, fine grained GNEISS. Low angle foliation; approximately 10 degrees.	
36.0				REC = 100%; RQD = 96% (excellent) 36.1 ft: mechanical break in rock core.	
36.5		36.5 - 37.5	5 mins.		
37.0				37.3 ft: loss of water return.	
37.5		37.5 - 37.8	1 min.	37.5 ft: mechanical break in rock core. Core barrel blocked at 37.8 ft.; core run terminated. End R2 at 37.8 ft.	
38.0	R3	37.8 - 38.8	5 mins.	Attempt R3; core barrel lodged in core hole. Retrieve core barrel and advance HW drill casing from 30.7 to 32.7 ft. Advance 3-7/8 in. button bit to remove casing shoe cuttings. Cuttings preserved in three sample jars. Begin R3 at 37.8 ft.	2
38.5				Fresh to slightly weathered, medium hard, gray, fine grained GNEISS. Low angle foliation; approximately 10 degrees. REC = 100%; RQD = 100% (excellent) 38.2 ft: shift drill rig to lower gear. (3rd gear)	
39.0		38.8 - 39.8	4 mins.	39.0 ft: mechanical break in rock core.	
39.5					
40.0		39.8 - 40.8	4.5 mins.		
40.5					

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Fractured rock noted in top of sample. May have been pushing cobble with sampler; therefore, N-value may be biased high.
3) Button bit cuttings sample obtained utilizing an 8-in. diameter #100 U.S. sieve.
4)

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Concord, New Hampshire 03302

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD - 11
New Bedford Harbor Superfund Site	SHEET	5 of 7
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696789.5	easting 814755.4	
Driller	A. Carter	Mudline El.	-13.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	10/5/99	Date End	10/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3 (cont.)	40.8 - 41.8	4.5 mins.		
41.0						
41.5						
			41.8 - 42.8	4.5 mins.		
42.0					41.9 ft: mechanical break in rock core.	
					42.1 ft: mechanical break in rock core.	
42.5						
					Perform constant head permeability test from 30.7 to 42.8 ft.	
					End R3 at 42.8 ft.	
		R4	42.8 - 43.8	4 mins.	Begin R4 at 42.8 ft. (3rd gear)	
43.0					Fresh to slightly weathered, medium hard, gray, fine grained GNEISS. Approximately horizontal foliation.	
					REC = 100%; RQD = 98% (excellent)	
					43.3 to 44.3 ft: quartz inclusion zone. Pink in color; coarse grained.	
43.5						
			43.8 - 44.8	3.5 mins.		
44.0						
					44.1 ft: mechanical break in rock core.	
44.5						
			44.8 - 45.8	4 mins.		
45.0					44.9 ft: mechanical break in rock core.	
					45.1 ft: Primary joint: low angle, very close to very widely spaced, rough, planar, slightly discolored, and partly open.	
					45.2 ft: Primary joint: low angle, very close to very widely spaced, rough, planar, discolored, and open.	
45.5						

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Fractured rock noted in top of sample. May have been pushing cobble with sampler; therefore, N-valve may be biased high.
3) Button bit cuttings sample obtained utilizing an 8-in. diameter #100 U.S. sieve.
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO FD - 11
New Bedford Harbor Superfund Site	SHEET 6 of 7
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696789.5 easting 814755.4
Driller	A. Carter	Mudline El.	-13.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/5/99 Date End 10/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
46.0		R4 (cont.)	45.8 - 46.8	4 mins.		
46.5						
47.0			46.8 - 47.5	4 mins.		
47.5					Core barrel full at 47.5 ft.; core run terminated. End R4 at 47.5 ft.	
		R5	47.5 - 48.5	5 mins.	Begin R5 at 47.5 ft. (3rd gear) Fresh to slightly weathered, medium hard, gray, fine grained GNEISS. Horizontal foliation. REC=100%; RQD = 100% (excellent)	
48.0						
48.5			48.5 - 49.5	5.5 mins.		
49.0						
49.5					49.3 to 49.6 ft: Secondary joint: moderately dipping, extremely widely spaced, smooth, planar, slightly discolored, and partly open. Traces of slickensides noted along joint.	
			49.5 - 50.5	4.5 mins.	49.4 ft: mechanical break in rock core.	
50.0						
50.5					50.5 ft: mechanical break in rock core.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Fractured rock noted in top of sample. May have been pushing cobble with sampler; therefore, N-value may be biased high.
3) Button bit cuttings sample obtained utilizing an 8-in. diameter #100 U.S. sieve.
4)

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Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD - 11
New Bedford Harbor Superfund Site	SHEET 7 of 7
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696789.5 easting 814755.4
Driller	A. Carter	Mudline El.	-13.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/5/99 Date End 10/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R5 (cont.)	50.5 - 51.5	4 mins.		
51.0						
51.5			51.5 - 52.5	4.5 mins.		
52.0					52.1 ft. mechanical break in rock core.	
52.5					End R5 at 52.5 ft.	
					Bottom of exploration at 52.5 ft.; boring terminated in bedrock.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Fractured rock noted in top of sample. May have been pushing cobble with sampler; therefore, N-valve may be biased high.
3) Button bit cuttings sample obtained utilizing an 8-in. diameter #100 U.S. sieve.
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	
New Bedford Harbor Superfund Site	
New Bedford, Massachusetts	

BORING NO.	FD-12
SHEET	1 of 3
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696647.2 easting 814700.0
Driller	A. Carler	Mudline El.	-20.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/23/99 Date End 8/25/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 2 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 2 ft.		
	Hyd.								
2	Push								
	Hyd.	UO-1	24/23	2-4	————	—	Top: Poorly graded sand with silt (SP-SM); 60% medium sand, 30% fine sand, 10% silt,	SP-SM	
3	Push						moderate odor, gray.		
	Hyd.						Bottom: Clayey sand (SC); 45% fine sand, 30% medium sand, 15% organic clay, 10%		
4	Push						organic silt, slight organic odor, gray.	SC	
	Hyd.						Advance HW drill casing to 5 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 2 to 5 ft.		
	Hyd.	S-1	24/4	5-7	1/24"	0	Poorly graded sand with silt (SP-SM); very loose, 50% medium sand, 40% fine sand, 10%	SP-SM	
6	Push						silt, slight odor, gray.		
	Hyd.						Advance HW drill casing to 7 ft. (hydraulic push)		
7	Push						Advance 3-7/8 in. button bit from 5 to 7 ft.		
		S-2	24/14	7-9	2-3-4-9	7	Silty sand (SM); loose, 50% medium sand, 20% fine sand, 5% coarse sand, 20% silt, 5%	SM	
8	9						clay, moderate odor, dark gray to gray. Two approximate 1 in. thick layers of wood noted		
							in sample.		
9	12						Advance HW drill casing to 10 ft.		
							Add bentonate to drilling fluid.		
10	23						Advance 3-7/8 in. button bit from 7 to 10 ft.		
		S-3	24/16	10-12	4-5-2-1	7	Poorly graded sand (SP); loose, 60% medium sand, 35% fine sand, 5% silt, strong	SP	
11	9						organic odor, dark gray to gray.		
							Advance HW drill casing to 15 ft.		
12	9						Advance 3-7/8 in. button bit from 10 to 15 ft.		
13	8								
14	13								
15	17								
		S-4	24/18	15-17	1-1-1-6	2	S-4A: Sandy silt (ML); very soft, 65% silt, 33% fine sand, 2% medium sand, gray. (12 in.)	ML	1
16	14						S-4B: Poorly graded sand (SP); 75% medium sand, 20% fine sand, 5% silt, brown. (5 in.)		
							Advance HW drill casing to 17 ft.	SP	
17	9						Advance 3-7/8 in. button bit from 15 to 17 ft.		
		S-5	24/18	17-19	2-3-3-2	6	Poorly graded sand (SP); loose, 65% medium sand, 30% fine sand, 5% silt, brown. Some	SP	
18	14						iron staining noted in sample. Approximate 2 in. thick clay/silt seam noted in bottom of		
							sample.		
19	11						Advance HW drill casing to 20 ft.		
							Advance 3-7/8 in. button bit from 17 to 20 ft.		
20	13								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2)
3)
4)

	PROJECT	
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-12 SHEET 2 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696647.2 easting 814700.0		
Driller	A. Carter	Mudline El.	-20.2	Datum	NGVD
Logged B	E. Thibodeau	Date Start	8/23/99	Date End	8/25/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/16	20-22	3-2-2-1	4	Poorly graded sand (SP); very loose, 75% medium sand, 20% fine sand, 5% silt, brown.	SP	
21	12						Approximate 2 in. thick clay seam noted in bottom of sample.		
							Advance HW drill casing to 22 ft.		
22	13						Advance 3-7/8 in. button bit from 20 to 22 ft.		
		S-7	24/20	22-24	WOR/12"-	3	Sandy lean clay (CL); soft, 54% clay/silt, 42% fine sand, 4% medium sand, brown.	CL	1
23	14				3-2		Advance HW drill casing to 25 ft.		
							Advance 3-7/8 in. button bit from 22 to 25 ft.		
24	14								
25	17								
		S-8	24/18	25-27	2-3-6-8	9	S-8A: Silty sand (SM); loose, 50% fine sand, 20% medium sand, 25% silt, 5% clay,	SM	
26	19						brown. (6 in.)		
							S-8B: Poorly graded sand (SP); loose, 65% medium sand, 30% fine sand, 5% silt,	SP	
27	18						brown. (12 in.)		
							Advance HW drill casing to 30 ft.		
28	19						Advance 3-7/8 in. button bit from 25 to 30 ft.		
29	22								
30	27								
		S-9	24/16	30-32	6-7-11-12	18	Poorly graded sand with gravel (SP); medium dense, 40% medium sand, 30% fine sand,	SP	
31	21						10% coarse sand, 15% gravel, 5% silt, brown.		
							Advance HW drill casing to 35 ft.		
32	32						Advance 3-7/8 in. button bit from 30 to 35 ft.		
							Flush casing with potable water to remove drilling mud.		
33	33								
34	43								
35	67						Perform borehole permeability test at 35 ft.		
		S-10	24/16	35-37	10-10-6-7	16	Poorly graded sand with gravel (SP); medium dense, 40% medium sand, 17% fine sand,	SP	1
36	41						15% coarse sand, 25% gravel, 3% silt, reddish brown.		
							Advance HW drill casing to 40 ft.		
37	38						Advance 3-7/8 in. button bit from 35 to 40 ft.		
38	48								
39	50								
40	45								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2)
3)
4)

PROJECT	
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts

BORING NO. FD-12
SHEET 3 of 3
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696647.2 easting 814700.0
Driller	A. Carter	Mudline El.	-20.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/23/99 Date End 8/25/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140-lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-11	24/2	40-42	8-4-3-4	7	Fractured rock lodged in tip of sampler; probable cobble.		
41	31						Advance HW drill casing to 42 ft.		
							Advance 3-7/8 in. button bit from 40 to 42 ft.		
42	34								
		S-12	24/18	42-44	11-8-11-12	19	Well-graded sand with silt and gravel (SW-SM); medium dense, 40% medium sand,	SW-SM	1
43	42						29% coarse sand, 8% fine sand, 17% gravel, 6% silt, brown.		
							Advance HW drill casing to 46.5 ft.		
44	63						Advance 3-7/8 in. button bit from 42 to 46.5 ft.		
							Top of bedrock at 46.5 ft.		
45	73						Telescope and advance NW drill casing to 47 ft. for coring. (spin)		
							Begin NX rock core at 46.5 ft.		
46	90		[redacted]		[redacted]				
	60/6"								
47		R1	46.5-47.5		9 mins.		R1: 46.5 - 56.5 ft.	BEDROCK	
							Fresh, moderately hard, gray, aphanitic GNEISS with horizontal to high angle, very		
48			47.5-48.5		5.5 mins.		close to widely spaced, smooth to rough, undulating, fresh to discolored, open		
							joints.		
49			48.5-49.5		5 mins.		REC = 90%; RQD = 65% (fair)		
							Highly fractured zone noted from 48.7 to 50.6 ft.		
50			49.5-50.5		5 mins.		Quartz inclusions noted from 49.1 to 49.6 ft., 50.7 to 51.0 ft., 52.2 to 52.5 ft., 53.1 to		
							53.4 ft., and 54.7 to 54.9 ft.		
51			50.5-51.5		9.5 mins.		Consumed approximately 300 gallons of potable water during coring activities.		
52			51.5-52.5		7.5 mins.				
53			52.5-53.5		7.5 mins.				
54			53.5-54.5		8 mins.				
							Attempt constant head permeability test in bedrock; water return noted in annular		
55			54.5-55.5		12 mins.		space between HW and NW drill casings. Test terminated.		
							Advance NW drill casing to 47.5 ft. (spin)		
56			55.5-56.5		15.5 mins.		Attempt constant head permeability test in bedrock; water return noted in annular		
							space between HW and NW drill casings. Test terminated.		
57							Bottom of exploration at 56.5 ft.; boring terminated in bedrock.		
58									
							Note: Pumped approximately 50 gallons of grout to grout completed hole to top		
59							of HW drill casing.		
60									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express; dated October 28, 1999.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-13 SHEET 1 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited | Boring Locatio northing 2696492.9 easting 814749.9
Driller A. Carter | Mudline El. -13.2 | Datum NGVD
Logged By E. Thibodeau | Date Start 10/7/99 | Date End 10/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		1
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
	Hyd.	S-1	24/1	1-3	WOR/24"	0	Sandy organic soil (OH); very soft, 65% organic clay/silt, 30% fine sand, 5% shell	OH	
2	Push						fragments, strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
3	Push						Advance 3-7/8 in. button bit from 1 to 3 ft.		
	Hyd.	UO-1	24/24	3-5	———	—	Organic clay with sand (OH); 78% organic clay, 2% medium sand, 20% fine sand, strong	OH	2
4	Push						organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 6 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 6 ft.		
	Hyd.								
6	Push								
	Hyd.	UO-2	24/24	6-8	———	—	Organic clay with sand (OH); 72% organic clay, 1% coarse sand, 2% medium sand,	OH	2
7	Push						25% fine sand, moderate organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 9 ft. (hydraulic push)		
8	Push						Advance 3-7/8 in. button bit from 6 to 9 ft.		
	Hyd.								
9	Push								
	Hyd.	UO-3	24/24	9-11	———	—	Clayey sand (SC); 4% medium sand, 36% fine sand, 12% gravel, 48% organic clay,	SC	2
10	Push						moderate oganic odor, dark gray.		
	Hyd.						Advance HW drill casing to 12 ft. (hydraulic push)		
11	Push						Advance 3-7/8 in. button bit from 9 to 12 ft.		
	Hyd.								
12	Push								
	Hyd.	UO-4	24/21	12-14	———	—	Sandy organic soil (OH); 55% organic clay/silt, 40% fine sand, 5% medium sand,	OH	
13	Push						moderate organic odor, dark gray. Traces of peat (Pt) noted in bottom of sample.		
	Hyd.						Advance HW drill casing to 15 ft. (hydraulic push)		
14	Push						Advance 3-7/8 in. button bit from 12 to 15 ft. Traces of peat/wood/vegetable matter		
	Hyd.						noted in wash.	Pt	
15	Push								
		UO-5	24/0	15-17	———	—	No recovery. Attempt to obtain sample with split-barrel.	SM	
16	Spin	S-2	24/8	15-17	WOH/24"	0	Silty sand (SM); 35% fine sand, 30% medium sand, 5% coarse sand, 10% gravel, 20%		3
							silt, gray.		
17	Spin						Advance HW drill casing to 17 ft.		
		S-3	24/12	17-19	5-1-7-6	8	Advance 3-7/8 in. button bit from 15 to 17 ft.	SM	
18	Spin						S-3: Silty sand (SM); loose, 62% fine sand, 7% medium sand, 2% coarse sand, 8% gravel,		4
							21% silt, gray.		
19	Spin						Advance HW drill casing to 20 ft.		
20	Spin								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Upon sounding mudline with survey rod, bottom felt competent. Sand and/or sediments may be present.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
3) Material previously sampled with Osterberg sampler; therefore, N-value may be biased low.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

Nobis Engineering PO Box 2890 Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-13 SHEET 2 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696492.9 easting 814749.9
Driller	A. Carter	Mudline El.	-13.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/7/99 Date End 10/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-4	24/24	20-22	6-2-1-1	3	S-4A: Silty sand (SM); 60% fine sand, 10% medium sand, 30% silt, gray. (12 in.)	SM	
21	Spin						S-4B: Sandy silt (ML); very soft, 40% silt, 25% clay, 35% fine sand, gray. (12 in.)		
							Advance HW drill casing to 25 ft.	ML	
22	Spin								
23	Spin								
24	Spin								
25	Spin								
		S-5	24/24	25-27	WOR/6"-	8	S-5A: Lean clay with sand (CL); very soft, 80% clay, 18% fine sand, 2% medium sand,	CL	4
26	Spin				4-4-7		brown. (14 in.)		
							S-5B: Clayey sand (SC); loose, 45% fine sand, 10% medium sand, 5% coarse sand,	SC	
27	Spin						40% clay, brown. (10 in.)		
							Advance HW drill casing to 30 ft.		
28	Spin								
29	Spin								
30	Spin								
		S-6	24/9	30-32	3-4-5-6	9	Poorly graded sand (SP); loose, 75% fine sand, 20% medium sand, 5% silt, brown.	SP	
31	Spin						Advance HW drill casing to 32 ft.		
							Encounter difficulty in advancing casing at 32 ft. Loss of water return to drill bit,		
32	Spin						sands closing around casing; difficult to spin. Mix bentonite and polymer drilling		
							mud to help stabilize hole.		
33	Spin						Advance HW drill casing to 35 ft. with the aid of drilling mud.		
34	Spin								
35	Spin								
		S-7	24/17	35-37	9-10-10-13	20	Poorly graded sand with silt (SP-SM); medium dense, 80% fine sand, 10% medium	SP-SM	
36	0						sand, 10% silt, brown. Some iron staining noted in sample.		
							HW drill casing advanced to 38 ft. by self-weight.		
37	0						Advance HW drill casing to 40 ft.		
38	Spin								
39	Spin								
40	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) Upon sounding mudline with survey rod, bottom felt competent. Sand and/or sediments may be present.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
3) Material previously sampled with Osterberg sampler; therefore, N-value may be biased low.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-13 SHEET 3 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696492.9 easting 814749.9
Driller	A. Carter	Mudline El.	-13.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/7/99 Date End 10/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-8	24/11	40-42	7-7-9-12	16	Poorly graded sand (SP); medium dense, 70% fine sand, 20% medium sand, 5%	SP	
41	Spin						coarse sand, 5% silt, brown.		
							Advance HW drill casing to 43 ft.		
42	Spin						Difficult drilling at 43 ft. Sands closing in around casing; difficult to spin. Mix		
							bentonite and polymer drilling mud to help stabilize hole.		
43	Spin						Advance HW drill casing to 45 ft. with the aid of drilling mud.		
44	Spin								
45	Spin								
		S-9	24/19	45-47	9-10-10-12	20	Poorly graded sand with silt (SP-SM); medium dense, 60% fine sand, 35% medium	SP-SM	
46	Spin						sand, 5% silt, reddish-brown.		
							Advance HW drill casing to 50 ft.		
47	Spin						Slight increase in drilling resistance noted at 48 ft.		
48	Spin								
49	Spin								
50	Spin								
		S-10	24/0	50-52	8-8-6-7	14	No recovery. Two pieces of gravel/fractured rock lodged in tip of sampler.		
51	Spin						Advance HW drill casing to 52 ft.		
52	Spin								
		S-11	24/3	52-54	11-9-4-8	13	S-11A: Fractured rock. (1 in.)	SP-SM	
53	Spin						S-11B: Poorly graded sand with silt and gravel (SP-SM); medium dense, 20%		
							coarse sand, 15% medium sand, 15% fine sand, 40% gravel, 10% silt, brown. (2 in.)		
54	Spin						Advance HW drill casing to 54 ft.		
		S-12	24/9	54-56	12-6-7-10	13	Poorly graded sand with silt and garvel (SP-SM); medium dense, 33% fine sand,	SP-SM	5
55	Spin						14% medium sand, 7% coarse sand, 39% gravel, 7% silt, brown.		
							Advance HW drill casing to 58.1 ft.		
56	Spin								
57	Spin								
							Very difficult drilling at 57 ft.; probable glacial till.		
58	Spin								
		S-13	24/6	58.1-	22-14-50/0"	—	Silty sand with gravel (SM); 15% medium sand, 15% fine sand, 10% coarse sand,	SM	
59	Spin			59.1			40% gravel, 20% silt, brown. (GLACIAL TILL)	(GLACIAL TILL)	
							Advance HW drill casing to 59.1 ft.		
60	Spin						Top of bedrock at 59.1 ft.	BEDROCK	

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) Upon sounding mudline with survey rod, bottom felt competent. Sand and/or sediments may be present.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
3) Material previously sampled with Osterberg sampler; therefore, N-value may be biased low.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

	PROJECT		
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01	BORING NO.	FD-13
	New Bedford Harbor Superfund Site	SHEET	4 of 8
	New Bedford, Massachusetts	FILE NO.	48138.07
		CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696492.9 easting 814749.9
Driller	A. Carter	Mudline El.	-13.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/7/99 Date End 10/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance HW drill casing to 59.4 ft. for coring. (spin)		
							Begin HV rock core at 59.1 ft.		
							(boring log continued on next page)		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) Upon sounding mudline with survey rod, bottom felt competent. Sand and/or sediments may be present.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
3) Material previously sampled with Osterberg sampler; therefore, N-value may be biased low.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-13

FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2696492.9 easting 814749.9
Mudline El. -13.2 Datum NGVD
Date Start 10/7/99 Date End 10/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	59.1 - 60.1	5.5 mins.	Begin R1 at 59.1 ft. (3rd gear) Fresh to slightly weathered, medium hard, gray, fine grained GNEISS. Low angle foliation; approximately 10 to15 degrees. REC = 100%; RQD = 95% (excellent) 59.1 to 59.2 ft: slight discoloration/weathering noted. 59.1 to 61.6 ft: Healed joint: high angle to vertical, very widely spaced, rough, and undulating.	
59.5						
60.0			60.1 - 61.1	5.5 mins.	60.0 ft: mechanical break in rock core.	
60.5						
61.0			61.1 - 62.1	4.5 mins.	61.2 ft: mechanical break in rock core. 61.6 to 61.8 ft: Primary joint: low angle, moderate to widely spaced, rough, planar, discolored, slightly decomposed, and wide.	
61.5						
62.0			62.1 - 63.1	6 mins.	62.2 ft: mechanical break in rock core.	
62.5						
63.0			63.1 - 64.1	5 mins.		
63.5					63.6 ft: mechanical break in rock core. Perform constant head permeability test from 59.4 to 64.1 ft. End R1 at 64.1 ft.	
64.0						

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) Upon sounding mudline with survey rod, bottom felt competent. Sand and/or sediments may be present.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
3) Material previously sampled with Osterberg sampler; therefore, N-value may be biased low.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

PROJECT		
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-13 SHEET 6 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696492.9 easting 814749.9
Driller	A. Carter	Mudline El.	-13.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/7/99 Date End 10/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	64.1 - 65.1	5.5 mins.	Begin R2 at 64.1 ft. (3rd gear) Fresh, medium hard, gray, fine grained GNEISS. Low angle foliation; approximately 10 degrees. REC = 100%; RQD = 98% (excellent)	
64.5						
65.0					64.9 ft: Primary joint: low angle, moderate to widely spaced, rough, planar, discolored, and tight.	
			65.1 - 66.1	5 mins.		
65.5						
66.0						
			66.1 - 67.1	5 mins.		
66.5					66.4 ft: mechanical break in rock core.	
					66.8 ft: mechanical break in rock core.	
67.0					66.9 ft: Primary joint: low angle, moderate to widely spaced, slickensides, planar, slightly discolored, and tight.	
			67.1 - 68.1	5 mins.		
67.5						
68.0					67.9 ft: Primary joint: low angle, moderate to widely spaced, smooth, planar, slightly discolored, and open.	
			68.1 - 69.1	4.5 mins.		
68.5						
69.0					Perform constant head permeability test from 59.4 to 69.1 ft. End R2 at 69.1 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	15 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:

1) Upon sounding mudline with survey rod, bottom felt competent. Sand and/or sediments may be present.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
3) Material previously sampled with Osterberg sampler; therefore, N-value may be biased low.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-13
New Bedford Harbor Superfund Site	SHEET	7 of 8
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696492.9 easting 814749.9
Driller	A. Carter	Mudline El.	-13.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/7/99 Date End 10/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	69.1 - 70.1	4.5 mins.	Begin R3 at 69.1 ft. (3rd gear) Fresh, medium to moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 10 degrees.	
69.5					REC = 100%; RQD = 100% (excellent)	
					69.8 ft: mechanical break in rock core.	
70.0			70.1 - 71.1	4 mins.		
70.5					70.7 ft: mechanical break in rock core.	
71.0			71.1 - 72.1	4 mins.	71.0 to 71.7 ft: Quartz/feldspar inclusion. Pink/dark gray in color. 71.0 ft: mechanical break in rock core. 71.2 ft: healed joint.	
71.5					71.3 ft: mechanical break in rock core. 71.4 ft: healed joint. 71.7 ft: mechanical break in rock core.	
72.0			72.1 - 73.1	4 mins.		
72.5					72.6 ft: mechanical break in rock core.	
73.0			73.1 - 74.1	4.5 mins.		
73.5					73.5 ft: mechanical break in rock core.	
74.0					73.9 ft: mechanical break in rock core. End R3 at 74.1 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS
1) Upon sounding mudline with survey rod, bottom felt competent. Sand and/or sediments may be present.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
3) Material previously sampled with Osterberg sampler; therefore, N-value may be biased low.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-13 SHEET 8 of 8 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696492.9 easting 814749.9
Driller	A. Carter	Mudline El.	-13.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/7/99 Date End 10/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4	74.1 - 75.1	5.5 mins.	Begin R4 at 74.1 ft. (3rd gear) Fresh to weathered, medium hard, gray, fine grained GNEISS. Low angle foliation; approximately 10 degrees. REC = 100%; RQD = 67% (fair)	
74.5					74.7 ft: mechanical break in rock core.	
75.0			75.1 - 76.1	5 mins.	75.2 ft: mechanical break in rock core.	
75.5					75.5 to 75.7 ft: Primary joint: low angle, extremely close to moderately spaced, rough, planar, discolored, and very wide open. 75.8 and 75.9 ft: Primary joints: low angle, extremely close to moderately spaced, rough, planar, discolored, and open.	
76.0			76.1 - 77.1	5 mins.	76.1 ft: color change noted in water return. (brownish gray) 76.1 ft: Primary joint: low angle, extremely close to moderately spaced, rough, planar, discolored, and open.	
76.5					76.2 to 76.3 ft: Primary joint: low angle, extremely close to moderately spaced, rough, planar, discolored, and very wide open. 76.5 ft: mechanical break in rock core. 76.6, 76.8, 77.1, and 77.2 ft: Primary joints: low angle, extremely close to moderately spaced, rough, planar, discolored, and wide open.	
77.0			77.1 - 78.1	3.5 mins.		
77.5					77.4 to 77.8 ft: weathered zone. Rock appears to have different texture and hardness (soft). Slightly friable. 77.4, 77.5, 77.6, 77.8, 78.0, 78.1, and 78.3 ft: mechanical breaks in rock core.	
78.0			78.1 - 79.1	4 mins.	78.4 ft: Primary joint: horizontal, extremely close to moderately spaced, rough, planar, discolored, and open. 78.9 to 79.1 ft: Primary joints: horizontal to low angle, extremely closely spaced, rough, planar, discolored, slightly friable, and open. Joints spaced approximately 1/4 to 1/2 in. apart.	
78.5					Perform single packer water pressure test from 69.1 to 79.1 ft. Perform single packer water pressure test from 61.1 to 79.1 ft. End R4 at 79.1 ft.	
79.0					Bottom of exploration at 79.1 ft.; boring terminated in bedrock.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Upon sounding mudline with survey rod, bottom felt competent. Sand and/or sediments may be present.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
3) Material previously sampled with Osterberg sampler; therefore, N-value may be biased low.
4) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
5) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD - 18
SHEET 1 of 7
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co. Allantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau
Boring Location northing 2696322.5 easting 814282.0
Mudline El. -7.85 Datum NGVD
Date Start 10/13/99 Date End 10/15/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
	Hyd.	UO-1	24/24	1-3	—	—	Sandy organic clay (OH); 65% organic clay, 23% fine sand, 7% medium sand, 2%	OH	1
2	Push						coarse sand, 3% gravel, strong organic odor, dark gray. Traces of shell fragments		
	Hyd.						noted.		
3	Push						Advance HW drill casing to 4 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 1 to 4 ft.		
4	Push								2
	Hyd.	UO-2	24/24	4-6	—	—	Clayey sand (SC); 33% fine sand, 14% medium sand, 4% coarse sand, 3% gravel,	SC	1
5	Push						46% inorganic clay, strong organic odor, dark gray. Traces of shell fragments noted.		
	Hyd.						Advance HW drill casing to 7 ft. (hydraulic push)		
6	Push						Advance 3-7/8 in. button bit from 4 to 7 ft.		
	Hyd.								
7	Push								
	Hyd.	UO-3	24/24	7-9	—	—	Top: Silty sand (SM); 55% fine sand, 10% medium sand, 30% silt, 5% shell fragments,	SM	
8	Push						gray.		
	Hyd.						Bottom: Sandy silt (ML); 70% silt/clay, 30% fine sand, light gray.	ML	
9	Push						Advance HW drill casing to 9 ft. (hydraulic push)		
		S-1	24/12	9-11	2-7-12-12	19	Advance 3-7/8 in. button bit from 7 to 9 ft.	ML	
10	Spin						S-1: Silt with sand (ML); very stiff, 80% silt/clay, 20% fine sand, light gray. Traces of		
							iron staining.		
11	Spin						Advance HW drill casing to15 ft.		
12	Spin								
13	Spin								
14	Spin								
15	Spin								
		S-2	24/18	15-17	7-7-8-6	15	Sandy silt (ML); stiff, 65% silt/clay, 35% fine sand, olive brown.	ML	
16	Spin						Advance HW drill casing to 20 ft.		
17	Spin								
18	Spin								
19	Spin								
20	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 7 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Fractured rock/gravel noted in top of recovered sample; therefore, N-value may be biased high.
4) Button bit cuttings samples obtained utilizing an 8 in. diameter #100 U.S. sieve.

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-18 SHEET 2 of 7 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696322.5 easting 814282.0
Driller	A. Carter	Mudline El.	-7.85 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/13/99 Date End 10/15/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-3	24/20	20-22	6-6-6-8	12	Sandy silt (ML); stiff, 55% silt/clay, 45% fine sand, olive brown.	ML	
21	Spin						Advance HW drill casing to 25 ft.		
22	Spin								
23	Spin								
24	Spin								
25	Spin								
		S-4	24/16	25-27	6-6-8-10	14	Silt with sand (ML); stiff, 75% silt/clay, 25% fine sand, olive brown.	ML	
26	Spin						Advance HW drill casing to 30 ft.		
27	Spin								
28	Spin								
29	Spin								
30	Spin								
		S-5	24/20	30-32	7-16-12-16	28	Sandy lean clay (CL); very stiff, 65% clay/silt, 35% fine sand, olive brown.	CL	
31	Spin						Approximately 1 in. thick medium to fine sand seam noted in sample, reddish-brown. Traces of black also noted in sample.		
32	Spin						Advance HW drill casing to 35 ft.		
33	Spin								
34	Spin						Change in drilling resistance at approximately 33 ft.		
35	Spin								
		S-6	24/6	35-37	22-13-8-10	21	Silty sand with gravel (SM); medium dense, 30% fine sand, 20% medium sand, 10% coarse sand, 20% gravel, 20% silt, brown.	SM	3
36	Spin						Advance HW drill casing to 37 ft.		
37	Spin								
		S-7	24/10	37-39	21-13-14-20	27	Lean clay with sand (CL); very stiff, 85% clay/silt, 15% fine sand, olive brown.	CL	
38	Spin						Approximate 1/4 in. thick medium to fine sand seam noted in bottom of sample, brown.		
39	Spin						Advance HW drill casing to 40 ft.		
40	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 7 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Fractured rock/gravel noted in top of recovered sample; therefore, N-value may be biased high.
4) Button bit cuttings samples obtained utilizing an 8 in. diameter #100 U.S. sieve.

Nobis Engineering, PO Box 2890, Concord, New Hampshire 03302	PROJECT		
	Remedial Design For Operable Unit 01	BORING NO.	FD - 18
	New Bedford Harbor Superfund Site	SHEET	3 of 7
	New Bedford, Massachusetts	FILE NO.	48138.07
		CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696322.5 easting 814282.0
Driller	A. Carter	Mudline El.	-7.85 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/13/99 Date End 10/15/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-8	24/8	40-42	19-24-27-15	51	Poorly graded sand with silt and gravel (SP-SM); very dense, 40% fine sand, 20%	SP-SM	
41	Spin						medium sand, 5% coarse sand, 25% gravel, 10% silt, brown.		
							Advance HW drill casing to 45 ft.		
42	Spin						Very difficult drilling at 44 ft.		
43	Spin								
44	Spin								
45	Spin								
		S-9	24/0	45-47	59-16-12-15	28	No recovery.		
46	Spin						Advance HW drill casing to 47 ft.		
47	Spin								
		S-10	24/8	47-49	27-12-20-16	32	Poorly graded sand with silt and gravel (SP-SM); dense, 40% fine sand, 15% medium	SP-SM	3
48	Spin						sand, 10% coarse sand, 25% gravel, 10% silt, brown.		
							Advance HW drill casing to 50 ft.		
49	Spin								
50	Spin								
		S-11	24/2	50-52	19-11-11-15	22	Poor recovery. Piece of fractured rock lodged in tip of sampler. Possible		
51	Spin						weathered/fractured bedrock.		
							Advance HW drill casing to 52 ft.	POSSIBLE	
52	Spin							BEDROCK	
		S-12	24/0	52-54	16-30-30-29	60	Poor recovery. Fractured rock. Possible weathered/fractured bedrock.		
53	Spin						Advance 3-7/8 in. button bit from 52 to 54 ft. (open hole)		
							Button bit cuttings preserved in three sample jars. Cuttings appear to be bedrock.		4
54	Spin								
		S-13	2/1	54-54.2	75/2"	—	Fractured bedrock. Appears to be less weathered/more competent than samples		
							obtained in S-11 and S-12.		
							Advance HW drill casing to 54.7 ft. for coring. (spin)		
							Fill casing with water to check casing seal; water level dropped slowly.		
							Begin HV rock core at 54.2 ft.		
							(boring log continued on next page)		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 7 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Fractured rock/gravel noted in top of recovered sample; therefore, N-value may be biased high.
4) Button bit cuttings samples obtained utilizing an 8 in. diameter #100 U.S. sieve.

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD - 18
SHEET	4 of 7
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696322.5 easting 814282.0
Driller	A. Carter	Mudline El.	-7.85 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/13/99 Date End 10/15/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	54.2 - 55.2	4 mins.	Begin R1 at 54.2 ft. (3rd gear)	
54.5					Water return color: milky white.	
					Fresh to slightly weathered, moderately hard, gray, fine grained GNEISS. Appears to be high angle to vertical foliation.	
					REC = 83%; RQD = 70% (fair)	
55.0					54.2 to 54.3 ft: fractured piece of bedrock. Slightly discolored and weathered.	
					54.9 to 55.7 ft: core barrel dropped. Probable void. Recovered a few pieces of fractured bedrock and what appears to be fine gravel. Probably soil filled.	
55.5			55.2 - 56.2	1.5 mins.		
					55.7 ft: change in foliation from high angle/vertical to low angle; approximately 10 degrees.	
					55.7 ft: water return color: light brown.	
56.0					Water return still possible after coring through void.	
					56.2 ft: water return color: milky white.	
56.5			56.2 - 57.2	3.5 mins.	56.3 ft: mechanical break in rock core.	
57.0						
					57.2, 57.3, 57.4, and 57.5 ft: Primary joints: low angle, extremely close to moderately spaced, rough, planar, discolored, and partly open.	
57.5			57.2 - 58.2	4 mins.		
58.0						
					58.7 ft: Primary joint: low angle, extremely close to moderately spaced, rough, planar, discolored, and tight.	
58.5			58.2 - 59.2	5 mins.	58.9 ft: Primary joint: low angle, extremely close to moderately spaced, smooth, planar, discolored, and open.	
					Sound corehole after completion of core run; approximately 4 ft. of material in corehole. Attempt split-barrel sample. Drive sampler from 58 to 59 ft. REC = 24 in.	
59.0					S-14A: Mostly core bit cuttings; piece of fractured bedrock noted. (top)	
					S-14B: Mixture of medium to fine sand and gravel; could be void material.	
					Advance HW drill casing from 54.7 to 56.2 ft. to seal off void.	
					End R1 at 59.2 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 7 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Fractured rock/gravel noted in top of recovered sample; therefore, N-value may be biased high.
4) Button bit cuttings samples obtained utilizing an 8 in. diameter #100 U.S. sieve.

Nobis Engineering, PO Box 2890, Concord, New Hampshire 03302	PROJECT: Remedial Design For Operable Unit 01, New Bedford Harbor Superfund Site, New Bedford, Massachusetts	BORING NO. FD - 18 SHEET 5 of 7 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696322.5 easting 814282.0
Driller	A. Carter	Mudline El.	-7.85 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/13/99 Date End 10/15/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	59.2 - 60.2	5	Advance 3 7/8 in. button bit from 56 to 59.2 ft to remove cuttings.	
59.5				mins.	Fill casing with water to check casing seal; water level dropped slowly.	
					Begin R2 at 59.2 ft. (3rd gear)	
					Water return color: milky white.	
					Fresh to weathered, hard to medium hard, gray, fine grained GNEISS. Low angle foliation;	
60.0					approximately 10 to 20 degrees.	
					REC = 98%; RQD = 87% (good)	
			60.2 - 61.2	4.5		
60.5				mins.	60.4 to 60.5 ft: Primary joint: low angle, extremely close to moderately spaced, rough, stepped, discolored, and partly open.	
					60.5 to 60.6 ft: Primary joint: low angle, extremely close to moderately spaced, rough, planar, discolored, and tight.	
61.0						
			61.2 - 62.2	3		
61.5				mins.		
					61.7 to 62.8 ft: weathered zone; discolored.	
					61.7 to 61.9 ft: Primary joints: low angle to horizontal, extremely close to moderately spaced, rough,	
62.0					planar, discolored, slightly decomposed, and partly open. Joints spaced approximately 0.1 to 0.3 in. apart.	
					62.1 ft: mechanical break in rock core.	
			62.2 - 63.2	3	62.3 ft: mechanical break in rock core.	
62.5				mins.	62.5 ft: Primary joint: horizontal, extremely close to moderately spaced, rough, planar, discolored, and open.	
					62.6 to 62.8 ft: Primary joints: horizontal, extremely close to moderately spaced, rough, planar, discolored to slightly decomposed, and open. Decomposed to disintegrated (friable) zone noted	
63.0					from 62.6 to 62.7 ft. Traces of mud filling noted in this zone.	
					63.0 ft: water return color: light brown to milky white.	
			63.2 - 64.2	4		
63.5				mins.	63.5 ft: Primary joint: low angle, extremely close to moderately spaced, smooth, planar, discolored, slightly decomposed, and partly open.	
64.0					64.0 ft: mechanical break in rock core.	
					End R2 at 64.2 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 7 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Fractured rock/gravel noted in top of recovered sample; therefore, N-value may be biased high.
4) Button bit cuttings samples obtained utilizing an 8 in. diameter #100 U.S. sieve.

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-18 SHEET 6 of 7 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696322.5 easting 814282.0
Driller	A. Carter	Mudline El.	-7.85 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/13/99 Date End 10/15/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	64.2 - 65.2	5	Fill casing with water to check casing seal; water level dropped more rapidly.	
64.5				mins.	Begin R3 at 64.2 ft. (3rd gear)	
					Water return color: light brown to milky white.	
					Fresh, hard, gray, fine grained GNEISS. Low angle foliation; approximately 15 degrees.	
					REC = 100%; RQD = 97% (excellent)	
65.0					65.1 ft: mechanical break in rock core.	
			65.2 - 66.2	4		
65.5				mins.		
66.0					66.1 ft: mechanical break in rock core.	
			66.2 - 67.2	4		
66.5				mins.	66.5 ft: Primary joint: low angle, extremely close to widely spaced, smooth, planar, slightly discolored, and open. Minor core grinding noted on fracture surface.	
67.0						
			67.2 - 68.2	4.5		
67.5				mins.	67.7 ft: mechanical break in rock core.	
68.0						
			68.2 - 69.2	4.5	68.3 ft: Primary joint: low angle, extremely close to widely spaced, smooth, planar, slightly discolored,	
68.5				mins.	and open. Some core grinding noted on fracture surface.	
69.0					68.9 ft: mechanical break in rock core.	
					End R3 at 69.2 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 7 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Fractured rock/gravel noted in top of recovered sample; therefore, N-value may be biased high.
4) Button bit cuttings samples obtained utilizing an 8 in. diameter #100 U.S. sieve.

Nobis Engineering PO Box 2890 Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 18 SHEET 7 of 7 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau
Boring Location northing 2696322.5 easting 814282.0
Mudline El. -7.85 Datum NGVD
Date Start 10/13/99 Date End 10/15/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE NUM	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R4	69.2 - 70.2	5.5 mins.	Begin R4 at 69.2 ft. (3rd gear)	
69.5					Water return color: milky white. Fresh, hard, gray, fine grained GNEISS. Low angle foliation; approximately 10 degrees. REC = 98%; RQD = 98% (excellent)	
70.0					70.1 ft: mechanical break in rock core.	
			70.2 - 71.2	7.5 mins.		
70.5						
71.0					70.9 ft: mechanical break in rock core. 71.2 ft: mechanical break in rock core.	
			71.2 - 72.2	5.5 mins.		
71.5						
72.0					72.1 ft: mechanical breaks in rock core.	
			72.2 - 73.2	5.5 mins.		
72.5						
73.0					72.8 to 72.9 ft: Quartz/feldspar inclusion; pink in color. 73.0 ft: mechanical break in rock core.	
			73.2 - 74.2	4.5 mins.		
73.5					73.9 ft: mechanical break in rock core. Perform constant head permeability test from 56.2 to 74.2 ft.	
74.0					End R4 at 74.2 ft. Bottom of exploration at 74.2 ft.; boring terminated in bedrock. Grouted completed borehole with approximately 57 gallons of bentonite grout. (9.2 lbs/gal.)	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Strata break changed from 7 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3) Fractured rock/gravel noted in top of recovered sample; therefore, N-value may be biased high.
4) Button bit cuttings samples obtained utilizing an 8 in. diameter #100 U.S. sieve.

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-19
SHEET 1 of 4
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696353.5 easting 814172.2
Driller	R. Pryce	Ground Surface El.	6.98 Datum NGVD
Logged By	R. Chase	Date Start	9/8/99 Date End 9/9/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
9/9	7:00 AM	4.1 ft.	2.88	12 hours

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-1	15/9	0-2	6-50-50/3"	>50	Poorly graded sand (SP); dry, very dense, 50% fine sand, 30% medium sand, <5%	SP	
1	Spin						coarse sand, 5% fine gravel, 5% silt, <5% brick, brown. (FILL)	(FILL)	
							Advance HW drill casing to 3 ft.		
2	Spin								
3	Spin								
		S-2	8/3	3-3.6	8-50/2"	>50	Poorly graded sand (SP); wet, very dense, 50% medium sand, 30% coarse sand, 5%	SP (FILL)	
4	Spin						fine sand, 10% fine gravel, <5% silt, brown. (FILL)		
							Advance HW drill casing to 5 ft.		
5	Spin						Advance 3-7/8 in. roller bit to 8.5 ft.		
							Probable nested boulders from 3.6 to 8.5 ft.	Probable Nested Boulders	
6	Spin								
7	Spin								
8	Spin								
9	Spin	S-3	24/9	8.5-10.5	33-20-13-20	33	Poorly graded sand (SP); wet, dense, 80% fine sand, 5% medium sand, <5% coarse	SP	
							sand, <5% fine gravel, 5% silt, oily odor, black.		
10	Spin						Advance HW drill casing to 13 ft.		
11	Spin								
12	Spin								
13	Spin								
		S-4	24/14	13-15	44-36-25-37	61	Similar to S-3 except very dense. Oily odor noted.	SP	
14	Spin						Advance 3-7/8 in. roller bit to 18 ft. (open hole)		
15	Spin								
16	Spin								
17	Spin								
18	Spin								
		S-5	24/8	18-20	12-6-22-35	28	Poorly graded sand (SP); wet, medium dense, 55% fine sand, 5% medium sand, <5%	SP	
19	Spin						coarse sand, 30% fine gravel, 5% silt, gray.		
							Advance HW drill casing to 23 ft.		
20	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 71 ft.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-19 SHEET 2 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696353.5 easting 814172.2
Driller	R. Pryce	Ground Surface El.	6.98 Datum NGVD
Logged By	R. Chase	Date Start	9/8/99 Date End 9/9/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
9/9	7:00 AM	4.1 ft.	2.88	12 hours

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	Spin								
22	Spin								
23	Spin								
		S-6	24/9	23-25	25-20-20-20	40	Silt (ML); wet, hard, 100% silt, gray.	ML	
24	Spin						Advance HW drill casing to 28 ft.		
25	Spin								
26	Spin								
27	Spin								
28	Spin								
		S-7	24/17	28-30	20-19-27-34	46	Similar to S-6, except several lenses of fine sand noted in sample.	ML	
29	Spin						Advance HW drill casing to 33 ft.		
30	Spin								
31	Spin								
32	Spin								
33	Spin								
		S-8	24/22	33-35	15-15-20-22	35	Similar to S-7.	ML	
34	Spin						Advance HW drill casing to 38 ft.		
35	Spin								
36	Spin								
37	Spin								
38	Spin								
		S-9	24/12	38-40	10-19-22-20	41	Silt (ML); wet, hard, 95% silt, 5% fine gravel.	ML	
39	Spin						Advance HW drill casing to 43 ft.		
40	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 71 ft.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-19
SHEET 3 of 4
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller R. Pryce
Logged By R. Chase

Boring Location northing 2696353.5 easting 814172.2
Ground Surface El. 6.98 Datum NGVD
Date Start 9/8/99 Date End 9/9/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
9/9	7:00 AM	4.1 ft.	2.88	12 hours

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	Spin								
42	Spin								
43	Spin								
		S-10	24/4	43-45	23-19-20-21	39	Poorly graded gravel (GP); wet, dense, 95% fine gravel, 5% coarse sand, gray.	GP	
44	Spin						Advance HW drill casing to 48 ft.		
45	Spin								
46	Spin								
47	Spin								
48	Spin								
		S-11	24/7	48-50	32-15-20-24	35	Poorly graded sand (SP); wet, dense, 50% fine sand, 30% medium sand, 10% coarse	SP	
49	Spin						sand, <5% fine gravel, 5% silt, brown.		
							Advance HW drill to 53 ft.		
50	Spin								
51	Spin								
52	Spin								
53	Spin								
		S-12	5/3	53-53.4	50/5"	>50	Poorly graded sand (SP); wet, dense, 55% medium sand, 40% coarse sand, 5% fine	SP	
54	Spin						sand, brown.		
							Advance HW drill casing to 58 ft.		
55	Spin						Possible cobble from 53.4 to 53.8 ft.		
56	Spin								
57	Spin								
58	Spin								
		S-13	0/0	58-58	50/0"	>50	Refusal.		
59							Top of bedrock at 58 ft.		
							Advance 3-7/8 in. roller bit to 60.8 ft.	BEDROCK	
60							Advance HW drill casing from 58 to 60.7 ft.		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 71 ft.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-19
SHEET	4 of 4
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696353.5 easting 814172.2
Driller	R. Pryce	Ground Surface El.	6.98 Datum NGVD
Logged By	R. Chase	Date Start	9/8/99 Date End 9/9/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
9/9	7:00 AM	4.1 ft.	2.88	12 hours

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance 3-7/8 in. roller bit to 61 ft.		
61							Begin NX rock core at 61 ft.		
		R1	61-62		7.75 mins.		R1: 61 to 66 ft.		
62							Fresh, medium hard, gray, aphanitic GNEISS with very low angle, very closely spaced,		
			62-63		8 mins.		rough, planar, fresh, open joints.		
63							REC = 80%; RQD = 78%		
			63-64		7.8 mins.		90% of rock core breaks are mechanical.		
64									
			64-65		7 mins.				
65									
			65-66		11.4 mins.				
66									
		R2	66-67		10.9 mins.		R2: 66 to 71 ft.	BEDROCK	
67							Similar to R1		
			67-68		9.5 mins.		REC =98%; RQD = 98%		
68									
			68-69		9.1 mins.				
69									
			69-70		9.6 mins.				
70									
			70-71		11.1 mins.				
71									1
							Bottom of exploration at 71 ft.; boring terminated in bedrock.		
72									
73									
74									
75									
76									
77									
78									
79									
80									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 71 ft.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-20
SHEET 1 of 3
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696458.0 easting 814073.9
Driller	A. Carter	Mudline El.	-4.08 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/7/99 Date End 9/8/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 3 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.	S-1	24/8	3-5	WOR/24"	0	Organic soil with sand (OH); very soft, 60% organic clay, 20% organic silt, 15% fine	OH	
4	Push						sand, 5% medium sand, strong organic odor, slight sheen, dark gray to black.		
	Hyd.						Advance HW drill casing to 5 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 5 ft.		
	Hyd.	S-2	24/18	5-7	WOR/15"-	0	S-2A: Sandy organic soil (OH); very soft, 40% organic clay, 25% organic silt, 30% fine	OH	
6	Push				1/3"-3		sand, 5% shell fragments, strong organic odor, dark gray. (12 in.)		
	Hyd.						*S-2B: Poorly graded sand with silt (SP-SM); 50% fine sand, 40% medium sand, 10%*		
7	Push						silt, gray to brown. (6 in.)	SP-SM	
							Advance HW drill casing to10 ft. (hydraulic push)		
8	19						Very difficult push at 7 ft.; drive casing.		
							Advance 3-7/8 in. button bit from 5 to 10 ft.		
9	16								
10	21								
	7/	S-3	24/19	10-12	17-29-29-26	58	Poorly graded sand (SP); very dense, 50% medium sand, 35% fine sand, 5% coarse	SP	1
11	6"						sand, 5% gravel, 5% silt, brown.		
							Advance HW drill casing to 15 ft.		
12	18						Advance 3-7/8 in. button bit from 10 to 15 ft.		
13	26								
14	37								
15	43								
		S-4	24/12	15-17	6-6-7-7	13	Poorly graded sand (SP); medium dense, 40% medium sand, 25% fine sand, 20%	SP	
16	14						coarse sand, 10% gravel, 5% silt, brown.		
							Advance HW drill casing to 20 ft.		
17	26						Add bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 15 to 20 ft.		
18	41								
19	46								
20	49								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) HW drill casing advanced approximately 6 in. during standard penetration test; therefore, N-value may be biased high.
2) Slight loss of drilling fluid noted during advancement of button bit.
3)
4)

M:/Reports/Active/48138.07/Logs/CDFC/Fd-20/FD-20

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-20
SHEET 2 of 3
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited | Boring Location northing 2696458.0 easting 814073.9
Driller A. Carter | Mudline El. -4.08 | Datum NGVD
Logged By E. Thibodeau | Date Start 9/7/99 | Date End 9/8/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/19	20-22	11-14-21-31	35	Poorly graded sand with gravel (SP); dense, 30% medium sand, 30% fine sand, 15%	SP	
21	36						coarse sand, 20% gravel, 5% silt, brown.		
							Advance HW drill casing to 25 ft.		
22	37						Advance 3-7/8 in. button bit from 20 to 25 ft.		
23	30								
24	36								
25	60								
		S-6	24/6	25-27	10-14-11-13	25	Poorly graded sand with silt and gravel (SP-SM); medium dense, 30% medium sand,	SP-SM	
26	61						15% coarse sand, 15% fine sand, 30% gravel,10% silt, brown.		
							Advance HW drill casing to 30 ft.		
27	120						Advance 3-7/8 in. button bit from 25 to 30 ft.		
28	191								
29	123								
30	115								
		S-7	24/10	30-32	25-17-14-14	31	Silty sand with gravel (SM); dense, 20% medium sand, 15% coarse sand, 15% fine	SM	
31	78						sand, 35% gravel, 15% silt, brown.		
							Advance HW drill casing to 35 ft.		
32	73						Advance 3-7/8 in. button bit from 30 to 35 ft.		
33	85								
34	113								
35	115								
		S-8	24/6	35-37	39-18-10-10	28	Poorly graded sand with silt and gravel (SP-SM); medium dense, 30% coarse sand,	SP-SM	
36	76						20% fine sand, 10% medium sand, 30% gravel, 10% silt, brown. Piece of gravel		
							lodged in tip of sampler.		
37	70						Advance HW drill casing to 40 ft.		
							Advance 3-7/8 in. button bit from 35 to 40 ft.		
38	130								
39	128								
40	81								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) HW drill casing advanced approximately 6 in. during standard penetration test; therefore, N-value may be biased high.
2) Slight loss of drilling fluid noted during advancement of button bit.
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-20 SHEET 3 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696458.0 easting 814073.9
Driller	A. Carter	Mudline El.	-4.08 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/7/99 Date End 9/8/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-9	24/6	40-42	30-24-11-9	35	Poorly graded sand with silt (SP-SM); dense, 40% medium sand, 30% fine sand, 10%	SP-SM	
41	78						coarse sand, 10% gravel, 10% silt, brown.		
							Advance HW drill casing to 46 ft.		
42	100						Advance 3-7/8 in. button bit from 40 to 46 ft.		
43	196								
44	89								
45	63								
46	79								
		S-10	24/18	46-48	19-12-7-5	19	Poorly graded sand with gravel (SP); medium dense, 40% medium sand, 20% coarse	SP	
47	56						sand, 20% fine sand, 15% gravel, 5% silt, brown. Traces of weathered bedrock noted		
							in sample.		
48	65						Advance HW drill casing to 48.8 ft.		
	218/						Top of bedrock at 48.8 ft.		
49	9"						Advance 3-7/8 in. button bit from 46 feet to 50.8 ft.		2
50								BEDROCK	
51									
							Bottom of exploration at 50.8 feet; boring terminated in probable bedrock.		
52									
53							Note: Pumped approximately 59 gallons of grout to grout completed borehole to		
							top of HW drill casing.		
54									
55									
56									
57									
58									
59									
60									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) HW drill casing advanced approximately 6 in. during standard penetration test; therefore, N-value may be biased high.
2) Slight loss of drilling fluid noted during advancement of button bit.
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-21
SHEET 1 of 3
FILE NO. 48138.07
CHKD. BY J.Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller R. Pryce
Logged By R. Chase

Boring Location northing 2696526.5 easting 814030.9
Ground Surface El. 10.9 Datum NGVD
Date Start 8/31/99 Date End 9/1/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)				
Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-1	17/11	0-1.4	14-38-50/5"	>50	Poorly graded sand (SP); dry, very dense, 80% fine sand, 5% coarse sand, 5% medium	SP	
1	Spin						sand, 5% fine gravel, 5% silt, brown. (FILL)	(FILL)	
							Advance HW drill casing to 3 ft.		
2	Spin								
3	Spin								
		S-2	5/5	3-3.4	50/5"	>50	Similar to S-1, except wet.	SP	
4	Spin						Advance HW drill casing to 8 ft.	(FILL)	
5	Spin								
6	Spin								
7	Spin								
8	Spin								
		S-3	24/6	8-10	27-20-6-5	26	Similar to S-2, except medium dense.	SP	
9	Spin						Advance HW drill casing to 13 ft.	(FILL)	
10	Spin								
11	Spin								
12	Spin								
13	Spin								
		S-4	3/3	13-13.3	50/3"	>50	Poorly graded sand (SP); wet, 40% coarse sand, 40% medium sand, <5% fine sand, 10%	SP (FILL)	
14	Spin						fine gravel, <5% silt, red-brown. Traces of brick noted in sample. (FILL)		
							Advance HW drill casing to 18 ft.	Probable	
15	Spin						Probable boulder from 13.3 to 14.3 ft.	Boulders	
							Probable boulder from 14.3 to 15.5 ft.		
16	Spin								
17	Spin								
18	Spin								
		S-5	24/14	18-20	9-6-6-6	12	Organic soil (OL); wet, stiff, 100% organic silt, black.	OL	
19	Spin						Advance HW drill casing to 23 ft.		
20	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 49 ft.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-21 SHEET 2 of 3 FILE NO. 48138.07 CHKD. BY J.Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller R. Pryce
Logged By R. Chase
Boring Location northing 2696526.5 easting 814030.9
Ground Surface El. 10.9 Datum NGVD
Date Start 8/31/99 Date End 9/1/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	Spin								
22	Spin								
23	Spin						Inferred strata change at 23 ft.		
		S-6	24/10	23-25	14-9-10-14	19	Silty sand (SM); wet, medium dense, 85% fine sand, 15% silt, gray.	SM	
24	Spin						Advance HW drill casing to 28 ft.		
25	Spin								
26	Spin								
27	Spin								
28	Spin								
		S-7	24/10	28-30	8-9-11-10	20	Similar to S-6.	SM	
29	Spin						Advance HW drill casing to 33 ft.		
30	Spin								
31	Spin								
32	Spin								
33	Spin								
		S-8	24/6	33-35	11-14-13-13	27	Poorly graded sand (SP); wet, medium dense, 95% fine sand, 5% silt, gray.	SP	
34	Spin						Advance HW drill casing to 38 ft.		
35	Spin								
36	Spin								
37	Spin								
38	Spin								
		S-9	10/6	38-38.9	18-50/4"	>50	Well-graded sand with gravel (SW); wet, 35% coarse sand, 30% medium sand, 15%	SW	
39	Spin						fine sand, 15% fine gravel, 5% silt.		
							Advance HW drill casing to 43 ft.		
40	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 49 ft.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-21
SHEET 3 of 3
FILE NO. 48138.07
CHKD. BY J.Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller R. Pryce
Logged By R. Chase

Boring Location northing 2696526.5 easting 814030.9
Ground Surface El. 10.9 Datum NGVD
Date Start 8/31/99 Date End 9/1/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	Spin								
42	Spin								
43	Spin								
		S-10	24/4	43-45	14-11-12-25	23	Poorly graded sand (SP); wet, medium dense, 50% coarse sand, 35% medium sand,	SP	
44	Spin						5% fine sand, <5% fine gravel, <5% silt, gray.		
							Advance HW drill casing to 46.5 ft.		
45	Spin						Top of bedrock at 46.5 ft.		
							Advance 3-7/8 in. roller bit to 49.0 ft. to confirm bedrock.		
46	Spin								
47									
48								BEDROCK	
49									1
							Bottom of exploration at 49 ft.; boring terminated in probable bedrock.		
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

0 to 4 - Very Loose
5 to 10 - Loose
11 to 30 - Medium Dense
31 to 50 - Dense
Over 50 - Very Dense

0 to 2 - Very Soft
3 to 4 - Soft
5 to 8 - Medium Stiff
9 to 15 - Stiff
16 to 30 - Very Stiff
Over 30 - Hard

1. S denotes split-barrel sampler.
2. U denotes 3-inch O.D. undisturbed sample.
3. UO denotes 3-inch Osterberg undisturbed sample.
4. PEN denotes penetration length of sampler.
5. REC denotes recovered length of sample.
6. SPT denotes Standard Penetration Test.
7. PID denotes Photoionization Detector
8. PPM denotes parts per million.
9. PP denotes Pocket Penetrometer.
10. FVST denotes field vane shear test.
11. RQD denotes Rock Quality Designation.
12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 49 ft.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO.	FD-22
SHEET	1 of 3
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696654.2 easting 814095.5
Driller	R. Pryce	Ground Surface El.	11.28 Datum NGVD
Logged By	S. Bonis	Date Start	9/15/99 Date End 9/20/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
		No water levels recorded		

DEPTH ft	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-1	24/12	0-2	14-30-14-9	44	Poorly graded sand with silt and gravel (SP-SM); dry, dense, 60% fine sand, 10% coarse	SP-SM	
1	Spin						sand, 15% gravel, 15% silt, dark brown. Wood and concrete fragments noted in	(FILL)	
							sample. (FILL)		
2	Spin						Advance HW drill casing to 3 ft.		
							Advance 3-7/8 in. roller bit to 3 ft.		
3	Spin								
		S-2	24/1	3-5	9-30-9-4	39	Poorly graded gravel (GP); dense, 90% gravel, 10% coarse sand. (FILL)	GP	
4	Spin						Advance HW drill casing to 9.5 ft.	(FILL)	
							Very slow drilling; possible boulders.		
5	Spin						Advance 3-7/8 in. roller bit to 9.5 ft.		
6	Spin								
7	Spin								
8	Spin						Possible boulder from 7.5 to 9.5 ft.		
								Probable	
9	Spin							Boulder	
10	Spin	S-3	7/3	9.5-10.1	25-50/1"	>50	Poorly graded sand with silt and gravel (SP-SM); 70% sand, 20% gravel, 10% silt.	SP-SM	
							Fractured cobble fragments and bits of wire noted in sample. (FILL)	(FILL)	
11	Spin						Advance HW drill casing to 13 ft.		
							Advance 3-7/8 in. roller bit to 13 ft.		
12	Spin								
13	Spin								
		S-4	24/4	13-15	15-4-4-11	8	Poorly graded sand with silt (SP-SM); loose, 90% fine sand, 10% silt, heavy sheen,	SP-SM	
14	Spin						strong petroleum/tar odor, black. (FILL)	(FILL)	
							Advance HW drill casing to 18 ft.		
15	Spin						Advance 3-7/8 in. roller bit to 18 ft.		
16	Spin								
17	Spin								
18	Spin								
		S-5	24/7	18-20	9-6-5-7	11	Silty sand (SM); medium dense, 15% medium sand, 60% fine sand, 10% gravel,	SM	
19	Spin						15% silt, gray. Traces of shell fragments noted in sample. (FILL)	(FILL)	
							Advance HW drill casing to 23 ft.		
20	Spin						Advance 3-7/8 in. roller bit to 23 ft.		

Granular Soils (Blows/ft)	Cohesive Soils (Blows/ft)	SYMBOLS:	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-22 SHEET 2 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696654.2 easting 814095.5
Driller	R. Pryce	Ground Surface El.	11.28 Datum NGVD
Logged By	S. Bonis	Date Start	9/15/99 Date End 9/20/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
		No water levels recorded		

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Estimated strata change at 20 ft.		
21	Spin								
22	Spin								
23	Spin								
		S-6	24/8	23-25	25-8-5-6	13	Organic soil (OH); moist, stiff, 90% organic clay/silt, 10% fine sand, hydrogen sulfide	OH	
24	Spin						odor, dark gray. Plant material and shell fragments noted in sample.		
							Advance HW drill casing to 28 ft.		
25	Spin						Advance 3-7/8 in. roller bit. to 28 ft.		
26	Spin								
27	Spin								
28	Spin								
		S-7	24/20	28-30	7-5-7-7	12	Organic soil (OH); moist, stiff, 90% organic clay/silt, 5% coarse sand, 5% fine sand,	OH	
29	Spin						hydrogen sulfide odor, dark gray. Shell fragments noted in sample.		
							Advance HW drill casing to 33 ft.		
30	Spin						Advance 3-7/8 in. roller bit. to 33 ft.		
31	Spin								
32	Spin								
33	Spin								
		S-8	24/6	33-35	22-31-21-23	52	Well-graded sand with silt and gravel (SW-SM); very dense, 50% medium sand, 15%	SW-SM	
34	Spin						coarse sand, 10% fine sand, 15% gravel, 10% silt.		
							Advance HW drill casing to 38 ft.		
35	Spin						Advance 3-7/8 in. roller bit. to 38 ft.		
36	Spin								
37	Spin								
38	Spin								
		S-9	24/11	38-40	15-12-9-10	21	Similar to S-8; except medium dense.	SW-SM	
39	Spin						Advance HW drill casing to 43 ft.		
							Advance 3-7/8 in. roller bit. to 43 ft.		
40	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number

REMARKS:
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Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-22
SHEET 3 of 3
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696654.2 easting 814095.5
Driller	R. Pryce	Ground Surface El.	11.28 Datum NGVD
Logged By	S. Bonis	Date Start	9/15/99 Date End 9/20/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
		No water levels recorded		

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	Spin								
42	Spin								
43	Spin								
		S-10	24/20	43-45	14-11-13-11	24	Well-graded sand with silt and gravel (SW-SM); medium dense, 50% medium sand, 15%	SW-SM	
44	Spin						coarse sand, 10% fine sand, 15% gravel, 10% silt.		
							Advance HW drill casing to 48 ft.		
45	Spin						Advance 3-7/8 in. roller bit.		
46	Spin								
47	Spin								
48	Spin								
		S-11	24/16	48-50	35-17-18-17	35	Well-graded gravel with sand (GP); dense, 50% gravel, 30% coarse sand, 10%	GP	
49	Spin						medium sand, 5% fine sand, 5% silt.		
							Advance HW drill casing to 53 ft.		
50	Spin						Advance 3-7/8 in. roller bit.		
51	Spin								
52	Spin								
53	Spin								
		S-12	24/0	53-55	8-7-7-8	14	No recovery. (1st attempt) Stopped for the weekend.	SM	
54	Spin		24/4	53-55	8-5-6-14	11	Monday: 2 ft. of wash noted in bottom of casing. Advance 3-7/8 in. roller bit to		
							remove material. Re-attempt 53 to 55 ft. sample.		
55	Spin						S-12: Silty sand (SM); medium dense, 50% medium sand, 30% fine sand,		
							20% silt. (2nd attempt)		
56	Spin						Advance HW drill casing to 55.5 ft. (probable bedrock)		
							Advance HW drill casing to 56.5 ft.	BEDROCK	
57							Advance 3-7/8 in. roller bit to 57 ft. to confirm bedrock.		
							Bottom of exploration at 57 ft.; boring terminated in probable bedrock.		
58									
59									
60									

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:
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	PROJECT	
Nobis Nobis Engineering, PO Box 2890, Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-23 SHEET 1 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696825.4 easting 814041.8
Driller	R. Pryce	Ground Surface El.	9.82 Datum NGVD
Logged By	R. Chase	Date Start	9/2/99 Date End 9/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
								ASPHALT	
1	Spin								
		S-1	24/7	1-3	8-6-5-9	11	Silty sand (SM); wet, medium dense, 75% fine sand, 5% coarse sand, 5% medium	SM	
2	Spin						sand, 15% silt, brown. (FILL)	(FILL)	
3	Spin								
		S-2	24/12	3-5	15-8-7-8	15	Similar to S-1.	SM	
4	Spin						Advance HW drill casing to 6 ft.	(FILL)	
							Advance 3-7/8 in. roller bit from 6 to 7.5 ft.		
5	Spin						Advance HW drill casing to 8 ft.		
6	Spin								
							Probable boulder from 6 to 7.5 ft.		
7	Spin							Probable Boulder	
8	Spin								
		S-3	24/4	8-10	8-4-6-9	10	Poorly graded sand with gravel (SP); wet, loose, 50% fine sand, 10% medium sand,	SP	
9	Spin						5% coarse sand, 30% fine gravel, 5% silt, gray. (FILL)	(FILL)	
10	Spin								
11	Spin								
12	Spin								
13	Spin						Probable boulder from 12.5 to 13.5 ft.	Probable Boulder	
14	Spin	S-4	24/18	13.5-	6-4-6-7	10	Silty sand (SM); wet, loose, 50% fine sand, 50% silt, asphalt like odor, oily sheen,	SM	
				15.5			black. PID = 36 ppm when sampler was opened. (FILL)	(FILL)	
15	Spin								
16	Spin								
17	Spin								
18	Spin								
		S-5	24/5	18-20	42-19-15-20	34	Poorly graded gravel with sand (GP); wet, dense, 70% fine gravel, 10% coarse sand,	GP	
19	Spin						10% medium sand, 5% fine sand, 5% silt, gray. Traces of wood and brick noted in	(FILL)	
							sample. (FILL)		
20	Spin						Advance HW drill casing to 23 ft.		

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT		
	Remedial Design For Operable Unit 01	BORING NO.	FD-23
	New Bedford Harbor Superfund Site	SHEET	2 of 4
		FILE NO.	48138.07
	New Bedford, Massachusetts	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696825.4 easting 814041.8
Driller	R. Pryce	Ground Surface El.	9.82 Datum NGVD
Logged By	R. Chase	Date Start	9/2/99 Date End 9/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
		No water levels recorded		

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	Spin								
22	Spin								
23	Spin								
		S-6	24/5	23-25	15-7-9-9	16	Organic soil (OL); wet, very stiff, 99% organic silt, 1% brick, gray. Brick fragments	OL	
24	Spin						noted in top 1 in. of sample.		
							Advance HW drill casing to 28 ft.		
25	Spin								
26	Spin								
27	Spin								
28	Spin								
		S-7	24/16	28-30	6-5-8-18	13	Organic soil (OL); wet, stiff, 100% organic clay/silt.	OL	
29	Spin						Advance HW drill casing to 33 ft.		
30	Spin								
31	Spin								
32	Spin								
33	Spin								
		S-8	24/6	33-35	30-15-15-18	30	Poorly graded sand (SP); wet, medium dense, 50% fine sand, 10% medium sand, 5%	SP	
34	Spin						sand, 30% fine gravel, 5% silt, gray.		
							Advance HW drill casing to 38 ft.		
35	Spin								
36	Spin								
37	Spin								
38	Spin								
		S-9	24/12	38-40	8-12-13-17	25	Silty sand (SM); wet, medium dense, 85% fine sand, 15% silt, gray.	SM	
39	Spin						Advance HW drill casing to 43 ft.		
40	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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	PROJECT	
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-23 SHEET 3 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696825.4 easting 814041.8
Driller	R. Pryce	Ground Surface El.	9.82 Datum NGVD
Logged By	R. Chase	Date Start	9/2/99 Date End 9/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)				
Date	Time	Depth	Elev.	Stabilization Time
		No water levels recorded		

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	Spin								
42	Spin								
43	Spin								
		S-10	24/15	43-45	23-14-14-19	28	Silty sand (SM); wet, medium dense, 85% fine sand, 15% silt, gray.	SM	
44	Spin						Advance HW drill casing to 48 ft.		
45	Spin								
46	Spin								
47	Spin								
48	Spin								
		S-11	2/0	48-	50/2"	>50	No recovery.		
49	Spin			48.2			Advance HW drill casing to 53 ft.		
							Advance 3-7/8 in. roller bit to 58 ft.		
50	Spin								
51	Spin								
52	Spin								
53	Spin						Probable nested boulders from 52.5 to 55.8 ft.		
54	Spin							Probable Nested Boulders	
55	Spin								
56	Spin								
		S-12	20/10	56-	18-48-60-50/2"	108	Poorly graded sand (SP); wet, very dense, 75% fine sand, 10% medium sand, <5%	SP	
57	Spin			57.9			coarse sand, 5% fine gravel, <5% silt.		
							Advance HW drill casing to 57.9 ft.		
58	Spin						Top of bedrock at 57.9 ft.		
							Advance 3-7/8 in. roller bit to 60 ft.		
59							(boring log continued on next page)		
								BEDROCK	

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-23 SHEET 4 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696825.4 easting 814041.8
Driller	R. Pryce	Ground Surface El.	9.82 Datum NGVD
Logged By	R. Chase	Date Start	9/2/99 Date End 9/7/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
60							Begin NX rock core at 60 ft.		
		R1		60-61	9.5 mins.		R1: 60 to 65 ft.		
61							Fresh, medium hard, gray, aphanitic GNEISS with low angle, very closely spaced,		
				61-62	7.5 mins.		rough, planar, fresh, open joints.		
62							REC = 100%; RQD = 65%		
				62-63	8.5 mins.		Approximately 80% of rock core breaks are mechanical.		
63									
				63-64	8.5 mins.				
64								BEDROCK	
				64-65	8.5 mins.				
65									
		R2		65-66	7 mins.		R2: 65 to 70 ft.		
66							Similar to R1.		
				66-67	7.5 mins.		REC = 100%; RQD = 91%		
67									
				67-68	7 mins.				
68									
				68-69	6 mins.				
69									
				69-70	8.5 mins.				
70									
							Bottom of exploration at 70 ft.; boring terminated in bedrock.		
71									
72									
73									
74									
75									
76									
77									
78									
79									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-24 SHEET 1 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697050.8 easting 814049.7
Driller	A. Carter	Mudline El.	-2.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/14/99 Date End 9/14/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. roller bit from 0 to 3 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
		S-1	24/3	3-5	6-1-2/12"	0	Poorly graded sand with silt (SP-SM); very loose, 50% medium sand, 30% fine sand, 10%	SP-SM	
4	5						coarse sand, 10% silt, strong petroleum based odor, black. (Probable sediments)		
							Advance HW drill casing to 5 ft.		
5	2						Advance 3-7/8 in. roller bit from 3 to 5 ft.		
		S-2	24/0	5-7	WOH/24"	0	Distinct sheen noted in drilling water return.		
6	4						S-2: No recovery.		
							Advance HW drill casing to 7 ft.		
7	3						Advance 3-7/8 in. roller bit from 5 to 7 ft.		
		S-3	24/12	7-9	WOR/24"	0	Organic soil with sand (OH); very soft, 80% organic clay/silt, 15% fine sand, 5% shells, strong	OH	
8	5						organic odor, dark gray.		
							Advance HW drill casing to 11 ft.		
9	3						Advance 3-7/8 in. roller bit from 7 to 11 ft.		
10	3								
11	4								
		S-4	24/16	11-13	WOH/12"-	0	Organic soil with sand (OH); very soft, 80% organic clay/silt, 15% fine sand, 5% medium sand,	OH	
12	7				WOH/12"		<5% shells, strong organic odor, dark gray.		
							Advance HW drill casing to 15 ft.		
13	5						Advance 3-7/8 in. roller bit from 11 to 15 ft.		
14	4								
15	5								
		S-5	24/6	15-17	WOH/12"	0	Organic soil with sand (OH); very soft, 75% organic clay/silt, 25% fine sand, <5% shell	OH	
16	9						fragments, strong organic odor, dark gray.		
							Advance HW drill casing to 20 ft.		
17	7						Advance 3-7/8 in. roller bit from 15 to 20 ft.		
18	7								
19	8								
20	15								

Granular Soils (Blows/ft)	Cohesive Soils (Blows/ft)	Notes/Key	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-24 SHEET 2 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697050.8 easting 814049.7
Driller	A. Carter	Mudline El.	-2.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/14/99 Date End 9/14/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/18	20-22	4-6-10-11	16	S-6A: Silty sand (SM); medium dense, 50% fine sand, 30% medium sand, 20% silt, moderate	SM	
21	22						organic odor, gray. (6 in.)		
							S-6B: Poorly graded sand with silt and gravel (SP-SM); medium dense, 40% medium sand,	SP-SM	
22	25						15% coarse sand, 15% fine sand, 20% gravel, 10% silt, slight organic odor, gray. (12 in.)		
							Advance HW drill casing to 25 ft.		
23	25						Advance 3-7/8 in. roller bit from 20 to 25 ft.		
24	26								
25	24								
		S-7	24/14	25-27	21-16-7-8	23	Poorly graded sand with silt and gravel (SP-SM); medium dense, 25% medium sand, 20%	SP-SM	
26	30						coarse sand, 20% fine sand, 25% gravel, 10% silt, gray.		
							Advance HW drill casing to 30 ft.		
27	35						Add bentonite to drilling fluid.		
							Advance 3-7/8 in. roller bit from 25 to 30 ft		
28	41								
29	45								
30	47								
		S-8	24/6	30-32	28-9-5-3	14	Silty sand with gravel (SM); medium dense, 30% medium sand, 20% fine sand, 10% coarse	SM	
31	30						sand, 20% gravel, 20% silt, gray.		
							Advance HW drill casing to 35 ft.		
32	24						Advance 3-7/8 in. roller bit from 30 to 35 ft.		
33	25								
34	26								
35	44								
		S-9	24/12	35-37	29-45-23-15	68	Silty sand with gravel (SM); very dense, 20% coarse sand, 10% medium sand, 10% fine sand,	SM	
36	55						40% gravel, 20% silt, gray.		
							Advance HW drill casing to 40 ft.		
37	72						Advance 3-7/8 in. roller bit from 35 to 40 ft.		
38	97								
39	97								
40	156								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-24 SHEET 3 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697050.8 easting 814049.7
Driller	A. Carter	Mudline El.	-2.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/14/99 Date End 9/14/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Open	S-10	5/4	40-	125/5"	—	Silty sand with gravel (SM); 25% fine sand, 15% coarse sand, 10% medium sand, 30% gravel,	SM	
41	Hole			40.4			20% silt, brown. (GLACIAL TILL)	(GLACIAL TILL)	
	Open						Advance 3-7/8 in. button bit from 40 to 42 ft. (open hole)		
42	Hole								
	Open	S-11	8/6	42-	27-17/2" -	—	Silty sand with gravel (SM); 25% fine sand, 10% coarse sand, 10% medium sand, 35% gravel,	SM	
43	Hole			42.7	50/0"		20% silt, brown. (GLACIAL TILL)	(GLACIAL TILL)	
							Advance 3-7/8 in. button bit from 42 to 42.7 ft. (open hole)		
44							Top of bedrock at 42.7 ft.		
							Advance 3-7/8 in. button bit from 42.7 to 44.7 ft. to confirm bedrock.	BEDROCK	
45									
							Bottom of exploration at 44.7 ft.; boring terminated in probable bedrock.		
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-25
SHEET 1 of 3
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697209.8 easting 814043.7
Driller	R. Pryce	Ground Surface El.	7.19 Datum NGVD
Logged By	R. Chase	Date Start	8/26/99 Date End 8/30/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-1	24/16	0-2	26-29-32-25	61	Poorly graded sand (SP); dry, very dense, 75% fine sand, 5% coarse sand, 5% medium	SP	
1	Spin						sand, 5% fine gravel, 5% silt, 5% asphalt, gray. (FILL)	(FILL)	
							Advance HW drill casing to 3 ft.		
2	Spin								
3	Spin								
		S-2	24/10	3-5	22-18-15-15	33	Similar to S-1, except dense, and wet.	SP	
4	Spin						Advance HW drill casing to 8 ft.	(FILL)	
5	Spin								
6	Spin								
7	Spin								
8	Spin								
		S-3	21/8	8-9.8	49-38-20-	58	Poorly graded sand with gravel (SP); wet, very dense, 50% fine sand, 10% medium	SP	
9	Spin				50/3"		sand, 5% coarse sand, 30% fine gravel, 5% silt, gray. (FILL)	(FILL)	
							Advance HW drill casing to 13 ft.		
10	Spin								
11	Spin								
12	Spin								
13	Spin								
		S-4	24/8	13-15	44-17-8-4	25	Silty sand (SM); wet, medium dense, 60% fine sand, 5% coarse sand, 5% medium	SM	
14	Spin						sand, 30% silt, gray.		
							Advance HW drill casing to 18 ft.		
15	Spin								
16	Spin								
17	Spin								
18	Spin								
		S-5	24/12	18-20	5-6-6-6	12	Organic soil (OL); wet, stiff, 100% organic silt, gray.	OL	
19	Spin						Advance HW drill casing to 23 ft.		
20	Spin								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SOIL LOG KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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	PROJECT	
Nobis Nobis Engineering, PO Box 2890, Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-25 SHEET 2 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697209.8 easting 814043.7
Driller	R. Pryce	Ground Surface El.	7.19 Datum NGVD
Logged By	R. Chase	Date Start	8/26/99 Date End 8/30/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)				
Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	Spin								
22	Spin								
23	Spin						Inferred strata change at 23 ft.		
		S-6	24/17	23-25	9-5-9-11	14	Silty sand (SM); wet, medium dense, 80% fine sand, 20% silt, gray.	SM	
24	Spin						Advance HW drill casing to 28 ft.		
25	Spin								
26	Spin								
27	Spin								
28	Spin								
		S-7	24/6	28-30	22-20-15-15	35	Similar to S-6, except dense.	SM	
29	Spin						Advance HW drill casing to 33 ft.		
30	Spin								
31	Spin								
32	Spin								
33	Spin								
		S-8	24/7	33-35	24-12-15-15	27	Poorly graded sand (SP); wet, medium dense, 70% fine sand, 15% medium sand, 5%	SP	
34	Spin						coarse sand, <5% fine gravel, <5% silt, gray.		
							Advance HW drill casing to 38 ft.		
35	Spin								
36	Spin								
37	Spin								
38	Spin								
		S-9	24/7	38-40	14-10-9-7	19	Well-graded sand (SW); wet, medium dense, 65% fine sand, 20% medium sand, 10%	SW	
39	Spin						coarse sand, <5% silt, gray.		
							Advance HW drill casing to 43 ft.		
40	Spin								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-25 SHEET 3 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697209.8 easting 814043.7
Driller	R. Pryce	Ground Surface El.	7.19 Datum NGVD
Logged By	R. Chase	Date Start	8/26/99 Date End 8/30/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)				
Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	Spin								
42	Spin								
43	Spin								
		S-10	24/2	43-45	14-14-20-13	34	Poorly graded gravel (GP); wet, dense, 95% fine gravel, <2% fine sand, <1% medium sand, <1% coarse sand, <1% silt, gray.	GP	
44	Spin						Advance 3-7/8 in. roller bit to 50 ft.		
45	Spin						Advance HW drill casing to 50 ft.		
46	Spin								
47	Spin								
48	Spin						Probable boulder from 47.5 to 49.1 ft.	Probable Boulder	
49	Spin								
50	Spin								
		S-11	3/3	50-50.3	50/3"	>50	Poorly graded sand (SP); wet, 90% fine sand, 5% medium sand, 5% silt, gray.	SP	
51	Spin						Advance HW casing to 53 ft. Probable cobble/boulder from 50.3 to 51.5 ft.	Probable Boulder	
52	Spin								
53	Spin								
		S-12	24/6	53-55	11-6-5-5	11	Poorly graded sand (SP); wet, medium dense, 75% fine sand, <5% medium sand, <5% coarse sand, 10% fine gravel, <5% silt, gray.	SP	
54	Spin						Advance 3-7/8 in. roller bit to 55.5 ft.		
55	Spin						Advance HW casing to 56 ft. Advance 3-7/8 in. roller bit to 60.5 ft.		
56	Spin								
57							Possible bedrock from 55.8 to 57.5 ft.	POSSIBLE BEDROCK	
58							Possible void from 57.5 to 58.5 ft.	Probable Void	
59							Top of apparent bedrock at 58.5 ft.	BEDROCK	
60							Bottom of exploration at 60.5 ft; refusal.		

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-26 SHEET 1 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697349.6 easting 814116.2
Driller	R. Pryce	Ground Surface El.	7.48 Datum NGVD
Logged By	R. Chase	Date Start	8/24/99 Date End 8/25/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
8/25	6:45 PM	3.4 ft.	4.08	Upon completion of drilling

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-1	24/14	0-2	10-22-20-18	42	Poorly graded sand (SP); dry, dense, 85% fine sand, 5% medium sand, 5% fine gravel,	SP	
1	Spin						5% silt, gray. (FILL)	(FILL)	
							Advance HW drill casing to 2.5 ft.		
2	Spin								
3	Spin	S-2	12/9	2.5-3.5	86-54	>54	Similar to S-1, except wet.	SP	
							Advance HW drill casing to 7.5 ft.	(FILL)	
4	Spin								
5	Spin								
6	Spin								
7	Spin								
8	Spin	S-3	24/12	7.5-9.5	15-14-36-15	50	Poorly graded sand (SP); wet, dense, 85% fine sand, 5% medium sand, 5% silt, <5%	SP	
							wood, dark gray. (FILL)	(FILL)	
9	Spin						Advance HW drill casing to 12.5 ft.		
10	Spin								
11	Spin								
12	Spin								
13	Spin	S-4	18/4	12.5-14	18-12-50	62	Poorly graded gravel with sand (GP); wet, very dense, 50% fine gravel, 40% fine sand,	GP	
							5% medium sand, 5% silt, gray.		
14	Spin						Advance HW drill casing to 17.5 ft.		
15	Spin								
16	Spin								
17	Spin								
18	Spin	S-5	24/3	17.5-19.5	14-13-11-10	24	Sandy silt (ML); wet, very stiff, 55% silt, 40% fine sand, <5% medium sand, gray.	ML	
							Advance HW drill casing to 22.5 ft.		
19	Spin								
20	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 50.5 ft.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-26
SHEET 2 of 3
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller R. Pryce
Logged By R. Chase

Boring Location northing 2697349.6 easting 814116.2
Ground Surface El. 7.48 Datum NGVD
Date Start 8/24/99 Date End 8/25/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing, spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
8/25	6:45 PM	3.4 ft.	4.08	Upon completion of drilling

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	Spin								
22	Spin								
23	Spin	S-6	24/10	22.5- 24.5	11-11-12-13	23	Poorly graded sand with silt (SP-SM); wet, medium dense, 85% fine sand, 5% fine gravel, 10% silt, gray. Advance HW drill casing to 27.5 ft.	SP-SM	
24	Spin								
25	Spin								
26	Spin								
27	Spin								
28	Spin	S-7	24/10	27.5- 29.5	9-14-17-21	31	Similar to S-6, except dense. Advance 3-7/8 in. roller bit to 32 ft. Advance HW drill casing to 32.5 ft.	SP-SM	
29	Spin								
30	Spin								
31	Spin								
32	Spin								
33	Spin	S-8	24/0	32.5- 34.5	12-19-27-39	46	No recovery. Advance 3-7/8 in. roller bit to 37 ft. Advance HW drill casing to 37.5 ft.		
34	Spin								
35	Spin								
36	Spin								
37	Spin								
38	Spin	S-9	24/6	37.5- 39.5	18-15-20-14	35	Poorly graded gravel with sand (GP); wet, dense, 75% fine gravel, 10% medium sand, 5% coarse sand, 5% fine sand, 5% silt, gray. Advance HW drill casing to 43 ft.	GP	
39	Spin								
40	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 50.5 ft.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-26 SHEET 3 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697349.6 easting 814116.2
Driller	R. Pryce	Ground Surface El.	7.48 Datum NGVD
Logged By	R. Chase	Date Start	8/24/99 Date End 8/25/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
8/25	6:45 PM	3.4 ft.	4.08	Upon completion of drilling

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	Spin								
42	Spin								
43	Spin								
		S-10	24/6	43-45	17-15-18-16	33	Poorly graded gravel (GP); wet, dense, 85% fine gravel, <5% medium sand, <5% fine sand, <5% silt.	GP	
44	Spin						Advance HW drill casing to 47.2 ft.		
45	Spin								
46	Spin								
47	Spin						Casing refusal at 47.2 ft. Top of bedrock at 47.2 ft.		
48							Advance 3-7/8 in. roller bit to 50.5 ft. to confirm bedrock.	BEDROCK	
49									
50									1
51							Bottom of exploration at 50.5 ft.; boring terminated in probable bedrock.		
52									
53									
54									
55									
56									
57									
58									
59									
60									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Grout the completed borehole from 0 to 50.5 ft.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-27 SHEET 1 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697480.4 easting 814091.9
Driller	R. Pryce	Ground Surface El.	7.47 Datum NGVD
Logged By	R. Chase	Date Start	8/19/99 Date End 8/23/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)				
Date	Time	Depth	Elev.	Stabilization Time
		No water levels recorded		

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-1	24/17	0-2	5-10-12-6	22	Poorly graded sand with gravel (SP); dry, medium dense, 50% fine sand, 10% coarse sand,	SP	
1	Spin						5% medium sand, 30% fine gravel, 5% silt, brown. (FILL)	(FILL)	
							Advance HW drill casing to 3 ft.		
2	Spin								
3	Spin								
		S-2	24/12	3-5	10-13-11-10	24	Poorly graded sand with gravel (SP); wet, medium dense, 20% coarse sand, 20% medium	SP	
4	Spin						sand, 20% fine sand, 35% fine gravel, 5% silt, brown. (FILL)	(FILL)	
							Advance HW drill casing to 8 ft.		
5	Spin								
6	Spin								
7	Spin								
8	Spin								
		S-3	24/6	8-10	7-6-7-45	13	Silty sand (SM); wet, medium dense, 10% medium sand, 50% fine sand, 10% gravel,	SM	
9	Spin						30% silt, brown. (FILL)	(FILL)	
							Advance HW drill casing to 13 ft.		
10	Spin								
11	Spin								
12	Spin								
13	Spin								
		S-4	24/20	13-15	WOH/24"	0	Sandy organic soil (OH); moist to wet, very soft, 65% organic clay/silt, 30% fine sand, 5%	OH	
14	Spin						shell fragments, slight organic odor, dark gray.		
15	Spin								
		S-5	24/24	15-17	WOH/12"-1-1	1	Sandy organic soil (OH); moist, very soft, 60% organic clay/silt, 35% fine sand, 5% shell	OH	
16	Spin						fragments, dark gray.		
							Advance HW drill casing to 17 ft.		
17	Spin								
		S-6	24/20	17-19	1-2-4-6	6	Silty sand (SM); wet, loose, 80% fine sand, 20% silt, gray to brown.	SM	
18	Spin								
19	Spin								
		S-7	24/21	19-21	4-6-8-10	14	Poorly graded sand (SP); wet, medium dense, 20% medium sand, 75% fine sand, 5% silt,	SP	
20	Spin						brown.		

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-27 SHEET 2 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697480.4 easting 814091.9
Driller	R. Pryce	Ground Surface El.	7.47 Datum NGVD
Logged By	R. Chase	Date Start	8/19/99 Date End 8/23/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)				
Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

Depth	Casing Blows (ft)	Type & No.	Pen/Rec (inches)	Depth (feet)	Blows per 6 inches	SPT N-Value	Sample Description (ASTM D2488)	Stratum Description	Remarks
							Advance HW drill casing to 23 ft.		
21	Spin								
22	Spin								
23	Spin								
		S-8	24/12	23-25	3-3-5-5	8	Silty sand (SM); wet, loose, 85% fine sand, 15% silt, brown.	SM	
24	Spin								
25	Spin								
		S-9	24/24	25-27	9-8-10-10	18	Poorly graded sand with silt (SP-SM); wet, medium dense, 10% coarse sand, 10% medium	SP-SM	
26	Spin						sand, 60% fine sand, 10% gravel, 10% silt, brown.		
							Advance HW drill casing to 28 ft.		
27	Spin								
28	Spin								
		S-10	24/10	28-30	1-5-5-6	10	Poorly graded sand (SP); loose, 80% fine sand, 10% medium sand, 5% coarse sand, 5%	SP	
29	Spin						silt, brown.		
							Advance HW drill casing to 33 ft.		
30	Spin								
31	Spin								
32	Spin								
33	Spin								
		S-11	22/7	33-34.8	7-9-9-50/4"	18	Poorly graded sand (SP); wet, medium dense, 35% coarse sand, 35% medium sand, 15%	SP	
34	Spin						fine sand, 10% gravel, 5% silt, brown.		
							Advance HW drill casing to 36 ft.		
35	Spin								
							Begin NX rock core at 36 ft.		
36	Spin						Not bedrock; probable boulder from 35 to 36.5 ft.	Probable Boulder	
							Advance HW drill casing to 38 ft.		
37	Spin								
38	Spin								
		S-12	24/7	38-40	16-6-4-5	10	Well-graded sand with gravel (SW); loose, 35% medium sand, 25% coarse sand, 15% fine	SW	
39	Spin						sand, 20% gravel, 5% silt, gray.		
							Advance HW drill casing to 43 ft.		
40	Spin								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. SHEET FILE NO. CHKD. BY	FD-27 3 of 4 48138.07 J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697480.4 easting 814091.9
Driller	R. Pryce	Ground Surface El.	7.47 Datum NGVD
Logged By	R. Chase	Date Start	8/19/99 Date End 8/23/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)				
Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	Spin								
42	Spin								
43	Spin								
		S-13	24/1	43-45	5-5-5-4	10	Poorly graded gravel (GP); loose, 100% fine gravel, gray.	GP	
44	Spin						Advance HW drill casing to 47 ft.		
							Advance 3-7/8 in. roller bit to 48 ft.		
45	Spin								
46	Spin								
47	Spin								
							Probable boulder from 47 to 48 ft.	Probable	
48	Spin							Boulder	
		S-14	24/10	48-50	10-8-8-9	16	Poorly graded sand (SP); wet, medium dense, 80% fine sand, 5% medium sand, 10% fine	SP	
49	Spin						gravel, 5% silt, gray.		
							Advance 3-7/8 in. roller bit to 53 ft.		
50	Spin						Advance HW drill casing to 53 ft.		
51	Spin								
52	Spin								
53	Spin								
		S-15	24/17	53-55	12-11-10-8	21	Poorly graded sand (SP); wet, medium dense, 85% fine sand, 5% medium sand, 5% fine	SP	
54	Spin						gravel, 5% silt, gray.		
							Advance HW drill casing to 58 ft.		
55	Spin								
56	Spin								
57	Spin								
58	Spin								
		S-16	14/4	58-59.2	23-30-50/2"	>50	Poorly graded sand with gravel (SP); wet, very dense, 75% fine sand, 5% medium sand, 15%	SP	
59							fine gravel, 5% silt, gray.		
							Top of bedrock at 59.2 ft.		
							(boring log continued on next page)	BEDROCK	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-27 SHEET 4 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697480.4 easting 814091.9
Driller	R. Pryce	Ground Surface El.	7.47 Datum NGVD
Logged By	R. Chase	Date Start	8/19/99 Date End 8/23/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: CME 75 truck mount
Drilling Method: 4-inch (HW) flush-joint casing; spin and wash.

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time
No water levels recorded				

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
60							Begin NX rock core at 60 ft.		
		R1	60-61		5 mins.		R1: 60 to 65 ft.		
61							Fresh, medium hard, gray, aphanitic GNEISS with low angle, very closely spaced, rough,		
			61-62		5.5 mins.		planar, fresh, open, joints.		
62							REC = 100%; RQD = 70%		
			62-63		6 mins.		90% of rock core breaks are mechanical.		
63									
			63-64		6 mins.				
64									
			64-65		6.75 mins.			BEDROCK	
65									
		R2	65-66		7.75 mins.		R2: 65 to 70 ft.		
66							Similar to R1.		
			66-67		6.5 mins.		REC = 100%; RQD = 90%		
67									
			67-68		6.5 mins.				
68									
			68-69		6.75 mins.				
69									
			69-70		7.5 mins.				
70									
							Bottom of exploration at 70 ft.; boring terminated in bedrock.		
71									
72									
73									
74									
75									
76									
77									
78									
79									
80									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS
1)
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Nobis Engineering *PO Box 2890* *Concord, New Hampshire 03302*	**PROJECT** Remedial Design For Operable Unit 01. New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-28 SHEET 1 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697357.3 easting 814553.5
Driller	A. Carter	Mudline El.	-13.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/5/99 Date End 8/6/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush joint outer casing and 4-inch I.D. (HW) flush-joint inner casing.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Boring				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance PW outer drill casing to 3 ft. (hydraulic push)		
1	Push						Advance 4-7/8 in. roller bit from 0 to 3 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.	UO-1	24/24	3-5	———	—	Sandy organic soil (OH); 40% organic clay, 20% organic silt, 30% fine sand, 10% shells and	OH	
4	Push						shell fragments, dark gray.		
	Hyd.						Advance PW outer drill casing to 6 ft. (hydraulic push)		
5	Push						Advance 4-7/8 in. roller bit from 3 to 6 ft.		
	Hyd.								
6	Push								
	Hyd.	UO-2	24/24	6-8	———	—	Similar to UO-1.	OH	
7	Push						Advance PW outer drill casing to 9 ft. (hydraulic push)		
	Hyd.						Advance 4-7/8 in. roller bit from 6 to 9 ft.		
8	Push								
	Hyd.								
9	Push								
	Hyd.	UO-3	24/17	9-11	———	—	Top: Sandy organic soil (OH); 35% organic silt, 15% organic clay, 40% fine sand, 10% shells	OH	
10	Push						and shell fragments, dark gray. (disturbed)		
	Hyd.						Bottom: Organic soil with sand (OH); 50% organic clay, 30% organic silt, 15% fine sand, 5%		
11	Push						shells and shell fragments, dark gray.		
	Hyd.						Advance PW outer drill casing to 12 ft. (hydraulic push)		
12	Push						Advance 4-7/8 in. roller bit from 9 to 12 ft.		
	Hyd.	UO-4	24/6	12-14	———	—	Organic soil with sand (OH); 45% organic clay, 35% organic silt, 20% fine sand, strong organic		1
13	Push						odor, dark gray. (jarred sample)		
	Hyd.						Advance PW outer drill casing to 15 ft. (hydraulic push)		
14	Push						Very difficult push to 15 ft.		
	Hyd.						Advance 4-7/8 in. roller bit from 12 to 15 ft.		
15	Push								
		S-1	24/24	15-17	13-6-9-11	15	S-1A: Poorly graded sand with silt (SP-SM); medium dense, 40% fine sand, 25% medium	SP-SM	
16	37						sand, 15% coarse sand, 10% gravel, 10% silt, moderate organic odor, gray. (6 in.)	SP	
							S-1B: Poorly graded sand (SP); medium dense, 70% fine sand, 25% medium sand, 5% silt,		
17	35						slight organic odor, gray. (18 in.)		
							Telescope HW inner drill casing to 20 ft.		
18	20						Advance 3-7/8 in. button bit from 15 to 20 ft.		
19	11								
20	18								

GRANULAR SOILS (Blows/ft)	COHESIVE SOILS (Blows/ft)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Due to low recovery, sample was removed from Shelby Tube and placed into a sample jar.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-28
SHEET 2 of 3
FILE NO. 48138.07
CHKD BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2697357.3 easting 814553.5
Mudline El. -13.9 Datum NGVD
Date Start 8/5/99 Date End 8/6/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush joint outer casing and 4-inch I.D. (HW) flush-joint inner casing.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Boring

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-2	24/12	20-22	13-5-4-7	9	Silty sand (SM); loose, 65% fine sand, 10% medium sand, 25% silt, mild organic odor, gray.	SM	
21	22						Advance HW inner drill casing to 25 ft.		
							Advance 3-7/8 in. button bit from 20 to 25 ft.		
22	27								
23	18								
24	23								
25	32								
		S-3	24/20	25-27	9-3-1-1	4	Sandy silt (ML); soft, 40% silt, 30% clay, 30% fine sand, brown to gray.	ML	
26	20						Advance HW inner drill casing to 30 ft.		
							Add bentonite to drilling fluid.		
27	15						Advance 3-7/8 in. button bit from 25 to 30 ft.		
28	13								
29	31								
30	32								
		S-4	24/12	30-32	20-10-11-9	21	Poorly graded sand (SP); medium dense, 45% medium sand, 30% fine sand, 10% coarse	SP	
31	33						sand, 10% gravel, 5% silt, brown.		
							Advance HW inner drill casing to 35 ft.		
32	55						Advance 3-7/8 in. button bit from 30 to 35 ft.		
33	60								
34	58								
35	61								
		S-5	24/8	35-37	20-11-10-5	21	Well-graded sand with gravel (SW); medium dense, 35% medium sand, 25% fine sand, 20%	SW	
36	32						coarse sand, 15% gravel, 5% silt, brown.		
							Advance HW inner drill casing to 40 ft.		
37	39						Advance 3-7/8 in. button bit from 35 to 40 ft.		
38	40								
39	43								
40	59								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number

REMARKS
1) Due to low recovery, sample was removed from Shelby Tube and placed into a sample jar.
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-28 SHEET 3 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697357.3 easting 814553.5
Driller	A. Carter	Mudline El.	-13.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/5/99 Date End 8/6/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush joint outer casing and 4-inch I.D. (HW) flush-joint inner casing.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Boring

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/10	40-42	18-8-7-6	15	Well-graded sand with gravel (SW); medium dense, 35% medium sand, 25% fine sand, 20%	SW	
41	52						coarse sand, 15% gravel, 5% silt, brown.		
							Advance HW inner drill casing to 45 ft.		
42	56						Advance 3-7/8 in. button bit from 40 to 45 ft.		
43	60								
44	52								
45	44								
		S-7	24/6	45-47	11-6-10-14	16	Poorly graded sand with gravel (SP); medium dense, 40% coarse sand, 20% medium	SP	
46	30						sand, 20% fine sand, 15% gravel, 5% silt, brown.		
							Advance HW inner drill casing to 48.9 ft.		
47	62						Advance 3-7/8 in button bit from 45 to 48.9 ft.		
48	84								
	150/								
49	11"	S-8	1/0	48.9-	50/1"	—	Trace amount of drill cuttings recovered.		
				49.0			Top of bedrock at 48.9 feet.		
50			Core Interval		Core Time		Advance 3-7/8 in. button bit from 48.9 to 50.9 ft.		
							Begin NX rock core at 50.9 ft.	BEDROCK	
51		R1	50.9-51.9		5 mins.		R1: 50.9 to 55.9 ft.		
							Fresh, moderately hard, light gray, aphanitic GNEISS with horizontal to moderately		
52			51.9-52.9		2.5 mins.		dipping, very close to closely spaced, rough, planar, slightly discolored, open joints.		
							REC = 78%; RQD = 53% (fair)		
53			52.9-53.9		5 mins.		Core barrel dropped from 51.9 to 52.2 ft. Probable void or cavity.		
							Loss of drilling fluid noted at 52.9 ft.		
54			53.9-54.9		6 mins.				
55			54.9-55.9		6 mins.				
56									
							Bottom of exploration at 55.9 ft.; boring terminated in bedrock.		
57									
58									
59									
60									

SPT VALUES (SOIL DENSITY)	COHESIVE SOILS (CONSISTENCY)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10 FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11 RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12 R denotes core run number.

REMARKS:

1) Due to low recovery, sample was removed from Shelby Tube and placed into a sample jar.
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3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-29 SHEET 1 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697062.2 easting 814575.0
Driller	A. Carter	Mudline El.	-14.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/31/99 Date End 9/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Perform continuous field vane shear testing from 1 to 6.8 ft. (no samples taken)		
1	Push						Advance HW drill casing to 7 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 0 to 7 ft.		
2	Push								
	Hyd.								
3	Push								
	Hyd.								
4	Push								
	Hyd.								
5	Push								
	Hyd.								
6	Push								
	Hyd.								
7	Push								
	Hyd.	S-1	24/18	7-9	WOR/24"	0	Organic soil with sand (OH); very soft, 50% organic clay, 30% organic silt, 20%	OH	
8	Push						fine sand, strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 10 ft. (hydraulic push)		
9	Push						Advance 3-7/8 in. button bit from 7 to 10 ft.		
	Hyd.								
10	Push								
	Hyd.	S-2	24/6	10-12	WOR/18"-2	0	Silty sand (SM); very loose, 40% fine sand, 35% medium sand, 20% silt, 5% shell		
11	Push						fragments, strong organic odor, gray.		
	Hyd.						Advance HW drill casing to 13 ft. (hydraulic push)		
12	Push						Advance 3-7/8 in. button bit from 10 to 13 ft.	SM	
	Hyd.								
13	Push								
		S-3	24/18	13-15	2-3-4-6	7	Poorly graded sand (SP); loose, 60% medium sand, 30% fine sand, 5% coarse		
14	10						sand, 5% silt, gray.		
							Advance HW drill casing to 15 ft.		
15	14						Add bentonite to drilling fluid.		
		S-4	24/13	15-17	4-7-7-7	14	Advance 3-7/8 in. button bit from 13 to 15 ft.	SP	
16	10						S-4A: Poorly graded sand (SP); medium dense, 60% medium sand, 20% fine		
							sand, 10% coarse sand, 5% gravel, 5% silt, gray. (10 in.)	SM	
17	17						S-4B: Silty sand (SM); medium dense, 40% fine sand, 30% medium sand, 25%		
							silt, 5% clay, gray. (3 in.)		
18	20						Advance HW drill casing to 20 ft.		
							Advance 3-7/8 in. button bit from 15 to 20 ft.		
19	27								
20	31								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-29 SHEET 2 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697062.2 easting 814575.0
Driller	A. Carter	Mudline El.	-14.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/31/99 Date End 9/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/12	20-22	5-3-4-7	7	S-5A: Poorly graded sand (SP); loose, 60% medium sand, 35% fine sand, 5% silt,	SP	
21	19						gray. (10 in.)		
							S-5B: Silty sand (SM); loose, 50% fine sand, 25% medium sand, 25% silt, gray. (2 in.)	SM	
22	15						Advance HW drill casing to 25 ft.		
							Advance 3-7/8 in. button bit from 20 to 25 ft.		
23	18								
24	17								
25	31								
		S-6	24/16	25-27	3-5-4-6	9	Poorly graded sand (SP); loose, 50% medium sand, 30% fine sand, 10% coarse	SP	
26	15						sand, 5% gravel, 5% silt, gray to brown.		
							Advance HW drill casing to 30 ft.		
27	17						Advance 3-7/8 in. button bit from 25 to 30 ft.		
28	24								
29	29								
30	33								
		S-7	24/4	30-32	3-5-2/12"	6	Poorly graded sand (SP); loose, 35% medium sand, 35% fine sand, 15% coarse	SP	
31	33						sand, 10% gravel, 5% silt, brown.		
							Advance HW drill casing to 32 ft.		
32	44						Advance 3-7/8 in. button bit from 30 to 32 ft.		
		S-8	24/14	32-34	WOR/12"-	6	S-8A: Silty sand (SM); loose, 60% fine sand, 10% medium sand, 30% silt, brown to	SM	
33	21				6-6		gray. (2 in.)		
							S-8B: Poorly graded sand (SP); loose, 70% medium sand, 25% fine sand, 5% silt,	SP	
34	26						gray. (12 in.)		
							Advance HW drill casing to 35 ft.		
35	28						Advance 3-7/8 in. button bit from 32 to 35 ft.		
		S-9	24/4	35-37	8-8-8-11	16	Poorly graded sand with gravel (SP); medium dense, 35% medium sand, 20% fine	SP	
36	44						sand, 15% coarse sand, 25% gravel, 5% silt, brown.		
							Advance HW drill casing to 40 ft.		
37	53						Advance 3-7/8 in. button bit from 35 to 40 ft.		
38	54								
39	51								
40	57								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-29 SHEET 3 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697062.2 easting 814575.0
Driller	A. Carter	Mudline El.	-14.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/31/99 Date End 9/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

Depth	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-10	24/8	40-42	4-2-2-11	4	Poorly graded sand with gravel (SP); very loose, 30% medium sand, 20% coarse	SP	
41	49						sand, 15% fine sand, 30% gravel, 5% silt, brown.		
							Advance HW drill casing to 45 ft.		
42	44						Advance 3-7/8 in. button bit from 40 to 45 ft.		
43	76								
44	58								
45	65								
		S-11	24/4	45-47	7-5-7-7	12	Silty sand with gravel (SM); dense, 20% medium sand, 20% fine sand, 15% coarse	SM	
46	89						sand, 30% gravel, 15% silt, brown.		
							Advance HW drill casing to 50 ft.		
47	72						Advance 3-7/8 in. button bit from 45 to 50 ft.		
							Loss of drilling fluid return at 50 ft.		
48	67						Add more bentonite to drilling fluid.		
49	98								
50	99								
		S-12	18/6	50-51.5	9-20-21-50/0"	41	Silty sand with gravel (SM); dense, 20% medium sand, 20% fine sand, 10% coarse	SM	
51	120		Core Interval		Core Time		sand, 30% gravel, 20% silt, brown.		
	137/						Advance HW drill casing to 51.5 ft.		
52	6"	R1	51.5-52.5		5 mins.		Advance 3-7/8 in. button bit from 50 to 51.5 ft.		
							Top of bedrock at 51.5 ft.		
53			52.5-53.5		6 mins.		Telescope and advance NW inner drill casing to 52 ft. for coring. (spin)	BEDROCK	
							Begin NX rock core at 51.5 ft.		
54			53.5-54.5		6 mins.		Mixture of bentonite and polymer drilling muds used for coring.		
							R1: 51.5 to 61.5 ft.		
55			54.5-55.5		4.5 mins.		Fresh, moderately hard, gray, fine grained GNEISS. Near horizontal foliation;		
							10 degrees. Primary joint set: horizontal, sand filled, moderate to widely spaced,		
56			55.5-56.5		5 mins.		rough, planar, fresh, and tight.		
							REC = 85%; RQD = 75% (good)		
57			56.5-57.5		5 mins.		Fractured zone noted from 53.7 to 54.5 ft.		
58			57.5-58.5		5 mins.				
59			58.5-59.5		5 mins.				
60			59.5-60.5		4 mins.				

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1)
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Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-29
SHEET 4 of 4
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697062.2 easting 814575.0
Driller	A. Carter	Mudline El.	-14.2 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/31/99 Date End 9/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
61		R1	60.5-61.5		4.5 mins.			BEDROCK	
		cont.							
62							Bottom of exploration at 61.5 ft.; boring terminated in bedrock.		
63							Note: Pumped approximately 74 gallons of grout to grout completed borehole to top of HW drill casing.		
64									
65									
66									
67									
68									
69									
70									
71									
72									
73									
74									
75									
76									
77									
78									
79									
80									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. ROD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03301	PROJECT		
	Remedial Design For Operable Unit 01	BORING NO.	FD - 30
	New Bedford Harbor Superfund Site	SHEET	1 of 3
	New Bedford, Massachusetts	FILE NO.	48138.07
		CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696533.2	easting 814545.8	
Driller	A. Carter	Mudline El.	-19.4	Datum	NGVD
Logged By	E. Thibodeau	Date Start	8/26/99	Date End	8/30/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing and 3-inch I.D. (NW) flush-joint drill casing.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
	Hyd.	UO-1	24/21	1-3	————	—	Sandy organic clay (OH); 56% organic clay/silt, 38% fine sand, 6% medium sand,	OH	1
2	Push						strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 4 ft. (hydraulic push)		
3	Push						Advance 3-7/8 in. button bit from 1 to 4 ft.		
	Hyd.								
4	Push								2
	Hyd.	UO-2	24/24	4-6	————	—	Clayey sand (SC); 40% fine sand, 17% medium sand, 2% coarse sand, 1% gravel, 40%	SC	1
5	Push						organic clay, moderate organic odor, gray to dark gray.		
	Hyd.						Advance HW drill casing to 7 ft. (hydraulic push)		
6	Push						Advance 3-7/8 in. button bit from 4 to 7 ft.		
	Hyd.								
7	Push								
	Hyd.	UO-3	24/24	7-9	————	—	Top: Silty sand (SM); 40% fine sand, 25% medium sand, 35% organic clay,	SM	
8	Push						moderate organic odor, gray.		
	Hyd.						Bottom: Sandy organic soil (OH); 40 % organic clay, 20% organic silt, 40% fine sand,		
9	Push						strong organic odor, dark gray.	OH	
	Hyd.						Advance HW drill casing to 10 ft. (hydraulic push)		
10	Push						Very difficult push at 9.5 ft.		
		UO-4	24/0	10-12	————	—	Advance 3-7/8 in. button bit from 7 to 10 ft.		
11	10						UO-4: No recovery; probable sands.		
							Advance HW drill casing to 12 ft.		
12	17						Advance 3-7/8 in. button bit from 10 to 12 ft.		
		S-1	24/15	12-14	7-5-8-10	13	Poorly graded sand with silt (SP-SM); medium dense, 60% medium sand, 30% fine	SP-SM	
13	15						sand, 10% silt, brown. Approximate 1 in. and 1/2 in. silt/clay lenses noted in sample.		
							Advance HW drill casing to 15 ft.		
14	18						Add bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 12 to 15 ft.		
15	15								
		S-2	24/16	15-17	3-5-6-7	11	S-2A: Clayey sand (SC); medium dense, 50% fine sand, 25% medium sand, 25% clay,	SC	
16	0						brown. (6 in.)		
							S-2B: Poorly graded sand with silt (SP-SM); medium dense, 60% fine sand, 30%	SP-SM	
17	0						medium sand, 10% silt, brown. (10 in.)		
							HW drill casing advanced from 15 to 17 ft. under self-weight.		
18	17						Advance HW drill casing to 20 ft.		
							Advance 3-7/8 in. button bit from 15 to 20 ft.		
19	19								
20	15								

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Strata break changed from 9.5 ft (shown on the field log) to 4 ft. based on the laboratory test data.
3)
4)

	PROJECT	
Nobis Nobis Engineering, PO Box 2890, Concord, New Hampshire 03302	Remedial Design For Operable Unit 01	BORING NO. FD-30
	New Bedford Harbor Superfund Site	SHEET 2 of 3
	New Bedford, Massachusetts	FILE NO. 48138.07
		CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696533.2 easting 814545.8
Driller	A. Cater	Mudline El.	-19.4 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/26/99 Date End 8/30/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing and 3-inch I.D. (NW) flush-joint drill casing.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-3	24/10	20-22	4-5-6-6	11	Poorly graded sand with gravel (SP); medium dense, 45% medium sand, 20% fine	SP	
21	22						sand, 10% coarse sand, 20% gravel, 5% silt, brown.		
							Advance HW drill casing to 25 ft.		
22	25						Advance 3-7/8 in. button bit from 20 to 25 ft.		
23	31								
24	28								
							[illegible] gravel [illegible]		
25	38							[illegible]	
		S-4	24/8	25-27	9-11-8-12	19	~~Silty gravel (GM)~~; medium dense, 47% gravel, 16% medium sand, 15% fine sand, 10%	~~GM~~	1
26	45						coarse sand, 13% silt, brown. (GLACIAL TILL)	(GLACIAL TILL)	
							Advance HW drill casing to 27.4 ft.		
27	61						Advance 3-7/8 in. button bit from 25 to 27.4 ft.		
	65/								
28	5"	S-5	0/0	27.4-	50/0"	—	No recovery.	Probable	
				27.4			Telescope and advance NW drill casing to 27.9 ft. for coring. (spin)	Boulder	
29	Spin						Begin NX rock core at 27.4 ft.		
							Core barrel popped out of probable cobble/boulder at 28.4 ft.		
30	Spin						Advance NW inner drill casing to 30 ft.		
		S-6	24/3	30-32	11-7-6-6	13	Poorly graded sand with silt and gravel (SP-SM); medium dense, 20% medium sand,	SP-SM	
31	Spin						15% coarse sand, 15% fine sand, 40% gravel, 10% silt, brown. (Glacial Till)	(GLACIAL TILL)	
							Advance NW inner drill casing to 35 ft.		
32	Spin								
33	Spin								
34	Spin								
35	Spin								
		S-7	24/4	35-37	20-19-21-13	40	Silty sand with gravel (SM); dense, 40% fine sand, 10% coarse sand, 10% medium	SM	
36	Spin						sand, 20% gravel, 20% silt, brown. (Glacial Till) Traces of weathered bedrock noted	(GLACIAL TILL)	
							in sample.		
37	Spin						Advance NW inner drill casing to 38.7 ft.		
							Top of bedrock at 38.7 ft. (assumed)		
38	Spin		[illegible]		[illegible]		Advance NW inner drill casing to 39.2 ft. for coring. (spin)		
							Begin NX rock core at 38.7 ft.		
39		R1	38.7-39.7		3 mins.		R1: 38.7 to 44.7 ft.	Possible	
							38.7 to 39.3 ft: Fresh, medium hard, gray, aphanitic GNEISS with one low angle, rough,	Cobble/Boulder	
40			39.7-40.7		4 mins.		undulating, discolored, wide joint. Possible cobble/boulder.	BEDROCK	

[illegible]

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Strata break changed from 9.5 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-30 SHEET 3 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696533.2 easting 814545.8
Driller	A. Carter	Mudline El.	-19.4 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/26/99 Date End 8/30/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing and 3-inch I.D. (NW) flush-joint drill casing.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches) / DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
						39.3 to 40.1 ft; mixture of apparent fractured bedrock and gravel.		
41		R1	40.7-41.7	3.5 mins.		40.1 to 44.7 ft: Fresh, moderately hard, gray, aphanitic GNEISS. No joint pattern noted.		
		cont.				REC = 75%; RQD = 49% (poor)		
42			41.7-42.7	6 mins.		Core barrel advanced rapidly from 39.3 to 40.1 ft.		
						43.1 to 43.7 ft: core barrel dropped.		
43			42.7-43.7	3.5 mins.		43.8 to 44.7 ft: core barrel dropped.		
						Sound hole at completion of core run; core hole caved from 39.7 to 44.7 ft.		
44			43.7-44.7	1 min.		Drive 2-in. split-barrel from 39.7 to 41.7 ft. S-8: Poorly graded sand with silt (SP-SM);		
						55% medium sand, 30% fine sand, 5% coarse sand, 10% silt, reddish brown.		
45		R2	44.7-45.7	1 min.		R2: 44.7 to 46.4 ft.		
						Slightly discolored, very fractured bedrock. REC = 85%; RQD = 0% (very poor)	BEDROCK	
46			45.7-46.4	6 mins.		Core barrel advanced rapidly from 44.7 to 46.4 ft.		
						No water return observed during coring operations.		
47		R3	46.4-47.4	6.5 mins.		Core barrel jammed at 46.4 ft; core run terminated.		
						R3: 46.4 to 51.0 ft.		
48			47.4-48.4	3.5 mins.		Fresh, medium hard, gray, aphanitic GNEISS with horizontal to low angle, very close		
						to closely spaced, rough, planar, slightly discolored, wide joints.		
49			48.4-49.4	2 mins.		REC = 100%; RQD = 64% (fair)		
						49.4 to 49.6 ft: sand filled joint or void noted.		
50			49.4-50.4	4 mins.				
						No water return observed during coring operations.		
51			50.4-51.0	10 mins.		Core barrel full at 51.0 ft.; core run terminated.		
						Bottom of exploration at 51.0 ft.; boring terminated in bedrock.		
52								
53								
54								
55								
56								
57								
58								
59								
60								

		SAMPLER KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Strata break changed from 9.5 ft. (shown on the field log) to 4 ft. based on the laboratory test data.
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 31 SHEET 3 of 4 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2697298.2 easting 814345.8
Mudline El. -7.5 Datum NGVD
Date Start 8/3/99 Date End 8/4/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush-joint casing and 4-inch I.D. (HW) flush-joint casing.
All casing driven with a 300 lb. center hole hammer free falling from a height of 30-inches

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/10	40-42	17-8-8-5	16	Poorly graded sand with gravel (SP); medium dense, 30% medium sand, 25% fine	SP	
41	44						sand, 15% coarse sand, 25% gravel, 5% silt, brown.		
							Advance HW inner drill casing to 45 ft.		
42	50						Advance 3-7/8 in. button bit from 40 to 45 ft.		
43	31								
44	35								
45	38								
		S-7	24/0	45-47	15-13-7-5	20	No recovery. Piece of gravel lodged in tip of sampler.		
46	48						Advance HW inner drill casing to 47 ft.		
							Advance 3-7/8 in. button bit from 45 to 47 ft.		
47	85								
		S-8	24/1	47-49	16-15-16-19	31	Poorly graded gravel with silt and sand (GP-GM): dense, 65% gravel, 10% coarse	GP-GM	2
48	52						sand, 10% medium sand, 5% fine sand, 10% silt, brown.		
							Advance HW inner drill casing to 50 ft.		
49	56						Advance 3-7/8 in. button bit from 47 to 50 ft.		3
50	92								
		S-9	24/8	50-52	16-13-24-19	37	S-9A: Poorly graded sand with gravel (SP); dense, 25% coarse sand, 25% medium	SP	2
51	68						sand, 15% fine sand, 30% gravel, 5% silt, brown. (6 in.)		
							S-9B: bedrock fragments. (2 in.)		
52	157						Advance HW inner drill casing to 52 ft.		
	100/						Top of bedrock at 52.0 ft.		
53	2"						Advance 3-7/8 in. button bit from 50 to 53.5 ft. Advance HW inner drill casing to 52.2 ft.		
							Begin NX rock core at 53.5 ft.	BEDROCK	
54		R1	53.5-54.5		7 mins.		R1: 53.5 to 63.5 ft.		
							Fresh, hard, light gray, aphanitic GNEISS with horizontal to low angle, close to		
55			54.5-55.5		3.5 mins.		moderately spaced, smooth, planar, slightly discolored, tight to open joints.		
							REC = 90%, RQD = 66% (fair)		
56			55.5-56.5		3.5 mins.				
57			56.5-57.5		3.6 mins.				
58			57.5-58.5		7.5 mins.				
59			58.5-59.5		8 mins.				
60			59.5-60.5		5 mins.				

0 to 4 - Very Loose 5 to 10 - Loose 11 to 30 - Medium Dense 31 to 50 - Dense Over 50 - Very Dense	0 to 2 - Very Soft 3 to 4 - Soft 5 to 8 - Medium Stiff 9 to 15 - Stiff 16 to 30 - Very Stiff Over 30 - Hard	1 S denotes split-barrel sampler. 2 U denotes 3-inch O.D. undisturbed sample. 3 UO denotes 3-inch Osterberg undisturbed sample. 4 PEN denotes penetration length of sampler. 5 REC denotes recovered length of sample. 6 SPT denotes Standard Penetration Test.	7 PID denotes Photoionization Detector 8 PPM denotes parts per million. 9 PP denotes Pocket Penetrometer. 10 FVST denotes field vane shear test 11 RQD denotes Rock Quality Designation. 12 R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb center hole hammer free falling from a height of 30 inches.
3) Loss of drilling fluid noted during advancement of button bit.
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD - 31
New Bedford Harbor Superfund Site	SHEET 4 of 4
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697298.2 easting 814345.8
Driller	A. Carter	Mudline El.	-7.5 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/3/99 Date End 8/4/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush-joint casing and 4-inch I.D. (HW) flush-joint casing.
All casing driven with a 300 lb. center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
61		R1	60.5-61.5		4.5 mins.			BEDROCK	
		cont.							
62			61.5-62.5		7 mins.				
63			62.5-63.5		7.5 mins.				
64							Bottom of exploration at 63.5 ft.; boring terminated in bedrock.		
65									
66									
67									
68									
69									
70									
71									
72									
73									
74									
75									
76									
77									
78									
79									
80									

GRANULAR SOILS (Blows/ft)	COHESIVE SOILS (Blows/ft)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb center hole hammer free falling from a height of 30 inches.
3) Loss of drilling fluid noted during advancement of button bit.
4)

	PROJECT	
Nobis Nobis Engineering, PO Box 2890, Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-32 SHEET 1 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696749.0 easting 814392.8
Driller	A. Carter	Mudline El.	-10.8 Datum NGVD
Logged By	E. Thibodeau	Date Start	7/30/99 Date End 8/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush-joint casing and 4-inch I.D. (HW) flush-joint casing.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance PW outer drill casing to 6 ft. (hydraulic push)		
1	Push						Advance 4-7/8 in. roller bit from 0 to 6 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.								
4	Push								
	Hyd.								
5	Push								
	Hyd.								
6	Push								
	Hyd.	UO-1	24/24	6-8	———	—	Sandy organic clay (OH); 69% organic clay, 25% fine sand, 5% medium sand, 1%	OH	1
7	Push						coarse sand, slight organic odor, dark gray. Shells and shell fragments noted in		
	Hyd.						sample.		
8	Push						Advance PW outer drill casing to 10 ft. (hydraulic push)		
	Hyd.						Advance 4-7/8 in. roller bit from 6 to 10 ft.		
9	Push								
	Hyd.								
10	Push								
	Hyd.	UO-2	24/24	10-12	———	—	Top: Poorly graded sand with silt (SP-SM); 85% fine sand, 5% medium sand, 10%	SP-SM	2
11	Push						silt, gray.		
	Hyd.						Bottom: Similar to UO-1.		
12	Push						Advance PW outer drill casing to 16 ft. (hydraulic push)	OH	
	Hyd.						Advance 4-7/8 in. roller bit from 10 to 16 ft.		
13	Push								
	Hyd.								
14	Push								
	Hyd.								
15	Push								
	Hyd.								
16	Push								
		S-1	24-20	16-18	2-5-5-10	10	Poorly graded sand with silt (SP-SM); loose, 65% medium sand, 20% fine sand, 5%	SP-SM	
17	3						coarse sand, 10% silt, gray. Approximate 2 in. organic layer noted in sample. Shell		
							fragments noted in top portion of sample.		
18	8						Telescope and advance HW inner drill casing to 20 ft.		
							Advance 3-7/8 in. button bit from 18 to 20 ft.		
19	18						Organic material noted in wash cuttings.		
20	23								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Tide dropped substanially during sampling activities; therefore, actual sample interval may be slightly deeper than indicated here.
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-32
New Bedford Harbor Superfund Site	SHEET	2 of 3
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696749.0 easting 814392.8		
Driller	A. Carter	Mudline El.	-10.8	Datum	NGVD
Logged By	E. Thibodeau	Date Start	7/30/99	Date End	8/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush-joint casing and 4-inch I.D. (HW) flush-joint casing. All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-2	24/12	20-22	12-10-9-11	19	S-2A: Poorly graded sand with silt (SP-SM); medium dense, 40% medium sand, 30%	SP-SM	
21	24						fine sand, 10% coarse sand, 10% gravel, 10% silt, gray (6 in.)		
							S-2B: Silt with sand (ML); 50% silt, 30% clay, 20% fine sand, brown. (6 in.)	ML	
22	20						Advance HW inner drill casing to 25 ft.		
							Advance 3-7/8 in. button bit from 20 to 25 ft.		
23	19								
24	17								
25	22								
		S-3	24/18	25-27	11-10-11-11	21	Silt with sand (ML); very stiff, 70% silt, 10% clay, 20% fine sand, brown. Approximately	ML	
26	34						1 in. coarse to medium sand lense noted in bottom portion of sample.		
							Advance HW inner drill casing to 30 ft.		
27	56						Advance 3-7/8 in. button bit from 25 to 30 ft.		
28	51								
29	48								
30	47								
		S-4	24/6	30-32	6-16-8-6	24	Poorly graded sand with silt (SP-SM); medium dense, 45% medium sand, 25% fine	SP-SM	
31	38						sand, 15% coarse sand, 5% gravel, 10% silt, brown.		
							Advance HW inner drill casing to 35 ft.		
32	40						Advance 3-7/8 in. button bit from 30 to 35 ft.		
33	55								
34	42								
35	59								
		S-5	24/10	35-37	4-4-24-14	28	S-5A: Poorly graded sand (SP); medium dense, 50% fine sand, 45% medium sand,	SP	
36	25						5% silt, brown. (8 in.)		
							S-5B: Poorly graded sand (SP); medium dense, 40% coarse sand, 25% medium sand,		
37	48						20% fine sand, 10% gravel, 5% silt, brown. (2 in.)		
							Advance HW inner drill casing to 40 ft.		
38	73						Add bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 35 to 40 ft.		
39	66								
40	71								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Tide dropped substanially during sampling activities; therefore, actual sample interval may be slightly deeper than indicated here.
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT		
	Remedial Design For Operable Unit 01	BORING NO.	FD-32
	New Bedford Harbor Superfund Site	SHEET	3 of 3
		FILE NO.	48138.07
	New Bedford, Massachusetts	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696749.0 easting 814392.8
Driller	A. Carter	Mudline El.	-10.8 Datum NGVD
Logged By	E. Thibodeau	Date Start	7/30/99 Date End 8/2/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 5-inch I.D. (PW) flush-joint casing and 4-inch I.D. (HW) flush-joint casing; All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/12	40-42	62-29-29-31	58	Poorly graded sand with gravel (SP); very dense, 40% medium sand, 30% fine sand,	SP	
41	117						10% coarse sand, 15% gravel, 5% silt, brown.		
							Advance HW inner drill casing to 45 ft.		
42	128						Advance 3-7/8 in. button bit from 40 to 45 ft.		
43	127								
44	127								
45	141								
		S-7	21/4	45-46.7	45-25-15-	40	Poorly graded sand with silt (SP-SM); dense, 45% fine sand, 25% medium sand, 15%	SP-SM	
46	111				14/3"-25/0"		coarse sand, 5% gravel, 10% silt, brown.		
	175/						Advance HW inner drill casing to 46.7 ft.; casing refusal.		
47	9"						Advance 3-7/8 in. button bit from 45 to 46.7 ft.		
							Top of bedrock at 46.7 ft.		
48			[illegible]		[illegible]		Advance 3-7/8 in. button bit from 46.7 to 48.2 ft.	BEDROCK	
							Begin NX rock core at 48.2 ft.		
49		R1	48.2-49.2		4 mins.		R1: 48.2 to 50.5 ft.		
							Fresh, hard, gray, aphanitic GNEISS with low angle, very close, rough, planar,		
50			49.2-50.2		8 mins.		discolored, open, joints. REC = 100%; RQD = 48% (poor)		
							49.2 ft: loss of water return observed.		
51			50.2-50.5		2 mins.		50.5 to 51.3 ft: core barrel dropped; probable void or cavity.		
							Terminate core run at 51.3 ft., attempt split-barrel sample.		
52		R2	51.3-52.3		8 mins.		S-8: 51.3 to 51.3 ft: 25/0". No material recovered.		
							R2: 51.3 to 56.6 ft.		
53			52.3-53.3		5 mins.		Fresh, hard, gray, aphanitic GNEISS with horizontal, moderately spaced, rough, planar,		
							slightly discolored, partly open joints.		
54			53.3-54.3		6 mins.		REC = 100%; RQD = 90% (excellent)		
							51.5 to 51.8 ft: highly fractured zone.		
55			54.3-55.3		8 mins.				
56			55.3-56.3		4 mins.				
57			56.3-56.6		1 min.		Bottom of exploration at 56.6 ft.; boring terminated in bedrock.		
58									
59									
60									

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 3, prepared by GeoTesing Express, dated October 28, 1999.
2) Tide dropped substanially during sampling activities; therefore, actual sample interval may be slightly deeper than indicated here.
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-33 SHEET 1 of 7 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2696779.7 easting 814163.2
Mudline El. -4.4 Datum NGVD
Date Start 9/8/99 Date End 9/13/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Perform continuous field vane shear testing through organic clay; move barge approximately		
1	Push						7 ft. west and start boring.		
	Hyd.	S-1	24/8	1-3	WOR/24"	0	Advance HW drill casing to 1 ft. (hydraulic push) Advance 3-7/8 in. button bit from 0 to 1 ft.	OH	
2	Push						S-1: Organic soil (OH); very soft, 70% organic clay, 20% organic silt, 5% fine sand, 5% shell		
	Hyd.						fragments, strong organic odor, slight sheen, dark gray to black.		
3	Push						Advance HW drill casing to 3 ft. (hydraulic push) Advance 3-7/8 in. button bit from 1 to 3 ft.		
	Hyd.	S-2	24/8	3-5	WOR/12"-1-1	0	Organic soil with sand (OH); very soft, 70% organic clay, 10% organic silt, 15% fine sand, 5%	OH	
4	Push						shell fragments, strong organic odor, dark gray to black.		
	Hyd.						Advance HW drill casing to 5 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 5 ft.		
	Hyd.	S-3	24/12	5-7	WOR/12"-	0	Sandy organic soil (OH); very soft, 40% organic clay, 25% organic silt, 25% fine sand, 10%	OH	
6	Push				WOH/12"		shells, strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 7 ft. (hydraulic push)		
7	Push						Advance 3-7/8 in. button bit from 5 to 7 ft.		
	Hyd.	S-4	24/8	7-9	WOR/24"	0	Organic soil with sand (OH); very soft, 50% organic clay, 30% organic silt, 15% fine sand, 5%	OH	
8	Push						shells, strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 9 ft. (hydraulic push)		
9	Push						Advance 3-7/8 in. button bit from 7 to 9 ft.		
		S-5	24/20	9-11	WOR/24"	0	Organic soil with sand (OH); very soft, 40% organic clay 35% organic silt, 20% fine sand, 5%	OH	
10	2						shells, strong organic odor, dark gray.		
							Advance HW drill casing to 11 ft.		
11	3						Advance 3-7/8 in. button bit from 9 to 11 ft.		
		S-6	24/18	11-13	WOR/24"	0	Organic soil with sand (OH); very soft, 40% organic silt 35% organic clay, 20% fine sand, 5%	OH	
12	4						medium sand, strong organic odor, dark gray.		
							Advance HW drill casing to 13 ft.		
13	4						Advance 3-7/8 in. button bit from 11 to 13 ft.		
		S-7	24/24	13-15	WOR/24"	0	Sandy organic soil (OH); very soft, 40% organic silt, 30% organic clay, 10% medium sand, 10%	OH	
14	4						fine sand, 5% coarse sand, 5% shells, strong organic odor, dark gray.		
							Advance HW drill casing to 15 ft.		
15	4						Advance 3-7/8 in. button bit from 13 to 15 ft.		
		S-8	24/10	15-17	WOR/18"-2	0	S-8A: Organic soil with sand (OH); very soft, 40% organic clay, 40% organic silt, 20% fine sand,	OH	
16	6						strong organic odor, dark gray. (8 in.)		
							S-8B: Silty sand (SM); 40% medium sand, 30% fine sand, 30% silt, moderate organic odor, dark		
17	9						gray. (2 in.)	SM	
		S-9	24/16	17-19	4-5-6-8	11	Advance HW drill casing to 17 ft. Advance 3-7/8 in. button bit from 15 to 17 ft.	SP-SM	
18	22						S-9: Poorly graded sand with silt (SP-SM); medium dense, 50% medium sand, 30% fine sand,		
							10% coarse sand, 10% silt, gray.		
19	26						Advance HW drill casing to 20 ft.		
							Add bentonite to drilling fluid.		
20	31						Advance 3-7/8 in. button bit from 17 to 20 ft.		

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:
1) 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb center hole hammer free falling from a height of 24 inches.
2) No water return noted during rock coring activities.
3)
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Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-33
New Bedford Harbor Superfund Site	SHEET	2 of 7
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696779.7 easting 814163.2
Driller	A. Carter	Mudline El.	-4.4 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/8/99 Date End 9/13/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-10	24/18	20-22	8-8-10-10	18	Poorly graded sand with silt (SP-SM); medium dense, 40% medium sand, 25% fine sand,	SP-SM	
21	11						15% coarse sand, 10% gravel, 10% silt, gray.		
							Advance HW drill casing to 25 ft.		
22	14						Add more bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 20 to 25 ft.		
23	17								
24	18								
25	25								
		S-11	24/10	25-27	8-5-6-7	11	Silty sand (SM), medium dense, 30% medium sand, 25% fine sand, 15% coarse sand, 10%	SM	
26	15						gravel, 20% silt, gray.		
							Advance HW drill casing to 30 ft.		
27	22						Advance 3-7/8 in. button bit from 25 to 30 ft.		
28	22								
29	28								
30	37								
		S-12	24/0	30-32	7-7-6-10	13	No recovery.		
31	26						Advance HW drill casing to 35 ft.		
							Advance 3-7/8 in. button bit from 30 to 35 ft.		
32	30								
33	61								
34	79								
35	82								
		S-13	24/3	35-37	10-6-6-12	12	Well-graded sand with gravel (SW); medium dense, 25% medium sand, 25% fine sand, 20%	SW	
36	36						coarse sand, 25% gravel, 5% silt, brown.		
							Advance HW drill casing to 37 ft.		
37	43						Advance 3-7/8 in. button bit from 35 to 37 ft.		
		S-14	24/1	37-39	16-9-4-3	13	Poor recovery; washed sample.		
38	56						Advance HW drill casing to 40 ft.		
							Advance 3-7/8 in. button bit from 37 to 40 ft.		
39	44								
40	38								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number

REMARKS
1) 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb center hole hammer free falling from a height of 24 inches.
2) No water return noted during rock coring activities.
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Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT		
	Remedial Design For Operable Unit 01	SHEET	3 of 7
	New Bedford Harbor Superfund Site	FILE NO.	48138.07
	New Bedford, Massachusetts	CHKD. BY	J. Trottier
		BORING NO.	FD-33

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696779.7	easting 814163.2	
Driller	A. Carter	Mudline El.	-4.4	Datum	NGVD
Logged By	E. Thibodeau	Date Start	9/8/99	Date End	9/13/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-15	24/0	40-42	5-3-3-5	6	No recovery.		1
41	38						Advance HW drill casing to 42 ft.		
							Advance 3-7/8 in. button bit from 40 to 42 ft.		
42	38								
		S-16	24/3	42-44	11-7-7-12	14	Poor recovery; washed sample.		1
43	31						Advance HW drill casing to 44 ft.		
							Add more bentonite to drilling fluid.		
44	49						Advance 3-7/8 in. button bit from 42 to 44 ft.		
		S-17	24/9	44-46	8-6-4-5	10	Poorly graded sand (SP); loose, 45% medium sand, 30% fine sand, 15% coarse sand, 5%	SP	
45	50						gravel, 5% silt, subrounded particles, brown.		
							Advance HW drill casing to 49 ft.		
46	39						Advance 3-7/8 in. button bit from 44 to 49 ft.		
47	41								
48	52								
49	53								
		S-18	14/6	49-	19-17-50/2"	—	Poorly graded sand with silt and gravel (SP-SM); 20% medium sand, 15% fine sand, 10%	SP-SM	
50	119			50.2			coarse sand, 45% gravel, 10% silt, subrounded to subangular particles, brown.		
							Advance HW drill casing to 50 ft.		
							Top of bedrock at 50.0 ft.		
							Telescope and advance NW inner drill casing to 50.5 ft. for coring. (spin)	BEDROCK	
							NW drill casing advanced rapidly; probable weathered bedrock.		
							Advance NW inner drill casing to 51.0 ft. for coring. (spin)		
							Begin NX rock core at 50.0 ft.		
							(boring log continued on next page)		

[illegible]

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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-33
New Bedford Harbor Superfund Site	SHEET	4 of 7
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2696779.7 easting 814163.2
Mudline El. -4.4 Datum NGVD
Date Start 9/8/99 Date End 9/13/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION
	R1	50.0 - 51.0	4.5 mins.	Begin R1 at 50.0 ft. Fresh, moderately hard, gray, fine grained GNEISS. Near horizontal foliation; 20 degrees. REC = 83%; RQD = 73% (fair) 50.0 to 50.2 ft: fractured bedrock from advancing NW inner drill casing. 50.6 ft: mechanical break in rock core.
50.5				
51.0		51.0 - 52.0	5 mins.	51.2 ft: Primary joint: low angle, very widely spaced, rough, planar, slightly discolored, and tight.
51.5				
52.0		52.0 - 53.0	5 mins.	
52.5				52.6 to 53.1 ft: Quartz inclusion.
53.0		53.0 - 54.0	30 sec.	53.1 to 53.4 ft: core barrel dropped; probable void or cavity. Loss of drilling water return at 53.1 ft.
53.5				53.6 to 54.1 ft: core barrel dropped; probable void or cavity.
54.0		54.0 - 55.0	3 mins.	54.1 to 54.4 ft: Secondary joint: high angle, moderate to widely spaced, rough, planar, fresh, and open.
54.5				54.6 ft: mechanical break in rock core.
55.0				End R1 at 55.0 ft.

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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:
1) 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb center hole hammer free falling from a height of 24 inches.
2) No water return noted during rock coring activities.
3)
4)

	PROJECT	
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-33 SHEET 5 of 7 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696779.7 easting 814163.2
Driller	A. Carter	Mudline El.	-4.4 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/8/99 Date End 9/13/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R2	55.0 - 56.0	3.5 mins.	Begin R2 at 55.0 ft. Slightly weathered, moderately hard, gray, fine grained GNEISS. Foliation approximately 30 degrees. REC = 93%; RQD = 62% (fair) 55.0 to 55.7 ft: fractured bedrock. 55.7 to 56.0 ft: Secondary joint: high angle, moderate to widely spaced, rough, planar, discolored, and open.	2
55.5					
56.0		56.0 - 57.0	4 mins.	56.0 to 56.2 ft: discoloration/weathering noted.	
56.5					
57.0		57.0 - 58.0	3.5 mins.		
57.5				57.8 to 58.3 ft: core barrel dropped; probable void or cavity.	
58.0		58.0 - 59.0	3.5 mins.	58.3 to 58.8 ft: Secondary joint: high angle, moderate to widely spaced, rough, planar, discolored, and open.	
58.5					
59.0		59.0 - 60.0	4 mins.		
59.5				59.4 to 59.8 ft: discoloration/weathering noted. 59.8 ft: Primary joint: moderately dipping, very widely spaced, rough, planar, slightly discolored, and tight.	
60.0				End R2 at 60.0 ft.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb center hole hammer free falling from a height of 24 inches.
2) No water return noted during rock coring activities
3)
4)

	PROJECT	
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-33 SHEET 6 of 7 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696779.7 easting 814163.2
Driller	A. Carter	Mudline El.	-4.4 Datum NGVD
Logged By	E. Thibodeau	Date Start	9/8/99 Date End 9/13/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE INFORMATION: CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	60.0 - 61.0	3 mins.	Begin R3 at 60.0 ft. Slightly weatherd, moderately hard, gray, fine grained GNEISS. Foliation approximately 30 degreees. REC = 100%; RQD = 100% (excellent)	2
60.5					60.0 to 60.5 ft: discoloration/weathering noted.	
61.0						
			61.0 - 62.0	3.5 mins.	61.0 ft: Primary joint: low angle, closely spaced, smooth, planar, decomposed, and very wide. 61.0 to 61.3 ft: discoloration/weathering noted.	
61.5					61.4 ft: Primary joint: low angle, closely spaced, smooth, planar, silightly discolored, and open.	
62.0						
			62.0 - 63.0	5 mins.		
62.5						
63.0					62.9 to 63 ft: Quartz inclusion.	
			63.0 - 64.0	6.5 mins.		
63.5						
64.0					64.0 ft: core barrel blocked/full; core run terminated. End R3 at 64.0 ft.	
		R4	64.0 - 65.0	3.5 mins.	Begin R4 at 64.0 ft. Fresh, moderately hard, gray, fine grained GNEISS. Foliation near horizontal; approximately 10 degrees REC = 93%; RQD = 93% (excellent)	2
64.5						
65.0						

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb center hole hammer free falling from a height of 24 inches.
2) No water return noted during rock coring activities
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT		
	Remedial Design For Operable Unit 01	BORING NO.	FD-33
	New Bedford Harbor Superfund Site	SHEET	7 of 7
	New Bedford, Massachusetts	FILE NO.	48138.07
		CHKD. BY	J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2696779.7 easting 814163.2
Mudline El. -4.4 Datum NGVD
Date Start 9/8/99 Date End 9/13/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4 (cont.)	65.0 - 66.0	3.5 mins.		
65.5						
					65.8 to 66.5 ft: Quartz inclusion.	
66.0			66.0 - 67.0	3.5 mins.		
66.5						
67.0			67.0 - 68.0	4.5 mins.		
67.5						
68.0			68.0 - 69.0	5.5 mins.	68.0 ft: mechanical break in rock core.	
68.5					68.6 ft: mechanical break in rock core.	
69.0					End R4 at 69.0 ft.	
					Bottom of exploration at 69.0 ft.; boring terminated in bedrock.	

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOLS KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb center hole hammer free falling from a height of 24 inches.
2) No water return noted during rock coring activities.
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-34
New Bedford Harbor Superfund Site	SHEET 1 of 3
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697646.5 easting 814916.5
Driller	A. Carter	Mudline El.	-12.1 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/11/99 Date End 8/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 3 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.	S-1	24/0	3-5	WOR/24"	0	No recovery; probable very soft sediments.		
4	Push						Advance HW drill casing to 5 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 3 to 5 ft.		
5	Push								
	Hyd.	S-2	24/0	5-7	WOR/24"	0	No recovery.		
6	Push						Remove basket from split-barrel sampler.		
	Hyd.						Advance HW drill casing to 7 ft. (hydraulic push)		
7	Push						Advance 3-7/8 in. button bit from 5 to 7 ft.		
	Hyd.	S-3	24/10	7-9	WOR/24"	0	Organic soil (OH); very soft, 60% organic clay, 25% organic silt, 10% fine sand, 5%	OH	
8	Push						shell fragments, strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 10 ft. (hydraulic push)		
9	Push						Advance 3-7/8 in. button bit from 7 to 10 ft.		
	Hyd.								
10	Push								
	Hyd.	S-4	24/6	10-12	WOR/24"	0	Organic soil with sand (OH); very soft, 50% organic clay, 25% organic silt,15% fine	OH	
11	Push						sand, 5% medium sand, 5% shell fragments, slight organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 15 ft. (hydraulic push)		
12	Push						Advance 3-7/8 in. button bit from 10 to 15 ft.		
	Hyd.								
13	Push								
	Hyd.								
14	Push								
	Hyd.								
15	Push								
		S-5	24/24	15-17	6-12-19-17	31	S-5A: Similar to S-4. (6 in.)	OH	
16	19						S-5B: Poorly graded sand with silt (SP-SM); dense, 45% medium sand, 30% fine	SP-SM	
							10% coarse sand, 5% gravel, 10% silt, gray. (18 in.)		
17	75						Advance HW drill casing to 20 ft.		
							Add bentonite to drilling fluid.		
18	55						Advance 3-7/8 in. button bit from 15 to 20 ft.		
19	40								
20	46								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) Loss of water return at 39.9 ft.
2)
3)
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-34 SHEET 2 of 3 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697646.5 easting 814916.5		
Driller	A. Carter	Mudline El.	-12.1	Datum	NGVD
Logged By	E. Thibodeau	Date Start	8/11/99	Date End	8/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/8	20-22	18-12-10-12	22	Poorly graded sand with gravel (SP); medium dense, 25% medium sand, 20% fine	SP	
21	52						sand, 15% coarse sand, 35% gravel, 5% silt, brown.		
							Advance HW drill casing to 25 ft.		
22	54						Advance 3-7/8 in. button bit from 20 to 25 ft.		
23	45								
24	45								
25	63								
		S-7	24/8	25-27	9-6-5-10	11	Poorly graded sand with gravel (SP); medium dense, 40% medium sand, 25% fine	SP	
26	11						sand, 15% coarse sand, 15% gravel, 5% silt, brown.		
							Advance HW drill casing to 30 ft.		
27	17						Advance 3-7/8 in. button bit from 25 to 30 ft.		
28	87								
29	130								
30	79								
		S-8	24/10	30-32	25-14-13-10	27	Poorly graded sand with silt and gravel (SP-SM); medium dense, 35% medium sand,	SP-SM	
31	46						20% coarse sand, 20% fine sand, 15% gravel, 10% silt, brown.		
							Advance HW drill casing to 35 ft.		
32	50						Advance 3-7/8 in. button bit from 30 to 35 ft.		
33	35								
34	30								
35	50								
	42/	S-9	6/5	35-35.5	26-50/0"	—	Poorly graded sand with silt and gravel (SP-SM); 30% medium sand, 30% fine sand,	SP-SM	
36	3"		Core Interval		Core Time		15% coarse sand, 15% gravel, 10% silt, brown.		
	30/						Advance HW drill casing to 35.3 ft.		
37	0"	R1	36.3-37.3		4 mins.		Top of bedrock at 35.,3 ft.	BEDROCK	
							Advance 3-7/8 in. button bit from 35 to 36.3 ft.		
38			37.3-38.3		4 mins.		Begin NX rock core at 36.3 ft.		
							R1: 36.3 to 41.9 ft.		
39			38.3-39.3		3.5 mins.		Fresh, moderately hard gray, aphanitic GNEISS with horizontal to low angle, very		
							close to moderately spaced, smooth, undulating, fresh to discolored, wide joints.		
40			39.3-40.3		4 mins.		REC = 90%; RQD = 60% (fair)		1

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number

REMARKS:
1) Loss of water return at 39.9 ft.
2)
3)
4)

Nobis Engineering
PO Box 1890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-34
SHEET 3 of 3
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2697646.5 easting 814916.5
Mudline El. -12.1 Datum NGVD
Date Start 8/11/99 Date End 8/12/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH ft.	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							39.3 to 41.9 ft: some core grinding noted.		
41		R1	40.3-41.3		9.5 mins.				
		cont.							
42			41.3-41.9		9 mins.		41.9 ft: core barrel blocked; core run terminated.		
		R2	41.9-42.9		5 mins.		R2: 41.9 to 46.9 ft.		
43							Fresh, moderately hard, gray, aphanitic GNEISS with low angle to moderately dipping,		
			42.9-43.9		4.5 mins.		close to moderately spaced, rough, planar, fresh, partly open joints.	BEDROCK	
44							REC =92%; RQD = 82% (good)		
			43.9-44.9		6.5 mins.				
45									
			44.9-45.9		5.5 mins.		45.4 to 46.2 ft: Quartz inclusion.		
46									
			45.9-46.9		5.5 mins.				
47									
							Bottom of exploration at 46.9 ft.; boring terminated in bedrock.		
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

Granular Soils (Blows per foot)	Cohesive Soils (Blows per foot)	Notes	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) Loss of water return at 39.9 ft
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-35
SHEET	1 of 3
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696890.1	easting 814853.7	
Driller	A. Carter	Mudline El.	-10.9	Datum	NGVD
Logged By	E. Thibodeau	Date Start	8/16/99	Date End	8/17/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 3 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.	S-1	24/7	3-5	WOR/3"-	0	Organic soil with sand (OH); very soft, 40% organic clay, 40% organic silt, 10% fine	OH	
4	Push				WOH/12"-1/9"		sand, 5% medium sand, 5% shell fragments, strong organic odor, black.		
	Hyd.						Advance HW drill casing to 5 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 5 ft.		
	Hyd.	S-2	24/12	5-7	WOR/24"	0	Similar to S-1.	OH	
6	Push						Advance HW drill casing to 10 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 5 to 10 ft.		
7	Push								
	Hyd.								
8	Push								
	Hyd.								
9	Push								
	Hyd.								
10	Push								
		S-3	24/12	10-12	WOR/15"-2	0	S-3A: Organic soil with sand (OH); very soft, 50% organic silt, 25% organic clay, 20%	OH	
11	3						fine sand, 5% shell fragments, moderate organic odor, dark gray. (8 in.)		
							S-3B: Similar to S-3A but with approximately 20% Peat (Pt), fibrous, dark brown. (4 in.)	Pt	
12	5						Advance HW drill casing to 15 ft.		
							Advance 3-7/8 in. button bit from 10 to 15 ft.		
13	5								
14	7								
15	7								
		S-4	24/18	15-17	1-2-13-18	15	S-4A: Peat (Pt); fibrous, dark brown. (12 in.)	Pt	
16	15						S-4B: Silty sand (SM); medium dense, 75% fine sand, 25% silt, slight organic odor,		
							gray. (6 in.)		
17	37						Advance HW drill casing to 20 ft.	SM	
							Advance 3-7/8 in. button bit from 15 to 20 ft.		
18	24								
19	26								
20	38								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1)
2)
3)
4)

Nobis Engineering
PO Box 7890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-35
SHEET	2 of 3
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696890.1 easting 814853.7
Driller	A. Carter	Mudline El.	-10.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/16/99 Date End 8/17/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/18	20-22	5-7-6-8	13	S-5A: Poorly graded sand (SP); medium dense, 50% medium sand, 35% fine sand,	SP	
21	24						5% coarse sand, 5% gravel, 5% silt, reddish brown. Some iron staining noted. (6 in.)		
							S-5B: Poorly graded sand (SP); medium dense, 60% medium sand, 35% fine sand,		
22	17						5% silt, brown. (12 in.)		
							Advance HW drill casing to 25 ft.		
23	35						Add benonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 20 to 25 ft.		
24	32								
25	28								
		S-6	24/18	25-27	4-7-10-10	17	S-6A: Poorly graded sand (SP); medium dense, 75% medium sand, 20% fine sand,	SP	
26	40						5% silt, brown. (12 in.)		
							S-6B: Poorly graded sand with silt (SP-SM); medium dense, 45% medium sand, 30%	SP-SM	
27	35						fine sand, 5% coarse sand, 10% gravel, 10% silt, reddish brown. Some iron staining		
							noted. (6 in.)		
28	37						Advance HW drill casing to 30 ft.		
							Advance 3-7/8 in. button bit from 25 to 30 ft.		
29	42								
30	48								
		S-7	24/18	30-32	7-10-10-10	20	Silty sand (SM); medium dense, 75% fine sand, 25% silt, gray.	SM	
31	49						Advance HW drill casing to 35 ft.		
							Advance 3-7/8 in. button bit from 30 to 35 ft.		
32	39								
33	41								
34	40								
35	35								
		S-8	24/2	35-37	7-8-10-14	18	Poorly graded sand with silt (SP-SM); medium dense, 45% medium sand, 30% fine	SP-SM	
36	53						sand, 5% coarse sand, 10% gravel, 10% silt, brown.		
							Advance HW drill casing to 40 ft.		
37	66						Advance 3-7/8 in. button bit from 35 to 40 ft.		
38	48								
39	50								
40	41								

[illegible]

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1)
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-35
SHEET	3 of 3
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696890.1 easting 814853.7
Driller	A. Carter	Mudline El.	-10.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/16/99 Date End 8/17/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-9	24/8	40-42	7-6-6-9	12	Poorly graded sand with silt and gravel (SP-SM); medium dense, 40% medium sand,	SP-SM	
41	53						20% fine sand, 15% coarse sand, 15% gravel, 10% silt, gray.		
							Advance HW drill casing to 43.8 ft.		
42	42						Advance 3-7/8 in. button bit from 40 to 46 ft.		
43	40								
	91/								
44	10"						Probable cobble or boulder from 43.8 to 44.5 feet.	Probable	
							Button bit advanced with little effort from 44.5 to 46 ft.	Cobble/boulder	
45	34								
46	41								
		S-10	24/12	46-48	4-5-3-4	8	Poorly graded sand (SP); loose, 70% medium sand, 20% fine sand, 5% gravel, 5%	SP	
47	35						silt, gray.		
							Advance HW drill casing to 48.8 ft.; casing refusal.		
48	52						Attempt to advance 3-7/8 in. button bit to 48.8 ft; drive shoe and lead section of HW		
	116/						drill casing damaged. Boring terminated at 48.8 ft.		
49	9"								
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

GRANULAR SOILS (DENSITY)	COHESIVE SOILS (CONSISTENCY)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS:
1)
2)
3)
4)

Nobis Engineering
PO Box 3890
Concord, New Hampshire 03302

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD - 36
SHEET 1 of 3
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696220.5 easting 814914.5
Driller	A. Carter	Mudline El.	-12.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/25/99 Date End 8/26/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 3 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 3 ft.		
	Hyd.								
2	Push								
	Hyd.								
3	Push								
	Hyd.	S-1	24/4	3-5	WOR/24"	0	Sandy organic soil (OH); very soft, 50% organic clay, 20% organic silt, 25% fine sand,	OH	
4	Push						5% medium sand, strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 5 ft. (hydraulic push)		
5	Push						Advance 3-7/8 in. button bit from 3 to 5 ft.		
	Hyd.	S-2	24/0	5-7	WOR/24"	0	Organic soil with sand (OH); very soft, 50% organic clay, 35% organic silt, 15% fine	OH	
6	Push						sand, strong organic odor, dark gray. (logged from trimmings)		
	Hyd.						Advance HW drill casing to 7 ft. (hydraulic push)		
7	Push						Advance 3-7/8 in. button bit from 5 to 7 ft.		
	Hyd.	S-3	24/2	7-9	WOR/24"	0	Similar to S-2.	OH	
8	Push						Advance HW drill casing to 9 ft. (hydraulic push)		
	Hyd.						Advance 3-7/8 in. button bit from 7 to 9 ft.		
9	Push								
	Hyd.	S-4	24/18	9-11	WOR/24"	0	Organic soil (OH); very soft, 60% organic clay, 30% organic silt, 10% fine sand, trace	OH	
10	Push						shell fragments, strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 14 ft. (hydraulic push)		
11	Push						Very difficult push at 13.5 ft.		
	Hyd.						Advance HW drill casing to 15 ft.		
12	Push						Advance 3-7/8 in. button bit from 9 to 15 ft.		
	Hyd.								
13	Push								
	Hyd.								
14	Push								
15	13								
		S-5	24/16	15-17	4-5-5-8	10	S-5A: Poorly graded sand with silt (SP-SM); loose, 50% medium sand, 35% fine sand,	SP-SM	
16	8						5% gravel, 10% silt, moderate organic odor, gray. (4 in.)		
							S-5B: Poorly graded sand (SP); loose, 60% medium sand, 20% fine sand, 10% coarse	SP	
17	7						sand, 5% gravel, 5% silt, moderate oragnic odor, gray. (12 in.)		
							Advance HW drill casing to 20 ft.		
18	9						Advance 3-7/8 in. button bit from 15 to 20 ft.		
19	11								
20	9								

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample	9. PP denotes Pocket Penetrometer
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) Possible run-in sands during driving of sampler; therefore, N-value may be biased low.
2)
3)
4)

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-36
New Bedford Harbor Superfund Site	SHEET	2 of 3
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696220.5	easting 814914.5	
Driller	A. Cater	Mudline El.	-12.3	Datum	NGVD
Logged By	E. Thibodeau	Date Start	8/25/99	Date End	8/26/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount.
Drilling Method: 4-inch I.D. (HW) flush-joint casing; wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30-inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/12	20-22	4-3-7-7	10	Poorly graded sand with silt (SP-SM); loose, 40% medium sand, 25% fine sand, 15%	SP-SM	
21	10						coarse sand, 10% gravel, 10% silt, slight organic odor, gray.		
							Advance HW drill casing to 25 ft.		
22	12						Add bentonite to drilling fluid.		
							Advance 3-7/8 in. button bit from 20 to 25 ft.		
23	16								
24	22								
25	33								
		S-7	24/12	25-27	4-4-4-5	8	Poorly graded sand (SP); loose, 75% medium sand, 20% fine sand, 5% silt, gray.	SP	
26	10						Advance HW drill casing to 30 ft.		
							Advance 3-7/8 in. button bit from 25 to 30 ft.		
27	15								
28	20								
29	32								
		S-8	24/20	30-32	1-2-2-4	4	Poorly graded sand (SP); very loose, 60% medium sand, 35% fine sand, 5% silt, gray.	SP	1
30	49						Advance HW drill casing to 35 ft.		
							Add bentonite to drilling fluid.		
31	20						Advance 3-7/8 in. button bit from 30 to 35 ft.		
32	25								
33	38								
34	87								
35	120								
		S-9	24/18	35-37	5-8-10-13	18	Poorly graded sand (SP); medium dense, 50% fine sand, 45% medium sand, 5% silt,	SP	
36	41						gray.		
							Advance HW drill casing to 40 ft.		
37	36						Advance 3-7/8 in. button bit from 35 to 40 ft.		
38	37								
39	43								
40	112								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Possible run-in sands during driving of sampler; therefore, N-value may be biased low.
2)
3)
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-36
New Bedford Harbor Superfund Site	SHEET 3 of 3
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2696220.5 easting 814914.5
Driller	A. Carter	Mudline El.	-12.3 Datum NGVD
Logged By	E. Thibodeau	Date Start	8/25/99 Date End 8/26/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing, wash and drive.
All casing driven with a 300 lb center hole hammer free falling from a height of 30 inches.

Groundwater Readings Not Applicable for Offshore Borings.

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-10	24/18	40-42	3-4-5-6	9	Poorly graded sand (SP); loose, 50% medium sand, 45% fine sand, 5% silt, gray.	SP	
41	50						Advance HW drill casing to 45 ft.		
							Add bentonite to drilling fluid.		
42	56						Advance 3-7/8 in. button bit from 40 to 45 ft.		
43	59								
44	58								
45	67								
		S-11	24/13	45-47	3-3-3-4	6	Poorly graded sand with silt (SP-SM); loose, 45% medium sand, 30% fine sand, 5%	SP-SM	
46	94						coarse sand, 10% gravel, 10% silt, gray.		
							Advance HW drill casing to 50 ft.		
47	108						Advance 3-7/8 in. button bit from 45 to 50 ft.		
48	117								
49	113								
50	89								
		S-12	24/10	50-52	6-13-11-9	24	S-12A: Silty sand (SM); medium dense, 55% fine sand, 5% medium sand, 40% silt,	SM	
51	114						gray. (5 in.)		
							S-12B: Poorly graded sand with silt and gravel (SP-SM); medium dense, 30%	SP-SM	
52	142						medium sand, 15% coarse sand, 15% fine sand, 30% gravel, 10% silt, gray. (5 in.)		
							Advance HW drill casing to 55 ft.		
53	153						Advance 3-7/8 in. button bit from 50 to 55.5 ft.		
54	162								
55	281								
	Open								
56	Hole	S-13	24/16	55.5-	23-14-16-12	30	Poorly graded sand with gravel (SP); medium dense, 30% medium sand, 20% fine	SP	
	Open			57.5			sand, 15% coarse sand, 30% gravel, 5% silt, gray.		
57	Hole						Switch to open hole mud rotary drilling techniques with bentonite drilling mud at 56 ft.		
	Open						Advance 3-7/8 in. button bit from 55.5 to 58.0 ft.		
58	Hole						Top of bedrock at 58.0 ft.		
							Advance 3-7/8 in. button bit from 58 to 59 ft. to confirm bedrock.	BEDROCK	
59									
							Bottom of exploration at 59.0 ft.; boring terminated in probable bedrock.		
60									

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) Possible run-in sands during driving of sampler; therefore, N-value may be biased low.
2)
3)
4)

M:/Reports/Active/48138.07/Logs/CDFD/FD-36.xls/FD-36(3)

PROJECT	
Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts

BORING NO. FD - 50
SHEET 1 of 5
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697581.9 easting 814307.4
Driller	A. Carter	Mudline El.	-12.7 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/20/99 Date End 10/21/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
	Hyd.	UO-1	24/17	1-3	———	—	Sandy organic clay (OH); 59% organic clay, 21% coarse sand, 11% medium sand,	OH	1
2	Push						9% fine sand, strong organic odor, dark gray to black.		
	Hyd.						Advance HW drill casing to 4 ft. (hydraulic push)		
3	Push						Advance 3-7/8 in. button bit from 1 to 4 ft.		
	Hyd.								
4	Push								
	Hyd.	UO-2	24/24	4-6	———	—	Sandy organic clay (OH); 59% organic clay, 4% coarse sand, 2% medium sand,	OH	1
5	Push						34% fine sand, 1% gravel, strong organic odor, dark gray.		
	Hyd.						Advance HW drill casing to 7 ft. (hydraulic push)		
6	Push						Advance 3-7/8 in. button bit from 4 to 7 ft.		
	Hyd.								
7	Push								
		UO-3	24/23	7-9	———	—	Top: Similar to UO-2.	OH	
8	Spin						Bottom: Silty sand (SM); 60% fine sand, 40% silt, gray.		
							Advance HW drill casing to 9 ft.	SM	
9	Spin						Advance 3-7/8 in button bit to 9 ft.		
		S-1	24/6	9-11	1-2-4-5	6	Silty sand (SM); loose, 65% fine sand, 5% medium sand, 30% silt, gray.	SM	
10	Spin						Advance HW drill casing to 13 ft.		
							Advance 3-7/8 in. button bit to 13 ft.		
11	Spin								
12	Spin								
13	Spin								
							Attempt borehole permeability test at 13 ft.; casing advanced 11 in. under self weight.		
14	0						Perform borehole permeability test at 14 feet.		
		S-2	24/13	14-16	2-2-2-2	4	Silty sand (SM); very loose, 50% fine sand, 5% coarse sand, 5% medium sand, 40%	SM	
15	Spin						silt, brown. Some iron staining noted in sample.		
							Advance HW drill casing to 19 ft.		
16	Spin								
17	Spin								
18	Spin								
19	Spin								
		S-3	24/3	19-21	9-8-8-7	16	S-3A: rock/gravel fragments. (1 in.)	SP-SM	
20	Spin						S-3B: Poorly graded sand with silt and gravel (SP-SM); medium dense, 30% medium		

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:

1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
3) Long core times due to the hardness of the bedrock formation and polishing of the Series 2 core bit.
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD - 50
SHEET 2 of 5
FILE NO. 48138.07
CHKD. BY J. Trottier

Boring Co. Atlantic Testing Laboratories, Limited
Driller A. Carter
Logged By E. Thibodeau

Boring Location northing 2697581.9 easting 814307.4
Mudline El. -12.7 Datum NGVD
Date Start 10/20/99 Date End 10/21/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							sand, 20% fine sand, 15% coarse sand, 25% gravel, 10% silt, brown. (2 in.)		
21	Spin						Advance HW drill casing to 21 ft.		
		S-4	24/1	21-23	8-5-4-5	9	Approximately 6 in. of material in casing; advance 3-7/8 in. button bit to clean out.		
22	Spin						S-4: Poor recovery; button bit cuttings and wash.		
							Advance HW drill casing to 23 ft.		
23	Spin						Perform borehole permeability test at 23 ft.		
		S-5	24/1	23-25	6-6-7-11	13	Poor recovery; piece of gravel/fractured rock lodged in tip of sampler. Possible		
24	Spin						cobbles.		
							Advance HW drill casing to 25 ft.		
25	Spin								
		S-6	24/1	25-27	16-17-19-7	36	Poor recovery; fractured rock. Possible cobbles.		
26	Spin						Advance HW drill casing to 27 ft.		
27	Spin								
		S-7	24/7	27-29	3-4-5-10	9	Poorly graded sand (SP); loose, 48% medium sand, 37% fine sand, 8% coarse sand,	SP	2
28	Spin						3% gravel, 4% silt, brown.		
							Advance HW drill casing to 29.2 ft.		
29	Spin						Very difficult drilling at 29.2 ft.		
		S-8	9/8	29.2-30.1	16-18/3"-	---	Silty sand with gravel (SM); 25% fine sand, 20% coarse sand, 10% medium sand, 25%	SM	
30	Spin				50/0"		gravel, 20% silt, brown.		
							Top of bedrock at 30.1 ft.		
							Advance HW drill casing to 30.4 ft. for coring. (spin)		
							Check seal on casing; water level in casing dropped quickly.	BEDROCK	
							Begin HV rock core at 30.1 ft.		
							(boring log continued on next page)		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number

REMARKS
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
3) Long core times due to the hardness of the bedrock formation and polishing of the Series 2 core bit
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD - 50
New Bedford Harbor Superfund Site	SHEET	3 of 5
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697581.9 easting 814307.4
Driller	A. Carter	Mudline El.	-12.7 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/20/99 Date End 10/21/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R1	30.1 - 31.1	6.5 mins.	Begin R1 at 30.1 ft. (3rd gear) Fresh, hard, gray, fine grained GNEISS. Low angle foliation; approximately 20 degrees. REC = 100%; RQD = 97% (excellent) 30.1 to 30.2 ft: fractured rock; slight discoloration noted.	
30.5						
31.0						
			31.1 - 32.1	7 mins.		
31.5						
32.0						
			32.1 - 33.1	7.5 mins.		
32.5						
33.0						
			33.1 - 34.1	6.5 mins.	33.1 ft: mechanical break in rock core.	
33.5						
34.0						
			34.1 - 35.1	7.5 mins.		
34.5						
					34.8 ft: mechanical break in rock core.	
35.0					End R1 at 35.1 ft.	

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
3) Long core times due to the hardness of the bedrock formation and polishing of the Series 2 core bit.
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD - 50 SHEET 4 of 5 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697581.9	easting 814307.4	
Driller	A. Carter	Mudline El.	-12.7	Datum	NGVD
Logged By	E. Thibodeau	Date Start	10/20/99	Date End	10/21/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	35.1 - 36.1	8.5 mins.	Begin R2 at 35.1 ft. Fresh, hard, gray, fine grained GNEISS. Low angle foliation; approximately 10-20 degrees. REC = 100%; RQD = 100% (excellent)	
35.5						
36.0						
			36.1 - 37.1	9 mins.		
36.5						
37.0					36.9 ft: mechanical break in rock core.	
			37.1 - 38.1	13 mins.		
37.5						
38.0						
			38.1 - 39.1	13.5 mins.		
38.5						
39.0					Switch drill rig into 4th gear.	
			39.1 - 40.1	9 mins.	39.1 ft: mechanical break in rock core.	
39.5						
					39.6 ft: mechanical break in rock core. 39.9 ft: mechanical break in rock core.	
40.0					End R2 at 40.1 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
3) Long core times due to the hardness of the bedrock formation and polishing of the Series 2 core bit.
4)

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD - 50
New Bedford Harbor Superfund Site	SHEET	5 of 5
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697581.9 easting 814307.4
Driller	A. Carter	Mudline El.	-12.7 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/20/99 Date End 10/21/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	40.1 - 41.1	13 mins.	Begin R3 at 40.1 ft. (4th gear) Fresh, hard to very hard, gray, fine grained GNEISS. Low angle foliation; approximately 20 degrees. REC = 100%; RQD = 100% (excellent)	
40.5					40.6 ft: mechanical break in rock core.	
41.0			41.1 - 42.1	14.5 mins.		
41.5						
42.0			42.1 - 43.1	21.5 mins.		3
42.5						
43.0			43.1 - 44.1	48 mins.		3
43.5						
44.0			44.1 - 44.8	59 mins.	44.2 ft: mechanical break in rock core.	3
44.5					44.6 ft: mechanical break in rock core. End R3 at 44.8 ft.	
45.0					Bottom of exploration at 44.8 ft.; boring terminated in bedrock.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 5, prepared by GeoTesing Express, dated November 29, 1999.
3) Long core times due to the hardness of the bedrock formation and polishing of the Series 2 core bit.
4)

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. SHEET FILE NO. CHKD. BY	FD - 51 - 1 of 7 48138.07 J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697228.5 easting 814725.2
Driller	A. Carter	Mudline El.	-22.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/26/99 Date End 10/29/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
	Hyd.						Advance HW drill casing to 1 ft. (hydraulic push)		
1	Push						Advance 3-7/8 in. button bit from 0 to 1 ft.		
	Hyd.	UO-1	24/24	1-3	————	—	Organic clay with sand (OH); 78% organic clay, 7% coarse sand, 4% medium sand,	OH	1
2	Push						10% fine sand, 1% gravel, strong organic odor, black.		
	Hyd.						Advance HW drill casing to 4 ft. (hydraulic push)		
3	Push						Advance 3-7/8 in. button bit from 1 to 4 ft.		
	Hyd.								
4	Push								
	Hyd.	UO-2	24/24	4-6	————	—	Top: Sandy organic soil (OH); 60% organic clay/silt, 30% fine sand, 5% medium sand,	OH	
5	Push						5% shells, strong organic odor, black.		
	Hyd.						Bottom: Silty sand (SM); 3% coarse sand, 32% medium sand, 37% fine sand,	SM	1
6	Push						2% gravel, 26% silt, dark gray. Piece of wood approximately 2 in. in length and 1 in. in	(Sand Layer)	
	Hyd.						diameter noted in bottom of sample; possible root or branch.		
7	Push						Advance HW drill casing to 7 ft. (hydraulic push)		
		UO-3	24/18	7-9	————	—	Advance 3-7/8 in. button bit from 4 to 7 ft.	SC	1
8	Spin						UO-3: Top: Clayey sand (SC); 1% coarse sand, 19% medium sand, 37% fine sand,		
							6% gravel, 37% organic clay, dark gray.		
9	Spin						UO-3: Bottom: Silty sand (SM); 50% fine sand, 5% coarse sand, 5% medium sand,		
		S-1	24/13	9-11	6-6-7-5	13	10% gravel, 30% silt, gray to black.	SM	
10	Spin						Advance HW drill casing to 9 ft.		
							S-1: Silty sand (SM); medium dense, 55% fine sand, 5% medium sand, 40% silt, gray.		
11	Spin						Advance HW drill casing to 12 ft.		
12	Spin								
		S-2	24/16	12-14	2-2-2-2	4	Silt with sand (ML); soft, 72% non-plastic silt, 27% fine sand, 1% medium sand, gray.	ML	2
13	Spin						Advance HW drill casing to 14 ft.		
14	Spin								
		S-3	24/10	14-16	1/12"-1/12"	1	Sandy silt (ML); very soft, 50% silt, 10% clay, 40% fine sand, brown to gray.	ML	
15	Spin						Advance HW drill casing to 16 ft.		
16	Spin								
		S-4	24/18	16-18	3-4-5-4	9	S-4A: Sandy lean clay (CL); 40% clay, 30% silt, 30% fine sand, olive brown. (8 in.)	CL	
17	Spin						S-4B: Poorly graded sand with gravel (SP); loose, 30% medium sand, 30% fine sand,	SP	
							15% coarse sand, 20% gravel, 5% silt, brown. (10 in.)		
18	Spin						Advance HW drill casing to 18 ft.		
		S-5	24/0	18-20	————	—	No recovery. Drill string with sampler attached was dropped into borehole; no blow		
19	Spin						counts recorded.		
							Advance HW drill casing to 20 ft.		
20	Spin								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
3) Possible fractured bedrock and quartz veins with soil filled voids. Driller notes increase in water pressure during advancement of HW drill casing.
4) Calculated RQD changes over the length of the core run: 45.9 to 46.9 ft: RQD = 0%; 46.9 to 50.6 ft: RQD = 67%.
5) Core time not recorded (NR).

Nobis *Nobis Engineering* *PO Box 2890* *Concord, New Hampshire 03302*	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. SHEET FILE NO. CHKD. BY	FD - 51 2 of 7 48138.07 J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697228.5 easting 814725.2
Driller	A. Carter	Mudline El.	-22.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/26/99 Date End 10/29/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-6	24/3	20-22	15-8-7-6	15	Poorly graded sand with gravel (SP); medium dense, 30% medium sand, 15% coarse	SP	
21	Spin						sand, 15% fine sand, 35% gravel, 5% silt, brown. Traces of fractured rock and a shell		
							noted in sample.		
22	Spin						Advance HW drill casing to 22 ft.		
		S-7	24/0	22-24	4-5-5-7	10	No recovery.		
23	Spin						Advance HW drill casing to 24 ft. Encountered possible cobbles during the	Possible	
							advancement of the casing.	Cobbles	
24	Spin								
		S-8	24/0	24-26	6-6-5-8	11	No recovery with 2 in. split-barrel. Attempt to resample material with 3-in. split-barrel.		
25	Spin						Drove sampler 12 in.; drill casing was advancing during driving operations. No		
							material recovered.		
26	Spin						Approximately 2 to 3 ft. of material in bottom of casing; advance 3-7/8 in. button bit		
							to remove material.		
27	Spin						Attempt to resample material with 2-in. split-barrel: 3 in. of recovery. Poorly graded		
		S-9	24/6	27-29	8-6-5-7	11	sand (SP); medium dense, 25% coarse sand, 50% medium sand, 10% fine sand, 10%	SP	
28	Spin						gravel, 5% silt, brown.		
							Advance HW drill casing to 27 ft.		
29	Spin						S-9: Poorly graded sand with gravel (SP); medium dense, 35% medium sand, 15% fine		
		S-10	24/7	29-31	9-5-6-7	11	sand, 15% coarse sand, 30% gravel, 5% silt, brown. Piece of fractured rock noted in	SP	
30	Spin						top of sample. Possible gravel or cobble.		
							Advance HW drill casing to 29 ft.		
31	Spin						S-10: Poorly graded sand with gravel (SP); medium dense, 40% medium sand, 30%		
		S-11	24/1	31-33	4-5-6-7	11	fine sand, 10% coarse sand, 15% gravel, 5% silt, brown. Piece of gravel lodged in tip		
32	Spin						of sampler.		
							Advance HW drill casing to 31 ft. Approximately 8 in. of material in bottom of casing;		
33	Spin						advance 3-7/8 in. button bit to remove material.		
		S-12	24/9	33-35	4-5-4-6	9	S-11: Poor recovery. Washed material, very angular. Possible button bit cuttings.	SP	
34	Spin						Advance HW drill casing to 33 ft. Approximately 6 in. of material in bottom of casing;		
							advance 3-7/8 in. button bit to remove material.		
35	Spin						S-12: Poorly graded sand with gravel (SP); loose, 31% medium sand, 17% fine sand,		3
		S-13	24/4	35-37	4-4-8-10	12	13% coarse sand, 35% gravel, 4% silt, brown.	SP-SM	
36	Spin						Advance HW drill casing to 35 ft. Approximately 7 in. of material in bottom of casing;		
							advance 3-7/8 in. button bit to remove material.		
37	Spin						S-13: Poorly graded sand with silt and gravel (SP-SM); medium dense, 20% fine sand,		
		S-14	24/6	37-39	6-6-7-6	13	15% coarse sand, 10% medium sand, 45% gravel, 10% silt, brown.	GP	
38	Spin						Advance HW drill casing to 37 ft. Approximately 6 in. of material in bottom of casing;		
							advance 3-7/8 in. button bit to remove material.		
39	Spin						S-14: Poorly graded gravel with sand (GP); medium dense, 65% gravel, 15% fine sand,		
							10% coarse sand, 5% medium sand, 5% silt, brown.		
40	Spin						Advance HW drill casing to 40 ft. Approximately 6 in. of material in bottom of casing;		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:

1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
3) Possible fractured bedrock and quartz veins with soil filled voids. Driller notes increase in water pressure during advancement of HW drill casing.
4) Calculated RQD changes over the length of the core run: 45.9 to 46.9 ft: RQD = 0%; 46.9 to 50.6 ft: RQD = 67%.
5) Core time not recorded (NR).

Nobis Engineering
PO Box 2890
Concord, New Hampshire 03302

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD - 51
New Bedford Harbor Superfund Site	SHEET	3 of 7
New Bedford, Massachusetts	FILE NO.	48138.07
	CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697228.5 easting 814725.2
Driller	A. Carter	Mudline El.	-22.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/26/99 Date End 10/29/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-15	24/5	40-42	9-9-12-5	21	advance 3-7/8 in. button bit to remove material.	SP-SM	
41	Spin						S-15A: Fractured rock/quartz. (top)		
							S-15B: Poorly graded sand with silt and gravel (SP-SM): medium dense, 21% fine		2
42	Spin						sand, 18% medium sand, 6% coarse sand, 44% gravel, 11% silt, brown. (5 in.)		
		S-16	24/2	42-44	9-5-6-4	11	Piece of fractured rock/quartz noted in top of sample.		3
43	Spin						Advance HW drill casing to 42 ft.		
							S-16: Poor recovery. Pieces of fractured rock and button bit cuttings.		
44	Spin						Advance HW drill casing to 44 ft.		
		S-17	23/6	44-	9-7-3-8/5"-	10	Silty sand with gravel (SM); loose, 30% fine sand, 5% coarse sand, 5% medium sand,	SM	
45	Spin			45.9	50/0"		40% gravel, 20% silt, brown. Piece of fractured bedrock noted in tip of sampler.		
							Top of bedrock at 45.9 ft.		
46	Spin						Advance HW drill casing to 46.5 ft. for coring. (spin)		
							Begin HV rock core at 45.9 ft.		
							(boring log continued on next page)	BEDROCK	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
3) Possible fractured bedrock and quartz veins with soil filled voids. Driller notes increase in water pressure during advancement of HW drill casing.
4) Calculated RQD changes over the length of the core run: 45.9 to 46.9 ft: RQD = 0%; 46.9 to 50.6 ft: RQD = 67%.
5) Core time not recorded (NR).

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PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-51
New Bedford Harbor Superfund Site	SHEET 4 of 7
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697228.5 easting 814725.2
Driller	A. Carter	Mudline El.	-22.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/26/99 Date End 10/29/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	45.9 - 46.9	6.5 mins.	Check seal on HW drill casing; water level in casing kept at a constant level by the addition of approximately 1.5 to 2 gallons per minute.	
					Begin R1 at 45.9 ft. (3rd gear)	4
46.5					Water return color: reddish brown to milky white.	
					Fresh, moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 30 degrees.	
					REC = 100%; RQD = 67% (fair)	
					45.9 to 46.7 ft: pieces of fractured bedrock. One piece of fractured quartz noted; possible quartz vein.	
47.0					45.9 to 46.7 ft: RQD = 0%.	
			46.9 - 47.9	11.5 mins.	46.9 ft: water return color: milky white.	
					47.0 ft: mechanical break in rock core.	
					47.3 ft: mechanical break in rock core.	
47.5						
48.0						
			47.9 - 48.9	8 mins.		
48.5						
49.0						
			48.9 - 49.9	9 mins.	49.1 ft: mechanical break in rock core. Quartz/GNEISS interface.	
					49.1 to 49.7 ft: Quartz vein; dark gray. Quartz/GNEISS interface appears to be intact. (mechanical breaks)	
49.5					49.1 to 49.7 ft: Fracture in quartz vein: high angle, to vertical, rough, planar, slightly discolored, and partly open. Possibly a healed joint.	
					49.7 ft: mechanical break in rock core. Quartz/GNEISS interface.	
50.0						
			49.9 - 50.6	17.5 mins.	50.0 ft: mechanical break in rock core.	
					50.3 ft: healed joint.	
					Good water return observed throughout core run.	
50.5					End R1 at 50.6 ft.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
3) Possible fractured bedrock and quartz veins with soil filled voids. Driller notes increase in water pressure during advancement of HW drill casing.
4) Calculated RQD changes over the length of the core run: 45.9 to 46.9 ft: RQD = 0%; 46.9 to 50.6 ft: RQD = 67%
5) Core time not recorded (NR).

Nobis Engineering PO Box 2890 Concord, New Hampshire 03302	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-51 SHEET 5 of 7 FILE NO. 48138.07 CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697228.5 easting 814725.2
Driller	A. Carter	Mudline El.	-22.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/26/99 Date End 10/29/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-Inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	50.6 - 51.6	8.5 mins.	Check seal on HW drill casing; water level in casing held at a constant level by the addition of approximately 1 gallon per minute with 2.7 ft. of head above harbor water level. Begin R2 at 50.6 ft. (3rd gear) Water return color: milky white. Fresh, moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 15-20 degrees. REC = 100%; RQD = 67% (fair)	
51.0						
51.5			51.6 - 52.6	7.5 mins.		
52.0						
52.5			52.6 - 53.6	6.5 mins.	52.8 ft: mechanical break in rock core; slight discoloration noted. 52.8 to 53.7 ft: Secondary joint: high angle, very widely spaced, rough, stepped, discolored, and partly open.	
53.0						
53.5			53.6 - 54.6	5.5 mins.	53.5 ft: mechanical break in rock core; slight discoloration noted due to secondary joint. 53.7 ft: mechanical break in rock core. Quartz/GNEISS interface. 53.7 to 54.5 ft: Quartz vein; dark gray, very brittle, some healed fractures noted. 53.9 and 54.1 ft: mechanical breaks in quartz vein. Possible healed joints. 53.7 to 54.3 ft: fractures in quartz vein: high angle to vertical, widely spaced, rough, stepped to undulating, discolored, and open. Possibly healed joints. Parallel set of fractures.	
54.0						
54.5					54.4 to 54.5 ft: Feldspar inclusion, pink in color.	
			54.6 - 54.9	NR	54.5 to 54.9 ft: slightly different texture and color noted in GNEISS; coarser texture and lighter color.	5
55.0					Perform constant head permeability test from 46.5 to 54.9 ft. End R2 at 54.9 ft.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOLOGY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
3) Possible fractured bedrock and quartz veins with soil filled voids. Driller notes increase in water pressure during advancement of HW drill casing.
4) Calculated RQD changes over the length of the core run: 45.9 to 46.9 ft: RQD = 0%; 46.9 to 50.6 ft: RQD = 67%.
5) Core time not recorded (NR).

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PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-51
SHEET	6 of 7
FILE NO.	48138.07
CHKD. BY	J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697228.5 easting 814725.2
Driller	A. Carter	Mudline El.	-22.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/26/99 Date End 10/29/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R3	54.9 - 55.9	6.5 mins.	Begin R3 at 54.9 ft. (3rd gear) Water return color: milky white. Fresh, moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 10 degrees. REC = 100%; RQD = 100% (excellent)	
55.5					
56.0		55.9 - 56.9	7 mins.		
56.5					
57.0				56.9 ft: mechanical break in rock core.	
		56.9 - 57.9	8.5 mins.		
57.5					
58.0		57.9 - 58.9	8 mins.		
58.5					
				58.8 ft. mechanical break in rock core.	
59.0		58.9 - 59.4	3.5 mins.	59.0 to 59.4 ft: Quartz/feldspar inclusion; pink in color. 59.0 ft: Primary joint: low angle, widely spaced, rough, planar, discolored, and open.	
59.5				End R3 at 59.4 ft.	

[illegible]

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
3) Possible fractured bedrock and quartz veins with soil filled voids. Driller notes increase in water pressure during advancement of HW drill casing.
4) Calculated RQD changes over the length of the core run: 45.9 to 46.9 ft: RQD = 0%; 46.9 to 50.8 ft: RQD = 67%.
5) Core time not recorded (NR).

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PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-51
New Bedford Harbor Superfund Site	SHEET 7 of 7
New Bedford, Massachusetts	FILE NO. 48138.07
	CHKD. BY J. Trottier

Boring Co.	Atlantic Testing Laboratories, Limited	Boring Location	northing 2697228.5 easting 814725.2
Driller	A. Carter	Mudline El.	-22.9 Datum NGVD
Logged By	E. Thibodeau	Date Start	10/26/99 Date End 10/29/99

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb safety hammer free falling from a height of 30 inches.
Drill Rig: Acker AD2 truck mount
Drilling Method: 4-inch I.D. (HW) flush-joint casing; spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4	59.4 - 60.4	10 mins.	Begin R4 at 59.4 ft. Water return color: milky white. Fresh, moderately hard, gray, fine grained GNEISS. Low angle foliation; approximately 20 degrees. REC = 100%; RQD = 100% (excellent) 59.4 to 59.5 ft: Quartz/feldspar inclusion; pink in color. (continued from R3)	
60.0						
60.5			60.4 - 61.4	11 mins.		
61.0						
61.5			61.4 - 62.4	14 mins.		
62.0						
62.5			62.4 - 63.4	16 mins		
63.0					63.2 ft: mechanical break in rock core.	
63.5			63.4 - 64.4	12.5 mins.		
64.0					Perform constant head permeability test from 46.5 to 64.4 ft. End R4 at 64.4 ft.	
64.5					Bottom of exploration at 64.4 ft.; boring terminated in bedrock.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 6, prepared by GeoTesing Express, dated December 23, 1999.
2) Sample description based on laboratory test data and ASTM D2487. Refer to Test Report No. 8, prepared by GeoTesing Express, dated February 2, 2000.
3) Possible fractured bedrock and quartz veins with soil filled voids. Driller notes increase in water pressure during advancement of HW drill casing.
4) Calculated RQD changes over the length of the core run: 45.9 to 46.9 ft: RQD = 0%; 46.9 to 50.6 ft: RQD = 67%.
5) Core time not recorded (NR)

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-101
SHEET 1 of 10
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418	easting 814321	
Driller	S. Laurenza	Mudline El.	-8.37	Datum	NGVD
Logged By	S. Bonis	Date Start	1/8/2001	Date End	1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1	WOC								
2	WOC								
		S-1	24/24	2-4	WOR/24"	—	Sandy organic soil (OH); 60% organic clay/silt, 40% fine sand, organic odor, gray. Shells noted.		
							Advance PW drill casing to 4 ft.		
3	WOC						Advance 3-7/8 in. roller bit to 4 ft.	ORGANIC CLAY	
4	12								
		S-2	24/18	4-6	WOR/24"	—	Similar to S-1.		
							Advance PW drill casing to 6 ft.		
							Advance 3-7/8 in. roller bit to 6 ft.		
5	7								
6	5								
		S-3	24/5	6-8	WOR/24"	—	Sandy organic soil (OH); 60% organic clay/silt, 40% fine sand, trace gravel, organic odor,		
	WOH						gray. Shells noted.		
							Advance PW drill casing to 8 ft.		
7	5						Advance 3-7/8 in. roller bit to 8 ft.		
8	8							8.0 ft.	
		S-4	24/12	8-10	2-4-3-4	7	Poorly graded sand (SP); loose, 75% fine sand, 20% medium sand,		
							5% silt, light gray to light brown.	MARINE SAND	
							Advance PW drill casing to 10 ft.		
9	15						Advance 3-7/8 in. roller bit to 10 ft.		
10	19						Perform falling head permeability test at 10 ft.		

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418	easting 814321	
Driller	S. Laurenza	Mudline El.	-8.37	Datum	NGVD
Logged By	S. Bonis	Date Start	1/8/2001	Date End	1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-5	24/12	10-12	5-2-4-5	6	**Silty sand (SM); 58% fine sand, 3% medium sand, 1% coarse sand, 1% gravel, 37% silt, grayish-brown.** Advance PW drill casing to 12 ft. Advance 3-7/8 in. roller bit to 12 ft.		1
11	23								
12	22								
		S-6	24/16	12-14	4-3-5-5	8	Poorly graded sand (SP); loose, 60% fine sand, 40% medium sand, brown. Iron staining noted Advance PW drill casing to 14 ft. Advance 3-7/8 in. roller bit to 14 ft.		
13	6								
14	10								
		S-7	24/11	14-16	3-1-1-5	2	Silty sand (SM); very loose, 75% fine sand, 10% medium sand, 15% silt, gray. Iron staining noted. Advance PW drill casing to 16 ft. Advance 3-7/8 in. roller bit to 16 ft.		
15	WOH							MARINE SAND	
16	13								
		S-8	24/6	16-18	3-1-4-6	5	**Silty sand (SM); 53% fine sand, 10% medium sand, 1% gravel, 36% silt, red and gray.** Brown interbedded silt lenses. Advance PW drill casing to 18 ft. Advance 3-7/8 in. roller bit to 18 ft.		1
17	16								
18	25								
		S-9	24/6	18-20	5-3-5-7	8	**Silty sand with gravel (SM); 29% fine sand, 19% medium sand, 9% coarse sand, 15% gravel, 28% silt, brown.** Interbedded silt lenses. Advance PW drill casing to 20 ft. Advance 3-7/8 in. roller bit to 20 ft.		1
19	24								
20	27						Estimated strata change at 20 ft.	20.0 ft.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-101
SHEET 3 of 10
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418	easting 814321	
Driller	S. Laurenza	Mudline El.	-8.37	Datum	NGVD
Logged By	S, Bonis	Date Start	1/8/2001	Date End	1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-10	24/14	20-22	4-4-3-7	7*	**Poorly graded sand with gravel (SP); 16% fine sand, 23% medium sand, 17% coarse sand, 42% gravel, 2% silt, brown.** Subrounded to subangular sand and gravel.		1,2
21	28						Advance PW drill casing to 22 ft. Advance 3-7/8 in. roller bit to 22 ft.		
22	30								
		S-11	24/0"	22-24	4-6-6-6	12*	Washed sample. Advance PW drill casing to 27 ft. Advance 3-7/8 in. roller bit to 27 ft.		2
23	24						Mix bentonite drilling mud, specific gravity = 1.07.	GLACIO FLUVIAL	
24	31								
25	46								
26	43								
27	70								
		S-12	24/0"	27-29	15-4-3-3	7	Washed sample. Advance PW drill casing to 32 ft. Advance 3-7/8 in. roller bit to 32 ft.		
28	53								
29	57								
30	109								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-101
SHEET	4 of 10
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418	easting 814321	
Driller	S. Laurenza	Mudline El.	-8.37	Datum	NGVD
Logged By	S. Bonis	Date Start	1/8/2001	Date End	1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
								GLACIO FLUVIAL	
31	164								
32	106							32.0 ft.	
							Top of bedrock at 32.0 ft. Advance 3-7/8 in. roller bit to 32.8 ft. Telescope HW drill casing to 32.8 ft.	BEDROCK	
33							Begin HQ rock core at 32.8 ft. (boring log continued on next page)		
34									
35									
36									
37									
38									
39									
40									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-101 SHEET 5 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418 easting 814321
Driller	S. Laurenza	Mudline El.	-8.37 Datum NGVD
Logged By	S. Bonis	Date Start	1/8/2001 Date End 1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R1	32.8-33.8	5 min.	Begin R1 at 32.8 ft. Fresh, hard to very hard, fine to medium grained GNEISS. Low angle foliation (approx. 10 to 20 degrees). REC. = 100%; RQD = 100% (excellent). Water return color: milky white.	
33.3						
33.8			33.8-34.8	5.25 min.		
34.3						
34.8			34.8-35.8	7 min.		
35.3						
35.8			35.8-36.8	6 min.		
36.3						
36.8			36.8-37.8	6 min.		
37.3						
37.8					37.5 ft.: Mechanical break in rock core. End R1 at 37.8 ft.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-101

SHEET 6 of 10

FILE NO. 48138.27

CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418 easting 814321
Driller	S. Laurenza	Mudline El.	-8.37 Datum NGVD
Logged By	S. Bonis	Date Start	1/8/2001 Date End 1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R2	37.8-38.8	5.5 min	Begin R2 at 37.8 ft. Fresh, hard to very hard, fine to medium grained GNEISS. Low angle foliation (approx. 10 to 20 degrees). REC. = 100%; RQD = 100% (excellent). Water return color: milky white, except as noted.	
38.3						
38.8			38.8-39.8	5 min	38.9 ft.: Mechanical break in rock core.	
39.3					39.4 to 40.5 ft.: Zone of red coloration, no change in grain size or texture noted. Water return color: pink to rusty.	
39.8			39.8-40.8	6 min	39.8 and 40.1 ft.: Mechanical breaks in rock core.	
40.3						
40.8			40.8-41.8	6.5 min	40.8 and 40.9 ft.: Mechanical breaks in rock core. Core grinding noted.	
41.3					41.3 ft.: Mechanical break in rock core. Core grinding noted.	
41.8			41.8-42.8	6.25 min	41.9 ft.: Mechanical break in rock core.	
42.3					42.2 ft.: Mechanical break in rock core.	
42.8					End R2 at 42.8 ft.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-101
SHEET 7 of 10
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418 easting 814321
Driller	S. Laurenza	Mudline El.	-8.37 Datum NGVD
Logged By	S. Bonis	Date Start	1/8/2001 Date End 1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R3	42.8-43.8	5.5 min.	Begin R3 at 42.8 ft. Fresh, hard to very hard, fine grained GNEISS. Low angle foliation (approx. 10 to 20 degrees). REC. = 100%; RQD = 100% (excellent). Water return color: milky white.	
43.3						
43.8			43.8-44.8	5.75 min.		
44.3						
44.8			44.8-45.8	5 min.		
45.3						
45.8			45.8-46.8	4.5 min.		
46.3						
46.8			46.8-47.8	6.75 min.	47.1 ft.: Mechanical break in rock core.	
47.3					End R3 at 47.8 ft. Bottom of exploration at 47.8 ft. Boring terminated in bedrock. Grout completed borehole to mudline with cement/bentonite grout, specific gravity = 1.44.	
47.8						

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-101 SHEET 8 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418	easting 814321	
Driller	S. Laurenza	Mudline El.	-8.37	Datum	NGVD
Logged By	S. Bonis	Date Start	1/8/2001	Date End	1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES

Core Runs R1 through R3

Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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	PROJECT	BORING NO. FD-101
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	SHEET 9 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418 easting 814321
Driller	S. Laurenza	Mudline El.	-8.37 Datum NGVD
Logged By	S. Bonis	Date Start	1/8/2001 Date End 1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES

Core Runs R1 through R3

Core Runs R1 through R3

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1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-101 SHEET 10 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697418	easting 814321	
Driller	S. Laurenza	Mudline El.	-8.37	Datum	NGVD
Logged By	S. Bonis	Date Start	1/8/2001	Date End	1/9/2001

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES

Core Runs R1 through R3

Reddish discoloration noted in R2

REMARKS:
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2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-102
SHEET 1 of 12
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476	easting 814636	
Driller	S. Laurenza	Mudline El.	-15.11	Datum	NGVD
Logged By	A. Juneau	Date Start	11/30/2000	Date End	12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1	WOC								
2	WOC								
		UO-1	24/24	2-4	———	—	Sandy organic soil (OH); 60% organic clay/silt, 10% medium sand, 30% fine sand, organic odor, dark gray.	ORGANIC CLAY	
3	WOC								
4	WOC								
5	WOC							5.0 ft.	
		UO-2	24/24	5-7	———	—	Clayey sand (SC); 45% organic clay/silt, 20% medium sand, 25% fine sand, 10% coarse sand, organic odor, dark gray.	CLAYEY SAND	
6	WOC								
7	WOC								
8	WOC								
		UO-3	12/11	8-9	———	—	Similar to UO-2, except light gray to black. Osterberg sampler did not fully extend due to density of soils.		
9	WOC								
		S-1	24/11	9-11	26-12-12-14	24	S-1A: Clayey sand (SC); very stiff, 10% coarse sand, 20% medium sand, 25% fine sand, 45% organic clay/silt, organic odor, dark gray. (3 in.)	9.5 ft.	
10	44						S-1B: Poorly graded sand (SP); medium dense, 10% medium sand, 85% fine sand, 5% silt, olive brown. (8 in.)	MARINE SAND	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-102 SHEET 2 of 12 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476	easting 814636	
Driller	S. Laurenza	Mudline El.	-15.11	Datum	NGVD
Logged By	A. Juneau	Date Start	11/30/2000	Date End	12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
11	42								
							Perform falling head permeability test at 11.5 ft.		
		S-2	24/14	11.5-13.5	5-3-4-15	7	S-2A: Poorly graded sand (SP); loose, 10% medium sand, 85% fine sand,		
12	NR						5% silt, light gray. (9 in.)		
							S-2B: Poorly graded sand with gravel (SP); loose, 40% coarse sand, 30% medium sand,		
							25% gravel, 5% fine sand, shells, angular to subangular sand and gravel, dark		
							olive-gray. (5 in.)		
13	39						Advance PW drill casing to 13.5 ft.		
							Mix bentonite drilling mud, specific gravity = 1.07.		
	47						Advance 4-7/8 in. roller bit to 13.5 ft.		
		S-3	24/15	13.5-15.5	9-4-5-5	9	S-3A: Silty sand (SM); loose, 80% fine sand, 5% medium sand, 15% silt,		
14							organic odor. (4 in.)		
							S-3B: Silty sand (SM); 50% fine sand, 1% medium sand, 49% silt, gray.		1
	45						(11 in.)		
15								MARINE	
							Advance PW drill casing to 15.5 ft.	SAND	
	42						Advance 4-7/8 in. roller bit to 15.5 ft.		
		S-4	24/17	15.5-17.5	6-3-4-2	7	Similar to S-3B, except olive gray. 1/16 in. seams of silt noted.		
16							Advance PW drill casing to 17.5 ft.		
							Advance 4-7/8 in. roller bit to 17.5 ft.		
	38								
17									
	36								
		S-5	24/20	17.5-19.5	8-5-5-4	10	**Silt with sand (ML); 28% fine sand, 72% silt, gray.**		1
18							1/16 to 1/4 in. seams of silt noted.		
							Advance PW drill casing to 20 ft.		
							Advance 4-7/8 in. roller bit to 20 ft.		
19	20								
20	21							20.0 ft.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-102

FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476	easting 814636	
Driller	S. Laurenza	Mudline El.	-15.11	Datum	NGVD
Logged By	A. Juneau	Date Start	11/30/2000	Date End	12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-6	24/18	20-22	5-1-1-7	2	**S-6A: Silty clay (CL-ML); 10% fine sand, 1% medium sand, 89% silt/clay, grayish brown.** Fine sand lenses (1/16 in.), high plasticity. (14 in.)	MARINE SAND	1
21	21						S-6B: Silty sand (SM); very loose, 55% fine sand, 30% silt, 15% clay, yellow brown. Slight to moderate plasticity. (4 in.)		
22	24								
		S-7	24/13	22-24	11-13-12-12	25	**S-7A: Silt with sand (ML); 27% fine sand, 2% medium sand, 71% silt, grayish brown.** (8 in.)		1
23	41						S-7B: Poorly graded sand with gravel (SP); medium dense, 5% coarse sand, 40% medium sand, 40% fine sand, 15% gravel, subangular to round gravel, subangular to subround sand, oxidized 2 in. horizon at soil interface. (5 in.)	23.0 ft.	
24	45							GLACIO FLUVIAL	
25	44						Perform falling head permeability test at 25 ft.		
		S-8	24/11	25-27	26-36-38-28	74	S-8A: Silty sand (SM); very dense, 75% fine sand, 25% silt, yellow brown. (4 in.)		
							S-8B: Well-graded gravel with sand (GW); 10% coarse sand, 13% medium sand, 9% fine sand, 66% gravel, 2% silt, yellowish-brown. (7 in.)		1
26	50						Advance PW drill casing to 30 ft. Advance 3-7/8 in. roller bit to 30 ft.		
27	41								
28	34								
29	26								
30	13								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-102
SHEET 4 of 12
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476	easting 814636	
Driller	S. Laurenza	Mudline El.	-15.11	Datum	NGVD
Logged By	A. Juneau	Date Start	11/30/2000	Date End	12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-9	24/6	30-32	11-9-15-7	24	Well-graded sand (SW); medium dense, 25% coarse sand, 35% medium sand, 30% fine sand, 5% gravel, 5% silt, subangular to subround sand and gravel, yellow brown.		
31	NR						Advance PW drill casing to 35 ft. Advance 3-7/8 in. roller bit to 35 ft.		
32	26								
33	35								
34	30								
35	35							GLACIO	
		S-10	24/7	35-37	6-7-24-35	31	**S-10A: Silt (ML); 4% fine sand, 1% medium sand, 95% silt, light brown.** (2 in.) S-10B: Silty sand (SM); 85% fine sand, 15% silt, yellow orange iron stained. (3 in.) S-10C: Poorly graded sand (SP); 60% fine sand, 25% medium sand, 5% coarse sand,	FLUVIAL	1
36	11						5% gravel, 5% silt, subround to angular sand and gravel, yellow brown. (2 in.) Advance PW drill casing to 40 ft. Advance 3-7/8 in. roller bit to 40 ft.		
37	17								
38	71								
39	61								
40	42						Perform falling head permeability test at 40 ft.		

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-102 SHEET 5 of 12 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476	easting 814636	
Driller	S. Laurenza	Mudline El.	-15.11	Datum	NGVD
Logged By	A. Juneau	Date Start	11/30/2000	Date End	12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-11	24/12	40-42	24-54-39-11	93*	**Poorly graded gravel with silt and sand (GP-GM); 13% fine sand, 17% medium sand, 11% coarse sand, 50% gravel, 9% silt, brown.** Coarse (1-1/2 to 2 in.) angular to subrounded gravel.		1,2
41	12						Obstruction passed at 41.3 ft. during sampling. Advance PW drill casing to 45 ft. Advance 3-7/8 in. roller bit to 45 ft.		
42	67								
43	104								
44	88								
45	106							GLACIO	
		S-12	24/2	45-47	28-11-9-8	21	Washed sample. Sample consists predominantly of coarse wash (disturbed sample). Sample anticipated to be similar to S-11 (ball check clogged in spoon). Advance PW drill casing to 50 ft.	FLUVIAL	
46	60						Advance 3-7/8 in. roller bit to 50 ft.		
47	60								
48	66								
49	112								
50	242								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-102
SHEET 6 of 12
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476, easting 814636
Driller	S. Laurenza	Mudline El.	-15.11
		Datum	NGVD
Logged By	A. Juneau	Date Start	11/30/2000
		Date End	12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-13	24/14	50-52	32-36-35-24	71	Poorly graded sand with gravel (SP); very dense, 60% medium sand, 25% fine sand, 15% gravel, angular to subangular sand, subrounded to subangular gravel, light olive brown.	GLACIO FLUVIAL	
51	122						Advance PW drill casing to 53.2 ft.		
52	132								
53	152							53.2 ft.	
	232/ 3"						Top of bedrock at 53.2 ft. Advance 3-7/8 in. roller bit to 54.2 ft. Telescope HW casing to 54.2 ft.	BEDROCK	
54							Begin HQ rock core at 54.2 ft. (boring log continued on next page)		
55									
56									
57									
58									
59									
60									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-102
SHEET	7 of 12
FILE NO.	48138.27
CHKD. BY	S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476	easting 814636	
Driller	S. Laurenza	Mudline El.	-15.11	Datum	NGVD
Logged By	A. Juneau	Date Start	11/30/2000	Date End	12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R1	54.2-55.2	30.5 min.	Begin R1 at 54.2 ft. Fresh, very hard, gray, fine to medium grained GNEISS. No natural joints/fractures observed in recovered pieces, semi-planar, low angle biotite foliation (approx. 15 to 25 degrees), no discontinuities or weathered zones observed in recovered pieces of core. REC = 70%; RQD =70% Water return color: milky white. Drive head pressure not used during first foot of core run R1 (54.2 - 55.2 ft.). No recovery obtained during core run R1 and first overcore of R1, three consecutive overcores of R1 yielded recoveries of 14, 12 and 16 in., respectively; with a total recovery of 42 in. Core recovery and RQD for core run R1 low due to core grinding during numerous overcores. Rock integrity is estimated to be similar to R2. RQD based upon Geologist interpretation of rock core and total recovery of 70%.	
54.5						
55.0						
			55.2-56.2	13.8 min.		
55.5						
56.0						
			56.2-57.2	12.25 min.		
56.5						
57.0						
			57.2-58.2	18.25 min.		
57.5						
58.0						
			58.2-59.2	16 min.		
58.5						
59.0					End R1 at 59.2 ft.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-102 SHEET 8 of 12 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476	easting 814636	
Driller	S. Laurenza	Mudline El.	-15.11	Datum	NGVD
Logged By	A. Juneau	Date Start	11/30/2000	Date End	12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	59.2-60.2	10 min.	Begin R2 at 59.2 ft. Fresh, very hard, pinkish gray, fine to medium grained GNEISS. No natural joints/fractures observed semi-planar, low angle biotite foliation (approx. 15 degrees), no discontinuities or weathered zones observed. R2 included 2.4 ft. of overcore from R1. REC = 100%; RQD =100% Water return color: milky white to light gray.	
59.5						
60.0						
			60.2-61.2	9.5 min.		
60.5						
					60.8 ft.: Mechanical break in rock core, no noticeable core grinding observed.	
61.0						
			61.2-62.3	10.4 min.	61.3 ft.: Mechanical break in rock core, no noticeable core grinding observed.	
61.5						
62.0						
		R3	62.2-63.2	11.2 min.	End R2 at 62.2 ft. Begin R3 at 62.2 ft. Fresh, very hard, pinkish gray, fine to medium grained GNEISS. No natural joints/fractures observed semi-planar, low angle biotite foliation (approx. 10 to15 degrees), no discontinuities or weathered zones observed. REC = 100%; RQD =100% Water return color: milky white.	
62.5						
63.0						
			63.2-64.2	11.5 min.	63.0 ft.: Mechanical break in rock core, no core grinding noted. 63.1 ft.: Mechanical break in rock core along biotite foliation, no core grinding noted.	
63.5					63.5 ft.: Mechanical break in rock core, no core grinding noted.	
64.0						

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-102
SHEET 9 of 12
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476 easting 814636
Driller	S. Laurenza	Mudline El.	-15.11 Datum NGVD
Logged By	A. Juneau	Date Start	11/30/2000 Date End 12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
			64.2-65.2	12.5 min.		
64.5						
65.0			65.2-66.2	10.7 min.	65.4 ft.: High angle mechanical break in rock core, no noticeable core grinding noted.	
65.5						
66.0			66.2-67.1	8.7 min.		
66.5					66.7 ft.: Mechanical break in rock core, no noticeable grinding noted.	
67.0					66.9 ft.: Mechanical break in rock core, no noticeable grinding noted.	
		R4	67.1-68.1	8.8 min.	End R3 at 67.1 ft. Begin R4 at 67.1 ft. Fresh, very hard, gray, fine to medium grained GNEISS, semi-planar, low angle biotite and feldspar foliation (approx. 15 degrees), possible minor, low angle (approx. 15 degrees) rough joint along orthoclase vein with no visible spacing and only slight discoloration (weathering), very tight. REC = 92%; RQD = 92%	
67.5						
68.0			68.1-69.1	7.3 min.		
68.5						
69.0						

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering
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Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-102
SHEET	10 of 12
FILE NO.	48138.27
CHKD. BY	S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697476 easting 814636
Driller	S. Laurenza	Mudline El.	-15.11 Datum NGVD
Logged By	A. Juneau	Date Start	11/30/2000 Date End 12/8/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
			69.1-70.1	6.5 min.		
69.5						
70.0					69.9 ft.: Mechanical break in rock core, no noticeable grinding noted.	
			70.1-71.1	6.3 min.		
70.5						
71.0						
			71.1-72.1	11.5 min.		
71.5						
72.0						
					End R4 at 72.1 ft. Bottom of exploration at 72.1 ft. Boring terminated in bedrock.	
72.5						
73.0						
73.5						
74.0						

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-103
SHEET 1 of 10
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697531 easting 814770
Driller	E. Thomas	Mudline El.	-21.27 Datum NGVD
Logged By	E. Thibodeau / S. Bonis	Date Start	11/20/2000 Date End 11/27/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance PW drill casing to 2 ft.	ORGANIC CLAY	
							Advance 3-7/8 in. roller bit to 2 ft. No water return noted in casing.		
1	WOC								
2	WOC								
							Attempt sample from 2 to 4 ft. Driller dropped drill string with sampler down drill casing.		
							Advance PW drill casing to 8 ft.		
							Advance 3-7/8 in. roller bit to 8 ft.		
3	WOC								
4	WOC								
5	WOC								
6	WOC								
7	WOC								
8	WOC							8.0 ft.	
		UO-1	24/0	8-10	—	—	Estimated strata change at 8 ft. No recovery.	MARINE SAND	
		S-1	24/6	8-10	3-2-2-1	4	Silty Sand (SM); loose, 75% fine sand, 25% silt, strong organic odor, gray.		
							Advance PW drill casing to 10 ft.		
9	15						Mix bentonite drilling mud, specific gravity = 1.07.		
							Advance 3-7/8 in. roller bit to 10 ft.		
10	28								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
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11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-103
SHEET 2 of 10
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697531		easting 814770
Driller	E. Thomas	Mudline El.	-21.27	Datum	NGVD
Logged By	E. Thibodeau / S. Bonis	Date Start	11/20/2000	Date End	11/27/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-2	24/13	10-12	7-4-1-1	5	**Silty clay with sand (CL-ML); 14% fine sand, 2% medium sand, 84% silt/clay, brown.**		1
							Advance PW drill casing to 12 ft.		
11	35						Advance 4-7/8 in. roller bit to 12 ft.		
								MARINE SAND	
12	21								
		S-3	24/10	12-14	6-2-3-4	5	S-3A: Similar to S-2. (7-in.)		
							S-3B: Silty sand (SM); 9% coarse sand, 29% medium sand, 36% fine sand, 2% gravel, 24% silt, brown. Subangular sand and gravel. (3 in.)		1
13	40						Advance PW drill casing to 14 ft.		
							Advance 4-7/8 in. roller bit to 14 ft.		
								13.5 ft.	
14	43								
		S-4	24/8	14-16	5-2-3-4	5	**Poorly graded sand with silt and gravel (SP-SM); 14% coarse sand, 27% medium sand, 18% fine sand, 36% gravel, 5% silt, brown.** Subangular sand and gravel.		1
							Advance PW drill casing to 16 ft.		
15	34						Advance 4-7/8 in. roller bit to 16 ft.		
16	41							GLACIO FLUVIAL	
		S-5	24/7	16-18	6-4-3-6	7	Similar to S-4. Subangular sand and gravel.		
							Advance PW drill casing to 18 ft.		
							Advance 4-7/8 in. roller bit to 18 ft.		
17	41								
18	44								
		S-6	24/8	18-20	23-8-10-9	18	**Poorly graded sand with silt and gravel (SP-SM); 11% coarse sand, 20% medium sand, 17% fine sand, 43% gravel, 9% silt, brown.** Subangular to angular sand and gravel.		1
							Advance PW drill casing to 23 ft.		
19	WOC						Advance 4-7/8 in. roller bit to 23 ft.		
							Specific gravity of drill fluid = 1.10.		
20	WOC								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-103 SHEET 3 of 10 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697531		easting 814770
Driller	E. Thomas	Mudline El.	-21.27	Datum	NGVD
Logged By	E. Thibodeau / S. Bonis	Date Start	11/20/2000	Date End	11/27/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
21	40								
22	34								
23	44								
		S-7	24/8	23-25	6-7-8-6	15	**Silty sand (SM); 14% coarse sand, 31% medium sand, 27% fine sand, 10%**		1
	WOC						**gravel, 18% silt, brown.** Subangular sand and gravel.		
							Advance PW drill casing to 28 ft.		
24	17						Advance 4-7/8 in. roller bit to 28 ft.	GLACIO FLUVIAL	
25	45								
26	46								
27	34								
28	42								
		S-8	24/9	28-30	10-8-8-9	16	Well-graded sand with gravel (SW); medium dense, 30% coarse sand, 35% medium sand,		
							20% fine sand, 15% gravel, subangular sand and gravel, red-brown. Iron staining noted.		
							Advance PW drill casing to 33 ft.		
29	WOC						Advance 4-7/8 in. roller bit to 33 ft.		
30	40								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 / New Bedford Harbor Superfund Site / New Bedford, Massachusetts	BORING NO. FD-103 / SHEET 4 of 10 / FILE NO. 48138.27 / CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697531 easting 814770
Driller	E. Thomas	Mudline El.	-21.27 Datum NGVD
Logged By	E. Thibodeau / S. Bonis	Date Start	11/20/2000 Date End 11/27/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
31	45								
32	46								
33	48							GLACIO FLUVIAL	
		S-9	24/6	33-35	18-10-9-10	19	**Silty sand with gravel (SM); 9% coarse sand, 24% medium sand, 23% fine sand, 26% gravel, 18% silt, brown.** Subangular to angular sand and gravel. Advance PW drill casing to 36.5 ft.		1
34	61								
35	87								
36	59								
	71							36.5 ft.	
37							Refusal of PW drill casing at 36.5 ft. Advance 4-7/8 in. roller bit to 36.5 ft. Advance 4-7/8 in. roller bit to 38 ft. to confirm bedrock.		
38								BOULDER	
39									
40							Break through at 40 ft. with 4-7/8 in. roller bit.	40.0 ft.	

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11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-103 SHEET 5 of 10 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697531 easting 814770
Driller	E. Thomas	Mudline El.	-21.27 Datum NGVD
Logged By	E. Thibodeau / S. Bonis	Date Start	11/20/2000 Date End 11/27/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-10	24/6	40-42	25-25-36-32	>50	Poorly graded sand with gravel (SP); very dense, 15% coarse sand, 55% medium sand, 15% fine sand, 15% gravel, angular to subangular sand and gravel, brown.		
							Telescope HW drill casing to 42 ft.		
41	SPIN						Advance 3-7/8 in. roller bit to 43 ft.	GLACIO FLUVIAL	
42	SPIN							42.0 ft.	
							Probable cobble/boulder from 42 to 43 ft.	COBBLE/ BOULDER	
43	SPIN						Estimated strata change at 43 ft.	43.0 ft.	
		S-11	14/13	43-44.2	23-39-13/2"-25/0"	—	Silty sand with gravel (SM); 10% coarse sand, 30% medium sand, 20% fine sand, 25% gravel, 15% silt, angular to sub-angular sand and gravel, brown (GLACIAL TILL)		
							Advance HW drill casing to 45.5 ft.	GLACIAL TILL	
44	SPIN						Advance 3-7/8 in. roller bit to 45.5 ft.		
45	SPIN						Top of bedrock at 45 ft.	45.0 ft.	
							Begin HQ rock core at 45.5 ft.		
							(Boring log continued on next page)	BEDROCK	
46									
47									
48									
49									
50									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-103 SHEET 6 of 10 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697531 easting 814770
Driller	E. Thomas	Mudline El.	-21.27 Datum NGVD
Logged By	E. Thibodeau / S. Bonis	Date Start	11/20/2000 Date End 11/27/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	45.5-46.5	6 min.	Begin R1 at 45.5 ft. Fresh, hard, gray, fine-grained GNEISS. No jointing observed. Low angle foliation (10 degrees). REC=98%; RQD=98% (excellent). Water return color: milky white.	
46.0						
46.5			46.5-47.5	6 min.		
47.0						
47.5			47.5-48.5	6 min.	47.4 ft.: Mechanical break in rock core. Minor core grinding noted.	
48.0					47.8 ft.: Mechanical break in rock core. Minor core grinding noted. 48.1 ft.: Mechanical break in rock core. Minor core grinding noted.	
48.5			48.5-49.5	6.5 min.	48.4 ft.: Mechanical break in rock core.	
49.0					48.9 ft.: Mechanical break in rock core.	
					49.3 ft.: Mechanical break in rock core.	
49.5			49.5-50.5	8.5 min.	49.5 ft.: Mechanical break in rock core.	
50.0						
50.5					End R1 at 50.5 ft.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-103 SHEET 7 of 10 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697531		easting 814770
Driller	E. Thomas	Mudline El.	-21.27	Datum	NGVD
Logged By	E. Thibodeau / S. Bonis	Date Start	11/20/2000	Date End	11/27/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	50.5-51.5	6 min.	Begin R2 at 50.5 ft. Fresh, very hard, gray, fine-grained GNEISS. Low angle foliation (approx. 10-20 degrees). REC=98%; RQD 95% (excellent) Water return color: milky white. 50.8 ft.: Mechanical break in rock core.	
51.0						
51.5			51.5-52.5	8 min.		
52.0						
52.5			52.5-53.5	14.5 min.	52.6 ft.: Mechanical break in rock core.	
53.0						
53.5			53.5-54.5	13.5 min.		
54.0						
54.5					54.5 ft.: Mechanical break in rock core.	
			54.5-55.5	5 min.	54.5 ft.: Primary joint: low angle, rough, planar, slightly discolored and open.	
55.0						
55.5					End R2 at 55.5 ft.	

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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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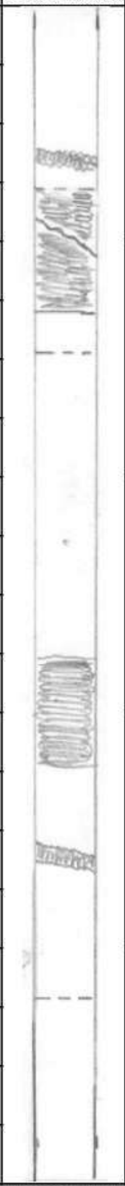
Boring Co.	Warren George, Inc.	Boring Location	northing 2697531		easting 814770
Driller	E. Thomas	Mudline El.	-21.27	Datum	NGVD
Logged By	E. Thibodeau / S. Bonis	Date Start	11/20/2000	Date End	11/27/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time



DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R3	55.5-56.5	8 min.	Begin R3 at 55.5 ft.	
				Fresh, very hard, gray, fine-grained GNEISS. Low angle foliation (approx. 20 degrees).	
				REC=96%; RQD=96% (excellent)	
56.0				Water return color: milky white.	
				56.3 ft.: Mechanical break in rock core.	
56.5				56.3 to 56.8 ft.: Quartz vein. Pink to dark gray in color.	
		56.5-57.5	20 min.	56.5 ft.: Primary joint: moderately dipping, smooth, planar, slightly discolored and open.	
57.0				56.9 ft.: Mechanical break in rock core.	
57.5				End R3 at 57.5 ft. Core run terminated due to core bit polishing and long core time.	
	R4	57.5-58.5	7 min.	Begin R4 at 57.5 ft.	
				Fresh, very hard, gray, fine-grained GNIESS. Low angle foliation (approx. 20 degrees).	
58.0				REC=92%; RQD=92% (excellent)	
				58.3 to 58.3 ft.: Quartz vein. Pink to dark gray in color.	
58.5					
		58-5-59.5	13 min.		
59.0					
59.5					
		59.5-60.5	14 min.	59.7 ft.: Mechanical break in rock core.	
60.0					
				End R4 at 60.5 ft. Perform constant head permeability test from 45.5 to 60.5 ft..	
				Bottom of exploration at 60.5 ft. Boring terminated in bedrock. Grout completed borehole to	
60.5				mudline. Specific gravity = 1.46.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
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Boring Co.	Warren George, Inc.	Boring Location	northing 2697531		easting 814770
Driller	E. Thomas	Mudline El.	-21.27	Datum	NGVD
Logged By	E. Thibodeau	Date Start	11/20/2000	Date End	11/27/2000

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
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Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES

Core Runs R1 through R3

Core Run R4

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Driller	E. Thomas	Mudline El.	-21.27	Datum	NGVD
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Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES

Quartz/feldspar vein noted in R3

Quartz/feldspar vein noted in R4

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Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-104
SHEET 1 of 11
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co. Warren George, Inc. | Boring Location northing 2697289 easting 814756
Driller E. Thomas | Mudline El. -20.91 | Datum NGVD
Logged By E. Thibodeau | Date Start 11/28/00 | Date End 11/30/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance sampler to 2 ft.		
1	WOC								
2	WOC								
		UO-1	24/24	2-4	———	—	Organic soil (OH); 90% organic clay/silt, 10% fine sand, moderate organic odor, dark gray.		
							Advance PW drill casing to 5 ft.		
3	WOC						Advance 3-7/8 in. roller bit to 5 ft. No water return noted.		
4	WOC							ORGANIC CLAY	
5	WOC								
		UO-2	24/24	5-7	———	—	Clayey sand (SC); 60% fine sand, 40% organic clay/silt, moderate organic odor, gray.		
							Advance PW drill casing to 8 ft.		
							Advance 3-7/8 in. roller bit to 8 ft. Water return noted.		
6	WOC								
7	WOC								
8	WOC								
		S-1	24/10	8-10	WOR-4-3-2	7	S-1A; Similar to UO-2. (6 in.)		
							S-1B; Lean clay with sand (CL); medium stiff, 75% clay, 25% fine sand, olive brown. (4 in.)	8.50 ft.	
							Advance PW drill casing to 10 ft.		
9	WOC						Advance 3-7/8 in. roller bit to 10 ft.	MARINE SAND	
10	WOC								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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2) *3-inch O.D. split barrel sampler driven with a 140-lb automatic hammer free-falling from a height of 30 inches.
3)
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New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-104
SHEET 2 of 11
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co. Warren George, Inc.
Driller E. Thomas
Logged By E. Thibodeau

Boring Location northing 2697289 easting 814756
Mudline El. -20.91 Datum NGVD
Date Start 11/28/00 Date End 11/30/00

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Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

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DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-2	24/12	10-12	4-2-1-1	3	Sandy lean clay (CL); soft, 40% clay, 25% silt, 35% fine sand, olive-brown, 1/2 in. thick medium to fine sand seam noted in sample.		
							Advance PW drill casing to 12 ft.	MARINE SAND	
11	WOC						Advance 3-7/8 in. roller bit to 12 ft.		
12	WOC							12.0 ft.	
		S-3	24/12	12-14	5-4-5-6	9	**S-3A: Silty sand (SM); 1% coarse sand, 32% medium sand, 28% fine sand, 12% gravel, 27% silt, olive-brown.** Some shell fragments noted (8 in.)		1
							S-3B: Poorly graded sand with gravel (SP); loose, 15% coarse sand, 30% medium sand,		
13	15						20% fine sand, 30% gravel, 5% silt, subrounded to subangular sand and gravel, brown (4 in.)		
							Mix bentonite drilling mud. Specific gravity = 1.07.		
							Advance PW drill casing to 14 ft.		
14	8						Advance 3-7/8 in. roller bit to 14 ft.		
		S-4	24/7	14-16	6-3-4-4	7	**S-4: Poorly graded gravel with sand (GP); 14% coarse sand, 20% medium sand, 13% fine sand, 50% gravel, 3% silt, brown.** Subrounded sand and gravel.		1
							Advance PW drill casing to 16 ft.		
15	20						Advance 3-7/8 in. roller bit to 16 ft.	GLACIO FLUVIAL	
16	27								
		S-5	24/1	16-18	9-4-9-9	13	Poor recovery; washed sample. Mixed additional bentonite into drilling mud.		
							Advance PW drill casing to 18 ft.		
							Advance 3-7/8 in. roller bit to 18 ft.		
17	22								
18	20								
		S-6	24/2	18-20	4-4-3-4	7	Poor recovery; washed sample.		
							Advance PW drill casing to 20 ft.		
							Advance 3-7/8 in. roller bit to 20 ft.		
19	11						Approximately 6 in. of gravel in drill casing, unable to remove material from casing.		
20	8								

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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-104 SHEET 3 of 11 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697289		easting 814756
Driller	E. Thomas	Mudline El.	-20.91	Datum	NGVD
Logged By	E. Thibodeau	Date Start	11/28/00	Date End	11/30/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
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Groundwater Readings Not Applicable for Offshore Borings

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DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-7	24/9	20-22	5-4-4-5	8*	**Poorly graded sand with gravel (SP); 13% coarse sand, 26% medium sand, 23% fine sand, 36% gravel, 2% silt, brown.** Subangular sand, subrounded gravel.		1,2
							Advance PW drill casing to 21 ft. Casing secured to barge.		
21	11						Advance 3-7/8 in. roller bit to 22 ft.		
22	DROP								
		S-8	24/9	22-24	4-4-5-5	9*	Poorly graded sand (SP); loose, 20% coarse sand, 30% medium sand, 10% fine sand, 35% gravel, 5% silt, subangular sand and gravel, brown.		2
							Casing dropped to 25 ft. No material in casing.		
23	DROP								
24	DROP								
25	DROP							GLACIO FLUVIAL	
		S-9	24/1	25-27	4-4-2-3	6	Poor recovery; washed sample		
							Advance PW drill casing to 30 ft. Casing advanced by own weight to 27.5 ft.		
							Attempted to seal zone off.		
26	WOC						Mix additional bentonite into drilling mud. Specific gravity = 1.12.		
							Advance 2 15/16 in. roller bit to 30 ft.		
							Approximately 18 in. of cuttings in casing. Mix additional bentonite into drilling mud.		
							Advance roller bit to remove material; approximately 6 to 8 in. of material in casing.		
27	WOC								
	WOC								
28									
	32								
29									
	39								
30	19								

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BORING NO. FD-104
SHEET 4 of 11
FILE NO. 48138.27
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Boring Co. Warren George, Inc. | Boring Location northing 2697289 easting 814756
Driller E. Thomas | Mudline El. -20.91 | Datum NGVD
Logged By E. Thibodeau | Date Start 11/28/00 | Date End 11/30/00

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DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-10	24/6	30-32	8-7-5-6	12*	**Poorly graded gravel with sand (GP); 55% gravel, 10% coarse sand, 18% medium sand, 14% fine sand, 3% silt, gray.** Subrounded to subangular gravel and sand. Switch to mud rotory drilling techniques at 32 ft. Attempt 5 ft. open hole.		1,2
31	NR						Advance 3- 7/8 in. roller bit to 37 ft. Hole stayed open, slowly losing mud during roller bit advancement.		
32	NR								
33	NR								
34	NR								
35	NR							GLACIO FLUVIAL	
36	NR								
37	NR								
		S-11	24/4	37-39	6-4-4-4	8	**Poorly graded sand with gravel (SP); 11% coarse sand, 23% medium sand, 15% fine sand, 47% gravel, 4% silt, gray.** Subrounded to subangular sand and gravel. Advance PW drill casing to 40 ft.		1
38	NR						Mix additional bentonite drilling mud. Advance 3-7/8 in. roller bit to 40 ft. Approximately 8 to 12 in. cuttings in casing. Unable to remove material.		
39	NR								
40	NR								

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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
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BORING NO. FD-104
SHEET 5 of 11
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Boring Co. Warren George, Inc.
Driller E. Thomas
Logged By E. Thibodeau

Boring Location northing 2697289 easting 814756
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DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-12	24/6	40-42	6-4-4-5	8	**Poorly graded gravel with silt and sand (GP-GM); 72% gravel, 5% coarse sand, 9% medium sand, 8% fine sand, 6% silt, gray.** Subrounded to subangular sand and gravel. Advance 3-7/8 in. roller bit to 45 ft. by mud rotary open hole.	GLACIO FLUVIAL	1
41	NR								
42	NR								
43	NR								
44	NR						Change in drilling resistance at 44 ft. Estimated strata change at 44 ft.	44.0 ft.	
45	NR								
		S-13	24/6	45-47	6-20-30-37	50	Silty sand with gravel (SM); very dense, 10% coarse sand, 15% medium sand, 30% fine sand, 25% gravel, 20% silt, angular gravel, brown. (Glacial Till) Mix additional bentonite drilling mud.	GLACIAL TILL	
46							Advance 3-7/8 in. roller bit to 47 ft. by mud rotary. Top of bedrock 47 ft. Advance PW drill casing to 45.5 ft. Advance 3-7/8 in roller bit to 47.6 ft.		
47							Telescope HW drill casing to begin HQ bedrock coring at 47.6 ft. (boring log continued on next page)	47.0 ft. BEDROCK	
48									
49									
50									

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Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	47.6-48.6	8 mins	Begin R1 at 47.6 ft. Fresh, hard, gray, fine grained GNEISS, low angle foliation (approximately 20 to 30 degrees). REC = 93%; RQD = 92% (excellent) Water return color: milky white. Most of water return noted coming up PW drill casing. 47.8 ft.: Mechanical break in rock core. Minor core grinding noted.	
48						
48.5			48.6-49.6	7 mins		
49						
49.5			49.6-50.6	9 mins		
50						
50.5			50.6-51.6	8.5 mins.		
51					50.9 ft.: Mechanical break in rock core.	
51.5					51.4 ft.: Mechanical break in rock core.	
			51.6-52.6	6.5 mins.	51.5 ft.: Mechanical break in rock core. 51.6 ft.: Mechanical break in rock core. Minor core grinding noted. 51.7 ft.: Primary joint: low angle, rough, planar, discolored, and open.	
52						
52.5					End R1 at 52.6 ft.	

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SHEET	7 of 11
FILE NO.	48138.27
CHKD. BY	S. Bonis

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DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	52.6 - 53.6	3 mins.	Begin R2 at 52.6 ft. Fresh, hard, gray, fine-grained GNEISS. Low angle foliation (approx. 20 degrees). REC=100%; RQD=95% (excellent)	
53					Water return color: milky white. Water return noted only from PW drill casing. 53 to 53.2 ft.: Mechanical break in rock core (vertical). 53.1ft.: Mechanical break in rock core (horizontal).	
53.5						
			53.6 - 54.6	3.5 mins.	53.8 to 54.4 ft.: Secondary joint; high angle, rough, planar, discolored and open.	
54					53.9 to 54.7 ft.: High angle to vertical healed joint. 54.1ft.: Mechanical break in rock core.	
54.5					54.4 to 57.6 ft.: High angle to vertical healed joint. Several mechanical breaks noted.	
			54.6 - 55.6	4 mins.		
55						
55.5						
			55.6 - 56.6	4.5 mins.		
56						
56.5						
			56.6 - 57.6	6 mins.	56.5 to 57.3 ft.: High angle to vertical healed joint. 56.6 ft.: Primary joint; low angle, rough, undulating, discolored and open.	
57						
57.5					End R2 at 57.6 ft.	

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New Bedford Harbor Superfund Site	SHEET 8 of 11
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY S. Bonis

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Logged By	E. Thibodeau	Date Start	11/28/00	Date End	11/30/00

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DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	57.6 - 58.6	3.5 mins.	Begin R3 at 57.6 ft. Fresh, hard, gray, fine-grained GNEISS. Low angle foliation (approx. 20 - 30 degrees). REC = 100%, RQD = 100% (excellent) Water return color: milky white. Water return noted from PW drill casing only. 57.6 to 58.4 ft.: Healed joint. High angle to vertical. Continuation from core run R2.	
58						
58.5			58.6 - 59.6	4.5 mins.		
59						
59.5			59.6 - 60.6	7 mins.		
60						
60.5					60.5 ft: Mechanical break in rock core. Minor core grinding noted.	
			60.6 - 61.6	4 mins.		
61						
61.5			61.6 - 62.6	4 mins.		
62					End of R3 at 62.6 ft. Attempt to seat and seal HW drill casing into bedrock for constant head permeability test. Attempt unsuccessful. Bottom of exploration at 62.6 ft.; boring terminated in bedrock.	
62.5					Grouted completed borehole to mudline, specific gravity = 1.42.	

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. *Refer to GeoTesting Express Report dated March 5, 2001.* Laboratory description presented in bold.
2) *3-inch O.D. split barrel sampler driven with a 140-lb automatic hammer free-falling from a height of 30 inches.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-104
SHEET 9 of 11
FILE NO. 48138.27
CHKD. BY S. Bonis

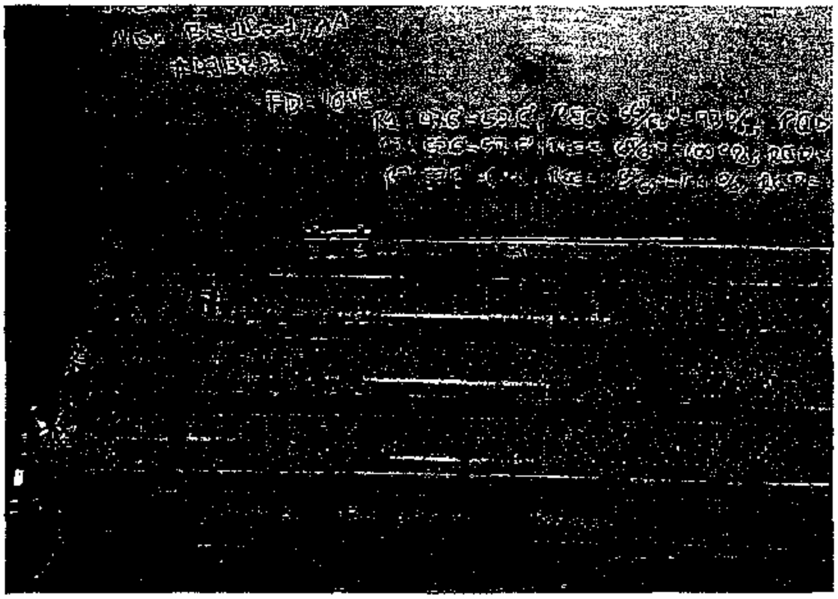
Boring Co.	Warren George, Inc.	Boring Location	northing 2697289 easting 814756
Driller	E. Thomas	Mudline El.	-20.91 Datum NGVD
Logged By	E. Thibodeau	Date Start	11/28/00 Date End 11/30/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

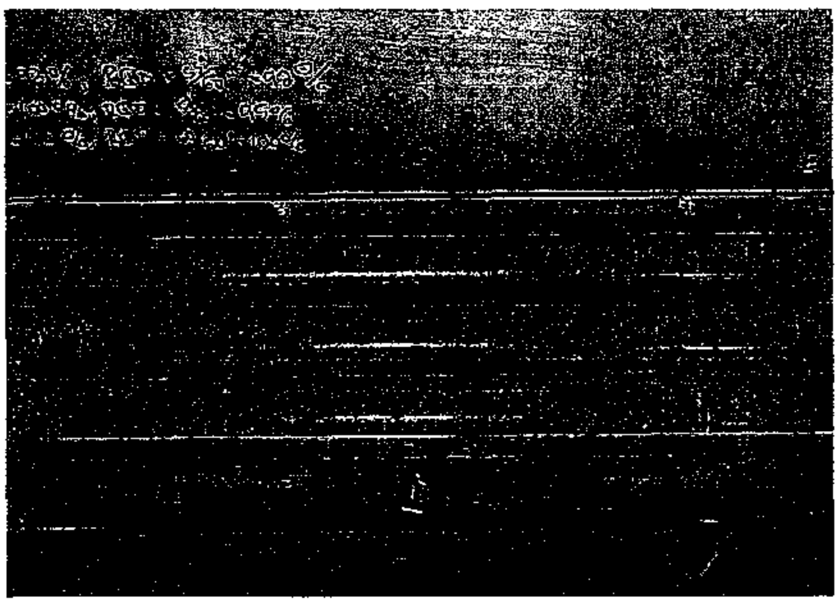
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split barrel sampler driven with a 140-lb automatic hammer free-falling from a height of 30 inches.
3)
4)

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Concord, New Hampshire 03301

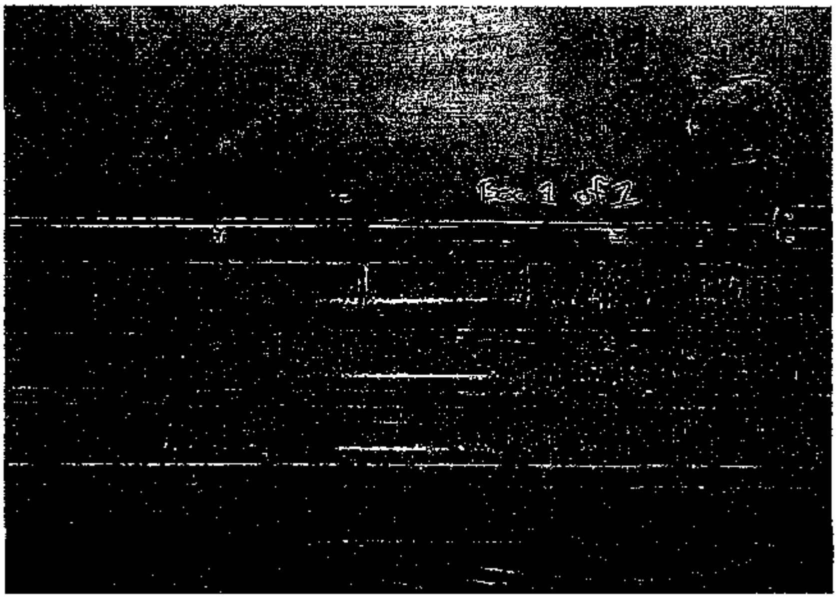
PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-104
New Bedford Harbor Superfund Site	SHEET	10 of 11
New Bedford, Massachusetts	FILE NO.	48138.27
	CHKD. BY	S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697289		easting 814756
Driller	E. Thomas	Mudline El.	-20.91	Datum	NGVD
Logged By	E. Thibodeau	Date Start	11/28/00	Date End	11/30/00

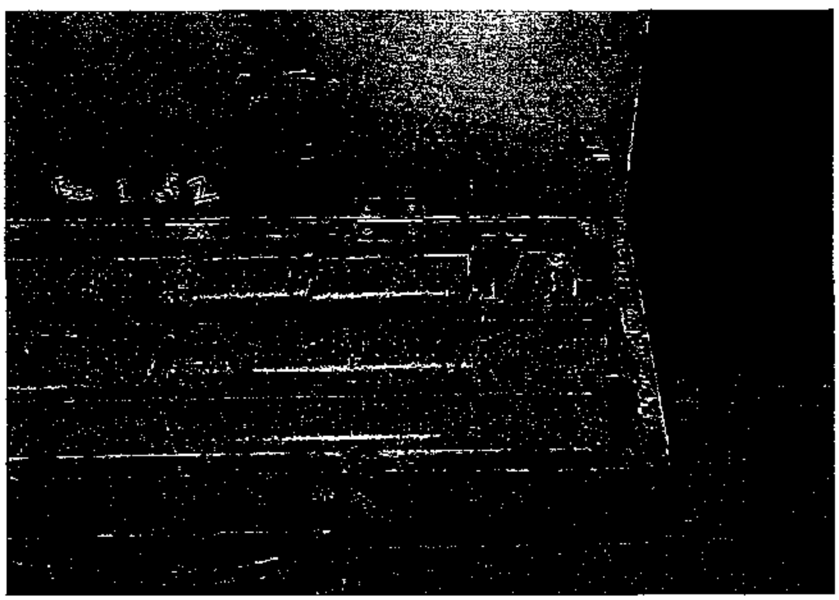
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split barrel sampler driven with a 140-lb automatic hammer free-falling from a height of 30 inches.
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Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

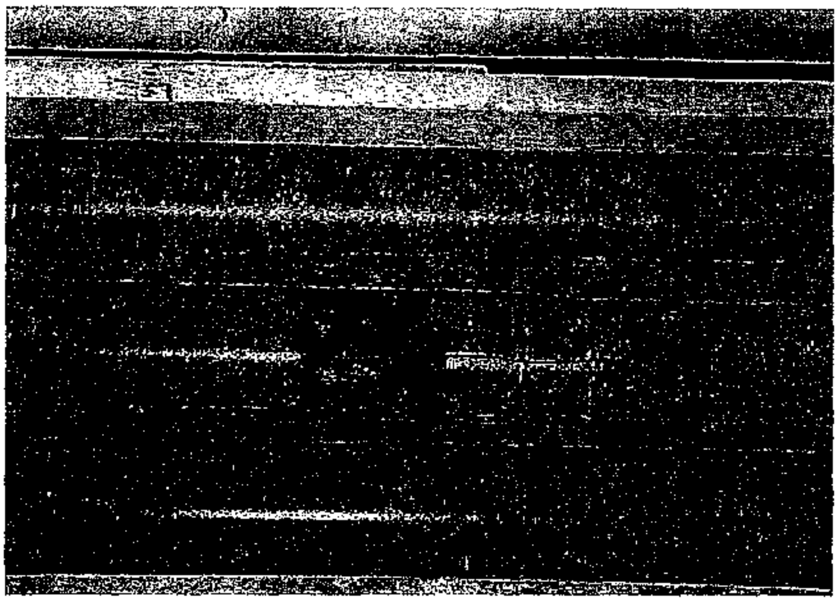
BORING NO. FD-104
SHEET 11 of 11
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697289		easting 814756
Driller	E. Thomas	Mudline El.	-20.91	Datum	NGVD
Logged By	E. Thibodeau	Date Start	11/28/00	Date End	11/30/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Secondary joint noted in R2

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split barrel sampler driven with a 140-lb automatic hammer free-falling from a height of 30 inches.
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Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-105
SHEET 1 of 5
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co. Warren George, Inc.
Driller S. Laurenza
Logged By A. Juneau

Boring Location northing 2697207 easting 814556
Mudline El. -12.29 Datum NGVD
Date Start 11/21/00 Date End 11/30/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing, 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

Depth (ft)	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance sampler to 2 ft.		
	WOC								
	WOC								
		UO-1	24/24	2-4	———	—	Organic soil with sand (OH); 5% coarse sand/shells, 15% fine sand, 80% organic clay/silt, strong organic odor, olive gray		
							Advance PW drill casing to 5 ft.		
	WOC						Advance 3-7/8 in. roller bit to 5 ft.		
	WOC								
	WOC							ORGANIC CLAY	
		UO-2	24/24	5-7	———	—	Similar to UO-1, possible disturbed sample.		
							Advance PW drill casing to 8.5 ft.		
							Advance 3-7/8 in. roller bit to 8.5 ft.		
	WOC								
	WOC								
8	WOC								
		UO-3	24/24	8.5-10.5	———	—	Sandy organic soil (OH); 35% fine sand, 65% organic clay/silt, strong organic odor, olive gray		
9	WOC								
							Advance PW drill casing to 11 ft.		
							Advance 3-7/8 in. roller bit to 11 ft.		
10	WOC								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-105
SHEET 2 of 5
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697207		easting 814556
Driller	S. Laurenza	Mudline El.	-12.29	Datum	NGVD
Logged By	A. Juneau	Date Start	11/21/00	Date End	11/30/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
11	WOH								
		UO-4	24/11	11-13	———	—	Sandy organic soil (OH); soft, 5% coarse sand, 35% fine sand, 60% organic clay/silt, strong organic odor, olive gray.	ORGANIC CLAY	
							Advance PW drill casing to 13 ft.		
12	WOH						Advance 3-7/8 in. roller bit to 13 ft.		
	3								
13	20								
		S-1	24/5	13-15	WOR-6-11-9	17	Poorly graded sand with silt (SP-SM); medium dense, 40% medium sand, 50% fine sand, 10% silt, light gray.	13.5 ft.	
							Estimated strata change at 13.5 ft.		
14	8						Advance PW drill casing to 15 ft.	MARINE SAND	
							Advance 3-7/8 in. roller bit to 15 ft.		
15	10						Perform falling head permeability test at 15 ft.		
		S-2	24/4	15-17	3-5-4-5	9	**Poorly graded sand with silt (SP-SM); 1% coarse sand, 9% medium sand, 77% fine sand, 13% silt, brownish gray.**		1
							Advance PW drill casing to 17 ft.		
16	11						Advance 3-7/8 in. roller bit to 17 ft.		
17	26								
		S-3	24/7	17-19	9-6-5-5	11	**Silty sand (SM); 2% coarse sand, 4% medium sand, 46% fine sand, 48% silt, light gray.** Organic odor.		1
							Casing dropped from 17 ft. to 18.4 ft. from 11-22-00 to 11-27-00.		
18	WOC						Advance PW drill casing to 21 ft.		
							Advance 3-7/8 in. roller bit to 21 ft.		
19	18								
20	20								

GRANULAR SOILS	COHESIVE SOILS	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO.	FD-105
SHEET	3 of 5
FILE NO.	48138.27
CHKD. BY	S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697207	easting 814556	
Driller	S. Laurenza	Mudline El.	-12.29	Datum	NGVD
Logged By	A. Juneau	Date Start	11/21/00	Date End	11/30/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	10						Perform falling head permeability test at 21 ft.		
		S-4	24/8	21-23	6-3-3-5	6	S-4A: Poorly graded sand with gravel (SP); loose, 20% coarse sand, 45% fine to medium sand, 30% fine gravel, 5% silt. Subround to round sand and gravel, light gray. (4 in.)		
22	20						**S-4B: Silt with sand (ML); 1% coarse sand, 1% medium sand, 26% fine sand, 1% gravel, 71% silt, grayish brown. (4 in.)**		1
							Advance PW drill casing to 23 ft.		
							Advance 3-7/8 in. roller bit to 23 ft.		
23	22								
		S-5	24/8	23-25	5-1-1-6	2	S-5A: Poorly graded sand with gravel (SP); very loose, 10% coarse sand, 20% medium sand, 50% fine sand, 15% gravel, 5% silt. Subround to subangular sand and gravel, light gray. (4 in.)		
24	22						**S-5B: Sandy silt (ML); 42% fine sand, 2% medium sand, 56% silt, grayish brown. (4 in.)**		1
							Advance PW drill casing to 25 ft.		
							Advance 3-7/8 in. roller bit to 25 ft.		
25	33							MARINE SAND	
		S-6	24/10	25-27	26-4-3-8	7	S-6A: Poorly graded sand with silt (SP-SM); loose, 85% fine sand, 5% medium sand, 10% silt, light brown. (5 in.)		
							S-6B: Well-graded sand with gravel (SW-SM); loose, 20% coarse sand, 35% medium		
26	33						sand, 25% fine sand, 10% gravel, 10% silt. Subround to subangular sand and gravel, yellow brown. (5 in.) Sample found as thin horizon in top and bottom of spoon sample.		
							Advance PW drill casing to 27 ft.		
							Advance 3-7/8 in. roller bit to 27 ft.		
27	33								
		S-7	24/0	27-29	14-3-4-3	7	No sample recovered.		
							Advance PW drill casing to 29 ft.		
							Advance 3-7/8 in. roller bit to 29 ft.		
28	44								
29	41								
		S-8	24/6	29-31	3-2-1-3	3	Poorly graded sand (SP); very loose, 40% coarse sand, 45% medium sand, 10% fine sand, 5% gravel, subround gravel, subround to subangular sand, yellow brown.		
30	35						Advance PW drill casing to 31 ft.		

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-105 SHEET 4 of 5 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co. Warren George, Inc. | Boring Location northing 2697207 easting 814556
Driller S. Laurenza | Mudline El. -12.29 | Datum NGVD
Logged By A. Juneau | Date Start 11/21/00 | Date End 11/30/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance 3-7/8 in. roller bit to 31 ft.	MARINE SAND	
31	39						Perform falling head permeability test at 31 ft.	31.0 ft.	
		S-9	24/8	31-33	6-7-18-23	25	**Poorly graded sand with gravel (SP); 42% coarse sand, 10% medium sand, 3% fine sand, 43% gravel, 2% silt, brown.**	GLACIO FLUVIAL	1
							Angular to subround sand and gravel, coarse gravel in tip of split spoon sampler.		
32	38								
							Advance PW drill casing to 35 ft.		
							Mix bentonite drilling mud, specific gravity = 1.07.		
33	36						Advance 3-7/8 in. roller bit to 35 ft.		
34	51								
35	171						Perform falling head permeability test at 35 ft.		
		S-10	2/2	35-35.1	100/2"	>50	Poorly graded sand with silt (SP-SM); 85% fine sand, 5% medium sand, 10% silt/clay, yellow brown	35.3 ft.	
							PW casing refusal at 35.3 ft. Telescope HW drill casing to 39.0 ft. (Spin and wash).		
36	177						Advance 3-7/8 in. roller bit to 39 ft.	BOULDER	
37	64								
38	24						Broke through boulder at 38.3 ft.	38.3 ft.	
39	52							GLACIO FLUVIAL	
		S-11	24/10	39-41	12-14-15-15	29	Poorly graded sand (SP); medium dense, 60% fine sand, 30% medium sand, 5% gravel, 5% silt, angular to subangular sand and gravel, light gray.		
40	170						Remove HW drill casing at 39.0 ft., switch to wash and drive.		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-105
SHEET	5 of 5
FILE NO.	48138.27
CHKD. BY	S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2697207		easting 814556
Driller	S. Laurenza	Mudline El.	-12.29	Datum	NGVD
Logged By	A. Juneau	Date Start	11/21/00	Date End	11/30/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance HW drill casing to 41 ft.		
							Mix bentonite drilling mud, specific gravity = 1.09.		
							Advance 3-7/8 in. roller bit to 41 ft.		
41	194/						Advance 3-7/8 in. roller bit to 45 ft. NW drill rod broke at 35.0 ft.		
	6"						Borehole abandoned at 41 ft.		
							Borehole grouted to mudline. specific gravity = 1.50.		
42									
43									
44									
45									
46									
47									
48									
49									
50									

GRANULAR SOILS	COHESIVE SOILS	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
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REMARKS:
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18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-105A
SHEET 1 of 16
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.	Boring Location	northing 2697202	easting 814558
Driller S. Laurenza	Mudline El.	-13.07	Datum NGVD
Logged By C. Thunberg	Date Start	1/2/01	Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Undisturbed samples obtained for environmental analysis.		
1	NR								
2	NR								
		UO-1	24/24	2-4	————	——	Organic soil with sand (OH); 15% fine sand, 85% organic clay/silt, shells, organic odor, dark gray to black.		
3	NR								
4	NR								
		UO-2	24/20	4-6	————	——	Similar to UO-1.		
							Advance PW drill casing to 37.8 ft.		
							Advance 3-7/8 in. roller bit to 38.5 ft., rock chips noted in wash water return.		
5	NR								
6	NR								
7	NR								
8	NR								
9	NR								
10	NR								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

M:\Reports\Active\48138.21\Field Forms\FD-105A.xls\FD-105A

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-105A SHEET 2 of 16 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller S. Laurenza
Logged By C. Thunberg
Boring Location northing 2697202 easting 814558
Mudline El. -13.07 Datum NGVD
Date Start 1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION: Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	NR						Advance 3-7/8 in. roller bit to 38.5 ft., rock chips noted in wash water return.		
12	NR								
13	NR								
14	NR								
15	NR								
16	NR								
17	NR								
18	NR								
19	NR								
20	NR								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

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18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-105A
SHEET 3 of 16
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202	easting 814558	
Driller	S. Laurenza	Mudline El.	-13.07	Datum	NGVD
Logged By	C. Thunberg	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance 3-7/8 in. roller bit to 38.5 ft., rock chips noted in wash water return.		
21	NR								
22	NR								
23	NR								
24	NR								
25	NR								
26	NR								
27	NR								
28	NR								
29	NR								
30	NR								

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-105A
SHEET 4 of 16
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202	easting 814558	
Driller	S. Laurenza	Mudline El.	-13.07	Datum	NGVD
Logged By	C. Thunberg	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance 3-7/8 in. roller bit to 38.5 ft., rock chips noted in wash water return.		
31	NR								
32	NR								
33	NR								
34	NR								
35	NR								
36	NR								
37	NR								
38	NR								
							Advance PW drill casing to 43.0 ft.		
39	NR								
40	NR								

[illegible]	[illegible]	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

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18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-105A

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202	easting 814558	
Driller	S. Laurenza	Mudline El.	-13.07	Datum	NGVD
Logged By	C. Thunberg	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	198								
42	154								
43	>400						Casing refusal at 43.0 ft. Top of bedrock at 43.0 ft. Advance 3-7/8 in. roller bit to 45.0 ft. Telescope HW drill casing to 45.0 ft. Begin HQ rock core at 45.0 ft. (boring log continued on next page)	43.0 ft. BEDROCK	
44									
45									
46									
47									
48									
49									
50									

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *RQD biased low due to recovery of less than 100%.*
2)
3)
4)

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

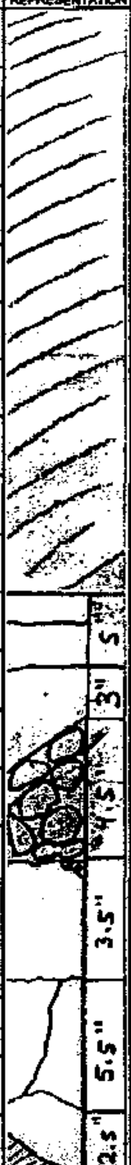
BORING NO. FD-105A
SHEET 6 of 16
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202 easting 814558
Driller	S. Laurenza	Mudline El.	-13.07 Datum NGVD
Logged By	C. Thunberg	Date Start	1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time



DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R1	45-46	11.5 min.	Begin R1 at 45.0 ft. Slightly weathered, moderately hard, light gray, medium grained GNEISS. Low angle foliation (approx. 5 to 10 degrees). Primary joint set along foliation. Secondary joint set, high angle. Could not determine joint spacing due to poor recovery. Recovered rock core is highly fractured. Difficult to determine whether breaks are mechanical or natural jointing. REC = 40%; RQD = 10% (very poor) Water return color: clear to gray. Steel recovered in top of R1, probable damaged drive shoe.	1
45.5					
46.0		46-47	10.5 min.		
46.5					
47.0		47-48	10.5 min.		
47.5					
48.0		48-49	5.5 min.		
48.5					
49.0		49-50	1.5 min.		
49.5					
50.0				End R1 at 50.0 ft.	

[illegible]	[illegible]	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-105A SHEET 7 of 16 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202 easting 814558
Driller	S. Laurenza	Mudline El.	-13.07 Datum NGVD
Logged By	C. Thunberg	Date Start	1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings.

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	50-51	6 min	Begin R2 at 50.0 ft. Slightly weathered, moderately hard, light gray, medium grained GNEISS. Low angle foliation (approx. 10 to 25 degrees). Primary joints along foliation. No secondary jointing observed.	
50.5					REC = 72%; RQD = 60% (fair) Water return color: milky white to gray. Steel recovered in top of R2, probable damaged drive shoe.	1
51.0			51-52	5.5 min		
51.5						
52.0			52-53	3 min		
52.5					52.25 ft.: Mechanical break in rock core. No water return noted after 52.5 ft.	
53.0			53-54	6 min	53.0 ft.: Primary joint.	
53.5						
54.0			54-55	6.5 min		
54.5						
55.0					End R2 at 55.0 ft.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-105A
SHEET 8 of 16
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202 easting 814558
Driller	S. Laurenza	Mudline El.	-13.07 Datum NGVD
Logged By	C. Thunberg	Date Start	1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	55-56	11 min.	Begin R3 at 55.0 ft. Fresh to slightly weathered, hard, dark gray, QUARTZ. Some discoloration noted. Several mechanical breaks and one infilled joint noted. Infilling material comprised of silt/clay. Possible QUARTZ vein.	
55.5	CORE NOT RECOVERED				REC = 50%; RQD = 0% (very poor) Several broken rock fragments recovered in top of core run; overcore from R2.	1
56.0					End of R3 at 56.0 ft. Core run terminated due to mechanical problems.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-105A
New Bedford Harbor Superfund Site	SHEET	9 of 16
	FILE NO.	48138.27
New Bedford, Massachusetts	CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202	easting 814558	
Driller	S. Laurenza	Mudline El.	-13.07	Datum	NGVD
Logged By	C. Thunberg	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
56.0–57.0 (56.5, 57.0)	R4	56-57	13 min.	Begin R4 at 56.0 ft. Fresh, hard, gray, fine to medium grained GNEISS. Low angle foliation (approx. 20 to 30 degrees). REC = 100%; RQD = 75% (fair/good) 56.0 to 56.2 ft.: Rock fragments; overcore from R3. 56.2 to 58.8 ft.: Feldspar/Quartz zone. Pink/dark gray/white in color. Very coarse grained. Pegmatic. 56.4 ft.: Mechanical break in rock core. 56.9, 57.4, 57.5, 58.0 ft.: Joints/fractures in pegmatic zone. Low angle to moderately dipping, rough,	
57.0–58.0 (57.5, 58.0)		57-58	8.5 min.	stepped to undulating, discolored, and open to tight. Clay/silt infilling noted on some joints/fractures.	
58.0–59.0 (58.5, 59.0)		58-59	7 min.		
59.0–60.0 (59.5, 60.0)		59-60	7.5 min.	59.2 ft.: Primary joint: Horizontal to low angle, smooth, planar, discolored, and tight. 59.8 ft.: Primary joint: Low angle, smooth, planar, discolored, and tight.	
60.0–61.0 (60.5, 61.0)		60-61	7.5 min.	60.3 to 60.5 ft.: Feldspar/Quartz vein. Pink/dark gray/white in color. Pegmatic. 60.3 ft.: Mechanical break in rock core. 60.4 ft.: Joint/fracture in pegmatic vein. Moderately dipping, rough, stepped, and discolored. Attempted packer test after R4, could not lower packer down borehole due to obstruction caused by incompetent fractured rock. Attempted to clear obstruction by advancing roller bit, unsuccessful. Telescoped 3 in. NW drill casing to 61 ft. Switch to NX core barrel for R5. End R4 at 61.0 ft.	

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOLS KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-105A SHEET 10 of 16 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202 easting 814558
Driller	S. Laurenza	Mudline El.	-13.07 Datum NGVD
Logged By	C. Thunberg	Date Start	1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R5	61-62	5.5 min.	Begin NX rock core at 61 ft. Begin R5 at 61.0 ft. Fresh, hard, gray, fine grained GNEISS. Low angle foliation (approx. 20 degrees).	
61.5					REC = 83%; RQD = 76% (good) 61.1 ft.: Mechanical break in rock core. 61.3 ft.: Primary joint: Low angle, rough, planar, discolored, and tight. 61.5 ft.: Mechanical break in rock core.	1
62.0					61.9 ft.: Mechanical break in rock core.	
			62-63	4 min.	62.1 ft.: Primary joint: Low angle, rough, stepped, discolored, and open.	
62.5					62.6 ft.: Mechanical break in rock core. 62.7 ft.: Primary joint: Low angle, smooth, planar, discolored, and tight.	
63.0					62.9, 63.1, and 63.2 ft.: Mechanical breaks in rock core.	
			63-64	4 min.	63.0 ft.: Loss of water return noted.	
63.5					63.4 to 63.6 ft.: Several mechanical breaks in rock core. Appears to be some quartz. Core grinding noted.	
64.0					63.8, 64.0, 64.3, 64.6, 64.7, and 65.0 ft.: Mechanical breaks in rock core.	
			64-65	6 min.	64.0 ft.: Water return restored.	
64.5						
65.0						
			65-66	5 min.		
65.5	CORE NOT RECOVERED				65.3 to 66.0 ft.: Rock core not recovered.	
66.0					End R5 at 66.0 ft.	

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOLOGY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-105A
SHEET	11 of 16
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202	easting 814558	
Driller	S. Laurenza	Mudline El.	-13.07	Datum	NGVD
Logged By	C. Thunberg	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
	R6	66-67	6 min.	Begin R6 at 66.0 ft. Fresh, hard, gray, medium to fine grained GNEISS. Low angle foliation (approx. 20 degrees). REC = 95%; RQD = 82% (good)	1
66.5				66.1 ft.: Mechanical break in rock core.	
67.0				66.9 ft.: Primary joint: Low angle, smooth, planar, discolored, and tight.	
		67-68	5.5 min.		
67.5				67.5 ft.: Mechanical break in rock core.	
68.0		68-69	6.5 min.	68.2 ft.: Primary joint: Low angle, smooth, planar, discolored, and open.	
68.5					
69.0				68.9 ft.: Mechanical break in rock core.	
		69-70	5 min.	69.1 ft.: Primary joint: Low angle, rough, planar, discolored, and open. 69.1 to 69.7 ft.: Several mechanical breaks in rock core, heavily fractured and broken up.	
69.5					
70.0		70-71	5 min.	70.0 and 70.5 ft.: Mechanical breaks in rock core.	
70.5					
71.0				End R6 at 71 ft. Bottom of exploration at 71 ft. Boring terminated in bedrock. Grout completed borehole to mudline with cement/bentonite grout, specific gravity = 1.32.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOLS KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

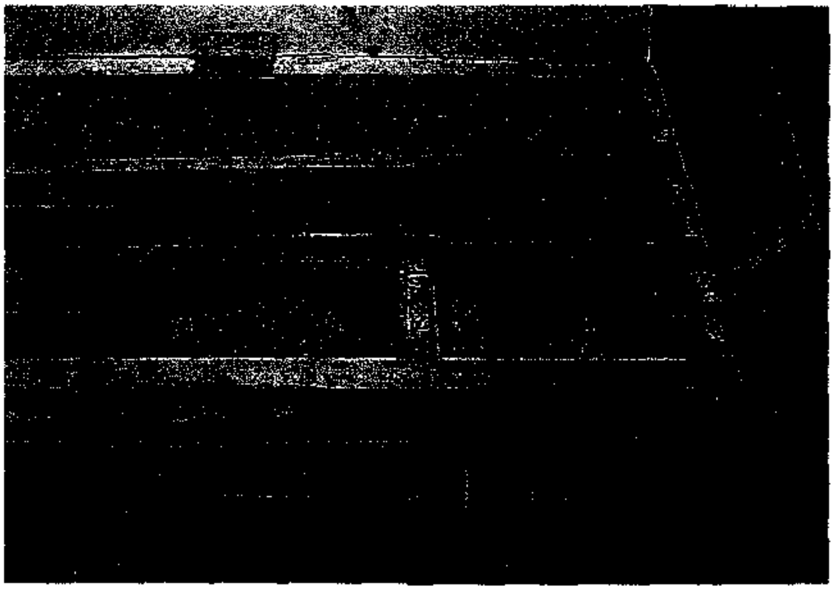
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-105A SHEET 13 of 16 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202	easting 814558	
Driller	S. Laurenza	Mudline El.	-13.07	Datum	NGVD
Logged By	C. Thunberg	Date Start	1/2/01	Date End	1/5/01

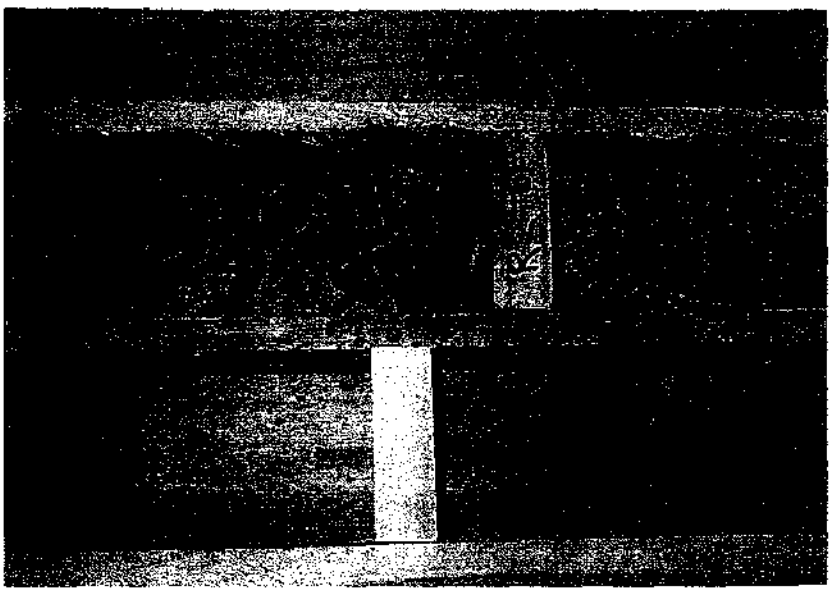
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Steel recovered in top of R2

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

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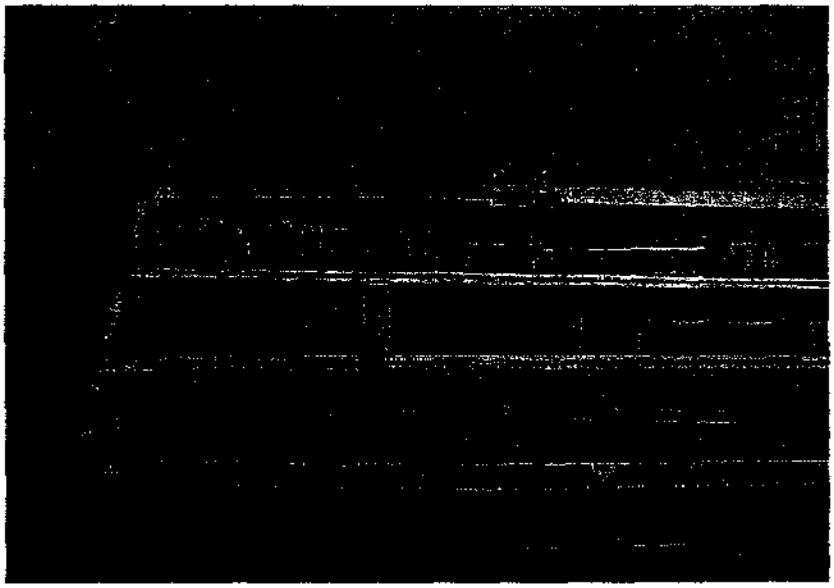
PROJECT		
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-105A SHEET 14 of 16 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202 easting 814558
Driller	S. Laurenza	Mudline El.	-13.07 Datum NGVD
Logged By	C. Thunberg	Date Start	1/2/01 Date End 1/5/01

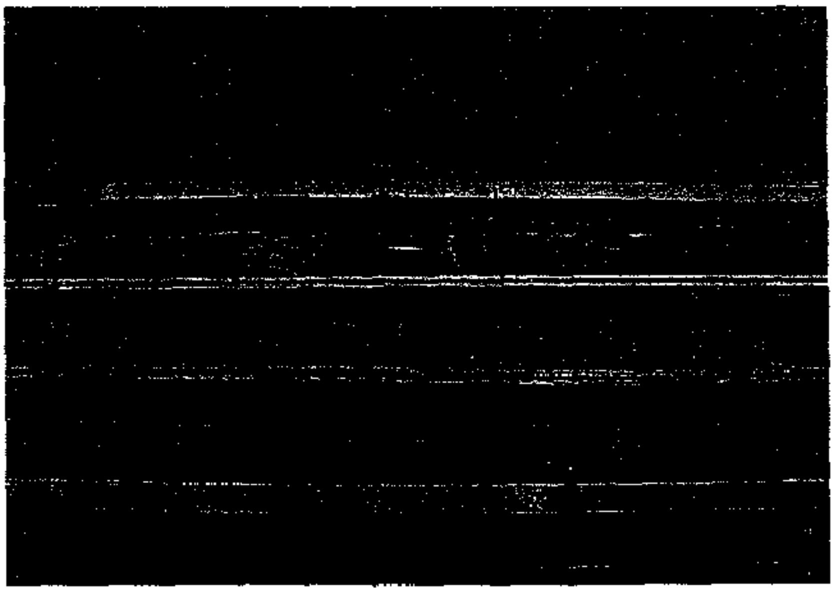
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R4 through R6



Core Runs R4 through R6

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

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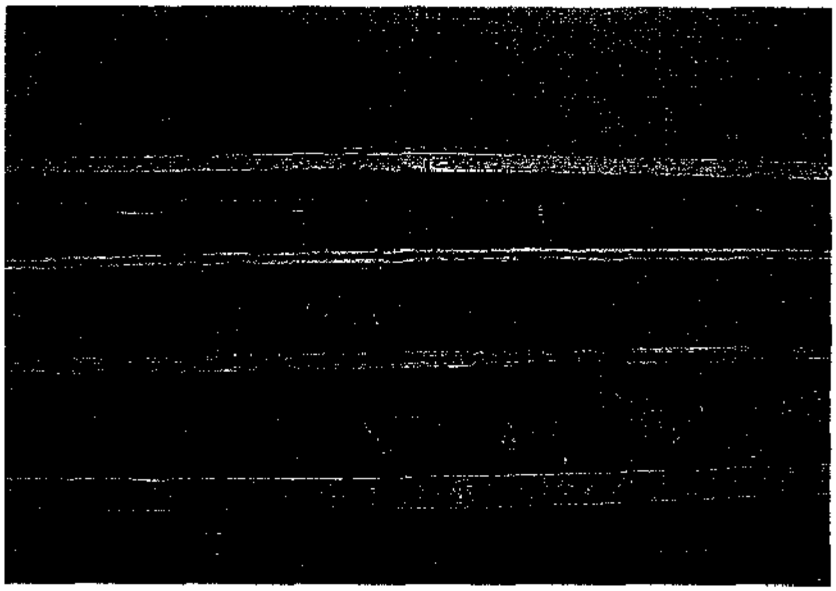
Nobis Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-105A SHEET 15 of 16 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2697202 easting 814558
Driller	S. Laurenza	Mudline El.	-13.07 Datum NGVD
Logged By	C. Thunberg	Date Start	1/2/01 Date End 1/5/01

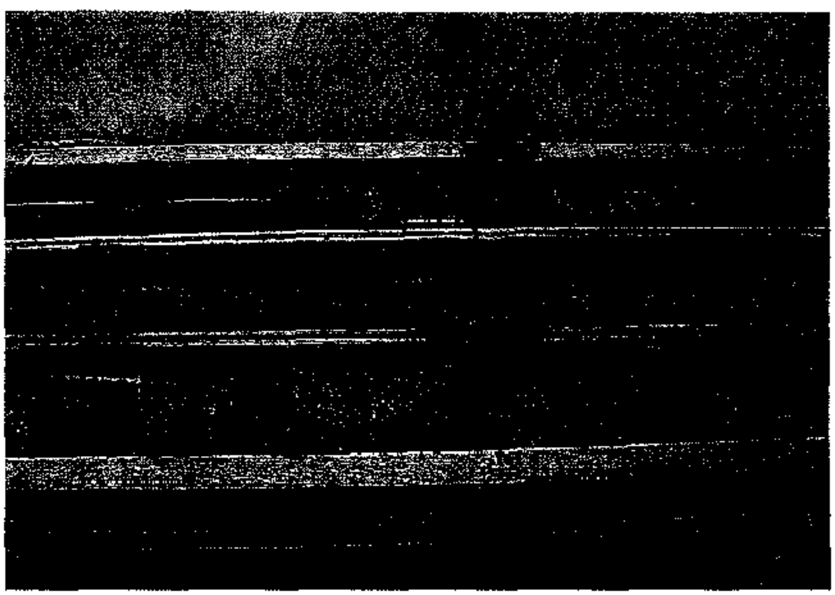
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R4 through R6



Core Runs R4 through R6

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-105A
New Bedford Harbor Superfund Site	SHEET 16 of 16
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

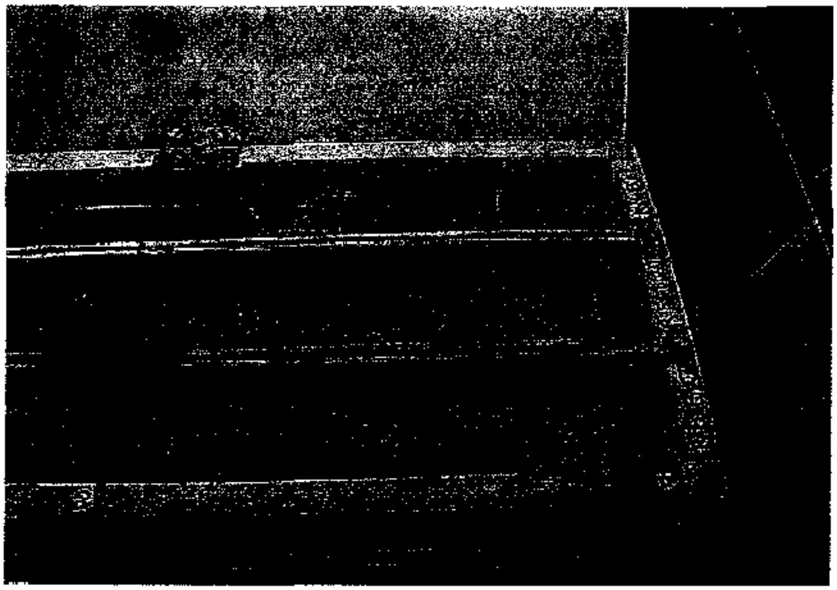
Boring Co.	Warren George, Inc.	Boring Location	northing 2697202	easting 814558	
Driller	S. Laurenza	Mudline El.	-13.07	Datum	NGVD
Logged By	C. Thunberg	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

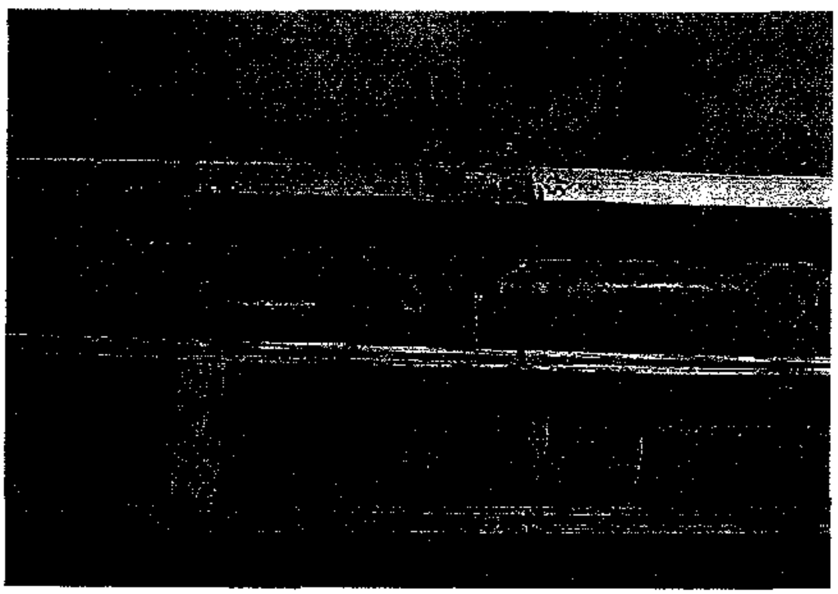
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R4 through R6



Quartz/feldspar (pegmatic) zone noted in R4

REMARKS:
1) RQD biased low due to recovery of less than 100%.
2)
3)
4)

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Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-106
SHEET 1 of 12
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller S. Laurenza
Logged By A. Juneau

Boring Location northing 2696916 easting 814510
Mudline El. -10.74 Datum NGVD
Date Start 12/7/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1	WOC								
2	WOC						Osterberg sampler did not extend when attempting to collect UO sample at 2 ft.; problem corrected and sample collected from 2.5 to 4.5 ft.		
		UO-1	24/23	2.5-4.5	———	—	Organic soil with sand (OH); 5% medium sand, 15% fine sand, 80% organic clay/silt, shells, plant material, dark olive gray.		
3	WOC						Advance PW drill casing to 5 ft. Advance 4-3/4 in. roller bit to 5 ft.		
4	WOC								
5	WOC							ORGANIC CLAY	
		UO-2	24/24	5-7	———	—	Organic soil with sand (OH); 10% medium sand, 15% fine sand, 75% organic clay/silt, shell, dark olive gray. Advance PW drill casing to 8 ft. Advance 4-3/4 in. to 8 ft.		
6	WOC								
7	WOC								
8	WOC								
		UO-3	24/24	8-10	———	—	Sandy organic soil (OH); 5% coarse sand, 5% medium sand, 25% fine sand, 5% gravel, 60% organic clay/silt, dark olive gray, subangular to subround sand and gravel. Advance PW drill casing to 11 ft. Advance 4-3/4 in. roller bit to 11 ft.		
9	WOC								
10	WOC								

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-106
SHEET 2 of 12
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696916	easting 814510	
Driller	S. Laurenza	Mudline El.	-10.74	Datum	NGVD
Logged By	A. Juneau	Date Start	12/7/00	Date End	12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	WOC							ORGANIC CLAY	
		UO-4	24/17	11-13	———	—	Sandy organic soil (OH); 10% medium sand, 25% fine sand, 65% organic clay/silt, dark olive gray. Advance PW drill casing to 13 ft. Advance 3-7/8 in. roller bit to 13 ft.		
12	WOC							12.5 ft.	
13	WOC								
		S-1	24/9	13-15	5-7-18-21	25	Poorly graded sand with gravel (SP); medium dense, 25% coarse sand, 40% medium sand, 10% fine sand, 20% gravel, 5% silt, subrounded to subangular sand and gravel, trace shell fragments, gray. Advance PW drill casing to 15 ft. Advance 3-7/8 in. roller bit to 15 ft.		
14	10								
15	14							GLACIO FLUVIAL	
		S-2	24/6	15-17	19-26-28-24	52	*Poorly graded gravel with silt and sand (GP-GM); very dense, 5% coarse sand,* 5% medium sand, 30% fine sand, 50% gravel, 10% silt, subround to subangular sand and gravel, gray. Advance PW drill casing to 20 ft. Mix bentonite drilling mud, specific gravity = 1.09. Advance 3-7/8 in. roller bit to 20 ft.		
16	25								
17	27								
18	19								
19	69								
20	76								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-106 SHEET 3 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696916 easting 814510
Driller	S. Laurenza	Mudline El.	-10.74 Datum NGVD
Logged By	A. Juneau	Date Start	12/7/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-3	24/12	20-22	6-6-6-7	12*	**Poorly graded sand with silt (SP-SM); 5% coarse sand, 18% medium sand, 56% fine sand, 11% gravel, 10% silt, gray.** Subangular to subround sand and gravel. Advance PW drill casing to 25 ft. Advance 3-7/8 in. roller bit to 25 ft.		1,2
21	15								
22	47								
23	54								
24	77							GLACIO FLUVIAL	
25	94								
		S-4	24/15	25-27	12-10-9-12	19*	**Silty sand with gravel (SM): 11% coarse sand, 23% medium sand, 24% fine sand, 23% gravel, 19% silt, light gray.** Subangular to subround sand and gravel. Advance PW drill casing to 30.5 ft. Advance 3-7/8 in. roller bit to 30.5 ft.		1,2
26	76								
27	82								
28	74								
29	55								
30	64								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOLS KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. ROD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-106 SHEET 4 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696916	easting 814510	
Driller	S. Laurenza	Mudline El.	-10.74	Datum	NGVD
Logged By	A. Juneau	Date Start	12/7/00	Date End	12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/0	30-32	10-4-3-5	7*	Washed sample		1
							Advance PW drill casing to 32 ft.		
							Advance 3-7/8 in. roller bit to 32 ft.		
31	51								
								GLACIO FLUVIAL	
32	46								
		S-6	24/12	32-34	6-4-7-21	11*	Well graded sand with gravel (SW); medium dense, 20% coarse sand,		1
							20% medium sand, 15% fine sand, 40% gravel, 5% silt, subangular to subround sand and		
							gravel, light gray.		
33	73						Refusal of PW drill casing at 34.0 ft.		
							Advanced 3-7/8 in. roller bit to 34.0 ft.		
34	224/9"							34.0 ft.	
							Advance 3-7/8 in. roller bit through boulder from 34 to 36.5 ft.		
35	SPIN							BOULDER	
36	SPIN								
								36.5 ft.	
		S-7	24/12	36.7-38.7	13-20-14-14	34*	**S-7A: Poorly graded sand with gravel (SP), 20% coarse sand, 20% medium sand,**		1,2
37	SPIN						**13% fine sand, 45% gravel, 2% silt, brown.** (7 in.)		
							S-7B: Silty sand with gravel (SM); 8% coarse sand, 14% medium sand,		2
							18% fine sand, 40% gravel, 19% silt, brownish gray.		
							Subangular to angular sand and gravel (5 in.)	GLACIO FLUVIAL	
38	SPIN						Advance HW drill casing to 41 ft.		
							Advance 3-7/8 in. roller bit to 41 ft.		
39	SPIN								
40	SPIN								

GRANULAR SOILS (N VALUE)	COHESIVE SOILS (N VALUE)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-106
SHEET 5 of 12
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696916	easting 814510	
Driller	S. Laurenza	Mudline El.	-10.74	Datum	NGVD
Logged By	A. Juneau	Date Start	12/7/00	Date End	12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	SPIN								
		S-8	24/0	41-43	15-19-24-27	43*	Washed sample. Advance HW drill casing to 43 ft. Advancing 2-15/16 in. roller bit to 43 ft.		1
42	42								
43	45								
		S-9	24/6	44-46	14-21-28-37	49	Washed sample. Advance HW drill casing to 49.0 ft.		
44	40							GLACIO FLUVIAL	
45	45								
46	125								
47	154								
48	75								
49	54							49.0 ft.	
	100/0"						HW drill casing refusal at 49.0 ft. Advance 3-7/8 in. roller bit to 50.5 ft. Advance HW drill casing to 50.5 ft.	BEDROCK	
50									

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-106

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696916 easting 814510
Driller	S. Laurenza	Mudline El.	-10.74 Datum NGVD
Logged By	A. Juneau	Date Start	12/7/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Begin HQ rock core at 50.5 ft.		
							(boring log continued on next page)		
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. ROD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-106 SHEET 7 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co. Warren George, Inc. — Boring Location: northing 2696916 easting 814510
Driller: S. Laurenza — Mudline EL: -10.74 — Datum: NGVD
Logged By: A. Juneau — Date Start: 12/7/00 — Date End: 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE INFORMATION: CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	50.5-51.5	9 min.	Begin R1 at 50.5 ft. Fresh, very hard, gray, fine to medium grained GNEISS, low angle foliation (approx. 30 degrees), biotite/feldspar foliation, no joints/fractures (discontinuities) noted. REC = 82%; RQD = 82% Water return color: milky white.	
51.0						
51.5			51.5-52.5	8.83 min.		
52.0						
52.5			52.5-53.5	4.75 min.		
53.0						
53.5			53.5-54.5	5.25 min.		
54.0						
54.5			54.5-55.5	5.25 min.	54.6 ft.: Mechanical break in rock core. No core grinding noted. End of R1 recovered length	
55.0						
55.5					End R1 at 55.5 ft.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-106 SHEET 8 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2696916 easting 814510
Driller S. Laurenza | Mudline El. -10.74 | Datum NGVD
Logged By A. Juneau | Date Start 12/7/00 | Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R2	55.5-56.5	5.5 min.	Begin R2 at 55.5 ft. Fresh, very hard, gray, fine to medium grained GNEISS, low angle foliation (approx. 15 to 30 degrees), biotite/feldspar foliation, no joints/fractures (discontinuities) noted. REC = 102%; RQD = 102% Water return color: milky white.	
56.0						
56.5			56.5-57.5	4.5 min.		
57.0						
57.5			57.5-58.5	4.5 min.		
58.0					58.2 ft.: Mechanical break in rock core. No core grinding noted.	
58.5			58.5-59.5	6.5 min.		
59.0					58.8 ft.: Mechanical break in rock core. No core grinding noted. End of R2 recovered length	
59.5		R3	59.5-60.5	8.5 min.	Begin R3 at 59.5 ft. Slightly weathered, hard to very hard, gray, fine to medium grained GNEISS, low angle foliation (approx. 10 degrees), low angle joints are close to moderately spaced, orange discoloration up to 1/2 in. into rock, partly open to open, with no obvious infilling. REC = 98%; RQD = 96% 59.9 ft.: Irregular fracture at bottom of quartz/feldspar dike (1 in.), low angle (approx. 20 degrees), rough, planar, tight, iron stained, slightly weathered.	
60.0						
60.5						

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) 3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-106 SHEET 9 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696916 easting 814510
Driller	S. Laurenza	Mudline El.	-10.74 Datum NGVD
Logged By	A. Juneau	Date Start	12/7/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3 (cont.)	60.5-61.5	4.5 min.	60.5 ft.: Irregular joints: rough, planar, partly open, slightly weathered. Core grinding observed. 60.6 ft.: Irregular joint: rough, stepped, open, slightly weathered. Core grinding observed.	
61.0						
61.5			61.5-62.5	5.5 min.		
62.0					61.9 ft.: Mechanical break in rock core. Minimal core grinding noted.	
62.5			62.5-63.5	5 min.	62.5 ft.: Minor joint, smooth, planar, tight, iron staining on surface only.	
63.0					63.3 ft.: Mechanical break in rock core. No core grinding noted.	
63.5			63.5-64.5	4.5 min.	63.7 ft.: Mechanical break in rock core. No core grinding noted. End of R3 recovered length.	
64.0						
64.5		R4	64.5-65.5	5.5 min.	Fresh, very hard, gray, fine to medium grained GNEISS, low angle foliation (approx. 15 degrees), biotite/feldspar foliation, no joints/fractures noted. REC = 100%; RQD = 100% Water return color: milky white.	
65.0						
65.5						

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-106
SHEET 10 of 12
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller S. Laurenza
Logged By A. Juneau

Boring Location northing 2696916 easting 814510
Mudline El. -10.74 Datum NGVD
Date Start 12/7/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
			65.5-66.5	5.17 min.		
66.0						
66.5			66.5-67.5	5 min.		
67.0						
67.5			67.5-68.5	4.17 min.		
68.0					68.2 ft.: Mechanical break in rock core. No core grinding noted.	
68.5			68.5-69.5	5.83 min.	68.5 ft.: Mechanical break in rock core. No core grinding noted.	
69.0					69.0 ft.: Mechanical break in rock core. Minimal core grinding noted. Orthoclose feldspar rich zone from 69.0 to 69.3 ft. End of R4 recovered length. End R4 at 69.5 ft.	
69.5					Bottom of exploration at 69.5 ft. Boring terminated in bedrock. Grout completed borehole to mudline with cement/bentonite grout, specific gravity = 1.40.	
70.0						
70.5						

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-106 SHEET 11 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

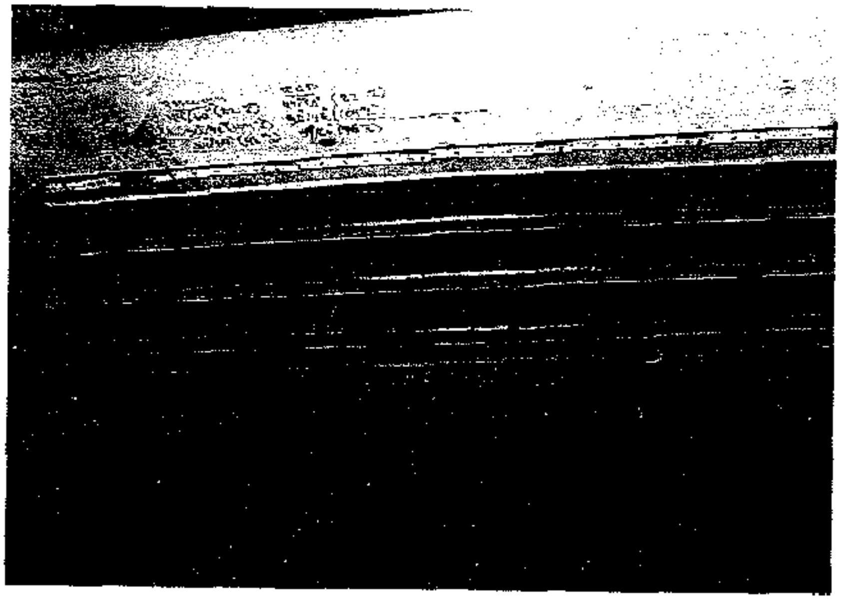
Boring Co. Warren George, Inc.
Driller S. Laurenza
Logged By A. Juneau

Boring Location northing 2696916 easting 814510
Mudline El. -10.74 Datum NGVD
Date Start 12/7/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3

Core Runs R1 through R3

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

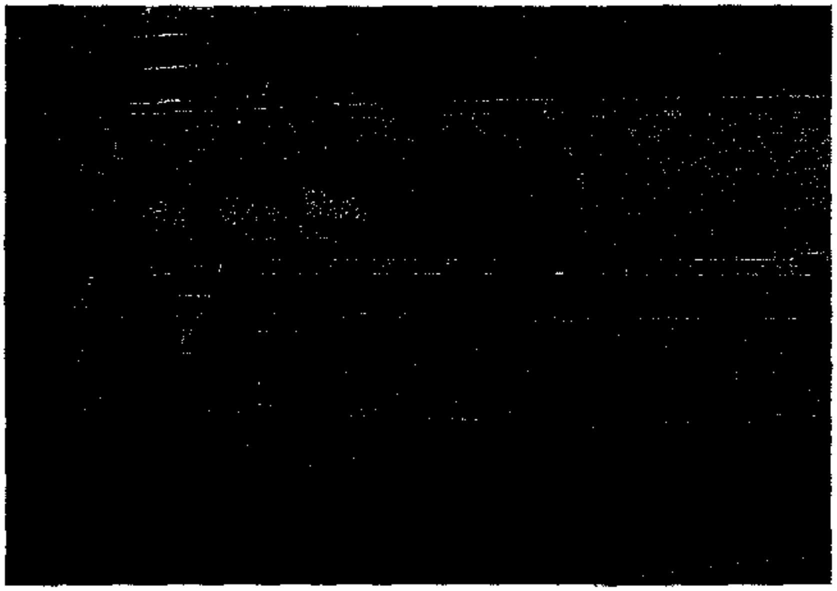
BORING NO. FD-106
SHEET 12 of 12
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696916	easting 814510	
Driller	S. Laurenza	Mudline El.	-10.74	Datum	NGVD
Logged By	A. Juneau	Date Start	12/7/00	Date End	12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Run R4

Core Run R4

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-107
SHEET 1 of 14
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller S. Laurenza
Logged By A. Juneau

Boring Location northing 2696748 easting 814534
Mudline El. -12.71 Datum NGVD
Date Start 12/18/00 Date End 12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1	WOC								
2	WOC								
		UO-1	24/23	2-4	—	—	Organic soil (OH); 10% fine sand, 90% organic clay/silt, shells, strong organic odor, dark olive gray. Pocket penetrometer: undrained shear strength = 0.06 kips/sf		
3	WOC						Advance PW drill casing to 5 ft. Advance 4-3/4 in. roller bit to 5 ft.		
4	WOC								
5	WOC							ORGANIC CLAY	
		UO-2	24/24	5-7	—	—	Organic soil (OH); similar to UO-1 Pocket penetrometer: undrained shear strength = 0.03 kips/sf Advance PW drill casing to 8 ft.		
6	WOC						Advance 4-3/4 in. roller bit to 8 ft.		
7	WOC								
8	WOC								
		UO-3	24/24	8-10	—	—	Sandy organic soil (OH); 60% organic clay/silt, 35% fine sand, 5% medium sand, strong organic odor, dark olive gray. Pocket penetrometer: undrained shear strength = 0.19 kips/sf		
9	WOC						Advance PW drill casing to11 ft. Advance 4-3/4 in. roller bit to 11 ft.		
10	WOC								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis *Nobis Engineering* *18 Chenell Drive* *Concord, New Hampshire 03301*	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-107 SHEET 2 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696748 easting 814534
Driller	S. Laurenza	Mudline El.	-12.71 Datum NGVD
Logged By	A. Juneau	Date Start	12/18/00 Date End 12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
11	WOC								
		UO-4	24/24	11-13	———	———	Organic soil (OH); 90% organic clay/silt, 10% fine sand, organic odor, dark olive gray.	ORGANIC CLAY	
							Pocket penetrometer: undrained shear strength = 0.19 kips/sf		
							Advance PW drill casing to 15 ft.		
12	WOC						Advance 4-3/4 in. roller bit to 15 ft.		
13	WOC							13.0 ft.	
14	26								
15	48								
		S-1	24/11	15-17	15-12-10-11	22	Silty sand (SM); medium dense, 75% fine sand, 10% medium sand, 15% silt,		
							yellow brown, round to subround gravel.		
							Advance PW drill casing to 17 ft.		
16	9						Advance 3-7/8 in. roller bit to 17 ft.	MARINE SAND	
17	19						Perform falling head permeability test at 17 ft.		
		S-2	24/6	17-19	6-5-7-10	12	**Silty sand (SM); 62% fine sand, 15% medium sand, 2% coarse**		1
							sand, 5% gravel, 16% silt, brown.		
							Advance PW drill casing to 22 ft.		
18	16						Advance 3-7/8 in. roller bit to 22 ft.		
19	33								
20	20								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	NOTES:	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-107 SHEET 3 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696748 easting 814534
Driller	S. Laurenza	Mudline El.	-12.71 Datum NGVD
Logged By	A. Juneau	Date Start	12/18/00 Date End 12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	22								
22	28								
		S-3	24/8	22-24	7-9-8-18	17	Silty sand (SM); medium dense; 70% fine sand, 10% medium sand, 5% coarse sand, 15% silt, yellow brown.		
							Advance PW drill casing to 25 ft.		
23	50						Advance 3-7/8 in. roller bit to 25 ft.		
24	66								
25	50						Perform falling head permeability test at 25 ft.	MARINE SAND	
		S-4	24/14	25-27	9-11-15-22	26*	**Silty sand with gravel (SM); 38% fine sand, 9% medium sand, 4% coarse sand, 34% gravel, 15% silt, brown.**		1,2
							Subround sand and gravel. 1 in. of coarse sand and gravel at 26 ft.		
26	46						Advance PW drill casing to 30 ft.		
							Advance 3-7/8 in. roller bit to 30 ft.		
27	59								
28	191								
29	96								
30	102								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-107
SHEET 4 of 14
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696748 easting 814534
Driller	S. Laurenza	Mudline El.	-12.71 Datum NGVD
Logged By	A. Juneau	Date Start	12/18/00 Date End 12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 3-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/9	30-32	6-7-10-11	17*	**Silty sand with gravel (SM); 21% fine sand, 12% medium sand, 4% coarse sand,**		1,2
							35% gravel, 28% silt, light brown. Subround sand and gravel.		
							Advance PW drill casing to 32 ft.	MARINE SAND	
31	52						Advance 3-7/8 in. roller bit to 32 ft.		
32	58							32.0 ft.	
		S-6	24/10	32-34	5-7-5-4	12*	**Poorly graded gravel with sand (GP); 52% gravel, 15% coarse sand, 25%**		1,2
							medium sand, 5% fine sand, 3% silt, brown. Subround to subangular sand and gravel.		
							Advance PW drill casing to 35 ft.		
33	54						Advance 3-7/8 in. roller bit to 35 ft.		
34	64								
35	68						Perform falling head permeability test at 35 ft.	GLACIO FLUVIAL	
		S-7	24/2	35-37	4-5-6-6	11*	Washed sample.		2
							Advance PW drill casing to 37 ft.		
							Advance 3-7/8 in. roller bit to 37 ft.		
36	70								
37	55								
		S-8	24/6	37-39	5-5-10-21	15*	**Well-graded gravel with sand (GW); 61% gravel, 14% coarse sand, 17%**		1,2
							medium sand, 7% fine sand, 1% silt, yellowish brown.		
							Subround to subangular sand and gravel.		
38	61								
							Advance PW drill casing to 42 ft.		
							Advance 3-7/8 in. roller bit to 42 ft.		
39	98								
40	137								

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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-107
SHEET	5 of 14
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696748 easting 814534
Driller	S. Laurenza	Mudline El.	-12.71 Datum NGVD
Logged By	A. Juneau	Date Start	12/18/00 Date End 12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
41	126							GLACIO FLUVIAL	
42	156								
		S-9	5/2	42-42.4	50/5"	>50*	Washed sample.		2
							Advance PW drill casing to 44 ft.	42.5 ft.	
							Top of competent bedrock 44 ft.		
43	186						Telescope HW drill casing to 44.5 ft.	WEATHERED BEDROCK	
							Advance 4-3/4 in. roller bit to remove cuttings.		
44	303							44.0 ft.	
								BEDROCK	
							Begin HQ rock core at 45.0 ft.		
45							(boring log continued on next page).		
46									
47									
48									
49									
50									

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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	PROJECT		
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. SHEET FILE NO. CHKD. BY	FD-107 6 of 14 48138.27 J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696748	easting 814534	
Driller	S. Laurenza	Mudline El.	-12.71	Datum	NGVD
Logged By	A. Juneau	Date Start	12/18/00	Date End	12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
45.5 46.0	R1	45.0-46.0	6.5 min.	Begin R1 at 45.0 ft. Fresh to moderatly hard, gray, fine to medium grained GNEISS, low angle (approx. 15 to 30 degrees) biotite/feldspar foliation. REC = 80%; RQD = 32% (poor) Water return observed in both HW and PW casing. 45.2 ft.: Mechanical break in rock core. No core grinding noted. 45.3 to 46.8 ft.: Weathered zone. Rock distinctly discolored with iron with no fresh surfaces noted on broken, non-intact core pieces. Only 6 of 18 in. recovered from this zone (assumed).	
46.5 47.0		46.0-47.0	5.5 min.	No water return observed from 46.0 to 50.0 ft.	
47.5 48.0		47.0-48.0	4.7 min.	47.0 to 47.5 ft.: Irregular fracture: high angle (approx. 75 degrees), rough, undulating, iron stained and tight. Slight to moderate weathering extends 1/4 to 1 in. into rock. 47.2 ft.: Mechanical break in rock core. No core grinding noted. 47.7 ft.: Irregular fracture: low angle (approx. 20 degrees), rough, undulating, iron stained and tight. 47.7 to 48.0 ft.: Slightly weathered zone with iron staining throughout section.	
48.5 49.0		48.0-49.0	4.8 min.	48.0 to 48.3 ft.: Highly weathered zone. Non-intact core section is iron stained throughout zone, highly fractured core remnants. 48.3 ft.: Smooth parellel fractures (2): low angle, rough, planar, tight, iron staining and clay deposited on fracture surfaces. Fractures parellel to foliation. 48.5 to 48.8 ft.: Irregular fracture: high angle (approx. 65 degrees), rough, planar, white mineralization (Kaolinite). Additional fractures (healed) extend from 48 .0 to 49.0 ft. Performed packer test from 48.5 to 55.0 ft.	
49.5 50.0		49.0-50.0	4.5 min.	Performed packer test from 49.5 to 55.0 ft. End R1 at 50.0 ft.	

GRANULAR SOILS (BLOWS/FT.)	COHESIVE SOILS (BLOWS/FT.)	SAMPLE KEY	
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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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REMARKS:
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Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	PROJECT	
	Remedial Design For Operable Unit 01	BORING NO. FD-107
	New Bedford Harbor Superfund Site	SHEET 7 of 14
	New Bedford, Massachusetts	FILE NO. 48138.27
		CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696748 easting 814534
Driller	S. Laurenza	Mudline El.	-12.71 Datum NGVD
Logged By	A. Juneau	Date Start	12/18/00 Date End 12/21/00

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Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R2	50.0-51.0	4.2 min.	Begin R2 at 50.0 ft. Fresh, hard, gray to dark gray, fine to medium grained GNEISS, low angle (approx. 15 to 30 degrees) biotite/feldspar foliation. Core from 50.0 to 51.0 ft. noticeably finer grained than remainder of R1 and R2. REC = 80%; RQD = 80% (good) 50.0 to 50.2 ft.: Mechanical breaks along biotite foliations. 50.4 to 50.8 ft.: Irregular fracture: high angle (approx. 60 degrees), rough, undulating, and tight. Serpentine/Kaolinite mineralization along fracture surface. (mechanical)	
50.5					
51.0		51.0-52.0	3.8 min.	50.7 ft.: Mechanical break along biotite foliation. 51.2 ft.: Mechanical break along biotite foliation. 51.2 to 53.3 ft.: Numerous stress fractures: moderate to high angle dip, rough, undulating, tight to open, extremely close to close, not broken. Fractures healed with serpentine minerlization.	
51.5					
52.0		52.0-53.0	4 min.		
52.5				52.7 ft.: Mechanical break in rock core along biotite foliation. 52.8 ft.: Mechanical break in rock core along biotite foliation.	
53.0		53.0-54.0	4.2 min.		
53.5				53.6 to 54.0 ft.: Irregular joint: high angle (approx. 70 degrees), rough, planar, tight. Minor Kaolinite mineralization along joint, otherwise fresh. (mechanical)	
54.0		54.0-55.0	3.8 min.		
54.5					
55.0				End R2 at 55.0 ft.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-107 SHEET 8 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co. Warren George, Inc. Boring Location northing 2696748 easting 814534
Driller S. Laurenza Mudline El. -12.71 Datum NGVD
Logged By A. Juneau Date Start 12/18/00 Date End 12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R3	55.0-56.0	4.5 min.	Begin R3 at 55.0 ft. Fresh, very hard, gray, fine to medium grained GNEISS, low angle (approx. 10 to 15 degrees) biotite/feldspar foliation. REC = 98%; RQD = 98% (excellent)	
55.5					
56.0		56.0-57.0	4.5 min.	56.0 ft.: Mechanical break in rock core.	
56.5					
57.0		57.0-58.0	7.5 min.	57.0 to 57.5 ft.: Pair of healed joints/fractures. High angle to vertical. 57.2 to 57.7 ft.: Secondary joint: high angle to vertical, smooth, planar, discolored, and tight. Possible mechanical break/healed joint.	
57.5				57.5 ft.: Mechanical break in rock core.	
58.0		58.0-59.0	7.3 min.	57.8 ft.: Healed joint/fracture. 58.1 ft.: Mechanical break in rock core. 58.3 to 59.0 ft.: Secondary joint: high angle, rough, planar, discolored, and tight. Possible mechanical break/healed joint. Several mechanical breaks noted along joint surfaces.	
58.5					
59.0		59.0-60.0	4.5 min.	58.9 to 59.2 ft.: Secondary joint: moderately dipping, rough, undulating, discolored, and tight. Possible mechanical break/healed joint. 59.3 ft.: Healed joint/fracture. 59.4 ft.: Mechanical break in rock core.	
59.5					
60.0				End R3 at 60.0 ft.	

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11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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PROJECT
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New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-107
SHEET 9 of 14
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696748 easting 814534
Driller	S. Laurenza	Mudline El.	-12.71 Datum NGVD
Logged By	A. Juneau	Date Start	12/18/00 Date End 12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R4	60.0-61.0	5.2 min.	Begin R4 at 60.0 ft. Fresh, hard, gray, fine to medium grained GNEISS, low angle (approx. 10 to 20 degrees) foliation. REC = 100%; RQD = 100% (excellent) 60.0 to 60.2 ft.: Reddish to maroon discoloration noted. Slightly different texture noted.	
60.5						
61.0			61.0-62.0	4.2 min.		
61.5					61.6 ft.: Mechanical break in rock core.	
62.0			62.0-63.0	4.2 min.		
62.5					Core barrel return water blocked at 63.0 ft. Perform packer test from 55.0 to 63.0 ft. End R4 at 63.0 ft.	
63.0					Bottom of exploration at 63.0 ft. Boring terminated in bedrock. Grout completed borehole to mudline with cement/bentonite grout, specific gravity = 1.45.	
63.5						
64.0						
64.5						
65.0						

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-107 SHEET 10 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696748	easting 814534	
Driller	S. Laurenza	Mudline El.	-12.71	Datum	NGVD
Logged By	A. Juneau	Date Start	12/18/00	Date End	12/21/00

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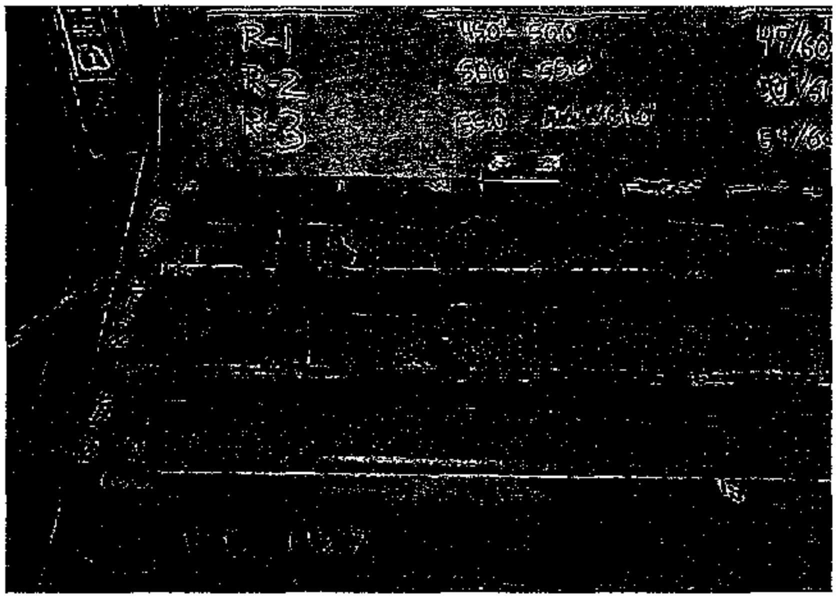
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

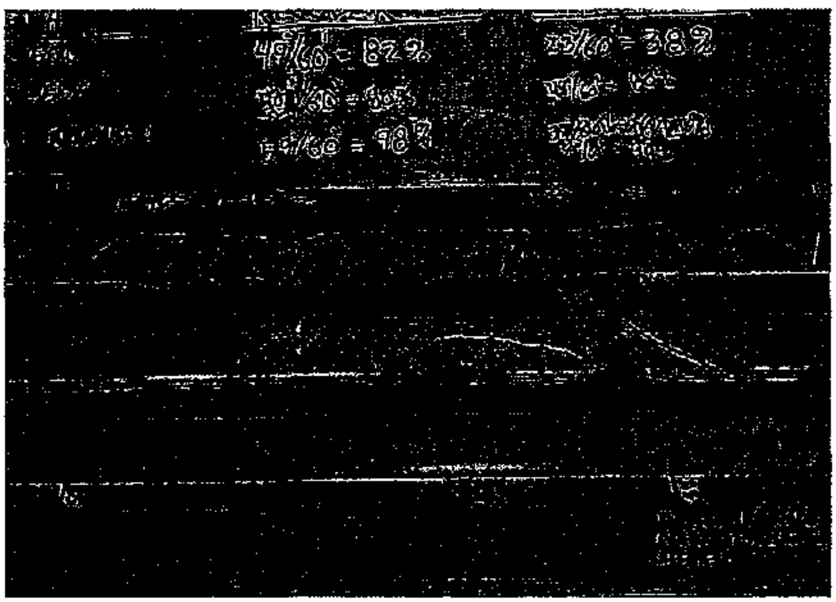
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

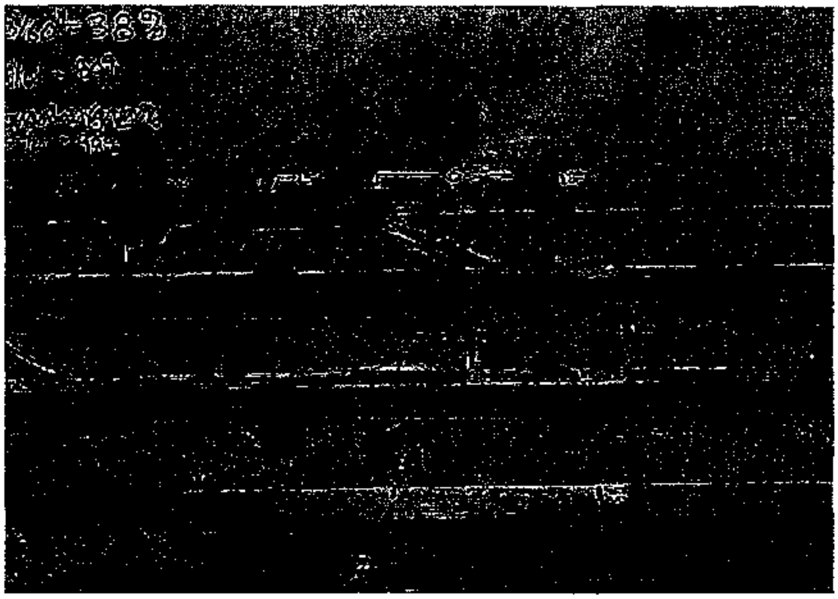
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-107 SHEET 11 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696748	easting 814534	
Driller	S. Laurenza	Mudline El.	-12.71	Datum	NGVD
Logged By	A. Juneau	Date Start	12/18/00	Date End	12/21/00

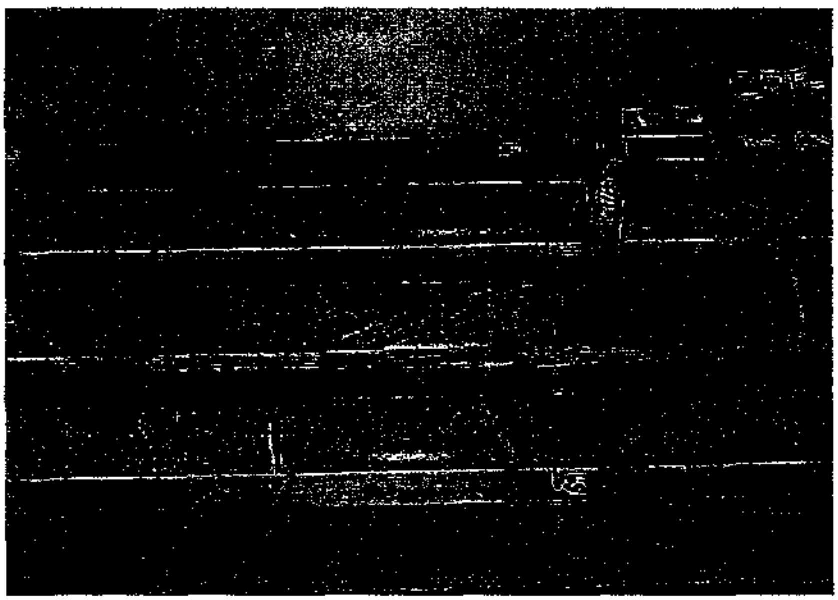
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-107
SHEET	12 of 14
FILE NO.	48138.27
CHKD. BY	J. Trottier

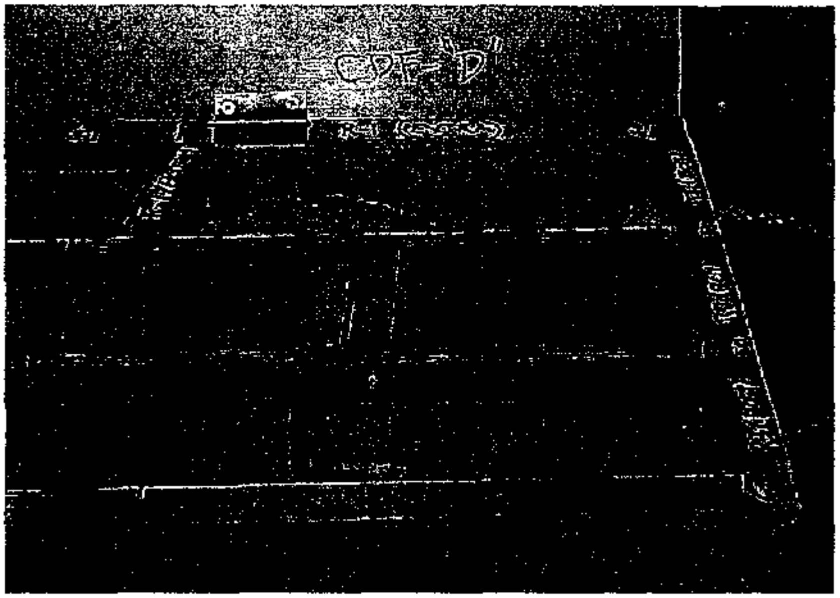
Boring Co.	Warren George, Inc.	Boring Location	northing 2696748 easting 814534
Driller	S. Laurenza	Mudline El.	-12.71 Datum NGVD
Logged By	A. Juneau	Date Start	12/18/00 Date End 12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

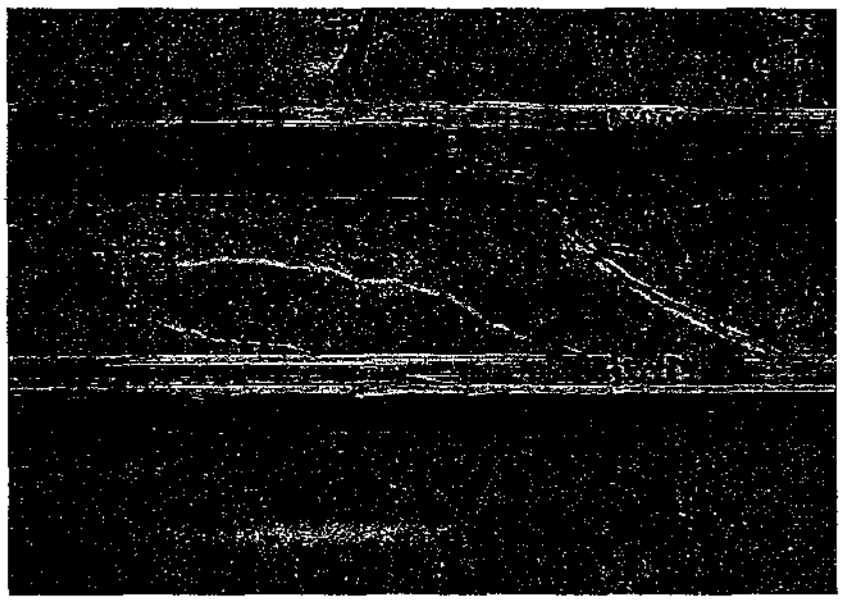
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Healed fractures noted in R2

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-107 SHEET 13 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

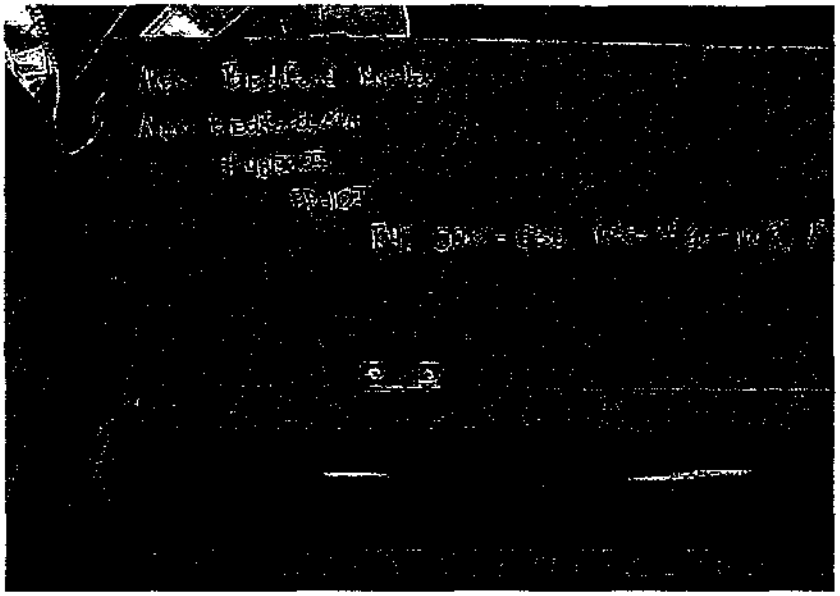
Boring Co.	Warren George, Inc.	Boring Location	northing 2696748 easting 814534
Driller	S. Laurenza	Mudline El.	-12.71 Datum NGVD
Logged By	A. Juneau	Date Start	12/18/00 Date End 12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Run R4

Core Run R4

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-107 SHEET 14 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

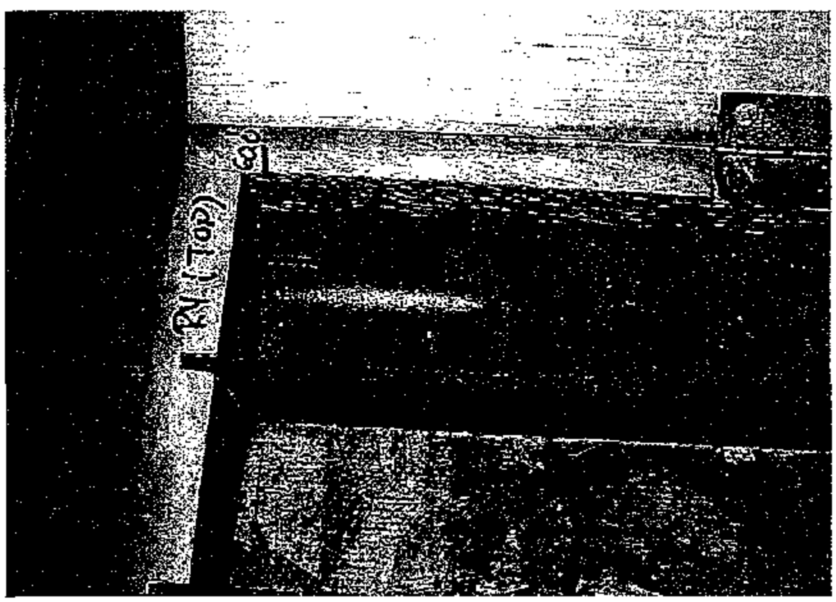
Boring Co.	Warren George, Inc.	Boring Location	northing 2696748	easting 814534	
Driller	S. Laurenza	Mudline El.	-12.71	Datum	NGVD
Logged By	A. Juneau	Date Start	12/18/00	Date End	12/21/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES

Core Run R4



Discoloration/texture change noted in top of R4

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-108
SHEET 1 of 15
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2696632 easting 814464
Driller S. Laurenza | Mudline El. -12.46 | Datum NGVD
Logged By A. Juneau / C. Thunberg | Date Start 12/21/00 | Date End 12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
1	WOC								
2	WOC								
		UO-1	24/17	2-4	———	—	Organic soil (OH); 10% fine sand, 90% organic clay/silt, shells, strong organic odor, dark olive gray/black. Pocket penetrometer: undrained shear strength = 0.02 kips/sf Advance PW drill casing to 5 ft. Advance 3-7/8 in. roller bit to 5 ft.		
3	WOC								
4	WOC							ORGANIC CLAY	
5	WOC								
		UO-2	24/23	5-7	———	—	Organic soil (OH); similar to UO-1 Pocket penetrometer: undrained shear strength = 0.05 kips/sf. Advance PW drill casing to 8 ft. Advance 3-7/8 in. roller bit to 8 ft.		
6	WOC								
7	WOC								
8	WOC								
		UO-3	24/20	8-10	———	—	Sandy organic soil (OH); 40% fine sand, 60% organic clay/silt, shells, organic odor, dark olive gray. Pocket penetrometer: undrained shear strength = 0.05 kips/sf Advance PW drill casing to 11 ft. Advance 3-7/8 in. roller bit to 11 ft.		
9	WOC								
10	WOC								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-108
SHEET 2 of 15
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller S. Laurenza
Logged By A. Juneau / C. Thunberg

Boring Location northing 2696632 easting 814464
Mudline El. -12.46 Datum NGVD
Date Start 12/21/00 Date End 12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.*

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	WOC								
		UO-4	24/13	11-13	———	—	Sandy organic soil (OH); 5% medium sand, 35% fine sand, 60% organic clay/silt, shells, strong organic odor, dark olive gray.	ORGANIC CLAY	
							Pocket penetrometer: undrained shear strength = 0.19 kips/sf		
12	WOC						Advance PW drill casing to14 ft.		
							Advance 3-7/8 in. roller bit to 14 ft.		
13	WOC								
14	WOC								
		UO-5	18/18	14-15.5	———	—	Sandy organic soil (OH); 5% medium sand, 45% fine sand, 50% organic clay/silt, organic odor, dark olive gray.		
							Sampler did not fully extend.		
15	WOC						Pocket penetrometer: undrained shear strength = 0.22 kips/sf		
								15.5 ft.	
		S-1	24/11	15.5-17.5	2-4-6-7	10	S-1A: Silty sand (SM); loose, 5% medium sand, 70% fine sand, 20% silt, 5% clay,	MARINE SAND	
16	WOC						organic odor, dark olive brown. (4 in.)		
							S-1B: Poorly graded sand (SP); 10% coarse sand, 35% medium sand, 50% fine sand,		
	10						5% gravel, gray. (7 in.)		
							Advance PW drill casing to 17.5 ft.		
17							End A. Juneau log; 12-21-00		
							12-28-00 Rig inspector C. Thunberg		
	22						Advance PW drill casing to 20.5 ft.		
							Advance 3-7/8 in. roller bit to 20.5 ft.		
18									
	30								
19									
	37								
20									

GRANULAR SOILS	COHESIVE SOILS	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-108
SHEET 3 of 15
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632	easting 814464	
Driller	S. Laurenza	Mudline El.	-12.46	Datum	NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00	Date End	12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
	42								
		S-2	24/11	20.5-22.5	13-12-15-20	27	**Sandy silt (ML); 40% fine sand, 2% medium sand, 58% silt, brown.**		1
21							Thinly stratified.		
							Advance PW drill casing to 25.5 ft.		
	68						Advance 3-7/8 in. roller bit to 25.5 ft.		
							Fine gravel noted in wash water return.		
22									
	61							MARINE SAND	
23									
	58								
24									
	63								
25									
	62							25.5 ft.	
		S-3	24/5	25.5-27.5	33-19-16-15	35	**Poorly graded gravel with silt and sand (GP-GM); 12% fine sand,**		1
26							**18% medium sand, 11% coarse sand, 52% gravel, 7% silt, reddish brown.**		
							Advance PW drill casing to 27.5 ft.		
	70						Mix drilling mud, specific gravity = 1.09.		
							Advance 3-7/8 in. roller bit to 27.5 ft.	GLACIO FLUVIAL	
27									
	85								
		S-4	24/3	27.5-29.5	13-10-8-6	18*	2-1/2 in. piece of gravel with small amount of medium to coarse sand. Insufficient volume		2
28							of sand to classify, reddish brown.		
							Advance PW drill casing to 29.5 ft.		
	44						Advance 3-7/8 in. roller bit to 29.5 ft.		
29									
	47								
		S-5	24/11	29.5-31.5	10-6-4-5	10*	**Silty sand with gravel (SM); 21% fine sand, 21% medium sand,**		1,2
30							**10% coarse sand, 18% silt, 30% gravel, light brown.** Subangular gravel.		

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
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4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-108
SHEET 4 of 15
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632	easting 814464	
Driller	S. Laurenza	Mudline El.	-12.46	Datum	NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00	Date End	12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance PW drill casing to refusal at 34 ft.		
	35						Advance 3-7/8 in. roller bit to 34.5 ft. Rock fragments noted in drilling mud.		
31									
	44								
32									
	60								
33									
	77								
34	100/4"								
35							Telescope HW casing to 34.5 ft.		
							Begin HQ rock core at 34.5 ft.		
							(boring log continued on next page)		
36									
37									
38									
39									
40									

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOLS KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
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4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-108 SHEET 5 of 15 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632 easting 814464
Driller	S. Laurenza	Mudline El.	-12.46 Datum NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00 Date End 12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
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Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	34.7 ft	R1	34.5-35.5	11 min.	Begin R1 at 34.5 ft. Fresh, moderately hard, pinkish gray, medium grained GRANITE, with horizontal (approx. 0 to 5 degrees) joints, moderately spaced and rough. Several joints filled with fine sand. REC = 100%; RQD = 87% (good) No water return noted.	
35.0						
35.5			35.5-36.5	11.5 min.		
36.0						
36.5	36.6 ft		36.5-37.5	13.5 min.	36.6 ft.: Break at horizontal joint.	
37.0	37.3 ft				37.3 ft.: Break at horizontal joint, sand seam.	
37.5			37.5-38.5	8 min.	38.75 ft.: Break with two pieces of broken gravel, sand seam.	
38.0	38 ft				38.0 ft.: Break at horizontal joint, sand seam.	
38.5	38.9 ft		38.5-39.5	8.5 min.		
39.0					38.9 ft.: Mechanical break in rock core. 39.2 ft.: Mechanical break in rock core. 39.3 ft.: Mechanical break in rock core.	
39.5					End R1 at 39.5 ft.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
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11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
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REMARKS:
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3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-108 SHEET 6 of 15 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632	easting 814464	
Driller	S. Laurenza	Mudline El.	-12.46	Datum	NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00	Date End	12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	39.5-40.5	11 min.	Begin R2 at 39.5 ft. Fresh, moderately hard, pinkish gray, medium grained GRANITE, with horizontal (approx. 0 to 5 degrees) joints, moderately spaced and rough. Several joints filled with fine sand. 12 in. of 36 in. rock core recovered, remainder of barrel filled with washed gravel. REC = 22%; RQD = 22% (very poor) Water return color: clear to gray, change to milky white at 40.5 ft., change to brown from 41.5 to 42.5 ft. Attempted to clear hole with roller bit and light drilling mud, attempted to spin casing; no success.	
40.0						
40.5			40.5-41.5	4.5 min.	Telescope NW casing to 46.0 ft. 39.5 to 43.4 ft.: Semi-angular/rounded gravel recovered in core barrel. Sample preserved in sample jar.	
41.0	WASHED GRAVEL					
41.5			41.5-42.5	2.5 min.		
42.0						
42.5			42.5-43.5	NR		
43.0						
43.5			43.5-44.5	NR	43.5 ft.: Mechanical break in rock core. Broken rock fragments. Core grinding noted on break surfaces. 43.8 ft.: Mechanical break in rock core.	
44.0						
44.5					End R2 at 44.5 ft.	

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-108

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632 easting 814464
Driller	S. Laurenza	Mudline El.	-12.46 Datum NGVD
Logged By	A. Junieau / C. Thunberg	Date Start	12/21/00 Date End 12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
	TELESCOPE CASING		44.5-45.5	—	44.5 to 46.0 ft.: Telescope NW drill casing. Not cored.	
45.0						
45.5			45.5-46.0	—		
46.0		R3	46.0-47.0	6 min.	Begin NX rock core at 46.0 ft. Begin R3 at 46.0 ft. Fresh, hard, gray, fine to medium grained GNEISS. Low angle foliation (approx. 20 to 30 degrees). No joints noted.	
46.5					REC = 97%; RQD = 97% (excellent) Water return color: milky white. 46.0 to 46.3 ft.: Discoloration noted. 47.1 to 47.4 ft.: Healed joint: high angle, sand infilled.	3
47.0			47.0-48.0	3.5 min.		
47.5						
48.0			48.0-49.0	6 min.	47.8 ft.: Healed joint: low angle, sand infilled. 48.0 ft.: Mechanical break in rock core. 48.3 ft.: Mechanical break in rock core.	
48.5						
49.0			49.0-50.0	4.5 min.		
49.5						

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-108
SHEET	8 of 15
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632 easting 814464		
Driller	S. Laurenza	Mudline El.	-12.46	Datum	NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00	Date End	12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
50.0		R3 (cont.)	50.0-51.0	5 min.		
50.5						
51.0		R4	51.0-52.0	6 min.	End R3 at 51.0 ft. Begin R4 at 51.0 ft. Fresh, moderately hard, gray, medium grained GNEISS. Low angle foliation (approx. 5 to 10 degrees). No joints noted. REC = 94%; RQD = 94% (excellent) Water return color: milky white.	3
51.5						
52.0			52.0-53.0	6 min.	52.3 ft.: Mechanical break in rock core.	
52.5						
53.0			53.0-54.0	6 min.		
53.5						
54.0			54.0-55.0	4.5 min.		
54.5						

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-108
New Bedford Harbor Superfund Site	SHEET 9 of 15
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Boring Co. Warren George, Inc. — Boring Location northing 2696632 easting 814464
Driller S. Laurenza — Mudline El. -12.46 — Datum NGVD
Logged By A. Juneau / C. Thunberg — Date Start 12/21/00 — Date End 12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
55.0		R4 (cont.)	55.0-56.0	6 min.		
55.5					55.7 to 56.0 ft.: Rock core not recovered. Attempt constant head permeability test. Test unsuccessful, water return noted up HW drill casing. End R4 at 56.0 ft.	
56.0		R5	56.0-57.0	6 min.	Begin R5 at 56.0 ft. Fresh, moderately hard, gray, medium grained GNEISS. Low angle foliation (approx. 5 to 10 degrees). No joints noted. REC = 100%; RQD = 100% (excellent) Water return color: milky white.	
56.5						
57.0			57.0-58.0	5 min.		
57.5						
58.0			58.0-59.0	5 min.		
58.5					58.5 ft.: Mechanical break in rock core.	
59.0			59.0-60.0	5.5 min.		
59.5						

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

	PROJECT	
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-108 SHEET 10 of 15 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co. Warren George, Inc. — Boring Location northing 2696632 easting 814464
Driller S. Laurenza — Mudline El. -12.46 — Datum NGVD
Logged By A. Juneau / C. Thunberg — Date Start 12/21/00 — Date End 12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
60.0		R5 (cont.)	60.0-61.0	6 min.	60.2 ft.: Mechanical break in rock core.	
60.5						
61.0			61.0-62.0		60.8 ft.: Mechanical break in rock core. End R5 at 61.0 ft. Bottom of exploration at 61.0 ft. Boring terminated in bedrock. Grout completed borehole to mudline with cement/bentonite grout, specific gravity = 1.40.	
61.5						
62.0			62.0-63.0			
62.5						
63.0			63.0-64.0			
63.5						
64.0			64.0-65.0			
64.5						

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
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4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

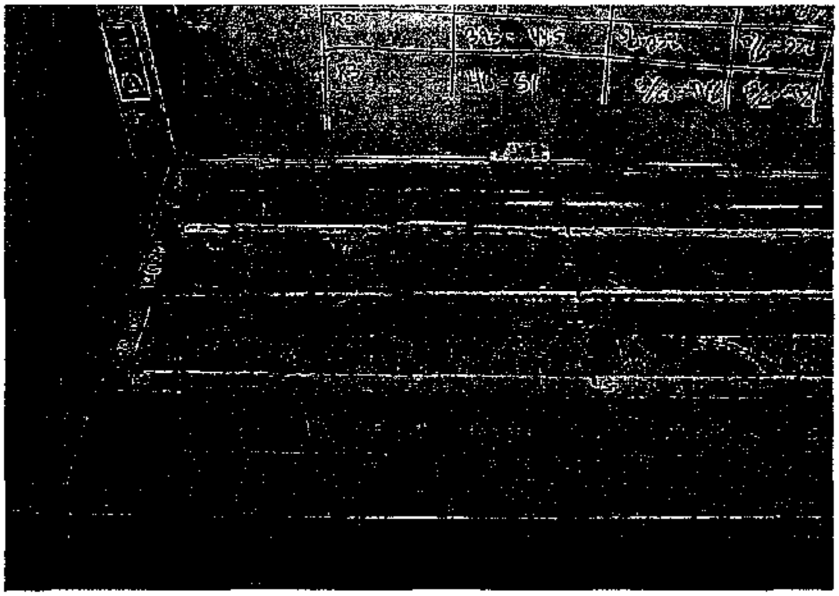
PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-108
New Bedford Harbor Superfund Site	SHEET	11 of 15
	FILE NO.	48138.27
New Bedford, Massachusetts	CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632	easting 814464
Driller	S. Laurenza	Mudline El.	-12.46	Datum NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00	Date End 12/29/00

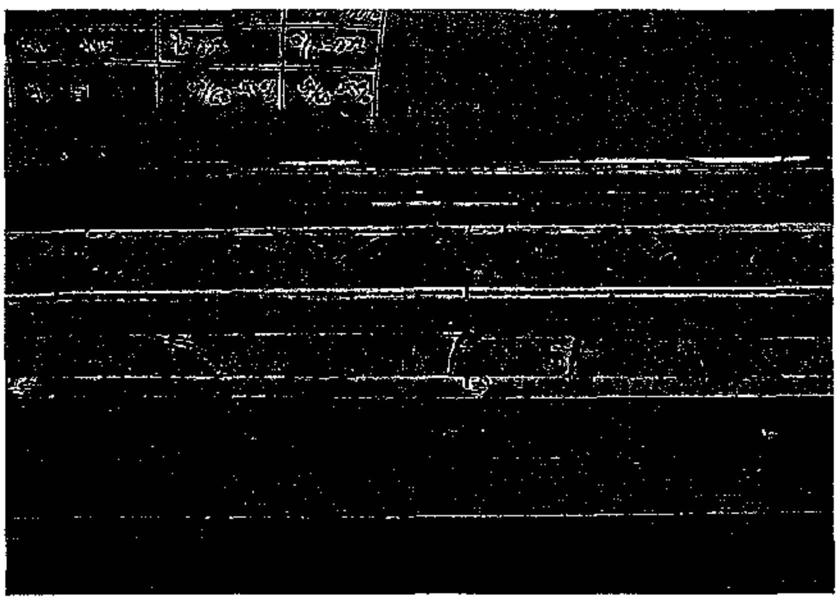
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

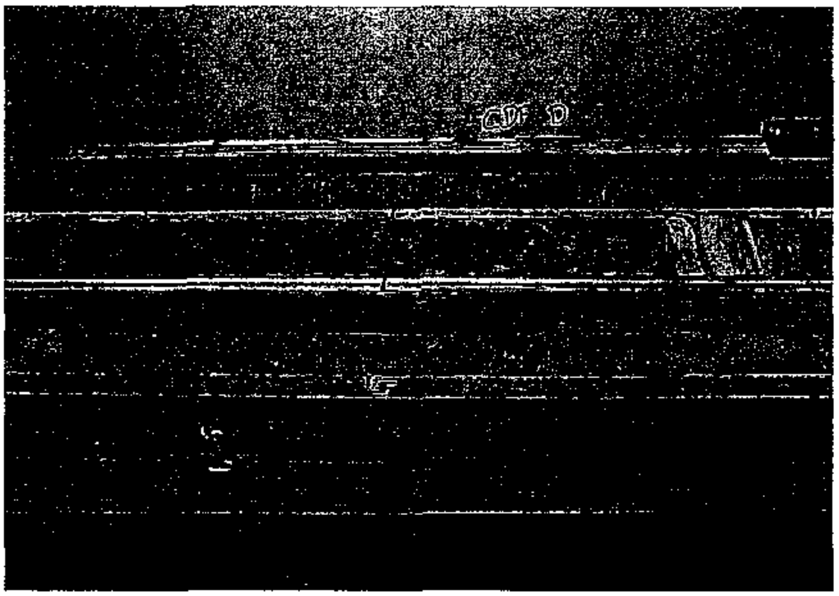
PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-108
New Bedford Harbor Superfund Site	SHEET	12 of 15
New Bedford, Massachusetts	FILE NO.	48138.27
	CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632	easting 814464	
Driller	S. Laurenza	Mudline El.	-12.46	Datum	NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00	Date End	12/29/00

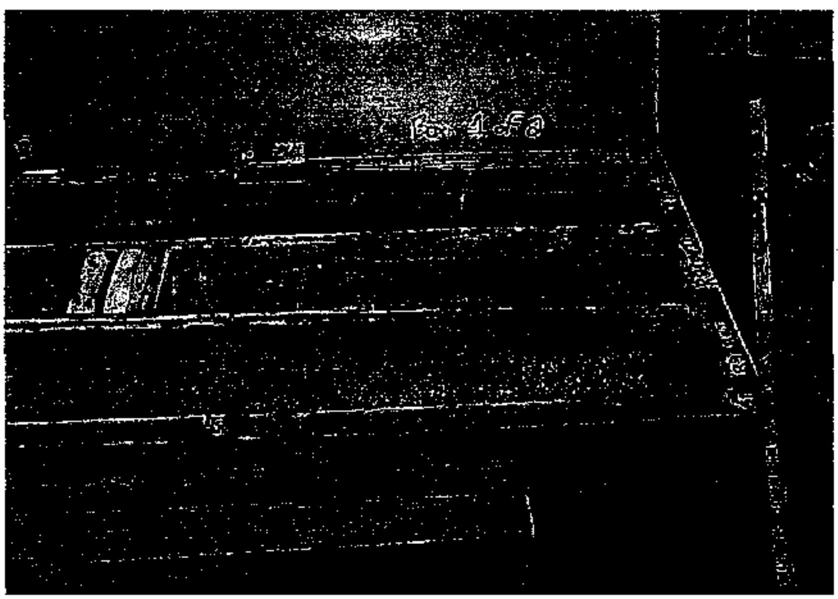
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

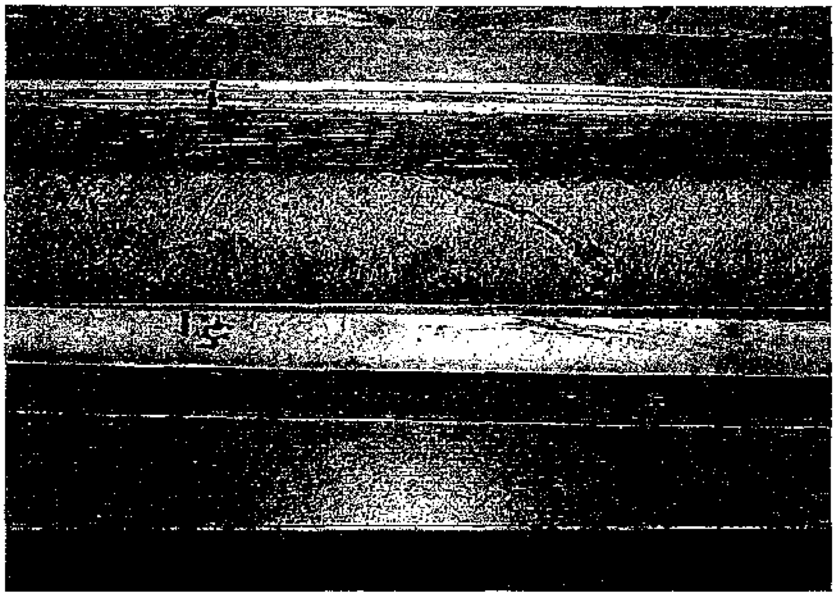
PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-108
New Bedford Harbor Superfund Site	SHEET	13 of 15
New Bedford, Massachusetts	FILE NO.	48138.27
	CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632	easting 814464	
Driller	S. Laurenza	Mudline El.	-12.46	Datum	NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00	Date End	12/29/00

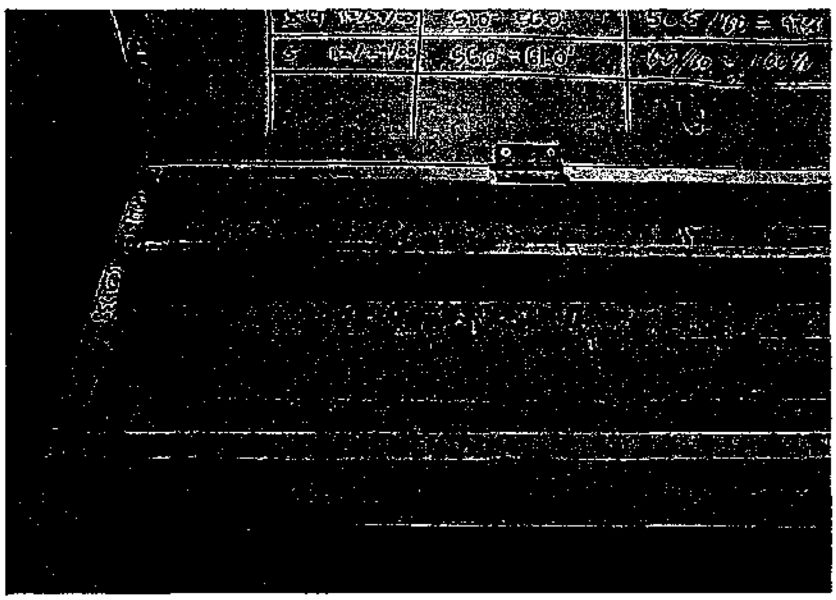
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Falling Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Heated sand infilled joint noted in R3



Core Runs R4 and R5

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-108
SHEET 14 of 15
FILE NO. 48138.27
CHKD. BY J. Trottier

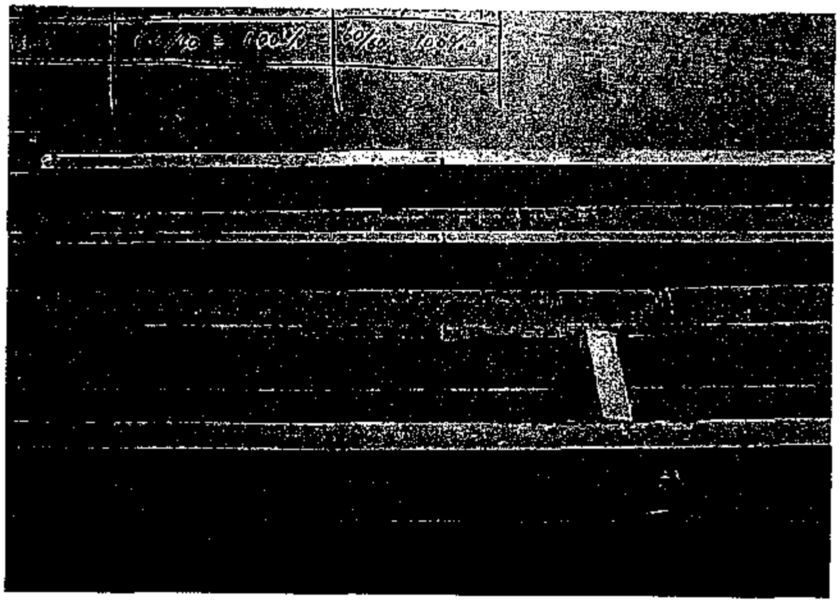
Boring Co.	Warren George, Inc.	Boring Location	northing 2696632 easting 814464
Driller	S. Laurenza	Mudline El.	-12.46 Datum NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00 Date End 12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

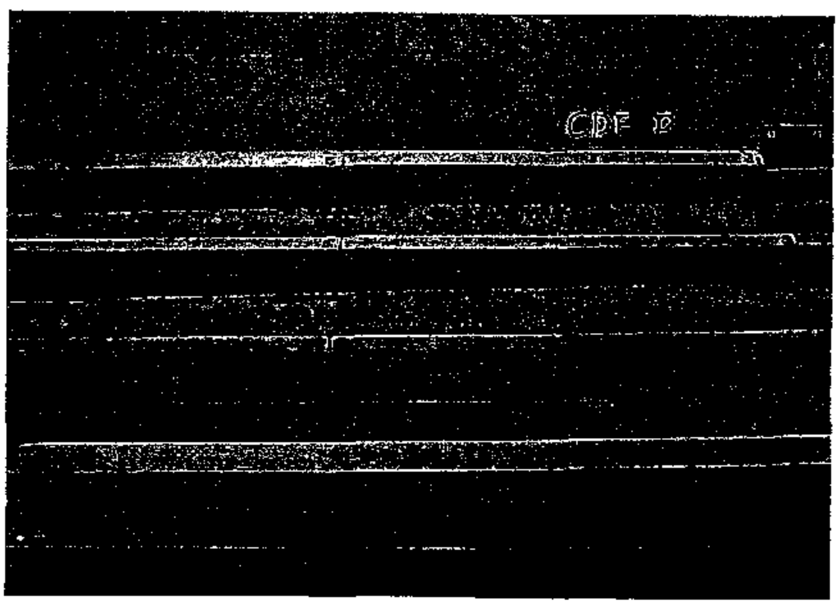
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R4 and R5



Core Runs R4 and R5

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

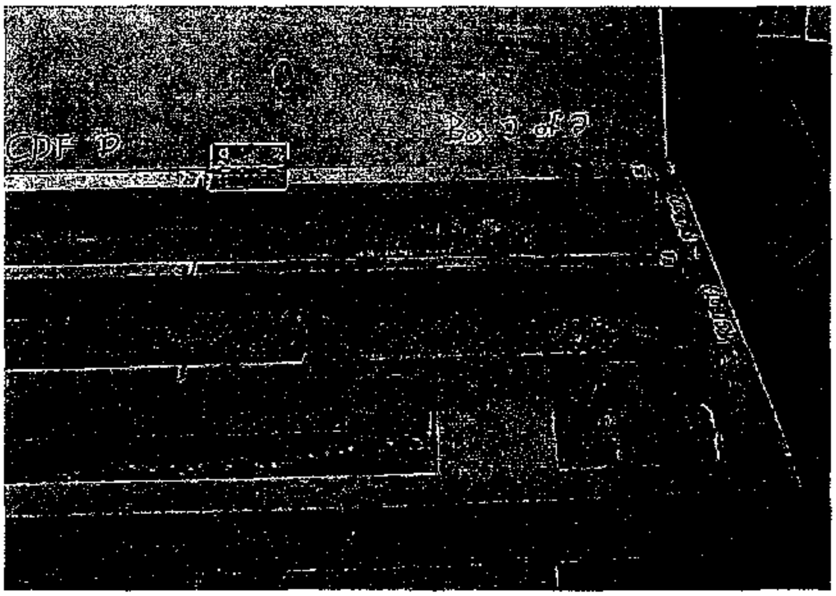
BORING NO.	FD-108
SHEET	15 of 15
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696632	easting 814464	
Driller	S. Laurenza	Mudline El.	-12.46	Datum	NGVD
Logged By	A. Juneau / C. Thunberg	Date Start	12/21/00	Date End	12/29/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 30 inches.
Drill Rig: Failing Truck Rig
Drilling Method: 5-inch (PW), 4-inch (HW), and 3-inch (NW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R4 and R5

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of less than 100%.
4)

Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	PROJECT: Remedial Design For Operable Unit 01, New Bedford Harbor Superfund Site, New Bedford, Massachusetts	BORING NO. FD-109
		SHEET 1 of 12
		FILE NO. 48138.27
		CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353, easting 814480
Driller	E. Thomas	Mudline El.	-33.04, Datum NGVD
Logged By	E. Thibodeau	Date Start	12/20/00, Date End 12/27/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	WOC								
		S-1	24/6	2-4	WOR/24	—	Organic soil (OH); 95% organic clay/silt, 5% fine sand, strong organic odor, black to dark gray.	ORGANIC CLAY	
							Advance PW drill casing to 4 ft.		
3	WOC								
4	WOC								
		S-2	24/18	4-6	WOR/18-6	—	S-2A: Organic soil (OH); similar to S-1. (12 in.)		
							S-2B: Silty sand (SM); 10% coarse sand, 35% medium sand, 35% fine sand, 5% gravel, 15% silt, subround sand and gravel, gray. (6 in.)		
5	WOC						Advance PW drill casing to 6 ft.		
							Advance 3-7/8 in. roller bit to 6 ft.	5.5 ft.	
6	WOC						Perform falling head permeability test at 6 ft.	MARINE SAND	
		S-3	24/6	6-8	15-12-10-11	22	**Silty sand with gravel (SM); 10% coarse sand, 20% medium sand, 19% fine sand, 33% gravel, 18% silt, light brown.** Subround to subangular sand and gravel.		1
							Advance PW drill casing to 11 ft.		
7	37						Advance 3-7/8 in. roller bit to 11 ft.		
8	35							GLACIO FLUVIAL	
9	21								
10	23								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-109
SHEET	2 of 12
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353	easting 814480	
Driller	E. Thomas	Mudline El.	-33.04	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/20/00	Date End	12/27/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing, 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	20								
		S-4	24/10	11-13	8-8-6-14	14	**Well-graded gravel with silt and sand (GW-GM); 50% gravel, 13% coarse sand, 18% medium sand, 12% fine sand, 7% silt, brown.**		1
							Subangular sand and gravel.		
12	22						Advance PW drill casing to 16 ft.		
							Advance 3-7/8 in. roller bit to 16 ft.	GLACIO FLUVIAL	
13	35								
14	29								
							Approximately 12 in. of material in bottom of casing. Mix bentonite drilling mud to remove material, specific gravity = 1.08. Flush casing with water to remove drilling mud.		
15	27								
16	28						Perform falling head permeability test at 16 ft.		
		S-5	11/2	16-16.9	18-75/5	—	Poor recovery; spoon refusal on probable cobble.		
							Advance PW drill casing to 16.5 ft.		
							Advance 3-7/8 in. roller bit to 17.5 ft. Probable cobble from 17 to 17.5 ft.		
17	109/6							17.0 ft.	
								COBBLE 17.5 ft.	
							Advance PW drill casing to 21 ft.		
18	40						Mix additional bentonite drilling mud, specific gravity = 1.09.		
							Advance 3-7/8 in. roller bit to 21 ft.	GLACIO FLUVIAL	
19	57								
20	54								

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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-109
New Bedford Harbor Superfund Site	SHEET 3 of 12
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2696353 easting 814480
Driller E. Thomas | Mudline El. -33.04 Datum NGVD
Logged By E. Thibodeau | Date Start 12/20/00 Date End 12/27/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing, 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	53								
		S-6	24/10	21-23	12-14-15-17	29	**Well-graded gravel with silt and sand (GW-GM); 62% gravel, 6% coarse sand, 13% medium sand, 12% fine sand, 7% silt, brown.** Subangular sand and gravel.		1
22	57						Advance PW drill casing to 23 ft. Advance 3-7/8 in. roller bit to 23 ft. with bentonite drilling mud to remove material from casing. Flush casing with water to remove drilling mud.		
23	63						Perform constant head permeabiltiy test at 23 ft.		
		S-7	24/6	23-25	40-59-16-14	75	**Poorly graded gravel with silt and sand (GP-GM); 12% coarse sand, 16% medium sand, 15% fine sand, 48% gravel, 9% silt, brown.** Subround to subangular sand and gravel.		1
24	100						Advanced sampler past probable cobble from 23 to 24 ft. Advanced PW drill casing to 25 ft. Pushed probable cobble with casing. Mix additional bentonite drilling mud. Advance 3-7/8 in. roller bit to 26 ft. past cobble.	GLACIO FLUVIAL	
25	95								
26	64						Unable to keep hole open, Advance PW drill casing to 27 ft. Mix additional bentonite drilling mud, specific gravity = 1.09. Advance 3-7/8 in. roller bit to 27 ft.		
27	113								
		S-8	24/10	27-29	14-14-14-12	28	Poorly graded sand with silt and gravel (SP-SM); medium dense, 10% coarse sand, 40% medium sand, 20% fine sand, 20% gravel, 10% silt, subrounded to subangular sand and gravel, brown.		
28	60						Advance PW drill casing to 31.5 ft; casing refusal. Top of bedrock 31.5 ft. Advance 3-7/8 in. roller bit to 32 ft.		
29	52								
30	56								

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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. SHEET FILE NO. CHKD. BY	FD-109 4 of 12 48138.27 J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353	easting 814480	
Driller	E. Thomas	Mudline El.	-33.04	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/20/00	Date End	12/27/00

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Drill Rig: Acker AD-II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

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DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance 4-7/8 in. roller bit to 32.5 ft. Cuttings indicate possible weathered bedrock. Telescope NW drill casing to 33 ft. (spin).	GLACIO FLUVIAL	
31	90								
	123							31.5 ft.	
32								BEDROCK	
33							Begin HQ rock core at 32.5 ft. (boring log continued on next page)		
34									
35									
36									
37									
38									
39									
40									

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	PROJECT	
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-109 SHEET 5 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353 easting 814480
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Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	32.5-33.5	6.5 min.	Begin R1 at 32.5 ft. Fresh, hard, gray medium to fine grained GNEISS. Low angle foliation (approx. 10-15 degrees). REC = 92%; RQD = 80% (good). Water return color: rust.	
33.0						
33.5					33.4 ft.: Mechanical break in rock core.	
			33.5-34.5	5 min.	33.5 ft.: Pause advancement of core R1 to advance HW drill casing to achieve better casing seal.	
34.0					34.2 ft.: Mechanical break in rock core.	
34.5					34.4 and 34.5 ft.: Primary joints: low angle, rough, planar, discolored, and open.	
			34.5-35.5	4.5 min.	34.5 ft.: Loss of water return noted. 34.4 to 34.8 ft.: Discoloration of rock core noted.	
35.0					35.1 ft.: Primary joint: low angle, rough, planar, partially discolored, and tight. Possible mechanical break.	
35.5						
			35.5-36.5	4 min.	35.5 ft.: Primary joint: horizontal, rough, planar, discolored, and open. 35.5 to -35.7 ft.: Secondary joint: moderatly dipping to high angle, smooth, planar, discolored, and open.	
36.0					35.6 to 36.1 ft.: Distinct discoloration and slight weathering of core noted. 36.0 ft.: Primary joint: low angle, rough, stepped, discolored, and open. Possible mechanical break. 36.2 and 36.3 ft.: Mechanical break in rock core.	
36.5						
			36.5-37.5	5.5 min.	36.6 to 37.2 ft.: Quartz/feldspar vein. Dark gray to milky white/pink in color. (pegmatic)	
37.0					37.2 ft.: Primary joint: low angle, rough, undulating, discolored, and tight.	
37.5					End R1 at 37.5 ft.	

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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-109

FILE NO. 48138.27
CHKD. BY J. Trottier

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Logged By	E. Thibodeau	Date Start	12/20/00 Date End 12/27/00

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Groundwater Readings Not Applicable for Offshore Borings

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DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R2	37.5-38.5	4.5 min.	Begin R2 at 37.5 ft. Fresh, hard, gray, medium to fine grained GNEISS. Low angle foliation (approx. 10-20 degrees). No natural joints/fractures or mechanical breaks noted. REC = 93%; RQD = 93% (excellent). No water return noted during R2.	2
38.0						
38.5			38.5-39.5	4 min.		
39.0						
39.5			39.5-40.5	3.5 min.		
40.0						
40.5			40.5-41.5	4 min.		
41.0						
41.5			41.5-42.5	2.5 min.		
42.0						
42.5					End R2 at 42.5 ft.	

GRANULAR SOILS (BLOWS/FT) DENSITY	COHESIVE SOILS (BLOWS/FT) CONSISTENCY	NOTES:	
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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
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PROJECT
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New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-109
SHEET 7 of 12
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353 easting 814480
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Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R3	42.5-43.5	4.5 min.	Begin R3 at 42.4 ft. Fresh to slightly weathered, hard, gray, medium to fine grained, GNEISS. Low angle foliation (approx. 10 degrees). REC = 90%; RQD = 90% (good/excellent). No water return noted during R2.	2
43.0						
43.5					43.4 ft.: Mechanical break in rock core.	
			43.5-44.5	4 min.	43.6 ft.: Mechanical break in rock core.	
44.0					43.8 ft.: Mechanical break in rock core. 44.0 ft.: Primary joint: low angle, smooth, planar, discolored, and open.	
44.5			44.5-45.5	5 min.		
45.0					44.9 ft.: Mechanical break in rock core.	
45.5			45.5-46.5	4 min.	45.6 to 47.0 ft.: Slightly weathered zone; minor discoloration noted. 45.7 ft.: Primary joint: low angle, smooth, planar, discolored, and open.	
46.0					46.2 ft.: Mechanical break in rock core. 46.3 and 46.4 ft.: Mechanical breaks in rock core.	
46.5			46.5-47.5	4.5 min.		
47.0					47.0 ft.: Mechanical break in rock core. 47.0 to 47.1 ft.: Quartz/feldspar vein. Dark gray to pink in color.	
47.5					End R3 at 47.5 ft.	

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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-109 SHEET 8 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353 easting 814480
Driller	E. Thomas	Mudline El.	-33.04 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/20/00 Date End 12/27/00

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Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R4	47.5-48.5	5.5 min.	Begin R4 at 47.5 ft. Fresh to slightly weathered, hard, gray, medium to fine grained GNEISS. REC = 100%; RQD = 85% (good). No water return noted during R4. 47.5 to 47.6 ft.: Weathered zone; discoloration noted. 48.4 ft.: Mechanical break in rock core.	
48.0					
48.5		48.5-49.5	3.5 min.		
49.0				48.9 ft.: Primary joint: low angle, rough, planar, discolored, and tight. 48.9 to 49.5 ft.: Weathered zone. Mechanical break at 49.1 ft. Rock has been weathered to a residual soil along mechanical break; material is friable.	
49.5		49.5-50.0	5.5 min.	49.6 ft.: Primary joint: low angle, to horizontal, smooth, planar, discolored, and tight. Possible mechanical break.	
50.0				50.2 ft.: Mechanical break in rock core.	
50.5		50.0-50.5	5 min.		
51.0				51.3 ft.: Mechanical break in rock core.	
51.5		50.5-51.0	5 min.		
52.0				52.3 ft.: Mechanical break in rock core. 52.4 to 52.5 ft.: Quartz/feldspar vein. Dark gray/pink in color. 52.5 ft.: Primary joint: low angle, smooth, planar, discolored, and open.	
52.5				End R4 at 52.5 ft.	

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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
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BORING NO. FD-109
SHEET 9 of 12
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353 easting 814480
Driller	E. Thomas	Mudline El.	-33.04 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/20/00 Date End 12/27/00

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Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R5	52.5-53.5	6 min.	Begin R5 at 52.5 ft. Fresh, very hard, gray, medium to fine grained GNEISS. Low angle foliation (approx. 10 degrees). REC = 97%; RQD = 93% (excellent).	2
53.0					No water return noted during R5. 52.5 to 52.7 ft.: Secondary joint: moderately dipping, rough, planar, discolored, and open. 53.0 to 53.2 ft.: Quartz/feldspar vein. Dark gray/pink in color. 53.2 ft.: Mechanical break in rock core.	
53.5			53.5-54.5	5.5 min.	53.9 ft.: Mechanical break in rock core.	
54.0					54.3 ft.: Mechanical break in rock core.	
54.5			54.5-55.5	6 min.		
55.0					55.0 ft.: Mechanical break in rock core. 55.0 to 55.1 ft.: Quartz/feldspar vein. Dark gray/pink in color. 55.3 ft.: Mechanical break in rock core.	
55.5			55.5-56.5	7 min.	55.7 ft.: Mechanical break in rock core	
56.0					56.0 to 56.1 ft.:Quartz/feldspar vein. Dark gray/pink in color.	
56.5			56.5-57.5	6.5 min.	56.4 to 56.5 ft.:Quartz/feldspar vein. Dark gray/pink in color.	
57.0					Perform single packer test from 47.5 to 57.5 ft. Perform single packer test from 37.5 to 57.5 ft. End R5 at 57.5 ft. Bottom of exploration at 57.5 ft; boring terminated in bedrock.	
57.5					Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.40.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) RQD biased low due to recovery of less than 100%.
3)
4)

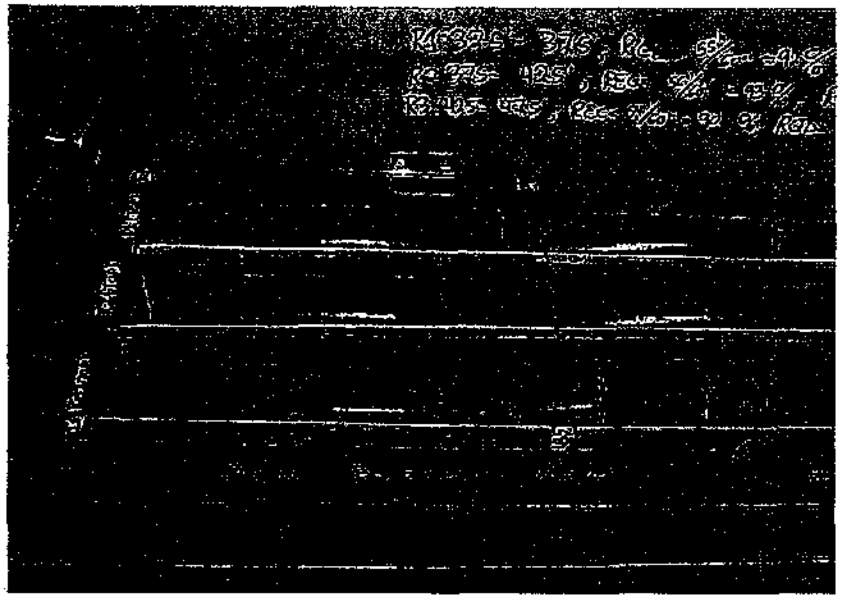
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. SHEET FILE NO. CHKD. BY	FD-109 10 of 12 48138.27 J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353	easting 814480	
Driller	E. Thomas	Mudline El.	-33.04	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/20/00	Date End	12/27/00

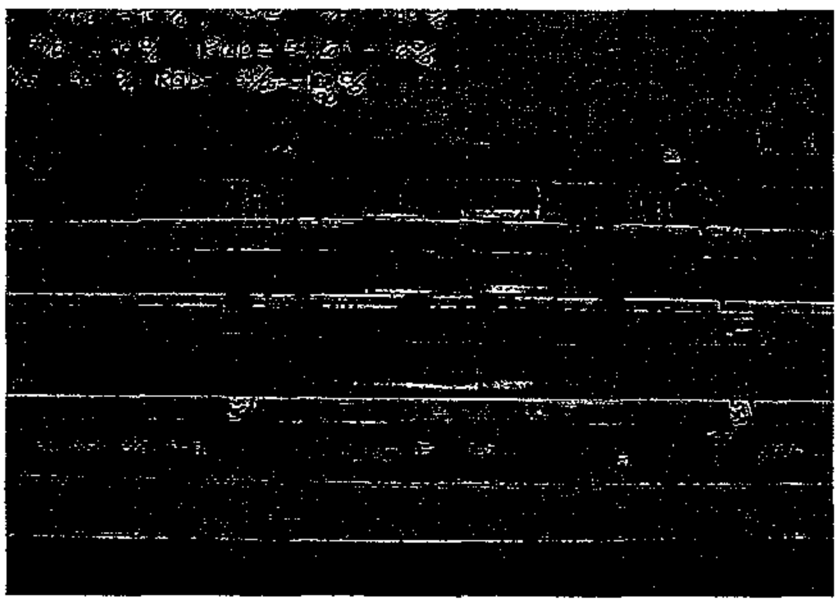
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-109 SHEET 11 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353	easting 814480	
Driller	E. Thomas	Mudline El.	-33.04	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/20/00	Date End	12/27/00

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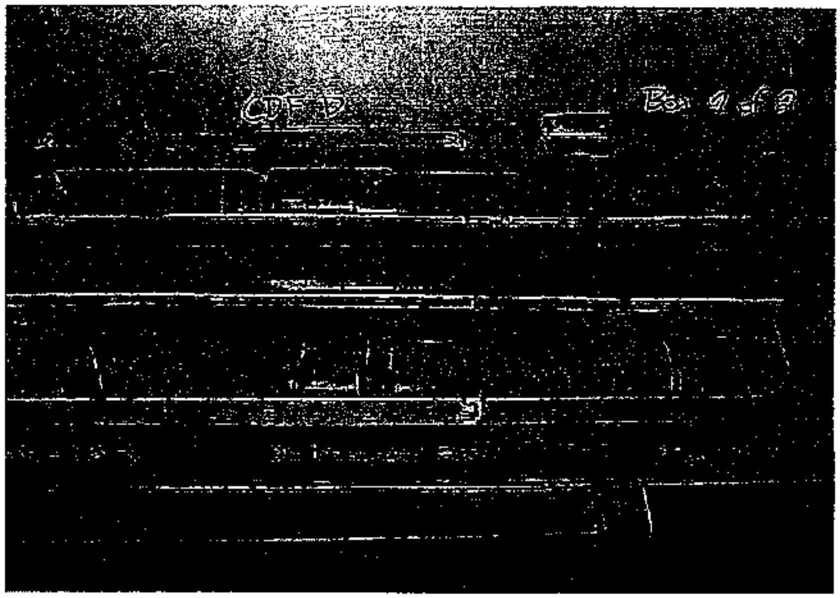
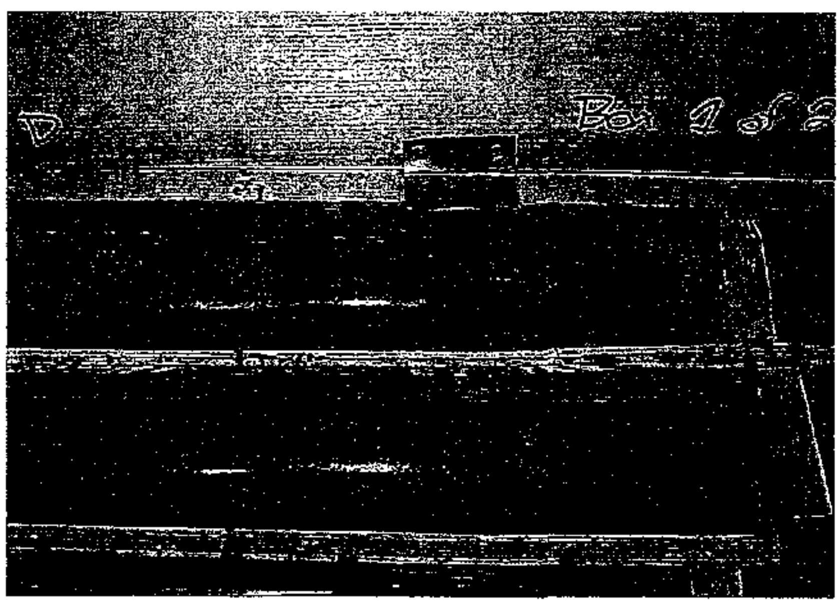
Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Quartz/feldspar vein (pegmatic) noted in bottom of R1

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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-109

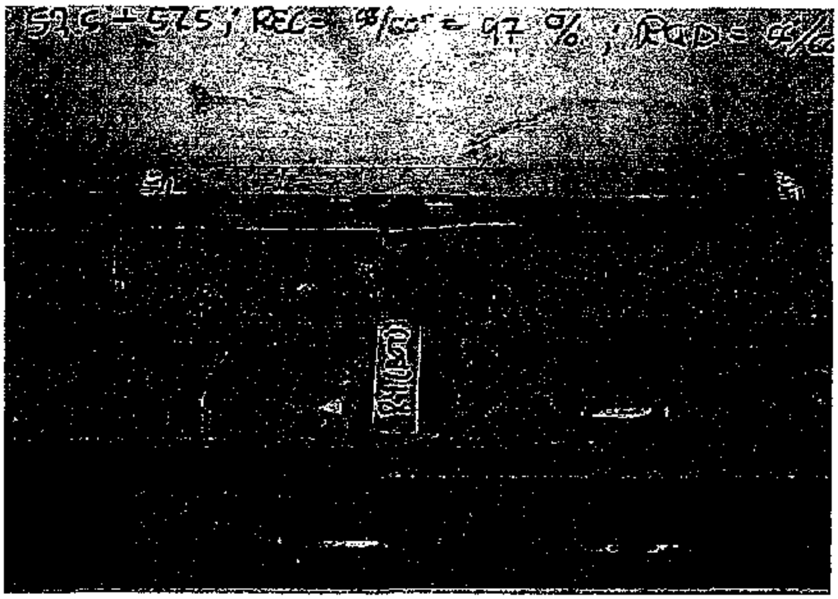
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696353 easting 814480
Driller	E. Thomas	Mudline El.	-33.04 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/20/00 Date End 12/27/00

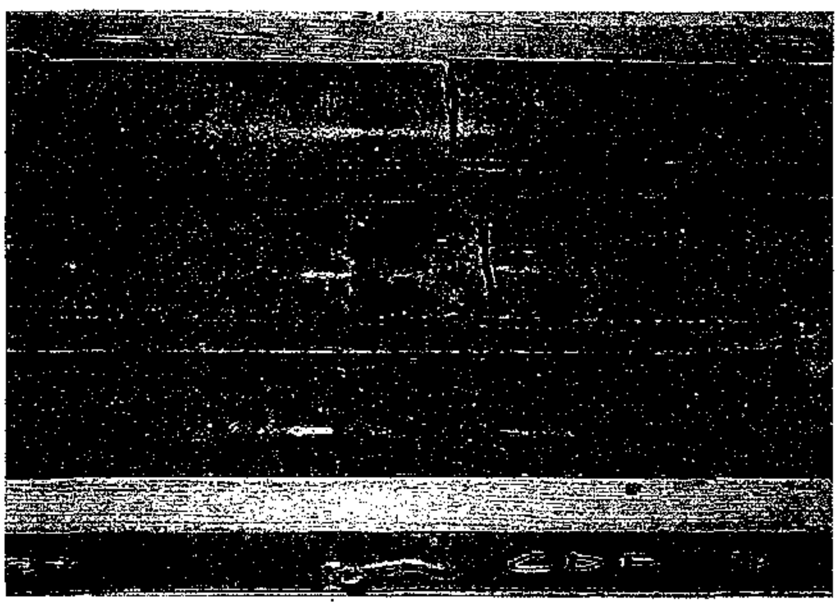
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Weathered zone noted in top of R4



Quartz/feldspar vein noted in R5

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Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-110
New Bedford Harbor Superfund Site	SHEET 1 of 14
	FILE NO. 48138.27
New Bedford, Massachusetts	CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313	easting 814763	
Driller	E. Thomas	Mudline El.	-14.29	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/5/00	Date End	12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance sampler to 2 ft., bottom felt hard with depth probe.		
1	WOC								
2	WOC								
		UO-1	24/23	2-4	———	—	Organic soil (OH); 95% organic clay/silt, 5% fine sand, strong organic odor, dark gray.		
							Advance PW drill casing to 5 ft.		
							Advance 3-7/8 in. roller bit to 5 ft.		
3	WOC								
4	WOC								
5	WOC							ORGANIC CLAY	
		UO-2	24/24	5-7	———	—	Sandy organic soil (OH); 65% organic clay/silt, 35% fine sand, strong organic odor, dark gray. Notable amount of fine sand observed in bottom of tube; possible sand seam.		
							Advance PW drill casing to 8 ft.		
6	WOC						Advance 3-7/8 in roller bit to 8 ft.		
7	WOC								
8	WOC								
		UO-3	24/24	8-10	———	—	Organic soil with sand (OH); 75% organic clay/silt, 20% fine sand, 5% shells and shell fragments, strong organic odor, dark gray. Removed large shell fragment from bottom of tube.		
9	WOC						Advance PW drill casing to 11 ft.		
							Advance 3-7/8 in. roller bit to 11 ft.		
10	WOC								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-110 SHEET 2 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313	easting 814763	
Driller	E. Thomas	Mudline El.	-14.29	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/5/00	Date End	12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	WOC							ORGANIC	
		UO-4	24/24	11-13	———	—	Organic soil with sand (OH); 75% organic clay/silt, 25% fine sand, strong organic odor, dark gray. Traces of peat noted in sample.	CLAY	
	HYD								
12	PUSH								
	HYD								
13	PUSH							13.0 ft.	
		UO-5	24/24	13-15	———	—	Sandy silt (ML); 55% silt, 10% clay, 35% fine sand, gray.		
							Advance PW drill casing to 15 ft.		
	HYD						Advance 3-7/8 in. roller bit to 15 ft.		
14	PUSH							MARINE SAND	
	HYD								
15	PUSH								
		S-1	36/24	15-17.5	2-1/12"-1/12"		Silt with sand (ML); very soft, 65% silt, 20% clay, 15% fine sand, gray.		
							Advance PW drill casing to 18 ft.		
	HYD						Advance 3-7/8 in. roller bit to 18 ft.		
16	PUSH								
	HYD								
17	PUSH								
	HYD								
18	PUSH								
		S-2	24/15	18-20	1-3-4-5	7	S-2A: Poorly graded sand (SP); loose, 65% medium sand, 25% fine sand, 5% gravel, 5% silt, gray. (6 in.)		
							S-2B: Poorly graded sand (SP); loose, 60% medium sand, 35% fine sand, 5% silt,		
19	26						olive brown. Some iron staining noted. (9 in.).		
							Advance PW drill casing to 20 ft.		
							Mix bentonite drilling mud, specific gravity = 1.10.		
							Advance 3-7/8 in. roller bit to 20 ft.		
20	20								

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	[illegible]	
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PROJECT
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New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-110
SHEET 3 of 14
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313 easting 814763
Driller	E. Thomas	Mudline El.	-14.29 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/5/00 Date End 12/8/00

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Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-3	24/3	20-22	6-2-2-2	4	Poorly graded sand (SP); very loose, 30% medium sand, 65% fine sand, 5% silt, brown.		
							Some iron staining noted.		
							Advance PW drill casing to 22 ft.	MARINE	
21	33						Advance 3-7/8 in. roller bit to 22 ft.	SAND	
22	31							22.0 ft.	
		S-4	24/12	22-24	3-2-2-4	4	**Silty sand (SM); 71% fine sand, 29% silt, light brown.**		1
							Advance PW drill casing to 24 ft.	GLACIO	
							Advance 3-7/8 in. roller bit to 24 ft.	FLUVIAL	
23	28								
24	39								
		S-5	24/12	24-26	3-2-3-4	5	Similar to S-4, except loose.		
							Advance PW drill casing to 26 ft.		
							Advance 3-7/8 in. roller bit to 26 ft.		
25	36								
26	65								
		S-6	24/8	26-28	5-3-3-3	6	**Poorly graded sand (SP); 1% coarse sand, 7% medium sand, 88% fine sand, 4% silt,**		1
							yellowish brown.		
							Advance PW drill casing to 28 ft.		
27	68						Advance 3-7/8 in. roller bit to 28 ft.		
28	86								
		S-7	24/10	28-30	4-6-5-6	11	Poorly graded sand (SP); medium dense, 30% medium sand, 65% fine sand, 5% silt,		
							brown.		
							Advance PW drill casing to 33 ft.		
29	53						Advance 3-7/8 in. roller bit to 33 ft.		
30	75								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-110
SHEET 4 of 14
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313 easting 814763
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Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

Depth	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	Depth (feet)	Blows per 6 inches	SPT N-Value	Sample Description (ASTM D2488)	Stratum Description	Remarks
31	83								
32	92								
33	87							GLACIO	
		S-8	24/10	33-35	5-5-7-8	12	**Poorly graded sand with silt (SP-SM); 16% medium sand, 75% fine sand, 1% gravel, 8% silt, yellowish brown.**	FLUVIAL	1
							Advance PW drill casing to 36 ft.		
34	66						Advance 3-7/8 in. roller bit to 36 ft.		
35	76								
36	84								
		S-9	24/7	36-38	5-5-4-5	9	**Poorly graded sand with gravel (SP); 14% coarse sand, 22% medium sand, 28% fine sand, 32% gravel, 4% silt, grayish brown.** Subangular sand and gravel.		1
							Advance PW drill casing to 39 ft.		
37	83						Advance 4-7/8 in. roller bit to 41 ft.		
							Probable boulder from 39 to 41 ft.		
38	73								
39	75							39.0 ft.	
								PROBABLE BOULDER	
40	SPIN								

GRANULAR SOILS	COHESIVE SOILS	SYMBOLS	
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-110
SHEET 5 of 14
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2696313 easting 814763
Driller E. Thomas | Mudline El. -14.29 | Datum NGVD
Logged By E. Thibodeau | Date Start 12/5/00 | Date End 12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
								PROBABLE BOULDER	
41	SPIN							41.0 ft.	
		S-10	24/6	41-43	7-5-8-10	13	Poorly graded sand with gravel (SP); medium dense, 25% medium sand, 10% fine sand, 40% gravel, 20% coarse sand, 5% silt, subrounded to subangular sand and gravel, brown.		
							Mix additional bentonite drilling mud, specific gravity =1.15.		
42	SPIN						Advance 4-7/8 in. roller bit to 44 ft.		
							Probable boulder at 44 ft.	GLACIO	
							Advance 4-7/8 in. roller bit to 47.5 ft. Attempt rock core.	FLUVIAL	
							Telescope HW drill casing to 44.8 ft. (spin), unable to to achieve casing seal; sands		
43	SPIN						falling into roller bit hole. Telescope NW drill casing to 47.6 ft., remove HW drill casing.		
							Advance 2-7/8 in. roller bit to remove sand from hole. Check seal on casing, water level dropped slowly.		
44	SPIN							44.0 ft.	
45	SPIN								
46	SPIN							BOULDER	
47	SPIN								
							Begin NX rock core at 47.5 ft.		
48	SPIN						R1: 47.5 to 49.5 ft. Core barrel dropped from 48 to 48.5 ft. and 49 to 49.5 ft.	48.0 ft.	
							Terminate rock core, 5 in. recovery.	SOIL?	
							Fresh, hard, gray, fine-grained GNEISS. Total core time 10 minutes.	48.5 ft.	
		S-11	24/18	48.5-50.5	4-7-10-10	17	Poorly graded sand with gravel (SP); medium dense, 25% medium sand, 70% fine sand,	COBBLE?	
49							5% gravel, 5% silt, gray. Piece of fractured GNEISS noted in sample.	49.0 ft.	
							Advance 2-7/8 in. roller bit to 51.5 ft.	GLACIO FLUVIAL	
50									

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOL KEY	
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2)
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313 easting 814763
Driller	E. Thomas	Mudline El.	-14.29 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/5/00 Date End 12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
								GLACIO FLUVIAL	
51							Top of bedrock at 51 ft.	51.0 ft.	
							Advance NW drill casing to 51 ft.		
							Begin NX rock core at 51.5 ft.	BEDROCK	
							(boring log continued on next page)		
52									
53									
54									
55									
56									
57									
58									
59									
60									

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-110
SHEET	7 of 14
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313 easting 814763
Driller	E. Thomas	Mudline El.	-14.29 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/5/00 Date End 12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R1	51.5-52.5	3.5 min.	Begin R1 at 51.5 ft. Fresh, hard, gray fine grained GNEISS. Low angle foliation (approx. 10 degrees). REC = 97%; RQD = 95% (excellent)	
52.0					Minimal water return noted. Water return color: milky white. 51.5 and 51.6 ft.: Primary joints: low angle, smooth, planar, discolored, and tight. Gray infilling noted on 51.6 ft. joint.	
52.5					52.0 ft.: Mechanical break in rock core.	
			52.5-53.5	3 min.	51.5 to 52.8 ft.: Zone of feldspar (pink) and quartz (dark gray) nodules. 52.5 ft.: Primary joint: low angle, smooth, planar, discolored, and open. 52.5 ft.: Loss of water return.	
53.0						
53.5					53.4 ft.: Mechanical break in rock core.	
			53.5-54.5	3.5 min.	53.5 to 53.7 ft.: Quartz/ feldspar vein (pink), some discoloration noted. 53.7 ft.: Mechanical break in rock core.	
54.0						
54.5					54.4 ft.: Primary joint: low angle, smooth, planar, discolored, and tight.	
			54.5-55.5	4 min.		
55.0						
55.5						
			55.5-56.5	3.5 min.	55.8 and 55.9 ft.: Primary joints: low angle, smooth, planar, discolored, and open.	
56.0					56.0 ft.: Mechanical break in rock core.	
56.5					End R1 at 56.5 ft.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

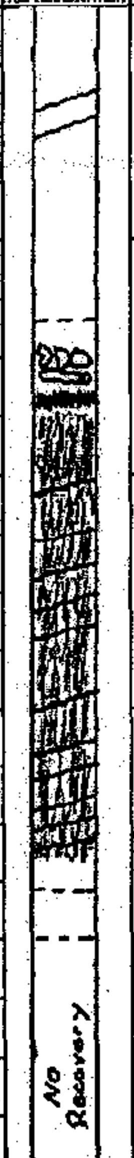
BORING NO.	FD-110
SHEET	8 of 14
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313 easting 814763
Driller	E. Thomas	Mudline El.	-14.29 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/5/00 Date End 12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 6-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time



DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R2	56.5-57.5	2 min.	Begin R2 at 56.5 ft. Fresh to slightly weathered, hard to soft, gray, fine grained GNEISS. Low angle foliation (approx. 10 degrees). REC = 80%; RQD = 43% (poor) No water return noted. 56.9 and 57.1 ft.: Primary joints: low angle to horizontal, smooth, planar, and discolored.	
57.0					
57.5		57.5-58.5	1.5 min.	57.8 ft.: Mechanical break in rock core. 57.9 to 58.1 ft.: Fractured rock zone. Slight discoloration noted on some of the fractured surfaces. Possible mechanical breaks. 58.1 ft.: Thin quartz/ feldspar vein (pink to dark gray). 58.2 to 60.2 ft.: Weathered zone. Rock distinctly discolored. Rock easily broken with hands; slightly friable. Total of eleven fractures noted throughout this zone. Fractures are low angle, smooth to rough , planar, and discolored. Some fractures may be mechanical in nature. Some residual soil noted along the surfaces of the fractures.	
58.0					
58.5		58.5-59.5	1.5 min.		
59.0					
59.5		59.5-60.5	2 min.		
60.0				60.3 ft.: Mechanical break in rock core.	
60.5		60.5-61.5	2 min.	60.5 to 61.5 ft.: No recovery.	
61.0					
61.5				End R2 at 61.5 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313 easting 814763
Driller	E. Thomas	Mudline El.	-14.29 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/5/00 Date End 12/6/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R3	61.5-62.5	5 min.	Begin R3 at 61.5 ft. Fresh, hard, gray, fine grained GNEISS. Low angle foliation (approx. 20 degrees). REC = 94%; RQD = 89% (good) No water return noted. 61.5 to 61.9 ft.: Secondary joints: high angle, rough, planar, fresh and open. 62.0 ft.: Mechanical break in rock core.	
62.0					
62.5		62.5-63.5	4.5 min.	62.5 ft.: Mechanical break in rock core. 62.9 ft.: Mechanical break in rock core.	
63.0					
63.5		63.5-64.5	5.5 min.		
64.0					
64.5		64.5-65.5	5 min.	64.5 ft.: Mechanical break in rock core. 64.7 ft.: Mechanical break in rock core. 64.9 to 66.0 ft.: Healed joint: high angle to vertical. Some discoloration noted along joint.	
65.0					
65.5		65.5-66.0	4 min.		
66.0	R4	66.0-67.0	7 min.	End R3 at 66.0 ft. Core barrel full; core run terminated. Begin R4 at 66.0 ft. Fresh, hard, gray, fine grained GNEISS. Low angle foliation (approx. 20 degrees). REC = 100%; RQD = 100% (excellent) No water return noted.	
66.5					

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-110 SHEET 10 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313	easting 814763	
Driller	E. Thomas	Mudline El.	-14.29	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/5/00	Date End	12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R4 (cont.)			66.0 to 67.0 ft.: Healed joint: high angle to vertical. Some discoloration noted along joint, continuation from R3.	
67.0			67.0-68.0	6.5 min.		
67.5					67.5 ft.: Mechanical break in rock core. Possible healed joint. 67.6 ft.: Healed joint.	
68.0					67.9 and 68.1 ft.: Mechanical break in rock core.	
			68.0-69.0	6.5 min		
68.5					68.4 ft.: Primary joint: low angle, rough, planar, discolored, and tight.	
69.0			69.0-70.0	7.5 min.		
69.5					69.5 to 69.8 ft.: Series of mechanical breaks in rock core.	
70.0					69.9 ft.: Mechanical break in rock core.	
			70.0-71.0	6.5 min.		
70.5						
71.0					End R4 at 71.0 ft.	
		R5	71.0-72.0	3 min.	Begin R5 at 71.0 ft. Fresh, hard, gray, fine grained GNEISS. Low angle foliation (approx. 20 to 30 degrees). REC = 100%; RQD = 100% (excellent) No water return noted.	
71.5						

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-110
SHEET 11 of 14
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313	easting 814763	
Driller	E. Thomas	Mudline El.	-14.29	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/5/00	Date End	12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
72.0					71.8 ft.: Secondary joint: moderately dipping, rough, planar, slightly discolored, and tight.	
			72.0-73.0	3.5 min.	Possible healed joint. 71.9 to 72.1 ft.: Healed joint: moderately dipping. 72.0 ft.: Mechanical break in rock core.	
72.5					72.5 ft.: Mechanical break in rock core. Possible healed joint. 72.6 to 72.8 ft.: Healed joint: moderately dipping and undulating.	
73.0						
			73.0-74.0	3 min.	73.3 ft.: Mechanical break in rock core.	
73.5						
74.0					73.9 ft.: Mechanical break in rock core.	
			74.0-75.0	3.5 min.		
74.5						
75.0					74.9 ft.: Mechanical break in rock core.	
			75.0-76.0	3.5 min.		
75.5					75.7 ft.: Mechanical break in rock core.	
76.0						
					End R5 at 76.0 ft. Bottom of exploration at 76.0 ft; boring terminated in bedrock. Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.32.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sample.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-110 SHEET 12 of 14 FILE NO. 48138.27 CHKD. BY J. Trottier

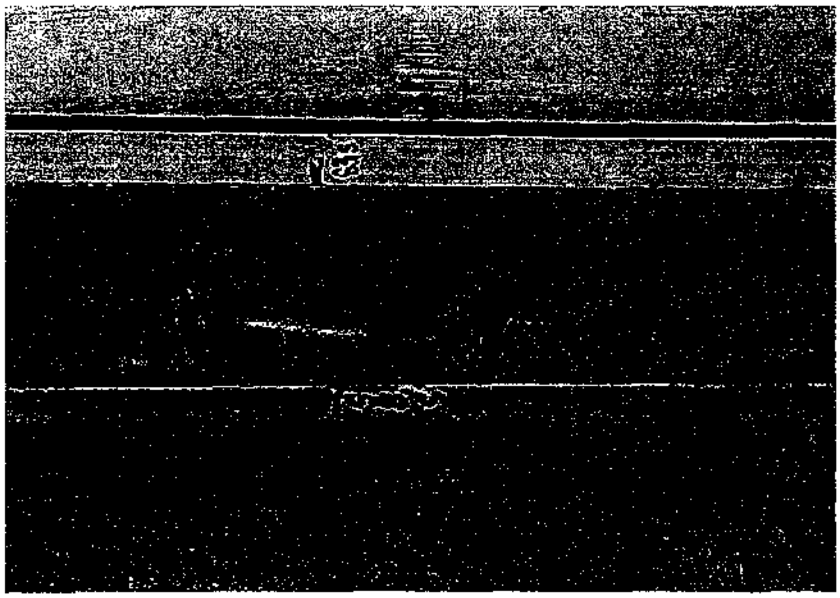
Boring Co.	Warren George, Inc.	Boring Location	northing 2696313	easting 814763	
Driller	E. Thomas	Mudline El.	-14.29	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/5/00	Date End	12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

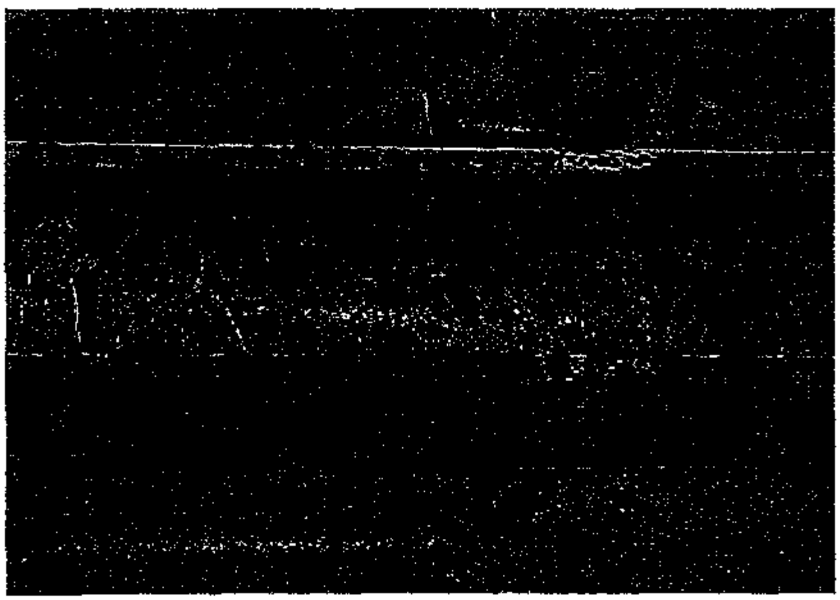
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Quartz/feldspar vein noted in R1



Weathered zone noted in R2

REMARKS:
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18 Chenell Drive
Concord, New Hampshire 03301

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-110
New Bedford Harbor Superfund Site	SHEET	13 of 14
New Bedford, Massachusetts	FILE NO.	48138.27
	CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696313	easting 814763	
Driller	E. Thomas	Mudline El.	-14.29	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/5/00	Date End	12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
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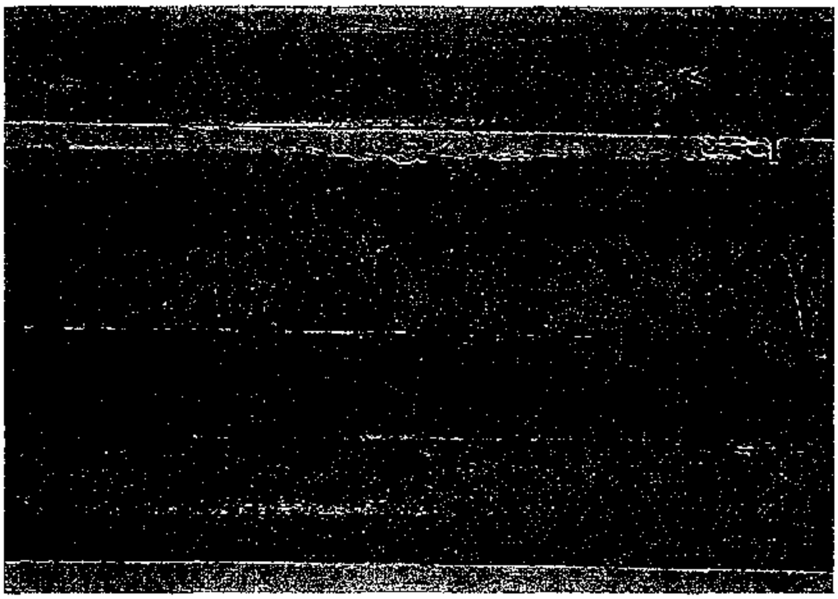
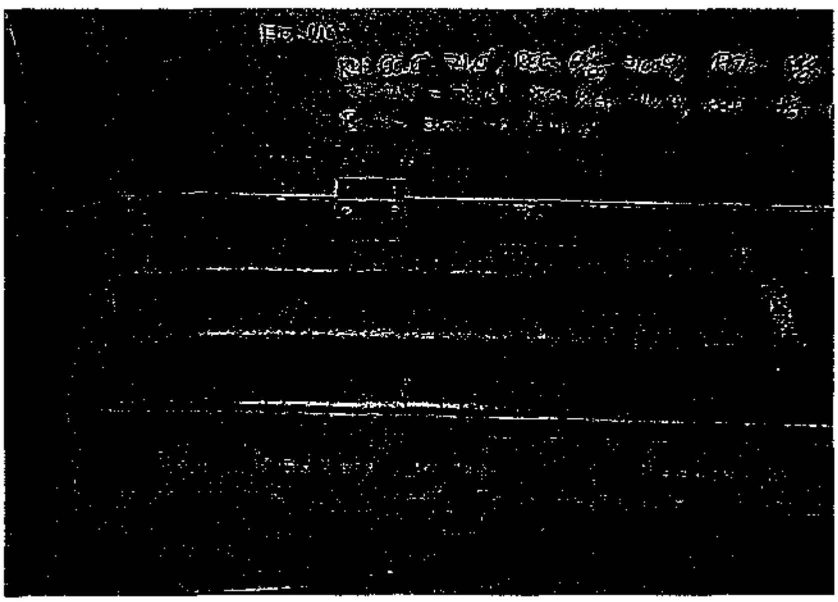
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Weathered zone noted in R2



Core Runs R4 and R5

REMARKS:
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-110
SHEET	14 of 14
FILE NO.	48138.27
CHKD. BY	J. Trottier

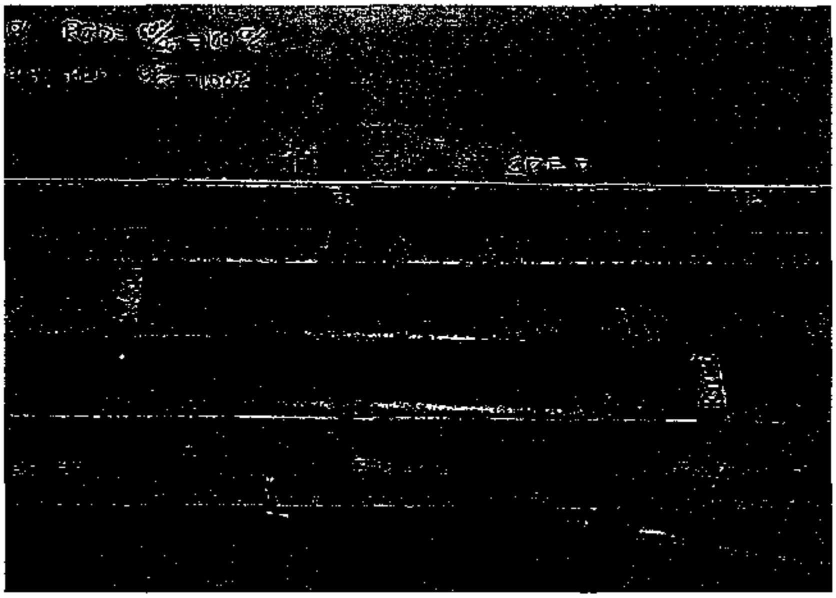
Boring Co.	Warren George, Inc.	Boring Location	northing 2696313	easting 814763	
Driller	E. Thomas	Mudline El.	-14.29	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/5/00	Date End	12/8/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

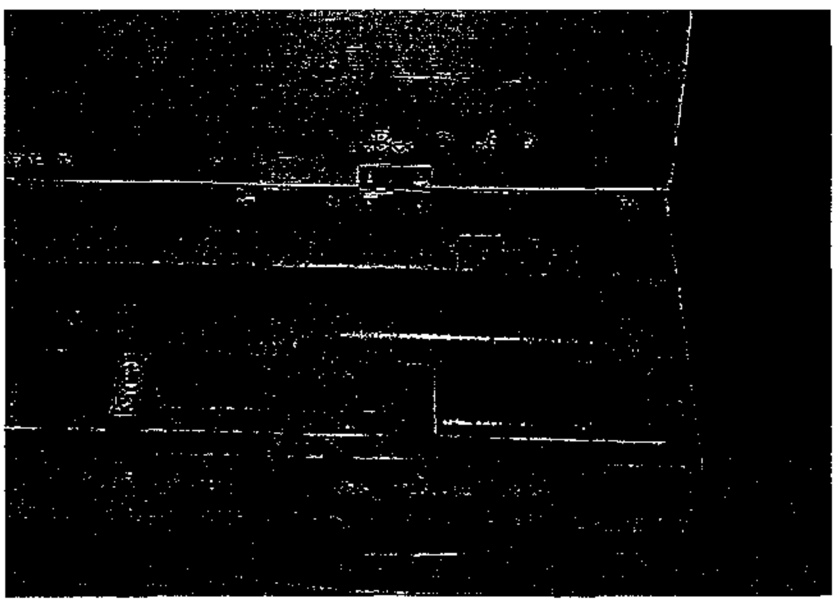
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R4 and R5



Core Runs R4, R5, and boulder core.

REMARKS:
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-111
SHEET 1 of 11
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2696247 easting 814699
Driller E. Thomas | Mudline El. -32.21 | Datum NGVD
Logged By E. Thibodeau | Date Start 12/11/00 | Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	WOC								
		S-1	24/6	2-4	WOR/24"	—	Organic clay (OH); very soft, 95% organic clay/silt, 5% fine sand, strong organic odor, black to dark gray. Slight sheen noted on sample.		
							Advance PW drill casing to 4 ft.	ORGANIC CLAY	
3	WOC								
4	WOC								
		S-2	24/6	4-6	WOR/24*	—	S-2A: Similar to S-1. (5 in.)		
							S-2B: Silty sand (SM); 80% fine sand, 5% gravel, 15% silt, subrounded gravel, gray. (1 in.)		
5	WOC						Advance PW drill casing to 6 ft.		
							Advance 3-7/8 in. roller bit to 6 ft.		
6	WOC							6.0 ft.	
		S-3	24/18	6-8	10-7-4-4	11	S-3A: Mixture of silty sand (SM) and disturbed organic soil (OH). (4 in.)		
							S-3B: Poorly graded sand with silt (SP-SM); medium dense, 30% medium sand, 60% fine sand, 10% silt, brown to orange brown. (14 in.)		
7	18						Advance PW drill casing to 8 ft.		
							Advance 3-7/8 in. roller bit to 8 ft.		
8	35						Perform falling head permeability test at 8 ft.	MARINE SAND	
		S-4	24/11	8-10	4-3-3-4	6	**Poorly graded sand (SP); 1% coarse sand, 5% medium sand, 91% fine sand, 3% silt, yellowish brown.**		1
							Approximate 1 inch thick lense of medium to fine sand and gravel noted in sample. Brown with minor black staining with a moderate organic odor.		
9	10						Advance PW drill casing to 10 ft.		
							Advance 3-7/8 in. roller bit to 10 ft.		
10	22								

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-111 SHEET 2 of 11 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696247 easting 814699
Driller	E. Thomas	Mudline El.	-32.21 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/11/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/14	10-12	1-1-2-4	3	Poorly graded sand (SP); very loose, 10% coarse sand, 50% medium sand, 30% fine sand, 5% gravel, 5% silt, brown. Approximate 1 inch thick lense of coarse sand and gravel noted in sample. Black to dark gray in color.	MARINE SAND	
11	11						Advance PW drill casing to 12 ft. Advance 3-7/8 in. roller bit to 12 ft.		
12	12						Perform constant head permeability test at 12 ft.		
		S-6	24/11	12-14	1-2-2-3	4	**Poorly graded sand with silt (SP-SM); 4% coarse sand, 26% medium sand, 61% fine sand, 1% gravel, 8% silt, yellowish brown.** Subangular gravel.		1
	0						Advance PW drill casing to 14 ft. Casing dropped 6 inches.		
13	11						Mix bentonite drilling mud, specific gravity = 1.07. Advance 3-7/8 in. roller bit to 14 ft.		
14	17							14.0 ft.	
		S-7	24/6	14-16	3-3-2-3	5	**Poorly graded sand with silt and gravel (SP-SM); 11% coarse sand, 24% medium sand, 32% fine sand, 24% gravel, 9% silt, yellowish brown.** Subrounded to subangular sand and gravel.	GLACIO FLUVIAL	1
15	22						Advance PW drill casing to 16 ft. Advance 3-7/8 in. roller bit to 16 ft.		
16	30								
		S-8	24/4	16-18	4-3-2-3	5	Washed sample. Advance PW drill casing to 18 ft. Advance 3-7/8 in. roller bit to 18 ft. with drilling mud to remove coarse wash material.		
17	32						Flush drill casing with water to remove drilling mud. Approximately 3-4 inches of material in bottom of casing. 12/12/00: Remove drill casing from hole to prepare for severe wind event. 12/13/00: Advance PW drill casing to 20 ft. Appears that hole stayed open to		
18	39						approximately 17 ft. Advance 3-7/8 in. roller bit to 20 ft. with drilling mud to remove coarse wash material, specific gravity = 1.07. Flush drill casing with water to remove drilling mud. Approximately 4 inches of material in bottom of casing.		
19	49								
20	73	S-					Perform constant head permeability test at 20 ft.		

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-111
SHEET 3 of 11
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2696247 easting 814699
Driller E. Thomas | Mudline El. -32.21 | Datum NGVD
Logged By E. Thibodeau | Date Start 12/11/00 | Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-9	24/6	20-22	3-5-5-8	10*	Poor recovery. Washed sample.		2
							Advance PW drill casing to 22 ft.		
							Mix additional bentonite drilling mud, specific gravity = 1.09.		
21	28						Advance 3-7/8 in. roller bit to 22 ft.		
22	31								
		S-10	24/4	22-24	6-2-3-3	5*	Poor recovery. Washed sample.		2
							Advance PW drill casing to 24 ft.		
							Mix additional bentonite drilling mud.		
23	33						Advance 3-7/8 in. roller bit to 24 ft.		
24	48								
		S-11	24/0	24-26	8-4-6-8	10*	No recovery.		2
							Advance PW drill casing to 26 ft.		
							Advance 3-7/8 in. roller bit to 26 ft.	GLACIO	
25	24							FLUVIAL	
26	46								
		S-12	24/6	26-28	8-9-10-12	19*	**Silty sand with gravel (SM); 4% coarse sand, 10% medium sand, 43% fine sand, 16% gravel, 27% silt, light gray.** Subrounded to subangular sand and gravel. (sample placed in 2 jars)		1,2
27	21						Advance PW drill casing to 28 ft.		
							Advance 3-7/8 in. roller bit to 28 ft. with drilling mud to remove coarse wash material.		
							Flush drill casing with water to remove drilling mud. Attempt constant head permeability test at 28 ft. Unable to keep constant water level in casing. Formation		
28	86						taking approximately 10 gallons of water every 20 - 30 seconds with 10 ft. of head.		
		S-13	24/1	28-30	15-6-4-6	10	Poor recovery. Washed sample.		
							Advance PW drill casing to 32 ft.		
							Advance 3-7/8 in. roller bit to 32 ft.		
29	53								
30	53								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-111

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller E. Thomas
Logged By E. Thibodeau
Boring Location northing 2696247 easting 814699
Mudline El. -32.21 Datum NGVD
Date Start 12/11/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
31	78								
32	71							GLACIO	
		S-14	17/6	32-33.4	10-7-8/5"-25/0"	--*	Silty sand with gravel (SM); 10% coarse sand, 30% medium sand, 30% fine sand, 15%	FLUVIAL	2
							gravel, 15% silt, subrounded to subangular sand and gravel. Strong hydrocarbon odor.		
							Headspace: 5.9 ppm. (2 jars)		
33	87						Advance PW drill casing to 33.7 ft.		
							Top of bedrock at 33.7 ft.		
							Advance 4-7/8 in. roller bit to 34 ft.		
							Telescope HW drill casing to 34.3 ft. (spin)		
34	90/						Begin HQ rock core at 34 ft.	33.7 ft.	
	8"						(boring log continued on next page)		
								BEDROCK	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-111 SHEET 5 of 11 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696247	easting 814699	
Driller	E. Thomas	Mudline El.	-32.21	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/11/00	Date End	12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R1	34-35	7 mins.	Begin R1 at 34 ft. Fresh to slightly weathered, moderately hard, gray, fine-grained GNEISS. Low angle foliation. (approx. 20 to 30 degrees) REC = 93%; RQD = 77% (good)	
34.5				Water return color: milky white. 34.3 ft.: Mechanical break in rock core. 34.7 to 34.8 ft.: Quartz vein. Gray in color. 34.8 ft.: Mechanical break in rock core.	
35.0				34.9 ft.: Primary joint: low angle, smooth, planar, slightly discolored, and open.	
		35-36	4.5 mins.	35.0 ft.: Secondary joint: moderately dipping, rough, undulating, slightly discolored, and tight. Loss of water return noted at 35 ft.	
35.5					
36.0				35.9 ft.: Secondary joint: moderately dipping, rough, planar, slightly discolored, and tight.	
		36-37	5 mins.		
36.5					
37.0					
		37-38	4.5 mins.		
37.5					
38.0					
		38-39	4 mins.		
38.5					
				38.7 and 38.5 ft.: Mechanical breaks in rock core.	
39.0				End R1 at 39 ft.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-111 SHEET 6 of 11 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696247	easting 814699	
Driller	E. Thomas	Mudline El.	-32.21	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/11/00	Date End	12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION
	R2	39-40	5 mins.	Begin R2 at 39 ft. Fresh, hard, gray, medium-grained GNEISS. Low angle foliation. (approx. 10 to 20 degrees) REC = 97%; RQD = 65% (fair) No water return noted during coring activities. 39.4 ft.: Mechanical break in rock core.
39.5				
40.0		40-41	4.5 mins.	
40.5				
41.0		41-42	4.5 mins.	41.2 to 43.3 ft.: Weathered zone. Six distinct low angle to horizontal breaks noted in rock core. Some discoloration and core grinding noted on the surfaces. Difficult to determine if breaks are mechanical or natural.
41.5				
42.0		42-43	3.5 mins.	41.9 ft.: Primary joint: horizontal, smooth, planar, discolored, and tight. 41.9 to 42.4 ft.: Secondary joint: high angle, rough, planar, discolored, and open.
42.5				42.4 ft.: Primary joint: low angle, smooth, planar, discolored, and tight. 42.4 to 42.6 ft.: Secondary joint: high angle to moderately dipping, rough, planar, discolored, and open. 42.7 ft.: Mechanical break in weathered zone. Rock around break is friable.
43.0		43-44	5 mins.	
43.5				43.3 ft.: Set of two primary joints extremely close spacing. Horizontal, smooth, planar, discolored to decomposed, and open. 43.6 and 43.8 ft.: Mechanical breaks in rock core.
44.0				End R2 at 44 ft.

GRANULAR SOILS - BLOWS/FT	COHESIVE SOILS - BLOWS/FT	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-111
SHEET 7 of 11
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696247	easting 814699	
Driller	E. Thomas	Mudline El.	-32.21	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/11/00	Date End	12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings.

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R3	44-45	5.5 mins.	Begin R3 at 44 ft. Fresh, hard, gray, fine-grained, GNEISS. Low angle foliation. (approx. 20 degrees) REC = 97%; RQD = 97% (excellent) No water return noted during coring activities. 44.0 ft.: Primary joint: low angle, smooth, planar, discolored, and open. 44.6 ft.: Mechanical break in rock core.	
44.5						
45.0					44.9 ft.: Mechanical break in rock core.	
			45-46	5.5 mins.		
45.5					45.5 ft.: Primary joint: low angle, smooth, planar, discolored, and tight.	
46.0						
			46-47	6 mins.		
46.5						
47.0						
			47-48	6 mins.	47.3 ft.: Mechanical break in rock core.	
47.5						
48.0					47.8 ft.: Mechanical break in rock core.	
			48-49	6 mins.		
48.5						
49.0					End R3 at 49 ft.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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REMARKS:
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PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-111
SHEET 8 of 11
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696247	easting 814699	
Driller	E. Thomas	Mudline El.	-32.21	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/11/00	Date End	12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
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Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4	49-50	4 mins.	Begin R4 at 49 ft. Fresh, hard, gray, fine-grained GNEISS. Low angle foliation. (approx. 20 degrees) REC = 100%; RQD = 93% (excellent) No water return noted during coring activities.	
49.5					49.5 and 49.6ft.: Primary joints: low angle, rough, planar, discolored, and open. 49.7 ft.: Primary joint: horizontal, rough, planar, discolored, and open.	
50.0			50-51	4 mins.		
50.5						
51.0			51-52	4.5 mins.		
51.5						
52.0			52-53	6 mins.		
52.5					52.5 ft.: Mechanical break in rock core. 52.8 ft.: Mechanical break in rock core.	
53.0			53-54	6 mins.	53.1 ft.: Mechanical break in rock core.	
53.5					Perform packer test from 45.3 to 54.0 ft. Perform packer test from 47.3 to 54.0 ft. End R4 at 54 ft. Bottom of exploration at 54 ft. Boring terminated in bedrock. Grout completed borehole to mudline with cement/bentonite grout, specific gravity = 1.30.	
54.0						

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-111 SHEET 9 of 11 FILE NO. 48138.27 CHKD. BY J. Trottier

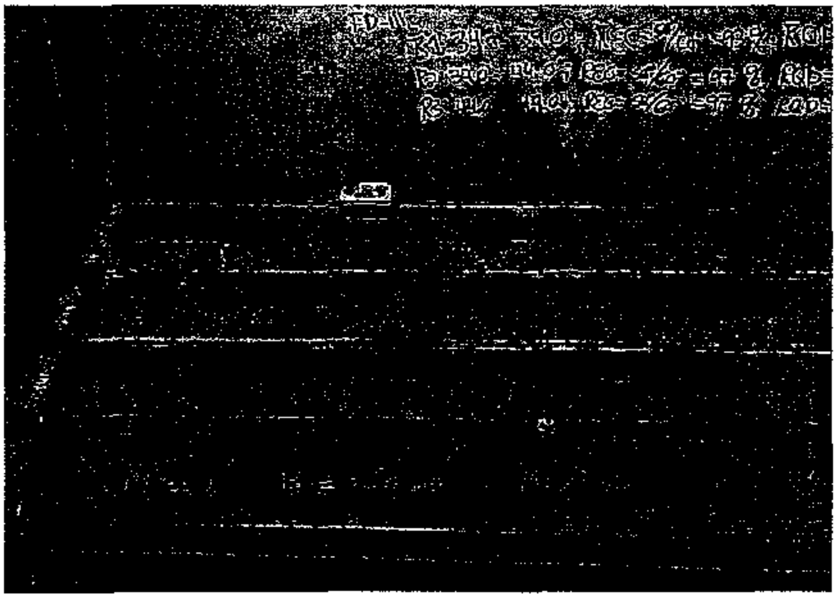
Boring Co.	Warren George, Inc.	Boring Location	northing 2696247 easting 814699
Driller	E. Thomas	Mudline El.	-32.21 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/11/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

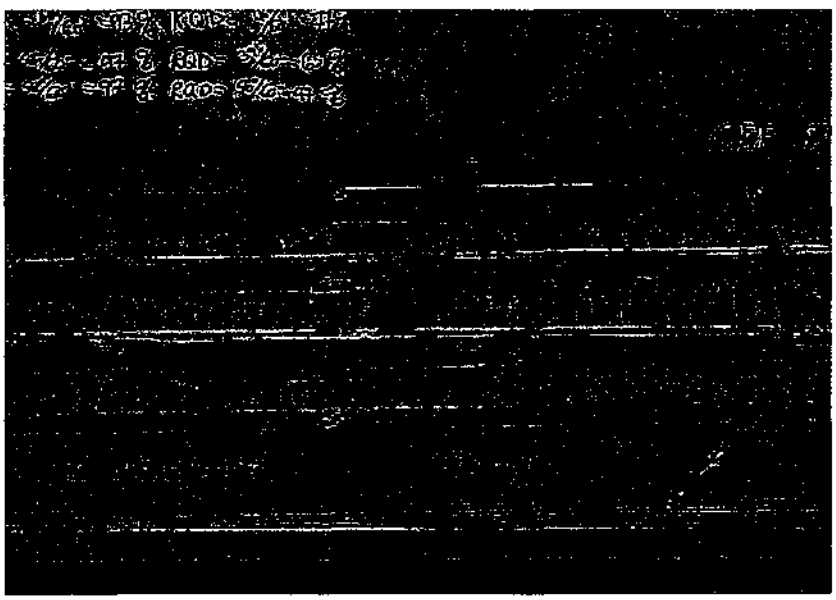
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

M:\Reports\Active\48138.21\Field Forms\FD-111.xls\Picture

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-111
SHEET 10 of 11
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller E. Thomas
Logged By E. Thibodeau

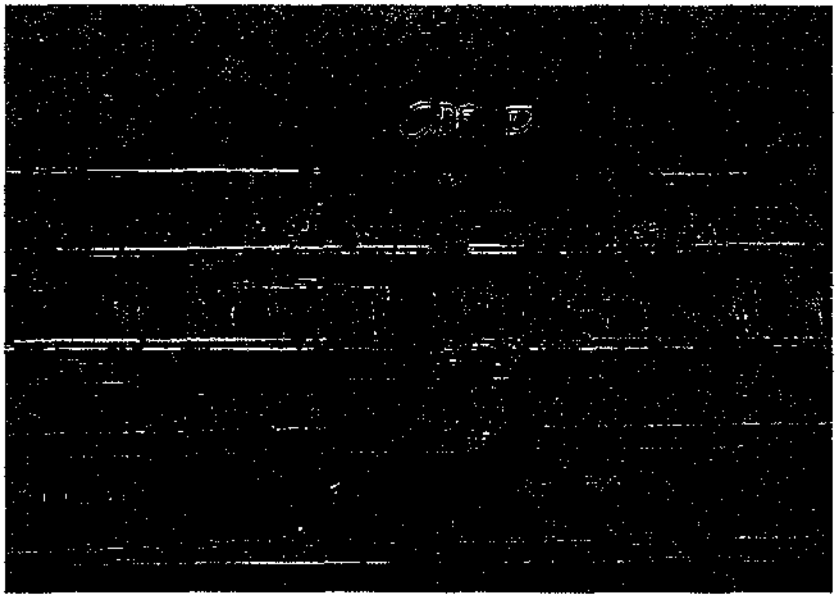
Boring Location northing 2696247 easting 814699
Mudline El. -32.21 Datum NGVD
Date Start 12/11/00 Date End 12/15/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

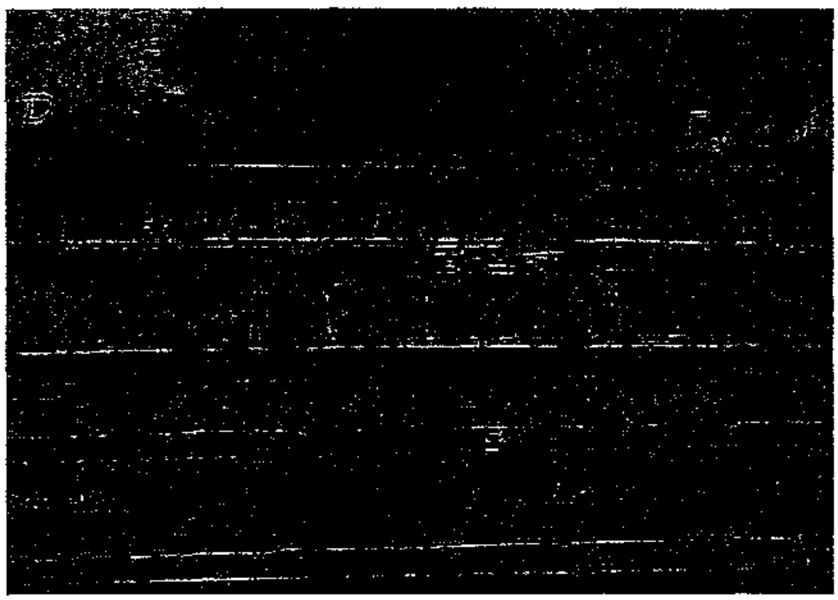
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

PROJECT	
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts

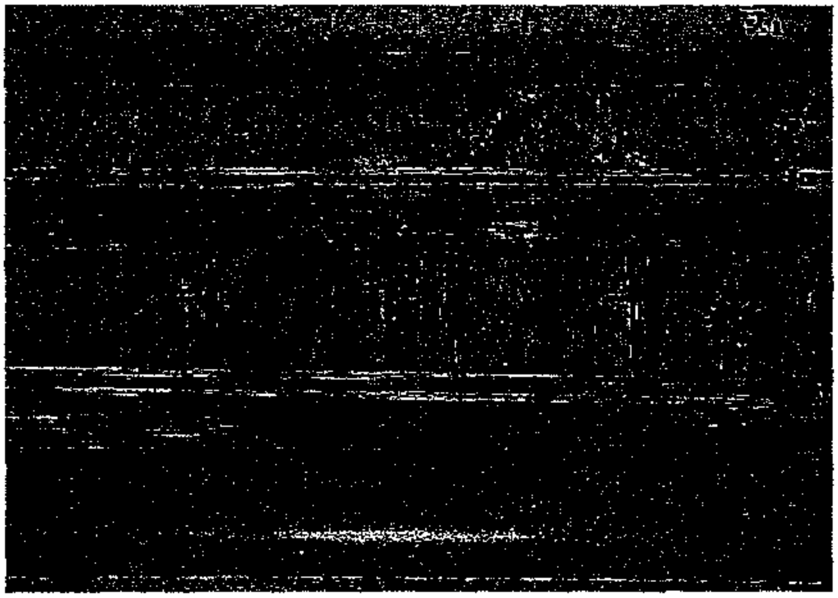
BORING NO.	FD-111
SHEET	11 of 11
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696247	easting 814699	
Driller	E. Thomas	Mudline El.	-32.21	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/11/00	Date End	12/15/00

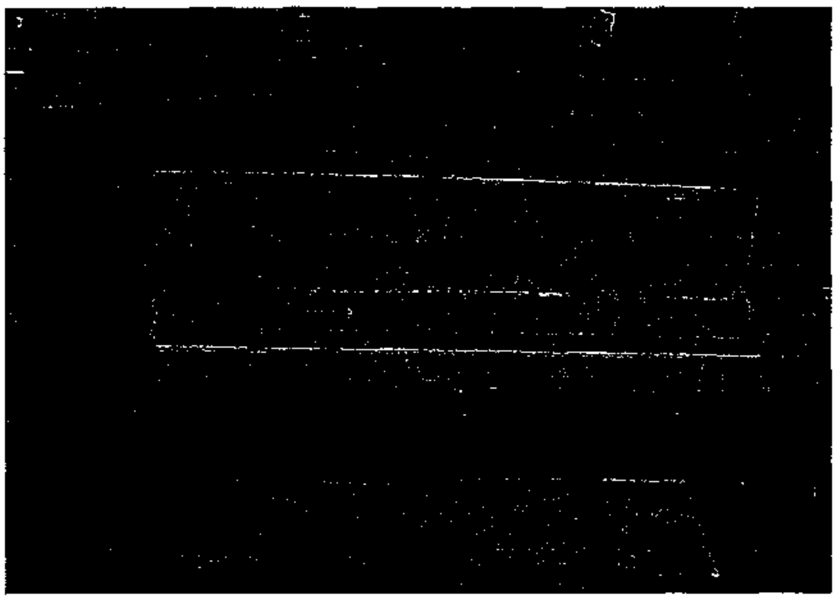
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Weathered zone noted in R2



Core Run R4

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO FD-112 SHEET 1 of 11 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co. Warren George, Inc. — Boring Location: northing 2696171, easting 814570
Driller E. Thomas — Mudline El. -32.79 — Datum NGVD
Logged By E. Thibodeau — Date Start 12/1/00 — Date End 12/4/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	WOC							ORGANIC CLAY	
		S-1	24/11	2-4	WOR/24"	—	Organic soil (OH); very soft, 95% organic clay/silt, 5% fine sand, strong organic odor, black to dark gray.		
							Advance PW drill casing to 4 ft.		
3	WOC						Advance 3-7/8 in. roller bit to 4 ft.		
4	WOC							4.0 ft.	
		S-2	24/13	4-6	3-6-5-4	11	Silty sand (SM); medium dense, 5% coarse sand, 25% medium sand, 35% fine sand, 10%gravel, 15% silt, slight organic odor, gray-brown.		
							Advance PW drill casing to 9 ft. Casing advanced under it's own weight from 4 to 5 ft.		
5	WOC						Mix bentonite drilling mud, specific gravity = 1.07.		
							Advance 3-7/8 in. roller bit to 9 ft.		
6	14							GLACIO FLUVIAL	
7	17								
8	17								
9	16								
		S-3	24/7	9-11	6-4-3-3	7	**Poorly graded sand with silt and gravel (SP-SM); 10% coarse sand, 24% medium sand, 41% fine sand, 19% gravel, 6% silt, yellowish brown.** Subrounded to subangular sand and gravel.		1
10	10						Advance PW drill casing to 11 ft.		

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of 80%.
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO FD-112 SHEET 2 of 11 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2696171	easting 814570	
Driller	E. Thomas	Mudline El.	-32.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/1/00	Date End	12/4/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD-II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance 3-7/8 in. roller bit to 11 ft.		
11	10								
		S-4	24/0	11-13	7-3-3-3	6	No Recovery.		
							Advance PW drill casing to 13 ft.		
							Mix additional bentonite drilling mud, specific gravity = 1.11.		
12	23						Advance 3-7/8 in. roller bit to 13 ft.		
13	22								
		S-5	24/6	13-15	5-5-4-4	9	Poorly graded sand with gravel (SP); loose, 15% coarse sand, 30% medium sand, 10% fine sand, 40% gravel, 5% silt, subangular sand, brown. Pieces of subangular gravel noted in sample.		
14	28						Advance PW drill casing to 15 ft.		
							Advance 3-7/8 in. roller bit to 15 ft.		
15	26							GLACIO	
		S-6	24/7	15-17	7-4-4-7	8	**Poorly graded sand with silt and gravel (SP-SM); 12% coarse sand, 24% medium sand, 23% fine sand, 33% gravel, 8% silt, light brown.**	FLUVIAL	1
							Subrounded to subangular sand and gravel.		
16	28						Advance PW drill casing to 17 ft.		
							Advance 3-7/8 in. roller bit to 17 ft.		
17	23								
		S-7	24/6	17-19	8-8-4-4	12	**Silty gravel with sand (GM); 9% coarse sand, 18% medium sand, 14% fine sand, 46% gravel, 13% silt, light brown.**		1
							Subrounded to subangular sand and gravel.		
18	50						Advance PW drill casing to 19 ft.		
							Advance 3-7/8 in. roller bit to 19 ft.		
19	40								
		S-8	24/1	19-21	10-7-6-7	13	Poor recovery.		
							Advance PW drill casing to 21 ft.		
							Advance 3-7/8 in. roller bit to 21 ft.		
20	27								

[illegible]

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of 80%.
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-112 SHEET 3 of 11 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2696171 easting 814570
Driller	E. Thomas	Mudline El.	-32.79 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/1/00 Date End 12/4/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
21	41								
		S-9	24/1	21-23	7-14-14-11	28	Poor recovery. Attempted to resample with 3 in. sampler. Several large		
							pieces of rock fragments recovered, appears to be GNEISS.		
							Advance PW drill casing to 26 ft.		
22	58						Advance 3-7/8 in. roller bit to 26 ft.		
23	62							GLACIO FLUVIAL	
24	80								
25	22								
26	140								
		S-10	24/4	26-28	33-31-23-14	54	**Poorly graded sand with silt and gravel (SP-SM); 41% gravel,**		1
							12% coarse sand, 18% medium sand, 17% fine sand, 12% silt, yellow brown.		
							Subangular sand and gravel.		
27	102						Advance PW drill casing to 28 ft.		
							Mix additional bentonite drilling mud.		
							Advance 3-7/8 in. roller bit to 28 ft.		
28	144								
		S-11	8/6	28-28.7	22-50/2"	—	**S-11A: Poorly graded sand with silt and gravel (SP-SM); 14% coarse sand,**		1,2
							21% medium sand, 16% fine sand, 41% gravel, 8% silt, light brown.	28.5 ft	
							Subangular sand and gravel. (4 in.)		
29	WOC						S-11B: Silty gravel with sand (GM); 70% gravel, 5% coarse sand, 5% medium		
							sand, 5% fine sand, 15% silt, subangular to angular sand and gravel, brown.	GLACIAL	
							(GLACIAL TILL) (2 in.)	TILL	
							Advance 4-7/8 in. roller bit to 33.5 ft.		
30	40								

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO FD-112
SHEET 4 of 11
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2696171 easting 814570
Driller	E. Thomas	Mudline El.	-32.79 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/1/00 Date End 12/4/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
31								GLACIAL TILL	
32									
33								33.0 ft.	
							Top of bedrock at 33 ft. Telescope HW drill casing to 33.5 ft. Advance 3-7/8 in. roller bit to 34 ft.	BEDROCK	
34							Advance HW drill casing to 34 ft. Checked seal on casing, water level dropped slowly. Begin HQ rock core at 34 ft. (boring log continued on next page)		
35									
36									
37									
38									
39									
40									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
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Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO FD-112
SHEET 5 of 11
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2696171	easting 814570	
Driller	E. Thomas	Mudline El.	-32.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/1/00	Date End	12/4/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
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Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R1	34-35	5 min.	Begin R1 at 34 ft. Fresh to slightly weathered, hard, gray, fine-grained GNEISS. Low angle foliation. (approx. 30 degrees) REC = 80%; RQD =73% (fair) Water return color: milky white. 34.2 ft.: Mechanical break in rock core.	3
34.5						
35.0			35-36	3.5 min.	35.3 and 35.4 ft.: Primary joints: low angle, smooth, planar, discolored, and open.	
35.5						
36.0			36-37	4 min.	36.0 and 36.1ft.: Mechanical breaks in rock core.	
36.5					36.8 ft.: Primary joint: low angle, smooth, planar, discolored, and open.	
37.0			37-38	6 min.	37.2 ft.: Mechanical break in rock core.	
37.5					37.7 ft.: Mechanical break in rock core.	
38.0			38-39	6.5 min.	38.0-39.0 ft.: Several large pieces of fractured rock. Not recovered upon completion of R1. Over cored and recovered in R2. RQD=0%.	
38.5					Perform constant head permeability test from 34 to 38 ft.	
39.0					End R1 at 39 ft.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOLS	
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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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REMARKS:
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4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO	FD-112
SHEET	6 of 11
FILE NO.	48138.27
CHKD. BY	S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2696171	easting 814570	
Driller	E. Thomas	Mudline El.	-32.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/1/00	Date End	12/4/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	39-40	5.5 min.	Begin R2 at 39 ft. Fresh, hard, gray, fine-grained GNEISS. Low angle foliation. (approx. 20 degrees) REC = 98%; RQD =85% (good) Water return color: milky white. 39.3 ft.: Primary joint: low angle, smooth, planar, slightly discolored, and tight. 39.5 ft.: Primary joint: low angle, smooth, undulating, slightly discolored, and tight.	
39.5						
40.0			40-41	6.5 min.		
40.5						
41.0			41-42	6 min.		
41.5					41.5-42.3 ft.: Quartz/feldspar vein, pink and white in color. (pegmatic)	
42.0			42-43	5.5 min.		
42.5						
43.0			43-44	5 min.	End R2 at 43 ft. Begin R3 at 43 ft. Slighly weathered to fresh, moderately hard to hard, gray, fine grained GNEISS. Low angle foliation (approx. 10 degrees). REC=100%; RQD=78% (good). Water return color: milky white. 43.0-43.1 ft.: Quartz/feldspar vein, continued from R1. 43.1 ft.: Primary joint: low angle, rough, planar, discolored and open. Some grinding noted. 43.8 ft.: Primary joint: low angle, smooth planar, discolored (black), and tight. Possibly	
43.5						
44.0						

[illegible]	[illegible]	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of 80%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-112
SHEET 7 of 11
FILE NO. 48138.27
CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2696171 easting 814570
Driller	E. Thomas	Mudline El.	-32.79 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/1/00 Date End 12/4/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3 (cont.)	44-45	5 min.	a healed joint. 43.9 ft.: Healed joint. Low angle. 44.0 ft.: Primary joint: low angle, rough, planar, discolored and open. 44.1 ft.: Primary joint: low angle, smooth, planar, discolored and open. Some grinding noted. 44.5 ft.: Primary joint: low angle, smooth, planar, discolored (black) and tight. Possible healed joint. 44.8 ft.: Primary joint: low angle, rough, planar, discolored (black and orange) and tight.	
44.5						
45.0			45-46	4.5 min.	45.2 ft.: Primary joint: low angle, smooth, planar, discolored (black and orange) and tight.	
45.5						
46.0		R4	46-47	5 min.		
46.5					46.6 ft.: Primary joint: low angle, smooth, planar, discolored (black and orange) and tight. Possible healed or mechanical break. 46.9 ft.: Primary joint: low angle, smooth, planar, discolored and tight.	
47.0			47-48	6 min.		
47.5						
48.0			48-49	8 min.	End R3 at 48 ft. Begin R4 at 48 ft. Fresh, hard, gray, fine-grained GNEISS. Low angle foliation (approx. 10 degrees). REC=100%; RQD=100% (excellent) Water return color: milky white. 48.1 ft.: Mechanical break in rock core. 48.5 ft.: Mechanical break in rock core.	
48.5						
49.0						

GRANULAR SOILS	COHESIVE SOILS	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of 80%.
4)

	PROJECT	
Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 / New Bedford Harbor Superfund Site / New Bedford, Massachusetts	BORING NO FD-112 / SHEET 8 of 11 / FILE NO. 48138.27 / CHKD. BY S. Bonis

Boring Co. Warren George, Inc. — Boring Location northing 2696171 easting 814570
Driller E. Thomas — Mudline El. -32.79 — Datum NGVD
Logged By E. Thibodeau — Date Start 12/1/00 — Date End 12/4/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4 (cont.)	49-50	8.5 min.	49.0 ft.: Mechanical break in rock core.	
49.5						
50.0					49.9 ft.: Mechanical break in rock core.	
			50-51	6.5 min.		
50.5						
51.0					50.9 ft.: Mechanical break in rock core.	
			51-52	5 min.		
51.5						
52.0						
			52-53	7 min.		
52.5					52.5 ft.: Mechanical break in rock core.	
					Performed constant head permeability test from 34 to 53 ft.	
53.0					End R4 at 53 ft.	
					Bottom of exploration at 53 ft. Boring terminated in bedrock. Grout completed borehole to mudline with cement/bentonite grout, specific gravity = 1.40.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of 80%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

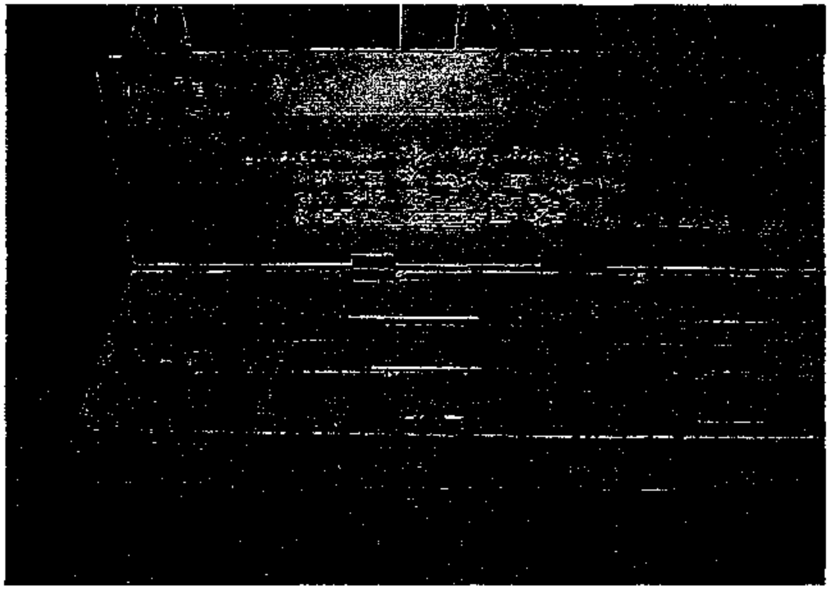
PROJECT	
Remedial Design For Operable Unit 01	BORING NO FD-112
New Bedford Harbor Superfund Site	SHEET 9 of 11
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2696171		easting 814570
Driller	E. Thomas	Mudline El.	-32.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/1/00	Date End	12/4/00

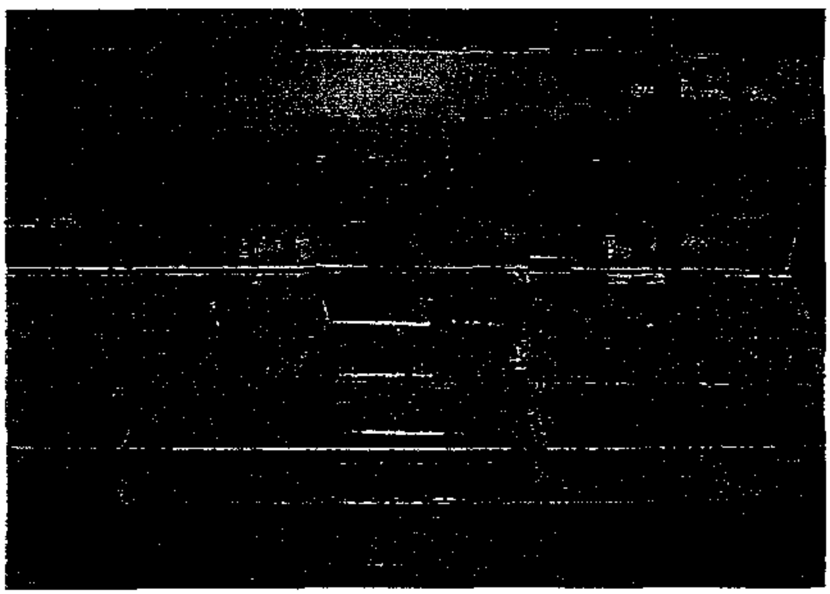
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3, and top of R4

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of 80%.
4)

M:\Reports\Active\48138.21\Field Forms\FD-112.xls\Picture

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

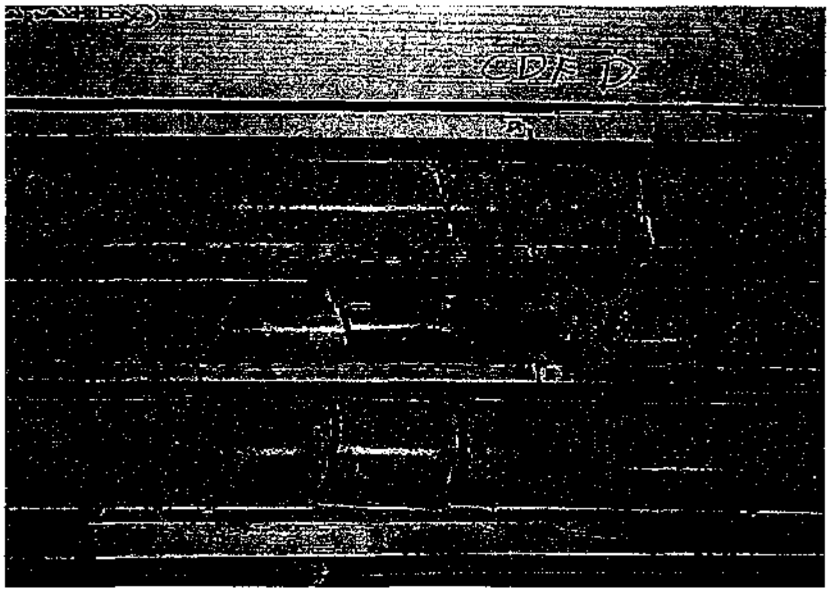
PROJECT	
Remedial Design For Operable Unit 01	BORING NO FD-112
New Bedford Harbor Superfund Site	SHEET 10 of 11
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2696171		easting 814570
Driller	E. Thomas	Mudline El.	-32.79	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/1/00	Date End	12/4/00

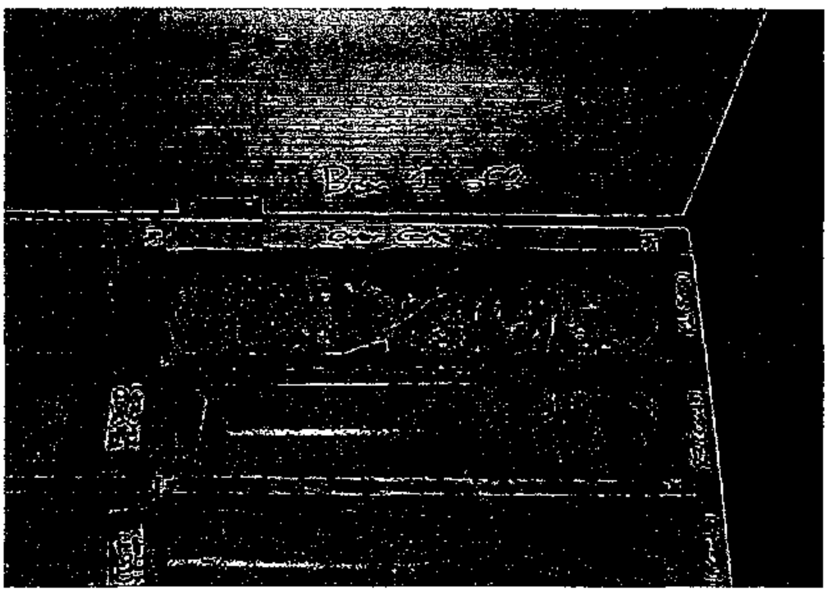
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Quartz/feldspar vein (pegmatic) noted in R2
Primary joints noted in R3



Overcore from the bottom of R1

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of 80%.
4)

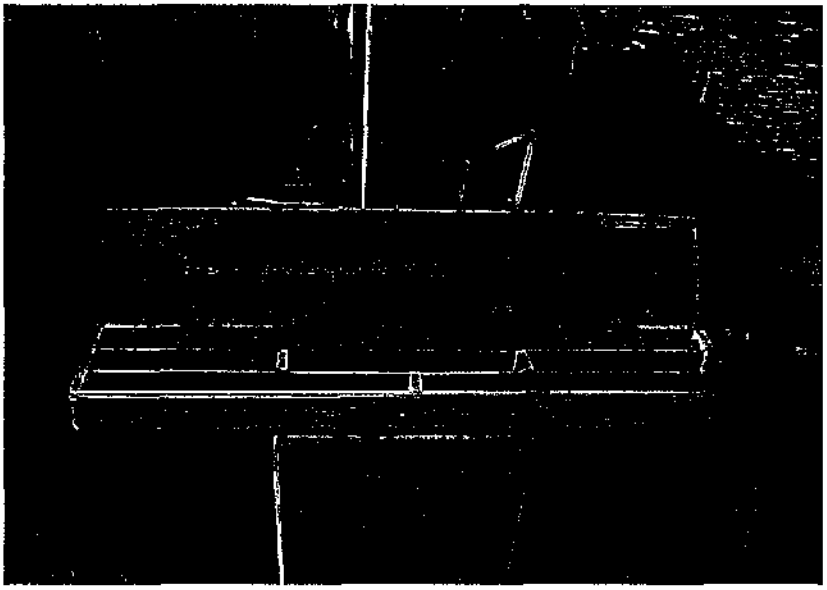
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO FD-112 SHEET 11 of 11 FILE NO. 48138.27 CHKD. BY S. Bonis

Boring Co.	Warren George, Inc.	Boring Location	northing 2696171 easting 814570
Driller	E. Thomas	Mudline El.	-32.79 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/1/00 Date End 12/4/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Run R4

PLACE PICTURE CAPTION HERE (Pitcure size = 3.85" x 5.65")

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. center hole hammer free falling from a height of 24 inches.
3) RQD biased low due to recovery of 80%.
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-113
SHEET 1 of 10
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696239 easting 814464
Driller	E. Thomas	Mudline El.	-33.31 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/18/00 Date End 12/20/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing; Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance PW drill casing to 2 ft.		
1	WOC								
2	WOC								
		S-1	24/1	2-4	WOR/24	—	Organic soil (OH); 95% organic clay/silt, 5% fine sand, strong organic odor, black.		
							Advance PW drill casing to 4 ft.		
3	WOC							ORGANIC CLAY	
4	WOC								
		S-2	24/6	4-6	WOR/24	—	Organic soil (OH); similar to S-1 except black to dark gray, slight sheen noted.		
							Advance PW drill casing to 6 ft.		
							Advance 3-7/8 in. roller bit to 6 ft., no water return noted.		
5	WOC								
6	WOC								
		S-3	24/18	6-8	WOR/24	—	S-3A: Organic soil with sand (OH); very soft, 75% organic clay/silt, 25% fine sand, moderate organic odor, black to dark gray. (12 in.)		
							S-3B: Poorly graded sand with silt (SP-SM); 5% coarse sand, 30% medium sand,		
7	WOC						55% fine sand, 10% silt, gray-brown. (6 in.)		
							Advance PW drill casing to 8 ft.		
							Advance 3-7/8 in. roller bit to 8 ft.	7.5 ft.	
8	WOC								
		S-4	24/12	8-10	4-3-4-3	7	S-4A: Poorly graded sand (SP); loose, 50% medium sand, 40% fine sand, 5% gravel, 5% silt, gray-brown. (4 in.)	MARINE SAND	
							S-4B: Poorly graded sand with gravel (SP); 15% coarse sand, 40% medium sand,		
9	11						15% fine sand, 25% gravel, 5% silt, subrounded to subangular sand and gravel, brown. (8 in.)		
							Advance PW drill casing to 10 ft.	9.5 ft.	
							Mix bentonite drilling mud, specific gravity = 1.09.	GLACIO	
10	13						Advance 3-7/8 in. roller bit to 10 ft.	FLUVIAL	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2)
3)
4)

Nobis Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	PROJECT: Remedial Design For Operable Unit 01, New Bedford Harbor Superfund Site, New Bedford, Massachusetts	BORING NO. FD-113	SHEET 2 of 10
		FILE NO. 48138.27	CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller E. Thomas
Logged By E. Thibodeau

Boring Location: northing 2696239 easting 814464
Mudline El. -33.31 Datum NGVD
Date Start 12/18/00 Date End 12/20/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-5	24/12	10-12	3-3-3-3	6	**Poorly graded sand with silt (SP-SM); 11% coarse sand, 26% medium sand, 42% fine sand, 13% gravel, 8% silt, yellowish brown. Subrounded to subangular sand and gravel.**		1
11	DROP						PW drill casing dropped to 12 ft. Advance 3-7/8 in. roller bit to 12 ft.		
12	DROP								
		S-6	24/6	12-14	7-4-3-5	7	Poorly graded sand with gravel (SP); loose, 35% coarse sand, 30% medium sand, 10% fine sand, 20% gravel, 5% silt, subangular to angular sand and gravel, brown. Advanced PW drill casing to 14 ft.		
13	26						Advance 3-7/8 roller bit to 14 ft.		
14	28								
		S-7	24/10	14-16	6-5-6-6	11	**Silty sand with gravel (SM); 13% coarse sand, 15% medium sand,**		1
	WOH						**15% fine sand, 41% gravel, 16% silt, brown. Subrounded to subangular sand and gravel.**		
15	7						Advance PW drill casing to 19 ft. Advance 3-7/8 in. roller bit to 19 ft.	GLACIO FLUVIAL	
16	34								
17	43								
18	69								
19	68								
		S-8	9/6	19-19.8	9-5/3-25/0	-	Silty sand with gravel (SM); 20% coarse sand, 10% medium sand, 15% fine sand, 40% gravel, 15% silt, subrounded to subangular sand and gravel, brown. Advance PW drill casing to 19.8 ft. Casing refusal on probable cobble. Advance 4-7/8 in.	19.8 ft.	
20	45/10						roller bit to 20.5 ft. Probable cobble from 19.8 to 20.1 ft.	COBBLE	

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	[illegible]	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-113
SHEET 3 of 10
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696239 easting 814464
Driller	E. Thomas	Mudline El.	-33.31 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/18/00 Date End 12/20/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
							Advance 4-7/8 in roller bit to 20.5 ft. Telescope HW drill casing to 20.5 ft. Advance 3-7/8 in. roller bit with stabilizer to 21 ft. Probable cobble 20.5 to 21 ft.	GLACIO FLUVIAL	
								COBBLE	
21	SPIN							20.75 ft.	
		S-9	24/5	21-23	15-14-6-6	20	**Silty sand with gravel (SM); 11% coarse sand, 20% medium sand, 21% fine sand, 27% gravel, 21% silt, brown.** Subangular sand and gravel. Advance HW drill casing to 26 ft.	GLACIO FLUVIAL	1
22	SPIN								
23	SPIN								
24	SPIN								
25	SPIN								
26	SPIN							26.0 ft.	
		S-10	19/14	26-27.6	11-16-21-8/1 25/0	37	S-10A: Poorly graded sand with silt and gravel (SP); dense, 60% medium sand, 20% fine sand, 15% gravel, 5% silt. S-10B: Possible Glacial Till; 10% coarse sand, 20% medium sand, 20% fine sand, 30% gravel, 20% silt.	GLACIAL TILL	
27									
28								27.9 ft.	
							Advance 3-7/8 in. bit with stabilizer to 29 ft. Top of competent bedrock 27.9 ft.	BEDROCK	
29							Advance HW drill casing to 28.4 ft. Advance 3-7/8 in. roller bit to remove cuttings. Begin HQ rock core at 29 ft. (boring log continued on next page)		
30									

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-113 SHEET 4 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696239	easting 814464	
Driller	E. Thomas	Mudline El.	-33.31	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/18/00	Date End	12/20/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	29-30	5 min.	Begin R1 at 29 ft. Fresh, moderately hard, gray, fine-grained GNEISS. Low angle (approx. 10 degrees) foliation. REC. = 88%; RQD = 63% (fair). Water return color: milky white.	
29.5					29.6 ft.: Mechanical break in rock core. 29.8 ft.: Primary joint: low angle, rough, undulating, and open. Distinct black discoloration on fracture surface. Loss of return water at 29.8 ft.	
30.0					29.9 to 30.5 ft.: Secondary joint: high angle to vertical, rough, planar, discolored, and open. Distinct	
			30-31	4.5 min.	black discoloration noted on fracture surface. 30.1 ft.: Mechanical break in rock core.	
30.5					30.5 and 30.7 ft.: Primary joints: low angle to horizontal, rough, planar, discolored, and open.	
31.0						
			31-32	5 min.	31.2 ft.: Primary joint: low angle, smooth, planer, discolored, and open. Distinct black discoloration on fracture surfaces.	
31.5					31.4 and 31.5 ft.: Primary joints: low angle, rough to smooth, planar, discolored, and open. Distinct black discoloration on fracture surfaces.	
32.0						
			32-33	6 min.	32.4 ft.: Mechanical break in rock core.	
32.5					32.8 ft.: Mechanical break in rock core.	
33.0						
			33-34	6 min.		
33.5					33.5 to 34.0 ft.: Rock fragments from overcore of R2. Perform packer test from 30 to 34 ft.	
34.0					End R1 at 34 ft.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOLS	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-113 SHEET 5 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696239 easting 814464
Driller	E. Thomas	Mudline El.	-33.31 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/18/00 Date End 12/20/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R2	34-35	4.5 min	Begin R2 at 34 ft. Fresh, moderately hard, gray, fine-grained GNEISS. Low angle (approx. 10 degrees) foliation. REC. = 97%; RQD = 85% (good). No return water noted. 34.2 ft.: mechanical break in rock core. 34.4 ft.: Primary joint: low angle, smooth, planar, discolored, and tight. 34.5 and 34.6 ft.: Tight joints; not fractured during coring. 34.6 to 34.8 ft.: Highly to completely weathered zone. Discolored rock weathered to residual soil in the form of sand, silt, and gravel.	
34.5						
35.0			35-36	4 min	35.1 ft.: Mechanical break in rock core. 35.6 ft.: Mechanical break in rock core.	
35.5						
36.0			36-37	5 min	36.3 ft.: Mechanical break in rock core. 36.3 to 36.5 ft.: Secondary joint: high angle, smooth, planar, slightly discolored, and tight.	
36.5						
37.0			37-38	5.5 min	37.4 ft.: Mechanical break in rock core. 37.7 ft.: Primary joint: low angle, smooth, planar, discolored, and tight.	
37.5						
38.0			38-39	4 min	Perform packer test from 32 to 39 ft. End R2 at 39 ft.	
38.5						
39.0						

GRANULAR SOILS (N-VALUE)	COHESIVE SOILS (N-VALUE)	SAMPLER KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-113

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696239 easting 814464
Driller	E. Thomas	Mudline El.	-33.31 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/18/00 Date End 12/20/00

Sampler: 2-inch O.D. split-barrel samples driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	39-40	5 min.	Begin R3 at 39 ft. Fresh, very hard, gray, fine-grained GNEISS. Low angle (approx. 10 to 20 degree) foliation. REC = 98%; RQD = 98% (excellent). No water return noted.	
39.5						
40.0			40-41	3 min.		
40.5						
41.0			41-42	3 min.		
41.5						
42.0			42-43	3 min.	41.8 to 42.2 ft.: Secondary joint: moderately dipping to high angle, smooth, planar, slightly discolored, and tight. Possible mechanical break of healed joint.	
42.5						
43.0			43-44	4 min.		
43.5					43.4 ft.: Mechanical break in rock core.	
44.0					End R3 at 44 ft.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-113
SHEET 7 of 10
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696239 easting 814464
Driller	E. Thomas	Mudline El.	-33.31 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/18/00 Date End 12/20/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
		R4	44-45	3 min.	Begin R4 at 44 ft. Fresh, hard, gray, fine-grained GNEISS. Low angle (approx. 20 -30 degree) foliation. REC = 100%; RQD = 100% (excellent). No water return noted.	
44.5						
45.0					44.9 ft.: Mechanical break in rock core.	
			45-46	3 min.	45.0 ft.: Primary joint: horizontal to low angle, smooth, planar, discolored, and tight.	
45.5					45.4 ft.: Primary joint: horizontal to low angle, smooth, planar, discolored and tight.	
46.0						
			46-47	3.5 min.		
46.5						
47.0						
			47-48	4.5 min.	46.9 to 47.2 ft.: Secondary joint: high angle, smooth, planar, slightly discolored, and tight. Possible mechanical break of healed joint.	
47.5						
48.0						
			48-49	6 min.		
48.5					Perform packer test from 39 to 49 ft. End of R4 at 49 ft. Bottom of exploration at 49.0 ft; boring terminated in bedrock.	
49.0					Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.45.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-113 SHEET 8 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

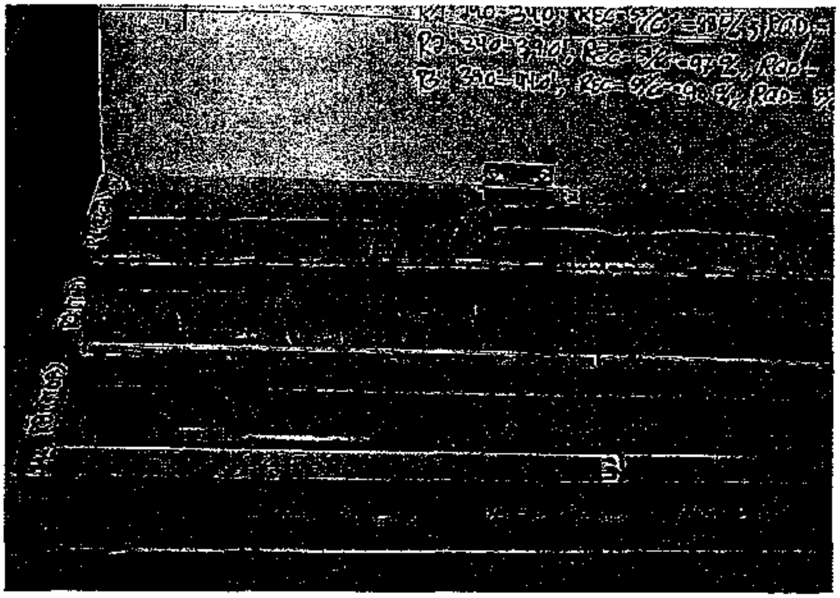
Boring Co.	Warren George, Inc.	Boring Location	northing 2696239	easting 814464	
Driller	E. Thomas	Mudline El.	-33.31	Datum	NGVD
Logged By	E. Thibodeau	Date Start	12/18/00	Date End	12/20/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

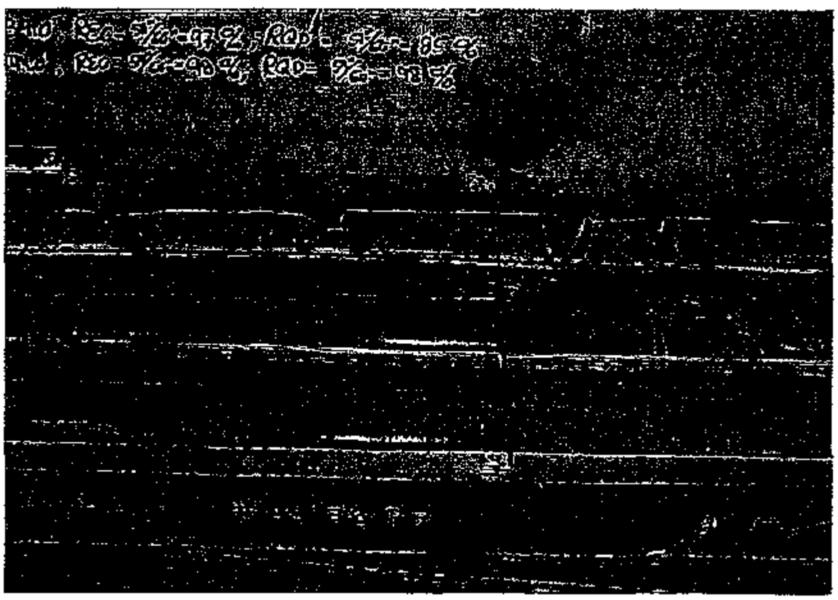
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-113 SHEET 9 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696239 easting 814464
Driller	E. Thomas	Mudline El.	-33.31 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/18/00 Date End 12/20/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
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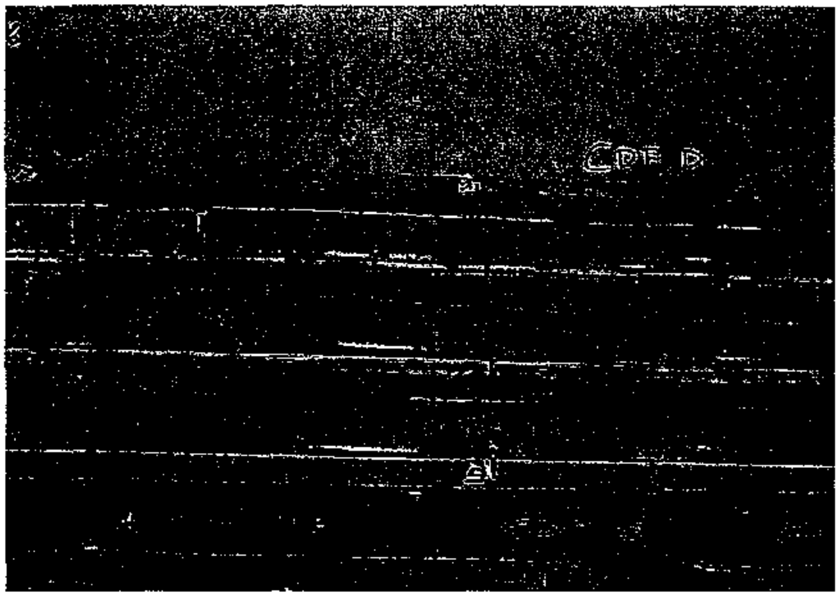
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

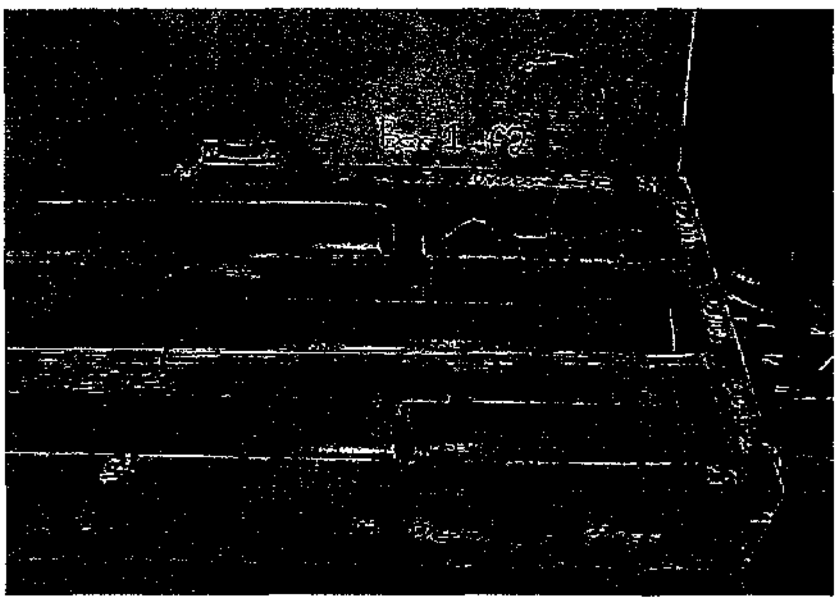
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3 and overcore from bottom of R1

REMARKS:
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	PROJECT	
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-113 SHEET 10 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

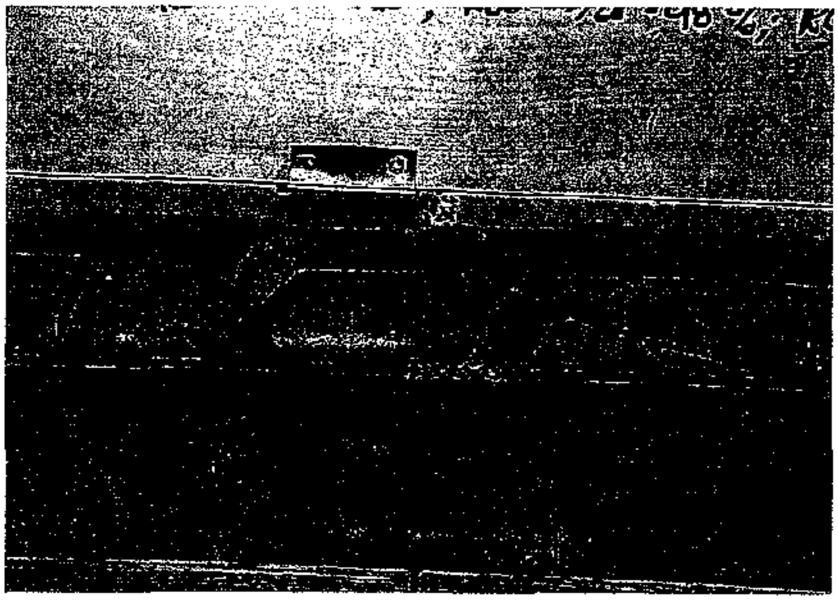
Boring Co.	Warren George, Inc.	Boring Location	northing 2696239 easting 814464
Driller	E. Thomas	Mudline El.	-33.31 Datum NGVD
Logged By	E. Thibodeau	Date Start	12/18/00 Date End 12/20/00

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. center hole hammer free falling from a height of 24 inches.

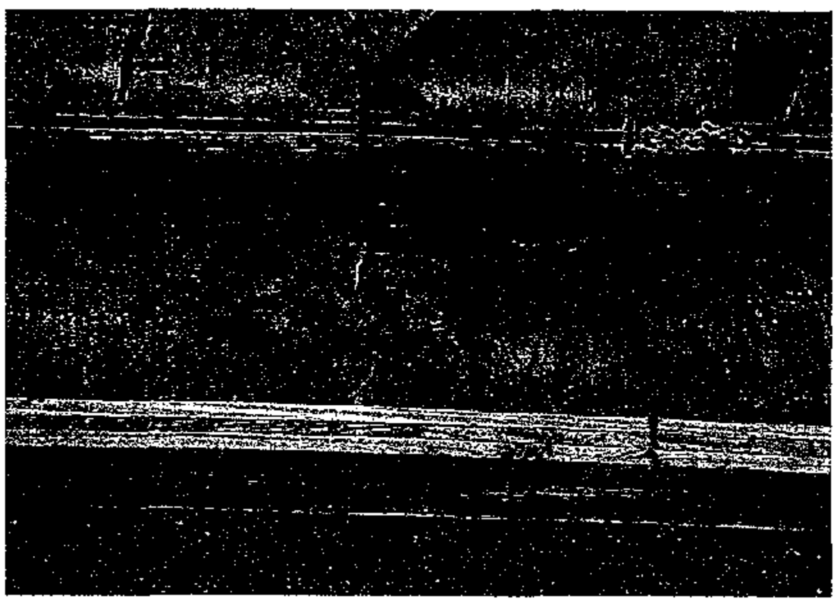
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Weathered/residual soil zone noted in R2



Weathered/residual soil zone noted in R2

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-114 SHEET 1 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166	easting 814321	
Driller	E. Thomas	Mudline El.	-20.28	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
		S-1	4/1	0-0.3	50/4"	—	Casing resting on mudline, very hard bottom, attempt split barrel sample.		
							S-1: Spoon refusal. Rock fragment noted in tip of sampler.	BOULDER/	
							Advance 4-7/8 in. roller bit to 1.2 ft.	DEBRIS	
1	SPIN						Probable boulder or piece of debris		
							Telescope HW drill casing to 2 ft. (spin and wash)	1.2 ft	
2	SPIN								
		S-2	24/6	2-4	1-1-3-6	4	Clayey sand (SC); loose, 20% organic clay/silt, 40% medium sand, 30% fine sand, 5% coarse sand, 5% shell fragments, strong organic odor, black.		
							Advance HW drill casing to 4 ft.		
3	SPIN						Advance 3-7/8 in. roller bit to 4 ft.	ORGANIC CLAY	
4	SPIN							4.0 ft.	
		S-3	24/6	4-6	7-5-5-11	10*	Poorly graded sand with gravel (SP); loose, 15% coarse sand, 35% medium sand, 20% fine sand, 25% gravel, 5% silt, subrounded to subangular sand and gravel, slight organic odor, gray. Several pieces of gravel were flat and elongated.	MARINE SAND	1
5	SPIN						Advance HW drill casing to 6 ft.		
							Advance 3-7/8 in. roller bit to 6 ft.		
6	SPIN						Perform falling head permeability test at 6 ft.		
		S-4	24/1	6-8	8-8-7-14	15	Poorly graded sand with silt (SP-SM); medium dense, 40% medium sand, 50% fine sand 10% silt, gray-brown.		
							Headspace: < 1 ppm.		
7	SPIN						Advance HW drill casing to 9 ft.		
							Advance 3-7/8 in. roller bit to 9 ft.		
8	SPIN								
9	SPIN								
		S-5	24/12	9-11	13-6-1-1	7	**Silt with sand (ML); 74% silt, 3% medium sand, 23% fine sand, light brown.**		2
							Headspace: < 1 ppm.		
							Advance HW drill casing to 14 ft.		
10	SPIN						Advance 3-7/8 in. roller bit to 14 ft.		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-114 SHEET 2 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166	easting 814321	
Driller	E. Thomas	Mudline El.	-20.28	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	SPIN								
12	SPIN							MARINE SAND	
13	SPIN								
14	SPIN						Perform falling head permeability test at 14 ft.		
		S-6	24/12	14-16	25-22-11-11	33	**Silty sand (SM); 3% coarse sand, 14% medium sand, 56% fine sand, 4% gravel, 23% silt, brown.** Subrounded to subangular sand and gravel. Headspace: < 1 ppm.		2
15	SPIN						Advance HW drill casing to 19 ft. Advance 3-7/8 in. roller bit to 19 ft.		
16	SPIN							16.5 ft.	
17	SPIN								
18	SPIN							GLACIO FLUVIAL	
19	SPIN								
		S-7	24/3	19-21	13-11-7-4	18	Poorly graded sand with silt and gravel (SP-SM); medium dense, 20% coarse sand, 25% medium sand, 20% fine sand, 25% gravel, 10% silt, brown. Subrounded to subangular sand and gravel.		
20	SPIN						Advance HW drill casing to 21 ft.		

0 to 4 - Very Loose 5 to 10 - Loose 11 to 30 - Medium Dense 31 to 50 - Dense Over 50 - Very Dense	0 to 2 - Very Soft 3 to 4 - Soft 5 to 8 - Medium Stiff 9 to 15 - Stiff 16 to 30 - Very Stiff Over 30 - Hard	1. S denotes split-barrel sampler. 2. U denotes 3-inch O.D. undisturbed sample. 3. UO denotes 3-inch Osterberg undisturbed sample. 4. PEN denotes penetration length of sampler. 5. REC denotes recovered length of sample. 6. SPT denotes Standard Penetration Test.	7. PID denotes Photoionization Detector 8. PPM denotes parts per million. 9. PP denotes Pocket Penetrometer. 10. FVST denotes field vane shear test. 11. RQD denotes Rock Quality Designation. 12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-114
SHEET 3 of 12
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166	easting 814321	
Driller	E. Thomas	Mudline El.	-20.28	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance 3-7/8 in. roller bit to 21 ft.		
21	SPIN						Perform constant head permeability test at 21 ft.		
		S-8	24/1	21-23	13-11-5-3	16	Poor recovery. Several large pieces of angular coarse gravel recovered.		
							One large angular flat and elongated piece of coarse gravel noted.		
							Advance HW drill casing to 23 ft.		
22	SPIN						Advance 3-7/8 in. roller bit to 23 ft.		
23	SPIN							GLACIO	
		S-9	24/10	23-25	22-17-22-27	39*	**Poorly graded sand with silt and gravel (SP-SM); 5% coarse sand, 38% medium sand,**	FLUVIAL	1,2
							17% fine sand, 34% gravel, 6% silt, brown. Subrounded to subangular sand and gravel.		
							(2 jars)		
24	SPIN						Headspace: 21 ppm. (jar #2)		
							Advance HW drill casing to 27 ft.		
							Advance 3-7/8 in. roller bit to 27 ft.		
25	SPIN								
26	SPIN								
27	SPIN								
		S-10	24/7	27-29	7-4-4-21	8*	**Poorly graded sand with silt and gravel (SP-SM); 11% coarse sand, 16% medium sand,**		1,2
							22% fine sand, 46% gravel, 5% silt, brown. Rounded to subangular sand and gravel.		
							(2 jars)		
28	SPIN						Headspace: 18 ppm. (jar #2)		
							Advance HW drill casing to 29 ft.		
							Advance 3-7/8 in. roller bit to 29 ft.		
							Perform constant head permeability test at 29 ft.		
29	SPIN							29.0 ft.	
		S-11	1/1	29-29.1	75/1"	—	Washed sample.		
			Interval		Time		Advance 3-7/8 in. roller bit to 29.5 ft.	BOULDER	
			29.5-30.5		7.5 min.		Advance HW drill casing to 29.7 ft.		
30	SPIN						Begin HQ rock core at 29.5 ft.		

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-114 SHEET 4 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166	easting 814321	
Driller	E. Thomas	Mudline El.	-20.28	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
			Interval		Time				
							Core: 29.5 to 32.0 ft.		
			30.5-31.5		5 min.		Core barrel penetrated boulder at 32 ft., core run terminated.		
31	SPIN						Advance 3-7/8 in. roller bit to 32 ft.	BOULDER	
							Roller bit cuttings recovered utilizing a U.S. No. 140 sieve and preserved in sample jar. Cuttings		
							indicate coarse to fine sand and gravel. Unable to keep hole through boulder open.		
			31.5-32.0		5 min.		Advance HW drill casing to 32 ft.		
32	SPIN							32.0 ft.	
		S-12	24/12	32-34	10-12-15-12	27	**Poorly graded sand with silt and gravel (SP-SM); 16% coarse sand, 23% medium**		2
							sand, 31% fine sand, 19% gravel, 11% silt, brown. Subrounded to angular sand and gravel.		
							Headspace: <1 ppm.		
33	SPIN						Advance 3-7/8 in. roller bit to 37 ft.	GLACIO	
							Advance HW drill casing to 37 ft.	FLUVIAL	
							Advance 3-7/8 in. roller bit to wash out casing.		
34	SPIN								
35	SPIN								
36	SPIN								
37	SPIN								
		S-13	16/9	37-38.3	14-36-75/4"	—	S-13A: Poorly graded gravel with silt and sand (GP-GM); 65% gravel, 10% coarse sand,		
							10% medium sand, 5% fine sand, 10% silt, subrounded to subangular sand and gravel,		
							brown. (3 in.)		
38	SPIN						Headspace: <1 ppm. (S-13A)		
							S-13B: Weathered bedrock / residual soil. (6 in.)		
							Headspace: <1 ppm. (S-13B)		
							Advance 3-7/8 in. roller bit to wash out casing.		
39	SPIN						Advance 3-7/8 in. roller bit to 40.5 ft.	39.0 ft.	
							Advance HW drill casing to 39.5 ft.		
							Top of competent bedrock at 40.0 ft.	WEATHERED	
							Begin HQ rock core at 40.5 ft.	BEDROCK	
40	SPIN						(boring log continued on next page)	40.0 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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	PROJECT	
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-114 SHEET 5 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166 easting 814321
Driller	E. Thomas	Mudline El.	-20.28 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	40.5-41.5	4.5 min.	Begin R1 at 40.5 ft. Slightly weathered, medium to moderately hard, gray, fine to medium grained GNEISS. Low angle (approx. 10-30 degrees) foliation. REC. = 95%; RQD = 45% (poor). Water return color: rust. 40.5 to 42.1 ft.: Weathered zone. Rock notably discolored. Rock structure still intact. Rock is slightly friable from 41 to 41.2 ft.	
41.0						
41.5			41.5-42.5	6 min.	41.6 ft.: Mechanical break in rock core. 41.6 to 43.0 ft.: Set of three high angle to vertical healed joints or fractures.	
42.0						
42.5			42.5-43.5	5.5 min.	42.5 ft.: Loss of water return.	
43.0					43.3 to 45.5 ft.: High angle to vertical joint. Joint is intact from 43.3 to 43.5 ft. Possible machine break from 43.5 to 45.5 ft. joint is smooth, planar, discolored, and tight.	
43.5			43.5-44.5	4 min.	43.5, 43.6, 43.9, 44.2, 44.4, 44.6, 44.7, 44.9, 45.0, and 45.2 ft.: Mechanical break in rock core along foliation and perpendicular to high angle joints. 43.5 to 45.0 ft.: High angle to vertical joint. Joint runs parallel to other high angle joint and the two joints appear to merge at 44.7 ft. Joint is rough, undulating, discoloration noted from 43.5 to 44.3 ft. Joint becomes open but infilled from 44.3 to 45.5 ft. Infilling material is dark gray in color.	
44.0						
44.5			44.5-45.5	5 min.		
45.0					Perform packer test from 43 to 45.5 ft.	
45.5					End R1 at 45.5 ft.	

0 to 4 - Very Loose 5 to 10 - Loose 11 to 30 - Medium Dense 31 to 50 - Dense Over 50 - Very Dense	0 to 2 - Very Soft 3 to 4 - Soft 5 to 8 - Medium Stiff 9 to 15 - Stiff 16 to 30 - Very Stiff Over 30 - Hard	1. S denotes split-barrel sampler. 2. U denotes 3-inch O.D. undisturbed sample. 3. UO denotes 3-inch Osterberg undisturbed sample. 4. PEN denotes penetration length of sampler. 5. REC denotes recovered length of sample. 6. SPT denotes Standard Penetration Test.	7. PID denotes Photoionization Detector 8. PPM denotes parts per million. 9. PP denotes Pocket Penetrometer. 10. FVST denotes field vane shear test. 11. RQD denotes Rock Quality Designation. 12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-114 SHEET 6 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166	easting 814321	
Driller	E. Thomas	Mudline El.	-20.28	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (FW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
45.5–46.5 (46.0, 46.5)	R2	45.5-46.5	4 min	Begin R2 at 45.5 ft. Fresh, hard, gray, fine to medium grained GNEISS. No distinct foliation noted. REC. = 100%; RQD = 17% (very poor). RQD biased low due to the presence of high angle/vertical joints No water return noted. 45.5 to 47.6 ft.: High angle to vertical joint/fracture. Joint is rough, undulating, and infilled. Joint is intact from 46.7 to 47.6 ft. Several mechanical breaks noted throughout zone. All breaks may be mechanical / broken during coring. Infilling material is dark gray in color. Appears to be comprised mostly of sand.	
47.0, 47.5		46.5-47.5	4 min		
48.0, 48.5		47.5-48.5	4.5 min	47.8 to 50.2 ft.: High angle to vertical joint/fracture. Joint is healed and intact with calcite or quartz infilling. Joint runs parallel to another high angle / verticle joint. Joints intersect at 49.2 ft. then split again. Several mechanical breaks noted across joint. 48.4 to 50.0 ft.: High angle to vertical joint/fracture. Joint is infilled and intact. Intersects aforementioned joint at 49.2 ft. then splits again. Infilling material appears to be comprised mostly of sand.	
49.0, 49.5		48.5-49.5	5.5 min		
50.0, 50.5		49.5-50.5	6 min	49.5 to 49.7 ft.: Quartz/feldspar zone. Pink/dark gray in color. Pegmatic. 49.8 to 50.2 ft.: Quartz/feldspar zone. Pink/dark gray in color. Pegmatic. 50.2 ft.: Mechanical break in rock core. 50.2 to 50.5 ft.: High angle/vertical joint. Distinct discoloration and weathering noted on joint surface. End R2 at 50.5 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-114
SHEET	7 of 12
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166 easting 814321
Driller	E. Thomas	Mudline El.	-20.28 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
50.5–51.5	R3	50.5-51.5	3.5 min.	Begin R3 at 50.5 ft. Fresh to slightly weathered, hard, gray, fine to medium grained GNEISS. Horizontal to low angle foliation (0 to 10 degrees). REC. = 100%; RQD = 30% (poor). RQD biased low due to the presence of high angle/vertical joints. No water return noted. 50.5 to 53.6 ft.: High angle/vertical joint/fracture. Joint is rough, undulating, discolored, and weathered from 50.5 to 51.7 ft. Joint is dark gray in color and consists primarily of sand/silt. Joint is broken/heavily fractured from coring process.	
51.5–52.5		51.5-52.5	6 min.	51.5 ft.: Mechanical break in rock core. 52.2 ft.: Mechanical break in rock core.	
52.5–53.5		52.5-53.5	4 min.		
53.5–54.5		53.5-54.5	5.5 min.	53.6 to 53.9 ft.: Healed joint/fracture. 53.6 to 54.4 ft.: Healed joint/fracture. 54.1 ft.: Mechanical break in rock core.	
54.5–55.5		54.5-55.5	4 min.	55.2 ft.: Mechanical break in rock core. 55.2 to 55.5 ft.: Mechanical break in rock core. (vertical) Perform packer test from 45.5 to 55.5 ft. End R3 at 55.5 ft.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-114
SHEET 8 of 12
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166 easting 814321
Driller	E. Thomas	Mudline El.	-20.28 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R4	55.5-56.5	2.5 min.	Begin R4 at 55.5 ft. Fresh to slightly weathered, moderately hard, gray, fine to medium grained GNEISS. Low angle foliation (approx. 10 to 20 degrees). REC. = 100%; RQD = 82% (good). No water return noted. 55.8 to 57.6 ft.: Slight discoloration/weathering noted. 55.5 to 56.3 ft.: Healed joint. High angle to vertical. Some discoloration noted along joint surface. 56.3, 56.5, 57.0, and 57.5 ft.: Mechanical breaks in rock core.	
56.0					
56.5		56.5-57.5	3 min.	56.3 to 57.1 ft.: Healed joint. High angle to vertical. Some discoloration noted along joint surface. 56.3 to 56.5 ft.: Mechanical break in rock core. 56.5 to 57.5 ft.: Secondary joint: high angle, smooth, planar, discolored, and tight. Healed from 57.0 to 57.5 ft. Possible mechanical break. 57.0 to 57.7 ft.: Secondary joint: high angle, smooth, planar, discolored, and tight. Possible mechanical break.	
57.0					
57.5		57.5-58.5	3.5 min.		
58.0					
58.5		58.5-59.5	3 min.	58.6 ft.: Quartz/feldspar vein. Dark gray/pink in color. 58.7 to 58.9 ft.: Quartz/feldspar vein. Dark gray/pink in color.	
59.0					
59.5		59.5-60.5	3 min.		
60.0					
60.5				End of R4 at 60.5 ft. Bottom of exploration at 60.5 ft; boring terminated in bedrock. Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.45.	

0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector.
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
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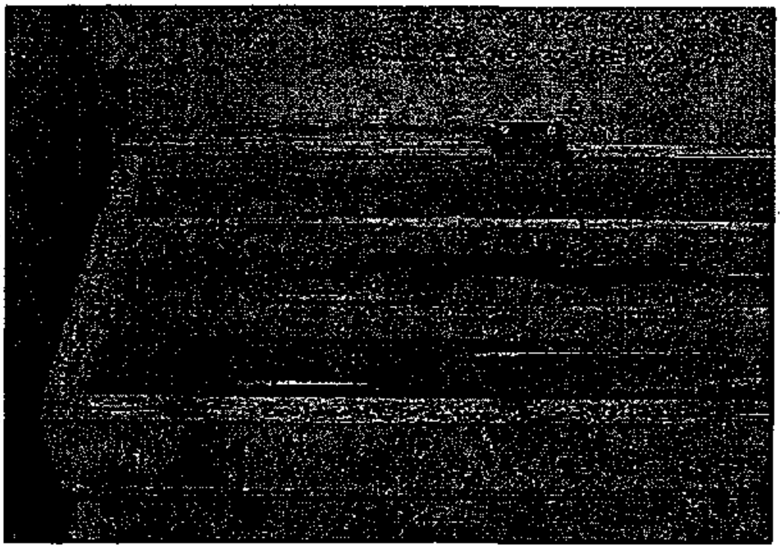
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-114 SHEET 9 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166	easting 814321	
Driller	E. Thomas	Mudline El.	-20.28	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/5/01

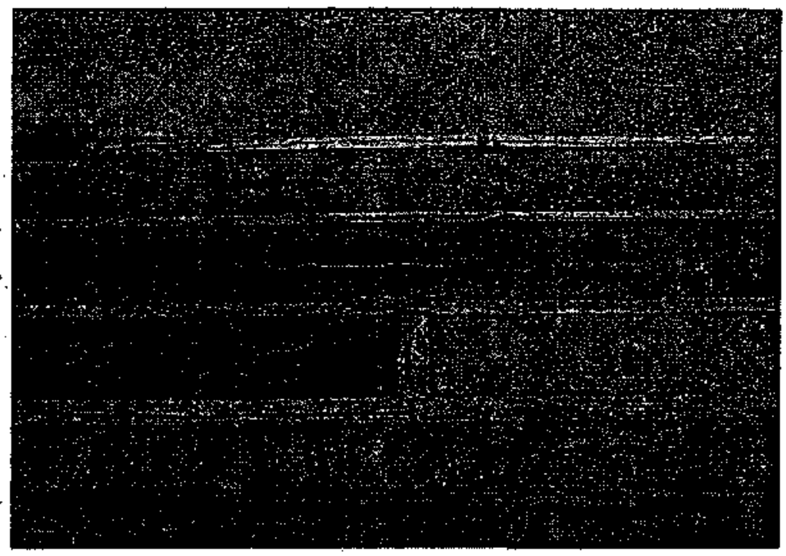
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1, R2, and boulder core



Core Runs R1, R2, and boulder core

POOR ORIGINAL

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-114 SHEET 10 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166 easting 814321
Driller	E. Thomas	Mudline El.	-20.28 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
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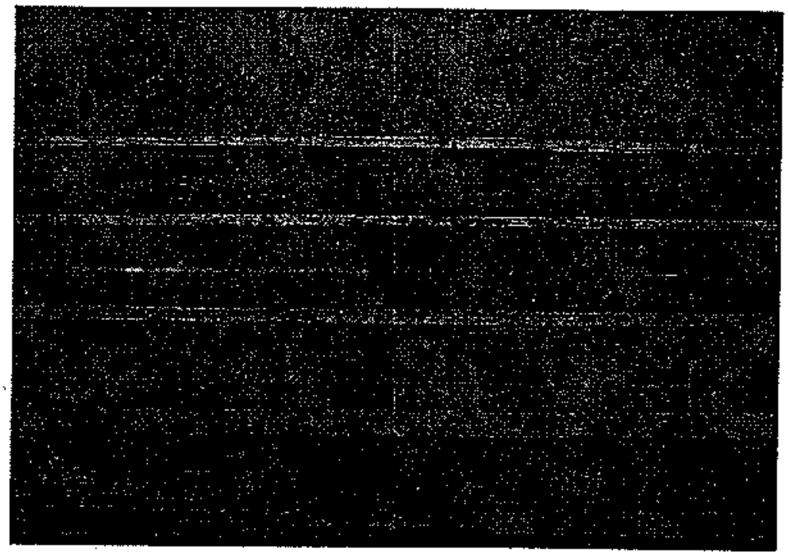
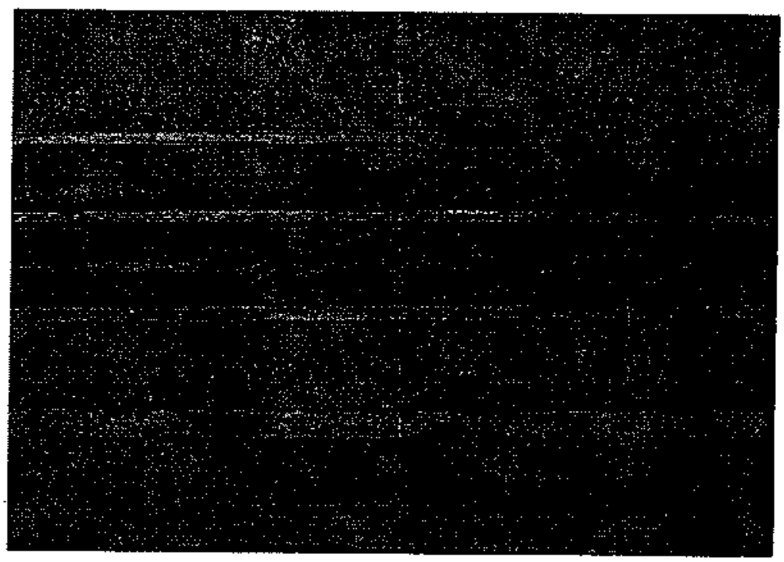
Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 and R2



Core Runs R1 and R2

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT		
Remedial Design For Operable Unit 01	BORING NO.	FD-114
New Bedford Harbor Superfund Site	SHEET	11 of 12
New Bedford, Massachusetts	FILE NO.	48138.27
	CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696166	easting 814321	
Driller	E. Thomas	Mudline El.	-20.28	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/2/01	Date End	1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
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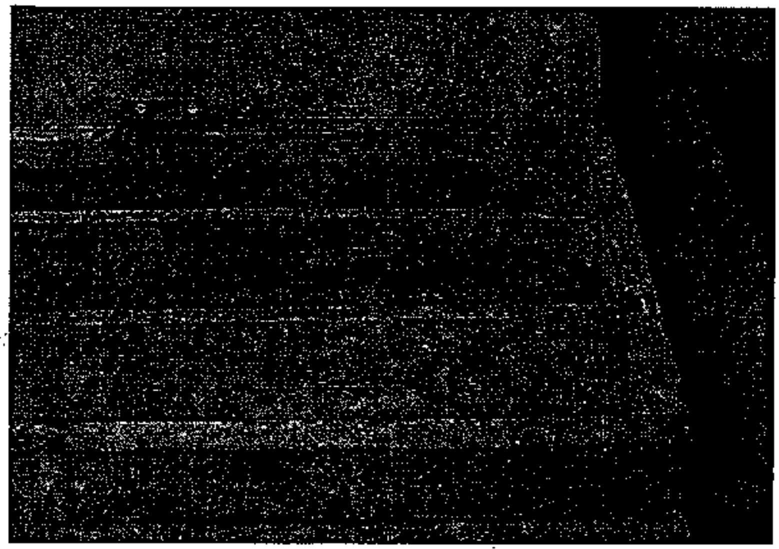
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 and R2

Core Runs R3 and R4

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-114 SHEET 12 of 12 FILE NO. 48138.27 CHKD. BY J. Trottier

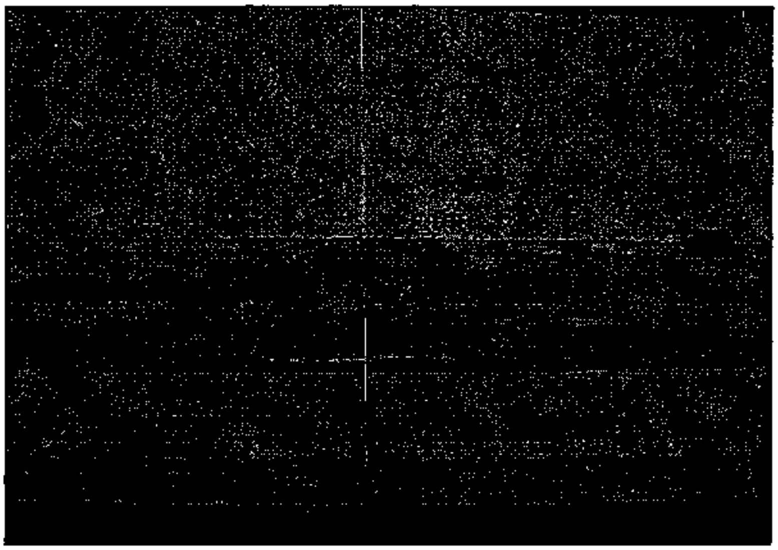
Boring Co.	Warren George, Inc.	Boring Location	northing 2696166 easting 814321
Driller	E. Thomas	Mudline El.	-20.28 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/2/01 Date End 1/5/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Spin and wash.

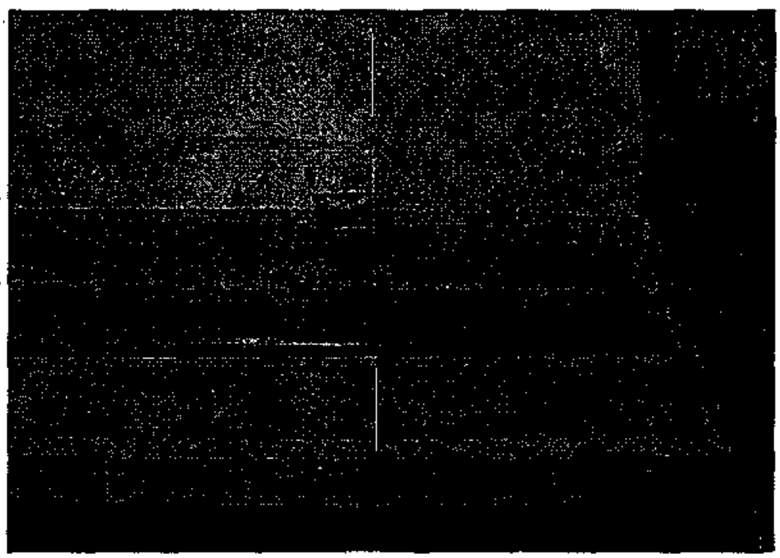
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R3 and R4



Core Runs R3 and R4

REMARKS:
1) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
2) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
3)
4)

M:\Reports\Active\48138.21\Field Forms\Fd-114\Picture (4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-115
New Bedford Harbor Superfund Site	SHEET 1 of 10
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696554	easting 814650	
Driller	E. Thomas	Mudline El.	-22.48	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/9/01	Date End	1/10/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
							Advance sampler to 2 ft.		
1	WOC								
2	WOC								
		UO-1	24/24	2-4	———	—	Organic soil (OH); 90% organic clay/silt, 10% fine sand, strong organic odor, black.		
							Tube fell over during preservation, tube discarded.		
							Advance PW drill casing to 5 ft.		
3	WOC						Advance 3-7/8 in. roller bit to 5 ft.	ORGANIC CLAY	
4	WOC								
5	WOC								
		UO-2	24/24	5-7	———	—	Organic soil with sand (OH); 70% organic clay/silt, 25% fine sand, 5% shell fragments,		
							strong organic odor, dark gray.		
							Pocket penetrometer: undrained shear strength = 0.22 kips/sf		
6	WOC						Advance PW drill casing to 8 ft.		
							Advance 3-7/8 in. roller bit to 8 ft.		
7	WOC								
8	WOC								
		UO-3	24/24	8-10	———	—	Top: Similar to UO-2.		
							Bottom: Poorly graded sand (SP); 45% fine sand, 50% medium sand, 5% silt, moderate	8.50 ft.	
	HYD						organic odor, gray.		
9	PUSH						Advance PW drill casing to 11 ft.		
							Advance 3-7/8 in. roller bit to 11 ft.	MARINE SAND	
	HYD								
10	PUSH								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-115 SHEET 4 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696554 easting 814650
Driller	E. Thomas	Mudline El.	-22.48 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/9/01 Date End 1/10/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMKS
31	63								
32	62								
33	67								
		S-9	24/10	33-35	13-13-12-12	25*	**Silty sand with gravel (SM); 30% fine sand, 22% medium sand, 8% coarse sand, 17% gravel, 23% silt, brown.** Subrounded to subangular sand and gravel. (2 jars) Advance PW drill casing to 38 ft. Advance 3-7/8 in. roller bit to 38 ft.		1,2
34	69								
35	80							GLACIO FLUVIAL	
36	79								
37	55								
38	55								
		S-10	24/4	38-40	25-27-7-25	34*	Silty sand with gravel (SM); dense, 5% clay, 20% fine sand, 15% medium sand, 5% coarse sand, 30% gravel, 25% silt, subangular to angular sand and gravel, gray. Advance PW drill casing to 43 ft. Advance 3-7/8 in. roller bit to 43 ft.		2
39	88								
40	131								

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. ROD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-115
SHEET	5 of 10
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696554 easting 814650
Driller	E. Thomas	Mudline El.	-22.48 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/9/01 Date End 1/10/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (/ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
								GLACIO FLUVIAL	
41	160								
42	140								
43	217								
		S-11	3/1	43-43.3	20/3"-25/0"	—	Washed sample.	43.3 ft.	2
							Advance 3-7/8 in. roller bit to 43.5 ft.		
							Advance 4-7/8 in. roller bit to 43.5 ft.	BEDROCK	
44							Top of bedrock at 43.3 ft.		
							Telescope HW drill casing to 43.8 ft.		
							Begin HQ rock core at 43.5 ft.		
							(boring log continued on next page)		
45									
46									
47									
48									
49									
50									

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT	
Remedial Design For Operable Unit 01	BORING NO. FD-115
New Bedford Harbor Superfund Site	SHEET 6 of 10
New Bedford, Massachusetts	FILE NO. 48138.27
	CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696554 easting 814650
Driller	E. Thomas	Mudline El.	-22.48 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/9/01 Date End 1/10/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R1	43.5-44.5	3 min.	Begin R1 at 43.5 ft. Fresh moderately hard, gray, fine to medium grained GNEISS. Low angle foliation (approx. 20 degrees). REC. = 92%; RQD = 92% (excellent). RQD biased low due to recovery less than 100%. Water return color: milky white. 41.1 to 44.4 ft.: Slight discoloration/weathering noted on surface of rock core. 44.2 ft.: Primary joint: low angle, rough, planar, discolored, and open. Some core grinding noted.	
44.0						
44.5			44.5-45.5	2.5 min.	44.5 ft.: Loss of water return.	
45.0					45.1 to 46.7 ft.: Slight discoloration/weathering noted on surface of rock core.	
45.5			45.5-46.5	2 min.	45.4 ft.: Mechanical break in rock core. 45.8 ft.: Mechanical break in rock core.	
46.0					46.2 ft.: Mechanical break in rock core.	
46.5			46.5-47.5	3 min.	46.5 ft.: Mechanical break in rock core.	
47.0						
47.5			47.5-48.5	2.5 min.	47.5 ft.: Primary joint: low angle, rough, planar, discolored, and open. Some core grinding noted. 47.7 ft.: Mechanical break in rock core. 47.9 ft.: Mechanical break in rock core.	
48.0						
48.5					End R1 at 48.5 ft.	

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	PROJECT	
	Remedial Design For Operable Unit 01	BORING NO. FD-115
	New Bedford Harbor Superfund Site	SHEET 7 of 10
		FILE NO. 48138.27
	New Bedford, Massachusetts	CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696554 easting 814650
Driller	E. Thomas	Mudline El.	-22.48 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/9/01 Date End 1/10/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	48.5-49.5	3.5 min	Begin R2 at 48.5 ft. Fresh hard, gray, fine to medium grained GNEISS. Low angle foliation (approx. 20 to 30 degrees). No natural joints/fractures noted. REC = 98%; RQD = 98% (excellent). RQD biased low due to recovery less than 100%. No water return noted.	
49.0						
49.5			49.5-50.5	4 min	49.7 ft.: Mechanical break in rock core.	
50.0						
50.5			50.5-51.5	3.5 min	50.6 to 50.9 ft.: Quartz/feldspar vein. Pink/dark gray in color.	
51.0						
51.5			51.5-52.5	3.5 min		
52.0					51.8 to 52.0 ft.: Quartz/feldspar vein. Dark gray/pink in color. 52.2 to 52.4 ft.: Quartz/feldspar vein. Dark gray/pink in color. 52.3 ft.: Mechanical break in rock core.	
52.5			52.5-53.5	4 min		
53.0					53.2 to 53.5 ft.: Quartz/feldspar vein. Dark gray/pink in color. Pegmatic.	
53.5					End R2 at 53.5 ft.	

GRANULAR SOILS (N-Value)	COHESIVE SOILS (N-Value)	SYMBOLS/KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-115
SHEET 8 of 10
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc.
Driller E. Thomas
Logged By E. Thibodeau

Boring Location northing 2696554 easting 814650
Mudline El. -22.48 Datum NGVD
Date Start 1/9/01 Date End 1/10/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R3	53.5-54.5	3.5 min.	Begin R3 at 53.5 ft. Fresh, hard, gray, fine to medium grained GNEISS. Low angle foliation (approx. 10 to 20 degrees). REC = 100%; RQD = 100% (excellent) No water return noted. 53.5 to 53.7 ft.: Quartz/feldspar vein. Dark gray/pink in color. Pegmatic. Continuation from R2. 53.9 ft.: Mechanical break in rock core.	
54.0						
54.5			54.5-55.5	2.5 min.		
55.0					55.3 ft.: Mechanical break in rock core.	
55.5			55.5-56.5	2.5 min.		
56.0						
56.5			56.5-57.5	3.5 min.	56.6 and 56.7 ft.: Mechanical breaks in rock core.	
57.0					48.9 ft.: Quartz/feldspar vein: Dark gray/pink in color. 57.0 to 57.2 ft.: Quartz/feldspar vein. Pink/dark gray in color. 57.0 to 57.2 ft.: Several mechanical breaks in rock core. 57.3 ft.: Mechanical break in rock core.	
57.5			57.5-58.5	3.5 min.	57.7 ft.: Mechanical break in rock core. 57.9 to 58.5 ft.: Quartz/feldspar zone. Very coarse grained. Pink/dark gray in color, Pegmatic.	
58.0					End of R3 at 58.5 ft. Bottom of exploration at 58.5 ft; boring terminated in bedrock.	
58.5					Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.39.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	NOTES	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-115 SHEET 9 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

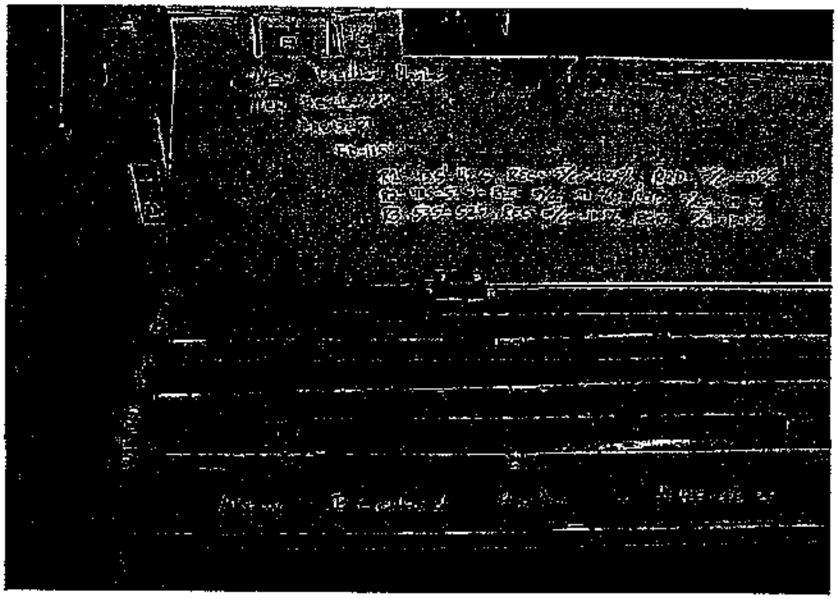
Boring Co.	Warren George, Inc.	Boring Location	northing 2696554 easting 814650
Driller	E. Thomas	Mudline El.	-22.48 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/9/01 Date End 1/10/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

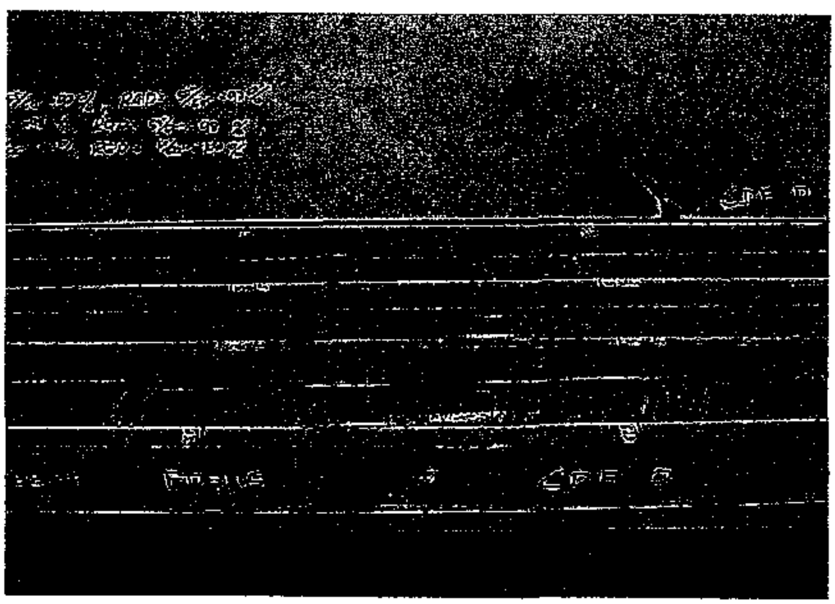
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

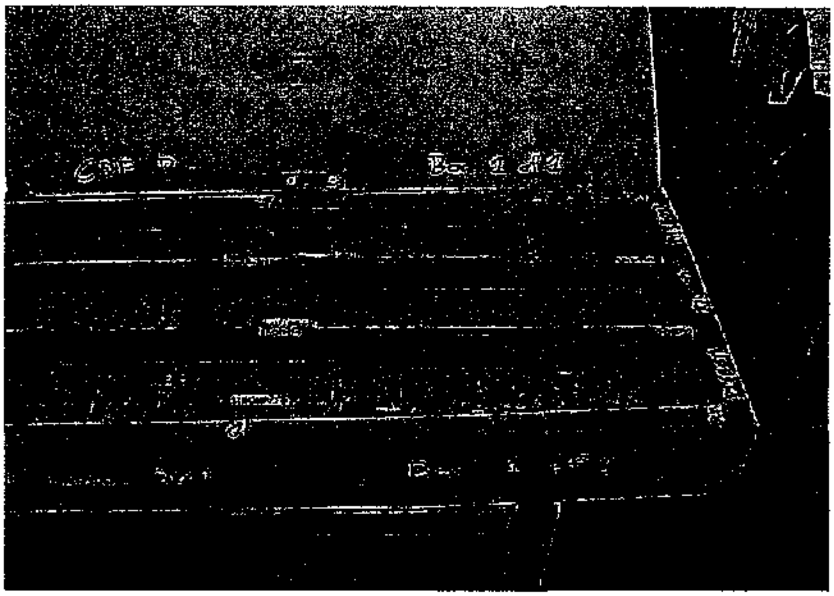
Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-115 SHEET 10 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696554	easting 814650	
Driller	E. Thomas	Mudline El.	-22.48	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/9/01	Date End	1/10/01

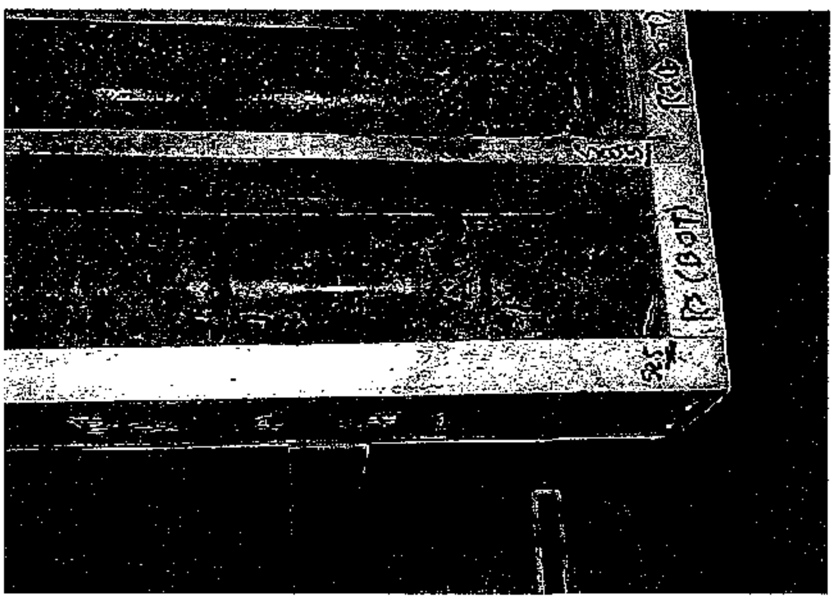
Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings				
Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Quartz/feldspar (pegmatic) zones noted in bottom of R2 and R3

REMARKS:

1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
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Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-116
SHEET 1 of 10
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co. Warren George, Inc. | Boring Location northing 2696328 easting 814635
Driller E. Thomas | Mudline El. -24.16 | Datum NGVD
Logged By E. Thibodeau | Date Start 1/5/01 | Date End 1/8/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
1	WOC								
2	WOC								
		UO-1	24/24	2-4	————	—	Sandy organic soil (OH); 65% organic clay/silt, 5% medium sand, 30% fine sand, strong organic odor, dark gray. Slight sheen noted on sample. Pocket penetrometer: undrained shear strength = 0.08 kips/sf		
3	WOC						Advance PW drill casing to 5 ft. Advance 3-7/8 in. roller bit to 5 ft.	ORGANIC CLAY	
4	WOC								
5	WOC								
		UO-2	24/24	5-7	————	—	Top: Sandy organic soil (OH); 60% organic clay/silt, 35% fine sand, 5% shell fragments, strong organic odor, dark gray. (UO-2A) Bottom: Poorly graded sand with silt (SP-SM); 60% fine sand, 25% medium sand, 10% silt, strong organic odor, gray. Traces of dark brown organic matter noted. (UO-2B)		
6	HYD PUSH						Advance PW drill casing to 7 ft. Advance 3-7/8 in. roller bit to 7 ft.	6.0 ft.	
7	HYD PUSH								
		S-1	24/13	7-9	3-2-2-2	4	Silty sand (SM); loose, 70% fine sand, 30% silt, moderate organic odor, gray. Advance PW drill casing to 9 ft. Advance 3-7/8 in. roller bit to 9 ft.	MARINE SAND	
8	15								
9	15								
		S-2	24/6	9-11	5-1/12"-1	1	Silty with sand (ML); very soft, 70% silt, 10% clay, 20% fine sand, gray. Advance PW drill casing to 11 ft. Advance 3-7/8 in. roller bit to 11 ft.		
10	11								

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5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering
18 Chenell Drive
Concord, New Hampshire 03301

PROJECT
Remedial Design For Operable Unit 01
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO. FD-116

FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696328	easting 814635	
Driller	E. Thomas	Mudline El.	-24.16	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/5/01	Date End	1/8/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
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Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
11	9								
		S-3	24/24	11-13	1-1/18"	—	Lean clay with sand (CL); very soft, 85% clay/silt, 15% fine sand, gray to olive brown. Interbedded.		
							Advance PW drill casing to 13 ft.		
12	12						Advance 3-7/8 in. roller bit to 13 ft.	MARINE SAND	
13	18								
		S-4	24/18	13-15	WOR/18"-2	—	Silty clay (CL-ML); very soft, 90% clay/silt, 10% fine sand, olive brown. Trace of iron staining noted.		
							Atterberg Limit = Liquid Limit = 21		1
14	21						**Plastic Limit = 16, Plasticity Index = 5**		1
							Advance PW drill casing to 15 ft.		
							Advance 3-7/8 in. roller bit to 15 ft.		
15	17								
		S-5	24/12	15-17	4-4-4-4	8	Poorly graded sand with silt (SP-SM); loose, 60% fine sand, 30% medium sand, 10% silt, brown. Traces of iron staining noted.		
							Advance PW drill casing to 17 ft.		
16	28						Mix bentonite drilling mud, specific gravity = 1.08.		
							Advance 3-7/8 in. roller bit to 17 ft.		
17	28								
		S-6	24/15	17-19	3-2-4-2	6	**Poorly graded sand (SP); 85% fine sand, 11% medium sand, 4% silt, brown.**		1
							Advance PW drill casing to 19 ft.		
18	18						Advance 3-7/8 in. roller bit to 19 ft.		
19	27							19.0 ft.	
		S-7	24/3	19-21	3-3-4-4	7	Poorly graded sand with silt and gravel (SP-SM); loose, 20% fine sand, 40% medium sand, 10% coarse sand, 20% gravel, 10% silt, subrounded to subangular sand and gravel, brown.	GLACIO FLUVIAL	
							Advance PW drill casing to 21 ft.		
20	15						Advance 3-7/8 in. roller bit to 21 ft.		

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11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

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Nobis Nobis Engineering, 18 Chenell Drive, Concord, New Hampshire 03301	**PROJECT** Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-116 SHEET 3 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696328	easting 814635	
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Logged By	E. Thibodeau	Date Start	1/5/01	Date End	1/8/01

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21	31								
		S-8	24/6	21-23	3-2-3-4	5	**Poorly graded sand with silt and gravel (SP-SM); 28% fine sand, 29% medium sand, 14% coarse sand, 17% gravel, 12% silt, grayish brown.** Subrounded to subangular sand and gravel. Advance PW drill casing to 23 ft. Advance 3-7/8 in. roller bit to 23 ft.		1
22	26								
23	27							GLACIO FLUVIAL	
		S-9	24/2	23-25	5-4-3-3	7	Poor recovery. Advance HW drill casing to 25 ft. Advance 3-7/8 in. roller bit to 25 ft.		
24	27								
25	38								
		S-10	24/8	25-27	7-5-5-4	10*	**Poorly graded sand with silt and gravel (SP-SM); 29% fine sand, 25% medium sand, 11% coarse sand, 28% gravel, 7% silt, brownish gray.** Subrounded to subangular sand and gravel. (2 jars) Advance PW drill casing to 30 ft. Advance 3-7/8 in. roller bit to 30 ft.		1,2
26	27								
27	41								
28	28								
29	27								
30	32								

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11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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18 Chenell Drive
Concord, New Hampshire 03301

PROJECT

Remedial Design For Operable Unit 01

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

BORING NO. FD-116
SHEET 4 of 10
FILE NO. 48138.27
CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696328 easting 814635
Driller	E. Thomas	Mudline El.	-24.16 Datum NGVD
Logged By	E. Thibodeau	Date Start	1/5/01 Date End 1/8/01

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Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	Casing Blows (ft)	Type & No.	PEN/REC (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	SPT N-Value	SAMPLE DESCRIPTION (ASTM D2488)	STRATUM DESCRIPTION	REMARKS
		S-11	24/4	30-32	5-13-13-12	26*	Washed sample.		1,2
							Advance PW drill casing to 32 ft.		
							Mix bentonite drilling mud, specific gravity = 1.08.		
31	106						Advance 3-7/8 in. roller bit to 32 ft.		
32	88								
		S-12	24/3	32-34	7-12-12-16	24*	Poor recovery. Washed sample.		1,2
							Advance PW drill casing to 34 ft.		
							Advance 3-7/8 in. roller bit to 34 ft.		
33	27							GLACIO FLUVIAL	
34	80								
		S-13	12/4	34-35	25-25-25/0"	—	Silty sand with gravel (SM); 30% fine sand, 15% medium sand, 10% coarse sand, 25% gravel, 20% silt, subrounded to subangular sand and gravel, gray.		1,2
							Advance PW drill casing to 35 ft.		
35	128						Top of bedrock at 35.0 ft.	35.0 ft.	
							Advance 3-7/8 in. roller bit to 35.3 ft.		
							Advance 4-7/8 in. roller bit to 35.5 ft.	BEDROCK	
							Telescope HW drill casing to 35.7 ft.		
36							Begin HQ rock core at 35.5 ft.		
							(boring log continued on next page)		
37									
38									
39									
40									

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	PROJECT	
Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-116 SHEET 5 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696328 easting 814635
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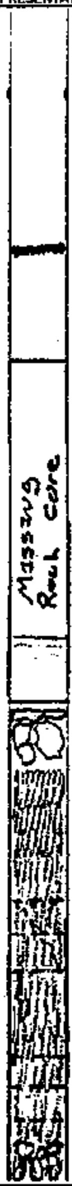
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time



DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMKS
	R1	35.5-36.5	6.5 min.	Begin R1 at 35.5 ft. Fresh to slightly weathered, moderately hard to medium, gray, fine to medium grained GNEISS. Low angle foliation (approx. 10 degrees). REC. = 70%; RQD = 48% (poor). RQD biased low due to recovery of less than 100%. Water return color: milky white to rust.	
36.0					
36.5		36.5-37.5	6 min.	36.6 ft.: Quartz vein: Dark gray in color.	
37.0				37.0 to 38.4 ft.: Missing rock core. Rock not recovered due to probable core grinding. Possible weathered/residual soil zone.	
37.5		37.5-38.5	5 min.		
38.0					
38.5		38.5-39.5	2 min.	38.4 to 38.7 ft.: Several pieces of fractured rock. Core grinding noted. One fragment showed signs of overcore. 38.7 to 40.5 ft.: Discoloration noted. Distinct weathering noted from 39.7 to 40.5 ft. Several mechanical breaks noted through this zone. Some core grinding noted at 39.9 ft.	
39.0					
39.5		39.5-40.5	5 min.		
40.0					
40.5				40.3 to 40.5 ft.: Broken rock fragments from core lifter. End R1 at 40.5 ft.	

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Boring Co.	Warren George, Inc.	Boring Location	northing 2696328 easting 814635
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Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R2	40.5-41.5	5.5 min	Begin R2 at 40.5 ft. Slightly weathered to fresh, moderately hard to hard, gray, fine to medium grained GNEISS. Low angle foliation (approx. 10 degrees). REC = 100%; RQD = 92% (excellent). RQD biased low due to recovery of less than 100%. No water return noted. 40.5 to 41.0 ft.: Secondary joint: high angle, rough, planar, discolored, and tight. 41.2 ft.: Mechanical break in rock core.	
41.0						
41.5			41.5-42.5	5 min	41.6 ft.: Mechanical break in rock core. 41.9 to 42.0 ft.: Primary joint: low angle, rough, planar, discolored/weathered, and open. Joint is notably weathered with some material being friable.	
42.0						
42.5			42.5-43.5	4 min	42.6 ft.: Mechanical break in rock core.	
43.0						
43.5			43.5-44.5	5 min	43.5 ft.: Mechanical break in rock core.	
44.0						
44.5					44.3 ft.: Mechanical break in rock core.	
			44.5-45.5	5 min	44.6 ft.: Primary joint: low angle, rough, planer, discolored, and open. Some weathering noted on surface of joint. 44.8 to 45.2 ft.: Weathering/discoloration noted. 45.1 ft.: Primary joint: low angle, rough, planar, discolored, and open. Weathering noted.	
45.0						
45.5					End R2 at 45.5 ft.	

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31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
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Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
	R3	45.5-46.5	7 min.	Begin R3 at 45.5 ft. Fresh, hard, gray, fine to medium grained GNEISS. Low angle foliation (approx. 10 to 20 degrees). REC = 100%; RQD = 100% (excellent)	
46.0				No water return noted. 46.3 ft.: Mechanical break in rock core.	
46.5		46.5-47.5	7 min.	46.6 ft.: Mechanical break in rock core.	
47.0				47.0 ft.: Mechanical break in rock core. 47.2 ft.: Mechanical break in rock core.	
47.5		47.5-48.5	5.5 min.	47.5 ft.: Primary joint: low angle, rough, planar, discolored/weathered, and open.	
48.0				48.0 ft.: Mechanical break in rock core. 48.2 ft.: Mechanical break in rock core. 48.4 ft.: Mechanical break in rock core.	
48.5		48.5-49.5	5 min.	48.7 ft.: Mechanical break in rock core.	
49.0				48.9 ft.: Quartz/feldspar vein: Dark gray/pink in color.	
49.5		49.5-50.5	7.5 min.	49.7 to 50.2 ft.: Quartz/feldspar vein. Dark gray and pink in color. 49.7 and 49.8 ft.: Mechanical breaks in rock core.	
50.0				50.4 ft.: Mechanical break in rock core.	
50.5				End R3 at 50.5 ft.	

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PROJECT
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New Bedford Harbor Superfund Site
New Bedford, Massachusetts

BORING NO.	FD-116
SHEET	8 of 10
FILE NO.	48138.27
CHKD. BY	J. Trottier

Boring Co.	Warren George, Inc.	Boring Location	northing 2696328 easting 814635
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Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

DEPTH (feet)	VISUAL REPRESENTATION	CORE RUN	CORE INTERVAL	CORE TIME	ROCK CORE DESCRIPTION	REMARKS
		R4	50.5-51.5	4 min.	Begin R4 at 50.5 ft. Fresh, hard, gray, fine to medium grained GNEISS. No natural joints/fractures noted. Low angle foliation (approx. 20 to 30 degrees). REC = 100%; RQD = 100% (excellent) No water return noted. 50.8 ft.: Mechanical break in rock core. 51.0 ft.: Mechanical break in rock core.	
51.0						
51.5			51.5-52.5	2.5 min.	51.5 ft.: Mechanical break in rock core.	
52.0					52.2 ft.: Mechanical break in rock core.	
52.5			52.5-53.5	3 min.		
53.0					53.2 ft.: Quartz/feldspar vein: Dark gray/pink in color. 53.4 ft.: Mechanical break in rock core.	
53.5			53.5-54.5	3 min.		
54.0						
54.5			54.5-55.5	3 min.		
55.0					54.8 ft.: Mechanical break in rock core. 55.2 ft.: Mechanical break in rock core. End of R4 at 55.5 ft. Bottom of exploration at 55.5 ft; boring terminated in bedrock.	
55.5					Grout completed boring to mudline with cement/bentonite slurry, specific gravity = 1.37.	

GRANULAR SOILS (BLOWS/FT)	COHESIVE SOILS (BLOWS/FT)	SYMBOLS/KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	1. S denotes split-barrel sampler.	7. PID denotes Photoionization Detector
5 to 10 - Loose	3 to 4 - Soft	2. U denotes 3-inch O.D. undisturbed sample.	8. PPM denotes parts per million.
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff	5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard	6. SPT denotes Standard Penetration Test.	12. R denotes core run number.

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-116 SHEET 9 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

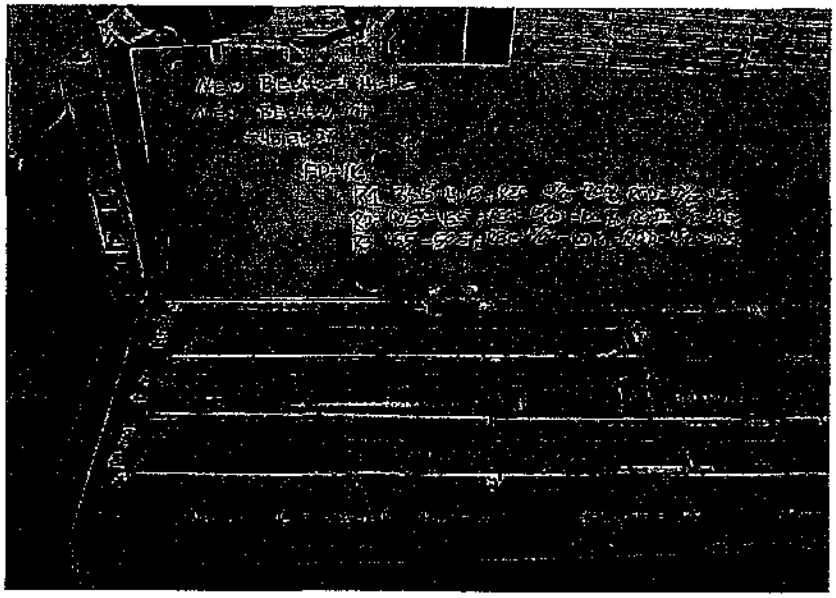
Boring Co. Warren George, Inc.	Boring Location	northing 2696328	easting 814635
Driller E. Thomas	Mudline El.	-24.16	Datum NGVD
Logged By E. Thibodeau	Date Start	1/5/01	Date End 1/8/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing.
Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

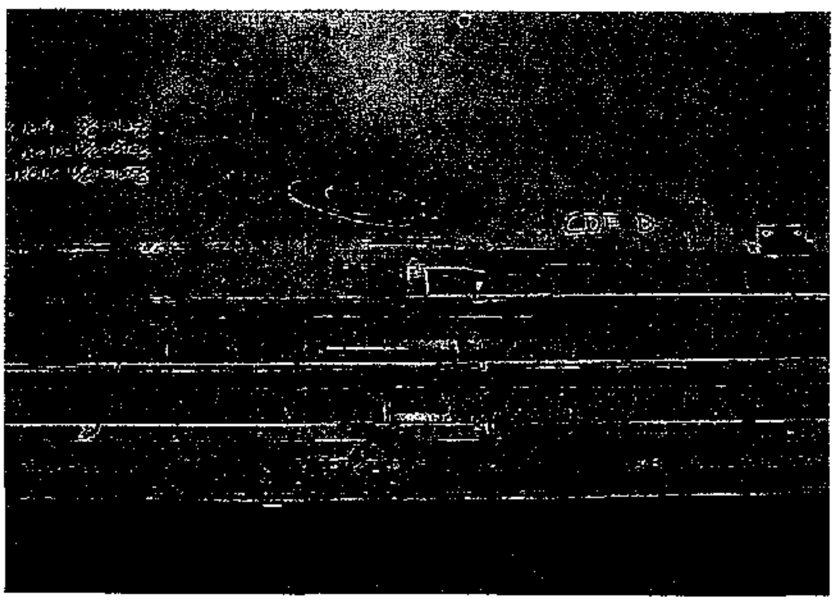
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Core Runs R1 through R3

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Nobis Engineering 18 Chenell Drive Concord, New Hampshire 03301	PROJECT Remedial Design For Operable Unit 01 New Bedford Harbor Superfund Site New Bedford, Massachusetts	BORING NO. FD-116 SHEET 10 of 10 FILE NO. 48138.27 CHKD. BY J. Trottier

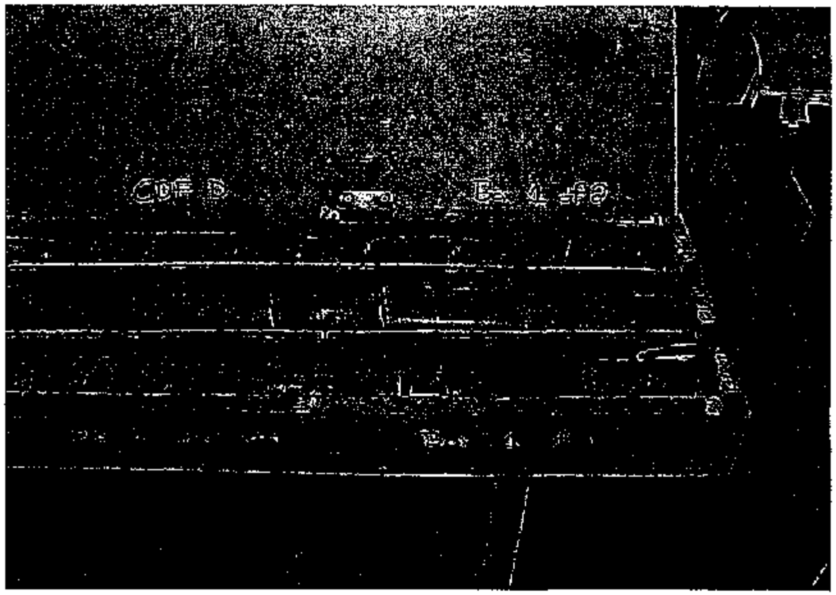
Boring Co.	Warren George, Inc.	Boring Location	northing 2696328	easting 814635	
Driller	E. Thomas	Mudline El.	-24.16	Datum	NGVD
Logged By	E. Thibodeau	Date Start	1/5/01	Date End	1/8/01

Sampler: 2-inch O.D. split-barrel sampler driven 24 inches with a 140 lb. automatic hammer free falling from a height of 30 inches.
Drill Rig: Acker AD II Truck Rig
Drilling Method: 5-inch (PW) flush joint drill casing. 4-inch (HW) flush joint drill casing. Casing driven with a 300 lb. Center hole hammer free falling from a height of 24 inches.

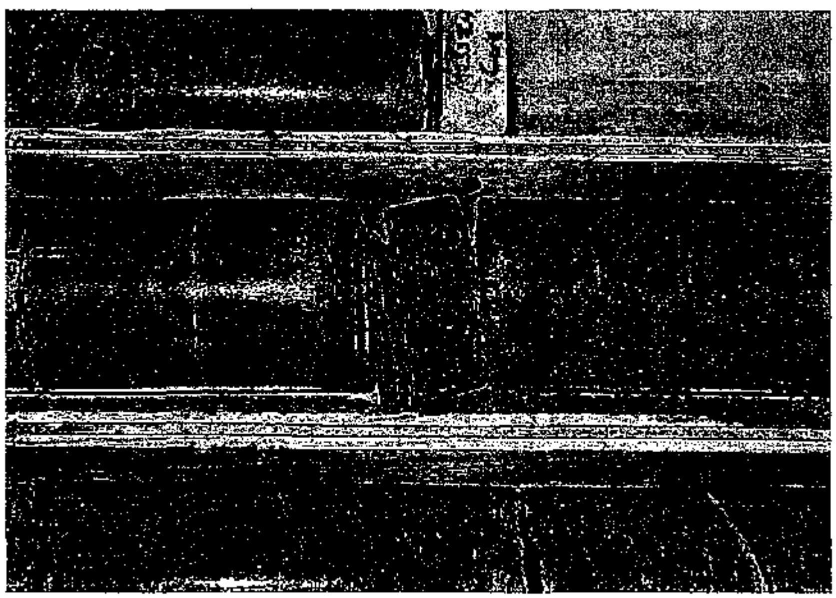
Groundwater Readings Not Applicable for Offshore Borings

Date	Time	Depth	Elev.	Stabilization Time

ROCK CORE PICTURES



Core Runs R1 through R3



Weathered primary joint noted in R2

REMARKS:
1) Sample description based on laboratory classification. Refer to GeoTesting Express Report dated March 5, 2001. Laboratory description presented in bold.
2) *3-inch O.D. split-barrel sampler driven 24 inches with a 300 lb. center hole hammer free falling from a height of 24 inches.
3)
4)

Depth (ft)	Casing Blows/ft	Sample No. / Penetration/Recovery	Lab Test	Water Content (%)	Shear Strength, Su Peak/Residual (psf) / Rod Probe (blows/ft)	Soil Description	Soil Class	Standard Penetration Resistance Blows/ft (0 10 20 30 40 50 60)	Piezometer Data	Elev (ft)
1	WOC				49/15	SANDY ORGANIC SILT — Dark gray sandy organic silt, little shell fragments, H_2S odor. Very soft, wet.				
2	WOC	S-1 2.0/0.0								
3								WOR		
4		S-2 2.0/0.0	G	114.9	122/37	4.0				
5					184/52	SILTY SAND — Dark gray silty sand, little shell fragments, very loose, H_2S odor, wet.		WOR		
6–7		S-3 2.0			203/21	No recovery.		WOR		
8–9		S-4 2.0			209/25			WOR		
10	WOC					Medium dark gray silty sand, little gravel, little shell fragments, medium dense, wet.				
11	7	S-5 2.0			235/31			19		
12	26					12.0 — Layer 0.05', brown fine fibrous peat.				
13	13	S-6				SAND — Gray fine to coarse sand, little to some gravel, trace silt, dense, wet.		31		
14	19					14.0				
15	21	S-7 2.0	G	12.5		GRAVELLY SAND — Gray gravelly fine to coarse sand, trace silt, medium dense, gap graded, wet.		26		
16	22									
17	54									
18	61									
19	46									
20	25	S-8 2.0						9		
21	17									
22	19									
23	16									
24	23									
25	15	S-9 2.0						8		
26	21									
27	23									
28	30									
29	38									
30	28	S-10 2.0						8		
31	19									
32	24					Gray gravelly fine to coarse sand, trace silt, medium dense, gap graded, wet.				
33	43					33.0				
34	60	S-11 2.0				SAND — Light brown fine to coarse sand, trace gravel, very loose, well graded, wet.		4		
35	40									
36	36				2	Probed from 35.0' to 42.8' with BW drill rods and hollow stem tip. Recorded blow counts per foot – 140 lb hammer dropped 24".				
37	53				7					
38	73				8					
39	90				13					
40	73				51					

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C. JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: RW-109A Page 1/2

Project No. 4959-19 | Date Drilled 2/4 – 2/9/88 | Sheet A-12

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psi) ROD PROBE (BLOWS/FT)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV (FT)
40 – 41	90					72	Grayish brown fine to medium sand, dense to very dense.				
42	175 197					172 62 - 100-	NO PENETRATION				
43 – 48		*R-1 5.3/2.5				42.8	BEDROCK AT 42.8 FEET Gray muscovite/biotite gneiss. trace garnet inclusions, some chloritization, schistose, friable.				
						48.1	RQD = 12.3%				
50							BOTTOM OF EXPLORATION AT DEPTH OF 48.1 FEET				
55 – 80							* Rock core obtained with a double barrel N core and NWX core bit.				

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C. JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BH-109A		Page 2/2
Project No. 4959-19	Date Drilled 2/4 - 2/9/88	Sheet A-13

DEPTH (FT.)	CASING BLOWS/FT	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0–2							Refer to Boring Log BW-109A for soil descriptions.				
2–4		U-1 H 2.0 / 1.3									
8–10		U-2 H 2.0 / 0.0				10.0	No recovery.				
10							BOTTOM OF EXPLORATION AT DEPTH OF 10.0 FEET. NO REFUSAL ENCOUNTERED.				
15											
20											
25											
30											
35											
40											

U: 3" or 3½" thin wall tube   S: split spoon   R: rock   C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C. JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-109B

Project No.	Date Drilled	
4959-19	2/9/88	Sheet A-14

DEPTH (FT.)	CASING BLOWS/FT	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT)
0											
1	WOC						ORGANIC SILT — Dark gray silt, some shell fragments.				
2	WOC	C-1 H 2.0 1.1		G M A C O	88.5	52/12	Trace to little fine sand, H_2S odor, wet.				
3	WOC				76.7						
4	WOC				87.3	52/12	Some fine sand, very soft.				
5	WOM	S-1 2.0 0.3							WOR		
	WOM										
6		C-2 H 2.0 1.9		G M A C O	85.6	92/18					
7					59.7						
8					52.0	221/43	Two layers, ±0.1' to 0.3', fine sandy silt.				
9		S-2 2.0 1.7							WOR		
10		C-3 H 2.0 1.7				166/13	10.0				
							SANDY ORGANIC SILT — Dark gray fine sandy silt, trace gravel, very soft, H_2S odor, moist.				
11						215/61	Layer, 0.2', silty fine sand.				
12		S-3 2.0 1.6							WOR		
14	WOM	C-4 H 2.0		G M C G	14.0	363 +					
15	3						15.3				
16	3	S-4 2.0 1.3					SAND — Dark gray fine to medium sand, little shell fragments, trace to little silt, very loose, well graded, H_2S odor, moist.		2		
17	4										
18	4	S-5 2.0 1.3					Layers of brown peat, moist.		2		
19	5						Fine sand, trace medium sand, very loose, faint H_2S odor.				
20	8						Some brown peat lenses.				
21	12										
22	16						23.0				
23	21	S-6 1.2 1.4					PEAT — 1.1'-1.4' Dark brown peat, some shell fragments, trace sand, very soft, H_2S odor, moist.		3		
24	21										
25	25						0.0'-1.1' Blackish dark brown silty peat, very soft, H_2S odor, moist.				
26	18										
27	18										
28	20	C-5 H 2.0 1.5					Layer, 0.2', gray silt, little fine sand.				
29	28						Gray "super" watered silty peat, saturated.				
30	30	S-7					Layer, 0.3', gray silt, little fine		11		
31	29						31.5				
32	39	S-8					SAND — Gray fine to med. sand, trace silt. 1.0'-1.5' Gray fine to coarse sand, some silt, trace shell fragments, trace gravel, peat lenses, wet.		12		
33	34						34.0				
34		S-9 2.0 0.6		G	10.9		0.0'-1.0' Gray fine to medium sand, little coarse sand, trace gravel, medium dense, wet.		31		
36						24	Gray gravelly fine to coarse sand, trace silt, dense, gap graded.				
37						28					
38						28	Probed from 36.0' to 62.0' with BW drill rods and hollow stem tip.				
39						33					
40											

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C. JORDAN CO.
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Engineering Log of: BW-110		Page 1/2
Project No. 4939-19	Date Drilled 2/9 - 2/10/88	Sheet A-15

DEPTH (FT)	CASING BLOWS/FT	SAMPLE NO.	PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV (FT)
40							31	Probed from 36.0' to 62.0' with BW drill rods and hollow stem tip. Recorded blow counts per foot - 140 lb. hammer dropped 30".				
41							16					
42							18					
43							23					
44							39					
45							53					
							45					
							33					
							21					
							14					
50							20					
							14					
							13					
							20					
							14					
55							19					
							18					
							16					
							45					
							102					
60							124					
							274					
							62.0	*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 62.0 FEET				
65								* Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.				
70												
75												
80												

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
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Engineering Log of: BW-110 Page 2/2

Project No. 4959-19 | Date Drilled 2/9 - 2/10/88 | Sheet A-16

Depth (ft)	Casing Blows/Ft	Sample No. / Penetration / Recovery	Water Content (%)	Soil Description	Standard Penetration Resistance Blows/Ft
0	3			SAND Brown fine sand, little silt.	
1	5				
2	5	S-1 2.0/1.0	18.0	Wet. No silt, medium dense, well graded.	11
3	7				
4	3	S-2 2.0/0.8		Trace coarse sand, trace shell fragments, loose.	10
5	3				
6	3	S-3 2.0/0.9	33.7		4
7	3				
8	3	S-4 2.0/1.15		Trace silt, no shell fragments.	10
9	3				
10	3	S-5 2.0/0.9		0.5'-0.9' Some coarse sand, trace medium sand, trace shell fragments, wet. Layer, 0.075', brown silt.	14
11	11				
12	4	S-6 2.0/[illegible]		0.0'-0.4' Brown fine sand, well graded, wet. Trace coarse sand, medium dense.	17
13	13				
14	18	S-7 2.0/[illegible]		Grayish brown fine sand, trace coarse sand, trace medium sand, medium dense, well graded, wet, brown mottling throughout, layer, 0.15', gray fine sandy silt.	11
15	25				
16	21				
17	26				
18	23				
19	18	S-8 [illegible]		Grayish brown fine to coarse sand, little silt, very loose, gap graded, wet. Fine sand, no silt, well graded.	3
20	23				
21	38				
22	43				
23	47	S-9 2.0/[illegible]		Brownish gray fine sand, trace medium sand, trace silt, loose, well graded, wet.	6
24	39				
25	52				
26	67				
27	54				
28	50	S-10 2.0/[illegible]		0.85'-1.1' Fine to coarse sand, trace gravel. Layer, 0.-5', brownish gray silty fine sand. 0.0'-0.4' Brownish gray fine sand, trace silt, loose, well graded, wet.	5
29	31				
30	44				
31	54				
32	68				
33	53	S-11 2.0/1.3	18.6	No silt, very loose.	2
34	64				
35	80				
36	96				
37	107				
38	71	S-12 2.0/1.2		Gray fine sand, trace silt, loose, well graded, wet.	5
39	55				
40					

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-111 Page 1/2

Project No. 4959-19 | Date Drilled 1/28 - 2/3/88 | Sheet A-17

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT)
40											
41	78										
42	102										
43	110	S-13 2.0/1.6					Layer, 1.0', gray silty fine sand. Gray fine sand, loose, well graded, wet.		6		
44	83										
45	97										
	110										
	122										
	136	S-14 2.0/1.2		G	29.6		Layer, >1.2', gray silty fine sand.		5		
	95										
50	116										
	73										
	62										
	83	S-15 2.0/1.5					Little to some silt, medium dense, well graded.		12		
	127										
55	98										
	114										
	117										
	125	S-16 2.0					Layer, 0.25', gray fine to coarse sand, trace gravel, trace silt, medium dense, well graded.		16		
	x										
60	x										
	x										
	x										
	x	R-1					Casing refusal, cored through large cobble. Telescoped casing from 4.0" nominal steel casing to 3.0" nominal to continue advancement of the borehole.				
	33										
	18										
65	27										
	43										
	50										
	63	S-17					Brown fine to medium sand, some gravel, trace coarse sand, trace silt, very dense, wet.				
	49										
70	54										
	58										
	48					73.0'	BEDROCK AT 73.0 FEET				
		R-2 1.75				74.75'	Gray, fine grained muscovite gneiss, few garnet inclusions, thin foliations (1" to 1"), trace chloritization. RQD = 0.0%				
75							BOTTOM OF EXPLORATION AT DEPTH OF 74.75 FEET				
80							* Rock core obtained with a single barrel B core and BWX core bit.				

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BH-111 Page 2/2

Project No. 4959-19 Date Drilled 1/28 - 2/3/88 Sheet A-18

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. / PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION		SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT (0 10 20 30 40 50 60)	PIEZOMETER DATA	ELEV. (FT)
0–1	WOC						ORGANIC SILT	Dark gray organic silt, some shell fragments, H_2S odor.				
1–2	WOC					110/15		Trace shell fragments, very soft, wet.				
2–3	WOC	S-1 2.0/0.9	G		38.0		2.5			WOH		
3–4	WOC		H				SILTY SAND	Dark gray silty fine sand, trace medium sand, very loose, H_2S odor, wet.				
4–5	WOH	S-2 2.0/0.0						No recovery		WOH		
5–6	WOH						6.0					
6–7	1	S-3 2.0/0.4	G		22.6		SAND	Dark brown fine to coarse sand, trace silt, very loose, wet. Layer, <0.1', peat.		4		
7–8	4											
8–9	12	S-4 2.0/1.0						Brown fine sand, little medium sand, trace coarse sand, medium dense, wet.		29		
9–10	19							Trace medium sand, trace gravel, trace silt, very dense, little mottling.				
10–11	22	S-5 2.0/[illegible]								55		
11–12	22											
12–13	12	S-6 [illegible]/1.35						Brownish gray fine sand, little gravel, trace coarse sand, trace medium sand, dense, wet.		46		
13–14	21											
14–15	18	S-7 [illegible]/0.7						Little to some gravel, gap graded.		22		
15–16	30											
16–17	34											
17–18	53											
18–19	35											
19–20	9	S-8 [illegible]	G		17.6			Some gravel, little coarse sand, loose.		8		
20–21	13											
21–22	26											
22–23	38											
23–24	13	S-9 [illegible]/1.35						Grayish brown fine to medium sand, some gravel, trace coarse sand, loose, wet.		6		
24–25	14											
25–26	32											
26–27	36											
27–28	54											
28–29	23	S-10 [illegible]	G		17.6			Little coarse sand.		[illegible]		
29–30	28											
30–31	32											
31–32	53											
32–33	55							0.4'–0.7' Grayish brown coarse sand, little gravel, trace med. sand, trace fine sand, medium dense.				
33–34	x	S-11 2.0/[illegible]				34.0				[illegible]		
34–35	x					SILTY SAND (Glacial Till)		0.0'–0.4' Gray silty fine sand, little to some gravel, little coarse sand, trace medium sand, trace clay, medium dense, wet.				
35–36						42		Probed from 35.0' to 42.8' with BW drill rods and hollow stem tip. Recorded blow counts per foot – 140 lb. hammer dropped 24".				
36–37						47						
37–38						29						
38–39						53						

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C. JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-112 Page 1/2

Project No. 4950-19 | Date Drilled 2/3/88 | Sheet A-19

DEPTH (FT.)	CASING BLOWS/FT	SAMPLE NO.	PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV (FT)
40							110					
41							183	NO PENETRATION				
42							100*					
43							42.8	*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 42.8 FEET				
44												
45								* Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.				
50												
55												
60												
65												
70												
75												
80												

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

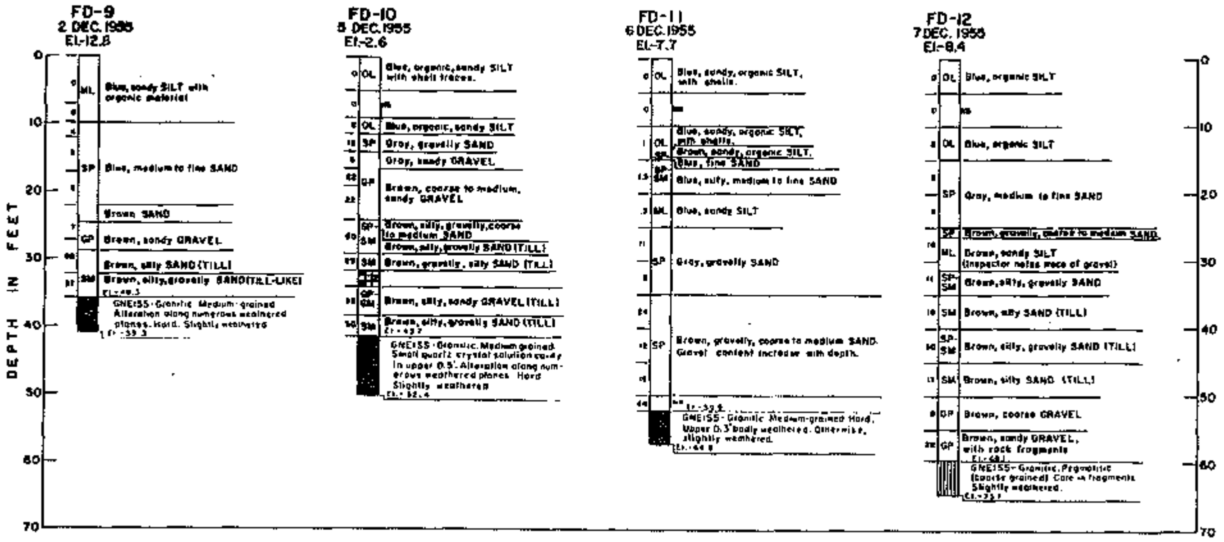
PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS.

E.C. JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-112 Page 2/2

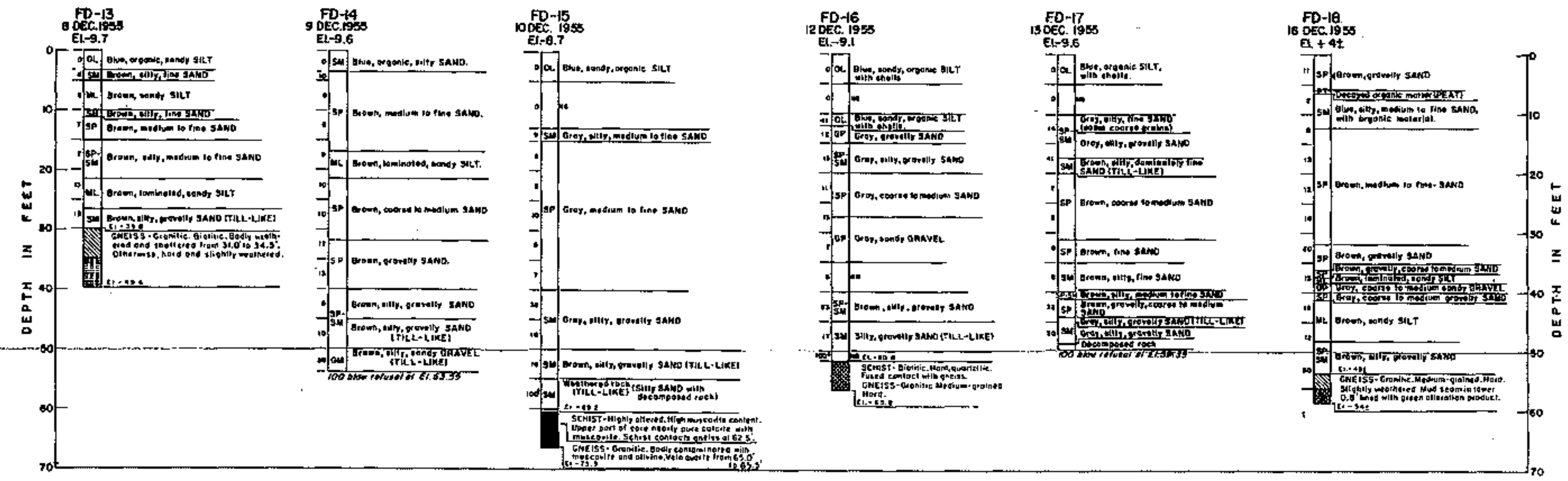
Project No.	Date Drilled	
4959-19	2/3/88	Sheet A-20

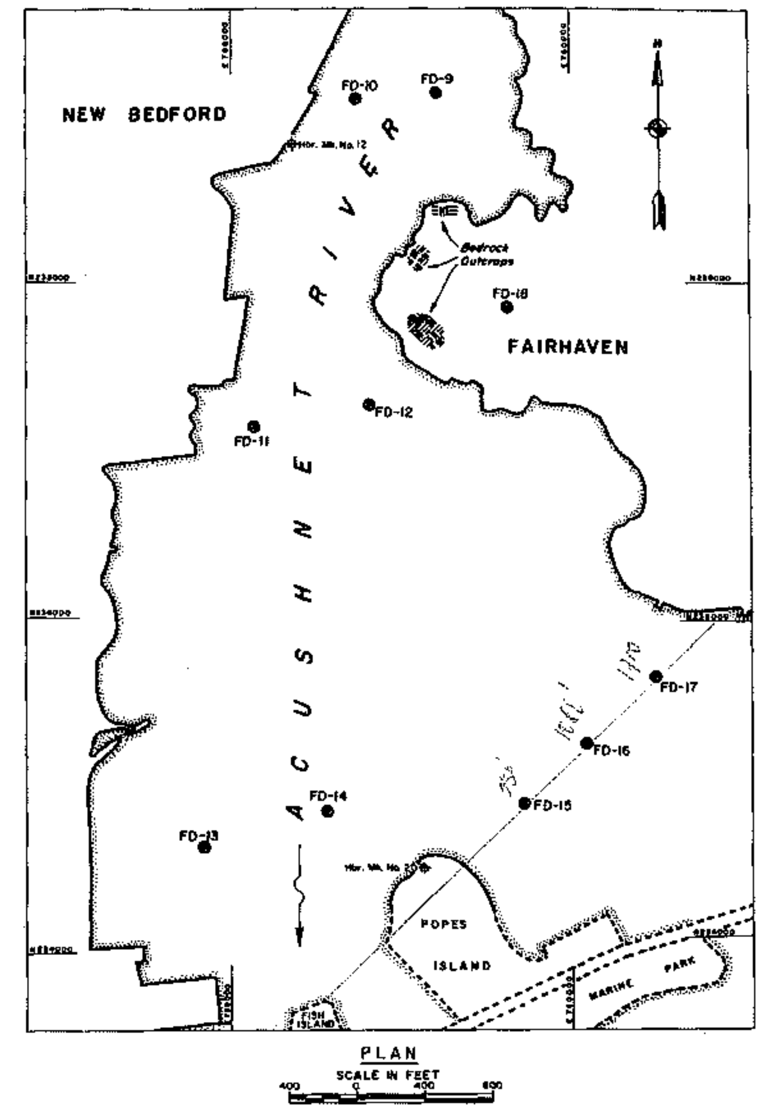
CORPS OF ENGINEERS U. S. ARMY



LEGEND FOR GRAPHIC LOGS

FD-10	Foundation Test Boring
5 DEC 1955	Date exploration completed.
El.-2.65	M.S.L. elevation of ground or river bottom at time of exploration.
	Subsurface water level in boring at time of exploration.
SM	Group letter symbol according to Unified Soil Classification System.
NR	No Recovery or unsatisfactory soil samples recovered.
NS	Not Sampled (Core-drilled, blasted and/or wash-bored).
80	Blows per foot of penetration considered most representative, usually within a 5-foot sample drive using a 350 pound hammer with a free fall of about 18 inches on a 2" O.D. or 1⅜" I.D. size sample spoon equipped with beveled and sharpened drive shoe. 2½" O.D. sample spoon used for FD-18.
	Blow count not recorded or not considered representative.
	Cobbles or boulders (Core-drilled).
	Cobbles or boulders continuous or nested. (Core-drilled and/or blasted and chopped.)
El-43.75	Elevation of bedrock surface.
	Rock core recovery 0 – 25 %
	Rock core recovery 25 – 50 %
	Rock core recovery 50 – 75 %
	Rock core recovery 75 – 90 %
	Rock core recovery 90 – 100 %
El-52.45	Elevation at bottom of exploration.





REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY C.G.H. | DR. BY H.C.S. | CK. BY R.C.G.

SUBMITTED: HEAD, GEOLOGY SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED: CHIEF, F&M & RATES BRANCH
APPROVAL RECOMMENDED: CHIEF, PLANN & RPTS BRANCH

HURRICANE PROTECTION
NEW BEDFORD - FAIRHAVEN
PLAN AND RECORD OF UPSTREAM EXPLORATIONS

NEW BEDFORD HARBOR MASSACHUSETTS

APPROVED: CHIEF, ENGINEERING DIVISION DATE FEB 1960

SCALE | SPEC. NO. | DRAWING NUMBER

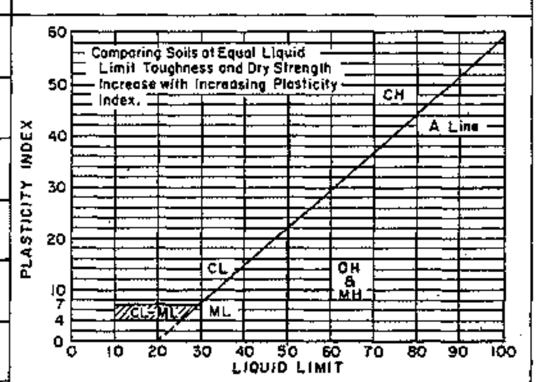
SHEET 11 OF 11

PLATE 11

UNIFIED SOIL CLASSIFICATION
(Including Identification and Description)

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weight).	Laboratory Classification Criteria	
Coarse-grained Soils. More than half of material is larger than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels. More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.	Determine percentages of gravel and sand from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows: Less than 5% GW, GP, SW, SP. More than 12% GM, GC, SM, SC. 5% to 12% Borderline cases requiring use of dual symbols.	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			GP	Poorly graded gravels, or gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		Not meeting all gradation requirements for GW
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixture.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		Atterberg limits below "A" line with PI less than 4. Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			GC	Clayey gravels, gravel-sand-clay mixture.	Plastic fines (for identification procedures see CL below).		Atterberg limits above "A" line with PI greater than 7
	Sands. More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.		$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			SP	Poorly graded sands or gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		Not meeting all gradation requirements for SW
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		Atterberg limits above "A" line or PI less than 4. Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		Atterberg limits above "A" line with PI greater than 7

Major Divisions		Group Symbols	Typical Names	Identification Procedures on Fraction Smaller than No. 40 Sieve Size: Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)
Fine-grained Soils. More than half of material is smaller than No. 200 sieve size.	Silts and Clays. Liquid limit is less than 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None
		CL	Inorganic clays of low to medium plasticity gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium
		OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight
	Silts and Clays. Liquid limit is greater than 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium
		CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High
		OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to Medium
Highly Organic Soils		PT	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.		



PLASTICITY CHART
For laboratory classification of fine-grained soils

(1) Boundry classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder.
(2) All sieve sizes on this chart are U. S. standard.

NOTE

For further information on Unified Soil Classification, refer to "The Unified Soil Classification System," Volumes 1 and 2, Technical Memorandum No. 3-357, published by U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. File copies may be examined at Headquarters, U. S. Army Engineer Division, New England, 424 Trapelo Road, Waltham, Massachusetts., Building 141, Foundation and Materials Branch.

Adopted by Corps of Engineers and Bureau of Reclamation, January 1952

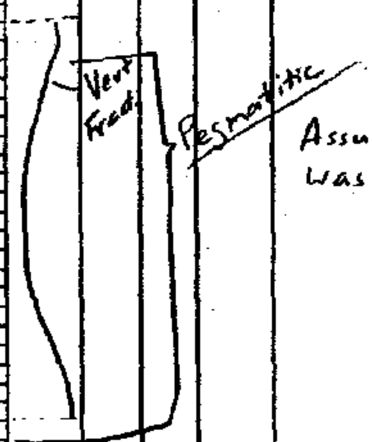
PLATE 12

U. S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION **FIELD LOG OF TEST BORING**	Site *New Bedford Harbor* Page 1 of *2* Pages Boring No. *FD-12* Desig. ____ Diam. (Casing) ____ Co-ordinates: N ____ E ____

Elevation Top of Boring ____ M.S.L.	Hammer Wt. ____ Boring Started ____
Total Overburden Drilled ____ Feet	Hammer Drop ____ Boring Completed ____
Elevation Top of Rock ____ M.S.L.	Casing Left ____
Total Rock Drilled ____ Feet	Subsurface Water Data ____ Page ____
Elevation Bottom of Boring ____ M.S.L.	Obs. Well ____
Total Depth of Boring ____ Feet	Drilled By ____
Core Recovered ____ % No. Boxes ____	Mfg. Des. Drill ____
Core Recovered ____ Ft: ____ Diam. ____ In.	Inspected By: ____
Soil Samples ____ In. Diam. ____ No.	Classification By: *R. Schmidt / P. Young*
Soil Samples ____ In. Diam. ____ No.	Classification By: *12 Jan. 2000*

66.7

DEPTH	1"=	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. / CORE RECV'Y	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
46.5'	47		Fol. 10°	R1	90 / 65	Re-calculate RQD for zones w/in Run: 46.5' - 48.7' = 100% 48.7' - 50.8' = 0% 50.8' - 56.5' = 4.6' / 5.7' = 81%	GRANITE GNEISS: f.-m. grained, hard, fresh except as noted, fol. dips ≤ 10°. 48.7' - 50.8' = Vert. Fract. down through core, sfc. is strongly coated blk + orange (Mn + Fe).
	48						
	49					Assume core loss was from B/Run.	48.9' - 50.9' = pegmatitic, lg. xlls of k feldspar + qtz, Qtz. Vein, brittle zone, resulting in many horiz. brks. in core.
	50						
	51						



GENERAL REMARKS:

Depths are from mudline, elev. -20.2 NGVD

Site	Boring No.	Page 2 of 2
New Bedford Harbor	FD-12	

DEPTH	ft.	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
	52		Fol.	R1 cont.			51.7'-51.8', 52.6'-52.9', 54.2'-54.4' C. crystals K feldspar
	53						53.3'-54.1' High Angle/Vert. Fract., irreg. sfc, sl. mineralized.
	54						
	55						
	56						
56.5'							EOB

3A(Test)

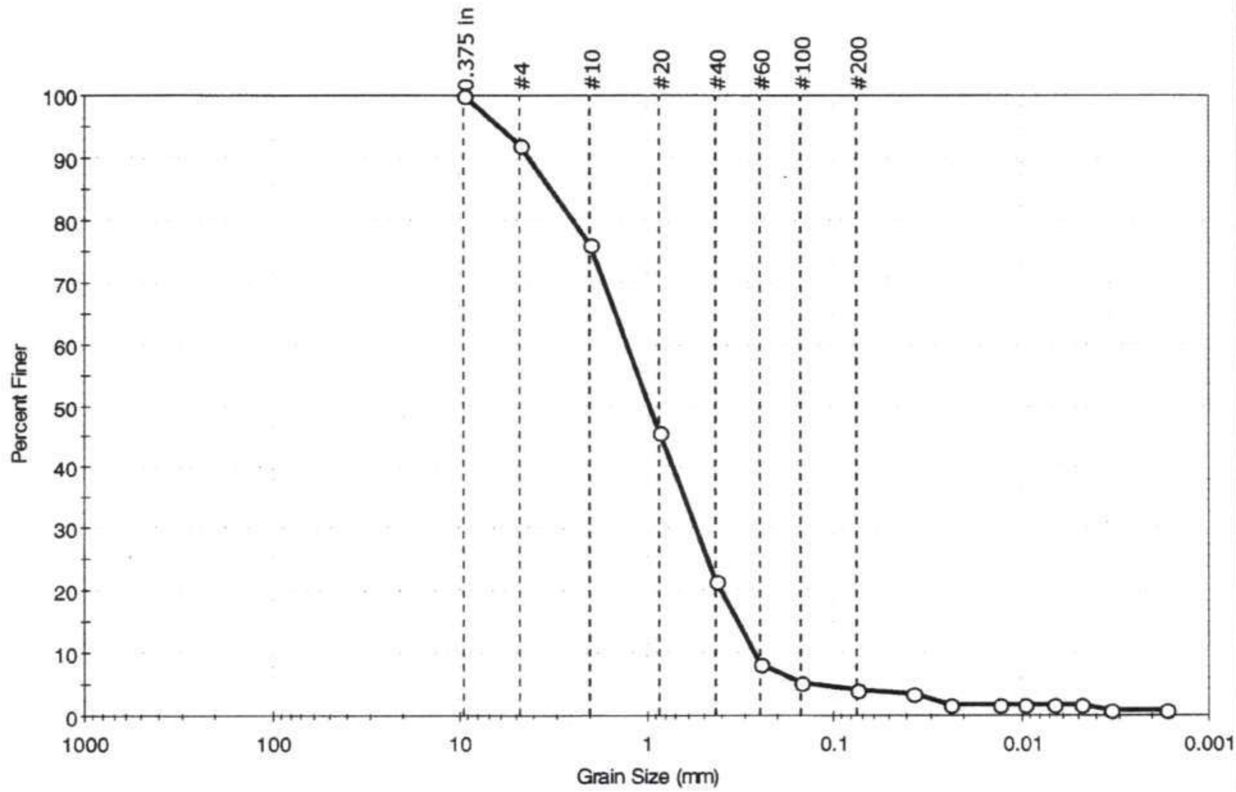
Boring No. FD-12

A-CAD3-2011-B1 18-20ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-1		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth :	18-20 ft	Test Id:	217463		
Test Comment:	---				
Sample Description:	Moist, olive sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	8.0	87.8	4.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	92		
#10	2.00	76		
#20	0.85	46		
#40	0.42	21		
#60	0.25	8		
#100	0.15	5		
#200	0.075	4		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0376	4		
---	0.0238	2		
---	0.0133	2		
---	0.0096	2		
---	0.0068	2		
---	0.0048	2		
---	0.0034	1		
---	0.0017	1		

Coefficients

D_{85} = 3.2346 mm | D_{30} = 0.5424 mm

D_{60} = 1.2689 mm | D_{15} = 0.3277 mm

D_{50} = 0.9589 mm | D_{10} = 0.2681 mm

C_u = 4.733 | C_c = 0.865

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

A-CAD3-2011-B1 18-20ft.

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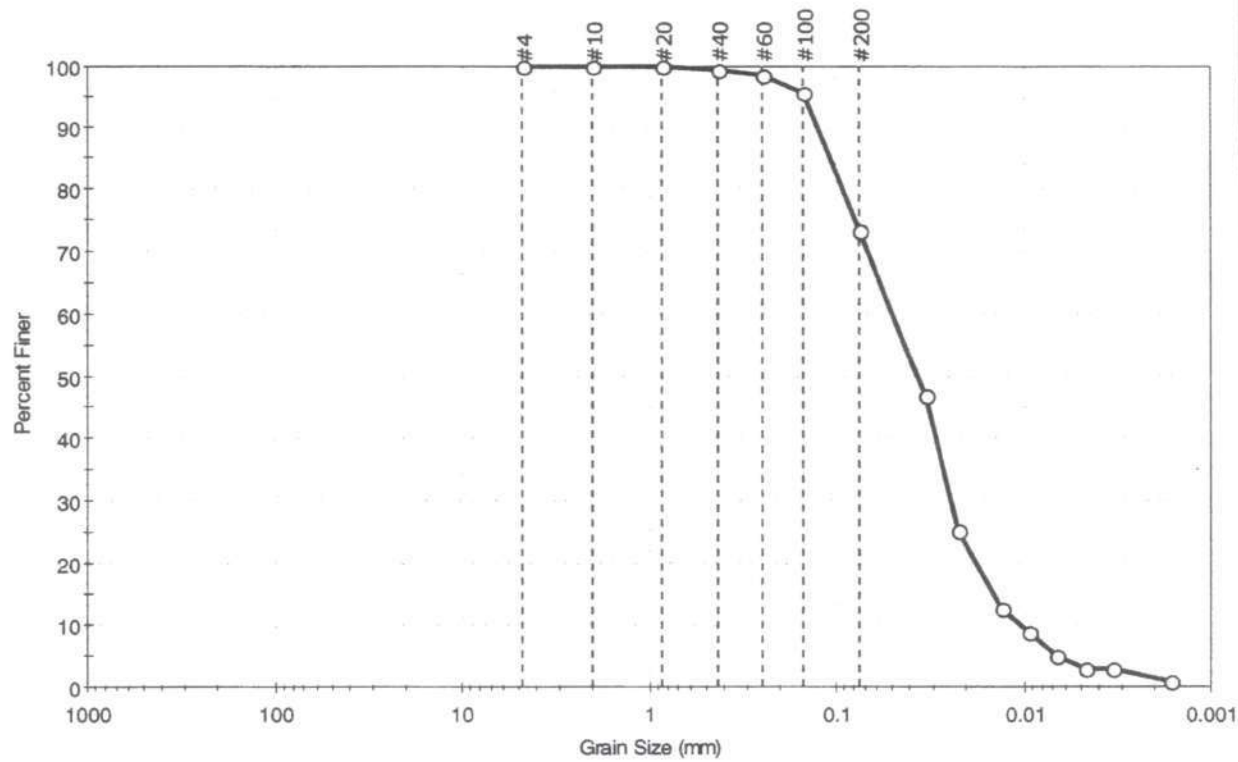
A-CAD3-2011-B1 44-46ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-1	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 44-46 ft	Test Id: 217464		

Test Comment: ---
Sample Description: Moist, greenish gray silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	26.8	73.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	98		
#100	0.15	96		
#200	0.075	73		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0335	47		
---	0.0221	25		
---	0.0133	13		
---	0.0094	9		
---	0.0067	5		
---	0.0048	3		
---	0.0034	3		
---	0.0016	1		

Coefficients

D_{85} = 0.1079 mm　D_{30} = 0.0242 mm
D_{60} = 0.0501 mm　D_{15} = 0.0146 mm
D_{50} = 0.0368 mm　D_{10} = 0.0105 mm
C_u = N/A　C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A-CAD3-2011-B1 44-46ft

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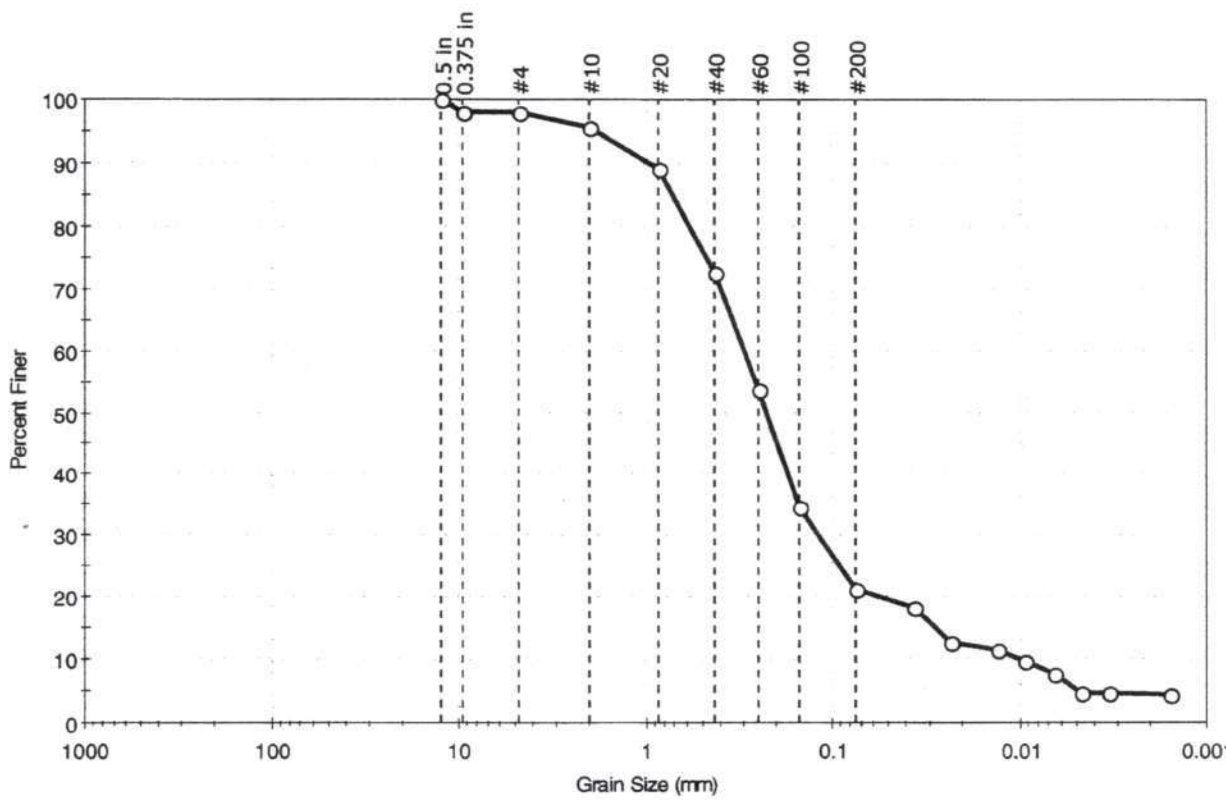
A-CAD3-2011-B2 0-6ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-2	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 0-6 ft	Test Id: 217465		
Test Comment: ---			
Sample Description: Moist, very dark gray silty sand			
Sample Comment: sample contains shells			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.0	76.8	21.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	98		
#4	4.75	98		
#10	2.00	96		
#20	0.85	89		
#40	0.42	73		
#60	0.25	54		
#100	0.15	35		
#200	0.075	21		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0367	18		
---	0.0231	13		
---	0.0133	12		
---	0.0094	10		
---	0.0066	8		
---	0.0047	5		
---	0.0034	5		
---	0.0016	4		

Coefficients

D_{85} =0.7187 mm
D_{30} =0.1180 mm
D_{60} =0.2988 mm
D_{15} =0.0280 mm
D_{50} =0.2268 mm
D_{10} =0.0099 mm
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A-CAD3-2011-B2 0-6ft

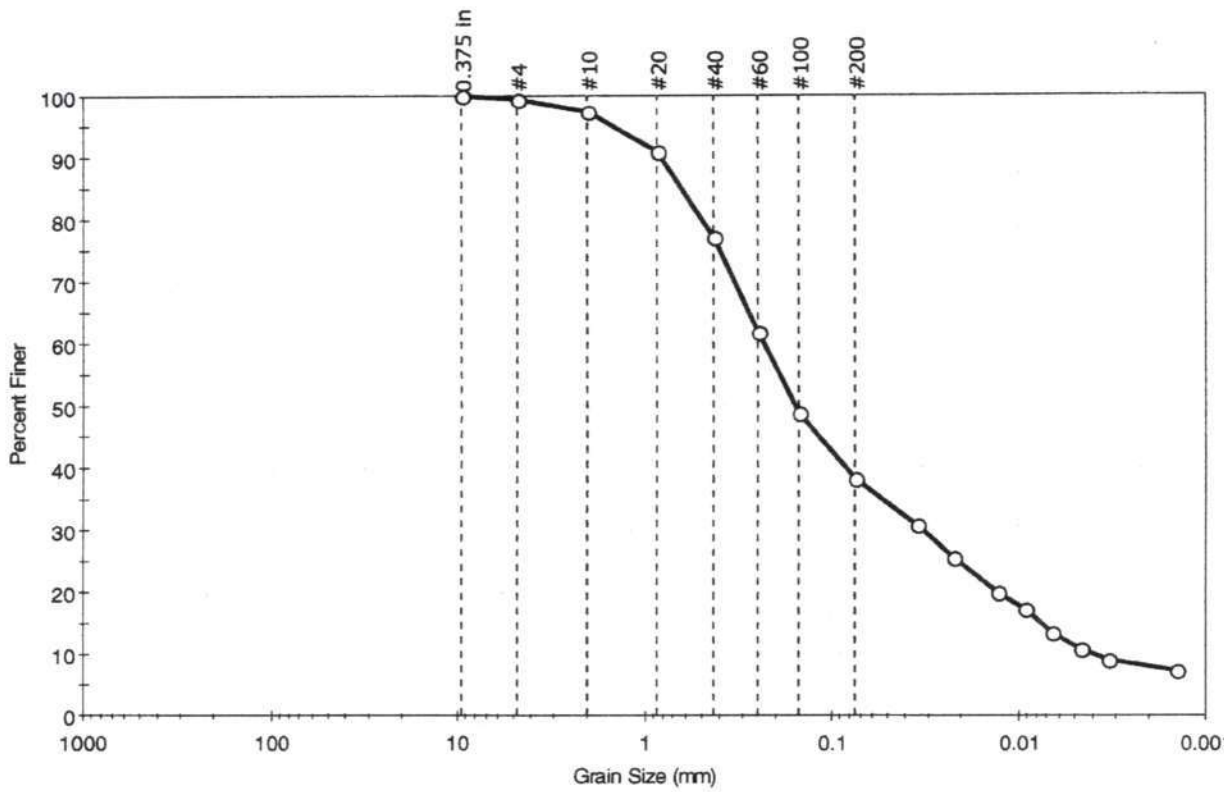
A-CA03-2011-B2-2-4ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-2	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 08/03/11	Checked By:	jdt
Depth : 2-4	Test Id: 213833		

Test Comment: ---
Sample Description: Moist, dark greenish gray silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.5	61.1	38.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	97		
#20	0.85	91		
#40	0.42	77		
#60	0.25	62		
#100	0.15	49		
#200	0.075	38		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0348	31		
---	0.0221	26		
---	0.0128	20		
---	0.0091	17		
---	0.0065	14		
---	0.0047	11		
---	0.0033	9		
---	0.0014	7		

Coefficients

D_{85} = 0.6344 mm　　D_{30} = 0.0319 mm
D_{60} = 0.2340 mm　　D_{15} = 0.0074 mm
D_{50} = 0.1578 mm　　D_{10} = 0.0039 mm
C_u = N/A　　C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A-CA03-2011-B2-2-4ft.

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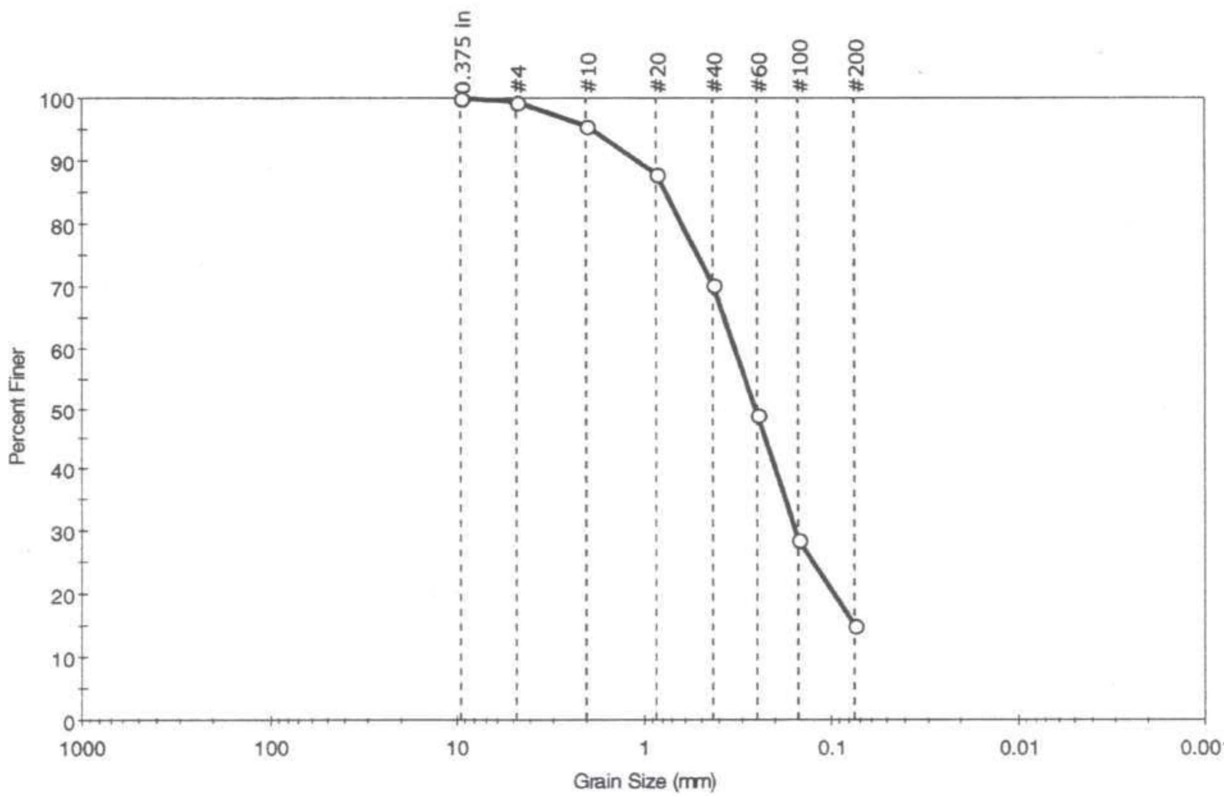
A-CAD3-2011-B2 8-10ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-2		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	08/03/11	Checked By:	jdt
Depth :	8-10	Test Id:	213834		
Test Comment:	---				
Sample Description:	Moist, olive brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.6	84.4	15.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	95		
#20	0.85	88		
#40	0.42	70		
#60	0.25	49		
#100	0.15	29		
#200	0.075	15		

Coefficients

D_{85} = 0.7559 mm	D_{30} = 0.1556 mm
D_{60} = 0.3286 mm	D_{15} = 0.0751 mm
D_{50} = 0.2559 mm	D_{10} = 0.0582 mm
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

A-CAD3-2011-B2 8-10ft

Sample/Test Description

Sand/Gravel Particle Shape : ---

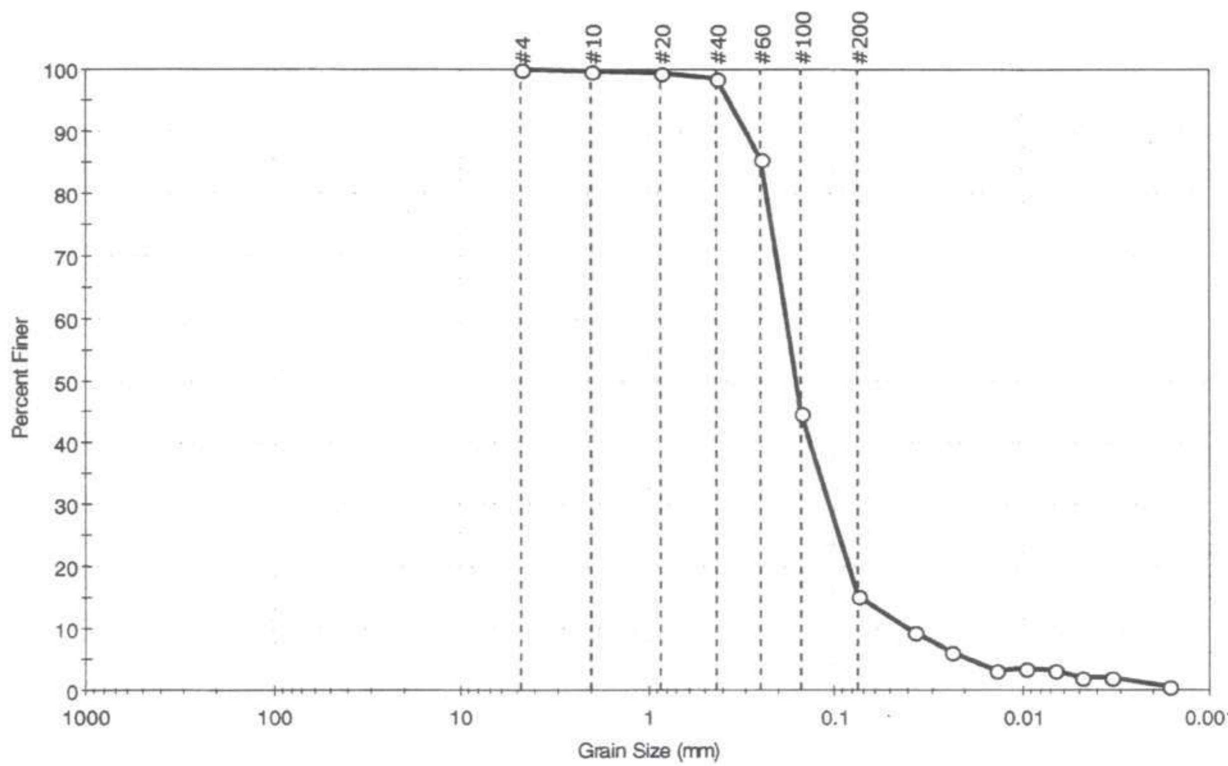
Sand/Gravel Hardness : ---

A-CAD3-2011-B2 14-16ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-2		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth :	14-16 ft	Test Id:	217466		
Test Comment:	---				
Sample Description:	Moist, dark gray silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	84.6	15.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	99		
#60	0.25	86		
#100	0.15	45		
#200	0.075	15		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0380	9		
---	0.0238	6		
---	0.0137	3		
---	0.0096	4		
---	0.0068	3		
---	0.0048	2		
---	0.0034	2		
---	0.0016	1		

Coefficients

D_{85} = 0.2481 mm	D_{30} = 0.1059 mm
D_{60} = 0.1815 mm	D_{15} = 0.0717 mm
D_{50} = 0.1602 mm	D_{10} = 0.0410 mm
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A-CAD3-2011-B2 14-16ft

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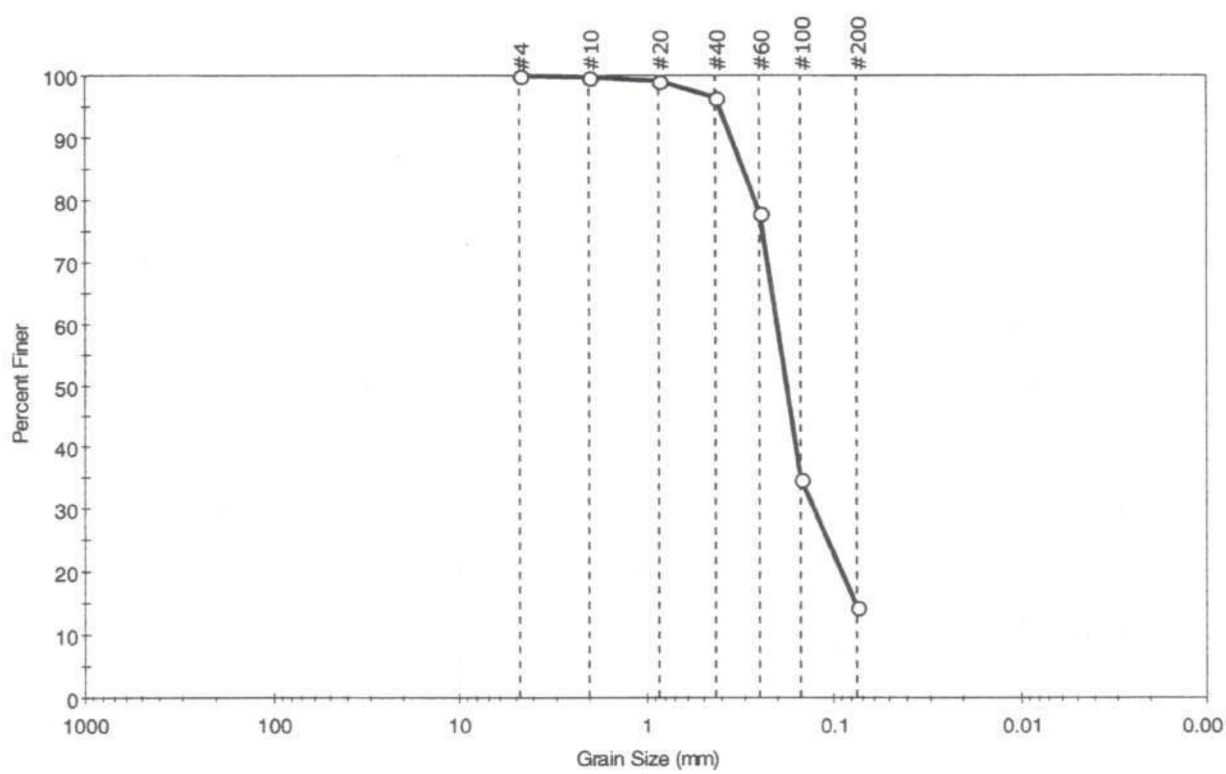
A-CAD3-2011-B2 22-24ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-2		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	08/03/11	Checked By:	jdt
Depth : 22-24		Test Id:	213835		
Test Comment:	---				
Sample Description:	Moist, olive silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	—	85.4	14.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	97		
#60	0.25	78		
#100	0.15	35		
#200	0.075	15		

Coefficients

D_{85} =0.3063 mm	D_{30} =0.1272 mm
D_{60} =0.2023 mm	D_{15} =0.0761 mm
D_{50} =0.1796 mm	D_{10} =0.0641 mm
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A-CAD3-2011-22-24ft.

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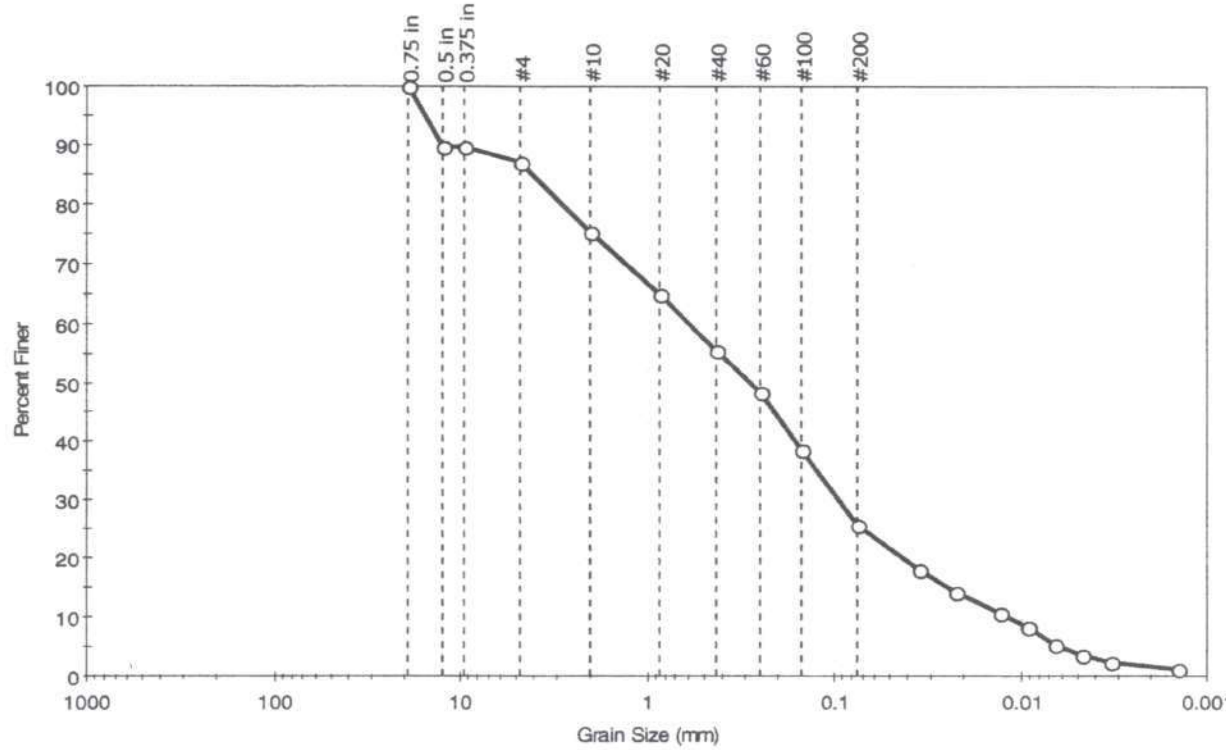
A-CAD3-2011-B2 42-44ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID:	B-2	Sample Type:	bag	Tested By:	jbr
Sample ID:	---	Test Date:	08/03/11	Checked By:	jdt
Depth :	42-44	Test Id:	213836		
Test Comment:	---				
Sample Description:	Moist, greenish gray sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	12.9	61.5	25.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	90		
0.375 in	9.50	90		
#4	4.75	87		
#10	2.00	75		
#20	0.85	65		
#40	0.42	56		
#60	0.25	48		
#100	0.15	39		
#200	0.075	26		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0353	18		
---	0.0224	14		
---	0.0129	11		
---	0.0093	8		
---	0.0066	5		
---	0.0047	4		
---	0.0033	2		
---	0.0014	1		

Coefficients

D_{85} = 4.0836 mm — D_{30} = 0.0947 mm

D_{60} = 0.5916 mm — D_{15} = 0.0245 mm

D_{50} = 0.2823 mm — D_{10} = 0.0117 mm

C_u = N/A — C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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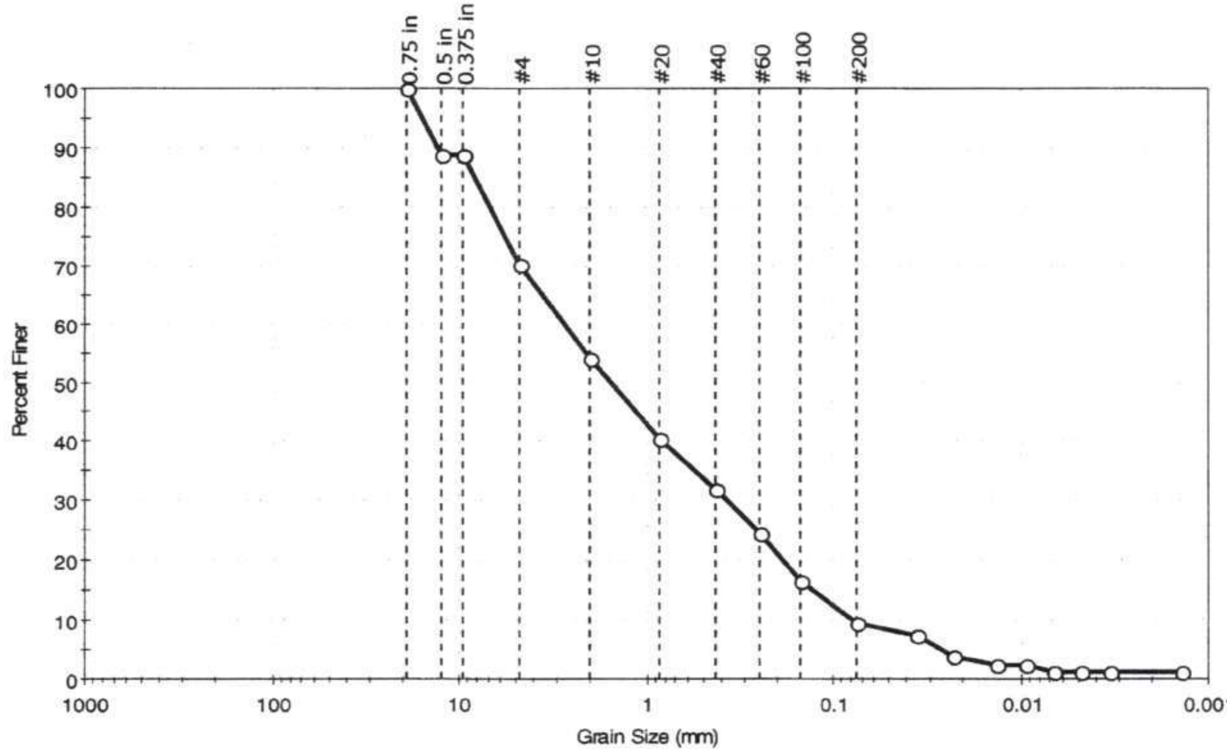
A-CAD3-2011-B2 42-44ft

A-CAD3-2011-B2- 44-46ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-2	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 44-46 ft	Test Id: 217468		
Test Comment: ---			
Sample Description: Moist, olive green sand with silt and gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	29.8	60.7	9.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	89		
0.375 in	9.50	89		
#4	4.75	70		
#10	2.00	54		
#20	0.85	40		
#40	0.42	32		
#60	0.25	24		
#100	0.15	17		
#200	0.075	9		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0359	7		
---	0.0227	4		
---	0.0134	2		
---	0.0095	2		
---	0.0068	1		
---	0.0048	1		
---	0.0034	1		
---	0.0014	1		

Coefficients

D_{85} = 8.2607 mm	D_{30} = 0.3721 mm
D_{60} = 2.7627 mm	D_{15} = 0.1287 mm
D_{50} = 1.5582 mm	D_{10} = 0.0789 mm
C_u = 35.015	C_c = 0.635

Classification

ASTM N/A

AASHTO 'Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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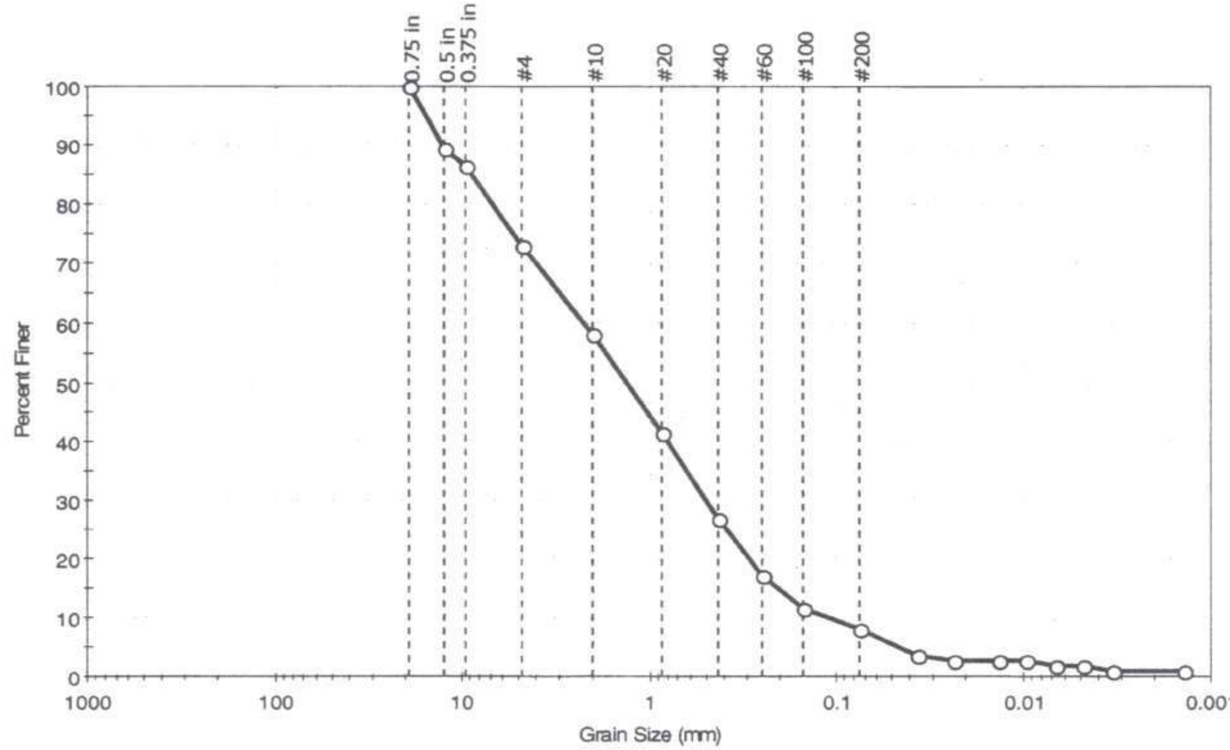
A CAD3-2011 B2- 44-46ft

A-CA03-2011-B2 55-57ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-2		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth :	55-57 ft	Test Id:	217469		
Test Comment:	---				
Sample Description:	Moist, light olive sand with silt and gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	27.2	65.0	7.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	89		
0.375 in	9.50	86		
#4	4.75	73		
#10	2.00	58		
#20	0.85	42		
#40	0.42	27		
#60	0.25	17		
#100	0.15	12		
#200	0.075	8		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0370	4		
---	0.0235	3		
---	0.0135	3		
---	0.0096	3		
---	0.0068	2		
---	0.0048	2		
---	0.0034	1		
---	0.0014	1		

Coefficients

D_{85} = 8.8559 mm D_{30} = 0.4936 mm
D_{60} = 2.2243 mm D_{15} = 0.2069 mm
D_{50} = 1.3095 mm D_{10} = 0.1122 mm
C_u = 19.824 C_c = 0.976

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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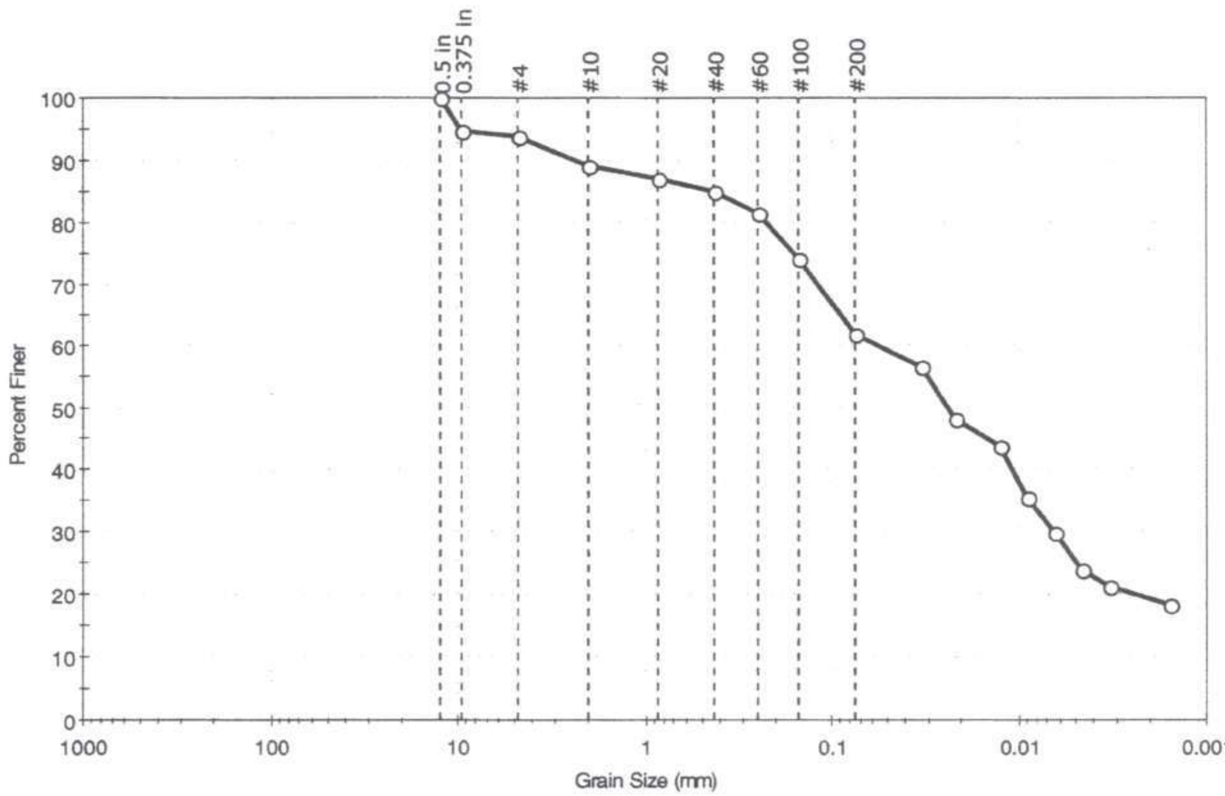
A CA03-2011-B2 55-57ft

A-CAD3-2011-B3 0-2ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-3		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	09/28/11	Checked By:	jdt
Depth : 0-2 ft		Test Id:	217470		
Test Comment:	---				
Sample Description:	Moist, olive brown sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.2	32.0	61.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	95		
#4	4.75	94		
#10	2.00	89		
#20	0.85	87		
#40	0.42	85		
#60	0.25	81		
#100	0.15	74		
#200	0.075	62		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0337	56		
---	0.0218	48		
---	0.0124	44		
---	0.0090	35		
---	0.0064	30		
---	0.0046	24		
---	0.0033	21		
---	0.0016	18		

Coefficients

D_{85} =0.4442 mm
D_{30} =0.0065 mm
D_{60} =0.0572 mm
D_{15} =N/A
D_{50} =0.0241 mm
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape :

Sand/Gravel Hardness :

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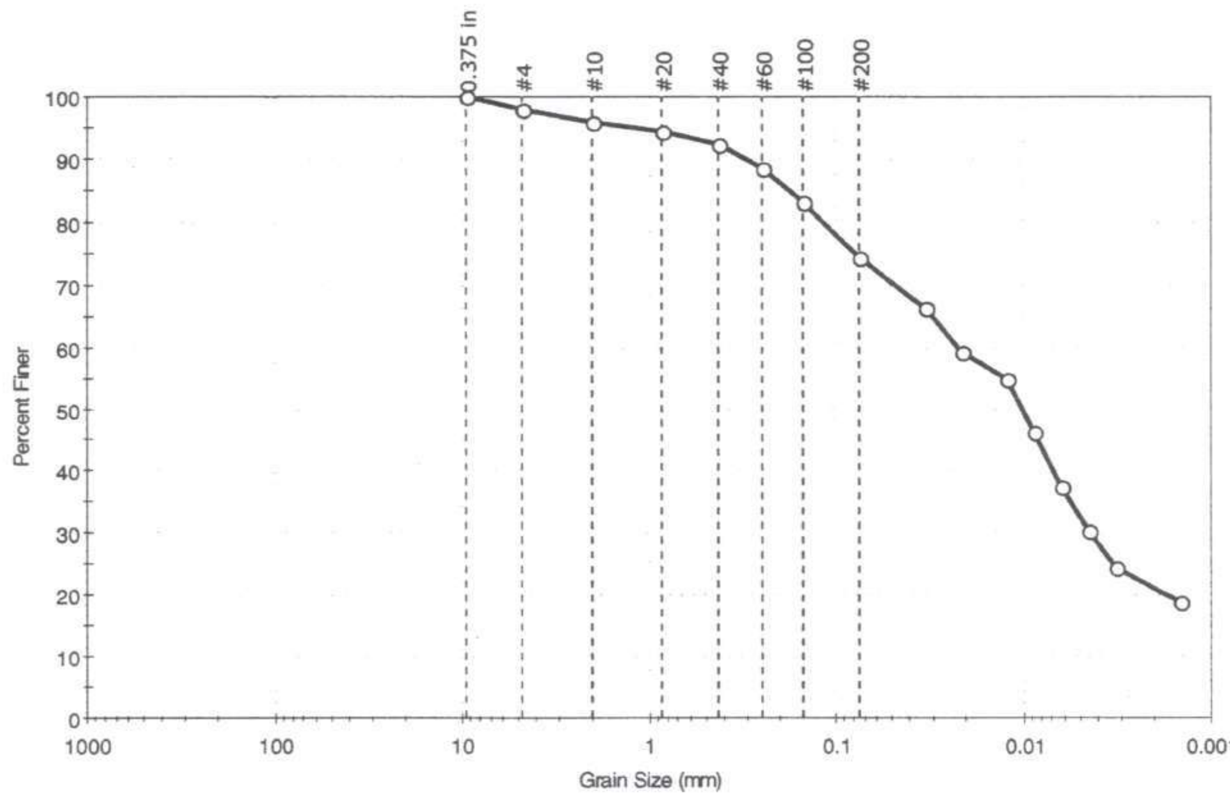
A-CAD3-2011-B3 0-2ft

A-CAD3-2011-B3 2-4ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC		
Project:	South Terminal Extension		
Location:	New Bedford, MA	Project No:	GTX-10697
Boring ID: B-3	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/29/11	Checked By:	jdt
Depth : 2-4 ft	Test Id: 217497		
Test Comment:	---		
Sample Description:	Moist, olive green silt with sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.1	23.7	74.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	96		
#20	0.85	95		
#40	0.42	92		
#60	0.25	88		
#100	0.15	83		
#200	0.075	74		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0336	67		
---	0.0210	59		
---	0.0123	55		
---	0.0088	46		
---	0.0063	38		
---	0.0045	30		
---	0.0033	25		
---	0.0014	19		

Coefficients

D_{85} = 0.1799 mm D_{30} = 0.0044 mm

D_{60} = 0.0220 mm D_{15} = N/A

D_{50} = 0.0101 mm D_{10} = N/A

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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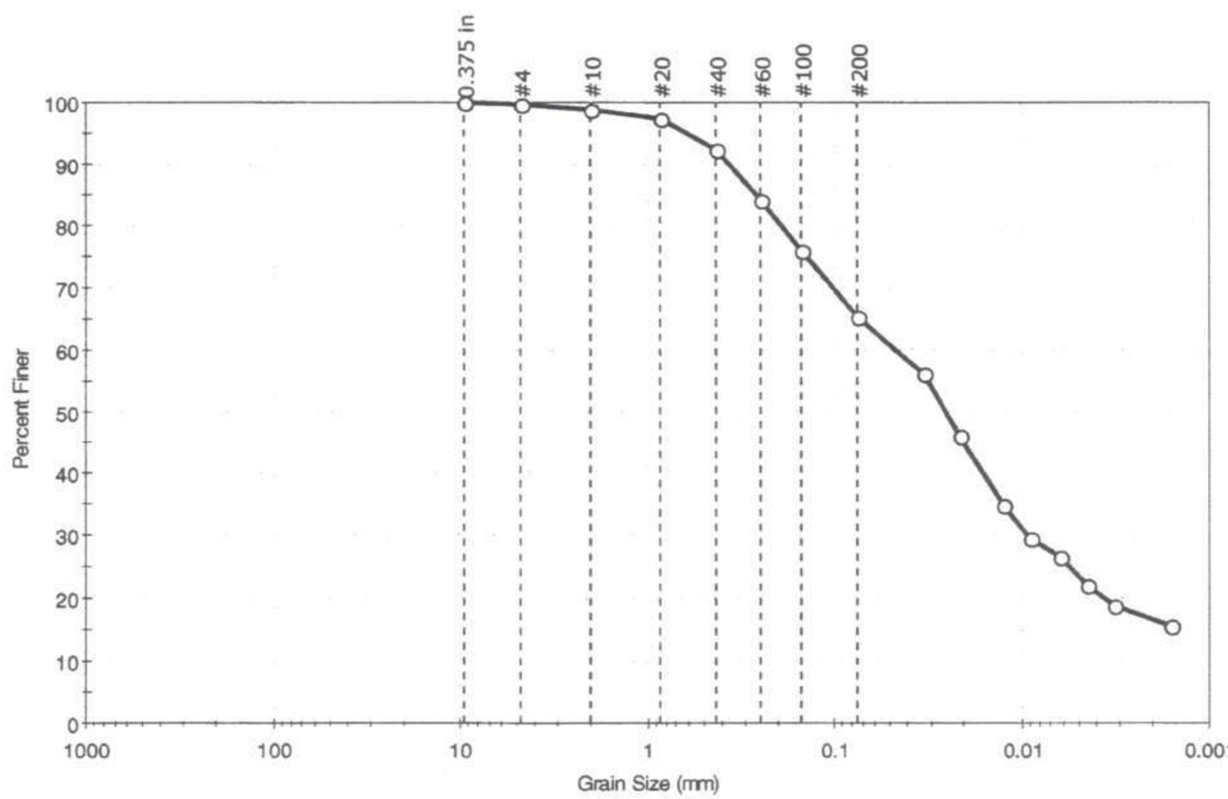
ACAD3-2011-B3 2-4ft.

A-CAD3-2011-B3 10-12ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-3		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth :	10-12 ft	Test Id:	217471		
Test Comment:	---				
Sample Description:	Moist, dark greenish gray sandy clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.4	34.3	65.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	99		
#20	0.85	97		
#40	0.42	92		
#60	0.25	84		
#100	0.15	76		
#200	0.075	65		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0334	56		
---	0.0211	46		
---	0.0126	35		
---	0.0090	29		
---	0.0064	27		
---	0.0045	22		
---	0.0033	19		
---	0.0016	16		

Coefficients

D_{85} =0.2640 mm | D_{30} =0.0094 mm

D_{60} =0.0475 mm | D_{15} =N/A

D_{50} =0.0254 mm | D_{10} =N/A

C_u =N/A | C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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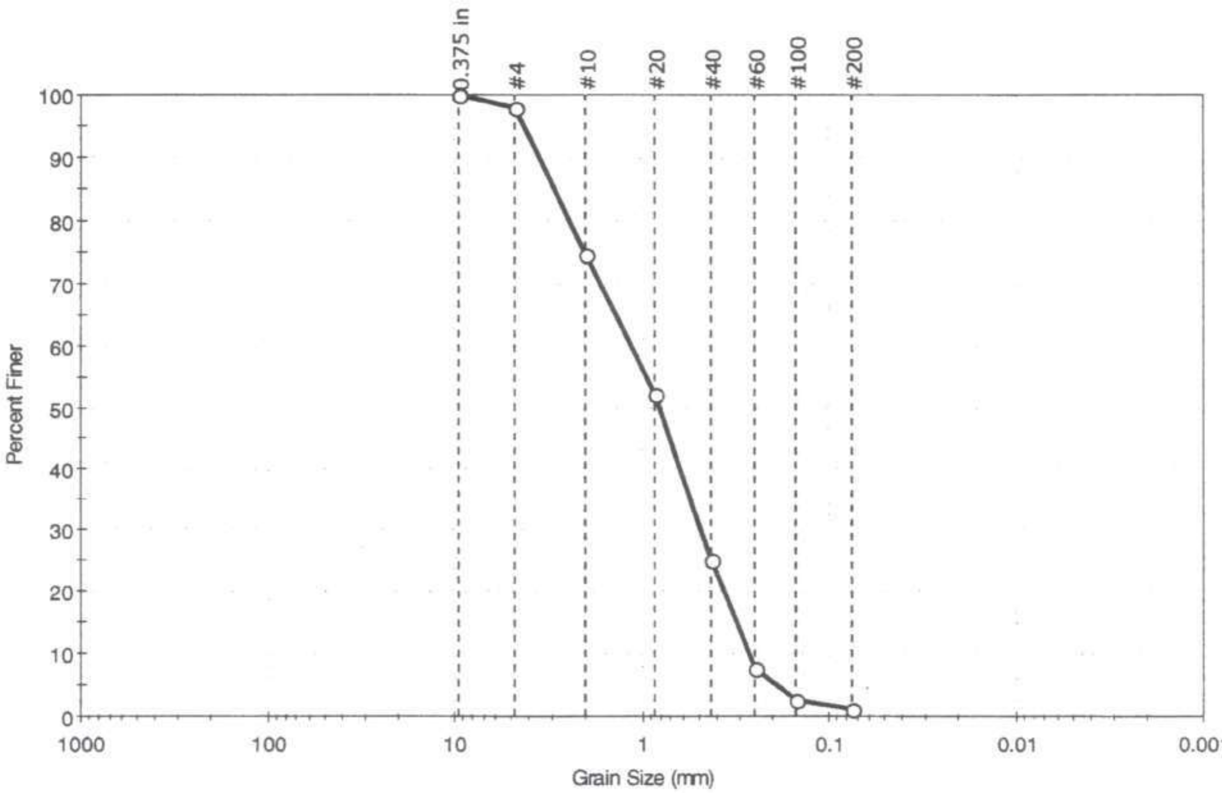
A-CAD3-2011-B3 10-12ft

A-CAD3-2011-B3 24-26ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-3		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth :	24-26 ft	Test Id:	217472		
Test Comment:	---				
Sample Description:	Moist, light olive brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.9	96.8	1.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	75		
#20	0.85	52		
#40	0.42	25		
#60	0.25	8		
#100	0.15	3		
#200	0.075	1		

Coefficients

D_{85} = 2.9378 mm	D_{30} = 0.4812 mm
D_{60} = 1.1433 mm	D_{15} = 0.3116 mm
D_{50} = 0.8020 mm	D_{10} = 0.2674 mm
C_u = 4.276	C_c = 0.757

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

A-CAD3-2011-B3-24-26ft

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

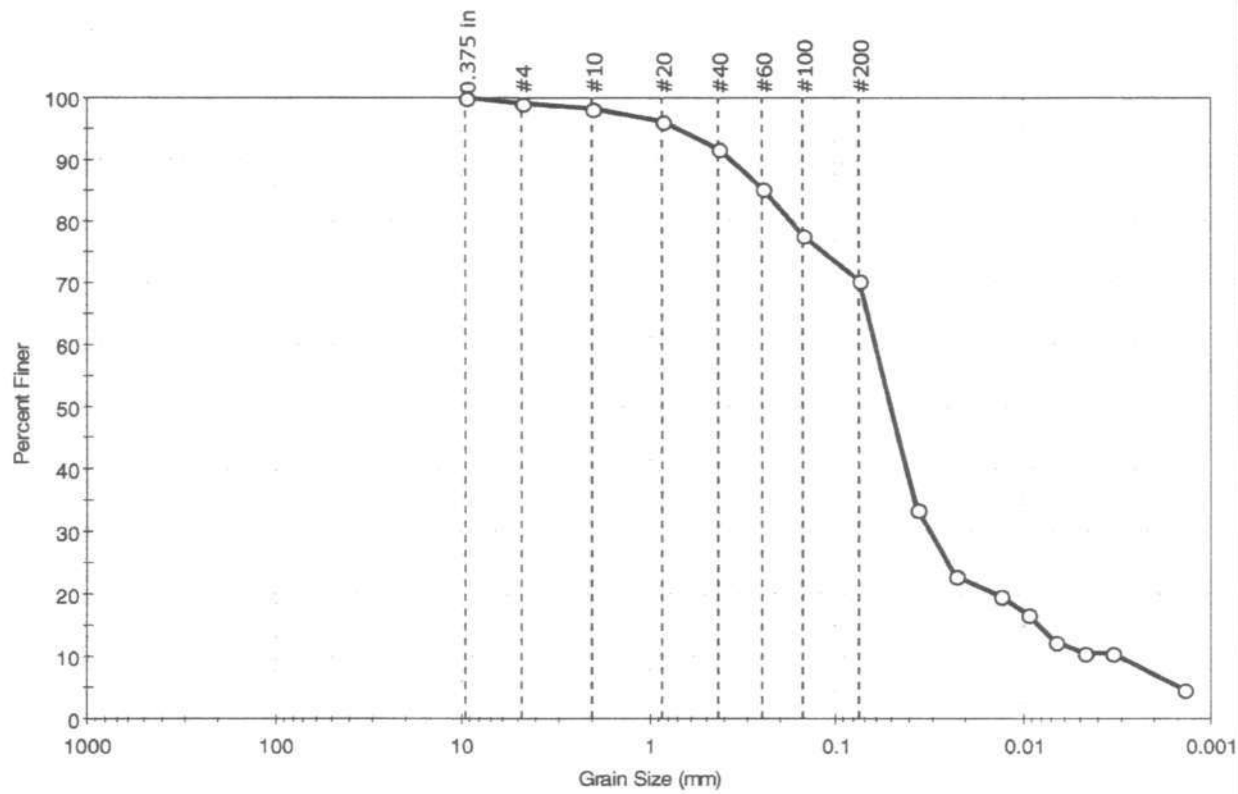
Sand/Gravel Hardness : HARD

A-CAD3-2011-B4 - 0-2ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-4		Sample Type: bag		Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth : 0-2 ft		Test Id:	217474		
Test Comment:	---				
Sample Description:	Moist, olive brown silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.9	28.8	70.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	96		
#40	0.42	92		
#60	0.25	85		
#100	0.15	78		
#200	0.075	70		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0363	34		
---	0.0230	23		
---	0.0132	20		
---	0.0094	17		
---	0.0067	12		
---	0.0047	11		
---	0.0033	11		
---	0.0014	5		

Coefficients

D_{85} = 0.2451 mm	D_{30} = 0.0310 mm
D_{60} = 0.0612 mm	D_{15} = 0.0082 mm
D_{50} = 0.0502 mm	D_{10} = 0.0030 mm
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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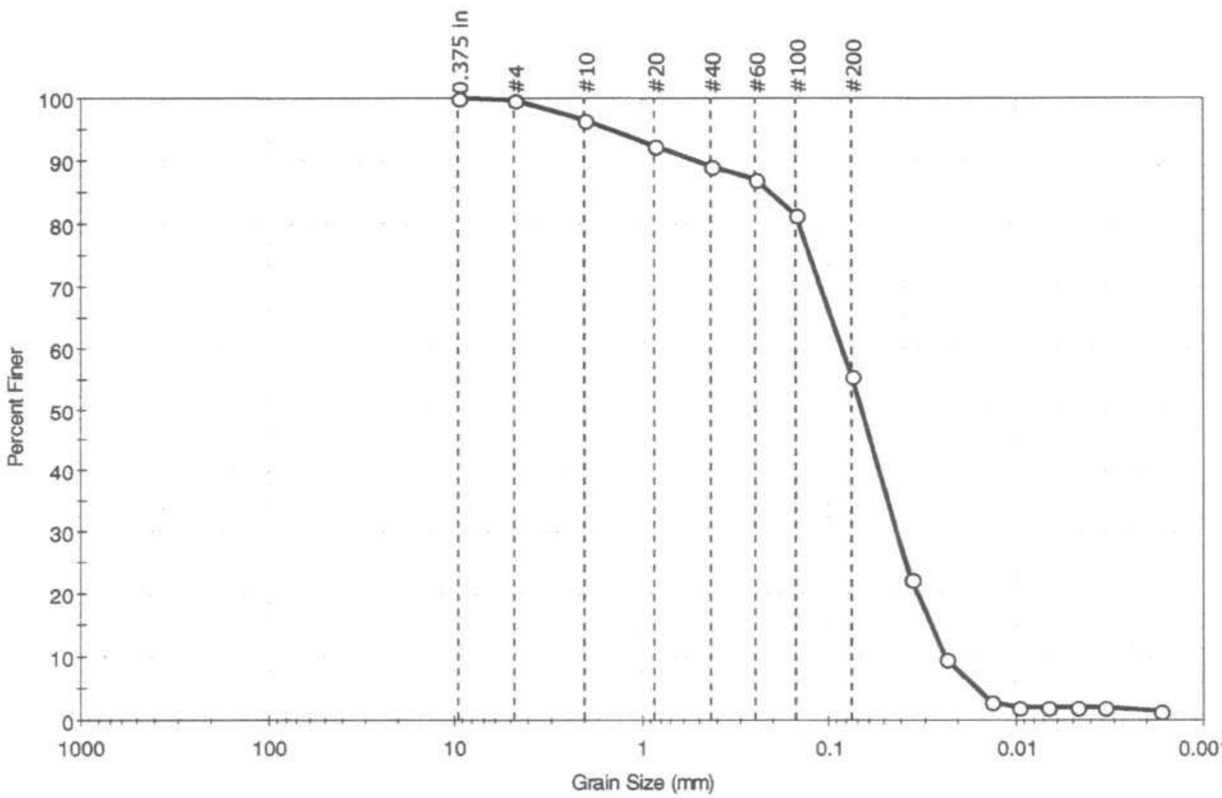
A-CAD3-2011 B4 - 0-2ft

A-CAD3-2011-B4· 16-18ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-4	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 16-18 ft	Test Id: 217475		
Test Comment: ---			
Sample Description: Moist, dark gray sandy silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.4	44.2	55.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	96		
#20	0.85	92		
#40	0.42	89		
#60	0.25	87		
#100	0.15	82		
#200	0.075	55		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0362	22		
---	0.0234	10		
---	0.0136	3		
---	0.0096	2		
---	0.0068	2		
---	0.0048	2		
---	0.0034	2		
---	0.0017	1		

Coefficients

D_{85} = 0.2086 mm
D_{30} = 0.0428 mm
D_{60} = 0.0846 mm
D_{15} = 0.0280 mm
D_{50} = 0.0665 mm
D_{10} = 0.0236 mm
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

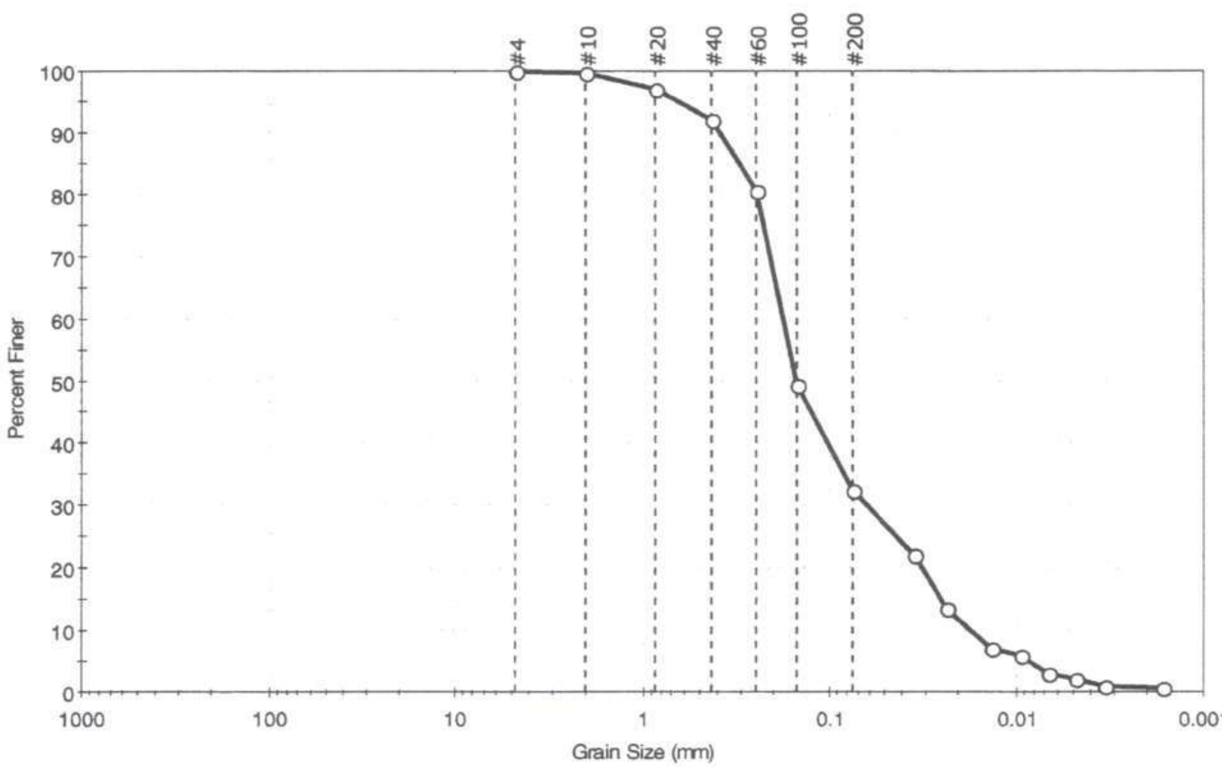
A-CAD3-2011-B4 16-18ft

A-CAD3-2011-B4- 50-52ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-4		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth :	50-52 ft	Test Id:	217476		
Test Comment:	---				
Sample Description:	Moist, dark gray silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.1	67.3	32.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	97		
#40	0.42	92		
#60	0.25	81		
#100	0.15	49		
#200	0.075	33		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0354	22		
---	0.0232	14		
---	0.0135	7		
---	0.0095	6		
---	0.0067	3		
---	0.0048	2		
---	0.0034	1		
---	0.0016	1		

Coefficients

D_{85} =0.3070 mm
D_{30} =0.0622 mm
D_{60} =0.1788 mm
D_{15} =0.0249 mm
D_{50} =0.1519 mm
D_{10} =0.0172 mm
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A-CAD3-2011-B4- 50-52ft.

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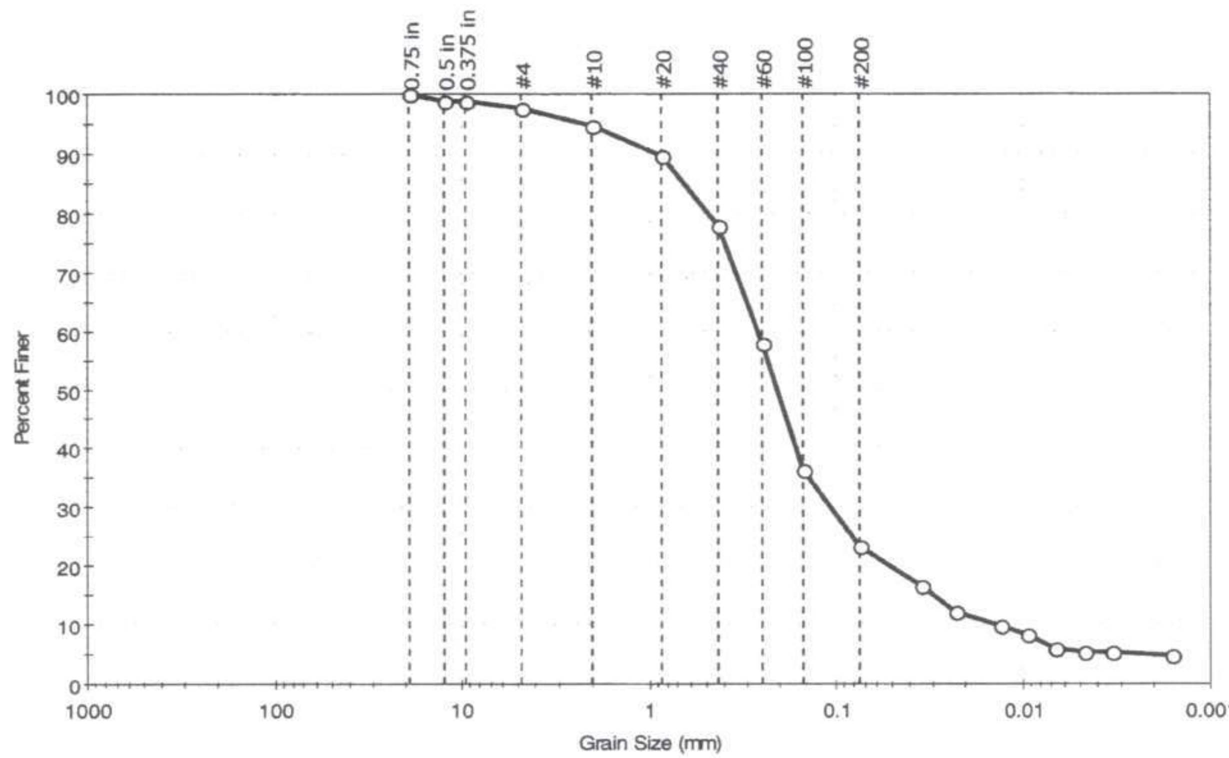
A-CAD3-2011-B5 0-2ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-5	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 0-2 ft	Test Id: 217477		
Test Comment: ---			
Sample Description: Moist, olive green silty sand			
Sample Comment: Sample contains shells			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	2.2	74.5	23.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	99		
0.375 in	9.50	99		
#4	4.75	98		
#10	2.00	95		
#20	0.85	90		
#40	0.42	78		
#60	0.25	58		
#100	0.15	36		
#200	0.075	23		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0351	16		
---	0.0226	12		
---	0.0132	10		
---	0.0094	8		
---	0.0067	6		
---	0.0047	5		
---	0.0033	5		
---	0.0016	5		

Coefficients

D_{85} = 0.6457 mm | D_{30} = 0.1070 mm

D_{60} = 0.2657 mm | D_{15} = 0.0304 mm

D_{50} = 0.2079 mm | D_{10} = 0.0141 mm

C_u = N/A | C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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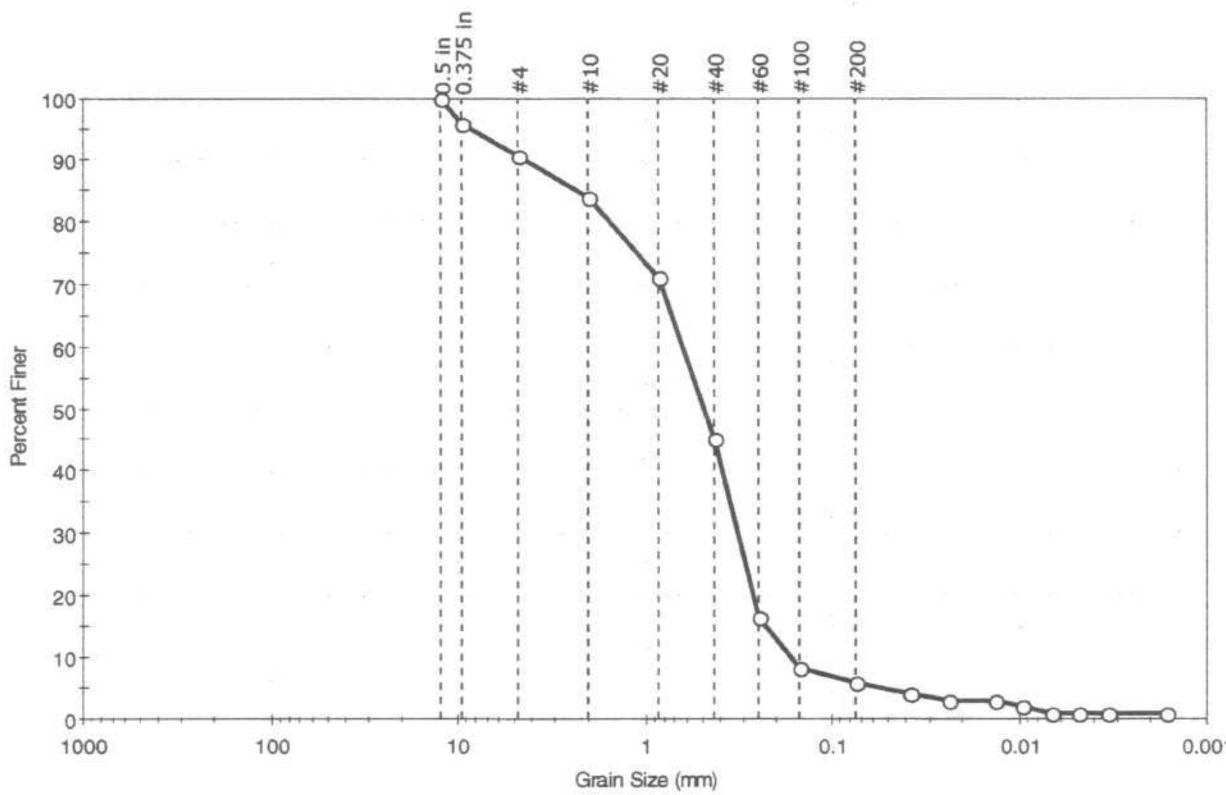
A-CAD3-2011-B5 0-2ft

A-CAD3-2011-B5-~~8-10~~ 8-10ft

GeoTesting EXPRESS

Client: Apex Companies, LLC					
Project: South Terminal Extension					
Location: New Bedford, MA				Project No:	GTX-10697
Boring ID: B-5		Sample Type: bag		Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth : 8-10 ft		Test Id:	217478		
Test Comment: ---					
Sample Description: Moist, dark brown sand with silt					
Sample Comment: ---					

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	9.6	84.6	5.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	96		
#4	4.75	90		
#10	2.00	84		
#20	0.85	71		
#40	0.42	45		
#60	0.25	16		
#100	0.15	8		
#200	0.075	6		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0386	4		
---	0.0238	3		
---	0.0136	3		
---	0.0096	2		
---	0.0068	1		
---	0.0048	1		
---	0.0034	1		
---	0.0016	1		

Coefficients

D_{85} = 2.3375 mm | D_{30} = 0.3217 mm
D_{60} = 0.6331 mm | D_{15} = 0.2293 mm
D_{50} = 0.4851 mm | D_{10} = 0.1677 mm
C_u = 3.775 | C_c = 0.975

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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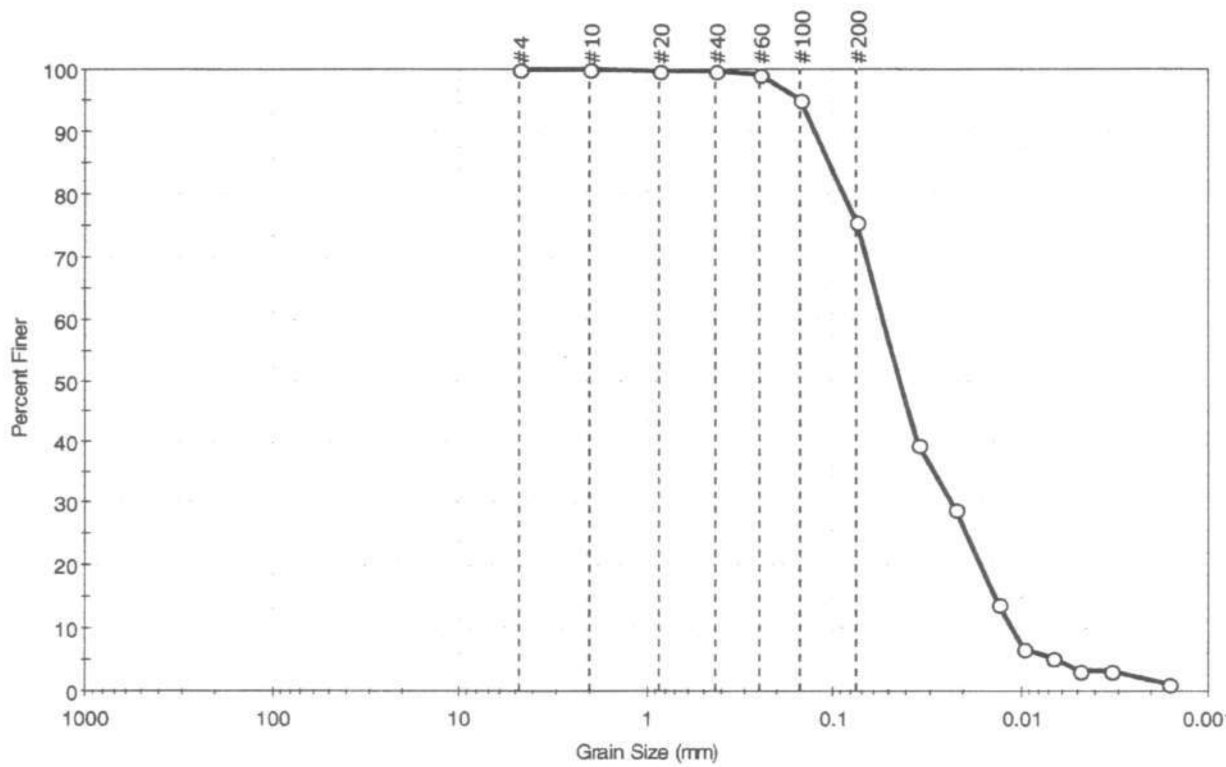
A-CAD3-2011 B5 8-10ft

A-CAD3-2011-B5 · 28-30ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID:	B-5	Sample Type:	bag	Tested By:	jbr
Sample ID:	---	Test Date:	09/27/11	Checked By:	jdt
Depth :	28-30 ft	Test Id:	217479		
Test Comment:	---				
Sample Description:	Moist, light yellowish brown silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	24.5	75.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	95		
#200	0.075	76		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0350	39		
---	0.0222	29		
---	0.0133	14		
---	0.0095	7		
---	0.0067	5		
---	0.0048	3		
---	0.0033	3		
---	0.0016	1		

Coefficients

D_{85} = 0.1051 mm D_{30} = 0.0232 mm

D_{60} = 0.0541 mm D_{15} = 0.0137 mm

D_{50} = 0.0438 mm D_{10} = 0.0111 mm

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A-CAD3-2011B5- 28-30ft

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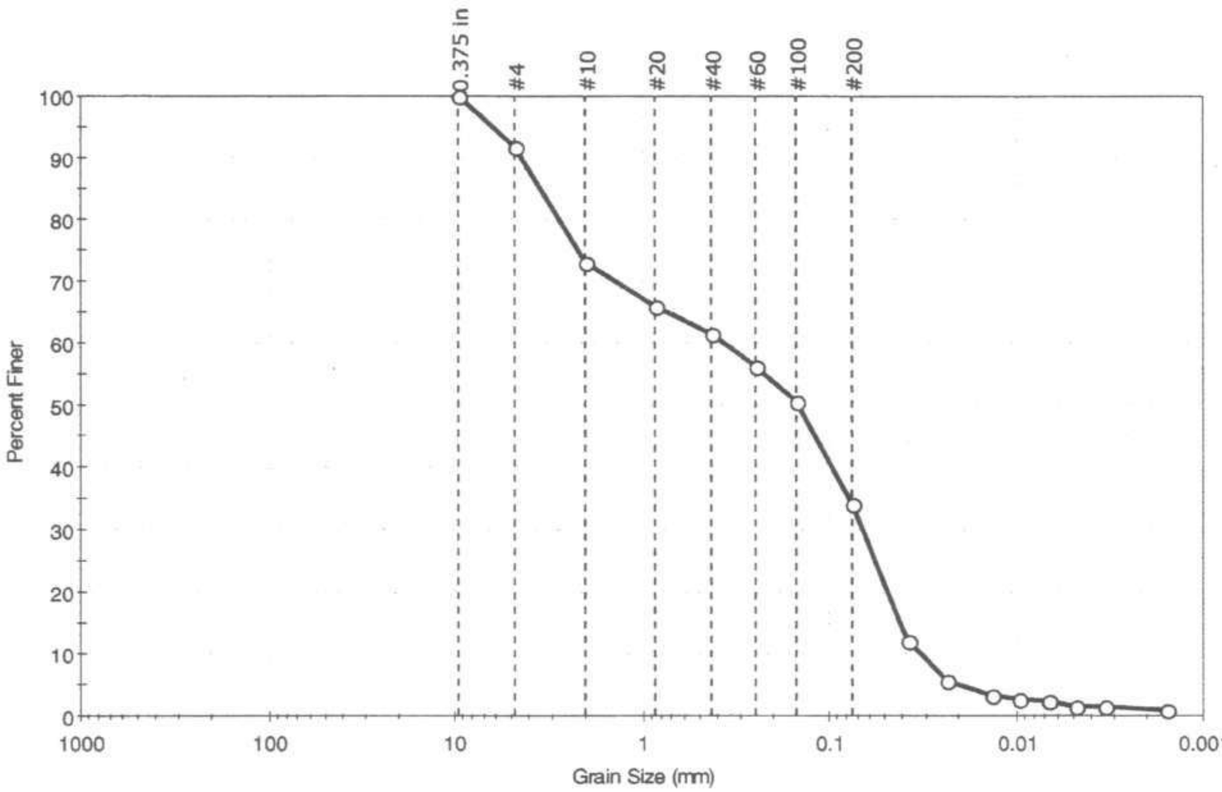
A-CAD3-2011-B5-48-50ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-5		Sample Type: bag		Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth :	48-50 ft	Test Id:	217480		
Test Comment:	---				
Sample Description:	Moist, olive yellow silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	8.3	57.4	34.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	92		
#10	2.00	73		
#20	0.85	66		
#40	0.42	61		
#60	0.25	56		
#100	0.15	50		
#200	0.075	34		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0373	12		
---	0.0235	6		
---	0.0136	3		
---	0.0096	3		
---	0.0068	2		
---	0.0048	2		
---	0.0034	2		
---	0.0016	1		

Coefficients

D_{85} = 3.4891 mm D_{30} = 0.0655 mm
D_{60} = 0.3735 mm D_{15} = 0.0410 mm
D_{50} = 0.1472 mm D_{10} = 0.0322 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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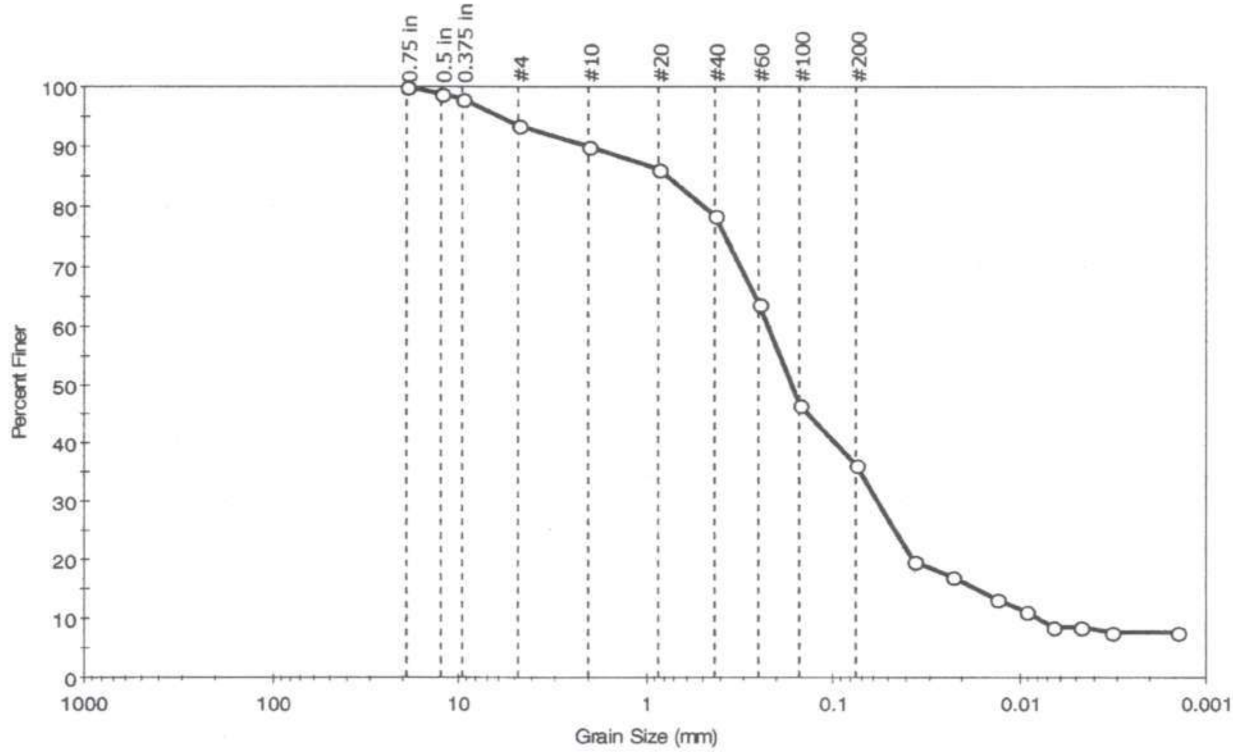
A-CAD3-2011-B5 48-50 ft

A-CAD3-2011-B6 0-2ft.

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-6		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	08/03/11	Checked By:	jdt
Depth : 0-2		Test Id:	213837		
Test Comment:	---				
Sample Description:	Moist, olive green silty sand				
Sample Comment:	sample contains shell fragments				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



%Cobble	%Gravel	%Sand	%Silt & Clay Size
—	6.5	57.1	36.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	99		
0.375 in	9.50	98		
#4	4.75	94		
#10	2.00	90		
#20	0.85	86		
#40	0.42	79		
#60	0.25	64		
#100	0.15	47		
#200	0.075	36		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0363	20		
---	0.0227	17		
---	0.0132	13		
---	0.0093	11		
---	0.0066	9		
---	0.0047	9		
---	0.0033	8		
---	0.0014	8		

Coefficients

D_{85} =0.7615 mm	D_{30} =0.0567 mm
D_{60} =0.2238 mm	D_{15} =0.0170 mm
D_{50} =0.1655 mm	D_{10} =0.0079 mm
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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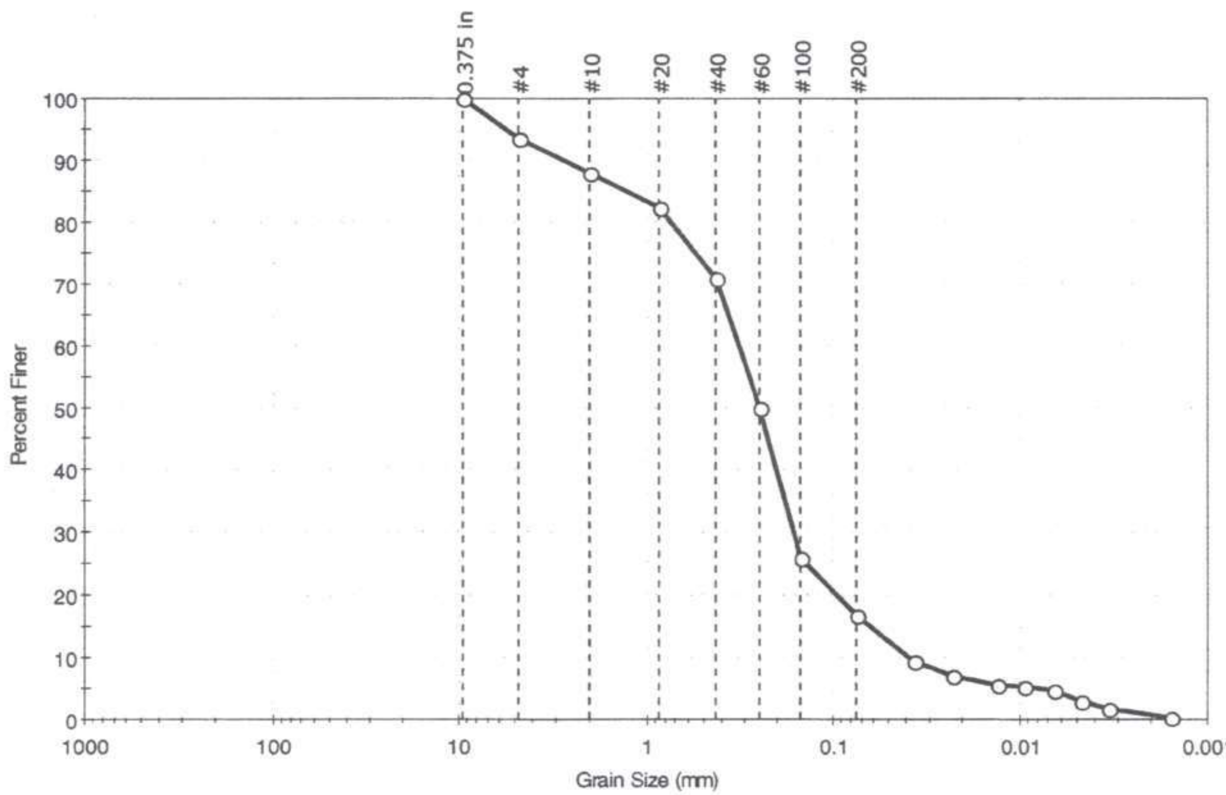
A-CAD3-2011-B6 0-2ft.

A-CAD3-2011 - B6 - 2-3ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-6	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 2-3 ft	Test Id: 217481		
Test Comment: ---			
Sample Description: Moist, olive green silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.3	76.8	16.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	94		
#10	2.00	88		
#20	0.85	82		
#40	0.42	71		
#60	0.25	50		
#100	0.15	26		
#200	0.075	17		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0368	10		
---	0.0229	7		
---	0.0132	6		
---	0.0094	5		
---	0.0066	5		
---	0.0047	3		
---	0.0034	2		
---	0.0016	0		

Coefficients

D_{85} = 1.2884 mm	D_{30} = 0.1639 mm
D_{60} = 0.3230 mm	D_{15} = 0.0625 mm
D_{50} = 0.2512 mm	D_{10} = 0.0385 mm
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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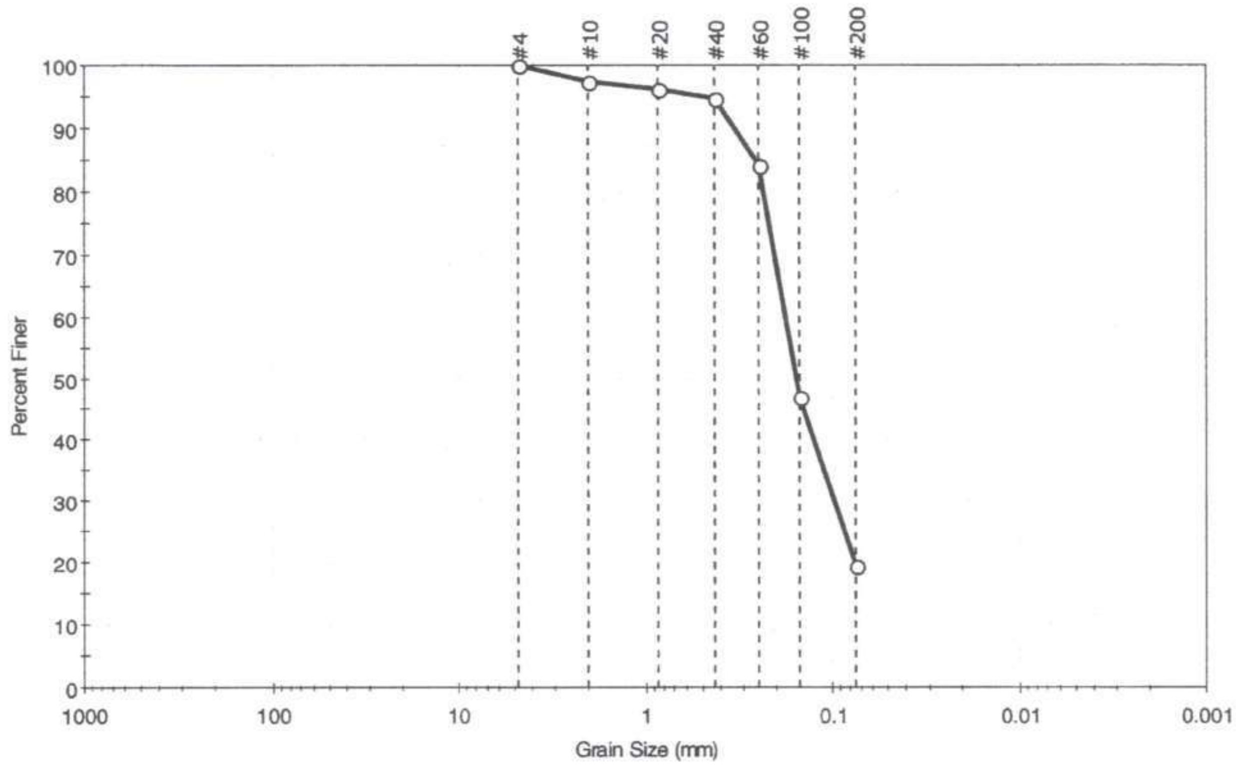
A-CAD-2011-B6 2-3ft

A-CAD3-2011-B6-4-6ft

GeoTesting EXPRESS

Client: Apex Companies, LLC					
Project: South Terminal Extension					
Location: New Bedford, MA				Project No:	GTX-10697
Boring ID: B-6	Sample Type:	bag		Tested By:	jbr
Sample ID:---	Test Date:	08/04/11		Checked By:	jdt
Depth : 4-6	Test Id:	213838			
Test Comment: ---					
Sample Description: Moist, olive gray silty sand					
Sample Comment: ---					

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	80.6	19.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	97		
#20	0.85	96		
#40	0.42	95		
#60	0.25	84		
#100	0.15	47		
#200	0.075	19		

Coefficients

D_{85} =0.2618 mm | D_{30} =0.0980 mm
D_{60} =0.1796 mm | D_{15} =N/A
D_{50} =0.1566 mm | D_{10} =N/A
C_u =N/A | C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A-CAD3-2011-B6-4-6ft

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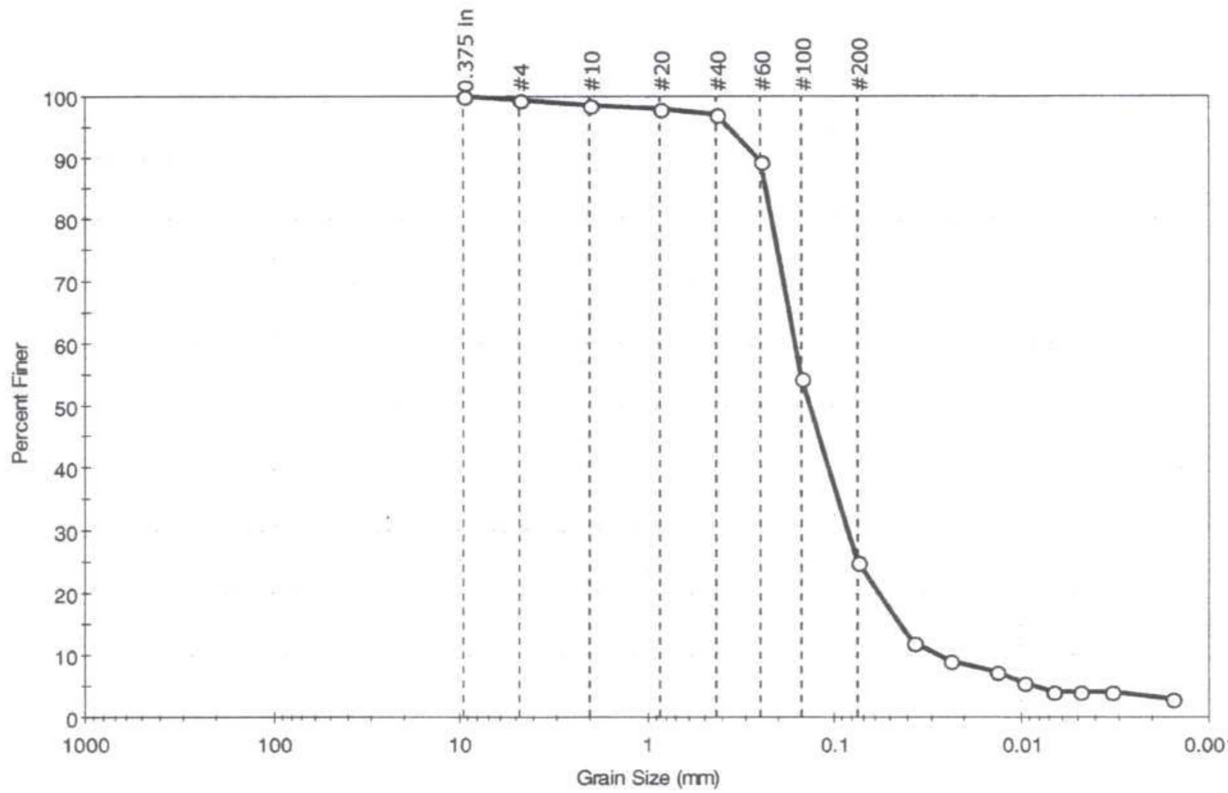
A-CAD3-2011-B6-8-10ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-6	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 8-10 ft	Test Id: 217482		
Test Comment: ---			
Sample Description: Moist, light brownish gray silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.7	74.1	25.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	98		
#40	0.42	97		
#60	0.25	89		
#100	0.15	54		
#200	0.075	25		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0378	12		
---	0.0236	9		
---	0.0135	8		
---	0.0096	6		
---	0.0067	4		
---	0.0048	4		
---	0.0033	4		
---	0.0016	3		

Coefficients

D_{85} =0.2343 mm D_{30} =0.0841 mm
D_{60} =0.1630 mm D_{15} =0.0441 mm
D_{50} =0.1355 mm D_{10} =0.0276 mm
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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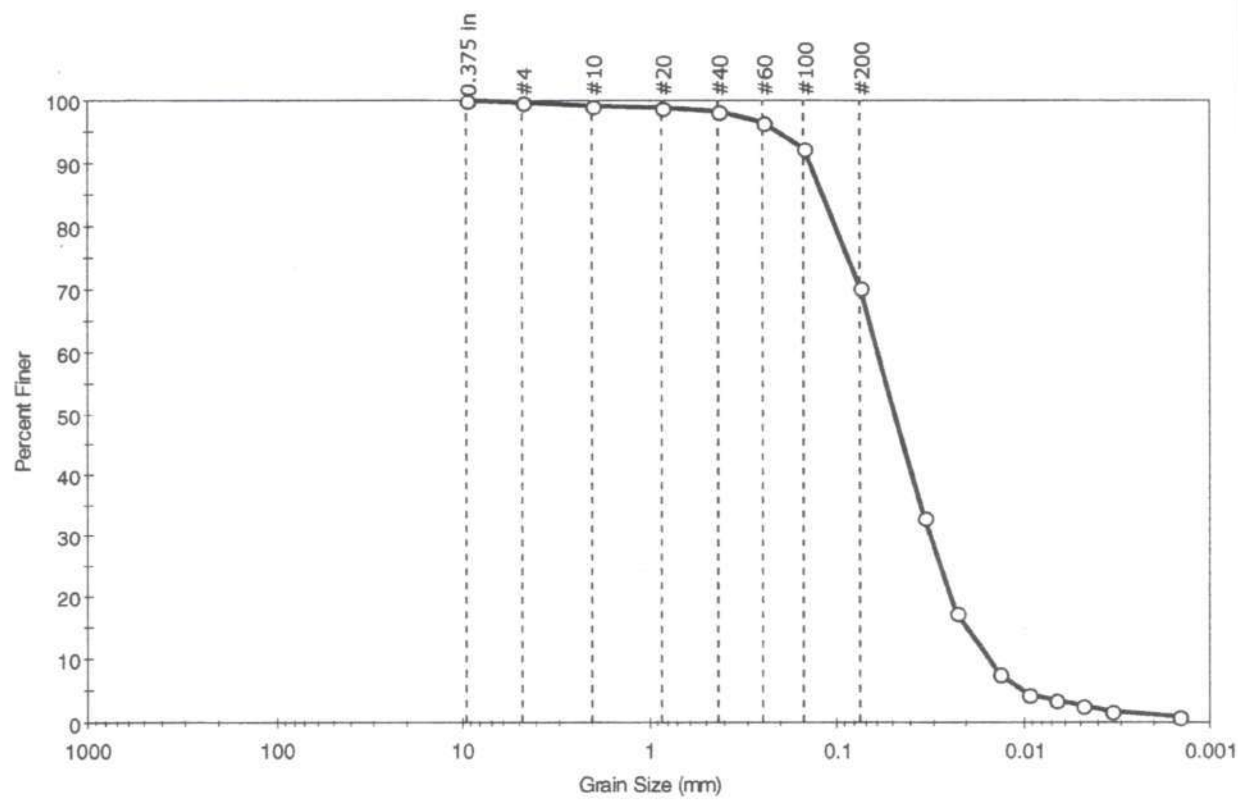
A-CAD3-2011-B6-8-10ft

A-CAD3-2011-B6 20-22ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-6		Sample Type: bag		Tested By:	jbr
Sample ID:---		Test Date:	08/03/11	Checked By:	jdt
Depth : 20-22		Test Id:	213839		
Test Comment:	---				
Sample Description:	Moist, light yellowish brown silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.3	29.5	70.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	98		
#60	0.25	97		
#100	0.15	92		
#200	0.075	70		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0344	33		
---	0.0225	17		
---	0.0133	8		
---	0.0094	4		
---	0.0067	3		
---	0.0048	3		
---	0.0034	2		
---	0.0014	1		

Coefficients

D_{85} =0.1192 mm D_{30} =0.0317 mm

D_{60} =0.0606 mm D_{15} =0.0198 mm

D_{50} =0.0491 mm D_{10} =0.0150 mm

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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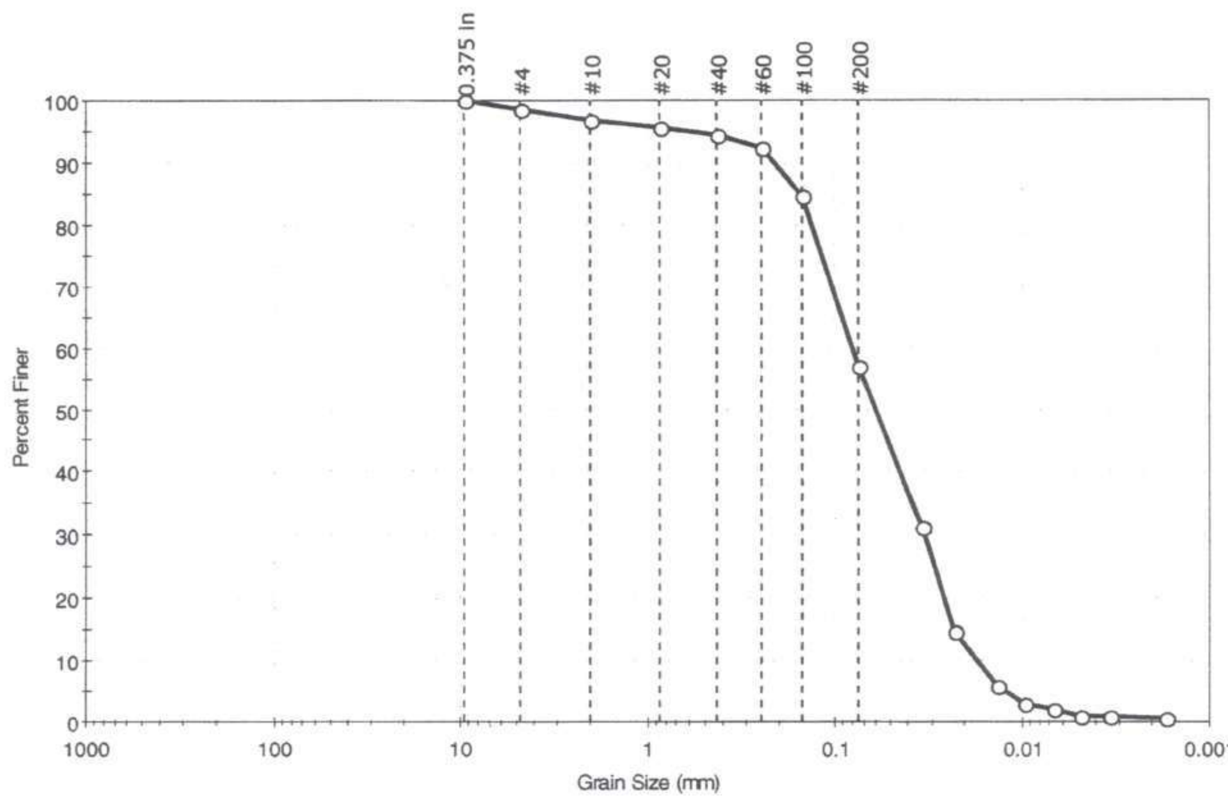
A-CAD3-2011.B6 20-22ft.

A-CAD3-2011-B6 28-30ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-6	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 28-30 ft	Test Id: 217483		
Test Comment: ---			
Sample Description: Moist, light olive gray sandy silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.3	41.6	57.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	97		
#20	0.85	95		
#40	0.42	94		
#60	0.25	92		
#100	0.15	85		
#200	0.075	57		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0343	31		
---	0.0229	15		
---	0.0135	6		
---	0.0096	3		
---	0.0068	2		
---	0.0048	1		
---	0.0034	1		
---	0.0017	0		

Coefficients

D_{85} = 0.1530 mm D_{30} = 0.0333 mm
D_{60} = 0.0808 mm D_{15} = 0.0231 mm
D_{50} = 0.0606 mm D_{10} = 0.0173 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD

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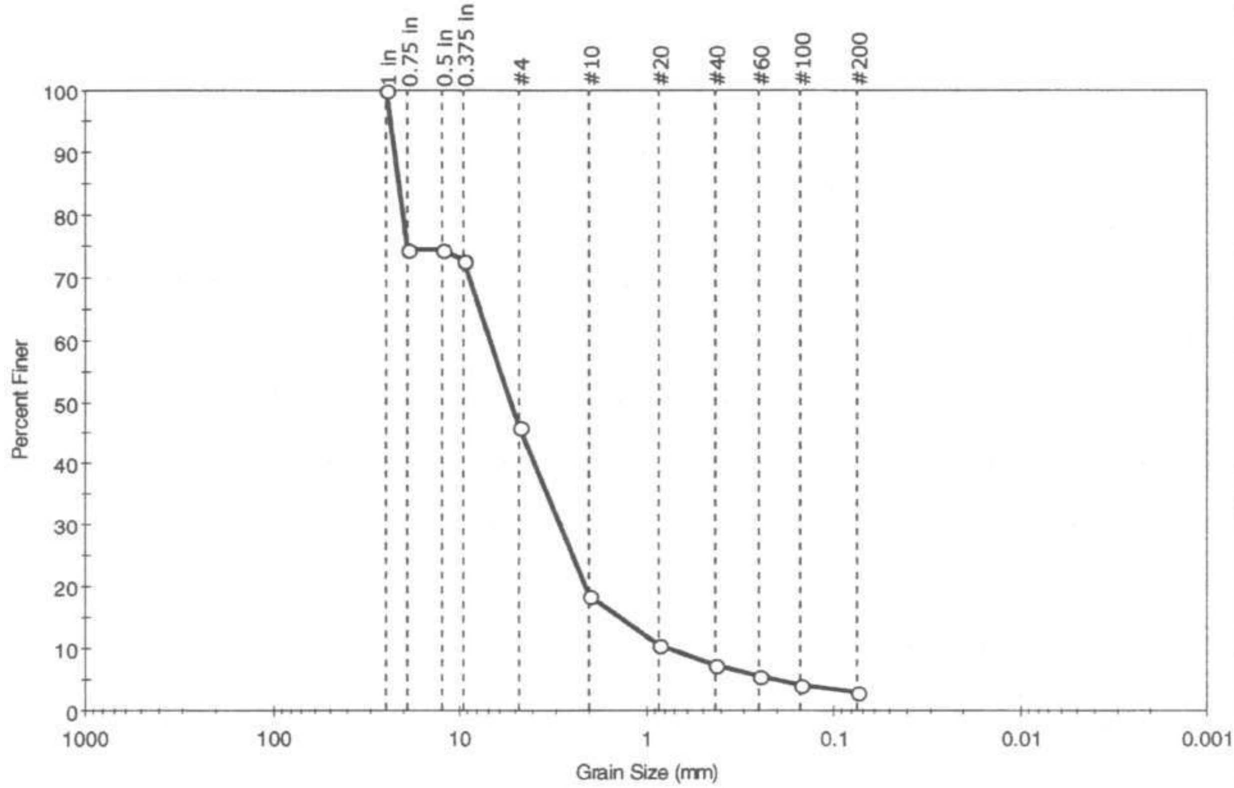
A-CAD3-2011 B6. 28-30ft

A-CAD3-2011-B6 48-50ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-6	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 08/03/11	Checked By:	jdt
Depth : 48-50	Test Id: 213841		
Test Comment: ---			
Sample Description: Moist, olive gravel with sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	54.1	42.9	3.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	74		
0.5 in	12.50	74		
0.375 in	9.50	73		
#4	4.75	46		
#10	2.00	19		
#20	0.85	11		
#40	0.42	7		
#60	0.25	6		
#100	0.15	4		
#200	0.075	3		

A-CAD3-2011-B6 48-50ft.

Coefficients

D_{85} = 21.2882 mm D_{30} = 2.8719 mm
D_{60} = 6.8427 mm D_{15} = 1.3626 mm
D_{50} = 5.2838 mm D_{10} = 0.7461 mm
C_u = 9.171 C_c = 1.616

Classification

ASTM Well-graded gravel with sand (GW)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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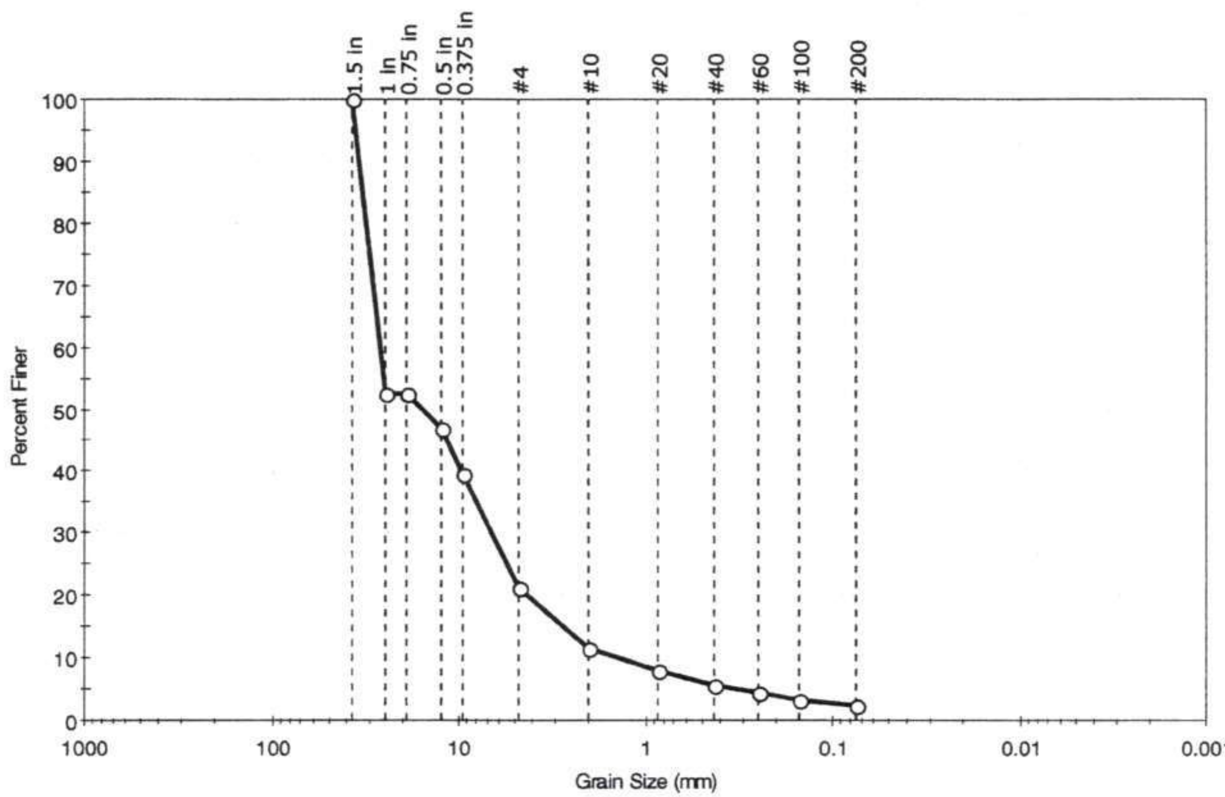
A-CAD3-2011-B6- 46-48ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-6	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 08/03/11	Checked By:	jdt
Depth : 46-48	Test Id: 213840		

Test Comment: ---
Sample Description: Moist, gray gravel with sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	78.8	18.9	2.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	52		
0.75 in	19.00	52		
0.5 in	12.50	47		
0.375 in	9.50	39		
#4	4.75	21		
#10	2.00	12		
#20	0.85	8		
#40	0.42	6		
#60	0.25	4		
#100	0.15	3		
#200	0.075	2		

Coefficients

D_{85} = 32.9990 mm	D_{30} = 6.6224 mm
D_{60} = 26.6654 mm	D_{15} = 2.7221 mm
D_{50} = 15.8248 mm	D_{10} = 1.3898 mm
C_u = 19.187	C_c = 1.183

Classification

ASTM Well-graded gravel with sand (GW)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

A-CAD3-2011-B6 46-48ft.

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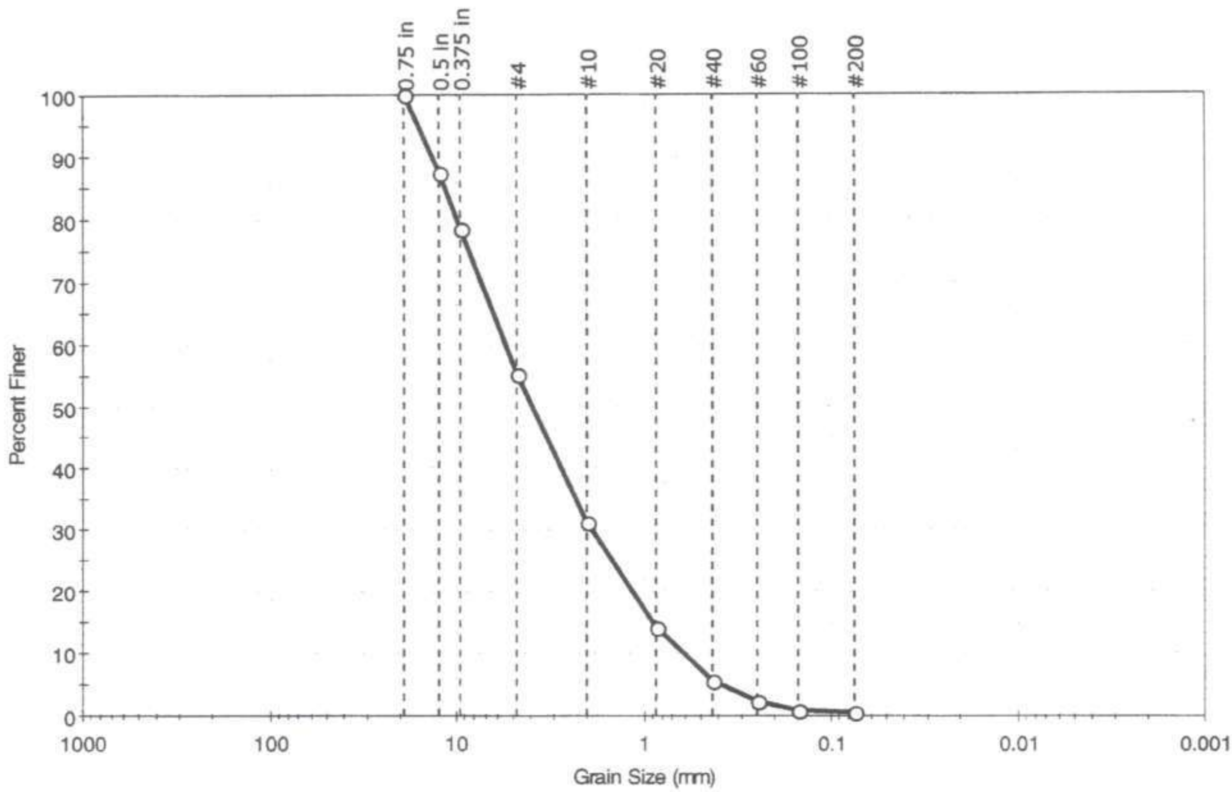
A-CAD3-2011-B6-53-55ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-6		Sample Type: bag		Tested By:	jbr
Sample ID:---		Test Date:	09/26/11	Checked By:	jdt
Depth :	53-55 ft	Test Id:	217484		
Test Comment:	---				
Sample Description:	Moist, olive sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	44.8	54.5	0.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	87		
0.375 in	9.50	78		
#4	4.75	55		
#10	2.00	31		
#20	0.85	14		
#40	0.42	6		
#60	0.25	2		
#100	0.15	1		
#200	0.075	1		

Coefficients

D_{85} = 11.6627 mm	D_{30} = 1.8670 mm
D_{60} = 5.4894 mm	D_{15} = 0.8887 mm
D_{50} = 3.9373 mm	D_{10} = 0.6079 mm
C_u = 9.030	C_c = 1.045

Classification

ASTM Well-graded sand with gravel (SW)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape :

Sand/Gravel Hardness :

A CAD3-2011-B6-53-55ft

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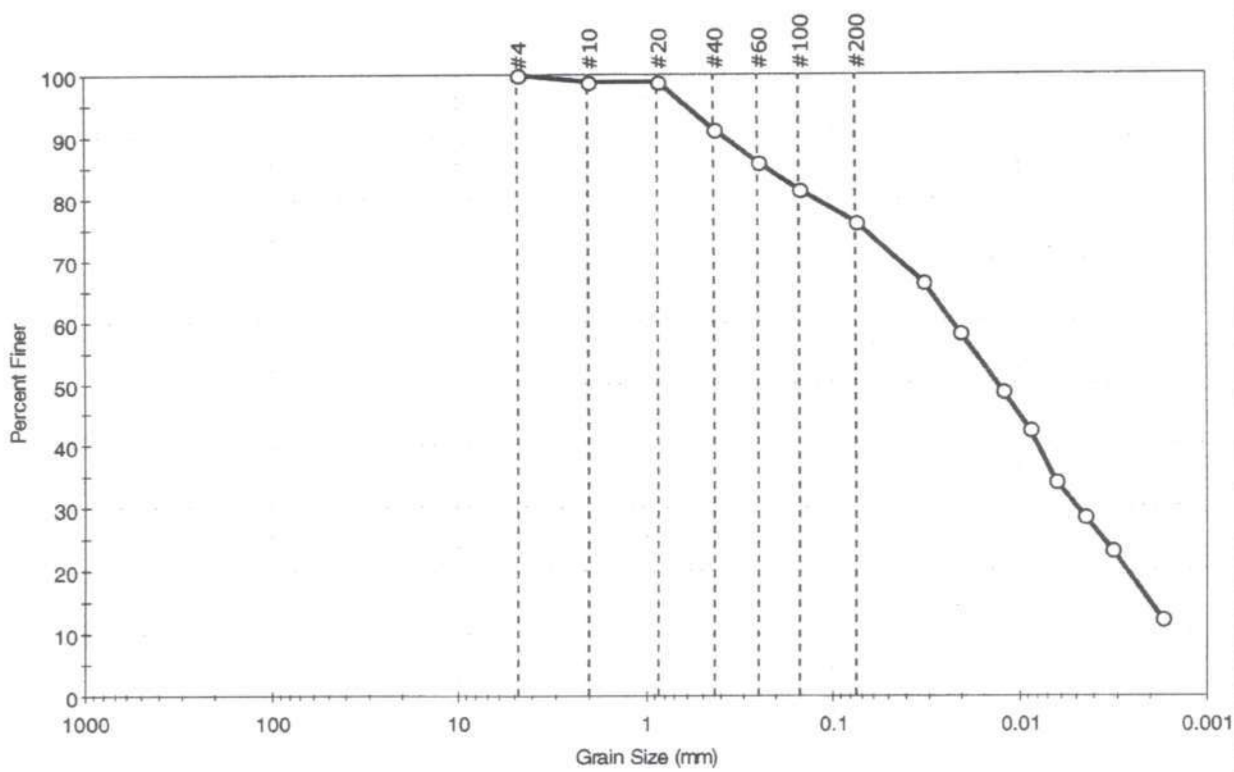
ACAD3-2011-B7-0-2ft.

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-7		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	09/28/11	Checked By:	jdt
Depth : 0-2 ft		Test Id:	217485		
Test Comment:	---				
Sample Description:	Moist, olive green silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	24.0	76.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	91		
#60	0.25	86		
#100	0.15	82		
#200	0.075	76		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0324	66		
---	0.0209	58		
---	0.0124	49		
---	0.0088	42		
---	0.0064	34		
---	0.0045	29		
---	0.0033	23		
---	0.0017	12		

Coefficients

D_{85} = 0.2270 mm	D_{30} = 0.0049 mm
D_{60} = 0.0230 mm	D_{15} = 0.0020 mm
D_{50} = 0.0133 mm	D_{10} = 0.0015 mm
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

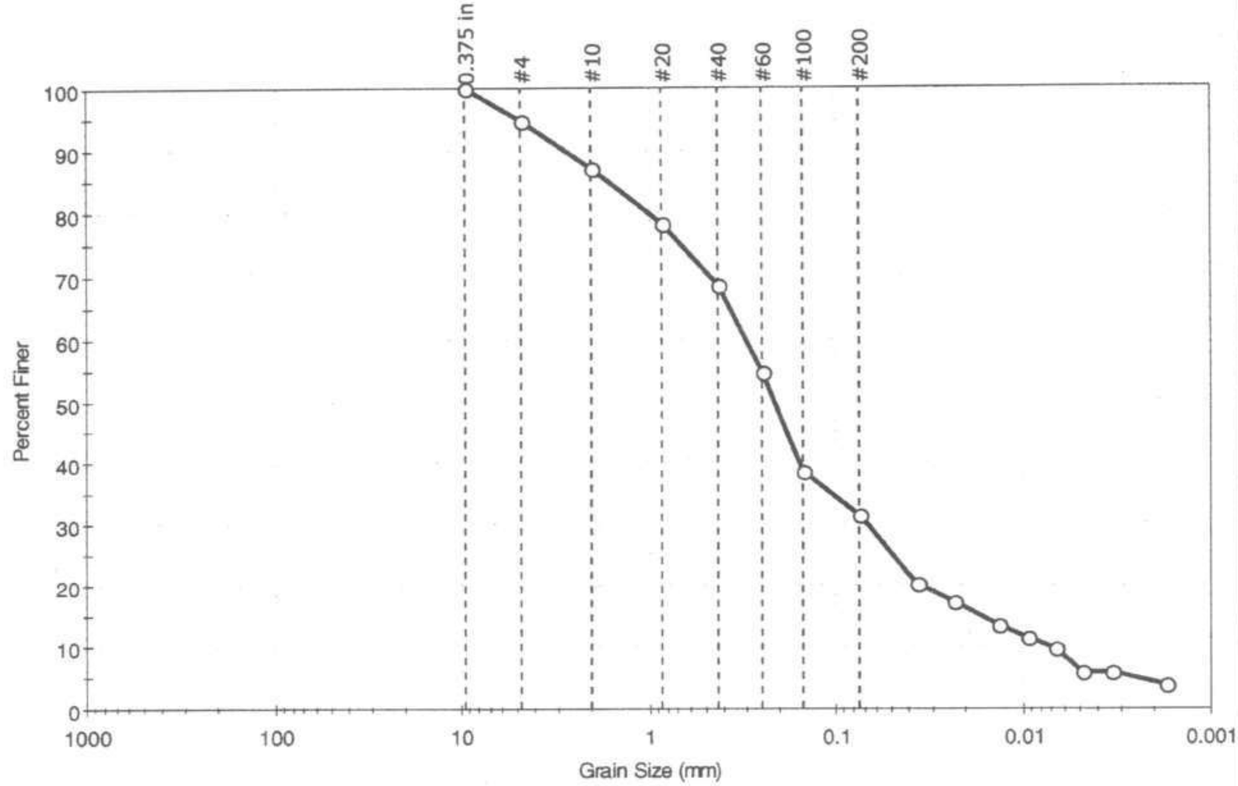
A CAD3-2011-B7-0-2ft.

A-CAD3 2011 B7-12-14ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-7	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/26/11	Checked By:	jdt
Depth : 12-14 ft	Test Id: 217486		
Test Comment: ---			
Sample Description: Moist, olive green silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	5.2	63.1	31.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	95		
#10	2.00	87		
#20	0.85	78		
#40	0.42	69		
#60	0.25	55		
#100	0.15	39		
#200	0.075	32		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0365	20		
---	0.0231	17		
---	0.0134	13		
---	0.0095	12		
---	0.0067	10		
---	0.0048	6		
---	0.0034	6		
---	0.0017	4		

Coefficients

D_{85} = 1.6445 mm | D_{30} = 0.0674 mm
D_{60} = 0.3065 mm | D_{15} = 0.0166 mm
D_{50} = 0.2156 mm | D_{10} = 0.0072 mm
C_u = N/A | C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

A CAD3 2011 B7 - 12-14 ft

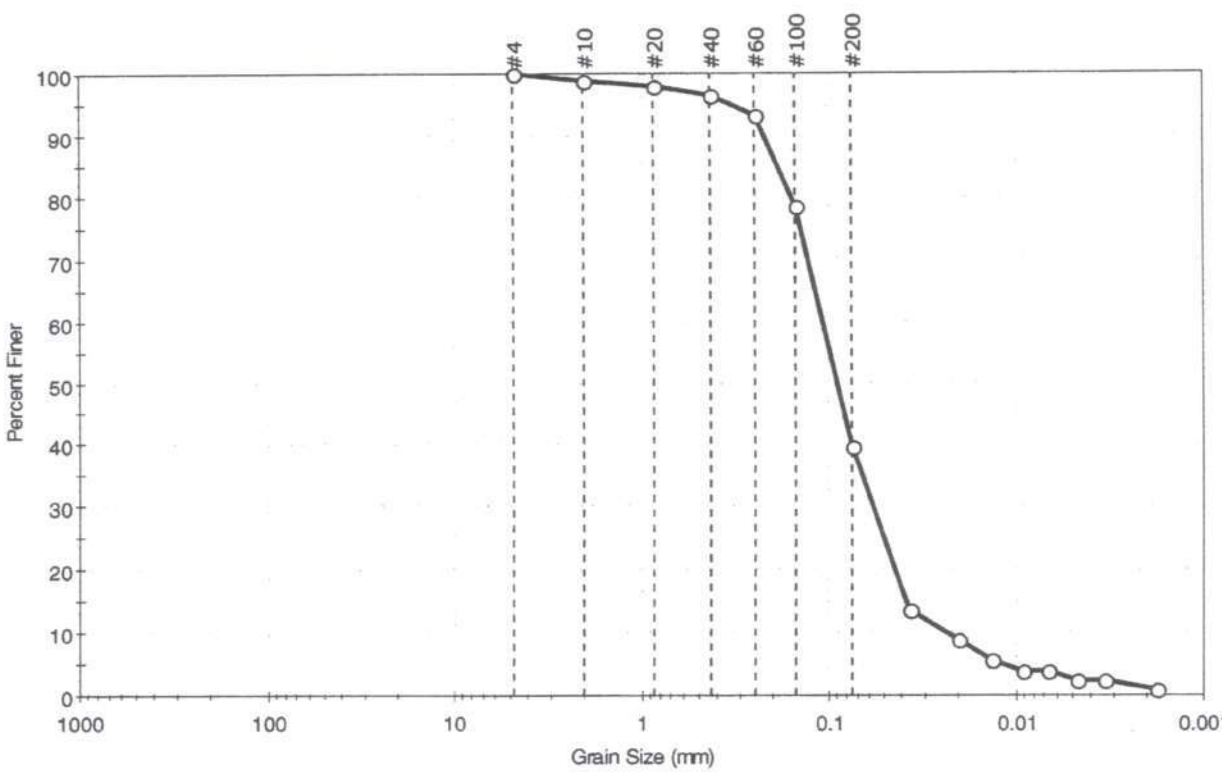
printed 9/29/2011 2:51:58 PM

A-CAD3-2011-B7 20-22ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-7	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 20-22 ft	Test Id: 217487		
Test Comment: ---			
Sample Description: Moist, olive green silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	60.6	39.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	98		
#40	0.42	96		
#60	0.25	93		
#100	0.15	79		
#200	0.075	39		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0369	13		
---	0.0204	9		
---	0.0134	6		
---	0.0092	4		
---	0.0067	4		
---	0.0048	2		
---	0.0034	2		
---	0.0018	1		

Coefficients

D_{85} = 0.1878 mm D_{30} = 0.0580 mm

D_{60} = 0.1080 mm D_{15} = 0.0384 mm

D_{50} = 0.0905 mm D_{10} = 0.0239 mm

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A CAD3-2011 B7- 20-22ft

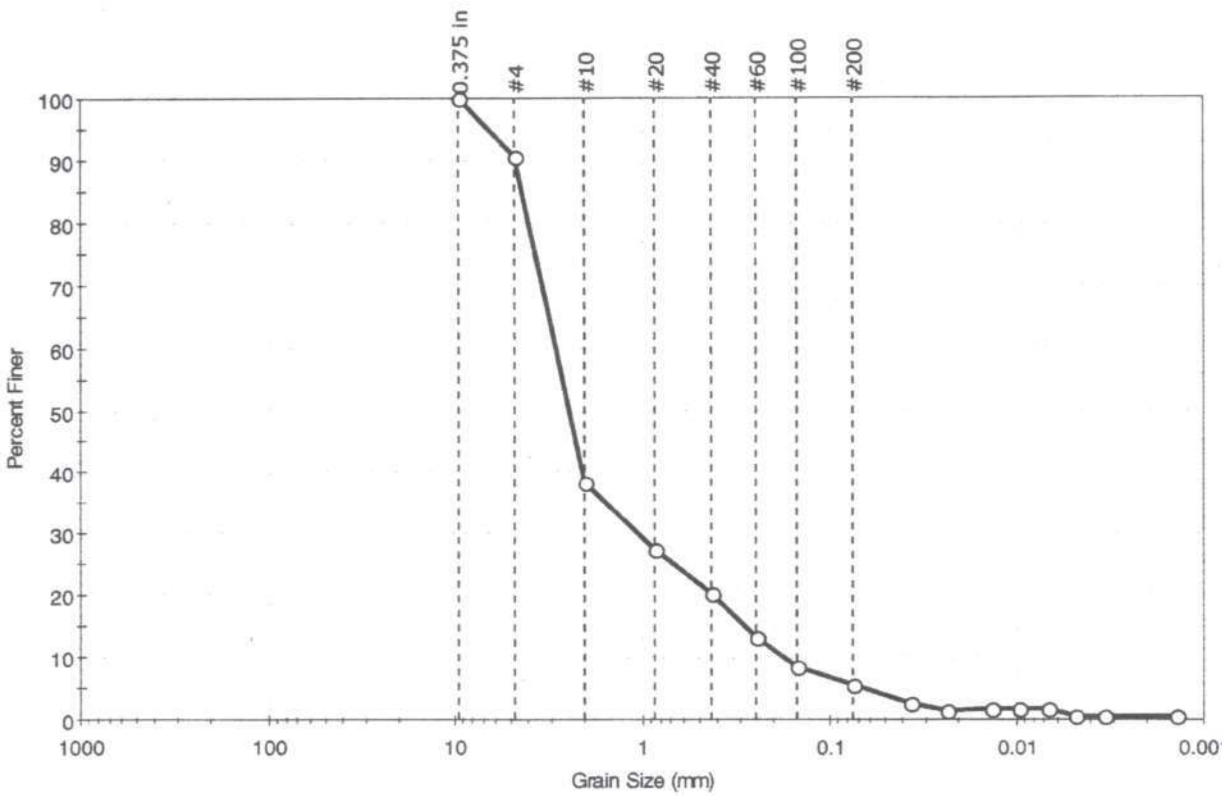
printed 9/29/2011 2:48:24 PM

ACAD3 2011- B7- 24-28ft

GeoTesting EXPRESS

Client: Apex Companies, LLC					
Project: South Terminal Extension					
Location: New Bedford, MA				Project No:	GTX-10697
Boring ID: B-7	Sample Type:	bag		Tested By:	jbr
Sample ID:---	Test Date:	09/26/11		Checked By:	jdt
Depth : 24-28 ft	Test Id:	217488			
Test Comment: ---					
Sample Description: Moist, olive brown sand with silt					
Sample Comment: ---					

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	9.5	84.7	5.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	90		
#10	2.00	38		
#20	0.85	27		
#40	0.42	20		
#60	0.25	13		
#100	0.15	8		
#200	0.075	6		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0371	3		
---	0.0236	1		
---	0.0135	2		
---	0.0096	2		
---	0.0068	2		
---	0.0048	1		
---	0.0034	1		
---	0.0014	1		

Coefficients

D_{85} = 4.3354 mm D_{30} = 1.0435 mm

D_{60} = 2.8624 mm D_{15} = 0.2836 mm

D_{50} = 2.4245 mm D_{10} = 0.1765 mm

C_u = 16.218 C_c = 2.155

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

A CAD3 2011 B7- 24-28ft

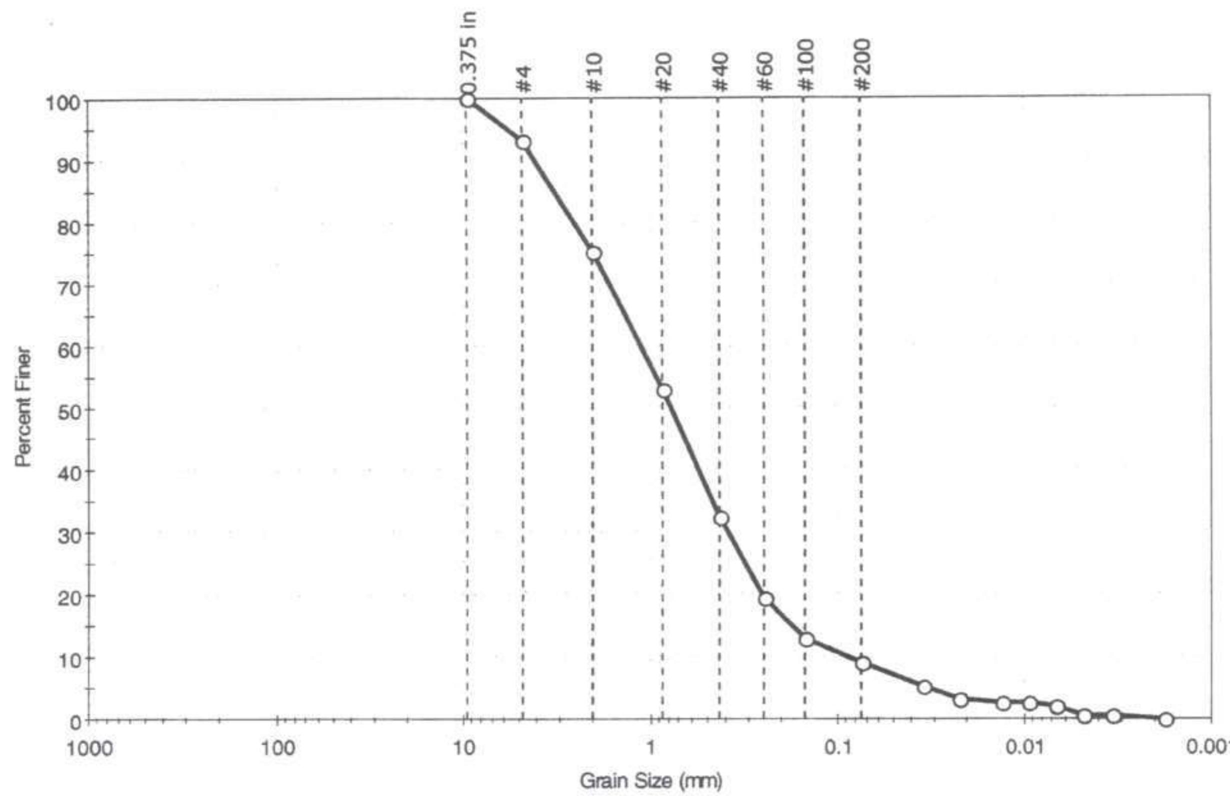
printed 9/29/2011 2:48:40 PM

A CAD3- 2011 · B7- 46-48ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-7	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/26/11	Checked By:	jdt
Depth : 46-48 ft	Test Id: 217489		
Test Comment: ---			
Sample Description: Moist, olive green sand with silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	6.8	84.1	9.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	93		
#10	2.00	75		
#20	0.85	53		
#40	0.42	32		
#60	0.25	20		
#100	0.15	13		
#200	0.075	9		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0347	5		
---	0.0222	3		
---	0.0131	3		
---	0.0095	3		
---	0.0067	2		
---	0.0048	1		
---	0.0034	1		
---	0.0018	0		

Coefficients

D_{85} = 3.1971 mm	D_{30} = 0.3851 mm
D_{60} = 1.1217 mm	D_{15} = 0.1760 mm
D_{50} = 0.7760 mm	D_{10} = 0.0889 mm
C_u = 12.618	C_c = 1.487

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A CAD3 2011 B7 46-48ft

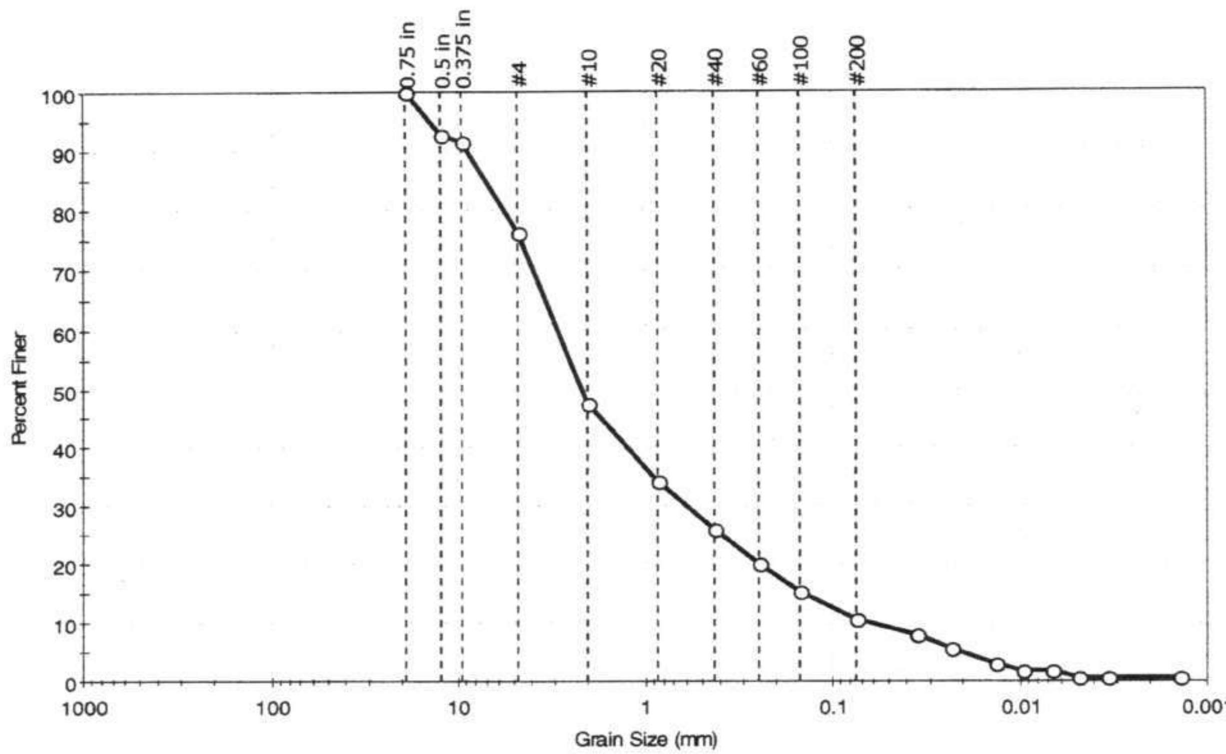
printed 9/29/2011 2:48:52 PM

A CAD3 2011- B7 - 56-58ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-7	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/26/11	Checked By:	jdt
Depth : 56-58 ft	Test Id: 217490		
Test Comment: ---			
Sample Description: Moist, olive green sand with silt and gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	23.8	65.7	10.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	93		
0.375 in	9.50	92		
#4	4.75	76		
#10	2.00	47		
#20	0.85	34		
#40	0.42	26		
#60	0.25	20		
#100	0.15	15		
#200	0.075	11		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0361	8		
---	0.0231	6		
---	0.0135	3		
---	0.0096	2		
---	0.0068	2		
---	0.0048	1		
---	0.0034	1		
---	0.0014	1		

Coefficients

D_{85} = 7.0617 mm
D_{30} = 0.5953 mm
D_{60} = 2.9167 mm
D_{15} = 0.1431 mm
D_{50} = 2.1592 mm
D_{10} = 0.0643 mm
C_u = 45.361
C_c = 1.890

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

A CAD3 2011 B7 56-58ft

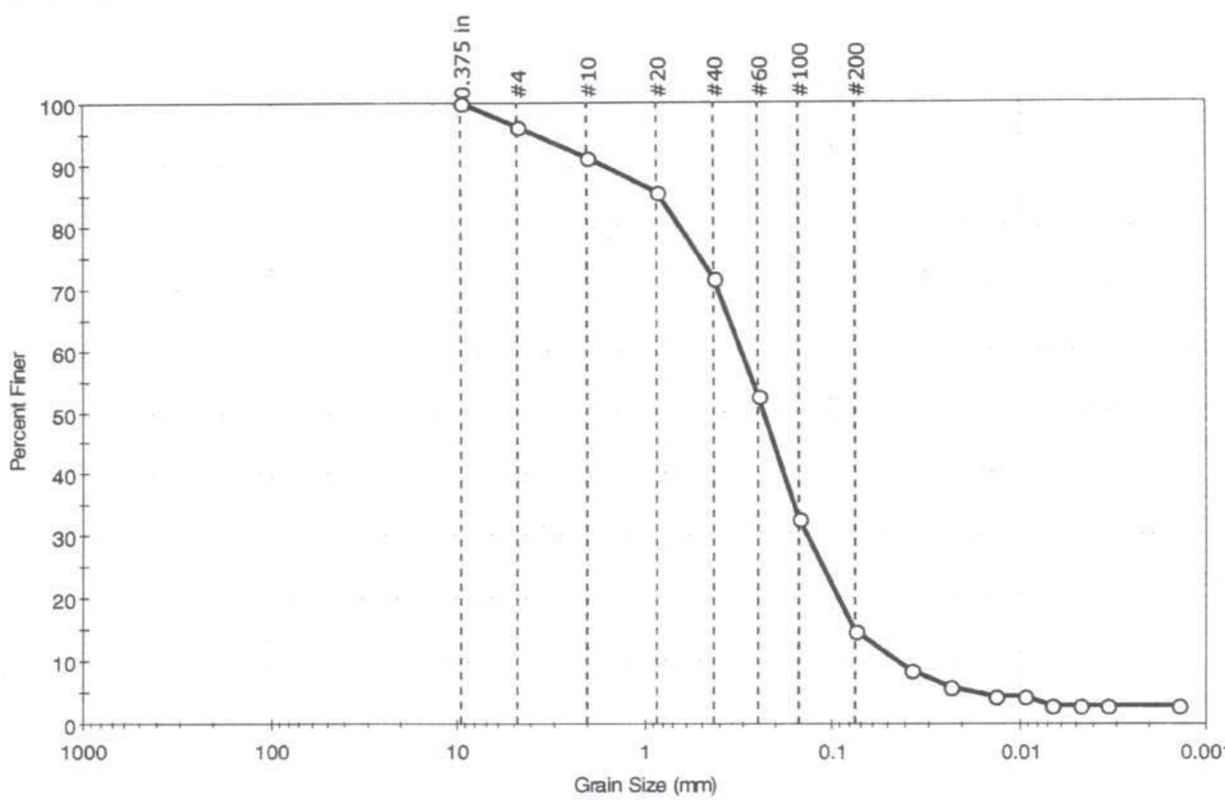
printed 9/29/2011 2:49:08 PM

A CAD3 2011 B8 0-2ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-8	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 0-2 ft	Test Id: 217491		
Test Comment: ---			
Sample Description: Moist, black silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	3.9	81.3	14.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	96		
#10	2.00	91		
#20	0.85	86		
#40	0.42	72		
#60	0.25	52		
#100	0.15	33		
#200	0.075	15		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0377	9		
---	0.0236	6		
---	0.0135	4		
---	0.0095	4		
---	0.0067	3		
---	0.0047	3		
---	0.0034	3		
---	0.0014	3		

Coefficients

D_{85} = 0.8288 mm D_{30} = 0.1347 mm
D_{60} = 0.3081 mm D_{15} = 0.0756 mm
D_{50} = 0.2344 mm D_{10} = 0.0439 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

A CAD3 2011 B8 0-2ft

printed 9/29/2011 2:52:47 PM

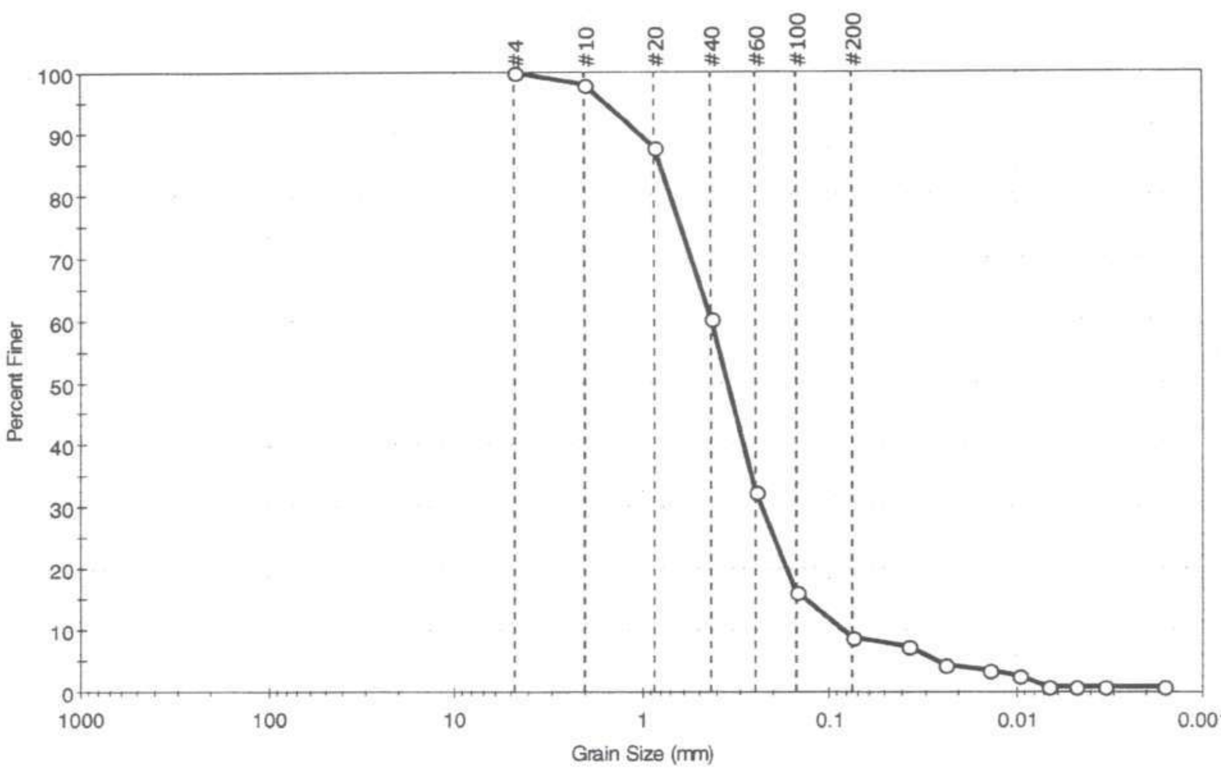
A CAD3-2011-B8- 6-8ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID: B-8		Sample Type:	bag	Tested By:	jbr
Sample ID:---		Test Date:	09/27/11	Checked By:	jdt
Depth : 6-8 ft		Test Id:	217492		

Test Comment: ---
Sample Description: Moist, grayish brown sand with silt
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	91.1	8.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	98		
#20	0.85	88		
#40	0.42	60		
#60	0.25	32		
#100	0.15	16		
#200	0.075	9		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0372	7		
---	0.0236	5		
---	0.0137	4		
---	0.0096	3		
---	0.0068	1		
---	0.0048	1		
---	0.0034	1		
---	0.0016	1		

Coefficients

D_{85} =0.7931 mm | D_{30} =0.2316 mm
D_{60} =0.4229 mm | D_{15} =0.1331 mm
D_{50} =0.3495 mm | D_{10} =0.0832 mm
C_u =5.083 | C_c =1.524

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

A-CAD3-2011-B8 6-8ft

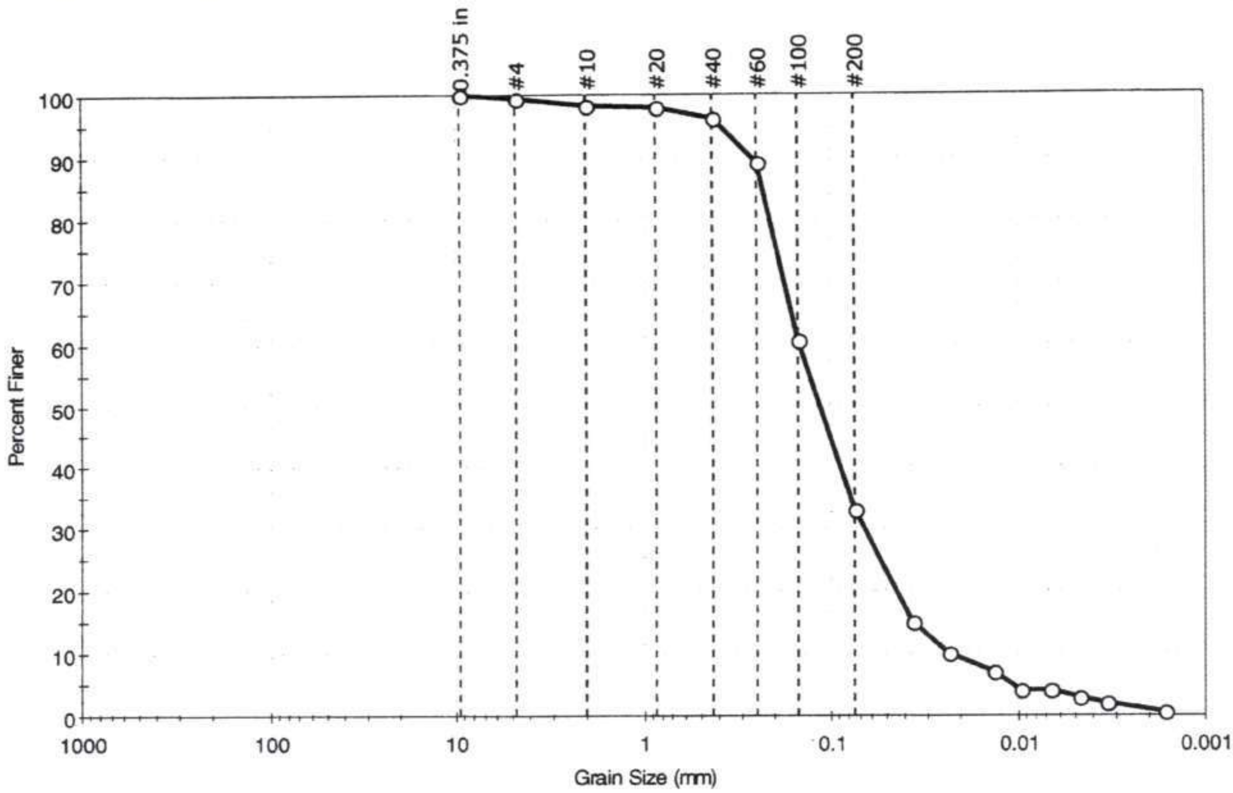
printed 9/29/2011 2:44:56 PM

A-CAD3-2011- B8 22-24ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-8	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 22-24 ft	Test Id: 217493		
Test Comment: ---			
Sample Description: Moist, olive gray silty sand			
Sample Comment:			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.5	66.5	33.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	98		
#40	0.42	96		
#60	0.25	89		
#100	0.15	60		
#200	0.075	33		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0365	15		
---	0.0232	10		
---	0.0135	7		
---	0.0095	4		
---	0.0067	4		
---	0.0047	3		
---	0.0034	2		
---	0.0016	1		

Coefficients

D_{85} = 0.2328 mm — D_{30} = 0.0666 mm

D_{60} = 0.1482 mm — D_{15} = 0.0362 mm

D_{50} = 0.1152 mm — D_{10} = 0.0230 mm

C_u = N/A — C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

ACAD3 2011 B8 22-24ft

printed 9/29/2011 2:53:42 PM

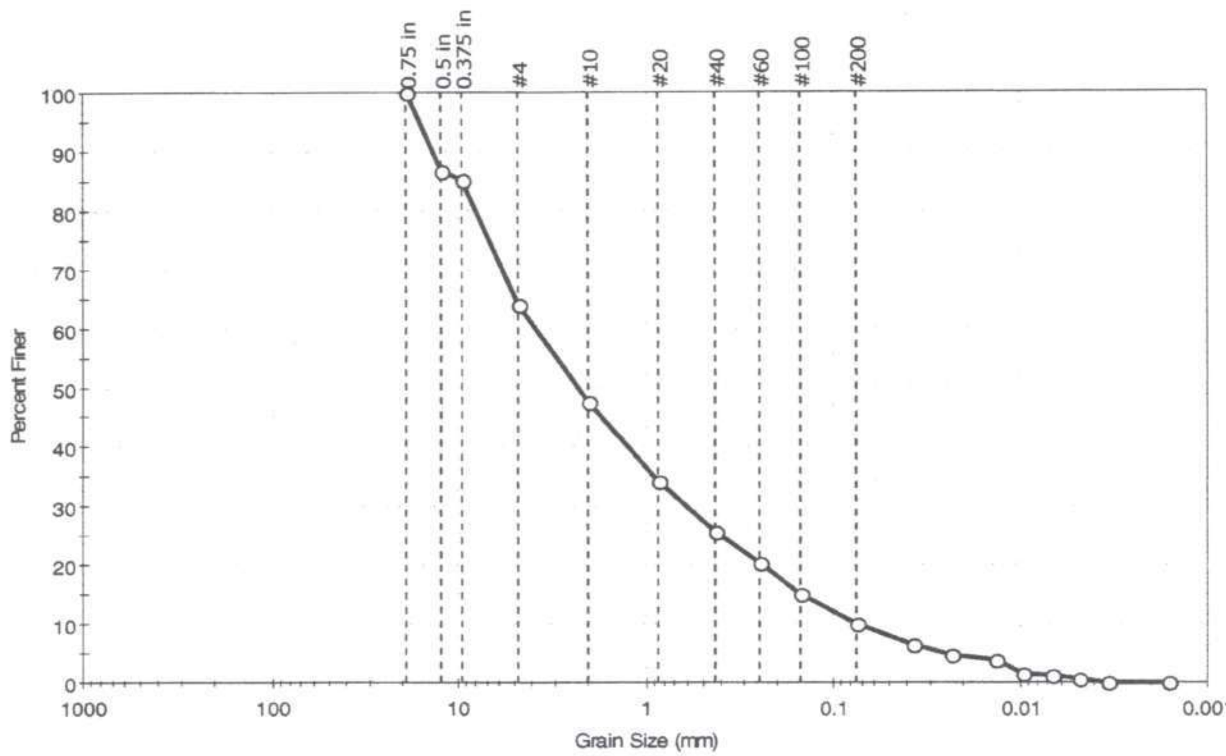
A-CAD3-2011-B8 44-46ft

GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: South Terminal Extension			
Location: New Bedford, MA		Project No:	GTX-10697
Boring ID: B-8	Sample Type: bag	Tested By:	jbr
Sample ID:---	Test Date: 09/27/11	Checked By:	jdt
Depth : 44-46 ft	Test Id: 217494		

Test Comment: ---
Sample Description: Moist, light olive green sand with silt and gravel
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	36.2	53.7	10.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	87		
0.375 in	9.50	85		
#4	4.75	64		
#10	2.00	48		
#20	0.85	34		
#40	0.42	26		
#60	0.25	20		
#100	0.15	15		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0375	6		
---	0.0236	5		
---	0.0136	4		
---	0.0096	2		
---	0.0068	1		
---	0.0048	1		
---	0.0034	0		
---	0.0016	0		

Coefficients

D_{85} = 9.4588 mm | D_{30} = 0.6032 mm
D_{60} = 3.8686 mm | D_{15} = 0.1479 mm
D_{50} = 2.2753 mm | D_{10} = 0.0730 mm
C_u = 52.995 | C_c = 1.288

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

A-CAD3 2011 B8 44-46ft.

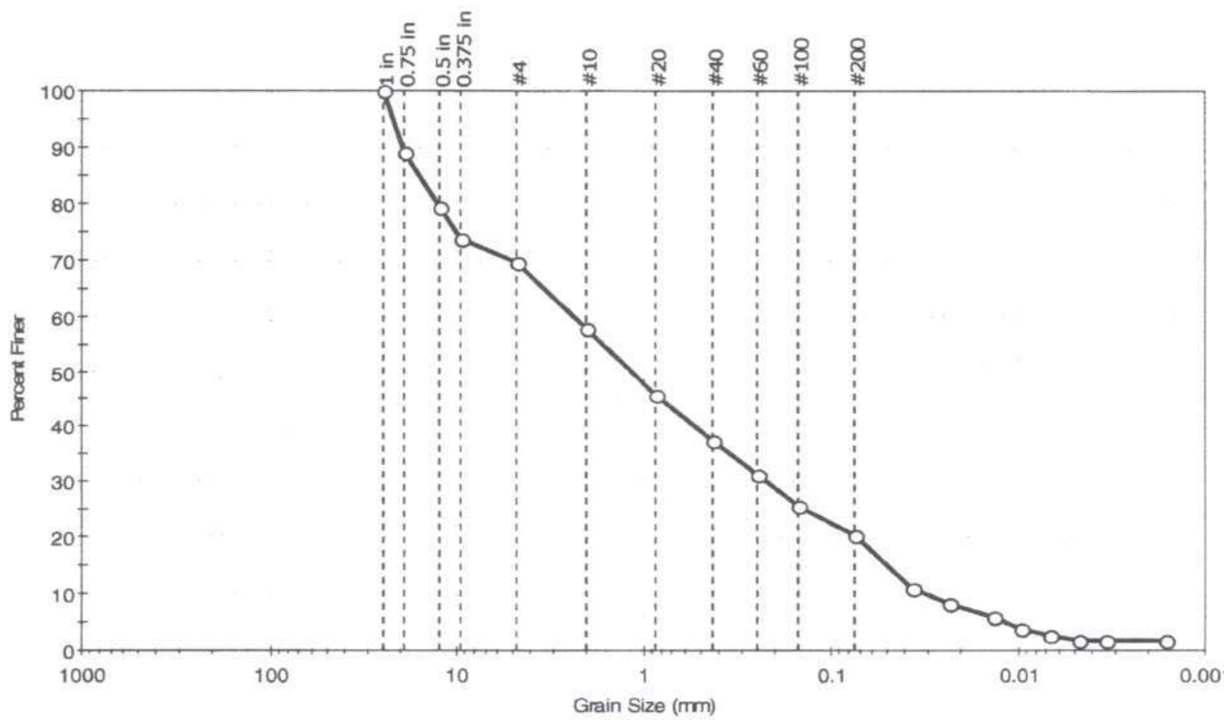
printed 9/29/2011 2:45:09 PM

A-CAD3-2011-B8-52-54ft

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	South Terminal Extension				
Location:	New Bedford, MA			Project No:	GTX-10697
Boring ID:	B-8	Sample Type:	bag	Tested By:	jbr
Sample ID:	---	Test Date:	09/27/11	Checked By:	jdt
Depth :	52-54 ft	Test Id:	217495		
Test Comment:	---				
Sample Description:	Moist, light olive green silty sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	30.2	49.3	20.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	89		
0.5 in	12.50	79		
0.375 in	9.50	74		
#4	4.75	70		
#10	2.00	58		
#20	0.85	46		
#40	0.42	37		
#60	0.25	31		
#100	0.15	26		
#200	0.075	20		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0371	11		
---	0.0231	8		
---	0.0134	6		
---	0.0096	4		
---	0.0068	3		
---	0.0048	2		
---	0.0034	2		
---	0.0016	2		

Coefficients

D_{85} = 15.9232 mm D_{30} = 0.2227 mm
D_{60} = 2.3450 mm D_{15} = 0.0502 mm
D_{50} = 1.1539 mm D_{10} = 0.0318 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

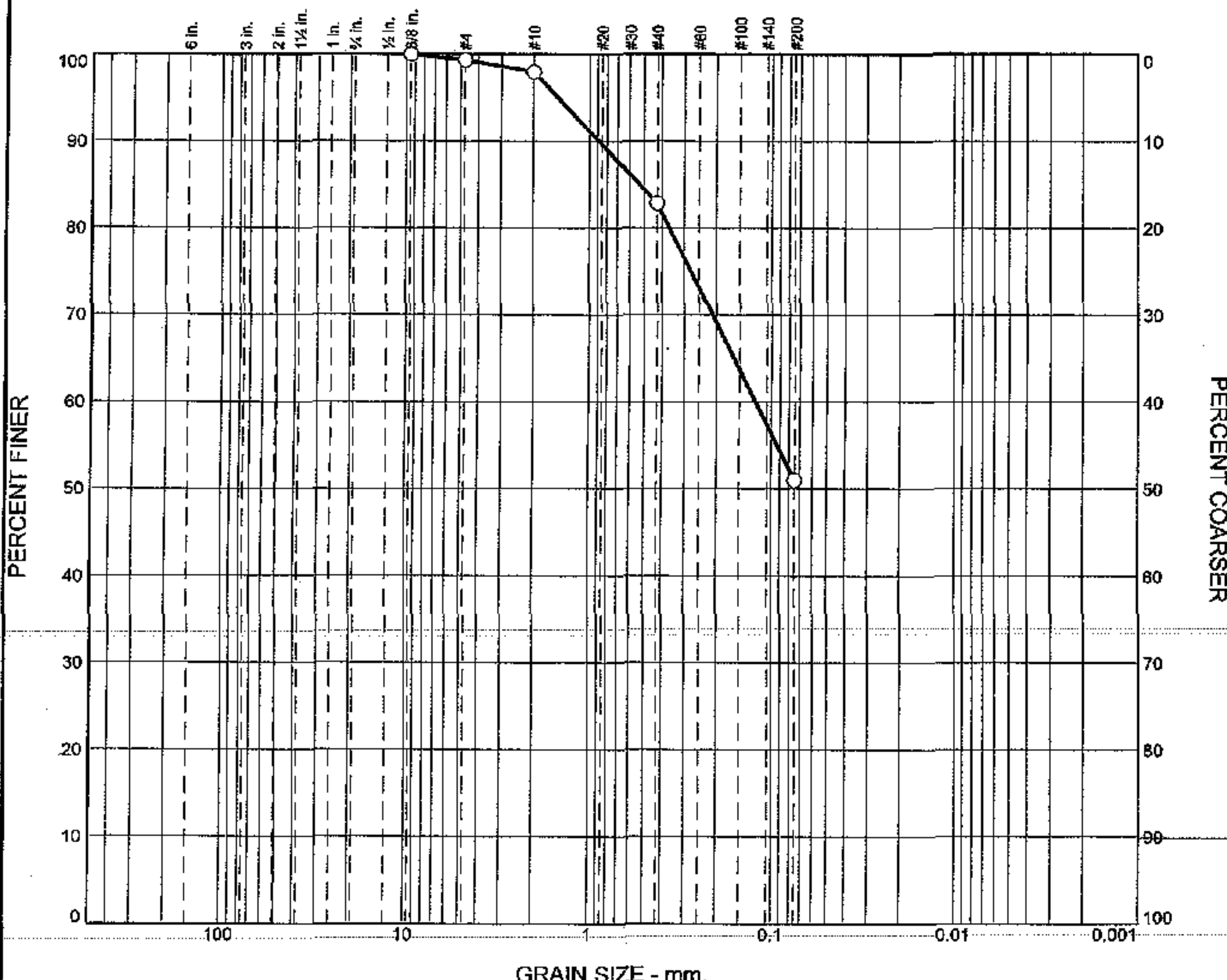
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

A CAD3 2011 B8 52-54ft

printed 9/29/2011 2:59:59 PM

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.6	48.4	51.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.5294	0.1225						

Material Description	USCS	AASHTO
○	ML	A-4(0)

Project No. 0801006 **Client:** Apex Companies, LLC
Project: CAD II Area

○ **Source of Sample:** VC 2007-101 4-5 **Sample Number:** 0801006-05

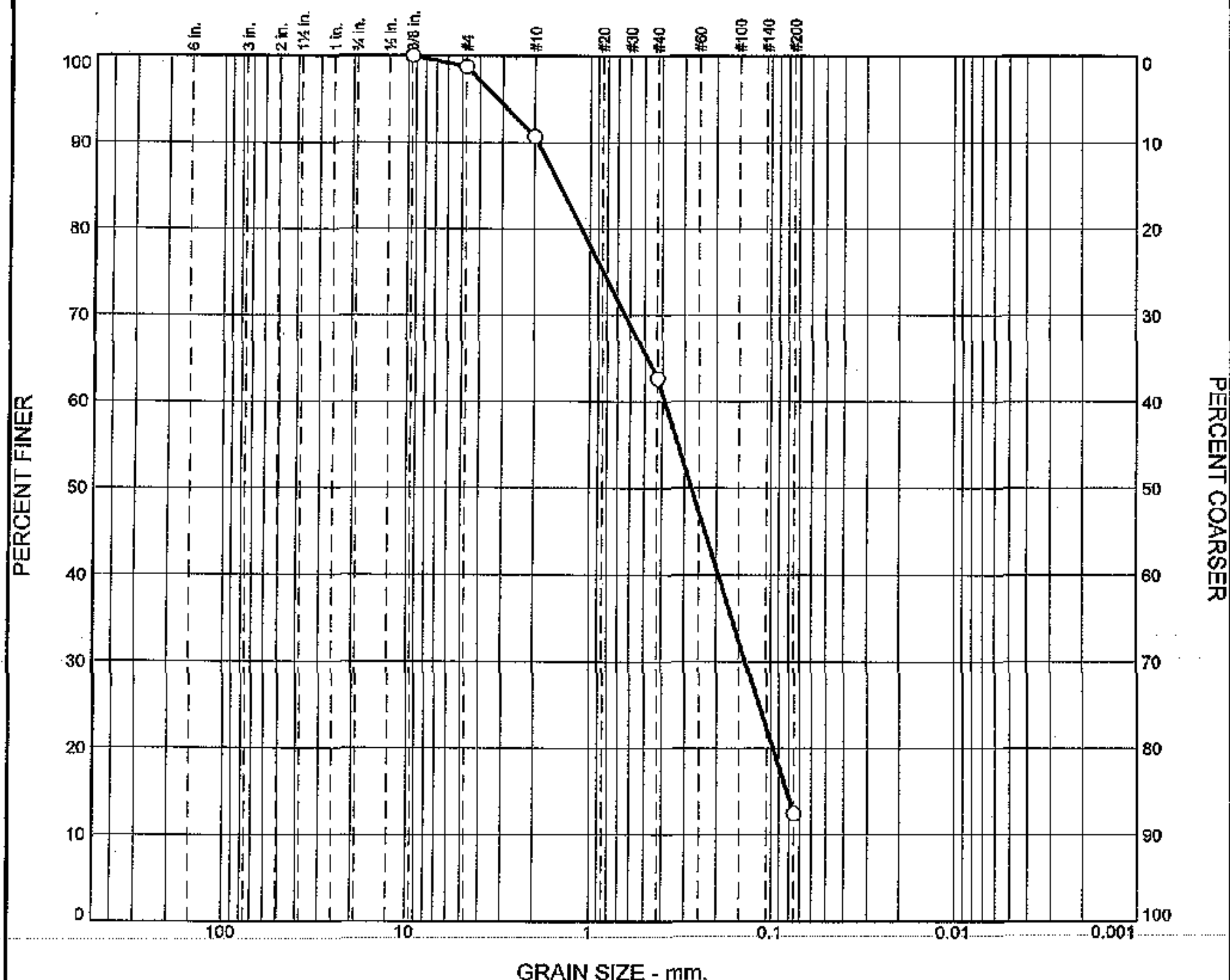
Remarks:

ALPHA WOODS HOLE LABS

Raynham, MA

Project

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
○	0.0	1.3	86.3	12.4	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.4594	0.3872	0.2742	0.1375	0.0820			

	Material Description	USCS	AASHTO
○		SM	A-2-4(0)

Project No. 0801006 **Client:** Apex Companies, LLC

Project: CAD II Area

○ **Sample Source:** VC 2007-102 3-4 & 4-5 COMP **Sample No.:** 0801006-13

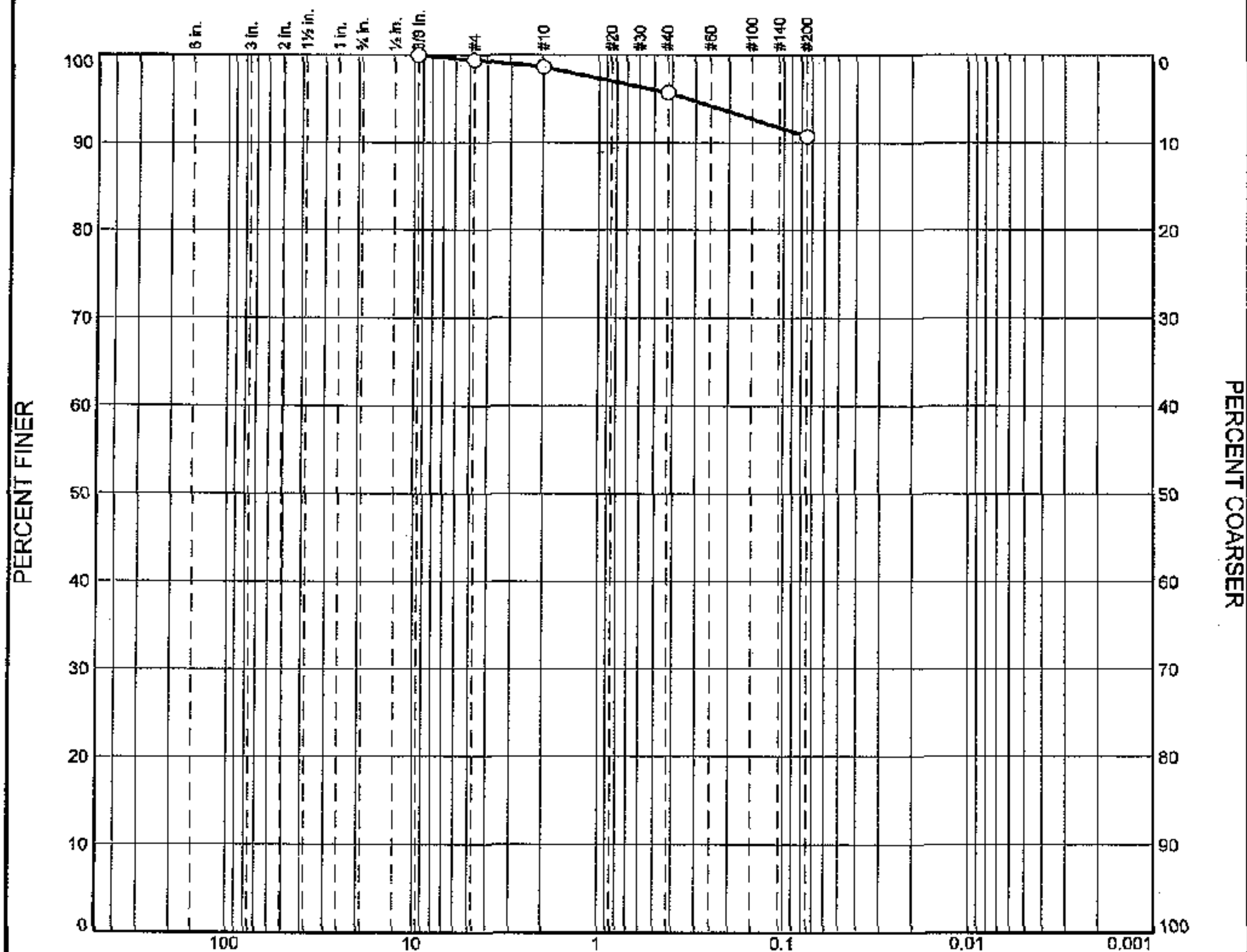
Remarks:

ALPHA WOODS HOLE LABS

Raynham, MA

Project

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.6	8.6	90.8	

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

	Material Description	USCS	AASHTO
○		ML	A-4(0)

Project No. 0801007 **Client:** Apex Companies, LLC

Project: CAD II Area

○ **Source of Sample:** VC 2007-103 1-2 **Sample Number:** 0801007-02

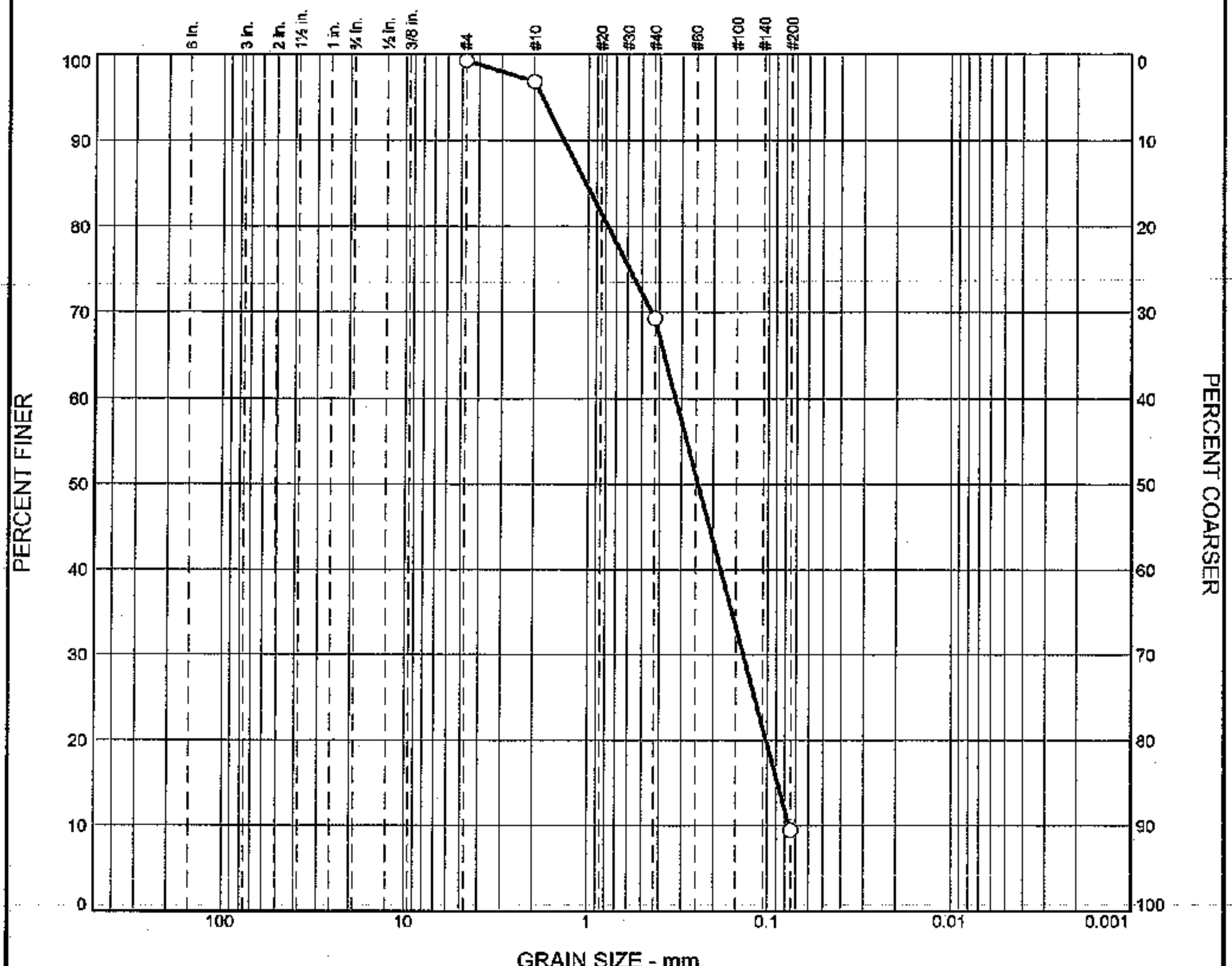
Remarks:

ALPHA WOODS HOLE LABS

Raynham, MA

Project

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
o			89.9	9.4	

X	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			1.0271	0.3248	0.2431	0.1362	0.0882	0.0763	0.75	4.26

	Material Description	USCS	AASHTO
o		SP-SM	A-3

Project No. 0801008 **Client:** Apex Companies, LLC.
Project: CAD II Area

o **Source of Sample:** VC 2007-104 1-2 **Sample Number:** 0801008-02

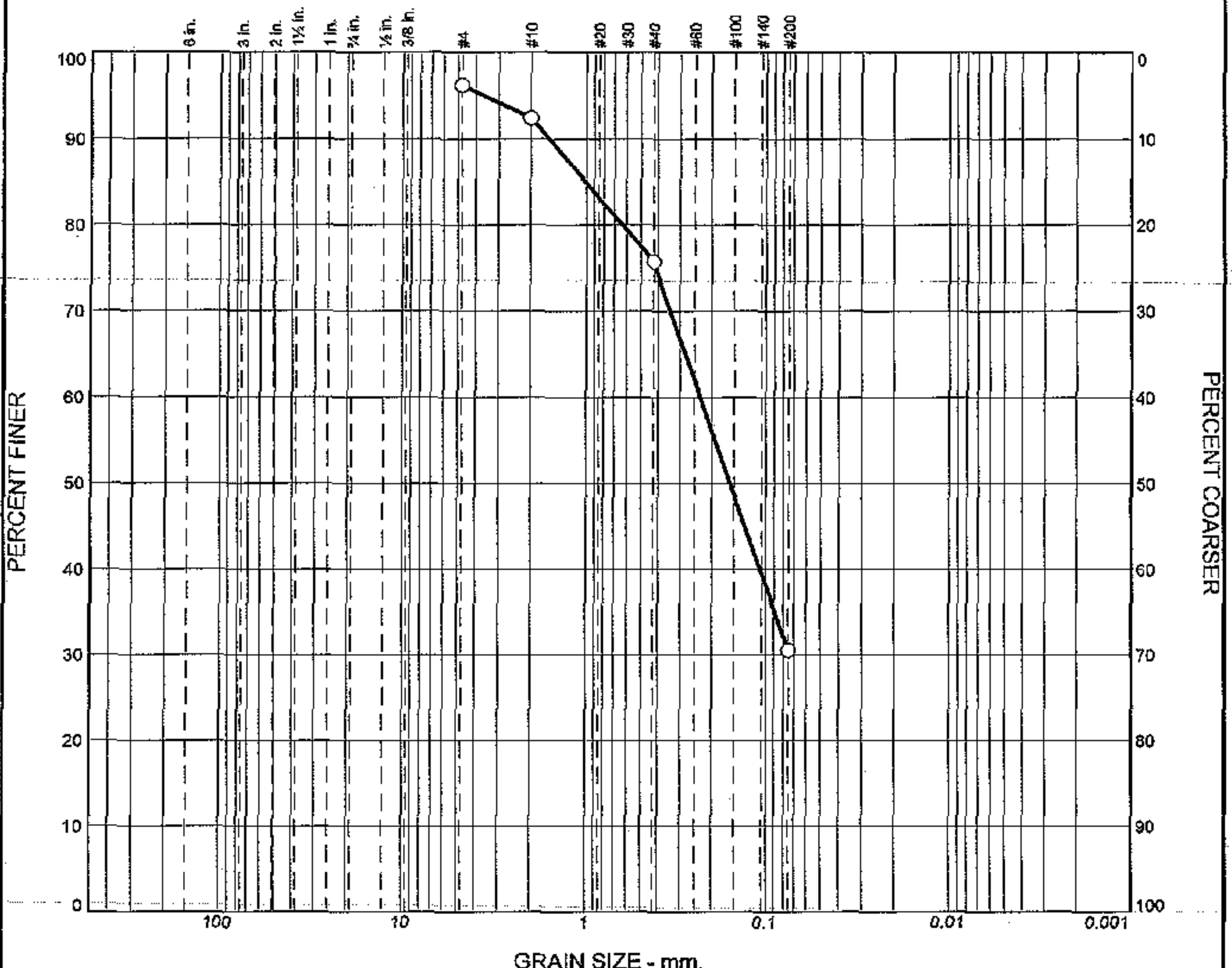
Remarks:

ALPHA WOODS HOLE LABS

Raynham, MA

Project

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
○			65.6	30.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.0039	0.2323	0.1582					

	Material Description	USCS	AASHTO
○		SM	A-2-4(0)

Project No. 0801008 **Client:** Apex Companies, LLC.

Project: CAD II Area

○ **Source of Sample:** VC 2007-105 2-3 **Sample Number:** 0801008-05

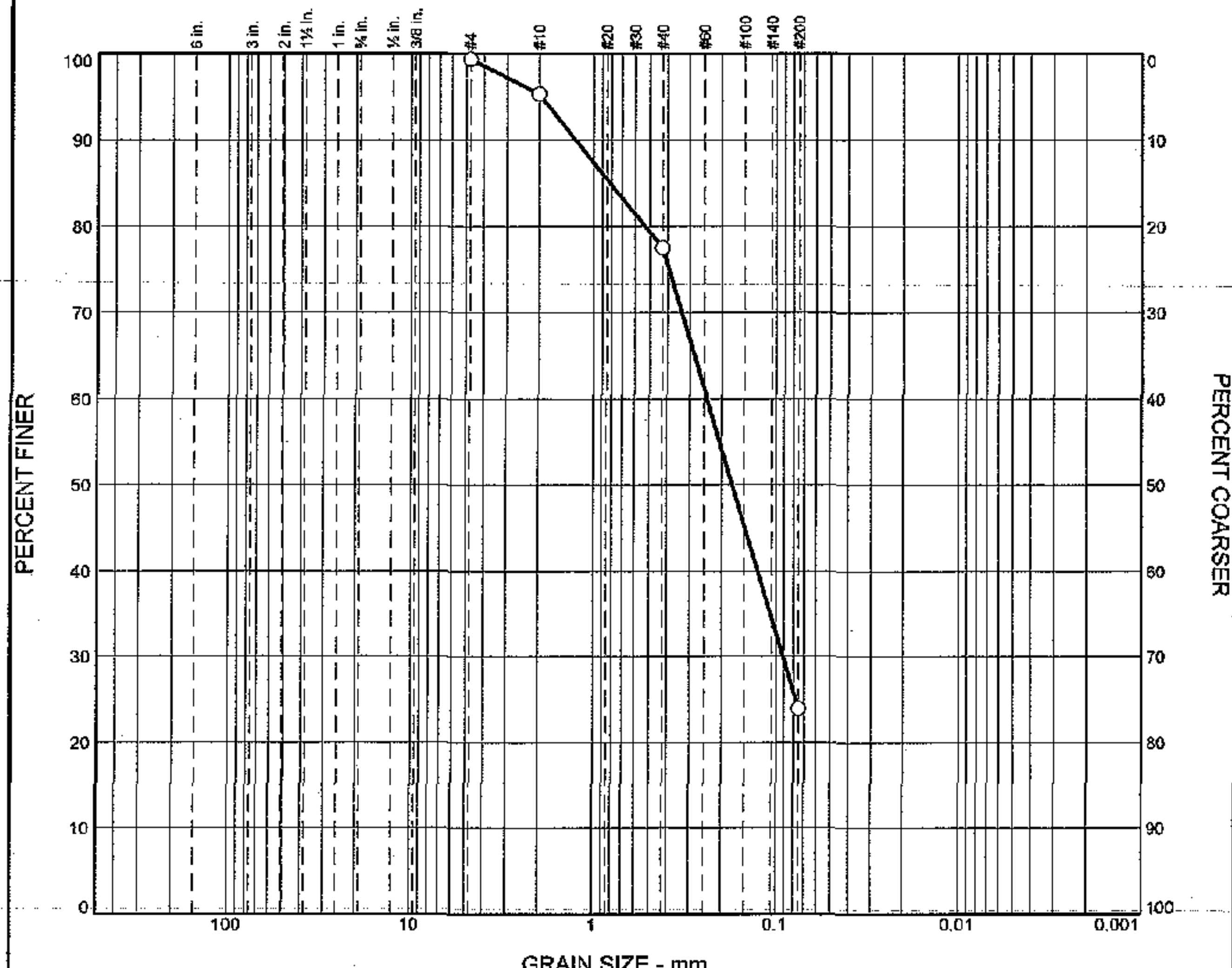
Remarks:

ALPHA WOODS HOLE LABS

Raynham, MA

Project

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
○			75.5	23.9	

X	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.8133	0.2409	0.1744	0.0913				

	Material Description	USCS	AASHTO
○		SM	A-2-4(0)

Project No. 0801008 **Client:** Apex Companies, LLC.

Project: CAD II Area

○ **Sample Source:** VC 2007-105 5-6 & 6-7 COMP **Sample No.:** 0801008-07

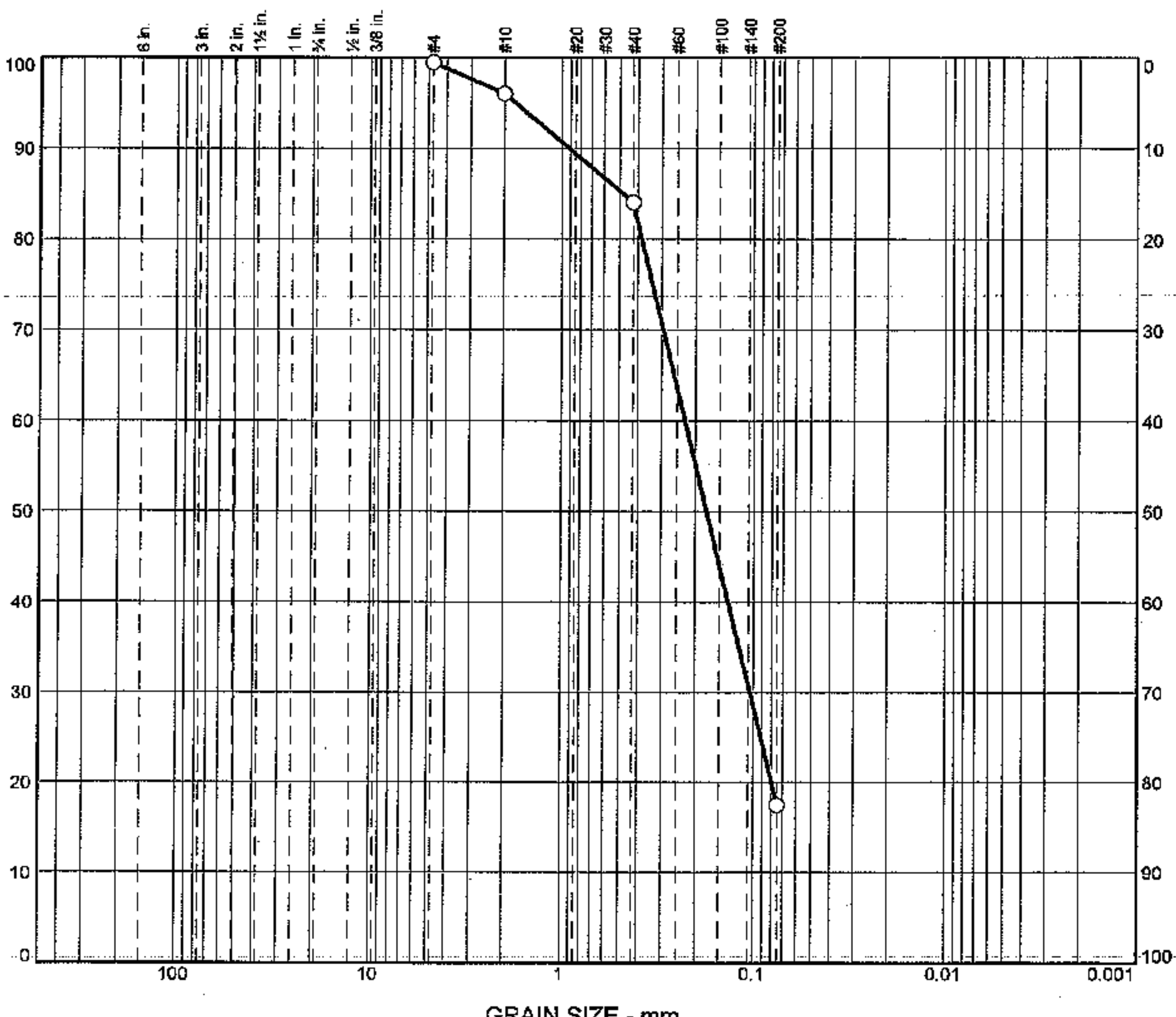
Remarks:

ALPHA WOODS HOLE LABS

Raynham, MA

Project

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
○			82.0	17.5	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.4782	0.2270	0.1749	0.1039				

Material Description	USCS	AASHTO
○	SM	A-2-4(0)

Project No. 0801008 **Client:** Apex Companies, LLC.

Project: CAD II Area

○ **Source of Sample:** VC 2007-118 1-2 **Sample Number:** 0801008-09

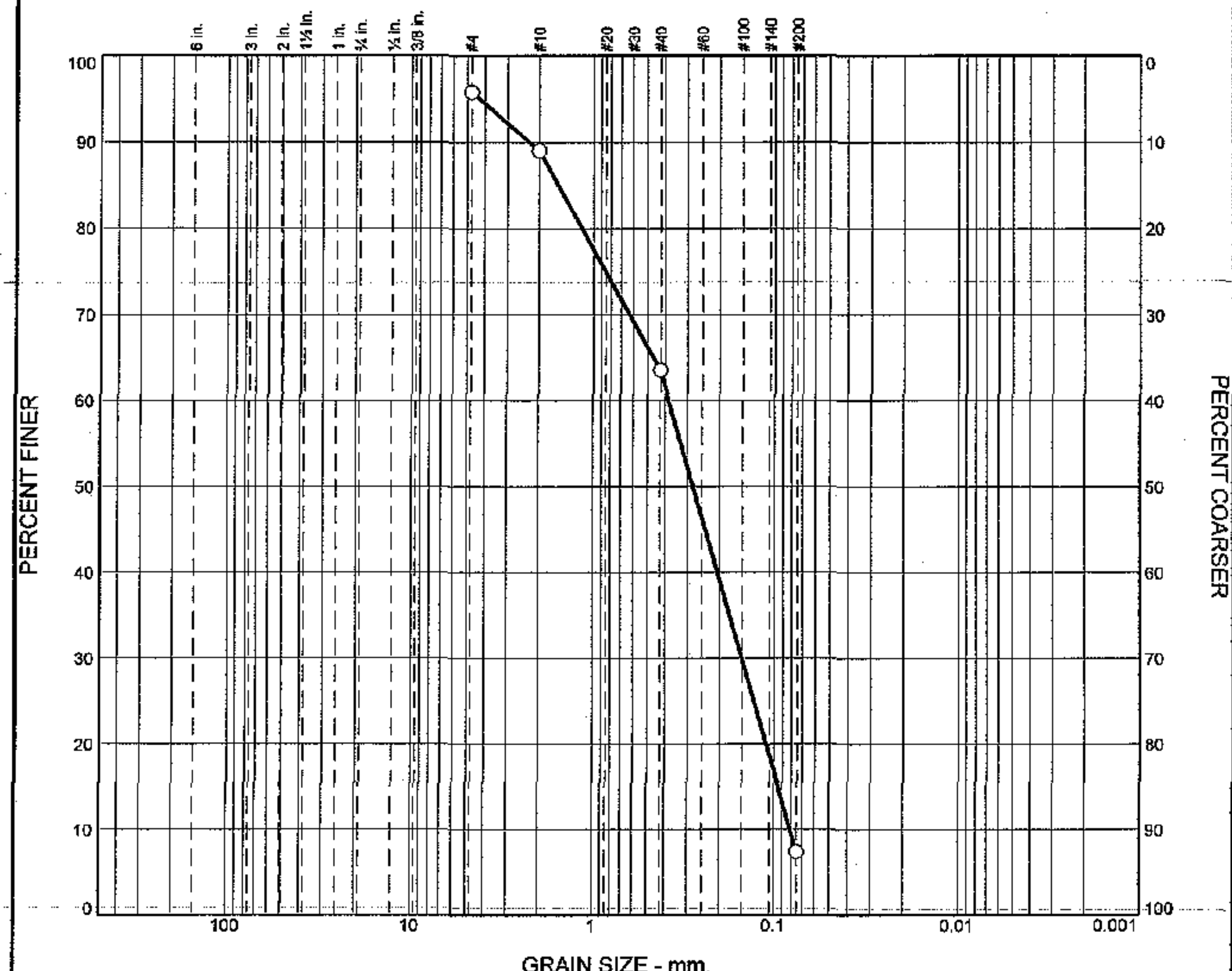
ALPHA WOODS HOLE LABS

Raynham, MA

Remarks:

Project

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
o			88.4	7.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			1.5650	0.3807	0.2795	0.1507	0.0948	0.0812	0.73	4.69

	Material Description	USCS	AASHTO
o		SP-SM	A-3

Project No. 0801008 **Client:** Apex Companies, LLC.

Project: CAD II Area

o **Source of Sample:** VC 2007-119 0-1 **Sample Number:** 0801008-11

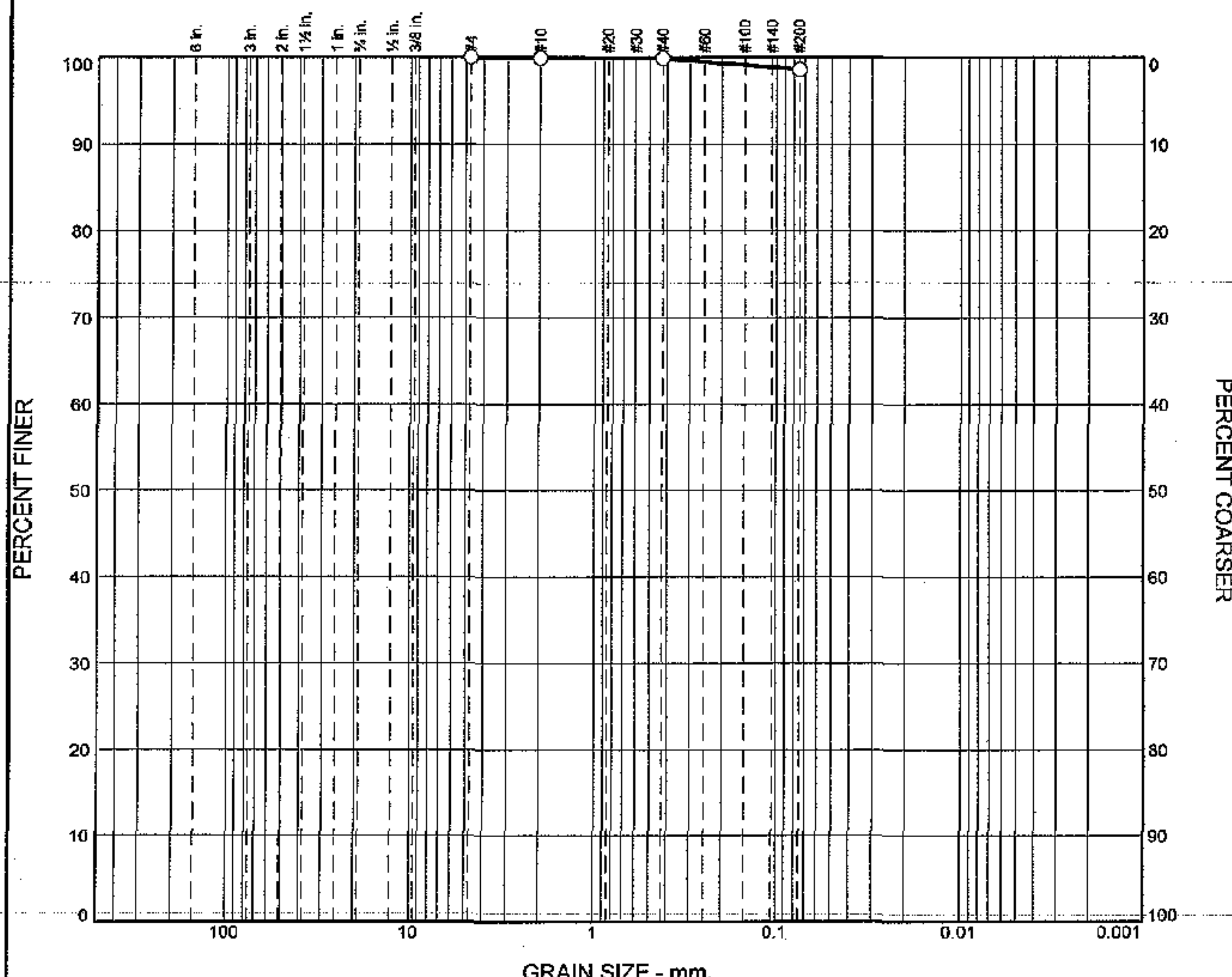
Remarks:

ALPHA WOODS HOLE LABS

Raynham, MA

Project

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0	1.4	98.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

	Material Description	USCS	AASHTO
○		ML	A-4(0)

Project No. 0801008 **Client:** Apex Companies, LLC.
Project: CAD II Area

○ **Source of Sample:** VC 2007-119 2-3 **Sample Number:** 0801008-13

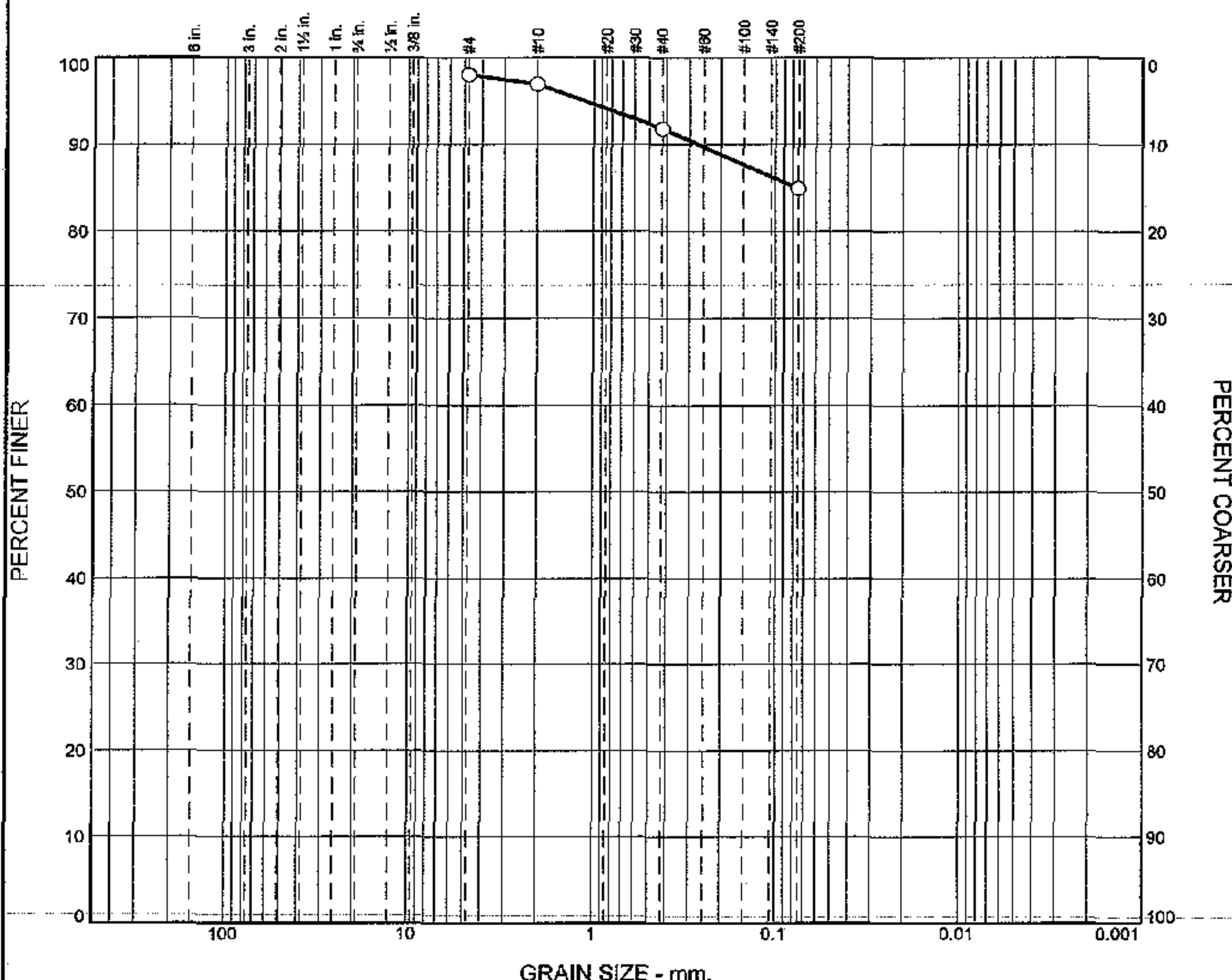
Remarks:

ALPHA WOODS HOLE LABS

Raynham, MA

Project

Particle Size Distribution Report



	% Cobbles	% Gravel	% Sand	% Silt	% Clay
○			13.1	85.0	

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0756							

Material Description	USCS	AASHTO
○	ML	A-4(0)

Project No. 0801008 **Client:** Apex Companies, LLC.

Project: CAD II Area

○ **Sample Source:** VC 2007-120 2-3 & 3-4 COMP **Sample No.:** 0801008-16

Remarks:

ALPHA WOODS HOLE LABS

Raynham, MA

Project

GRAIN SIZE DISTRIBUTION TEST DATA

1/24/2008

Client: Apex Companies, LLC.
Project: CAD II Area
Project Number: 0801008
Location: VC 2007-104 1-2
Sample Number: 0801008-02
USCS Classification: SP-SM **AASHTO Classification:** A-3
Sieve opening list: BS Bulk Sieve

Sieve Test Data

Post #200 Wash Test Weights (grams): Dry Sample and Tare = 125.47
Tare Wt. = 0.00
Minus #200 from wash = 8.9%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
137.70	0.00	#4	515.82	514.83	99.3
		#10	487.92	484.60	96.9
		#40	414.27	376.28	69.3
		#200	424.71	342.28	9.4

Fractional Components

Cobbles	Gravel	Sand	Silt	Clay
		89.9		

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0763	0.0882	0.1019	0.1362	0.2431	0.3248	0.7758	1.0271	1.3600	1.8007

Fineness Modulus	C_u	C_c
1.50	4.26	0.75

GeoTesting express
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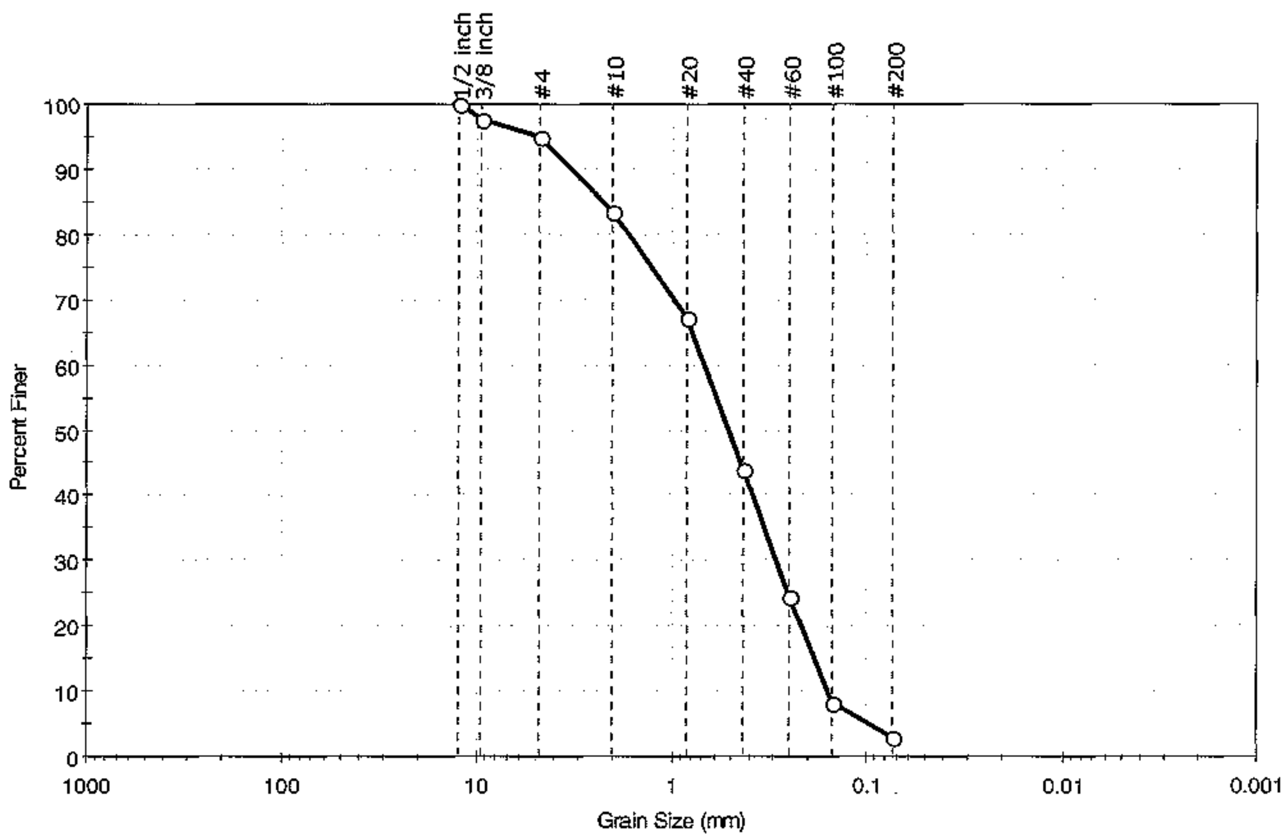
Client: Apex Companies, LLC			
Project: New Bedford CAD II (6615.003)			
Location: New Bedford, MA		Project No:	GTX-7817
Boring ID: ---	Sample Type: bag	Tested By:	ap
Sample ID: B01-CAD-072007	Test Date: 10/24/07	Checked By:	jdt
Depth : 4-6 ft	Test Id: 121641		
Test Comment: ---			
Sample Description: Moist, dark grayish brown sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	4.9	92.2	2.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.50	100		
3/8 inch	9.51	98		
#4	4.75	95		
#10	2.00	83		
#20	0.84	67		
#40	0.42	44		
#60	0.25	25		
#100	0.15	8		
#200	0.074	3		

Coefficients

D_{85} =2.2572 mm D_{30} =0.2894 mm
D_{60} =0.6797 mm D_{15} =0.1847 mm
D_{50} =0.5061 mm D_{10} =0.1578 mm
C_u =4.307 C_c =0.781

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
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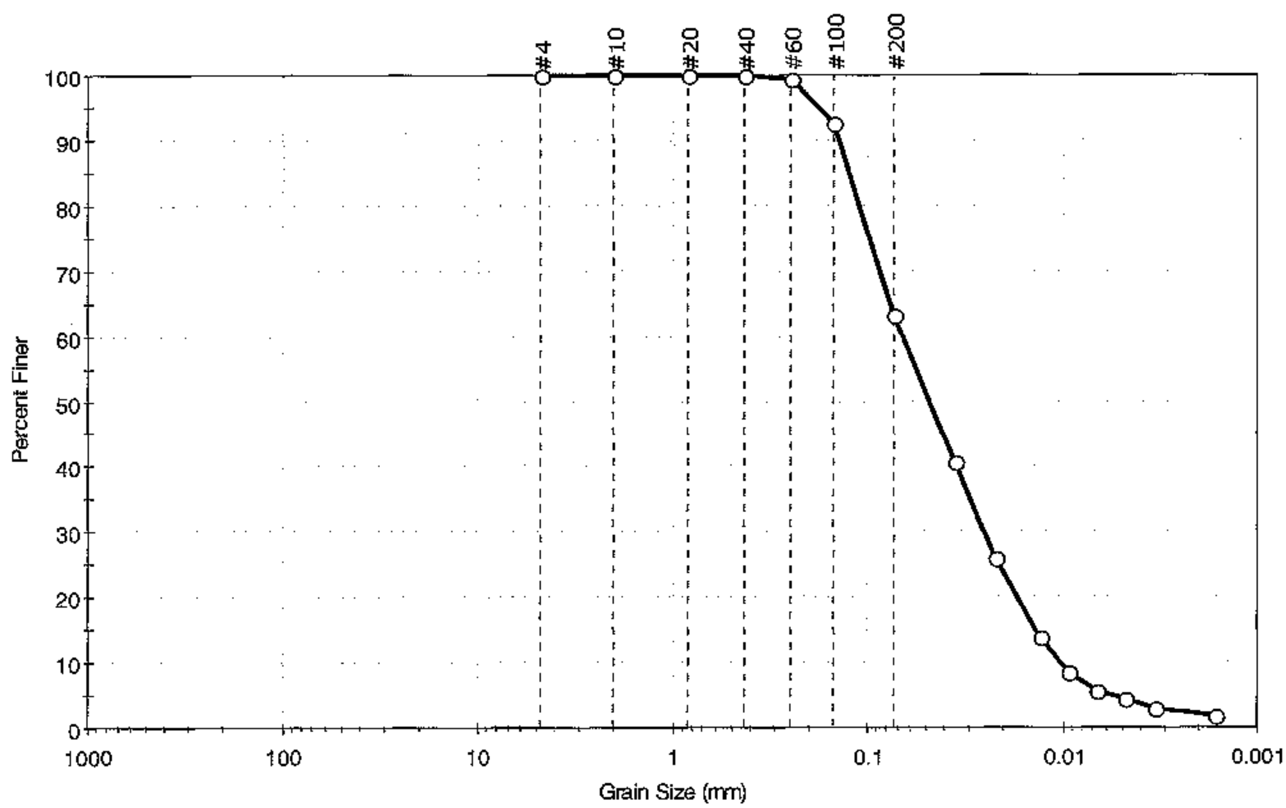
Client: Apex Companies, LLC			
Project: New Bedford CAD II (6615.003)			
Location: New Bedford, MA		Project No:	GTX-7817
Boring ID: ---	Sample Type: bag	Tested By:	ap
Sample ID:B01-CAD-072007	Test Date: 10/25/07	Checked By:	jdt
Depth : 26-28 ft	Test Id: 121646		

Test Comment: ---
Sample Description: Moist, light olive brown sandy silt
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	36.8	63.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	93		
#200	0.074	63		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0355	41		
---	0.0220	26		
---	0.0133	14		
---	0.0095	8		
---	0.0068	6		
---	0.0048	4		
---	0.0034	3		
---	0.0017	2		

Coefficients

D_{85} =0.1244 mm — D_{30} =0.0250 mm
D_{60} =0.0667 mm — D_{15} =0.0139 mm
D_{50} =0.0480 mm — D_{10} =0.0104 mm
C_u =N/A — C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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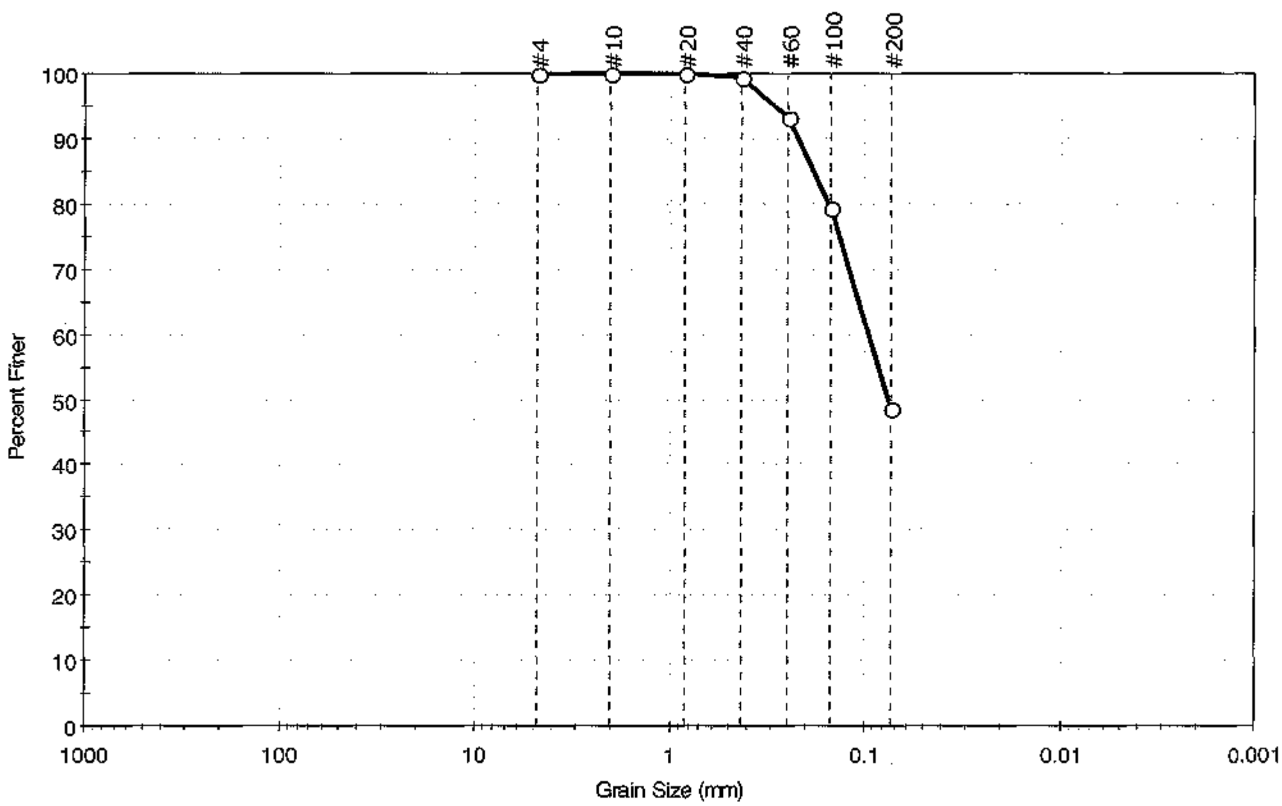
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Apex Companies, LLC				
Project:	New Bedford CAD II (6615.003)				
Location:	New Bedford, MA			Project No:	GTX-7817
Boring ID:	---	Sample Type:	bag	Tested By:	ap
Sample ID:	B01-CAD-072007	Test Date:	10/24/07	Checked By:	jdt
Depth :	44-46 ft	Test Id:	121642		

Test Comment: ---
Sample Description: Moist, greenish gray silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	51.5	48.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	100		
#40	0.42	99		
#60	0.25	93		
#100	0.15	79		
#200	0.074	49		

Coefficients

D_{85} =0.1841 mm D_{30} =N/A
D_{60} =0.0960 mm D_{15} =N/A
D_{50} =0.0765 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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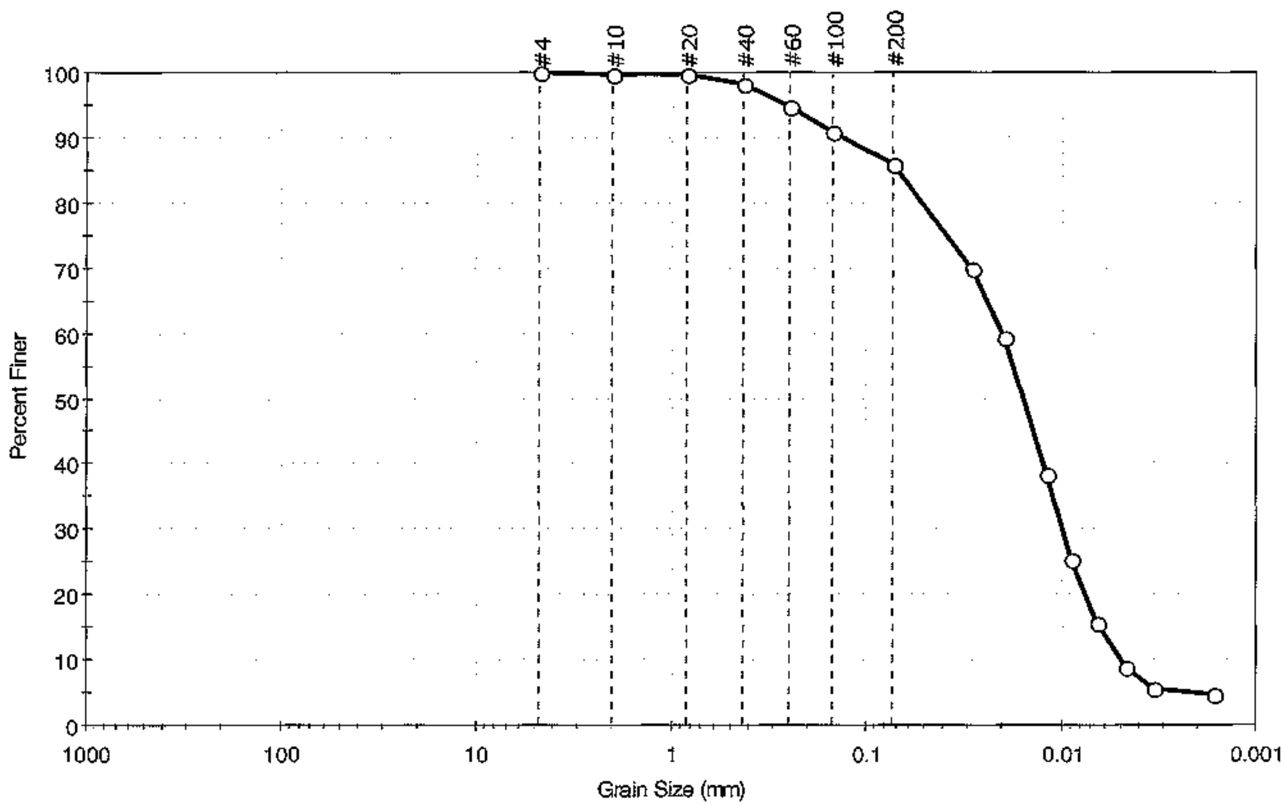
Client:	Apex Companies, LLC				
Project:	New Bedford CAD II (6615.003)				
Location:	New Bedford, MA			Project No:	GTX-7817
Boring ID:	---	Sample Type:	bag	Tested By:	ap
Sample ID:	B01-CAD-072007	Test Date:	10/25/07	Checked By:	jdt
Depth :	60-62 ft	Test Id:	121647		

Test Comment: ---
Sample Description: Moist, gray silt
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	14.1	85.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	100		
#40	0.42	98		
#60	0.25	95		
#100	0.15	91		
#200	0.074	86		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0290	70		
---	0.0198	59		
---	0.0119	38		
---	0.0091	25		
---	0.0066	16		
---	0.0047	9		
---	0.0034	6		
---	0.0017	5		

Coefficients

D_{85} =0.0702 mm
D_{30} =0.0100 mm
D_{60} =0.0204 mm
D_{15} =0.0064 mm
D_{50} =0.0158 mm
D_{10} =0.0050 mm
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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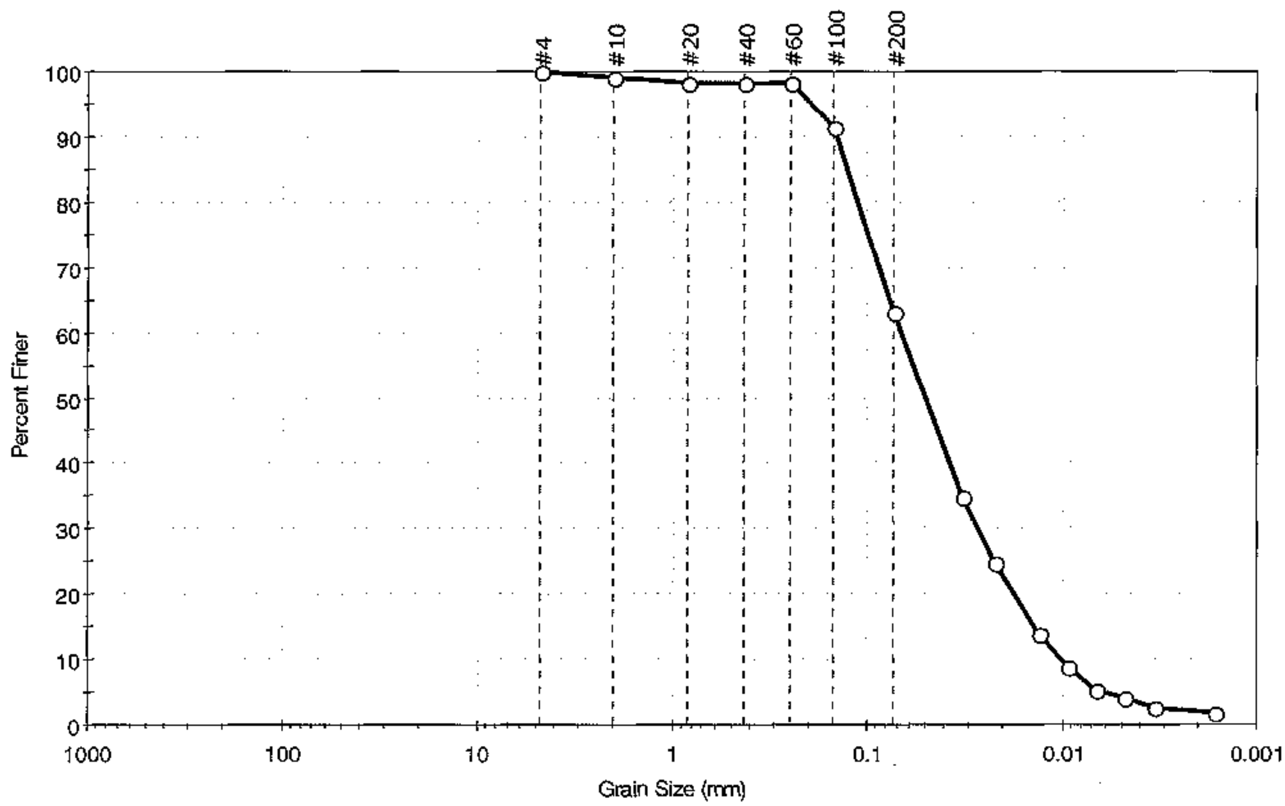
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Apex Companies, LLC				
Project:	New Bedford CAD II (6615.003)				
Location:	New Bedford, MA			Project No:	GTX-7817
Boring ID:	---	Sample Type:	bag	Tested By:	ap
Sample ID:	B04-CAD-072007	Test Date:	10/25/07	Checked By:	jdt
Depth :	9-11 ft	Test Id:	121648		

Test Comment: ---
Sample Description: Moist, light olive gray sandy silt
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	36.7	63.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.84	98		
#40	0.42	98		
#60	0.25	98		
#100	0.15	91		
#200	0.074	63		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0325	35		
---	0.0223	25		
---	0.0132	14		
---	0.0094	9		
---	0.0068	5		
---	0.0048	4		
---	0.0034	3		
---	0.0017	2		

Coefficients

D_{85} =0.1271 mm D_{30} =0.0271 mm
D_{60} =0.0674 mm D_{15} =0.0139 mm
D_{50} =0.0505 mm D_{10} =0.0102 mm
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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GeoTesting express
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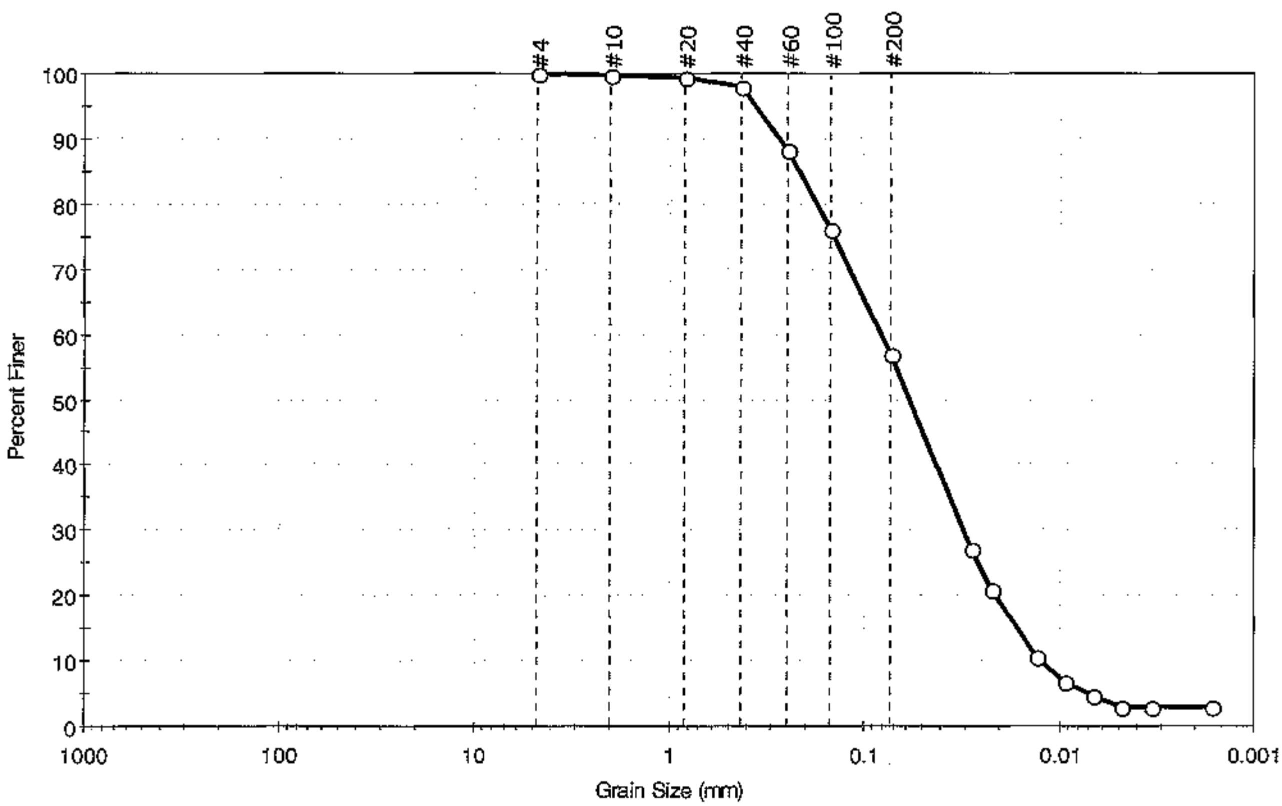
Client:	Apex Companies, LLC				
Project:	New Bedford CAD II (6615.003)				
Location:	New Bedford, MA			Project No:	GTX-7817
Boring ID:	---	Sample Type:	bag	Tested By:	ap
Sample ID:	B04-CAD-072007	Test Date:	10/25/07	Checked By:	jdt
Depth :	25-27 ft	Test Id:	121649		
Test Comment:	---				
Sample Description:	Moist, mottled light olive brown and red sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	43.0	57.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	99		
#40	0.42	98		
#60	0.25	88		
#100	0.15	76		
#200	0.074	57		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0283	27		
---	0.0223	21		
---	0.0130	11		
---	0.0095	7		
---	0.0067	5		
---	0.0048	3		
---	0.0034	3		
---	0.0017	3		

Coefficients

D_{85} =0.2184 mm D_{30} =0.0309 mm
D_{60} =0.0826 mm D_{15} =0.0164 mm
D_{50} =0.0590 mm D_{10} =0.0124 mm
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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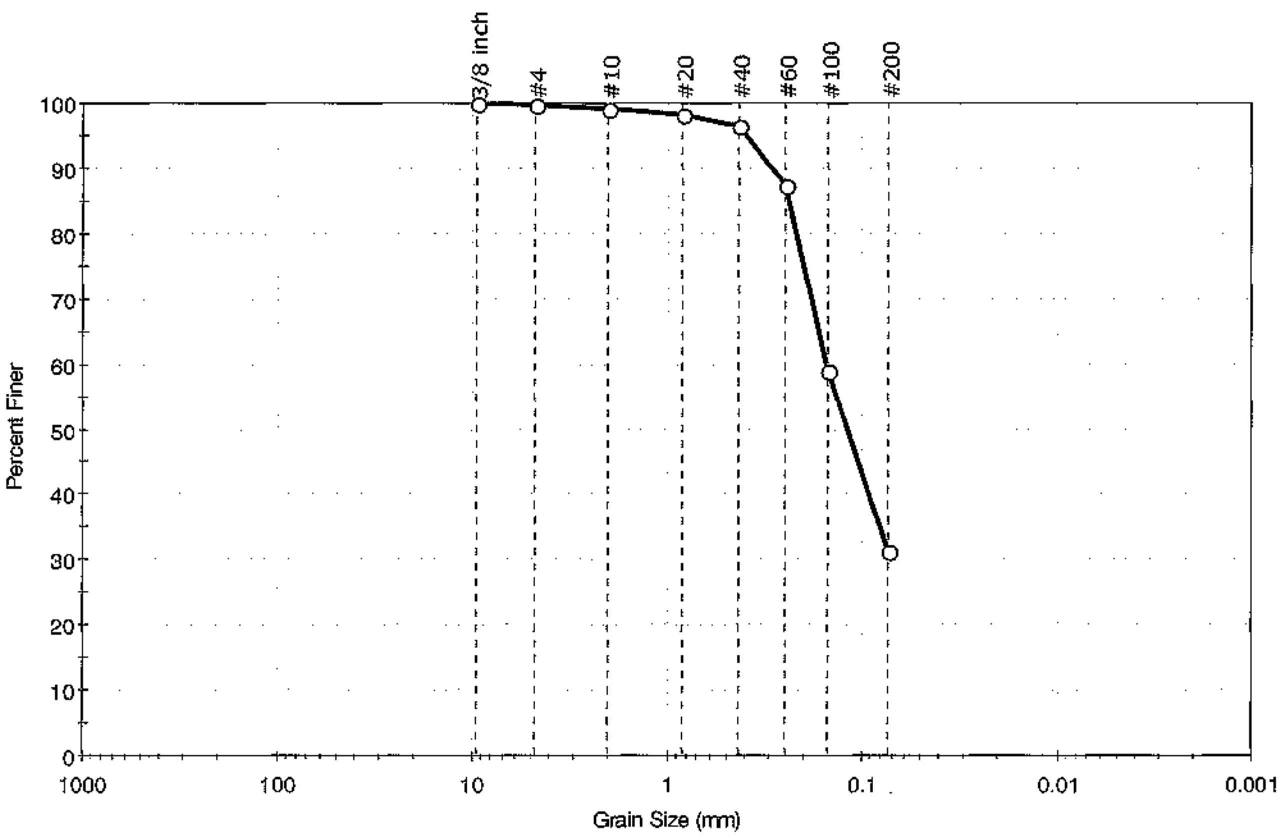
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Apex Companies, LLC				
Project:	New Bedford CAD II (6615.003)				
Location:	New Bedford, MA			Project No:	GTX-7817
Boring ID: ---		Sample Type:	bag	Tested By:	ap
Sample ID:B04-CAD-072007		Test Date:	10/24/07	Checked By:	jdt
Depth :	30-32 ft	Test Id:	121643		
Test Comment:	---				
Sample Description:	Moist, light yellowish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.4	68.3	31.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8 inch	9.51	100		
#4	4.75	100		
#10	2.00	99		
#20	0.84	98		
#40	0.42	97		
#60	0.25	87		
#100	0.15	59		
#200	0.074	31		

Coefficients

D_{85} =0.2394 mm	D_{30} =N/A
D_{60} =0.1515 mm	D_{15} =N/A
D_{50} =0.1185 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

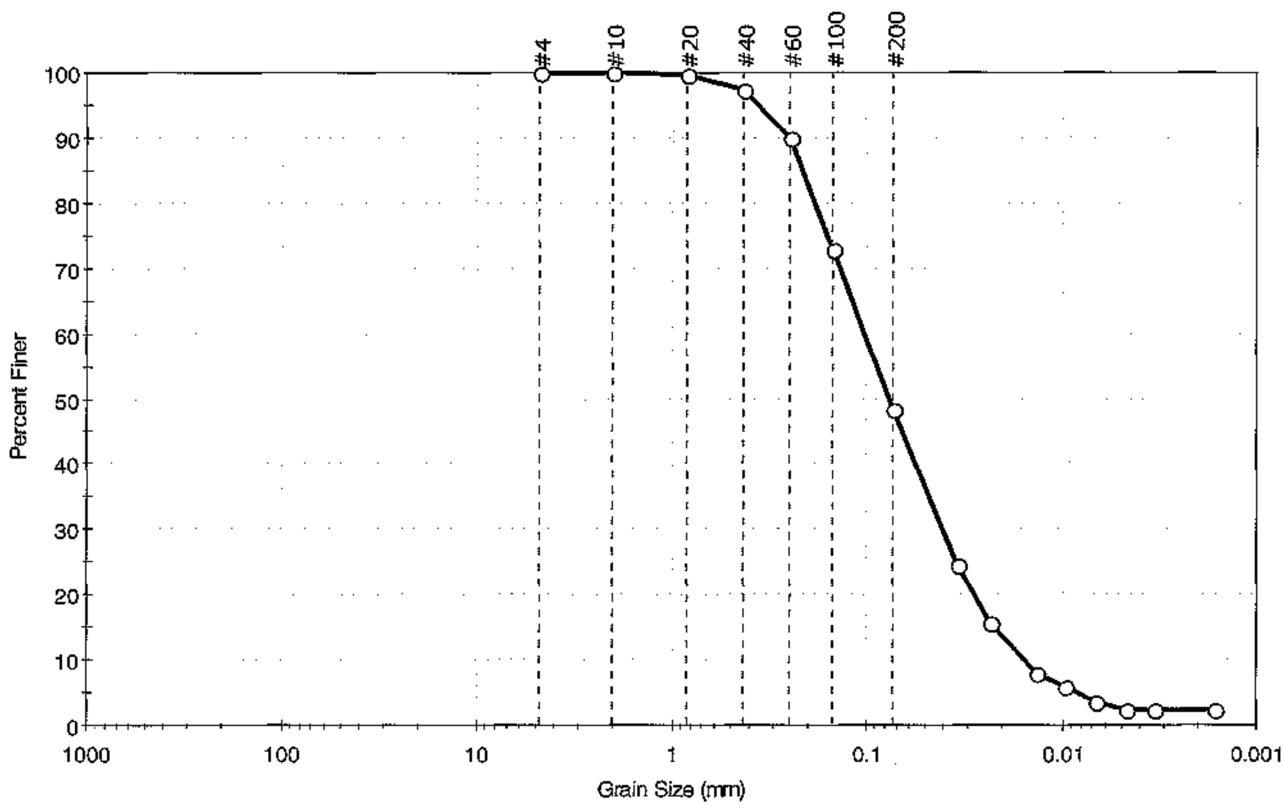
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client: Apex Companies, LLC			
Project: New Bedford CAD II (6615.003)			
Location: New Bedford, MA		Project No:	GTX-7817
Boring ID: ---	Sample Type: bag	Tested By:	ap
Sample ID:B04-CAD-072007	Test Date: 10/25/07	Checked By:	jdt
Depth : 45-47 ft	Test Id: 121650		
Test Comment: ---			
Sample Description: Moist, gray silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	51.6	48.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	100		
#40	0.42	97		
#60	0.25	90		
#100	0.15	73		
#200	0.074	48		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0342	24		
---	0.0231	16		
---	0.0133	8		
---	0.0095	6		
---	0.0068	4		
---	0.0048	2		
---	0.0034	2		
---	0.0017	2		

Coefficients

D_{85} =0.2148 mm　　D_{30} =0.0409 mm

D_{60} =0.1034 mm　　D_{15} =0.0220 mm

D_{50} =0.0775 mm　　D_{10} =0.0154 mm

C_u =N/A　　C_c =N/A

Classification

ASTM　N/A

AASHTO　Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

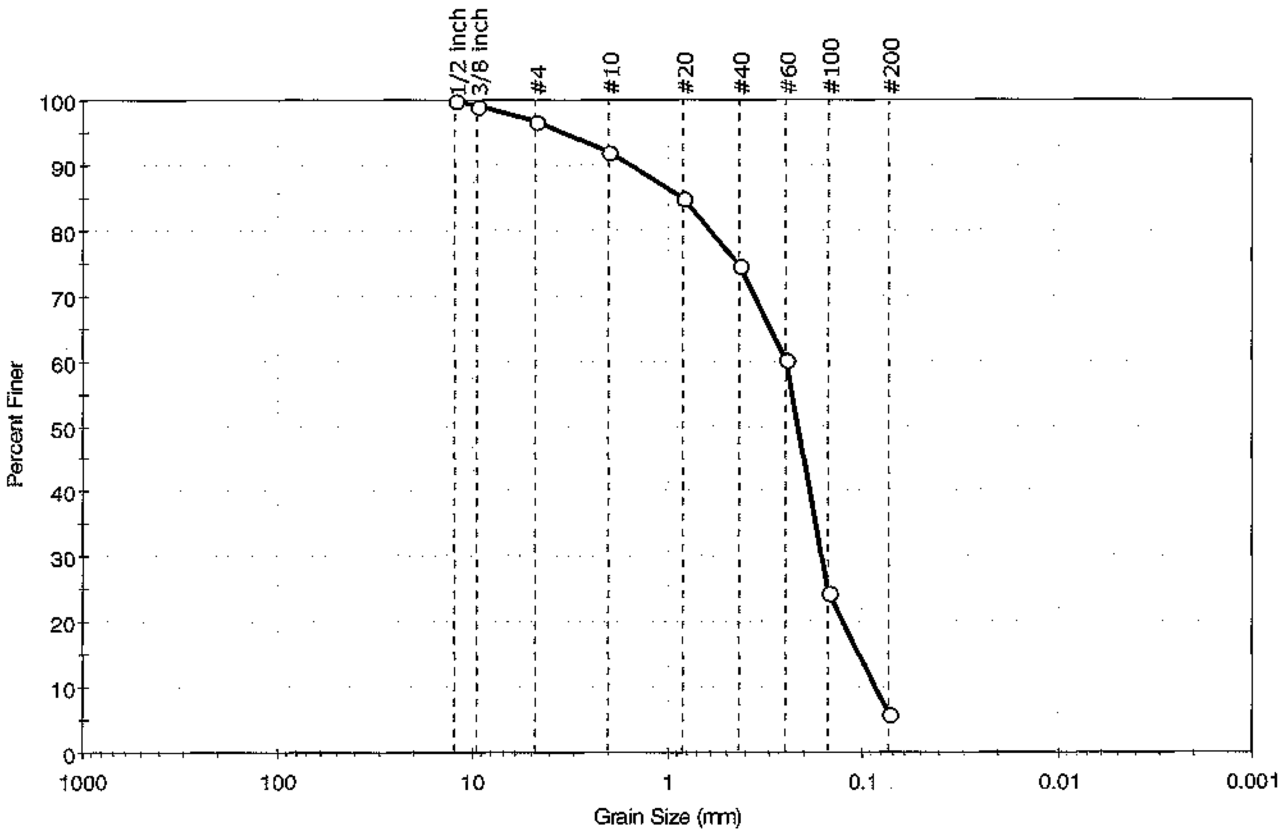
Sand/Gravel Hardness : HARD

printed 10/25/2007 2:21:20 PM

GeoTesting express
a subsidiary of Geocomp Corporation

Client: Apex Companies, LLC			
Project: New Bedford CAD II (6615.003)			
Location: New Bedford, MA		Project No:	GTX-7817
Boring ID: ---	Sample Type: bag	Tested By:	ap
Sample ID:B03-CAD-072007	Test Date: 10/24/07	Checked By:	jdt
Depth : 35-37 ft	Test Id: 121644		
Test Comment: ---			
Sample Description: Moist, greenish gray sand with silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	3.2	90.8	6.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.50	100		
3/8 inch	9.51	99		
#4	4.75	97		
#10	2.00	92		
#20	0.84	85		
#40	0.42	75		
#60	0.25	60		
#100	0.15	25		
#200	0.074	6		

Coefficients

D_{85} =0.8530 mm D_{30} =0.1612 mm
D_{60} =0.2494 mm D_{15} =0.1038 mm
D_{50} =0.2156 mm D_{10} =0.0860 mm
C_u =2.900 C_c =1.212

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

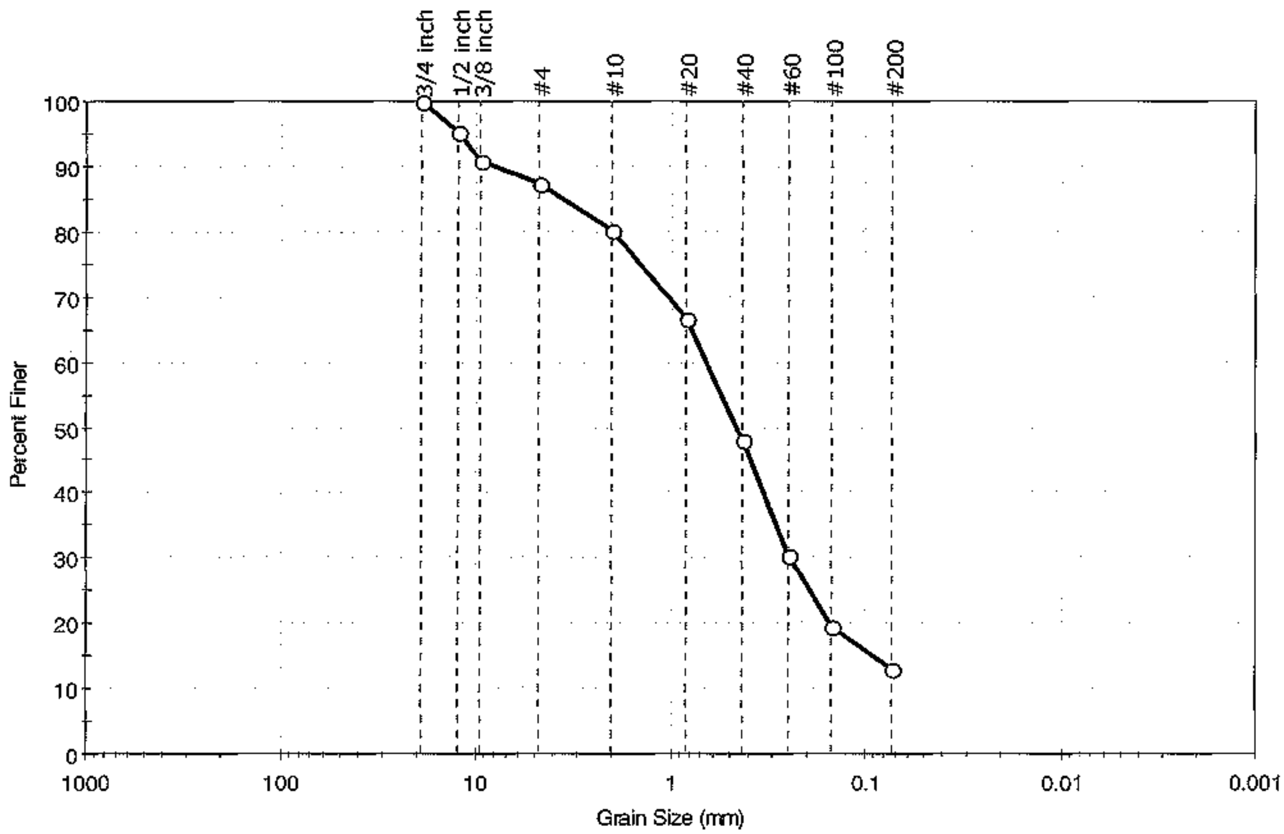
printed 10/25/2007 2:21:36 PM

GeoTesting express
a subsidiary of Geocomp Corporation

Client: Apex Companies, LLC					
Project: New Bedford CAD II (6615.003)					
Location: New Bedford, MA				Project No:	GTX-7817
Boring ID: ---		Sample Type:	bag	Tested By:	ap
Sample ID: B02-CAD-072007		Test Date:	10/24/07	Checked By:	jdt
Depth : 70-72 ft		Test Id:	121645		

Test Comment: ---
Sample Description: Dry, yellowish brown silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	12.6	74.5	12.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.50	95		
3/8 inch	9.51	91		
#4	4.75	87		
#10	2.00	80		
#20	0.84	67		
#40	0.42	48		
#60	0.25	30		
#100	0.15	20		
#200	0.074	13		

Coefficients

D_{85} =3.5619 mm	D_{30} =0.2462 mm
D_{60} =0.6586 mm	D_{15} =0.0920 mm
D_{50} =0.4575 mm	D_{10} =0.0544 mm
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

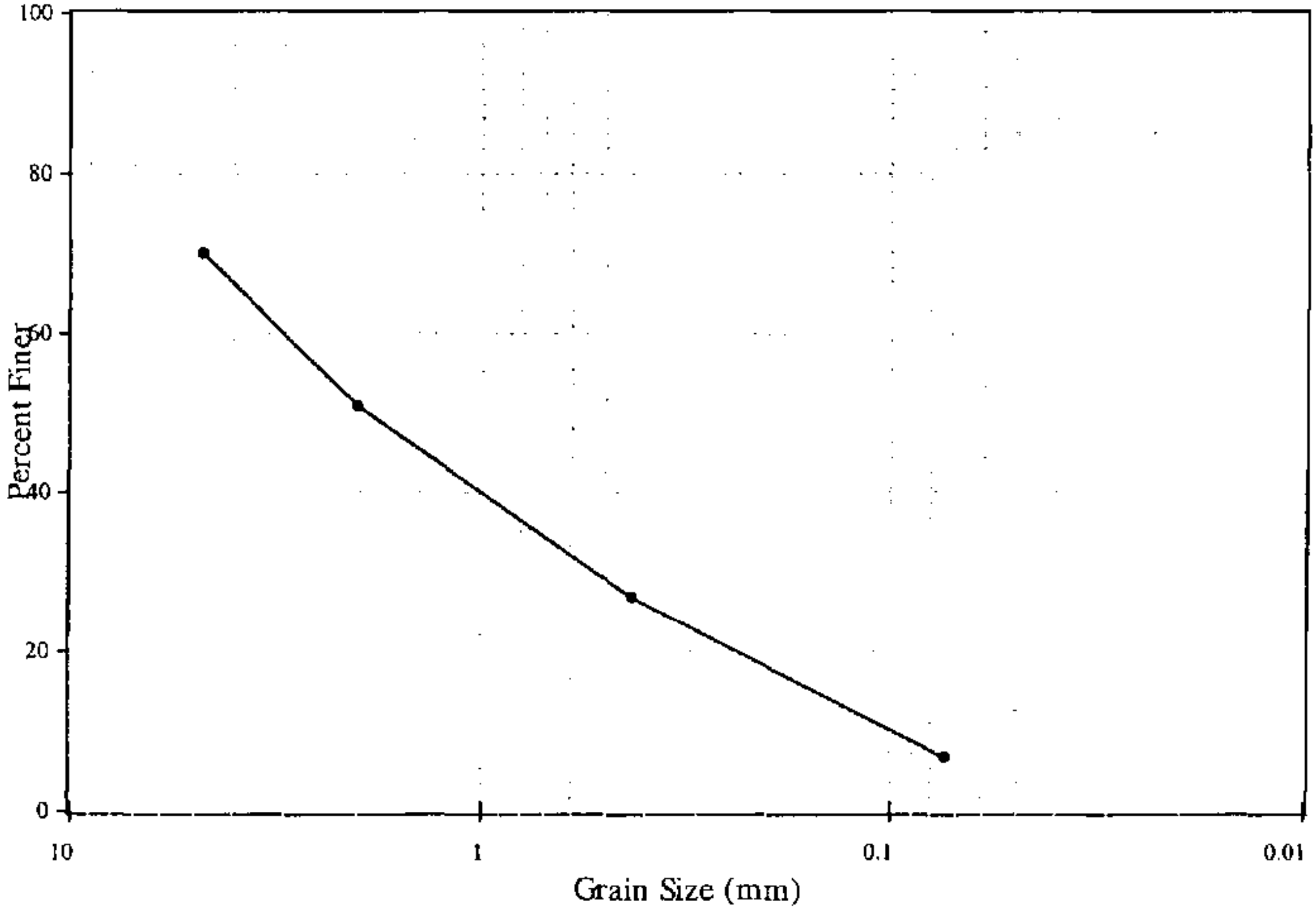
Sand/Gravel Hardness : HARD

printed 10/25/2007 2:22:19 PM

Sieve Analysis

Client:	Apex Environmental, Inc.		
Project:	NBHDC - COM-97		
Case:	N/A	SDG:	N/A
Client ID:	CAD-2 6'-8'		
Matrix:	Sediment		
Collection Date:	9/23/04		

Lab Code: MA00030
ETR: 0409167
Lab ID: 0409167-02
Concentration Units: %
Received Date: 9/24/04
Analysis Date: 10/6/04



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	29.87	Gravel
#10	<4.76 mm - 2 mm	19.30	Coarse Sand
#40	<2 mm - 0.425 mm	24.04	Medium Sand
#200	<0.425 mm - 0.074 mm	20.06	Fine Sand
Passing #200	<0.074 mm	6.74	Silt/Clay

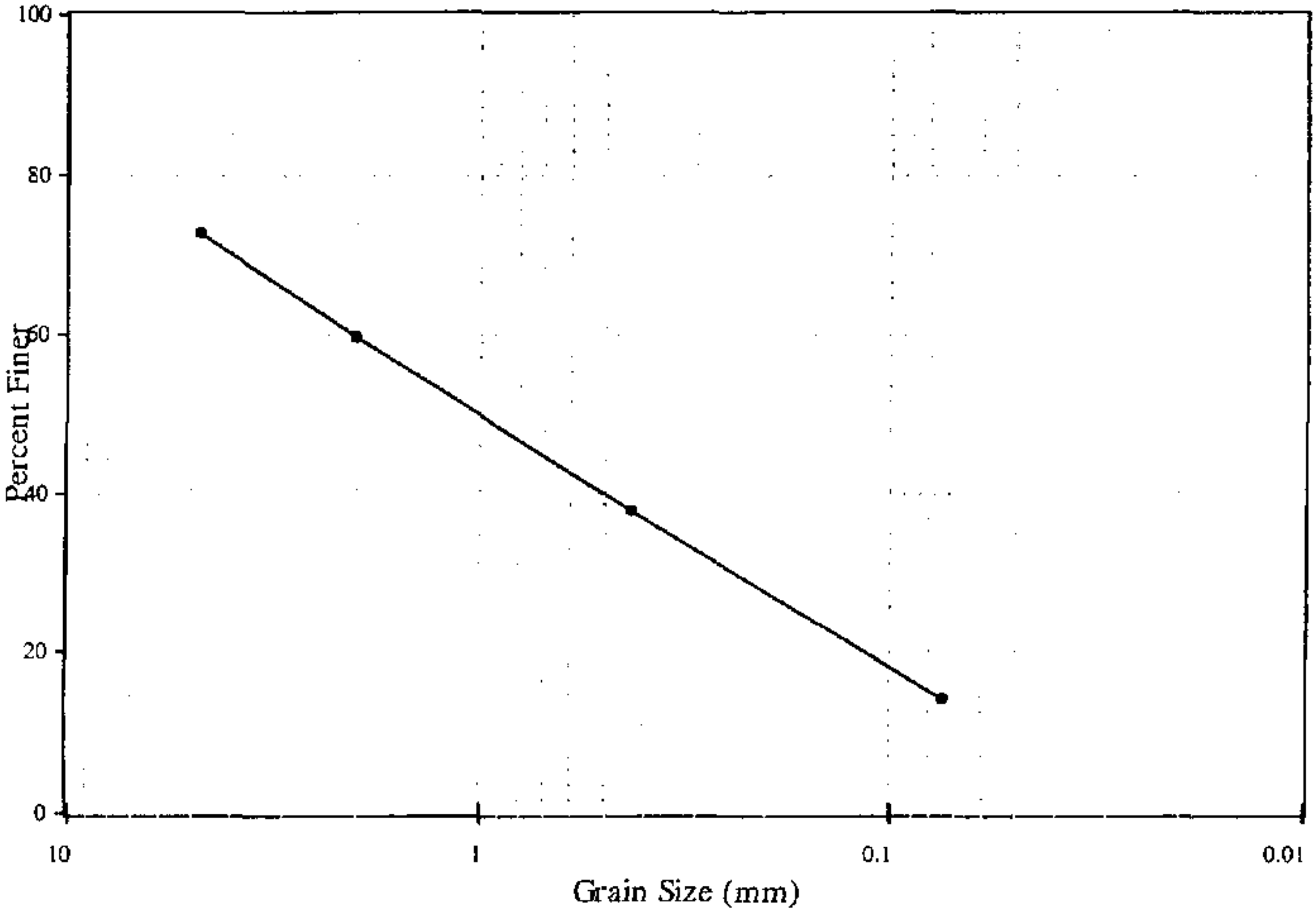
N/A - Not Applicable

10/07/04 10:37

Sieve Analysis

Client: **Apex Environmental, Inc.**
Project: **NBHDC - COM-97**
Case: **N/A** SDG: **N/A**
Client ID: **CAD-2 11'-13'**
Matrix: **Sediment**
Collection Date: **9/23/04**

Lab Code: **MA00030**
ETR: **0409167**
Lab ID: **0409167-04**
Concentration Units: **%**
Received Date: **9/24/04**
Analysis Date: **10/6/04**



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	27.59	Gravel
#10	<4.76 mm - 2 mm	12.76	Coarse Sand
#40	<2 mm - 0.425 mm	21.96	Medium Sand
#200	<0.425 mm - 0.074 mm	23.52	Fine Sand
Passing #200	<0.074 mm	14.24	Silt/Clay

N/A - Not Applicable

10/07/04 10:40

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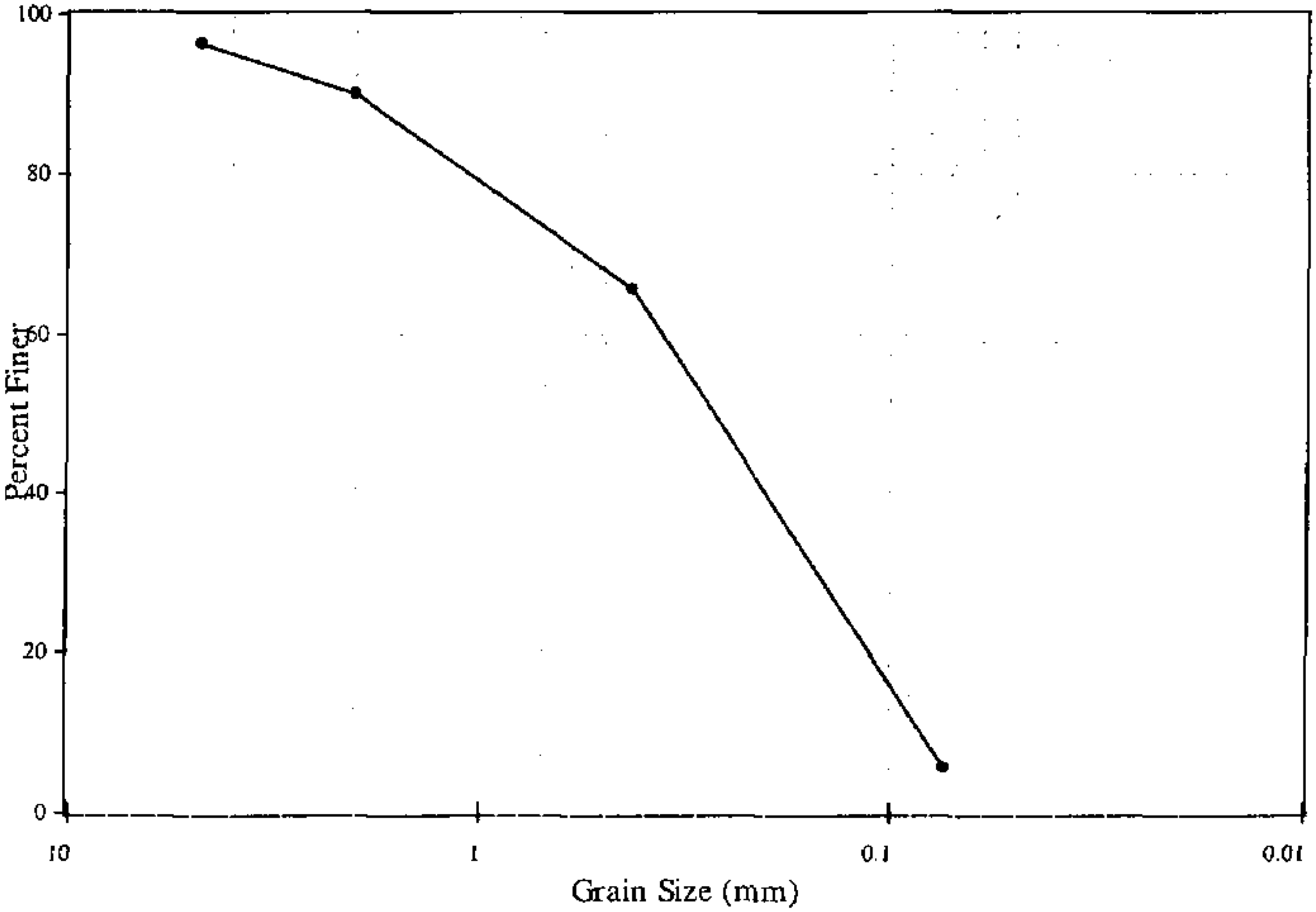
Sieve Analysis

Client: **Apex Environmental, Inc.**
Project: **NBHDC - COM-97**
Case: **N/A** SDG: **N/A**
Client ID: **CAD-2 16'-18'**
Matrix: **Sediment**
Collection Date: **9/23/04**

Lab Code: **MA00030**
ETR: **0409167**
Lab ID: **0409167-06**
Concentration Units: **%**
Received Date: **9/24/04**
Analysis Date: **10/6/04**



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	3.59	Gravel
#10	<4.76 mm - 2 mm	6.48	Coarse Sand
#40	<2 mm - 0.425 mm	24.47	Medium Sand
#200	<0.425 mm - 0.074 mm	59.97	Fine Sand
Passing #200	<0.074 mm	5.48	Silt/Clay

N/A - Not Applicable

10/07/04 10:43

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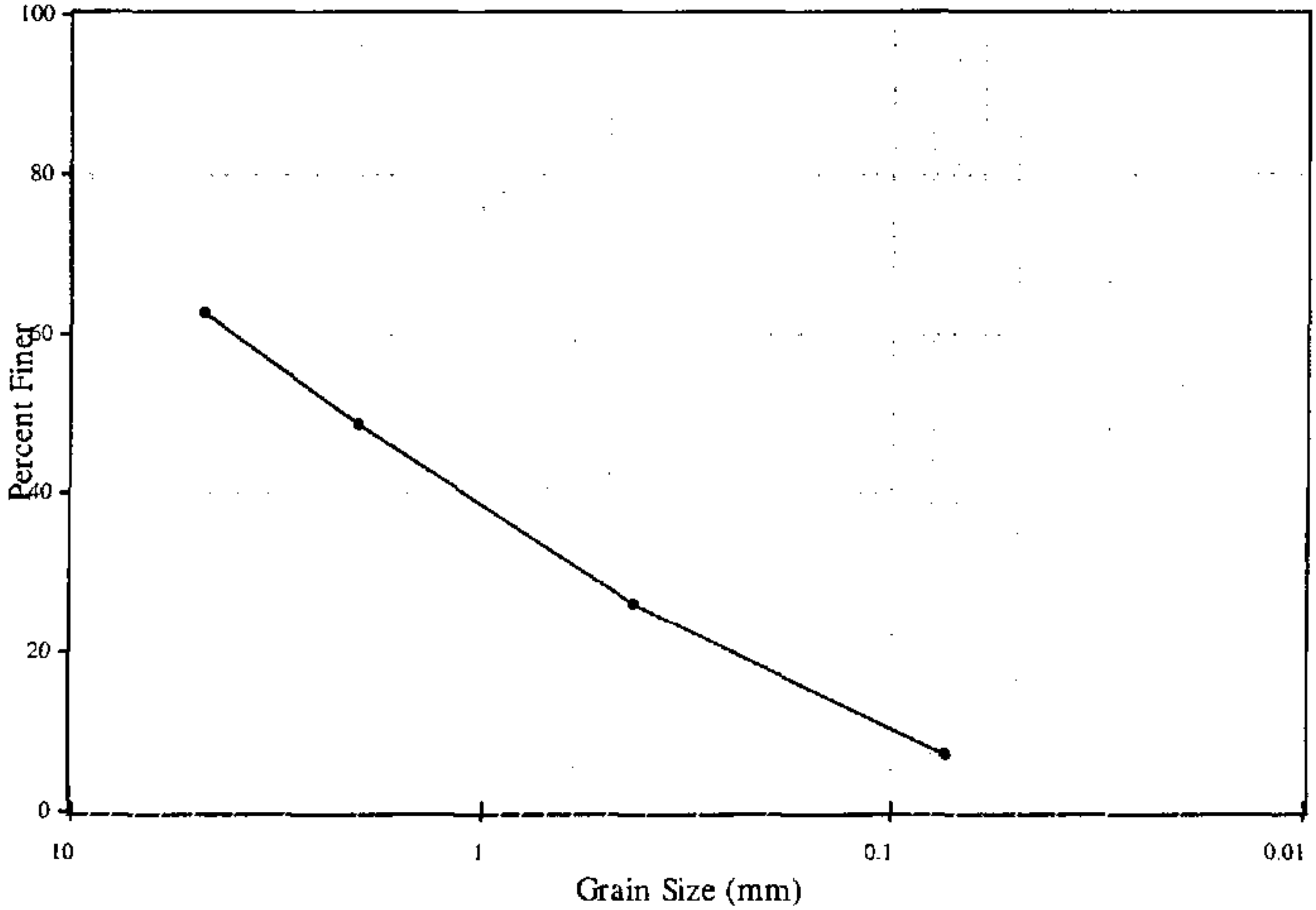
Sieve Analysis

Client: **Apex Environmental, Inc.**
Project: **NBHDC - COM-97**
Case: **N/A** SDG: **N/A**
Client ID: **CAD-2 24'-26'**
Matrix: **Sediment**
Collection Date: **9/24/04**

Lab Code: **MA00030**
ETR: **0409167**
Lab ID: **0409167-07**
Concentration Units: **%**
Received Date: **9/24/04**
Analysis Date: **10/6/04**



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	37.38	Gravel
#10	<4.76 mm - 2 mm	14.19	Coarse Sand
#40	<2 mm - 0.425 mm	22.42	Medium Sand
#200	<0.425 mm - 0.074 mm	18.85	Fine Sand
Passing #200	<0.074 mm	7.17	Silt/Clay

N/A - Not Applicable

10/07/04 10:46

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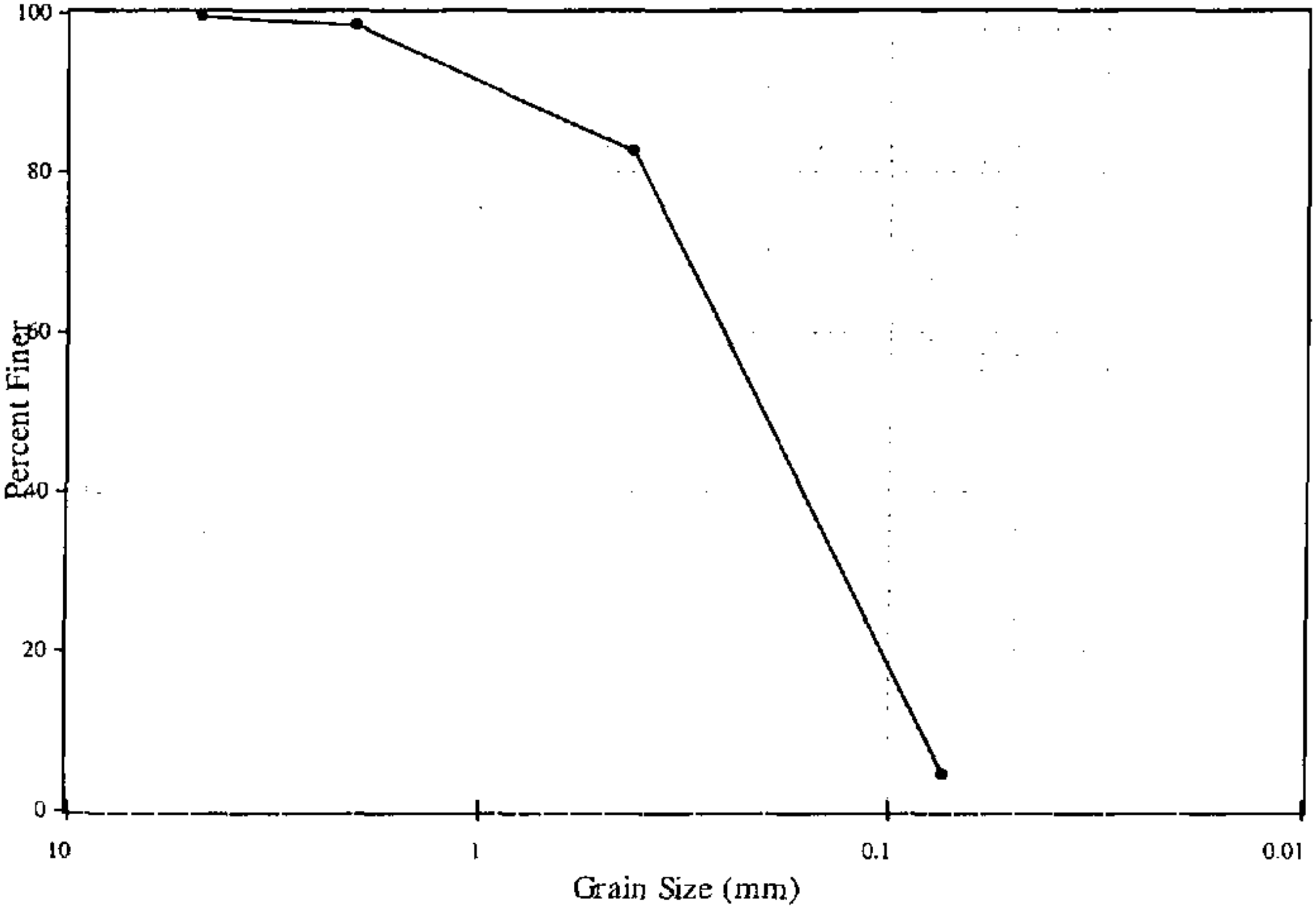
Sieve Analysis

Client:	Apex Environmental, Inc.		Lab Code: MA00030
Project:	NBHDC - COM-97		ETR: 0409167
Case:	N/A	SDG: N/A	Lab ID: 0409167-08
Client ID:	CAD-3A 4'-6'		Concentration Units: %
Matrix:	Sediment		Received Date: 9/14/04
Collection Date: 9/13/04			Analysis Date: 10/6/04



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	0.19	Gravel
#10	<4.76 mm - 2 mm	1.26	Coarse Sand
#40	<2 mm - 0.425 mm	15.85	Medium Sand
#200	<0.425 mm - 0.074 mm	78.41	Fine Sand
Passing #200	<0.074 mm	4.11	Silt/Clay

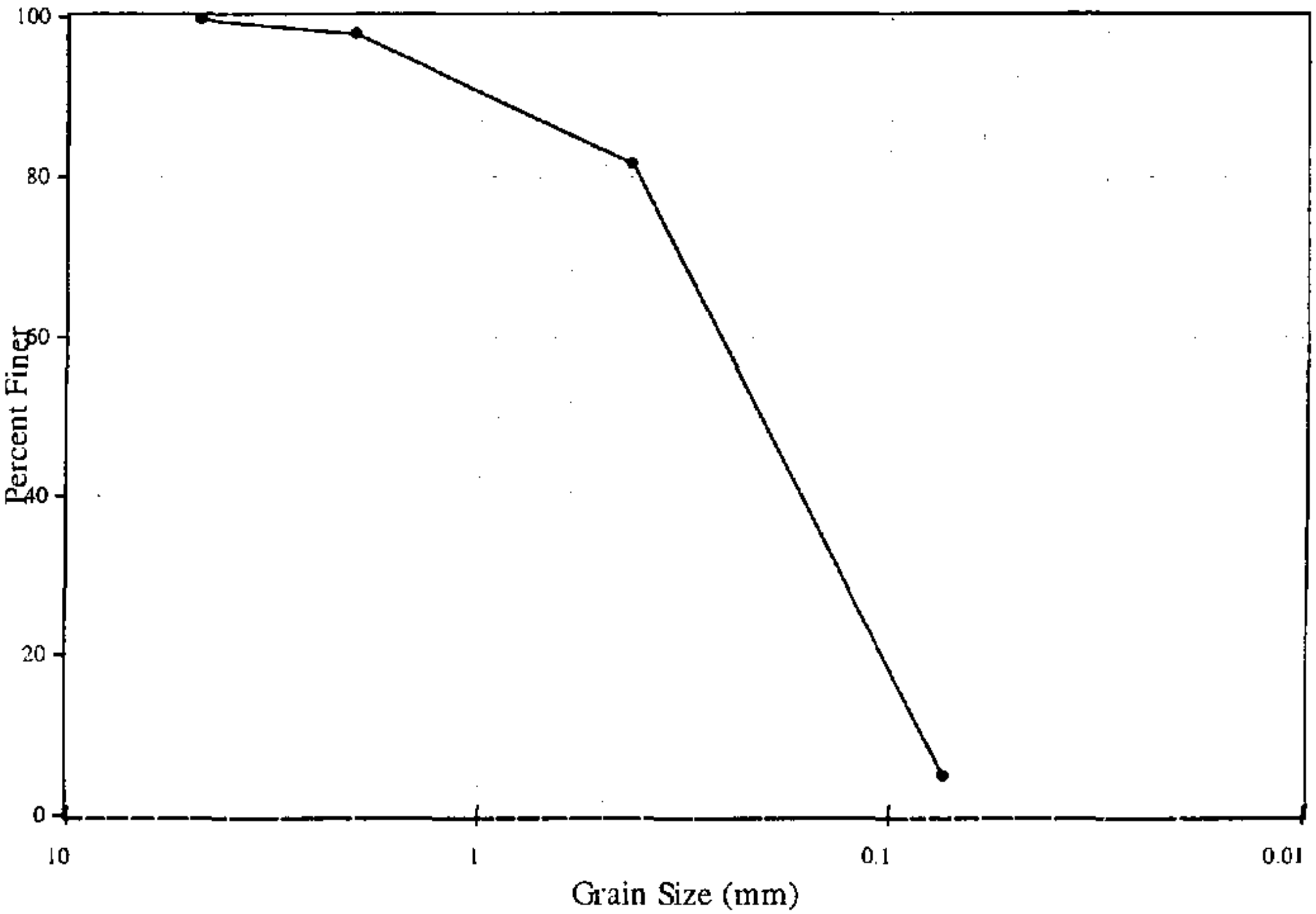
N/A - Not Applicable

10/07/04 10:50

Sieve Analysis

Client: **Apex Environmental, Inc.**
Project: **NBHDC - COM-97**
Case: N/A SDG: N/A
Client ID: **CAD-3A 4'-6'**
Matrix: **Sediment**
Collection Date: **9/13/04**

Lab Code: **MA00030**
ETR: **0409167**
Lab ID: **0409167-08 D**
Concentration Units: **%**
Received Date: **9/14/04**
Analysis Date: **10/6/04**



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	0.28	Gravel
#10	<4.76 mm - 2 mm	1.94	Coarse Sand
#40	<2 mm - 0.425 mm	16.18	Medium Sand
#200	<0.425 mm - 0.074 mm	76.81	Fine Sand
Passing #200	<0.074 mm	4.87	Silt/Clay

N/A - Not Applicable

10/07/04 11:55

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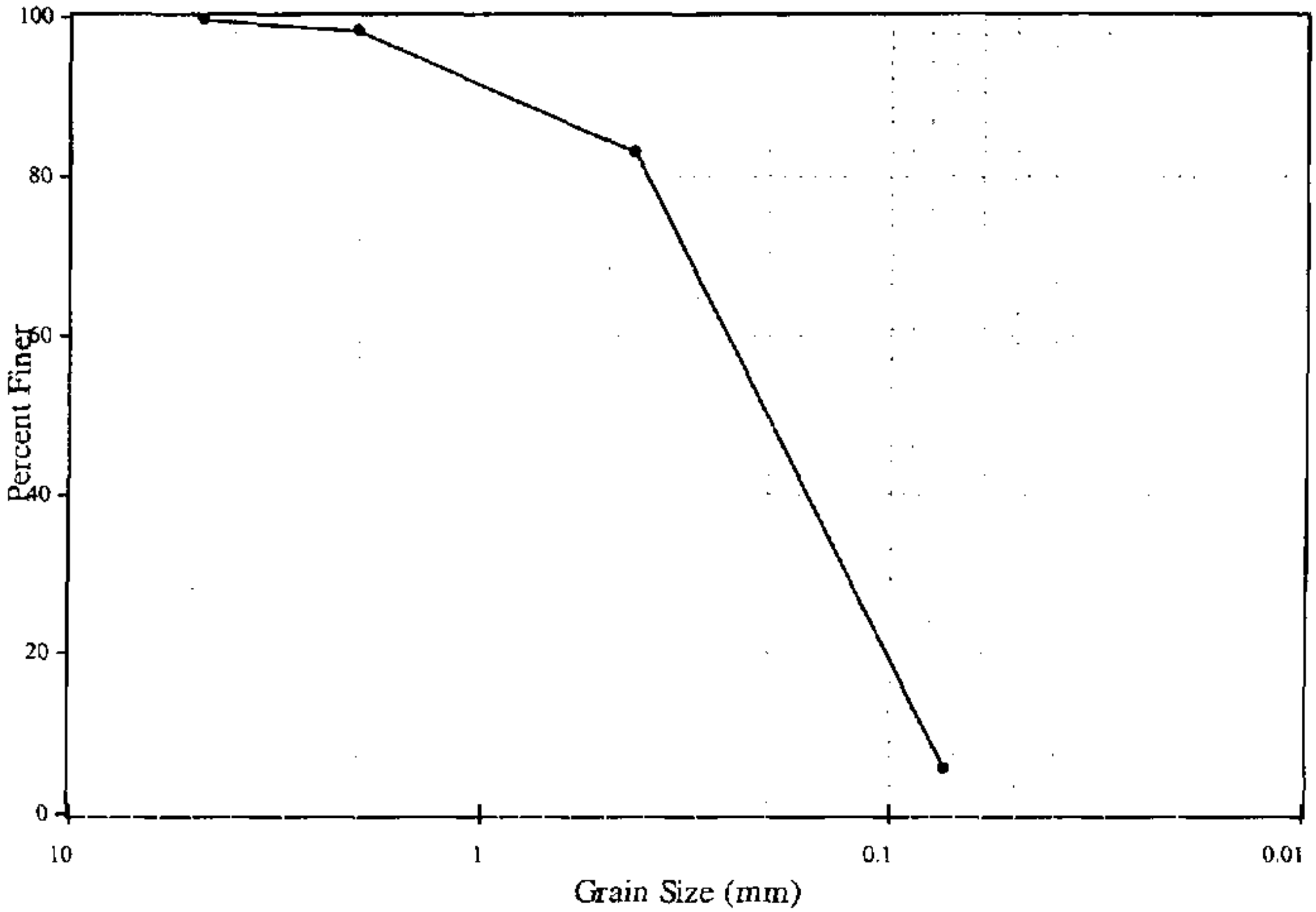
Sieve Analysis

Client: Apex Environmental, Inc.
Project: NBHDC - COM-97
Case: N/A SDG: N/A
Client ID: CAD-3A 8'-10'
Matrix: Sediment
Collection Date: 9/13/04

Lab Code: MA00030
ETR: 0409167
Lab ID: 0409167-09
Concentration Units: %
Received Date: 9/14/04
Analysis Date: 10/6/04



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	0.41	Gravel
#10	<4.76 mm - 2 mm	1.29	Coarse Sand
#40	<2 mm - 0.425 mm	15.37	Medium Sand
#200	<0.425 mm - 0.074 mm	77.35	Fine Sand
Passing #200	<0.074 mm	5.56	Silt/Clay

N/A - Not Applicable

10/07/04 10:53

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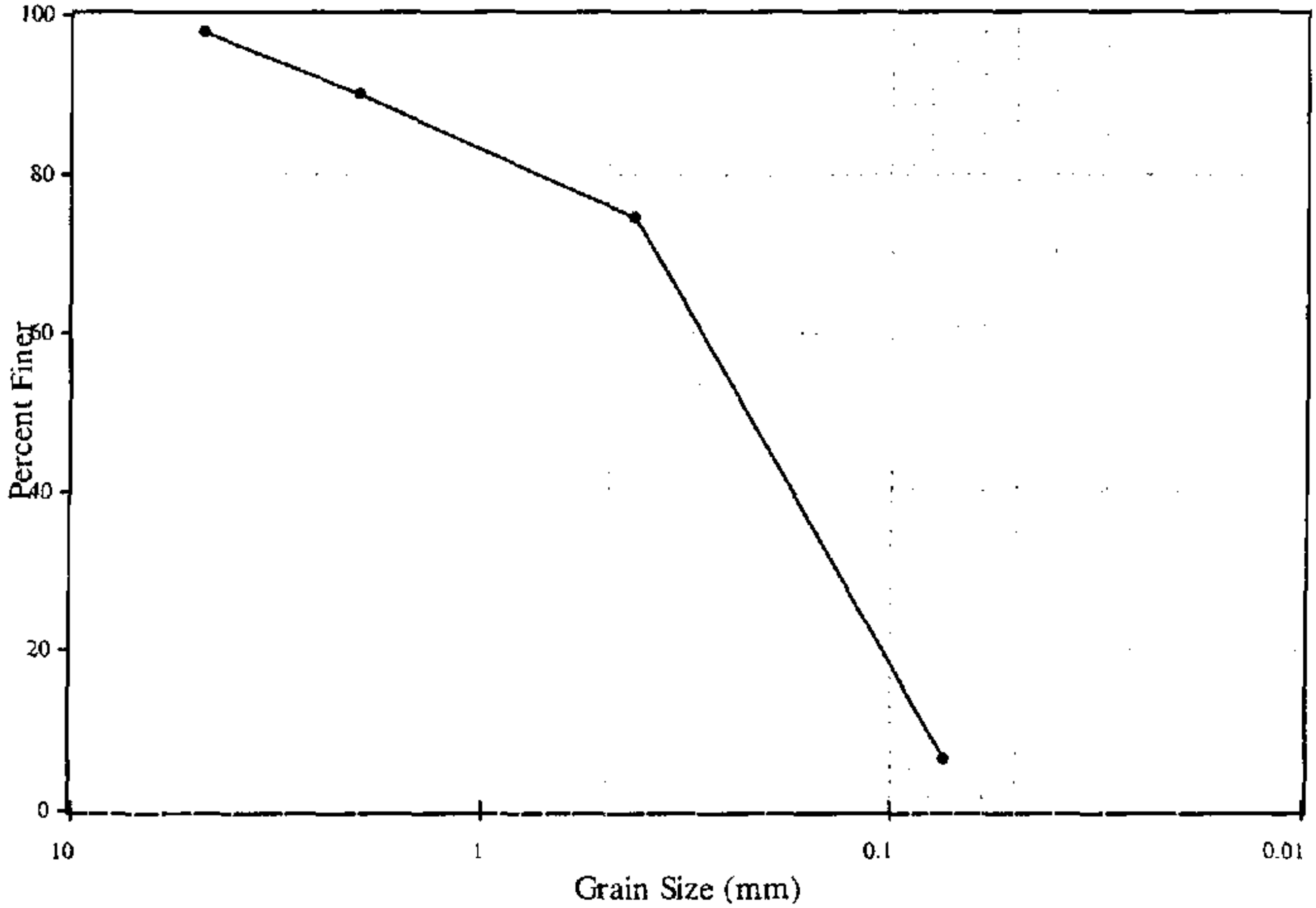
Sieve Analysis

Client:	Apex Environmental, Inc.
Project:	NBHDC - COM-97
Case:	N/A SDG: N/A
Client ID:	CAD-3A 26'-28'
Matrix:	*Sediment*
Collection Date:	9/13/04

Lab Code: **MA00030**
ETR: **0409167**
Lab ID: **0409167-10**
Concentration Units: *%*
Received Date: **9/14/04**
Analysis Date: **10/6/04**



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	2.15	Gravel
#10	<4.76 mm - 2 mm	7.67	Coarse Sand
#40	<2 mm - 0.425 mm	15.88	Medium Sand
#200	<0.425 mm - 0.074 mm	67.99	Fine Sand
Passing #200	<0.074 mm	6.25	Silt/Clay

N/A - Not Applicable

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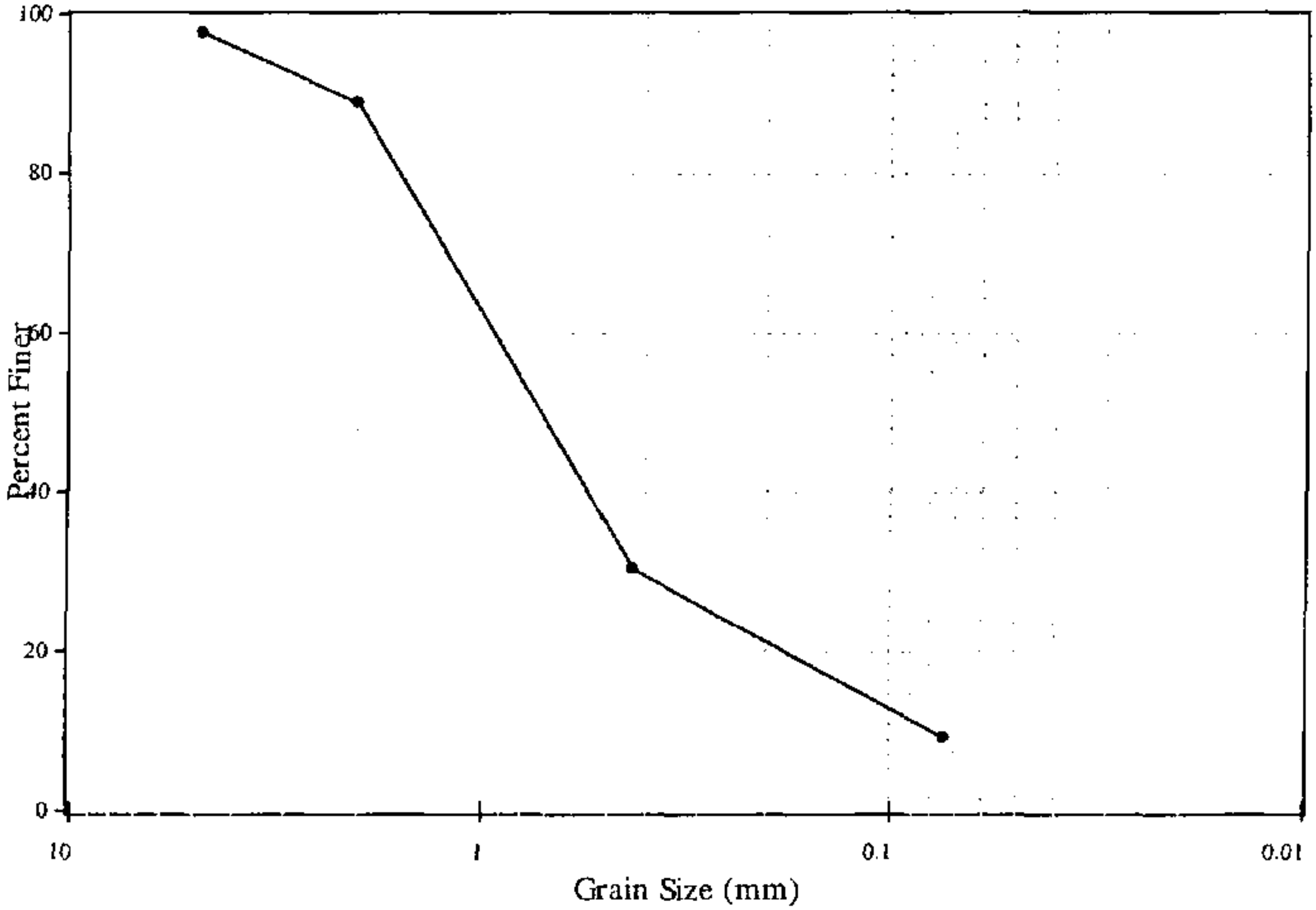
Sieve Analysis

Client:	Apex Environmental, Inc.	Lab Code:	MA00030
Project:	NBHDC - COM-97	ETR:	0409167
Case: N/A	SDG: N/A	Lab ID:	0409167-13
Client ID:	CAD-3 13'-14.5'	Concentration Units:	%
Matrix:	Sediment	Received Date:	9/3/04
Collection Date:	9/2/04	Analysis Date:	10/6/04



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	2.38	Gravel
#10	<4.76 mm - 2 mm	8.58	Coarse Sand
#40	<2 mm - 0.425 mm	58.61	Medium Sand
#200	<0.425 mm - 0.074 mm	21.13	Fine Sand
Passing #200	<0.074 mm	9.28	Silt/Clay

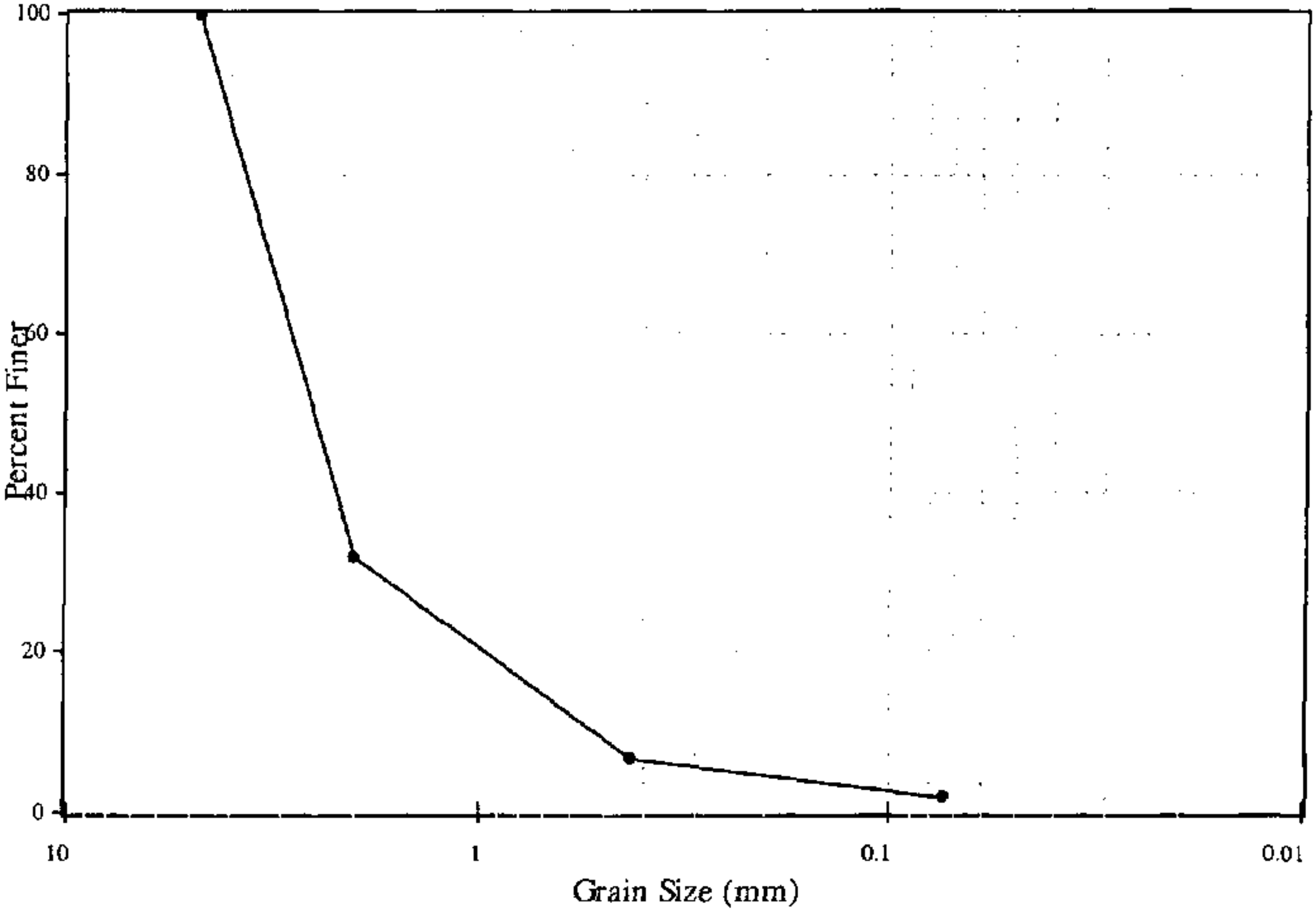
N/A - Not Applicable

10/07/04 11:06

Sieve Analysis

Client: **Apex Environmental, Inc.**
Project: **NBHDC - COM-97**
Case: **N/A** SDG: **N/A**
Client ID: **CAD-3 23'-24'**
Matrix: **Sediment**
Collection Date: **9/3/04**

Lab Code: **MA00030**
ETR: **0409167**
Lab ID: **0409167-14**
Concentration Units: **%**
Received Date: **9/3/04**
Analysis Date: **10/6/04**



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	0.48	Gravel
#10	<4.76 mm - 2 mm	67.76	Coarse Sand
#40	<2 mm - 0.425 mm	25.17	Medium Sand
#200	<0.425 mm - 0.074 mm	4.89	Fine Sand
Passing #200	<0.074 mm	1.66	Silt/Clay

N/A - Not Applicable

10/07/04 11:09

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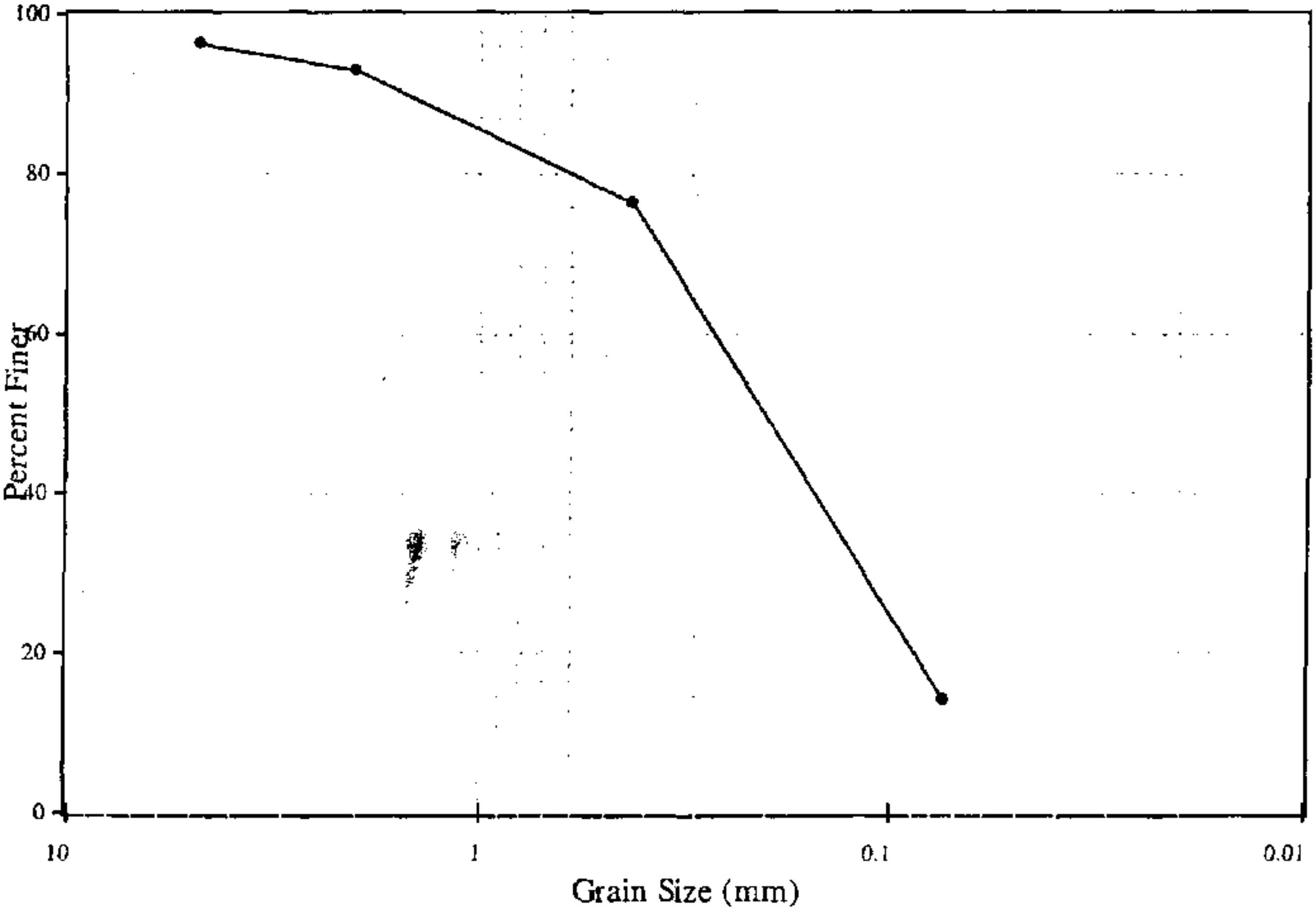
Sieve Analysis

Client: **Apex Environmental, Inc.**
Project: **NBHDC - COM-97**
Case: N/A SDG: N/A
Client ID: **CAD-6 2'-4'**
Matrix: **Sediment**
Collection Date: **9/8/04**

Lab Code: **MA00030**
ETR: **0409167**
Lab ID: **0409167-15**
Concentration Units: %
Received Date: **9/10/04**
Analysis Date: **10/6/04**



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	3.81	Gravel
#10	<4.76 mm - 2 mm	3.34	Coarse Sand
#40	<2 mm - 0.425 mm	16.54	Medium Sand
#200	<0.425 mm - 0.074 mm	62.22	Fine Sand
Passing #200	<0.074 mm	14.02	Silt/Clay

N/A - Not Applicable

10/07/04 11:15

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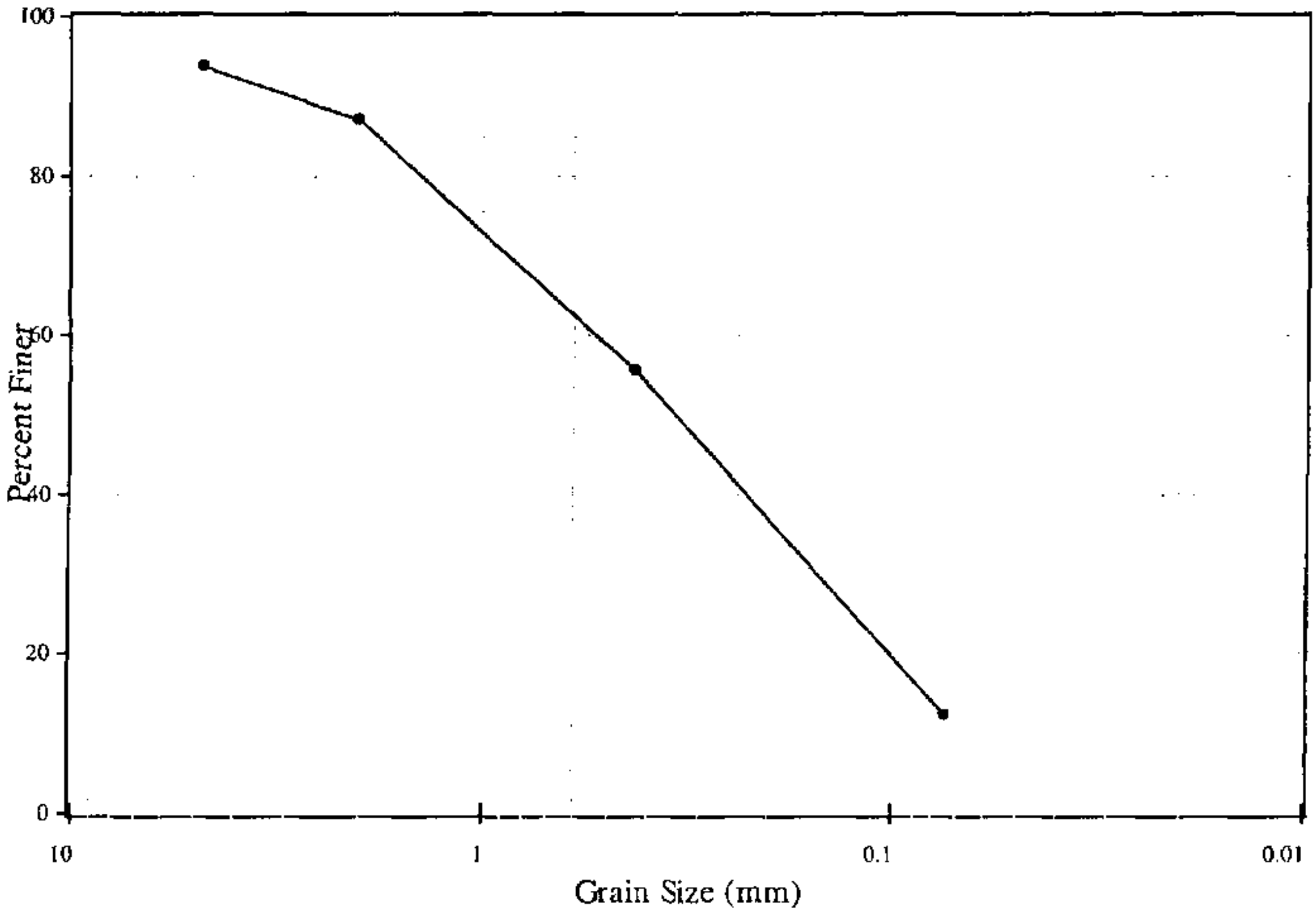
Sieve Analysis

Client:	Apex Environmental, Inc.	Lab Code:	MA00030
Project:	NBHDC - COM-97	ETR:	0409167
Case:	N/A SDG: N/A	Lab ID:	0409167-16
Client ID:	CAD-6 4'-6'	Concentration Units:	%
Matrix:	Sediment	Received Date:	9/10/04
Collection Date:	9/8/04	Analysis Date:	10/6/04



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	6.33	Gravel
#10	<4.76 mm - 2 mm	6.73	Coarse Sand
#40	<2 mm - 0.425 mm	31.46	Medium Sand
#200	<0.425 mm - 0.074 mm	43.37	Fine Sand
Passing #200	<0.074 mm	12.12	Silt/Clay

N/A - Not Applicable

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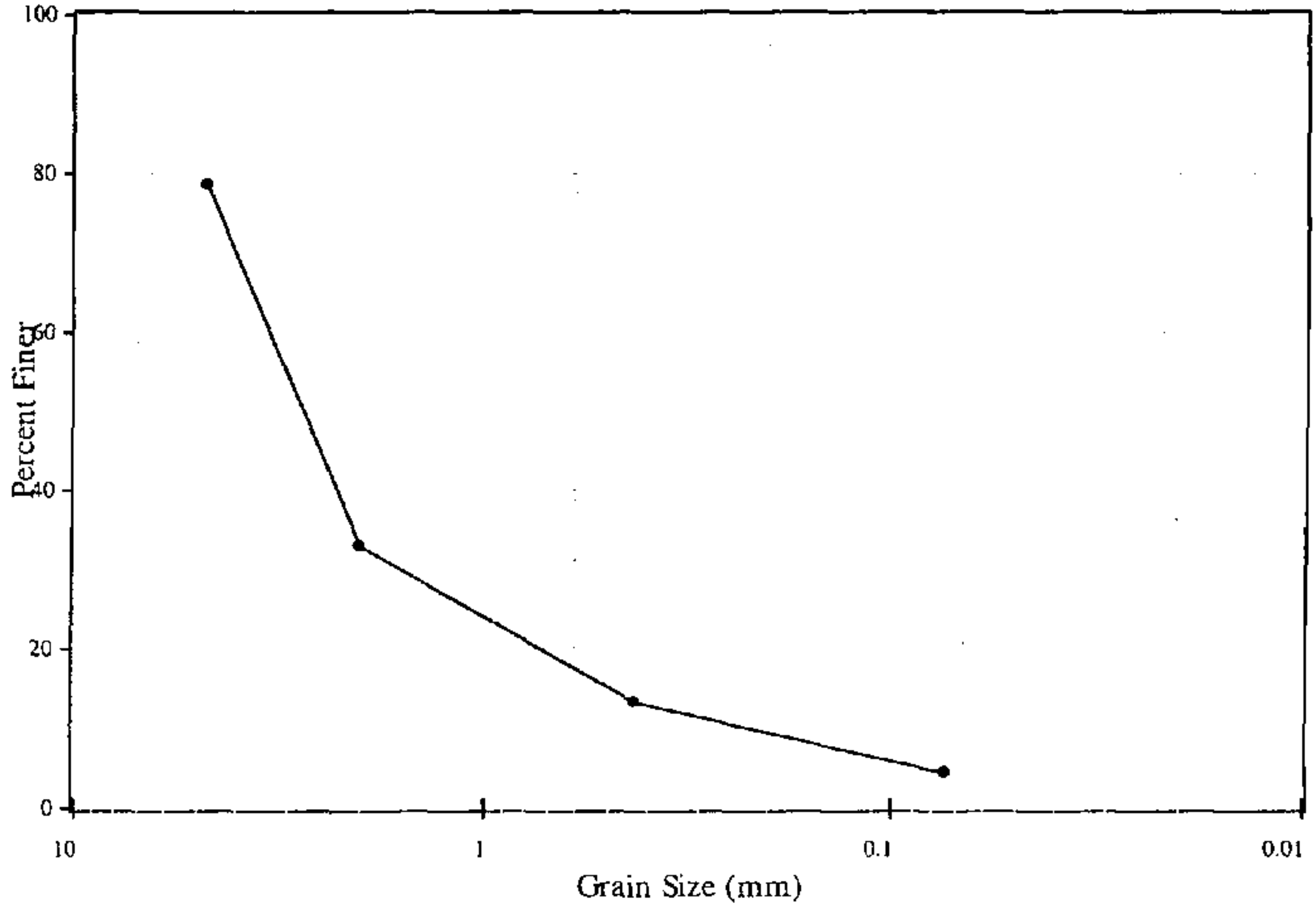
Sieve Analysis

Client:	Apex Environmental, Inc.	Lab Code:	MA00030
Project:	NBHDC - COM-97	ETR:	0409167
Case: N/A	SDG: N/A	Lab ID:	0409167-18
Client ID:	CAD-6 10'-12'	Concentration Units:	%
Matrix:	Sediment	Received Date:	9/10/04
Collection Date:	9/8/04	Analysis Date:	10/6/04



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	21.37	Gravel
#10	<4.76 mm - 2 mm	45.60	Coarse Sand
#40	<2 mm - 0.425 mm	19.52	Medium Sand
#200	<0.425 mm - 0.074 mm	8.89	Fine Sand
Passing #200	<0.074 mm	4.59	Silt/Clay

N/A - Not Applicable

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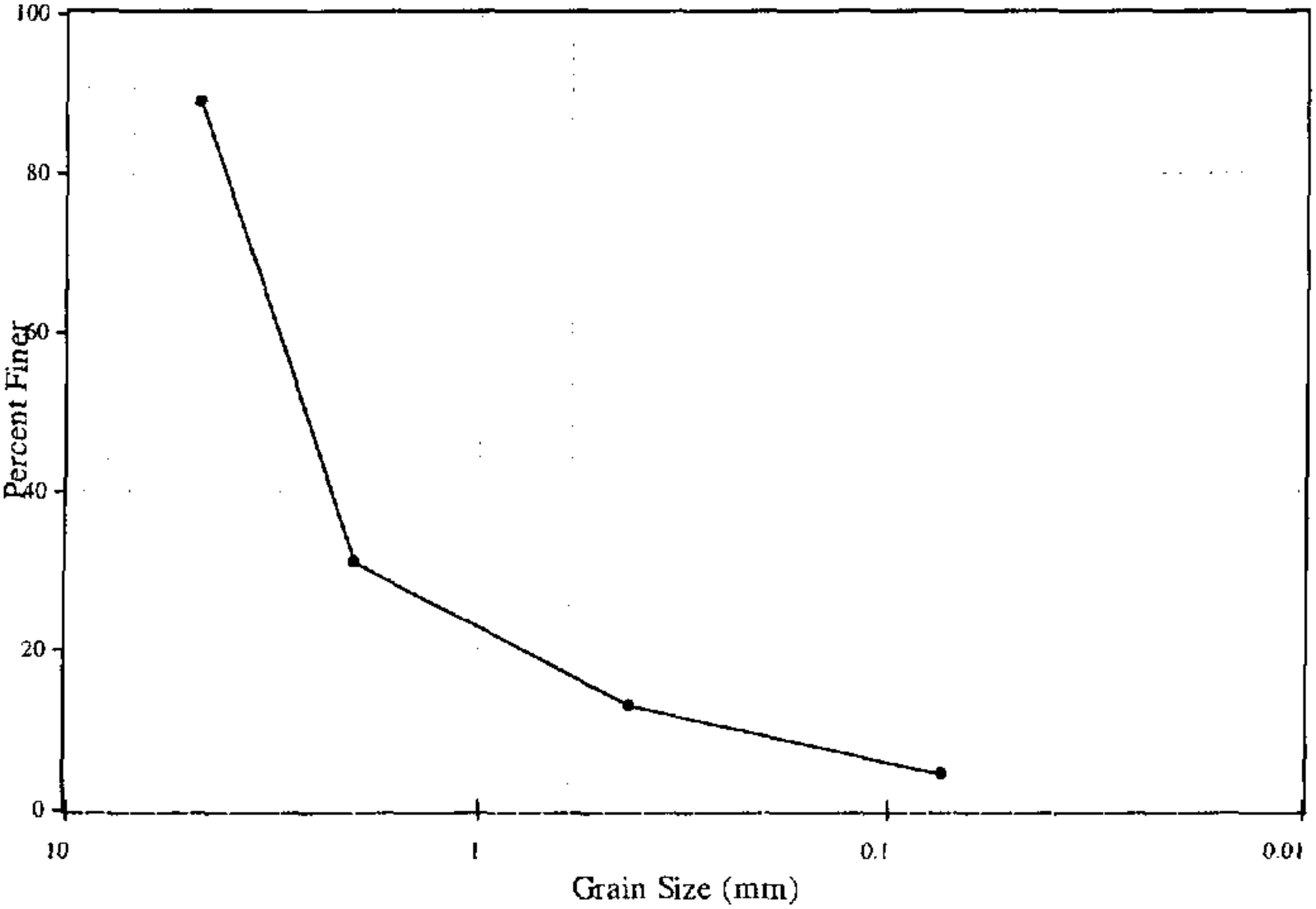
Sieve Analysis

Client: **Apex Environmental, Inc.**
Project: **NBHDC - COM-97**
Case: N/A SDG: N/A
Client ID: **CAD-6 14'-16'**
Matrix: **Sediment**
Collection Date: **9/8/04**

Lab Code: **MA00030**
ETR: **0409167**
Lab ID: **0409167-20**
Concentration Units: **%**
Received Date: **9/10/04**
Analysis Date: **10/6/04**



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	11.27	Gravel
#10	<4.76 mm - 2 mm	57.75	Coarse Sand
#40	<2 mm - 0.425 mm	17.98	Medium Sand
#200	<0.425 mm - 0.074 mm	8.58	Fine Sand
Passing #200	<0.074 mm	4.75	Silt/Clay

N/A - Not Applicable

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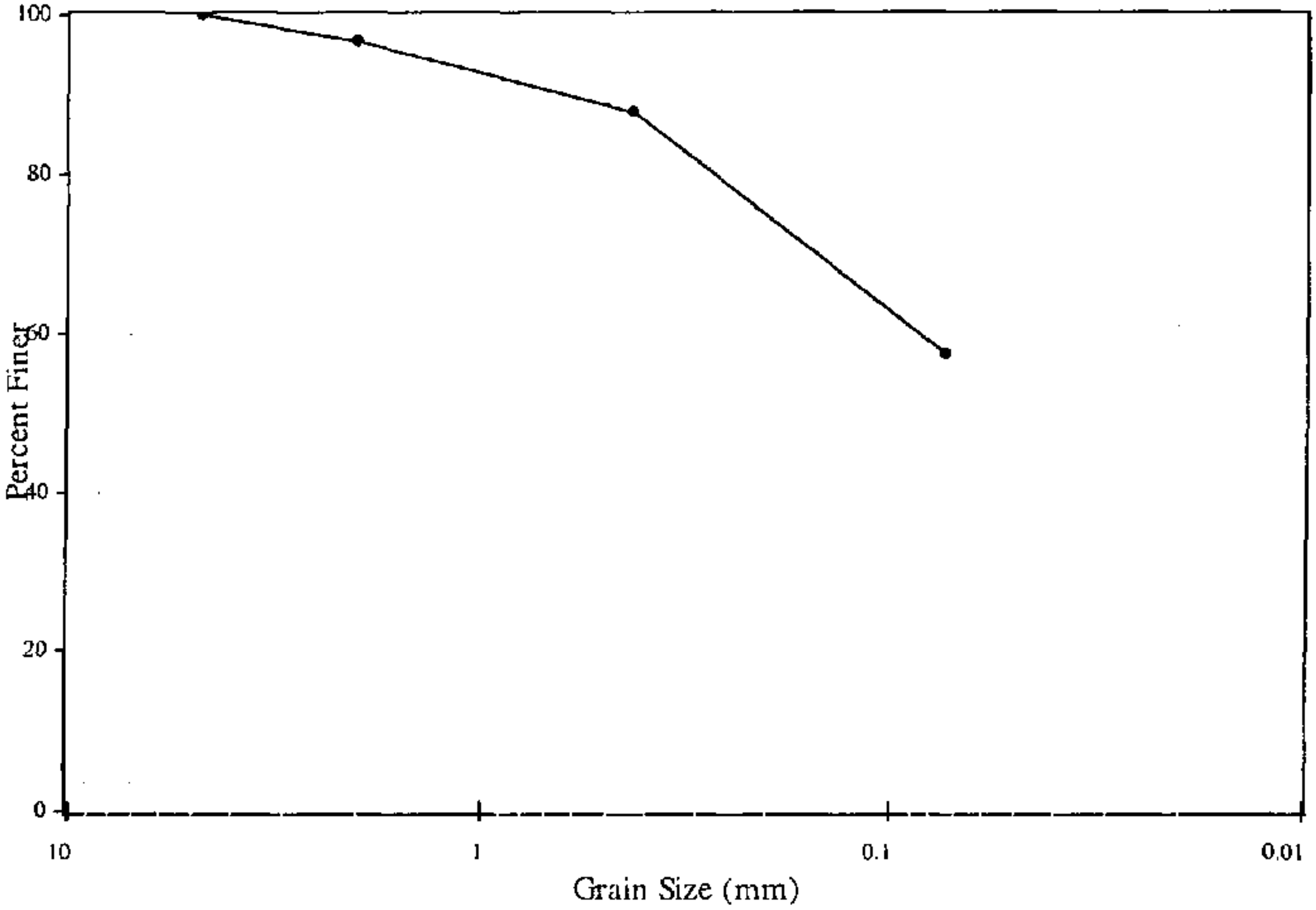
Sieve Analysis

Client:	Apex Environmental, Inc.		Lab Code: MA00030
Project:	NBHDC - COM-97		ETR: 0409167
Case:	N/A	SDG: N/A	Lab ID: 0409167-21
Client ID:	CAD-3 14.5'-15'		Concentration Units: %
Matrix:	Sediment		Received Date: 9/10/04
Collection Date:	9/8/04		Analysis Date: 10/6/04



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	0.14	Gravel
#10	<4.76 mm - 2 mm	3.15	Coarse Sand
#40	<2 mm - 0.425 mm	8.87	Medium Sand
#200	<0.425 mm - 0.074 mm	30.37	Fine Sand
Passing #200	<0.074 mm	57.54	Silt/Clay

N/A - Not Applicable

10/07/04 11:29

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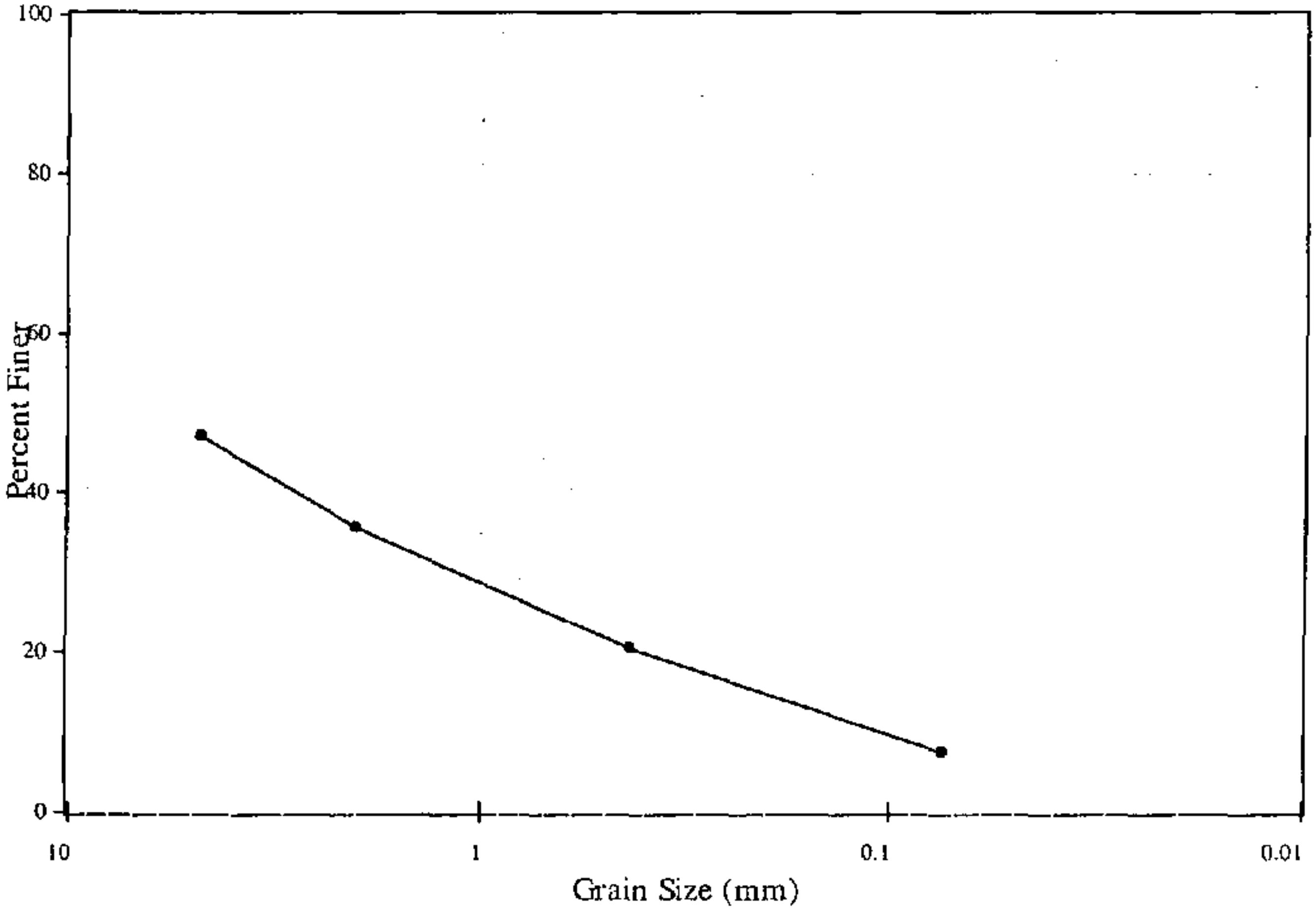
Sieve Analysis

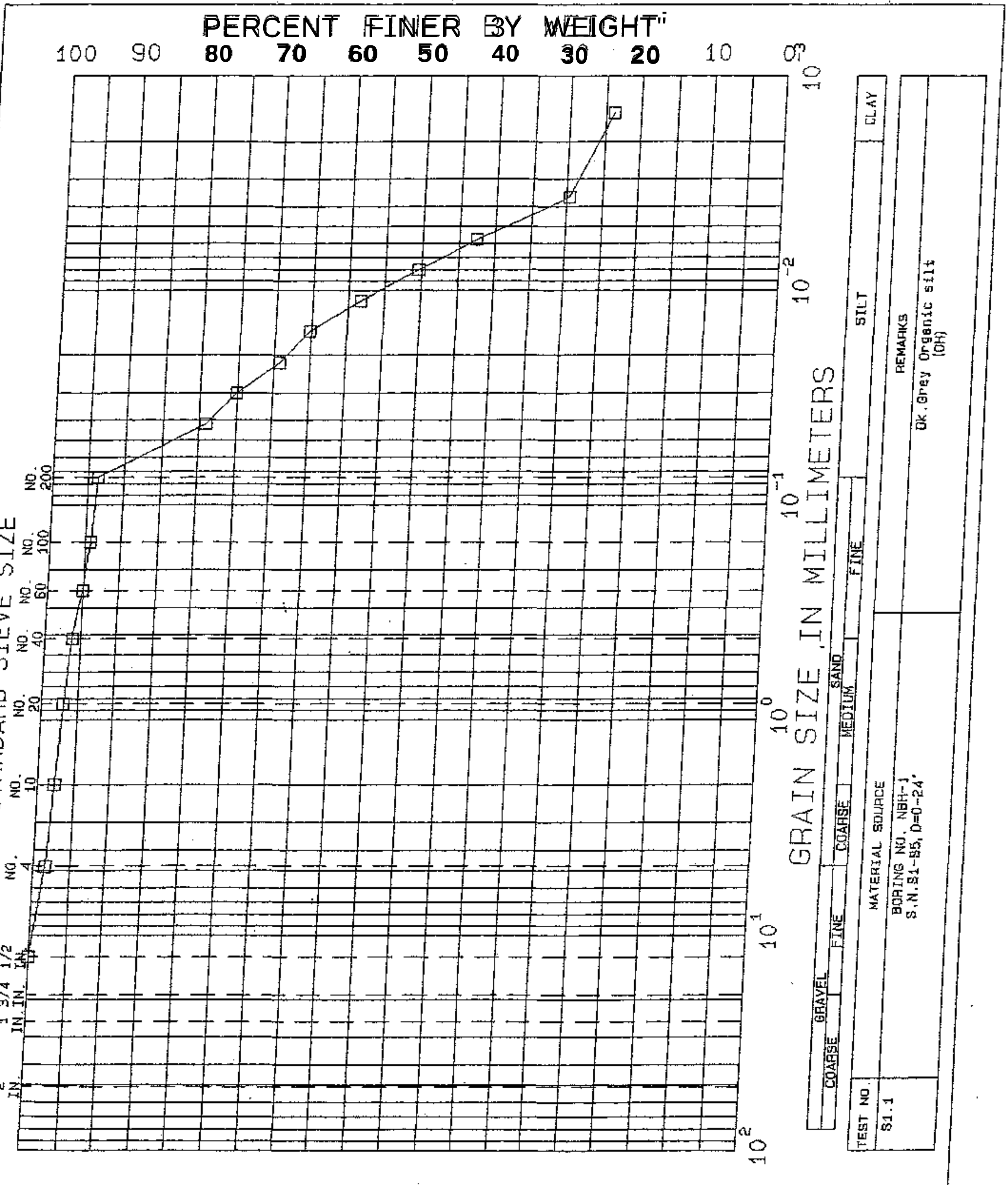
Client:	**Apex Environmental, Inc.**	Lab Code:	**MA00030**
Project:	**NBHDC - COM-97**	ETR:	**0409167**
Case:	N/A SDG: N/A	Lab ID:	**0409167-22**
Client ID:	**CAD-3 24'-25'**	Concentration Units:	**%**
Matrix:	**Sediment**	Received Date:	**9/10/04**
Collection Date:	**9/8/04**	Analysis Date:	**10/6/04**



Sieve Number	Diameter Range	Percent Retained	Description
#4	>4.76 mm	53.05	Gravel
#10	<4.76 mm - 2 mm	11.56	Coarse Sand
#40	<2 mm - 0.425 mm	14.98	Medium Sand
#200	<0.425 mm - 0.074 mm	13.01	Fine Sand
Passing #200	<0.074 mm	7.41	Silt/Clay

N/A - Not Applicable

10/07/04 11:39



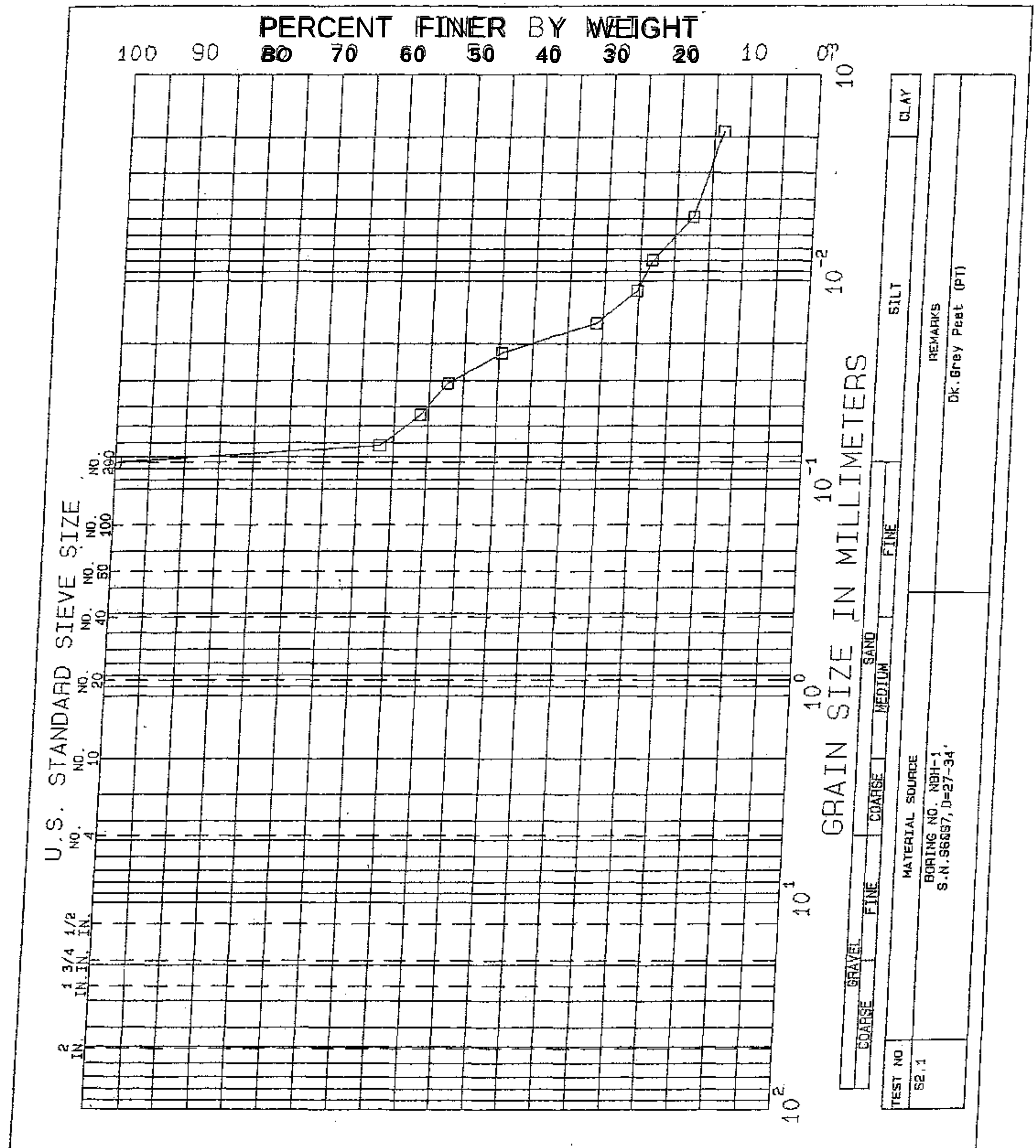
NEW BEDFORD HARBOR FEASIBILITY
STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO.NBH-1
SAMPLE S1-S-5
DEPTH 0-24'
TECH. mst
REVIEWER MCM

TEST SERIES
NO. 1
DATE SEPT. 01

FILE L16928



NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

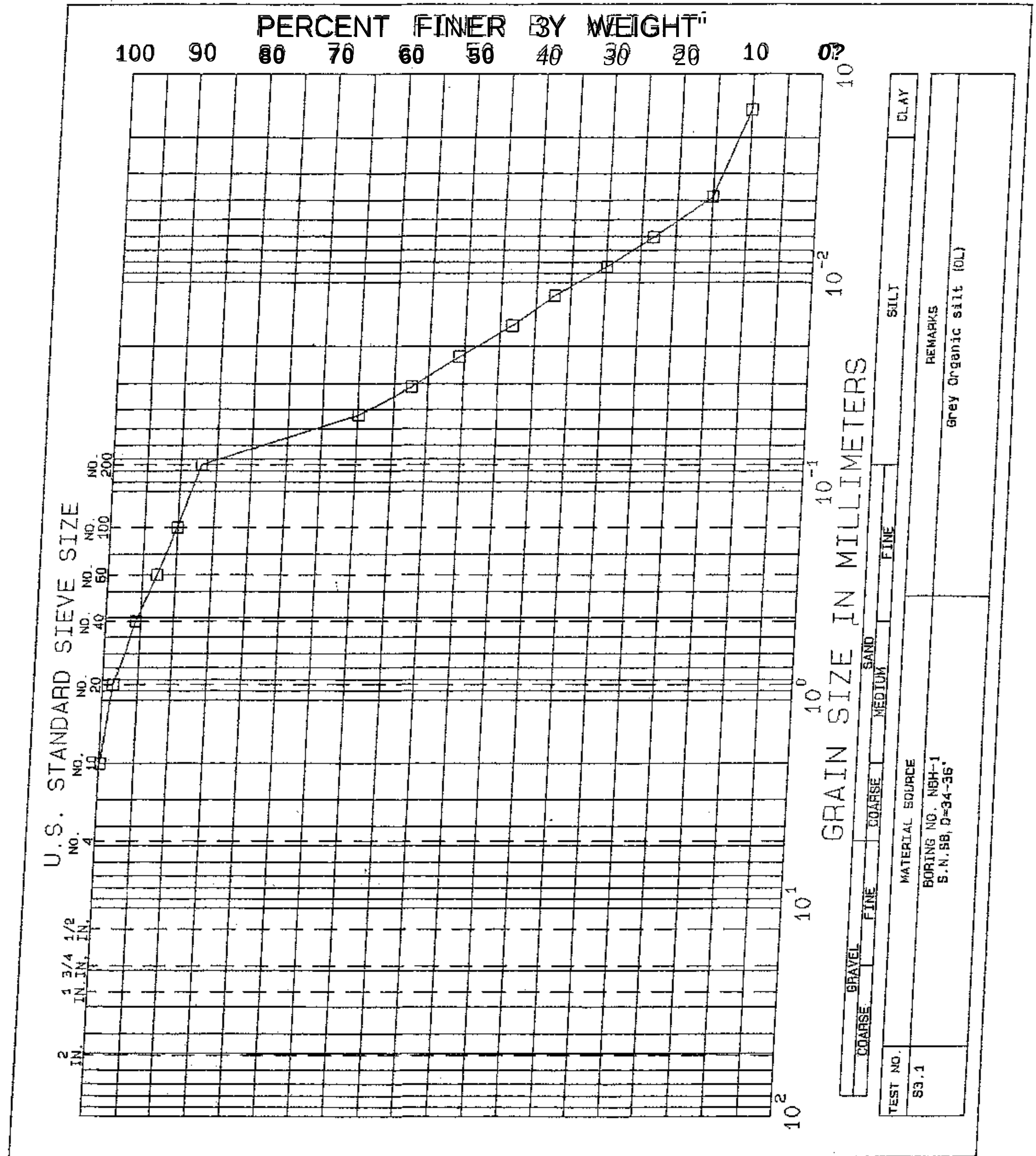
GRADATION TESTS

BORING NO.NBH-1
SAMPLE S6&S7
DEPTH 27-34'
TECH. mst
REVIEWER MCM

TEST SERIES NO. 2
DATE SEPT. 01

FILE L1892B

GZA GEOENVIRONMENTAL, INC.
ENGINEERS AND SCIENTISTS



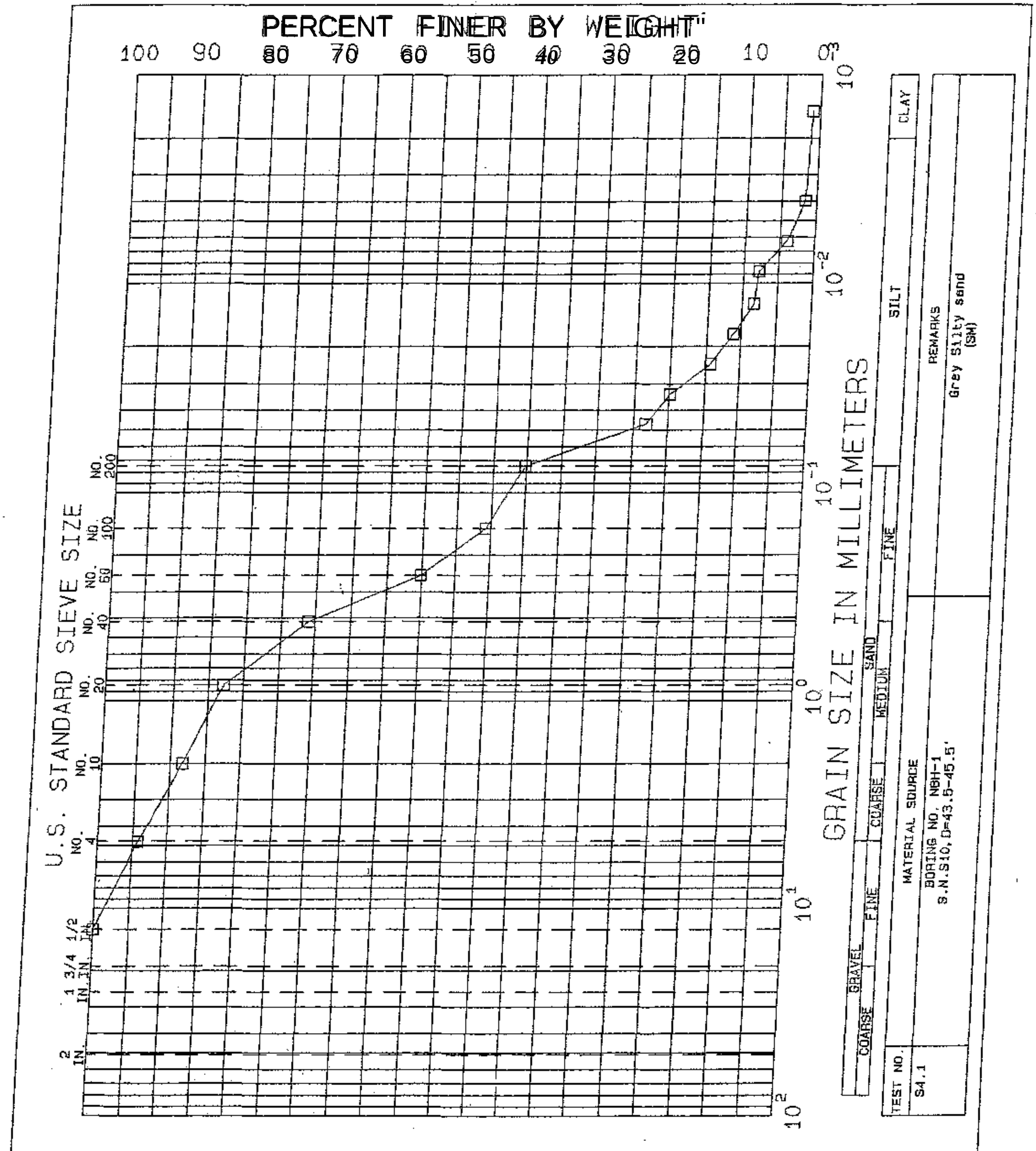
NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-1
SAMPLE S8
DEPTH 34-36'
TECH. mst
REVIEWER MCM

TEST SERIES
NO. 3
DATE SEPT. 01

FILE L15928



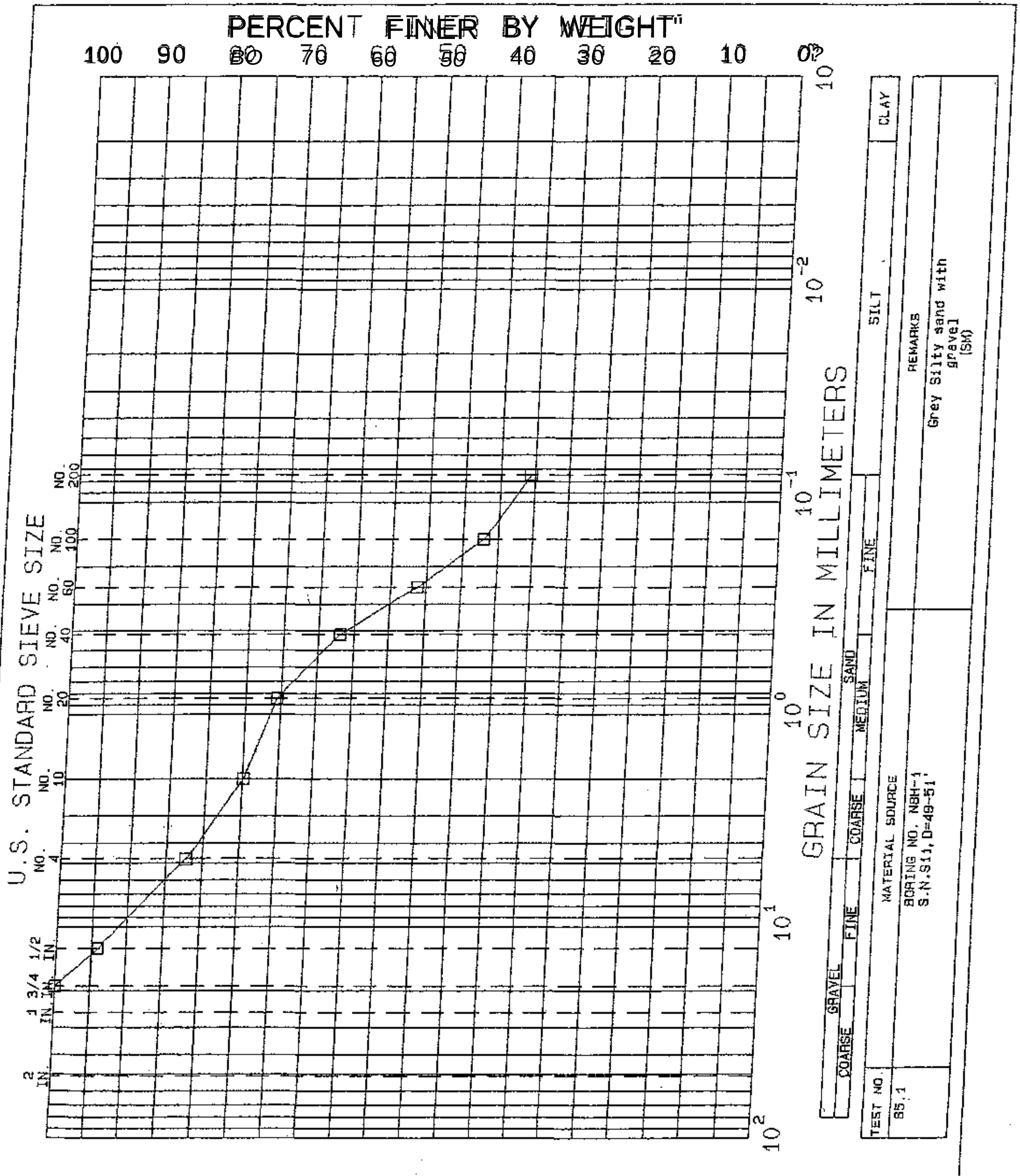
NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-1
SAMPLE S10
DEPTH 43.5-45.5'
TECH. mst
REVIEWER MCM

TEST SERIES NO. 4
DATE SEPT. 01

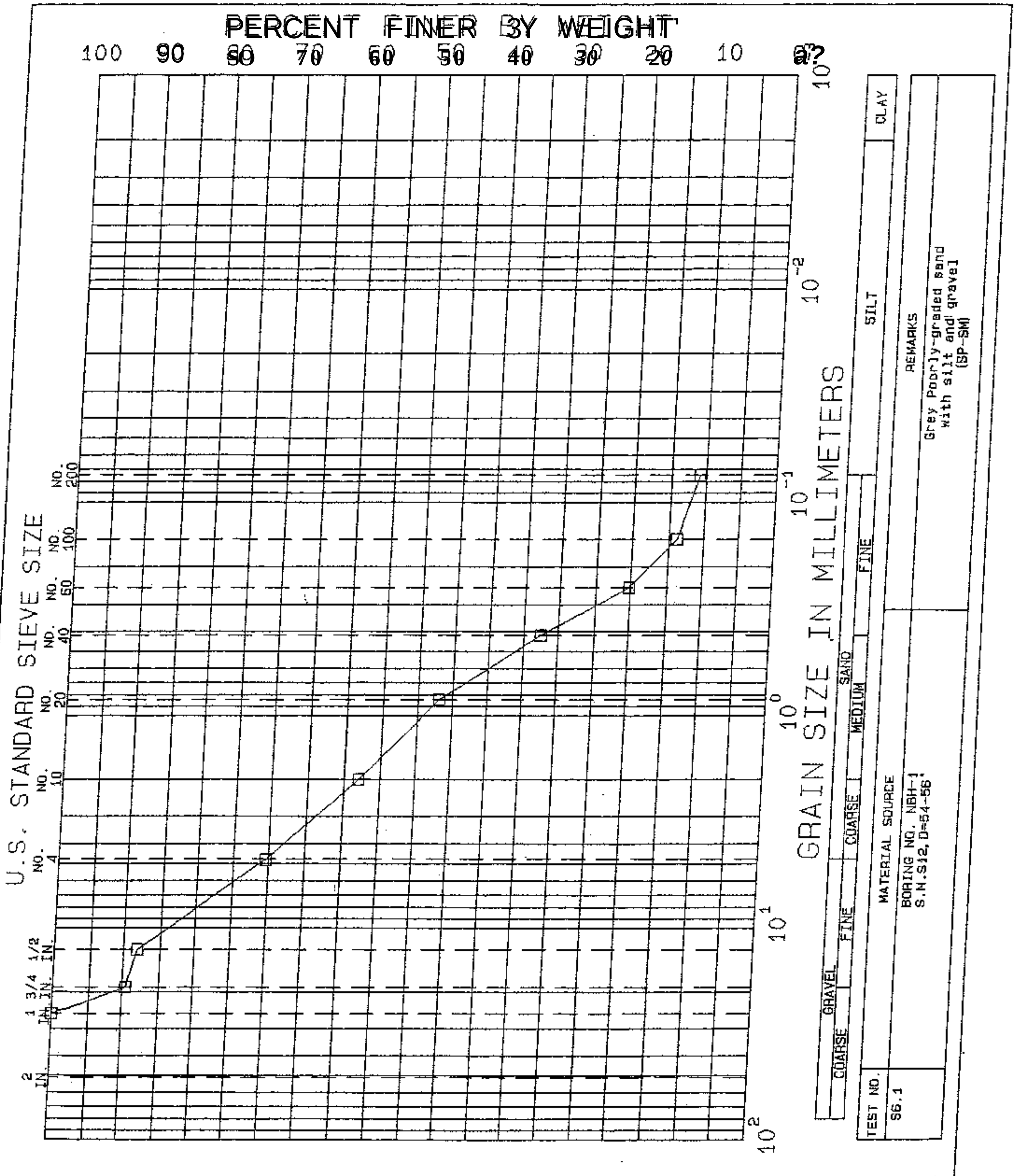
FILE L16928



NEW BEDFORD HARBOR FEAEIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO.NBH-1	TEST SERIES
SAMPLE S11	NO. 5
DEPTH 49-51'	DATE SEPT. 01
TECH. ffast	
REVIEWER MCM	FILE L16328

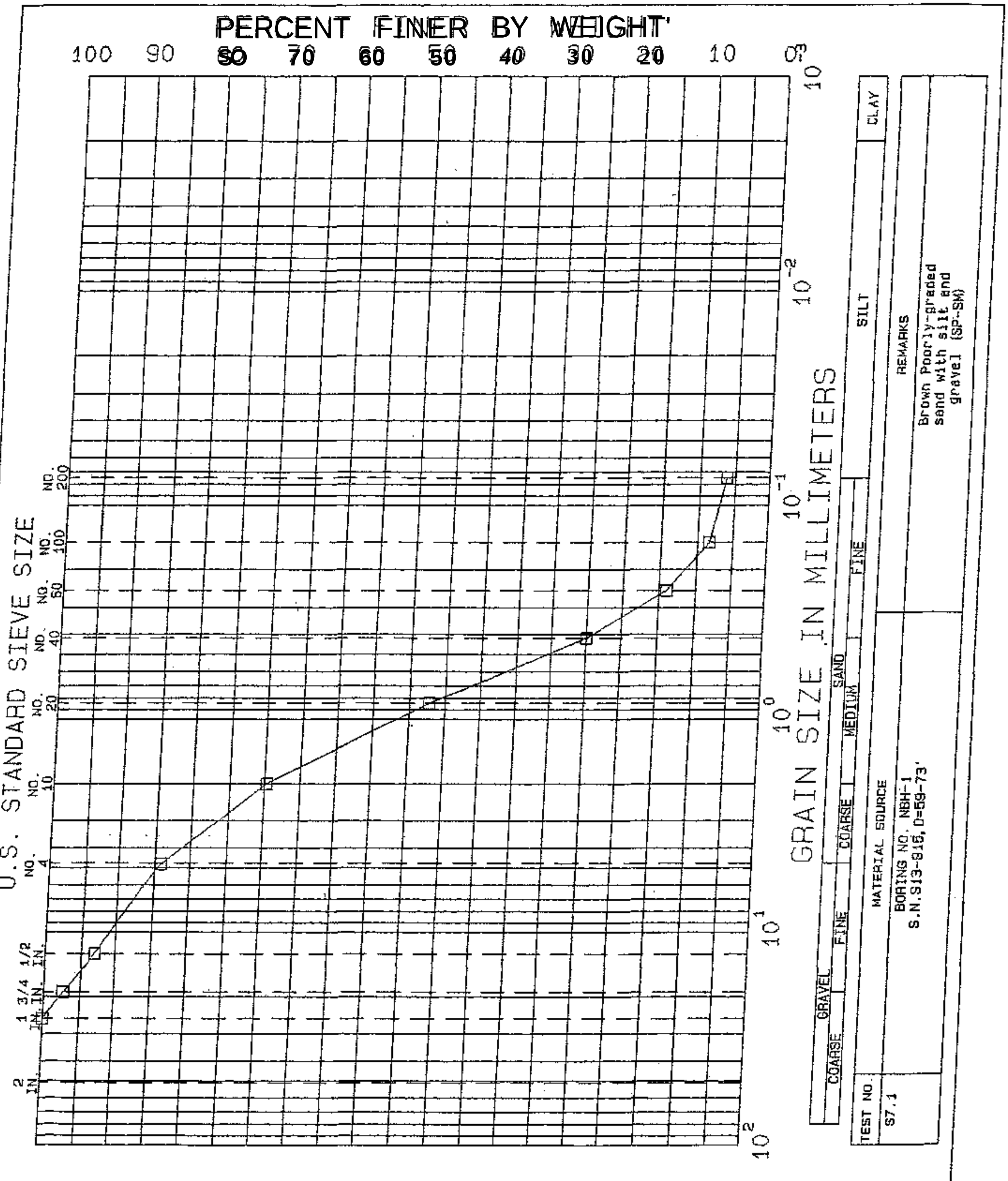


NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-1	TEST SERIES
SAMPLE S12	NO. 6
DEPTH 54-56'	DATE SEPT. 01
TECH. mst	
REVIEWER MCM	FILE L1692B

GZA GEOENVIRONMENTAL, INC.
ENGINEERS AND SCIENTISTS



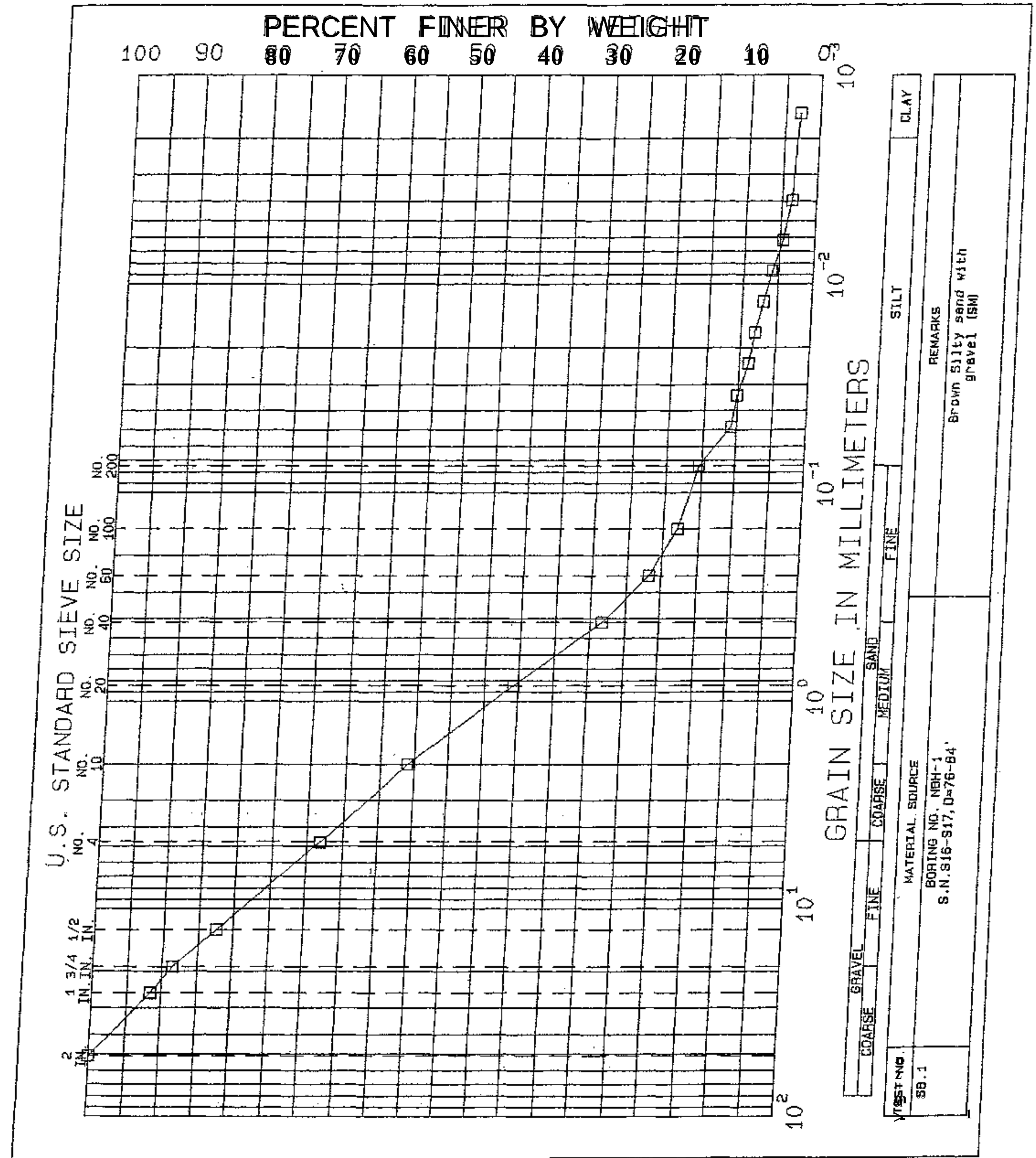
NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-1
SAMPLE S13-15
DEPTH 59-73'
TECH. mst
REVIEWER MCM

TEST SERIES
NO. 7
DATE SEPT. 01

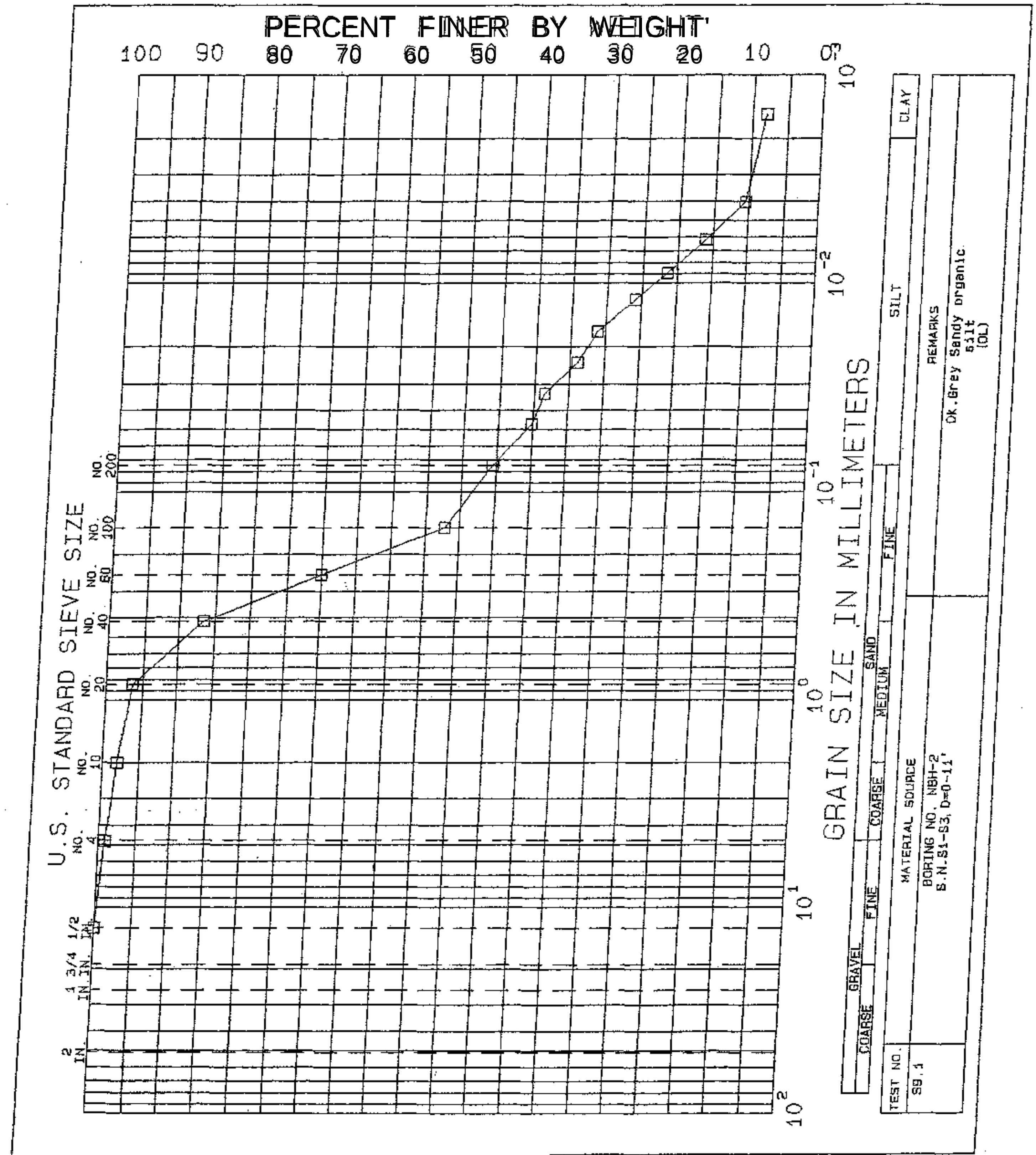
FILE L16928



NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

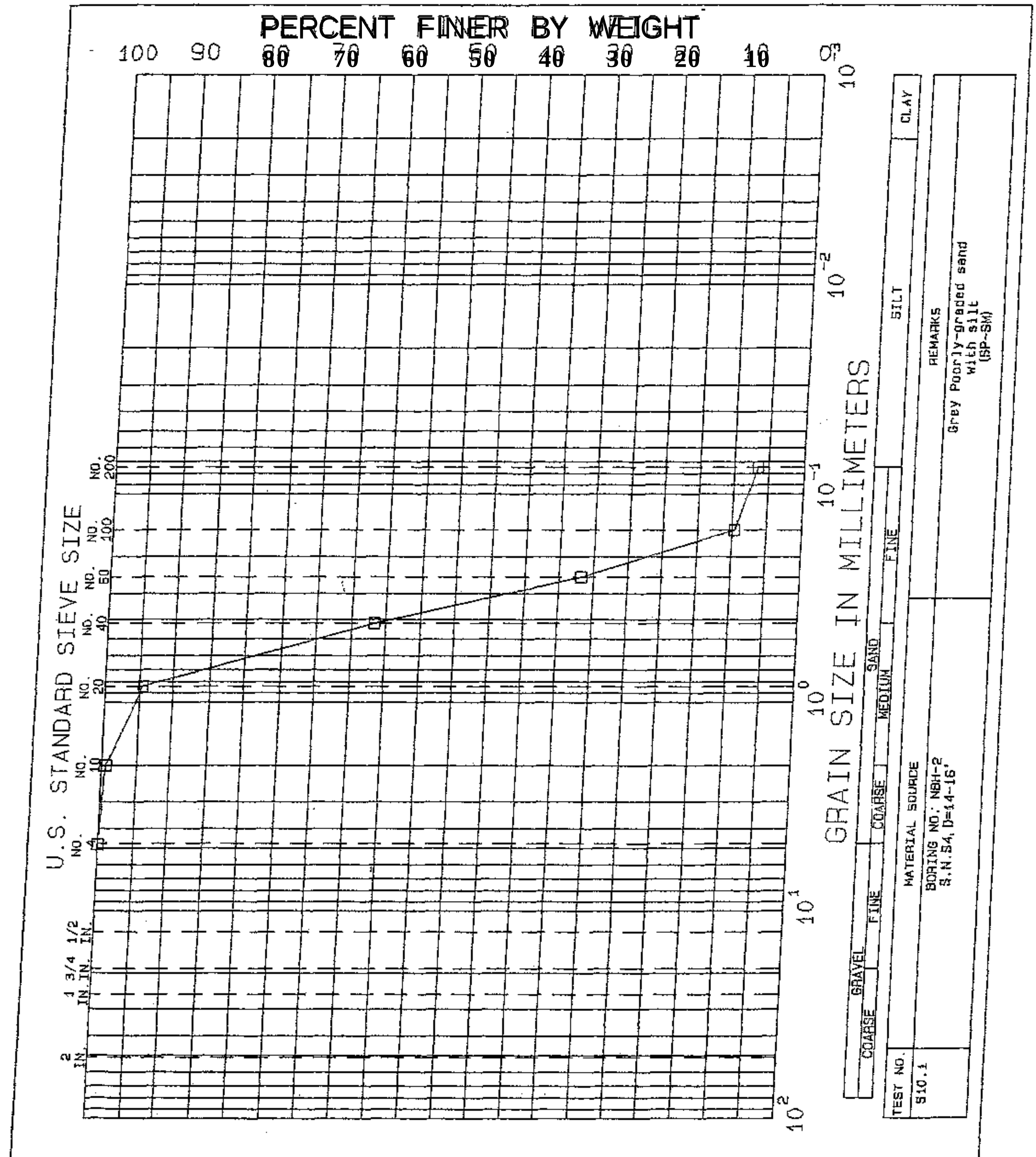
BORING NO.	NBH-1	TEST SERIES NO.	8
SAMPLE	S36S37	DATE	SEPT. 01
DEPTH	76-84'		
TECH.	mst		
REVIEWER	MCM .	FILE	L16S2B



NEW BEDFORD HARBOR FEASIBILITY
STUDY, NEW BEDFORD, MA.

GRADATION TESTS

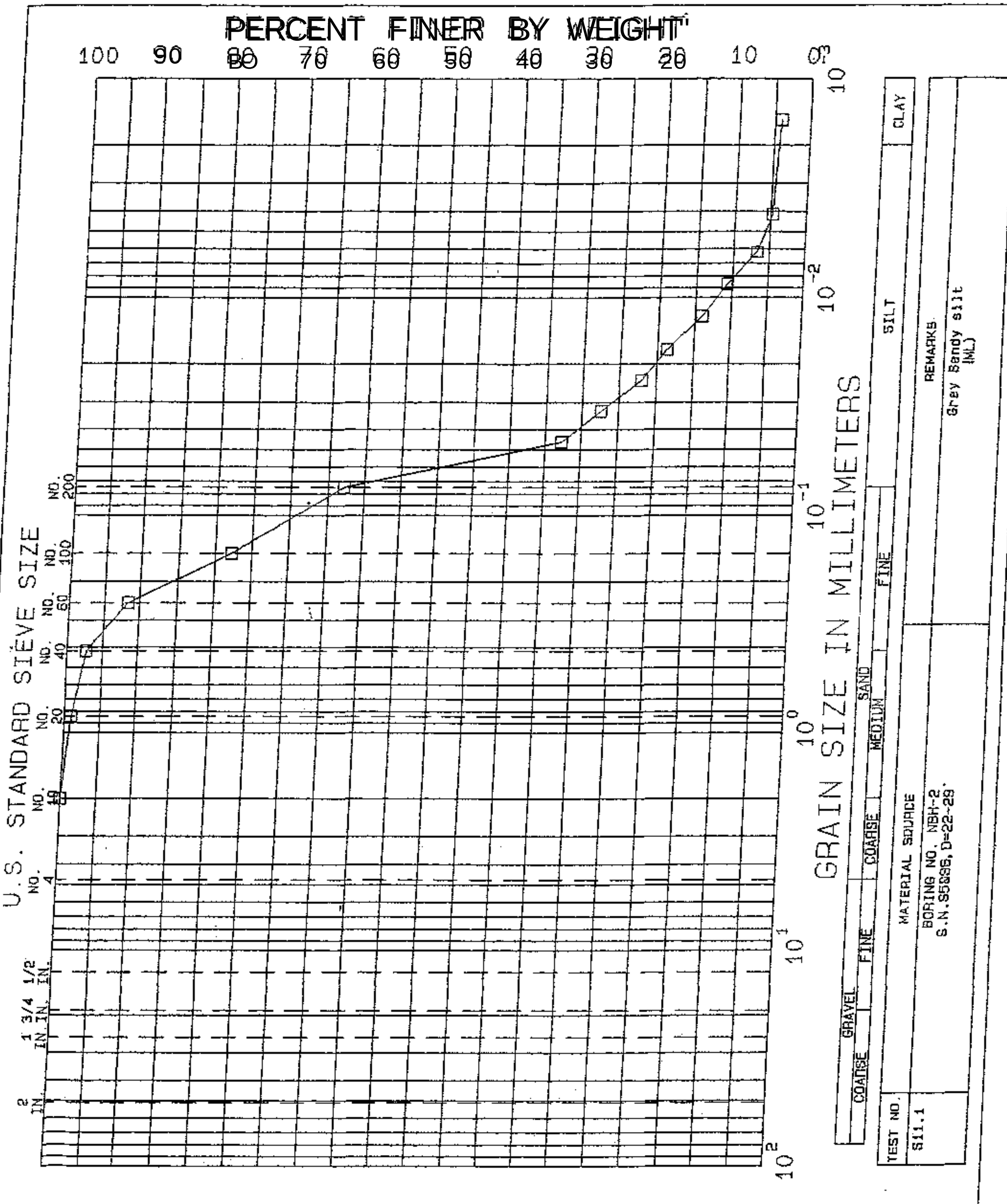
BORING NO. NBH-2	TEST SERIES
SAMPLE S1-S3	NO. 9
DEPTH 0-11'	DATE SEPT. 01
TECH. mst	
REVIEWER MCH	FILE L15928



NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-2	TEST SERIES
SAMPLE S4	NO. 10
DEPTH 14-16'	DATE SEPT. 01
TECH. mst	
REVIEWER MCM	FILE L16926



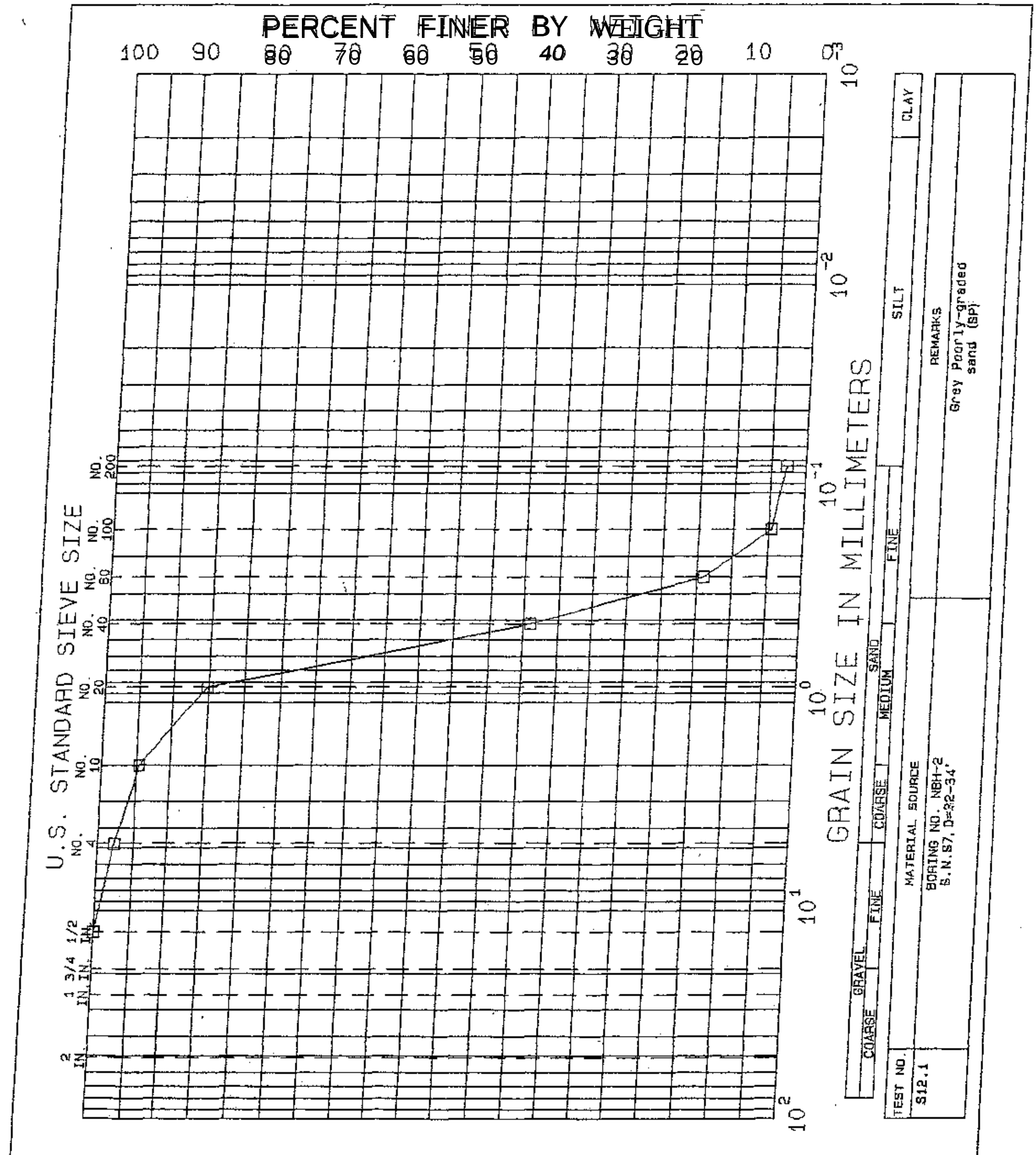
NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-2
SAMPLE S5SS6
DEPTH 22-29"
TECH. mst
REVIEWER MCM

TEST SERIES NO. 11
DATE SEPT. 01
FILE L1BS2B

GZA GEOENVIRONMENTAL, INC.
ENGINEERS AND SCIENTISTS



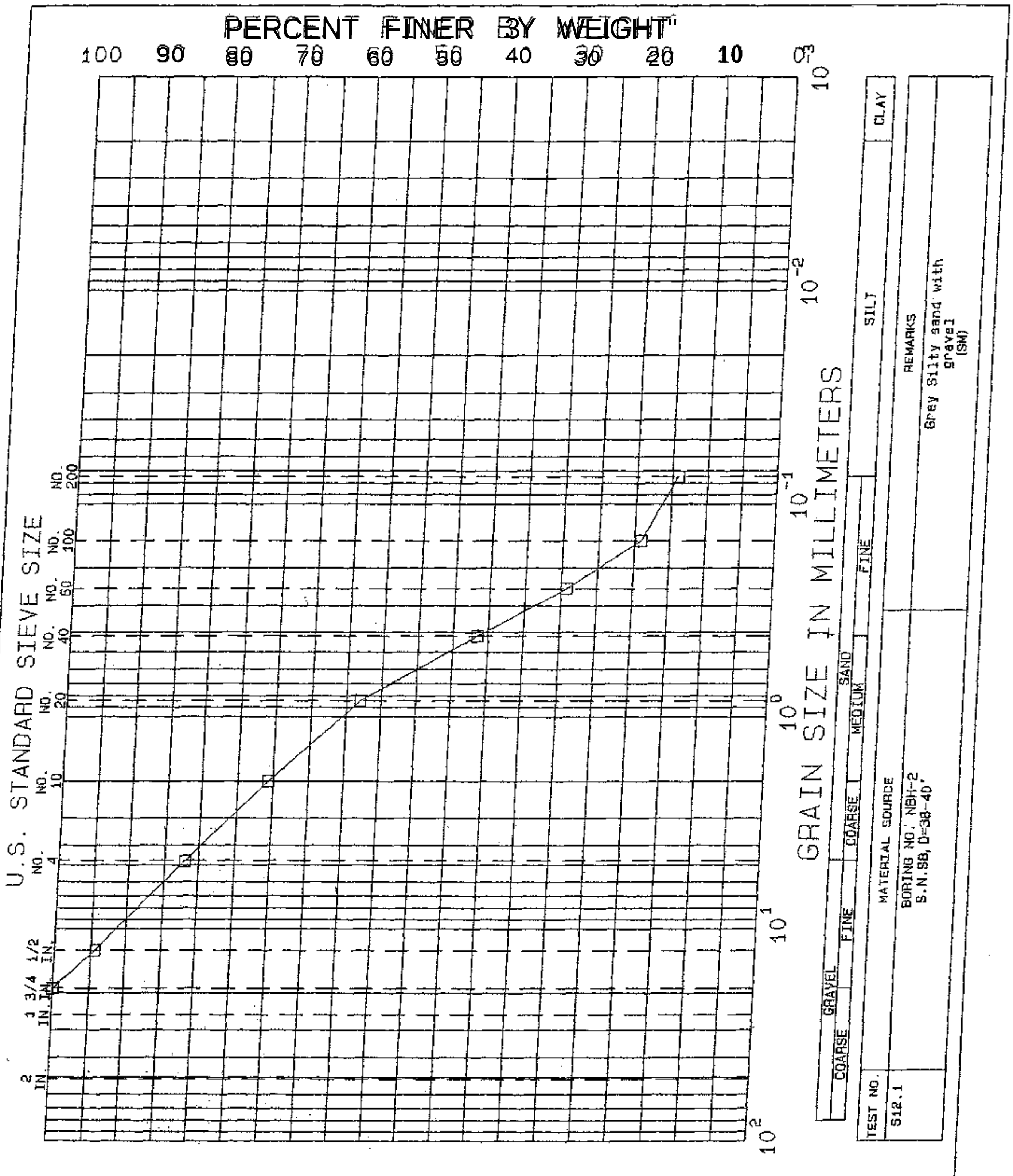
NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-2
SAMPLE S7
DEPTH 32-34'
TECH. mst
REVIEWER NCM

TEST SERIES
NO. 12
DATE SEPT. 01

FILE L16928



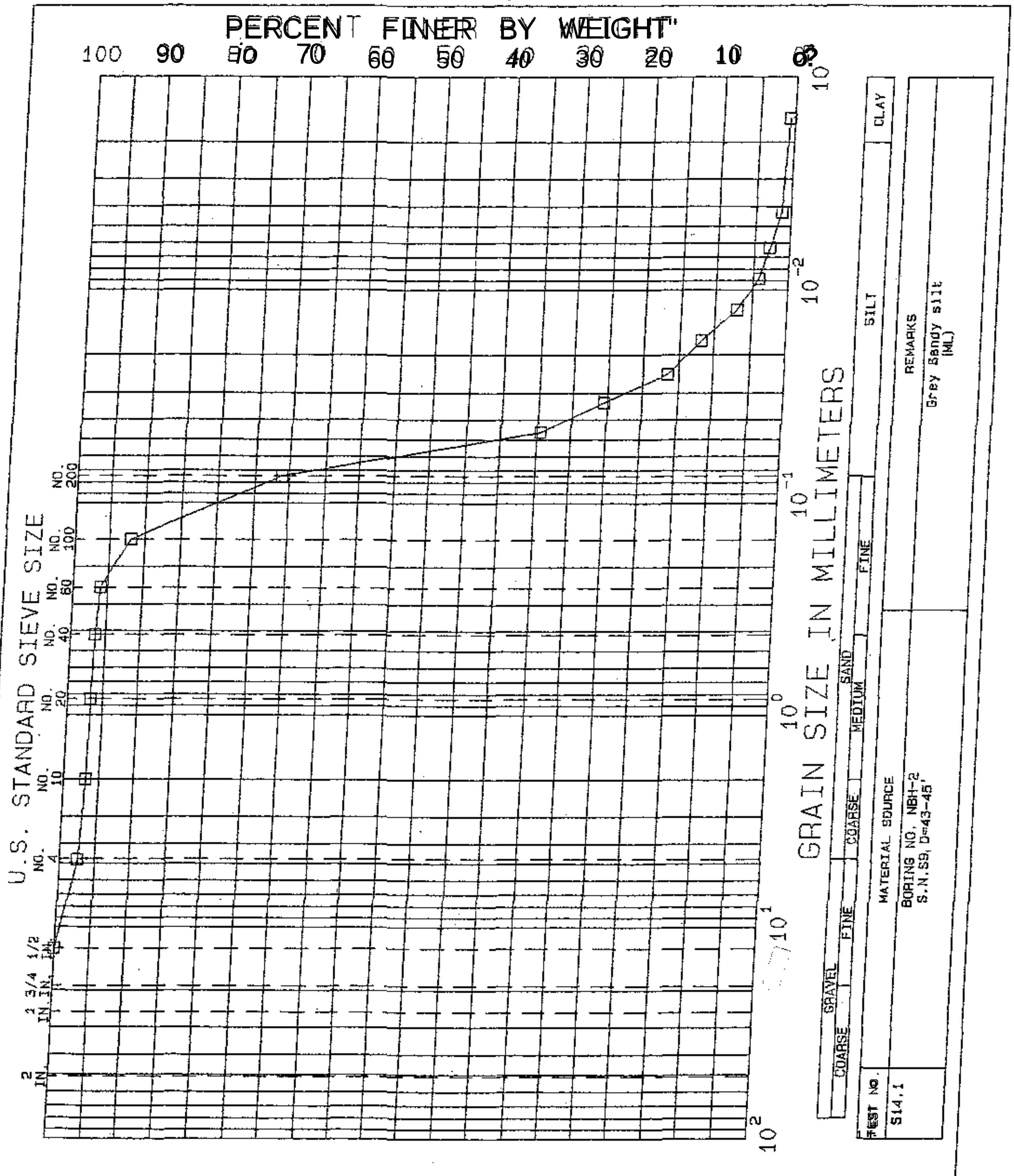
NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-2
SAMPLE S8
DEPTH 38-40'
TECH. mst
REVIEWER MCM

TEST SERIES
NO. 13
DATE SEPT. 01

FILE L16S28



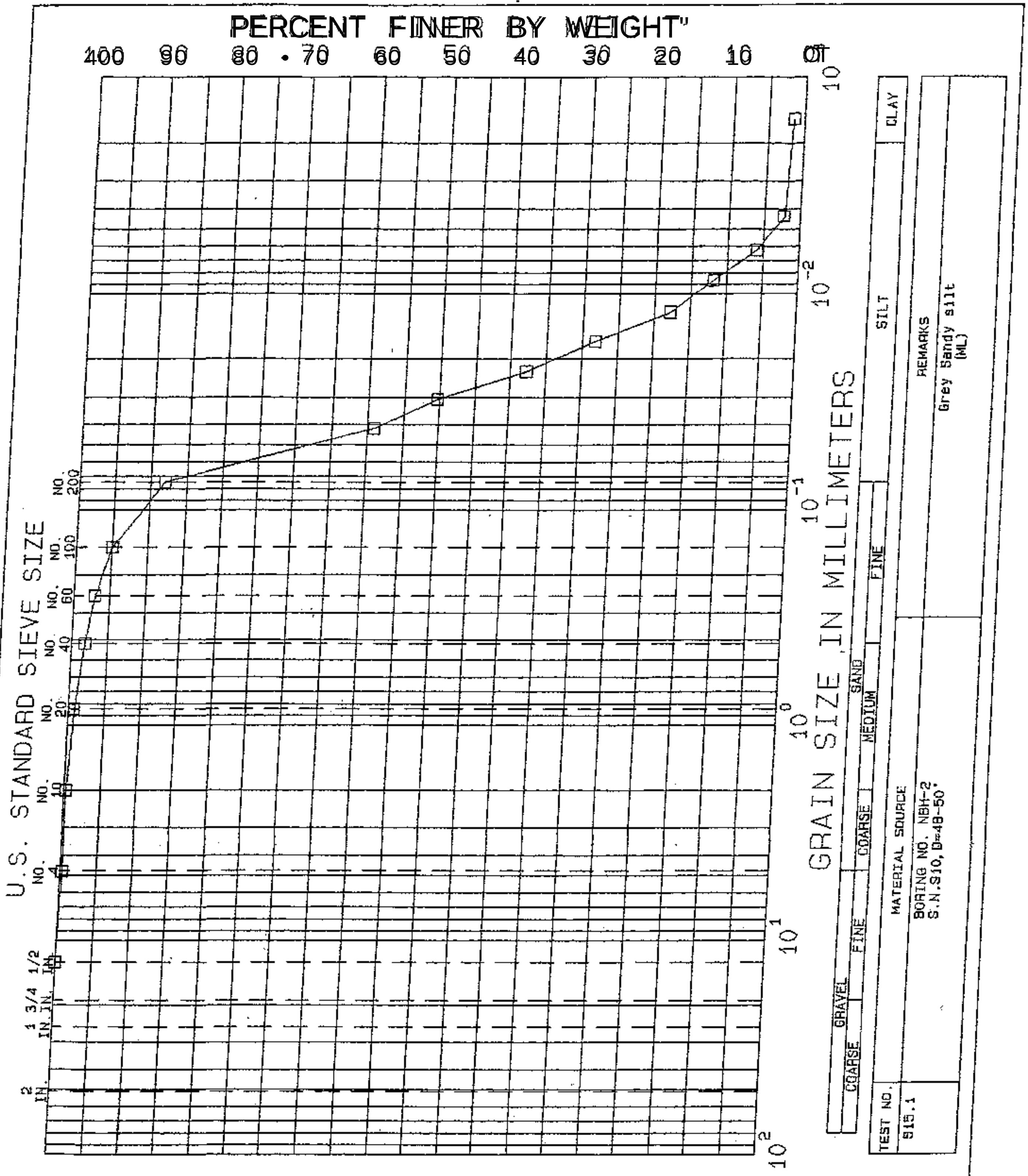
NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-2
SAMPLE S9
DEPTH 43-45'
TECH. Hist
REVIEWER MCM

TEST SERIES NO. 14
DATE SEPT. 01

FILE L15928



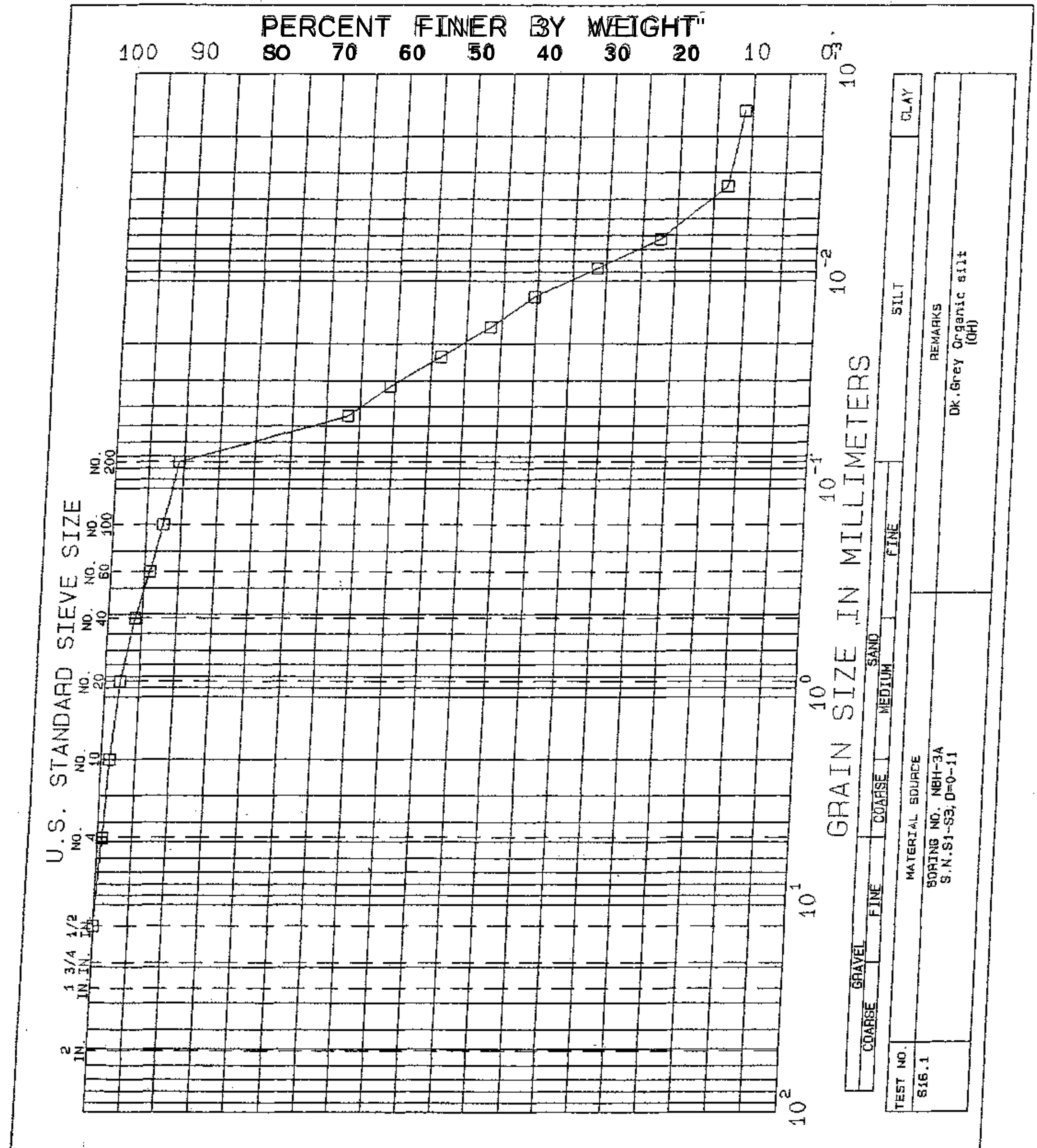
NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO.NBH-2
SAMPLE S10
DEPTH 48-50'
TECH. mst
REVIEWER MCM

TEST SERIES
NO. 15
DATE SEPT. 01

FILE L1BS2B



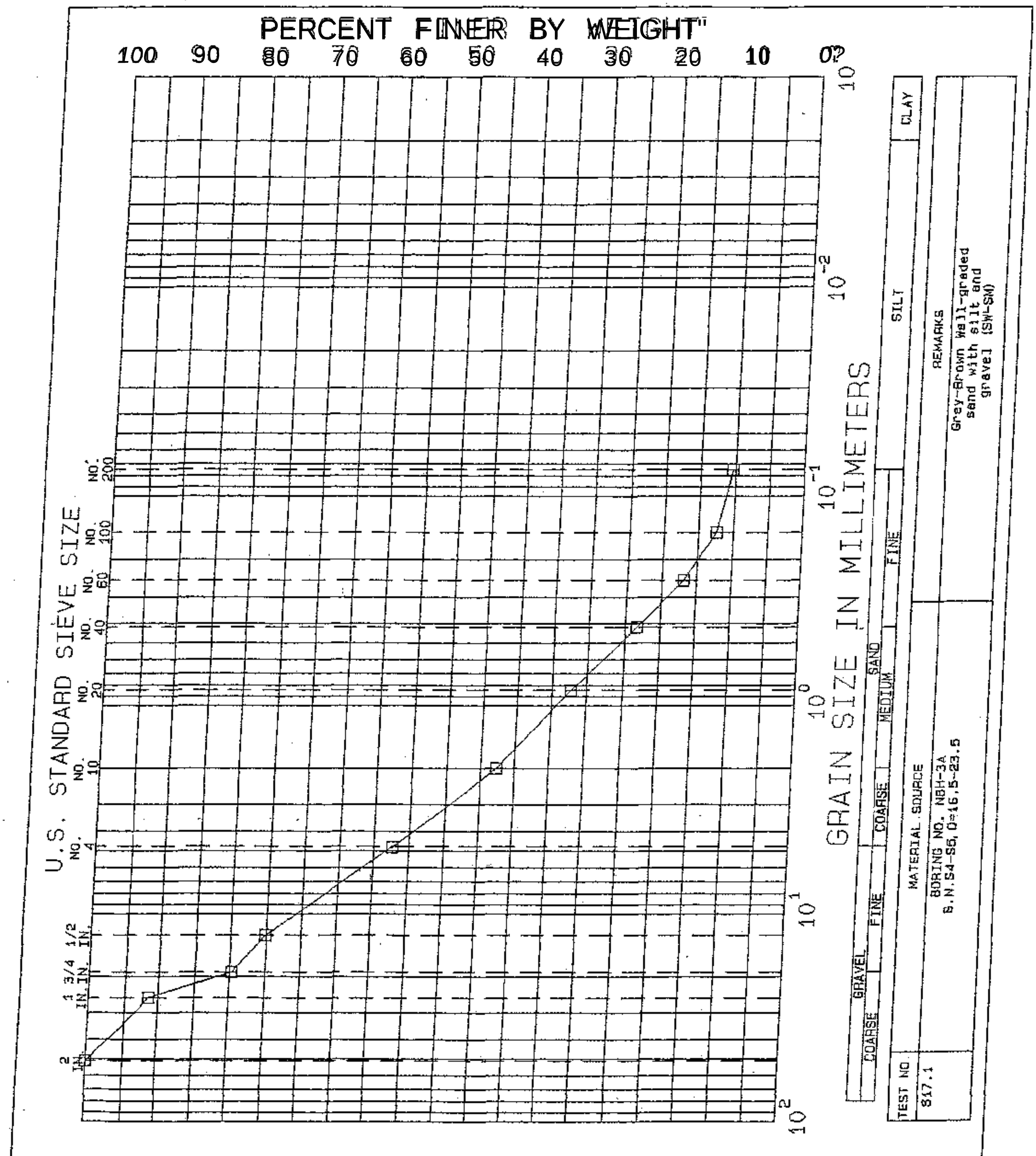
NEW BEDFORD HARBOR FEASIBILITY
STUDY, NEW BEDFDRD, MA.

GRADATION TESTS

BORING NO.NBH-3A
SAMPLE S1-S3
DEPTH 0-11''
TECH. mst
REVIEWER MCM

TEST SERIES
NO. 16
DATE SEPT. 01

FILE L16328



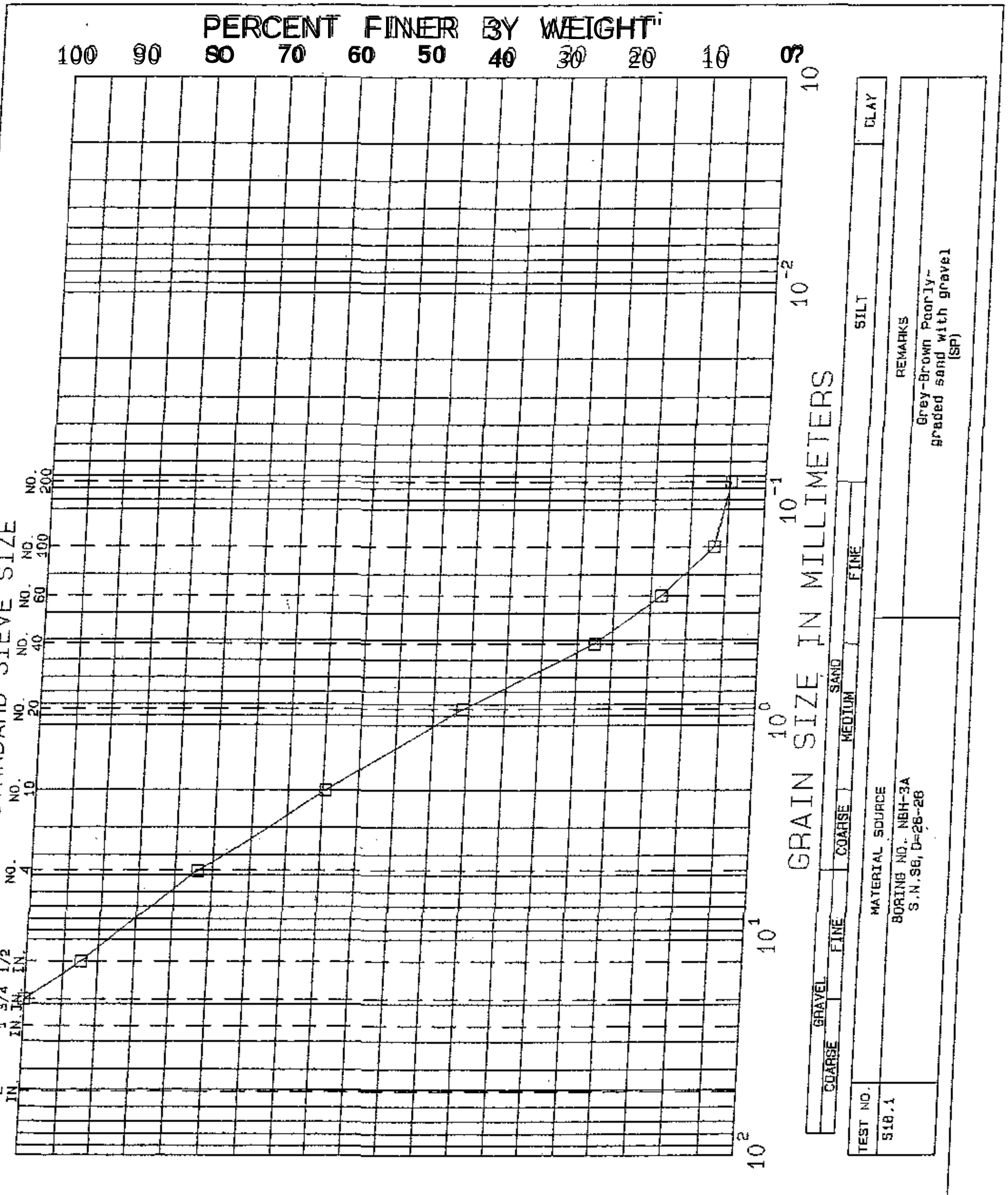
NEW BEDFORD HARBOR FEASIBILITY STUDY/ NEW BEDFORD, MA.

GRADATION TESTS

BORING NO.NBH-3A
SAMPLE S4-S5
DEPTH 36.5-23.5'
TECH. met
REVIEWER MCM

TEST SERIES
NO. 17
DATE SEPT. 03

FILE L1BS2B



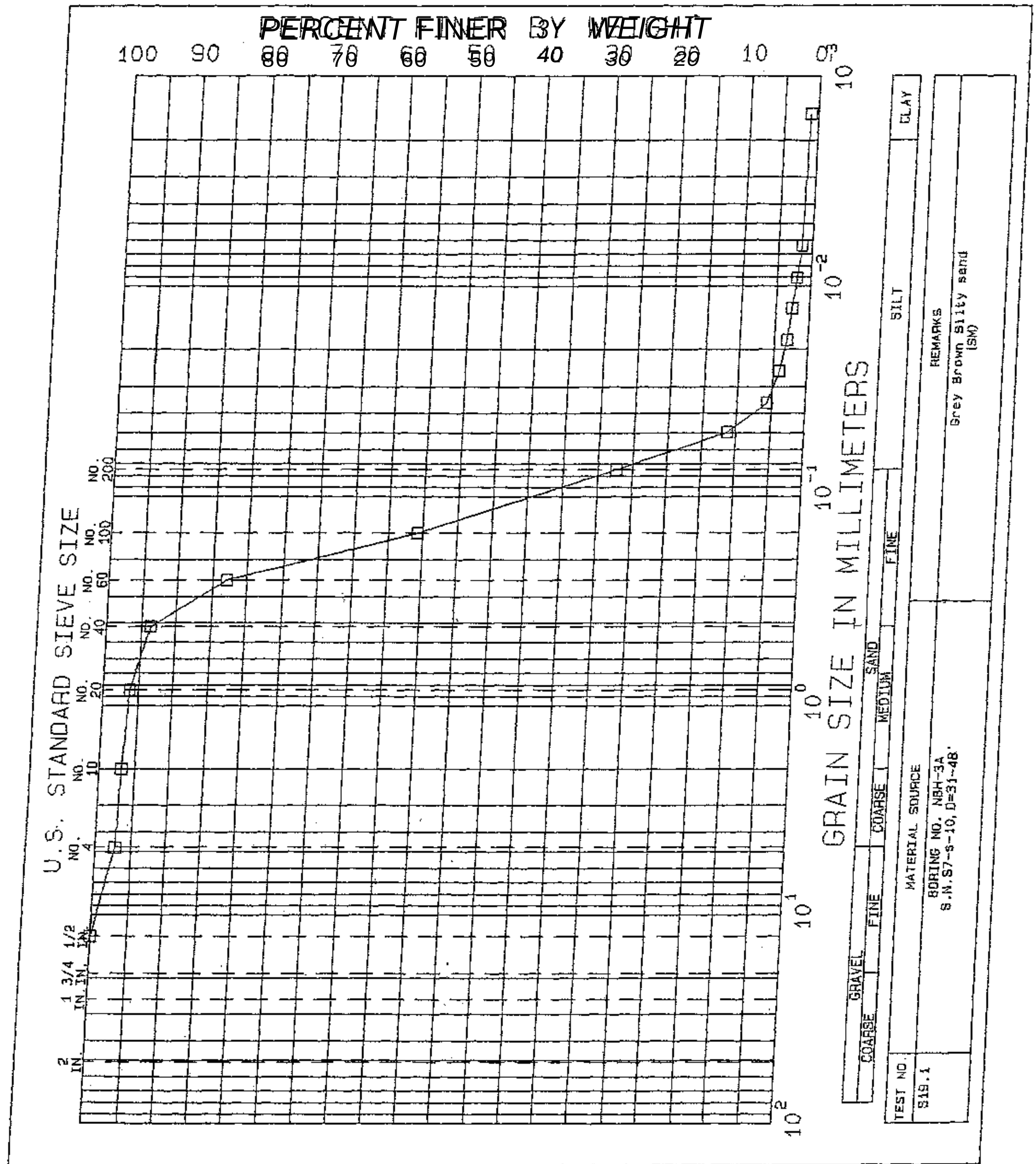
NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO.NBH-3A
SAMPLE S6
DEPTH 26-28'
TECH. met
REVIEWER MCM

TEST SERIES NO. I8
DATE SEPT. 01

FILE L16828

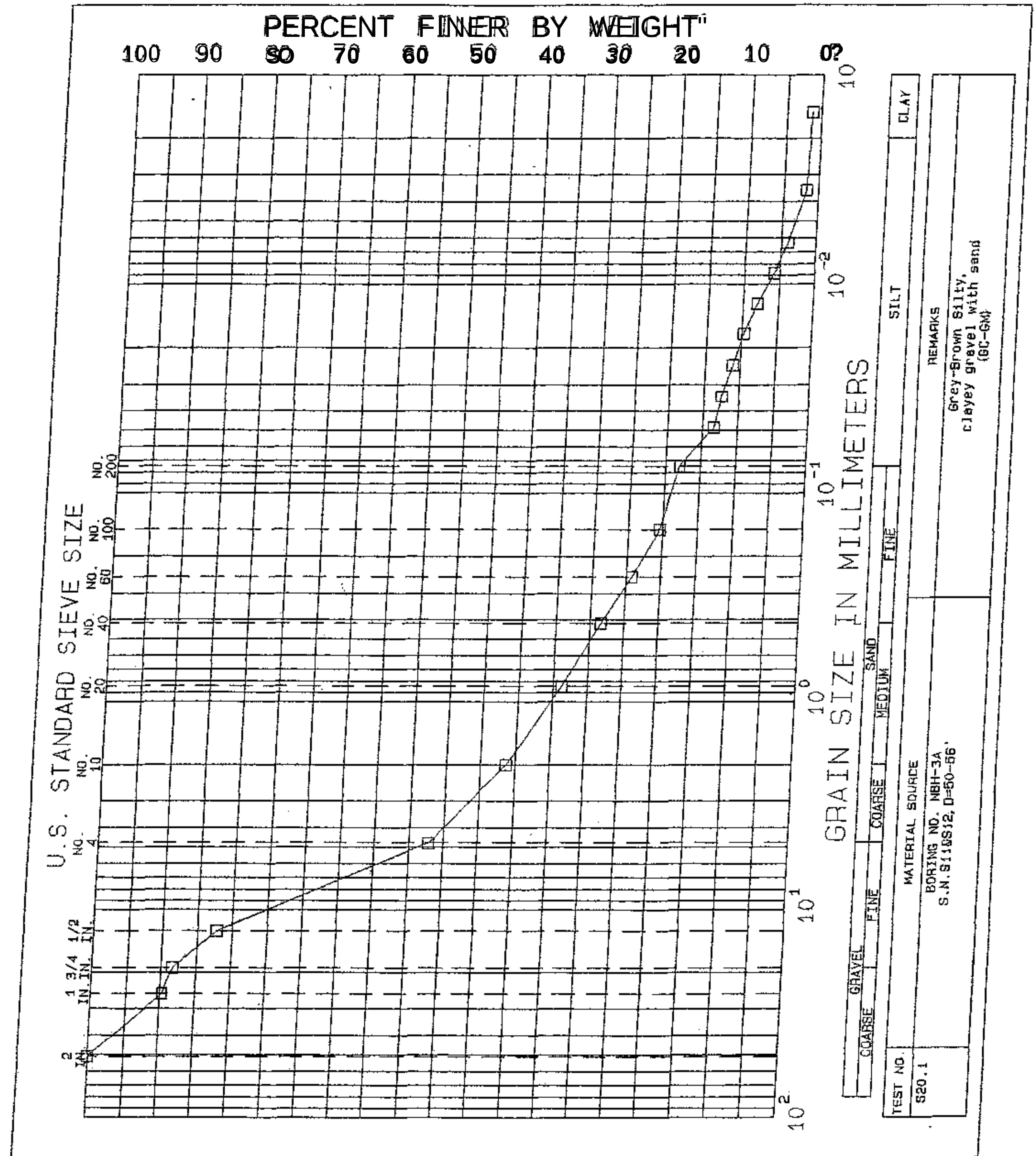


NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-3A
SAMPLE S7-S10
DEPTH 31-48'
TECH. mst
REVIEWER MCM

TEST SERIES NO. 19
DATE SEPT. 01
FILE L16S2B



NEW BEDFORD HARBOR FEASIBILITY STUDY, NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-3A
SAMPLE S11,12
DEPTH 50-56'
TECH. mst
REVIEWER MCM

TEST SERIES NO. 20
DATE SEPT. 01

FILE L16928

LABORATORY TESTING DATA SHEET

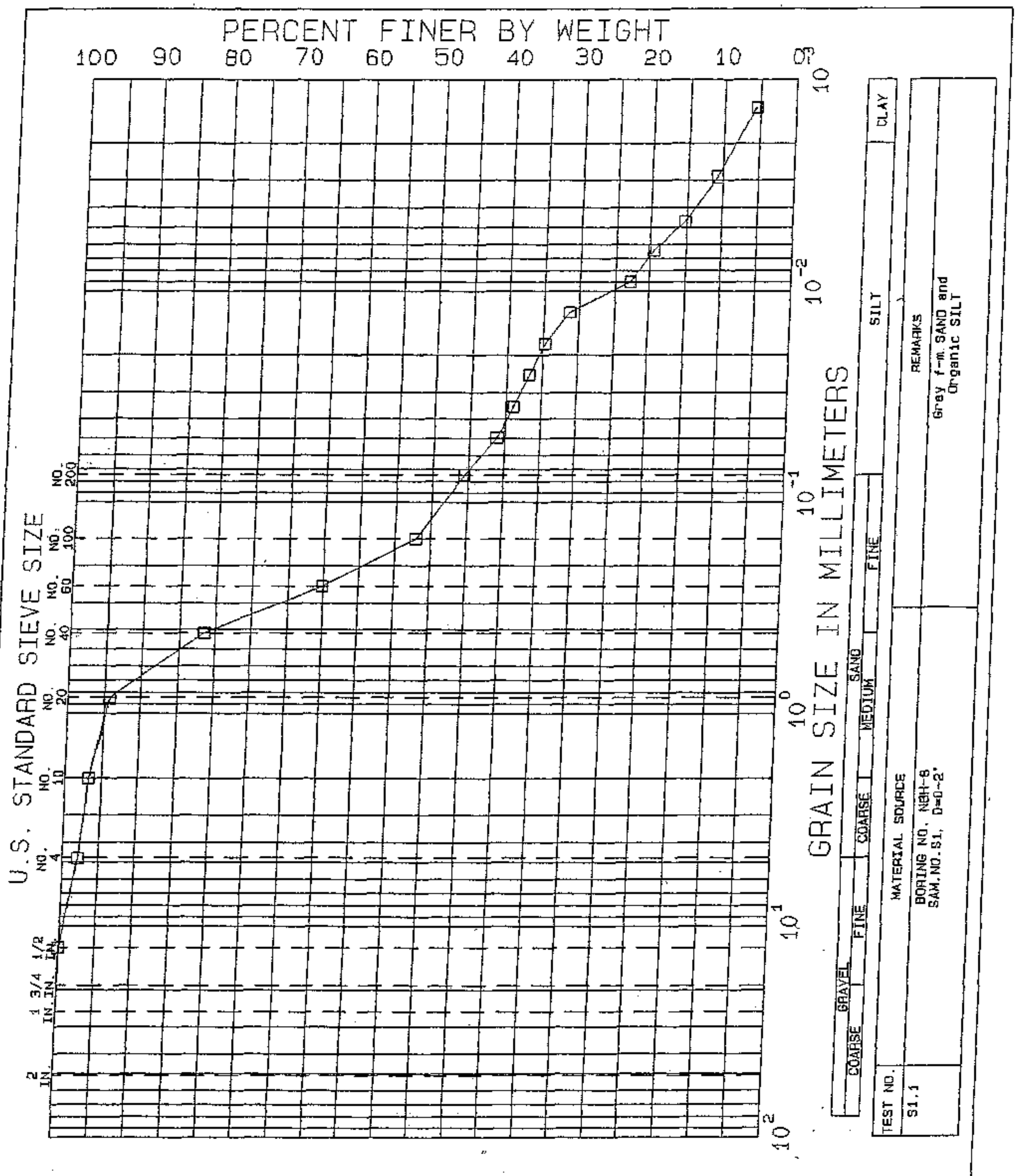
Project Name NEW BEDFORD HARBOR
NEW BEDFORD, MASS.
Project No. L17571
Project Engineer D. SCHULZE
Assigned By D. NACCI
Date DEC.02
Reviewed By
Date Reviewed

Boring/ Test Pit No.	Sample No.	Depth ft.	Lab No.	Identification Tests: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2µ %	ORG %	G_s	Dry unit wt. pcf	Density: γ_d MAX (pcf) / W_{opt} (%)	Perme-ability cm/sec	Strength Tests: Torvane or Type Test	$\bar{\sigma}_c$ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	Consol.: $\frac{[illegible]}{1 + e_0}$	Laboratory Log and Soil Description
NBH-8	UP-1	5-7	21		Average Total Unit Weight (5.0-6.8') = 127.7 Pcf															
		5.1		20.4																Brown fine SAND, little (-) Silt
		5.1-5.6		21.5							105.3									
		5.6		17.3																
		5.6-5.9		18.4	non-plastic		11	<1	0.4											
		5.9-6.4		21.1							105.9									
		6.4		20.1																

LABORATORY TESTING DATA SHEET

Project Name NEW BEDFORD HARBOR
NEW BEDFORD, MA.
Project No. L17571 Assigned By D. NACCI Reviewed By
Project Engineer D. SCHULZE Date DEC.02 Date Reviewed

				Identification Tests								Density		Strength Tests					Consol.	
Boring/ Test Pit No.	Sample No.	Depth ft.	Lab No.	Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	ORG %	G_s	Dry unit wt. pcf	γ_d MAX (pcf) W_{opt} (%)	Permeability cm/sec	Torvane or Type Test	$\bar{\sigma}_c$ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	[illegible] / $1 + e_0$	Laboratory Log and Soil Description
NBH-8	S-1	0-2	1	47.5	38	19	46	8	2.6											Grey f-m SAND and Organic SILT
	S-2	7-9	2				11													Brown f-c SAND, little (+) Gravel, little (-) Silt
	S-3-S-6	10-27	3				6													Brown f-c GRAVEL and m-c SAND trace Silt
	S-8 S-9	41.5-49.5	4				3													Grey-Brown f-c SAND, little (-) Gravel, trace Silt
	S-10	52.5-54.5	5				3													Brown fine SAND, trace Silt
	S-11 S-12	57.5-64.5	6				4													Grey-f-c SAND and f-c GRAVEL, trace Silt
	S-14	75.5-77.5	7				6													Grey f-m SAND, little Gravel, trace Silt
	S-15 S-16	80.5-87.5	8				9													Grey-Brown f-c SAND, little (-) Gravel, trace (+) Silt
NBH-9	S-1	0-2	9	114	100	47	86	14	10.4											Grey Organic SILT, little Sand
	S-2	12-14	10				11	1												Brown f-c GRAVEL and f-m SAND, little (-) Silt
	S-3	18-20	11				15	1												Brown f-m SAND and f-c GRAVEL, little Silt

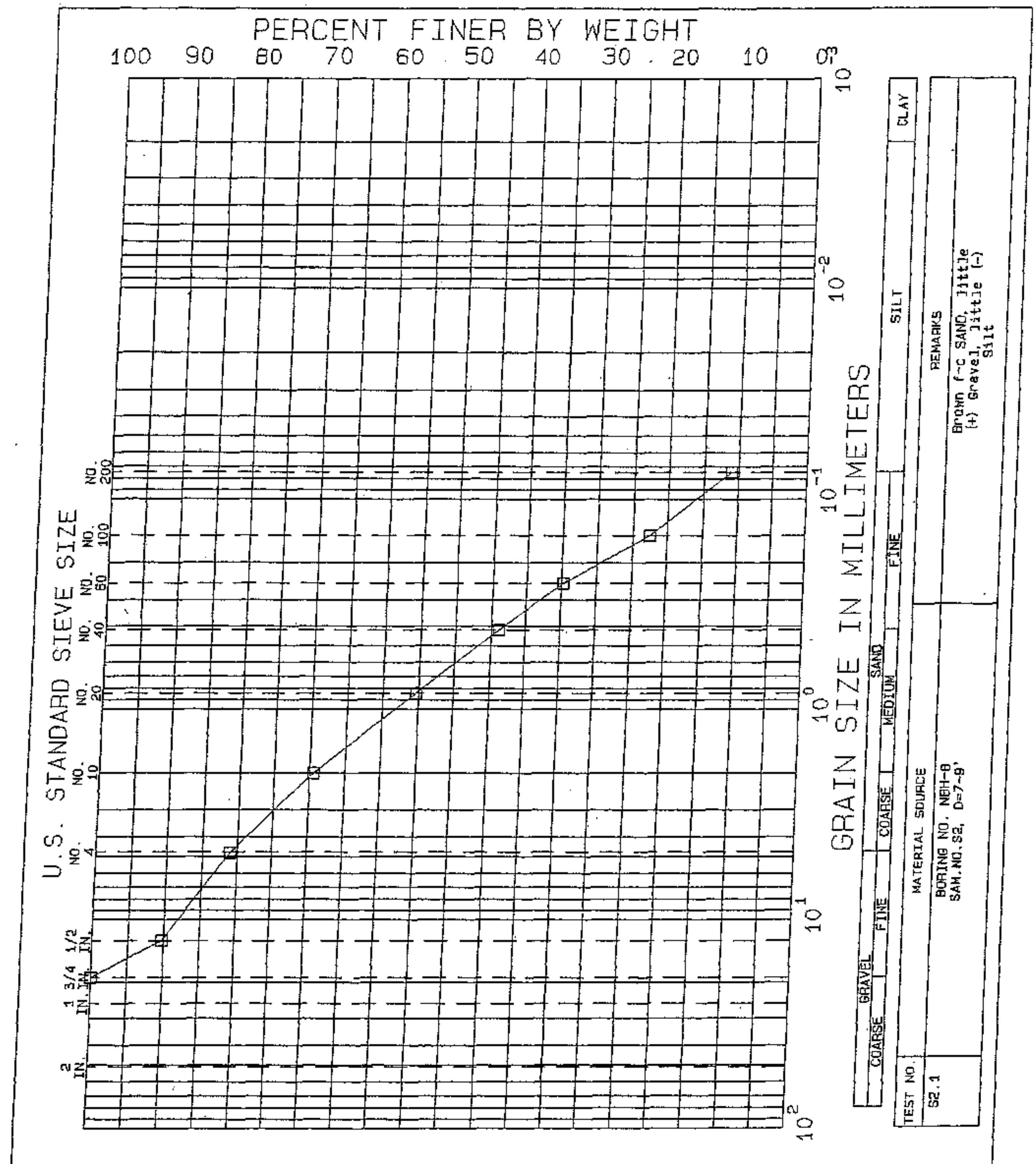


NEW BEDFORD HARBOR

NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-8		TEST SERIES
SAMPLE	S-1	NO. 1
DEPTH	0-2'	DATE Jan.03
TECH.	MST	
REVIEWER	MCM	FILE L17571



NEW BEDFORD HARBOR

NEW BEDFORD, MA.

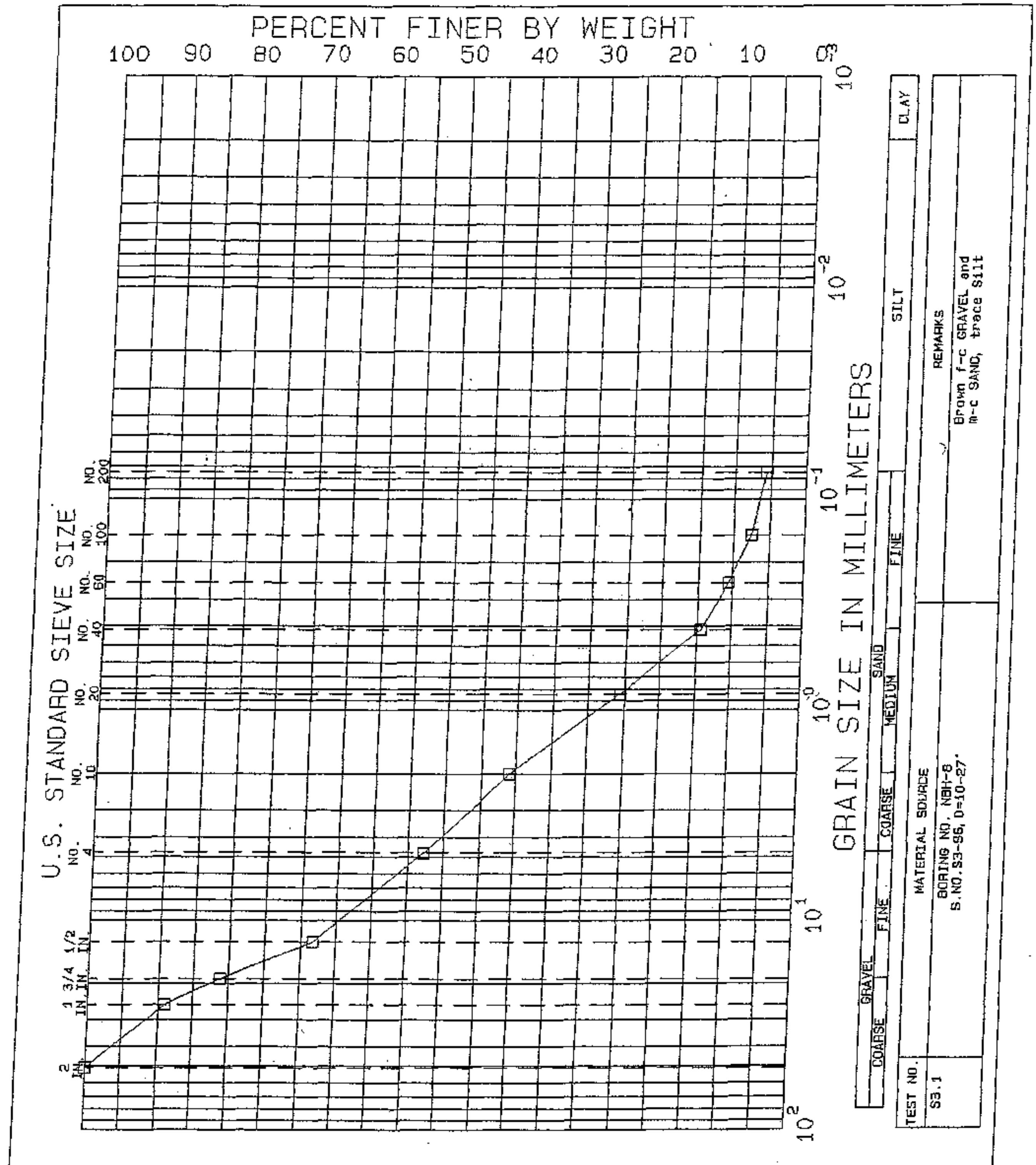
GRADATION TESTS

BORING NO. NBH-8
SAMPLE S-2
DEPTH 7-9'
TECH. MST
REVIEWER MCM

TEST SERIES
NO. 2
DATE Jan.03

FILE L17571

GZA GEOENVIRONMENTAL, INC.
ENGINEERS AND SCIENTISTS

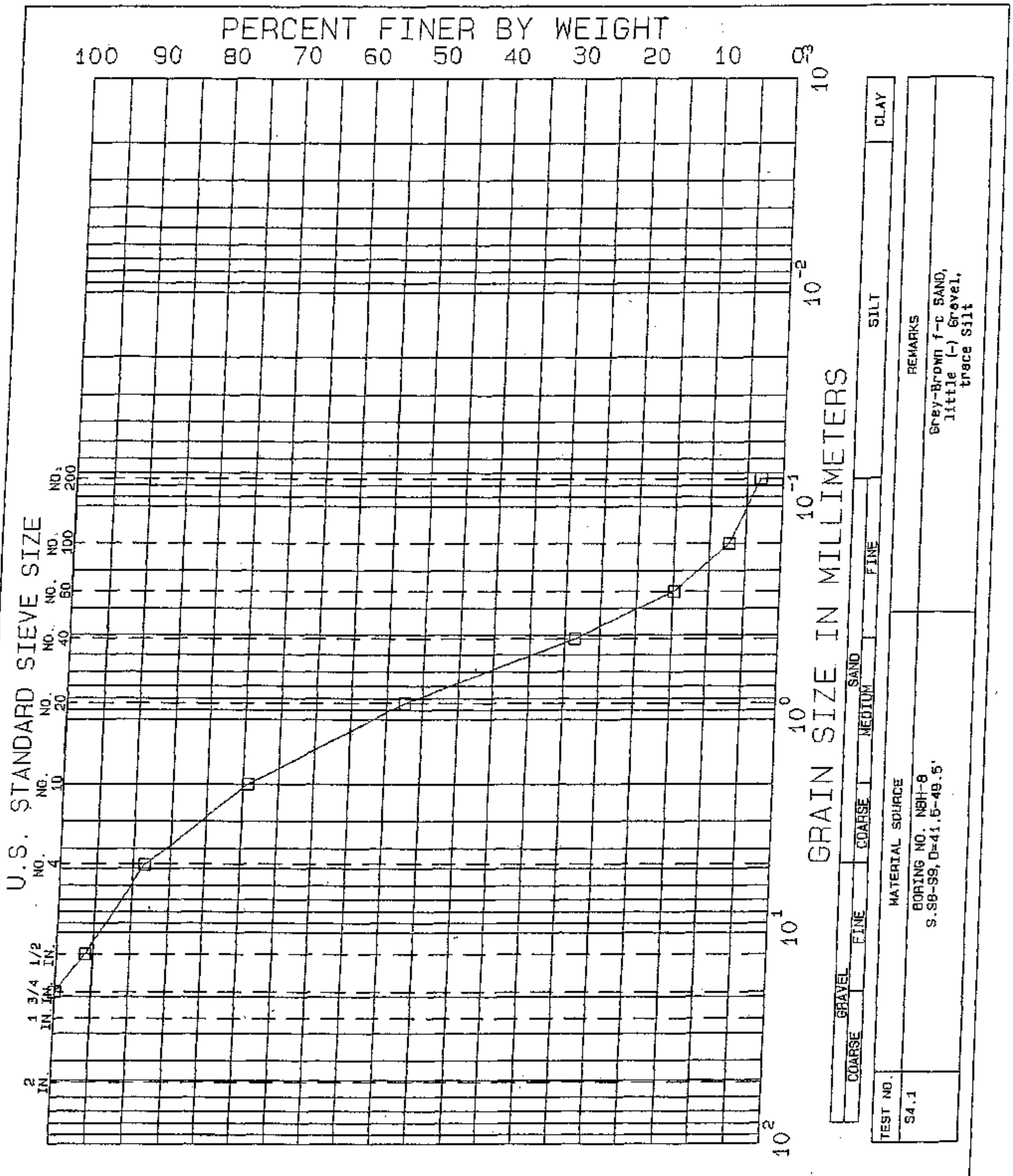


NEW BEDFORD HARBOR

NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-8	TEST SERIES
SAMPLE S3-S6	NO. 3
DEPTH 10-27'	DATE Jan.03
TECH. MST	
REVIEWER MCM	FILE L17571



NEW BEDFORD HARBOR

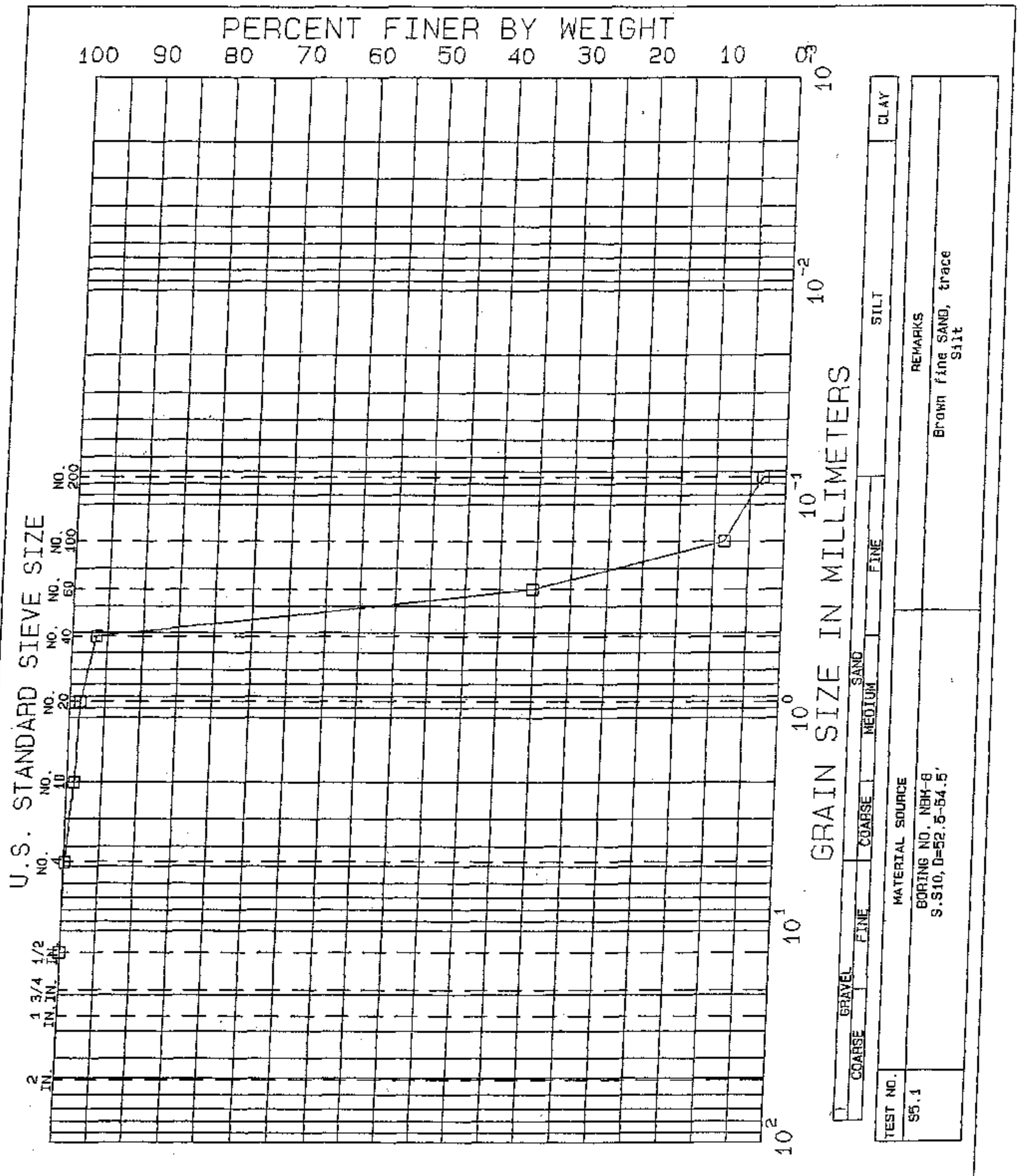
NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-8
SAMPLE S8-S9
DEPTH 41.5-49.5'
TECH. MST
REVIEWER MCM

TEST SERIES
NO. 4
DATE Jan.03

FILE L17571

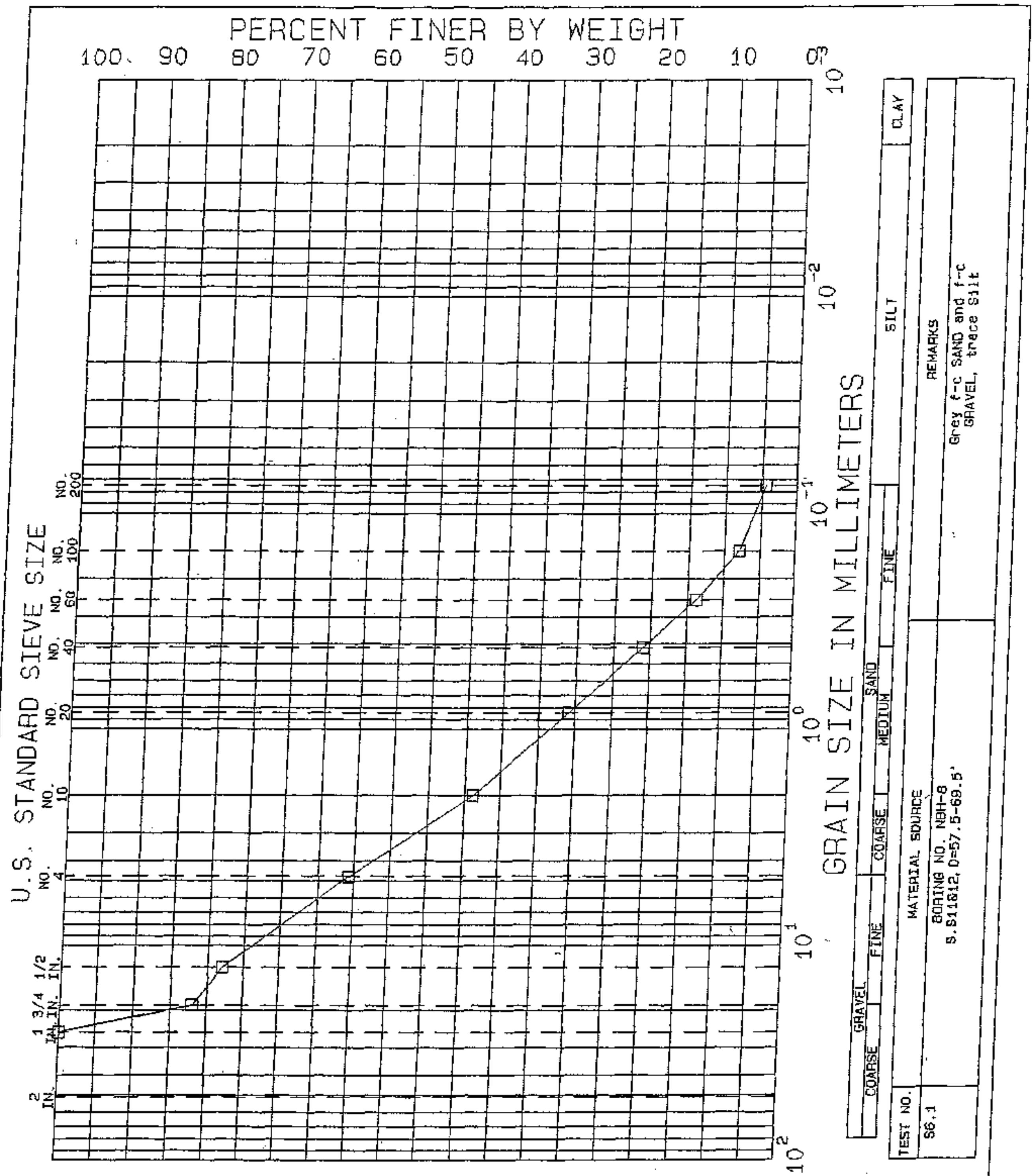


NEW BEDFORD HARBOR

NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-8	TEST SERIES
SAMPLE S10	NO. 5
DEPTH 52.5-54.5'	DATE Jan.03
TECH. MST	
REVIEWER MCM	FILE L17571



NEW BEDFORD HARBOR

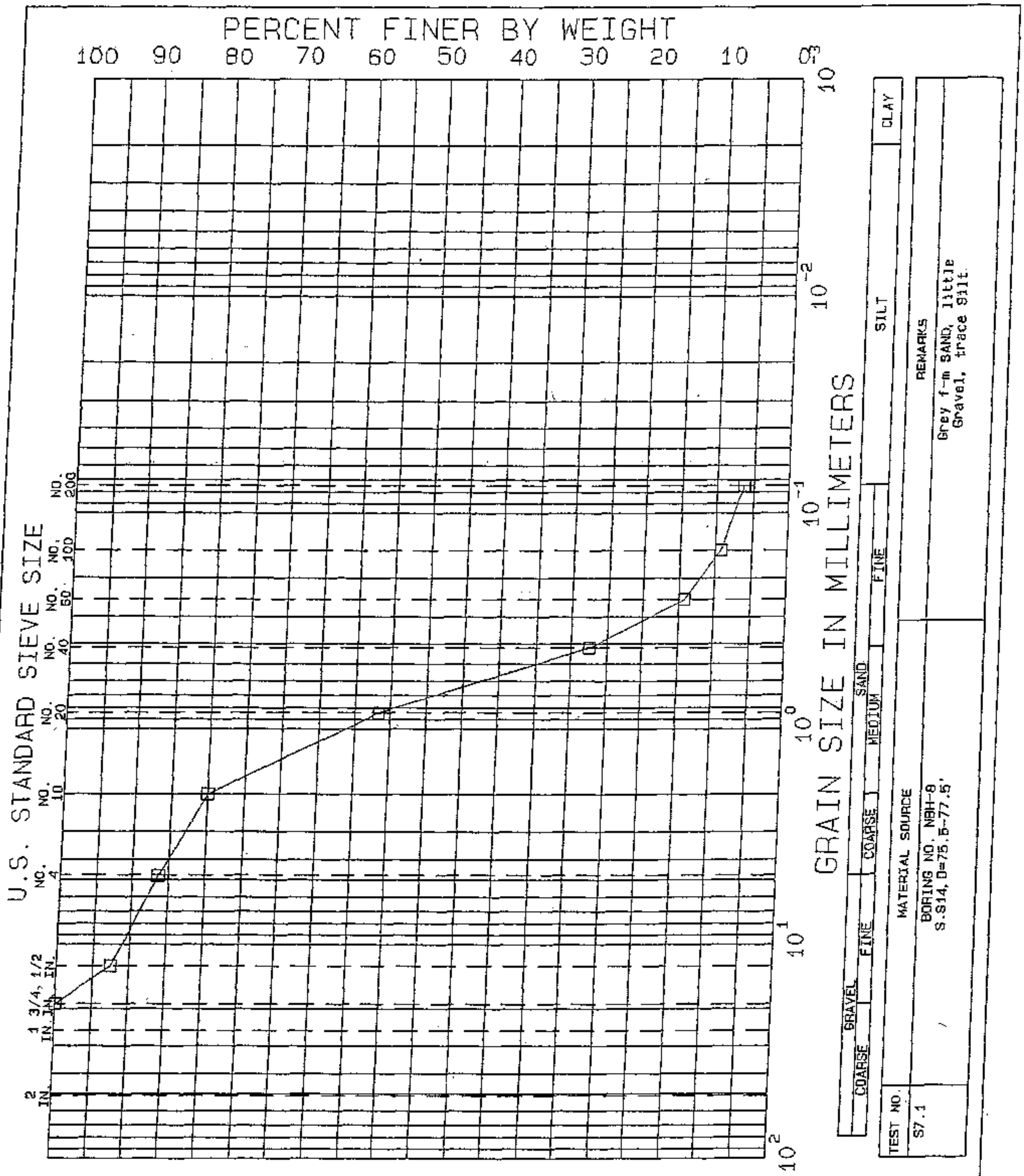
NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-8
SAMPLE S11&12
DEPTH 57.5-69.5'
TECH. MST
REVIEWER MCM

TEST SERIES
NO. 6
DATE Jan.03

FILE L17571



NEW BEDFORD HARBOR

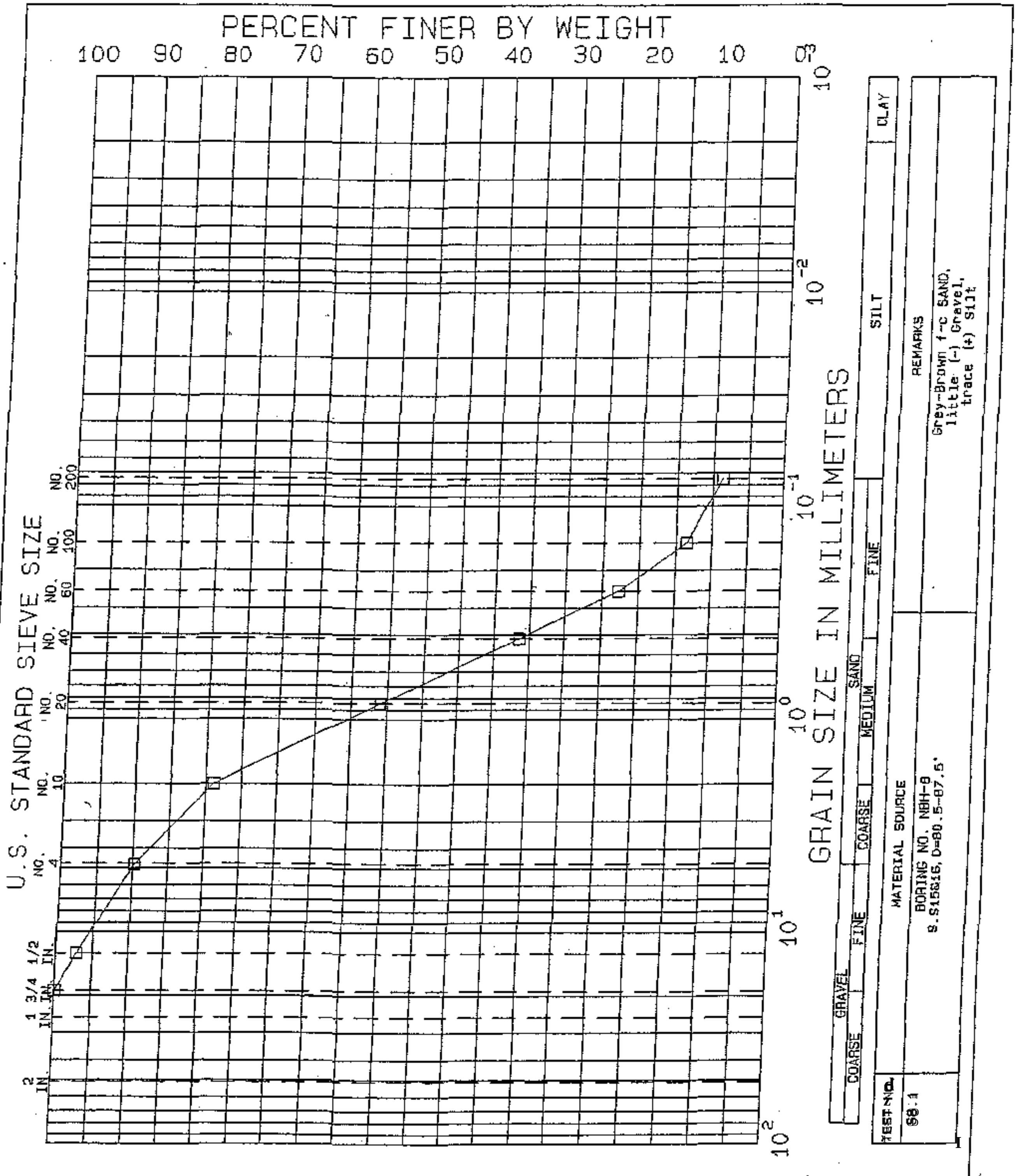
NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-8
SAMPLE S14
DEPTH 75.5-77.5'
TECH. MST
REVIEWER MCM

TEST SERIES
NO. 7
DATE Jan.03

FILE L17571



NEW BEDFORD HARBOR
NEW BEDFORD, MA.

GRADATION TESTS

BORING NO. NBH-8
SAMPLE S15616
DEPTH 80.5-87.5'
TECH. MST
REVIEWER MCM

TEST SERIES
NO. 8
DATE Jan.03

FILE L17571

Specific Gravity of Soils by ASTM D 854

Client: Nobis Engineering
Project Name: New Bedford Harbor Superfund Site
Project Location: New Bedford, MA

GTX #: 2409
Test Date: 10/18/99
Tested By: swj
Checked By: gtt

Boring #	Sample ID	Depth, ft	Visual Description	Specific Gravity @ 20° C
FD-2	UO-1	3-5	Wet, black sandy organic silt	2.49
FD-2	UO-2	6-8	Moist, very dark brown organic clay with sand	2.64
FD-5	UO-1	3-5	Moist, black organic clay	2.52
FD-5	UO-2	6-8	Moist, very dark brown sandy organic clay	2.64
FD-8	UO-2	6-8	Moist, very dark gray clayey sand with organics	2.59
FD-30	UO-2	4-6	Moist, dark gray clayey sand with organics	2.63
FD-31	UO-1	3-5	Moist, dark gray organic clay with sand	2.62
FD-31	UO-2	8-10	Moist, dark gray organic clay with sand	2.62
FD-31	UO-3	12-14	Moist, dark gray sandy organic clay	2.63
FD-32	UO-1	6-8	Moist, dark gray sandy organic clay	2.64

Notes: Specific gravity performed by using method B (moist specimens) of ASTM D 854

Moisture, Ash, and Organic Matter of Peat and Other Organic Soils by ASTM D 2974

Client:	Nobis Engineering	GTX #:	2409
Project Name:	New Bedford Harbor Superfund Site	Test Date:	11/30/99
Project Location:	New Bedford, MA	Tested By:	GSG
		Checked By:	GTT

Boring #	Sample ID	Depth, ft	Visual Description	Moisture Content, %	Ash Content, %	Organic Matter, %
FD-6	U-3	7-9	Moist, gray silty sand	22	99.5	0.5
FD-7	U-1	1-3	Moist, black organic clay with sand	142	90.1	9.9
FD-7	U-3	5-7	Moist, dark gray clayey sand with organics	50	96.3	3.7
FD-13	U-1	3-5	Moist, dark gray organic clay with sand	78	96.6	3.4
FD-13	U-2	6-8	Moist, dark gray sandy organic clay	77	93.4	6.6
FD-13	U-3	9-11	Moist, dark gray clayey sand with gravel, organics	62	93.0	7.0
FD-13	U-4	12-14	Moist, dark brown organic silt	123	84.6	15.4
FD-18	U-1	1-3	Moist, very dark gray sandy organic clay with shells	73	94.9	5.1
FD-18	U-3	7-9	Moist, dark brown sandy silt	24	99.4	0.6
FD-50	U-1	1-3	Moist, black sandy organic clay	93	91.7	8.3
FD-50	U-3	7-9	Moist, black silty sand	23	99.6	0.4

Notes: Moisture content determined by Method A & reported as a percentage of oven-dried mass; dried to constant mass at temperature of 110 °C
Ash content and organic matter determined by Method C; dried to constant mass at temperature of 440 °C

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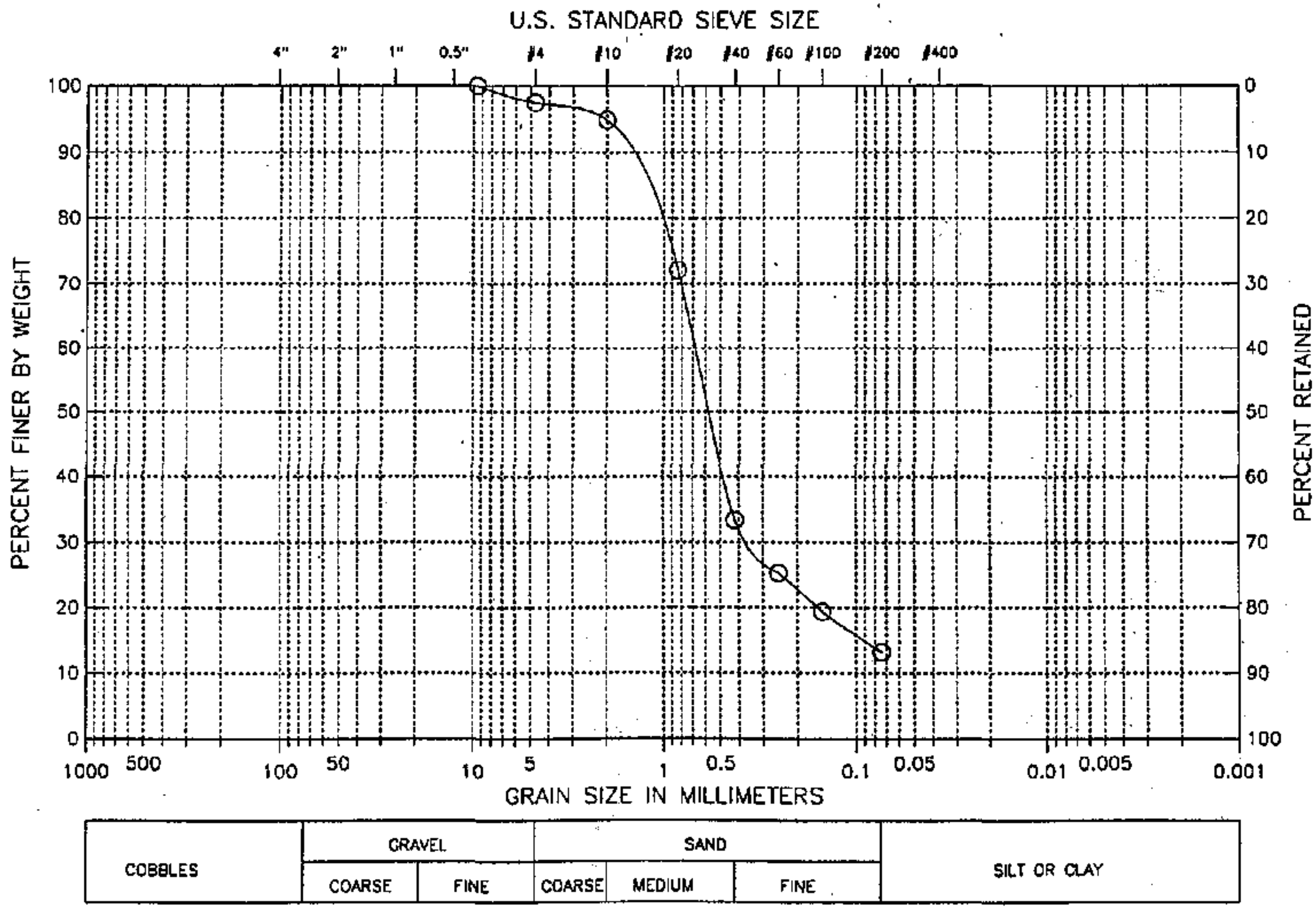
Boring No. : FD-1	Project : New Bedford Harbor Superfund Site
Sample No: S-2 (3.5-5.5)	Project No.: GTX-2409
Test Method ASTM D 422	Location: New Bedford, MA
Filename : FD1S2	Date : Tue Nov 23 1999



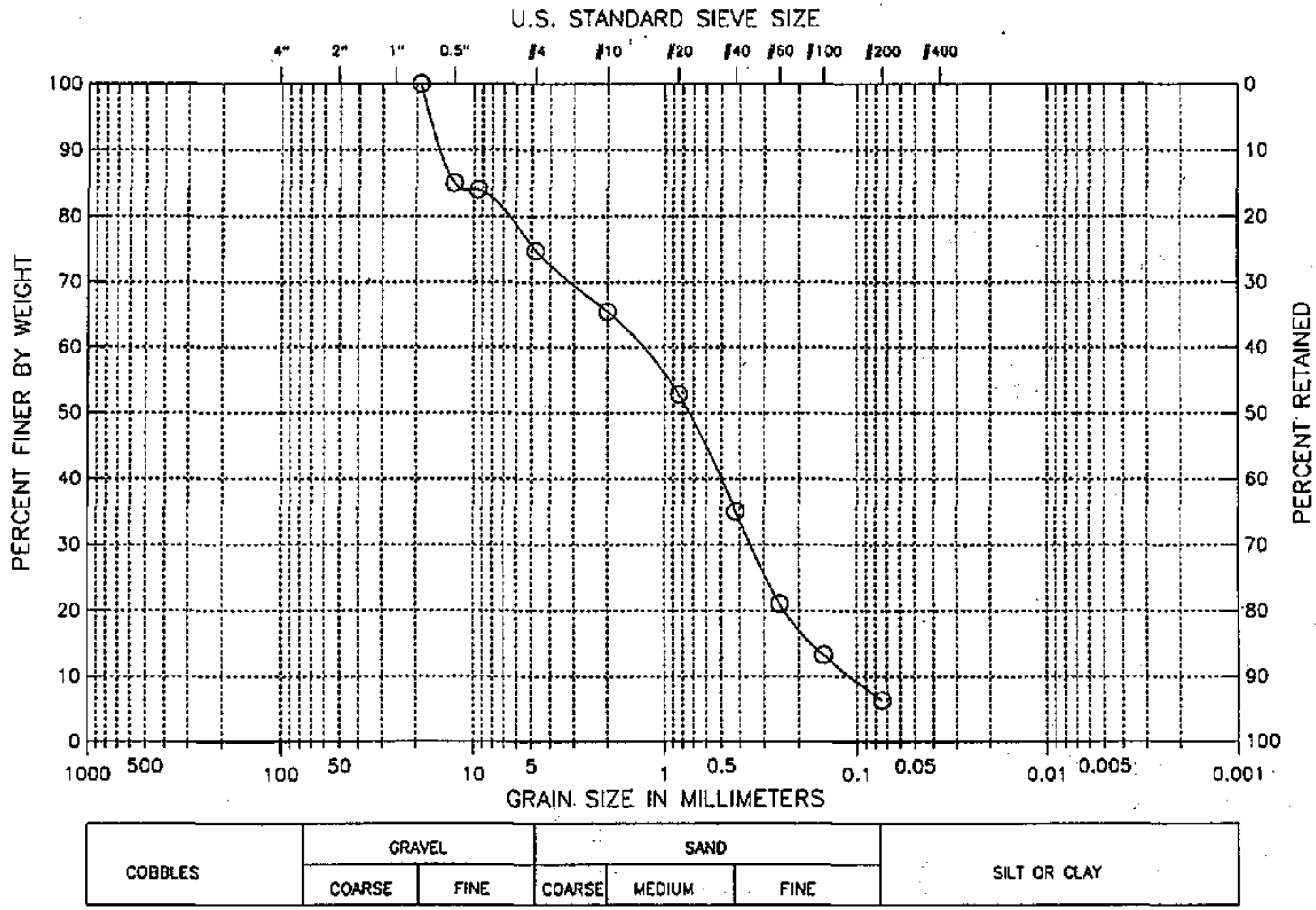
Classification :

Visual Description :
Wet, black silty sand

Remarks :
Hydrometer not required, fines < 15%

Figure 1

	Boring No. : FD-1 Sample No: S-9 (17.5-19.5 Test Method ASTM D 422 Filename : FD1S9	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Tue Nov, 23 1999



Classification :

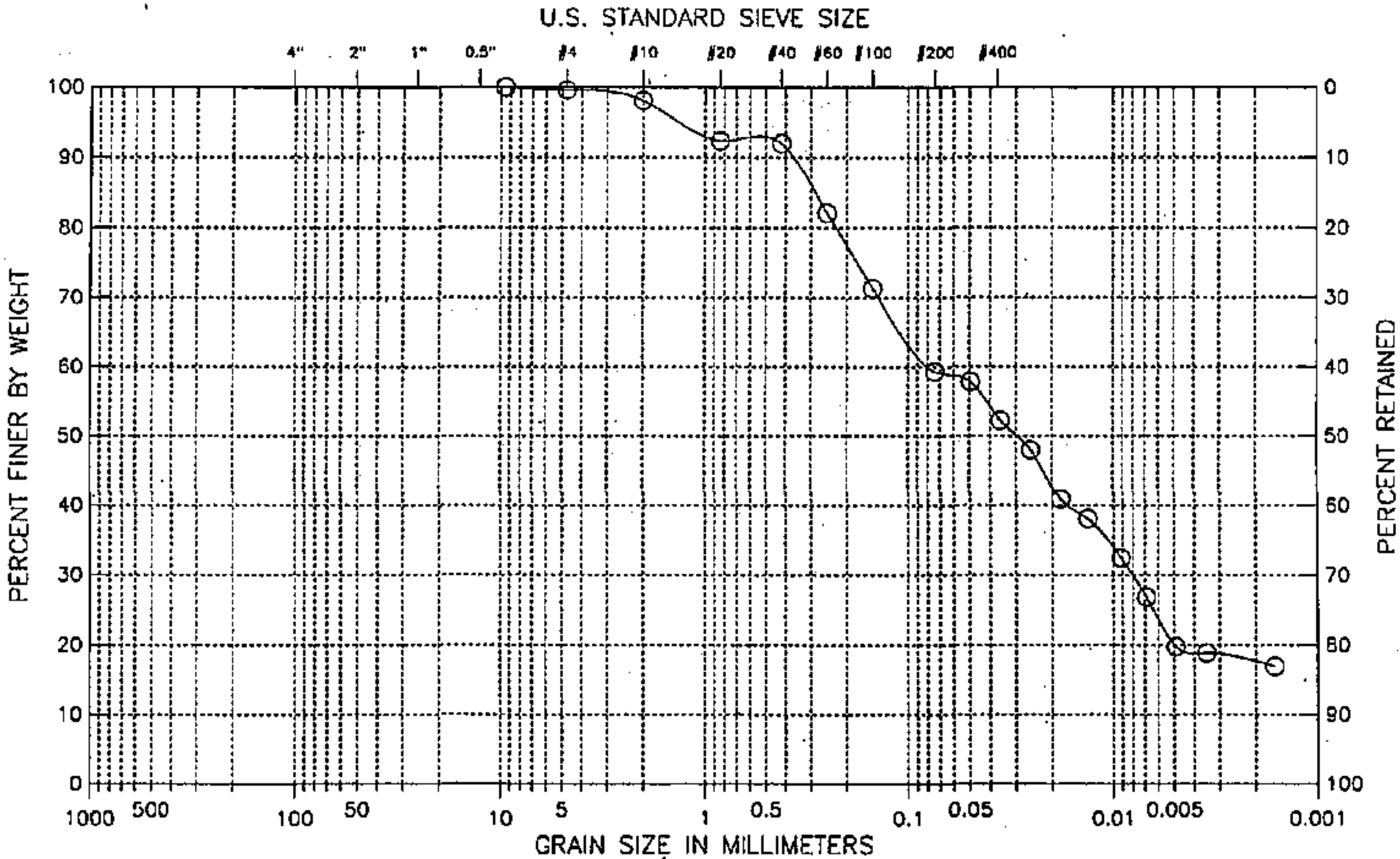
Remarks :
Hydrometer not required, fines < 15%

Visual Description :
Wet, yellowish brown sand with gravel, some silt

Figure 2

GeoTesting Express • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

Boring No. : FD-2	Project : New Bedford Harbor Superfund Site
Sample No: UO-1 (3-5)	Project No.: GTX-2409
Test Method ASTM D 422	Location: New Bedford, MA
Filename : FD2U01	Date : Thu Oct 28 1999



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(OH) Sandy organic silt

Visual Description :
Wet, black sandy organic silt

Remarks :

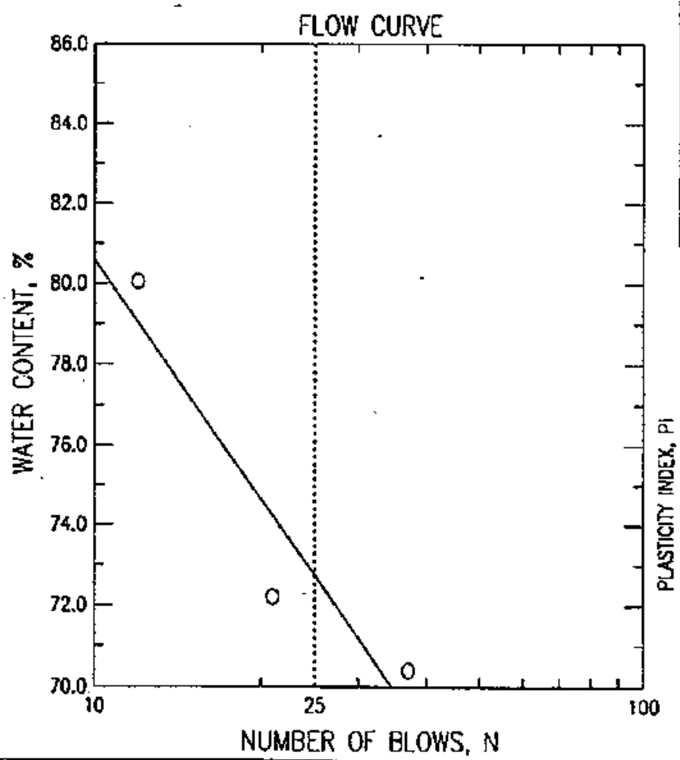
Figure 1

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	gsg/rjw	FD-2
LOCATION		CHECKED BY	SAMPLE NUMBER
New Bedford, MA		gll	U0-1 (3-5)
SAMPLE DESCRIPTION		DATE	FILENAME
Wet, black sandy organic silt		Thu Oct 28 1999	FD2U01

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk85	bk104	bk110		
WT. WET SOIL + TARE	37.82	36.2	34.42		
WT. DRY SOIL + TARE	34.49	32.77	31.57		
WT. WATER	3.33	3.43	2.85		
TARE WT.	29.76	28.02	28.01		
WT. DRY SOIL	4.73	4.75	3.56		
WATER CONTENT, W_N (%)	70.40	72.21	80.06		
NUMBER OF BLOWS, N	37	21	12		
ONE-POINT LIQUID LIMIT, LL	73.82	70.70	73.25		

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk4	bk137			
WT. WET SOIL + TARE	32.75	32.96			
WT. DRY SOIL + TARE	31.89	32.05			
WT. WATER	0.86	0.91			
TARE WT.	29.41	29.4			
WT. DRY SOIL	2.48	2.65			
WATER CONTENT (%)	34.68	34.34			



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	62.7
LIQUID LIMIT, LL	72.7
PLASTIC LIMIT, PL	34.5
PLASTICITY INDEX, PI	38.2
LIQUIDITY INDEX, LI*	0.74

*LI = (W − PL)/PI

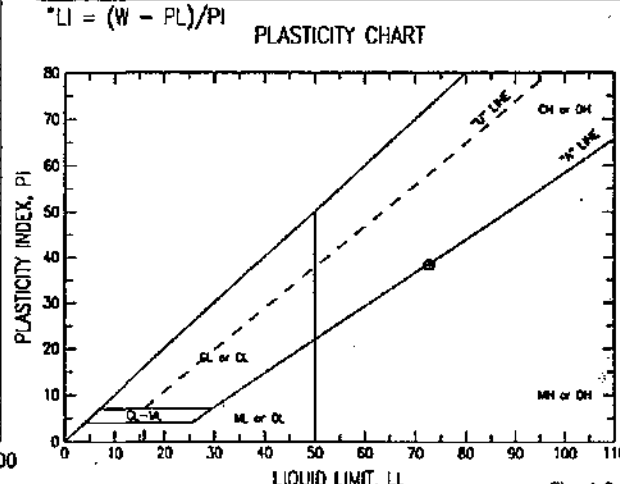
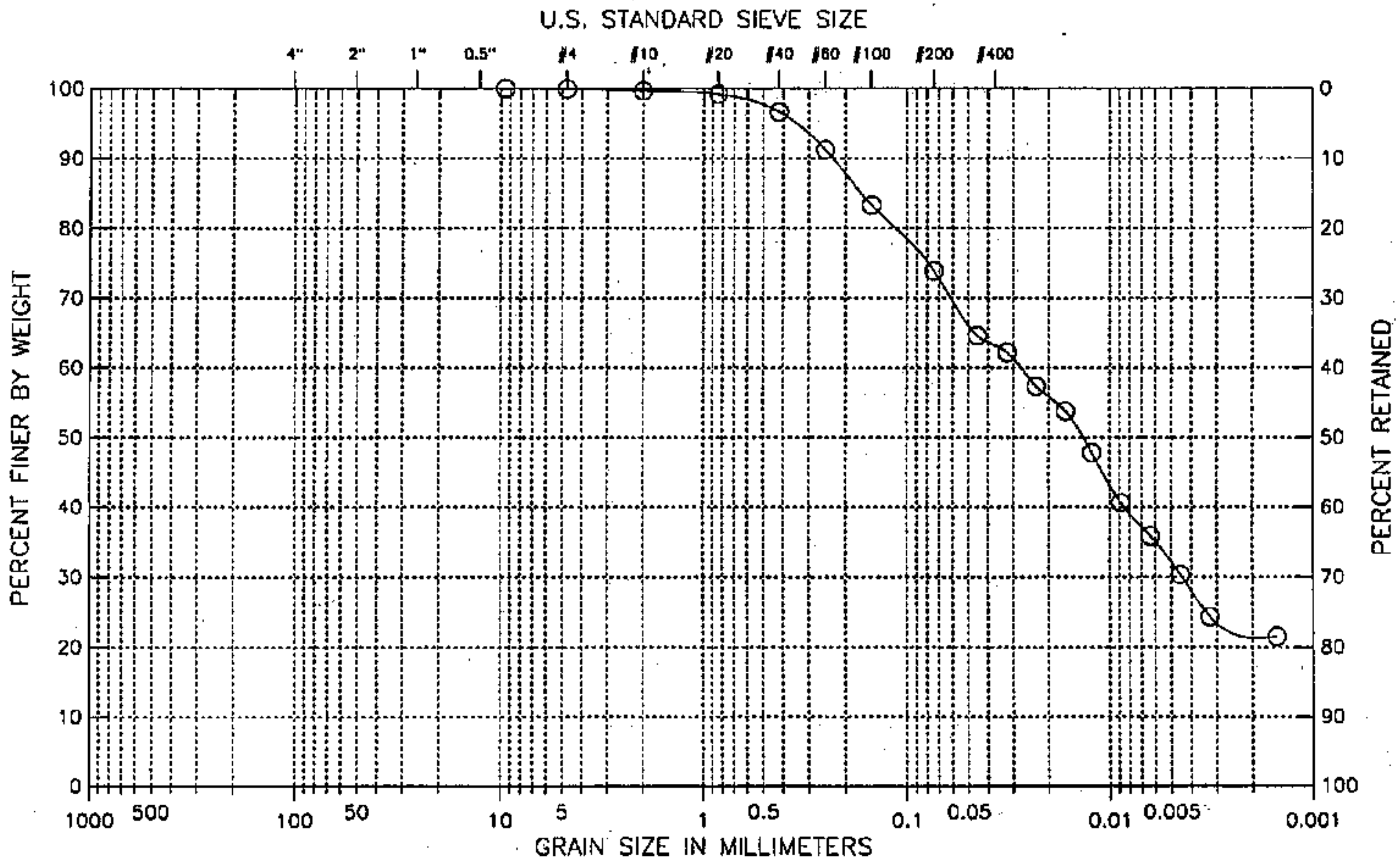


Fig. 1.0

	Boring No. : FD-2 Sample No: UO-2 (6-8) Test Method ASTM D 422 Filename : FD2UO2	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Thu Oct, 28 1999



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(OH) organic clay with sand

Visual Description :
Moist, very dark brown organic clay with sand

Remarks :

Figure 2

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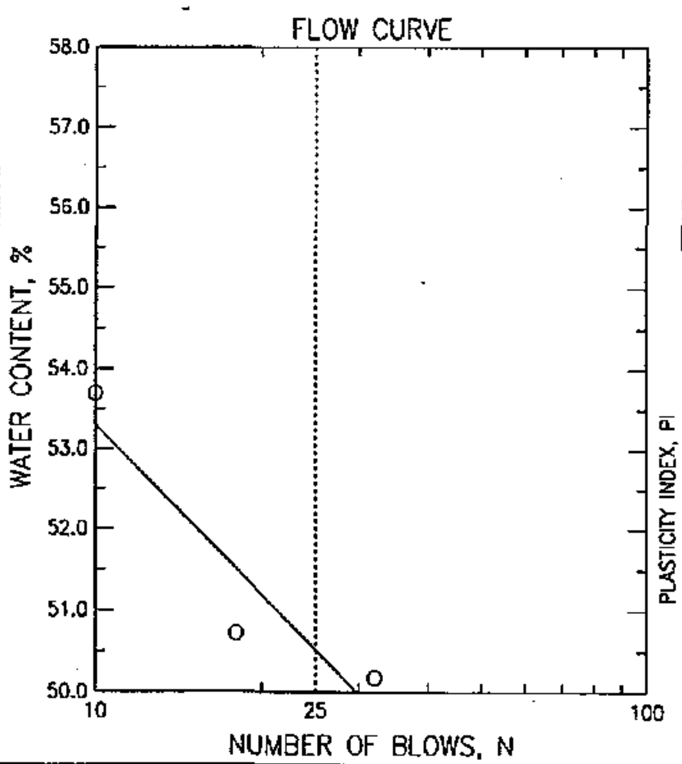
ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	gsg/rjw	FD-2
LOCATION New Bedford, MA		CHECKED BY glt	SAMPLE NUMBER U0-2 (6-8)
SAMPLE DESCRIPTION Moist, very dark brown organic clay with sand		DATE Thu Oct 28 1999	FILENAME FD2U02

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk71	bk16	bk37		
WT. WET SOIL + TARE	37.85	37.75	36.21		
WT. DRY SOIL + TARE	34.99	34.94	33.74		
WT. WATER	2.86	2.81	2.47		
TARE WT.	29.29	29.4	29.14		
WT. DRY SOIL	5.7	5.54	4.6		
WATER CONTENT, W_N (%)	50.18	50.72	53.70		
NUMBER OF BLOWS, N	32	18	10		
ONE-POINT LIQUID LIMIT, LL	51.70	48.75	48.06		
PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk76	bk10			
WT. WET SOIL + TARE	37.62	34.98			
WT. DRY SOIL + TARE	35.95	33.82			
WT. WATER	1.67	1.16			
TARE WT.	29.18	29.23			
WT. DRY SOIL	6.77	4.59			
WATER CONTENT (%)	24.67	25.27			



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	58.8
LIQUID LIMIT, LL	50.5
PLASTIC LIMIT, PL	25.0
PLASTICITY INDEX, PI	25.6
LIQUIDITY INDEX, LI*	1.32

*LI = (W − PL)/PI

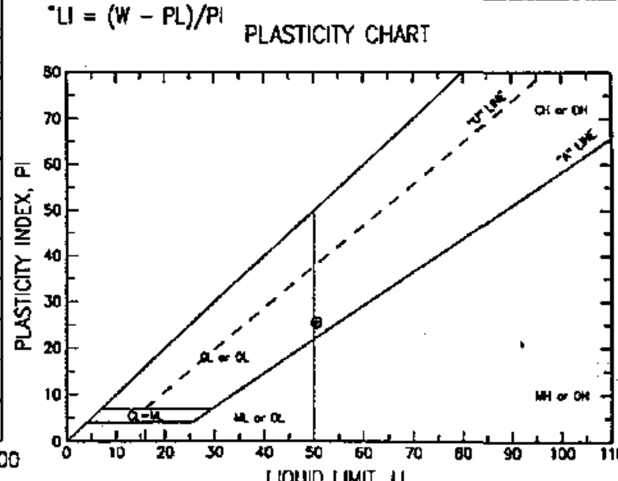
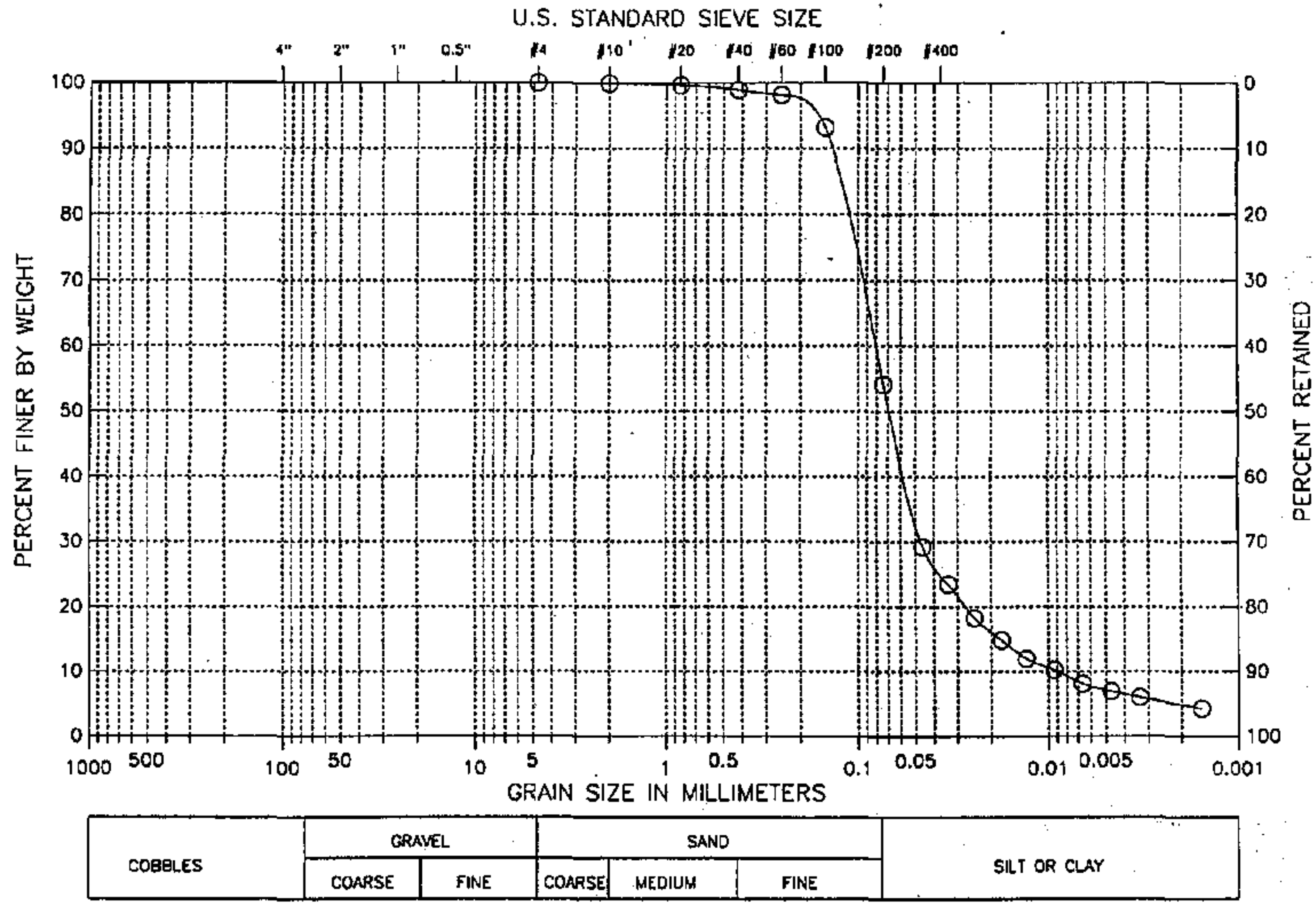


Fig. 2.0

Boring No. : FD-3 Sample No.: S-3 (10-12) Test Method ASTM D 422 Filename : FD3S3	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Tue Nov 23 1999



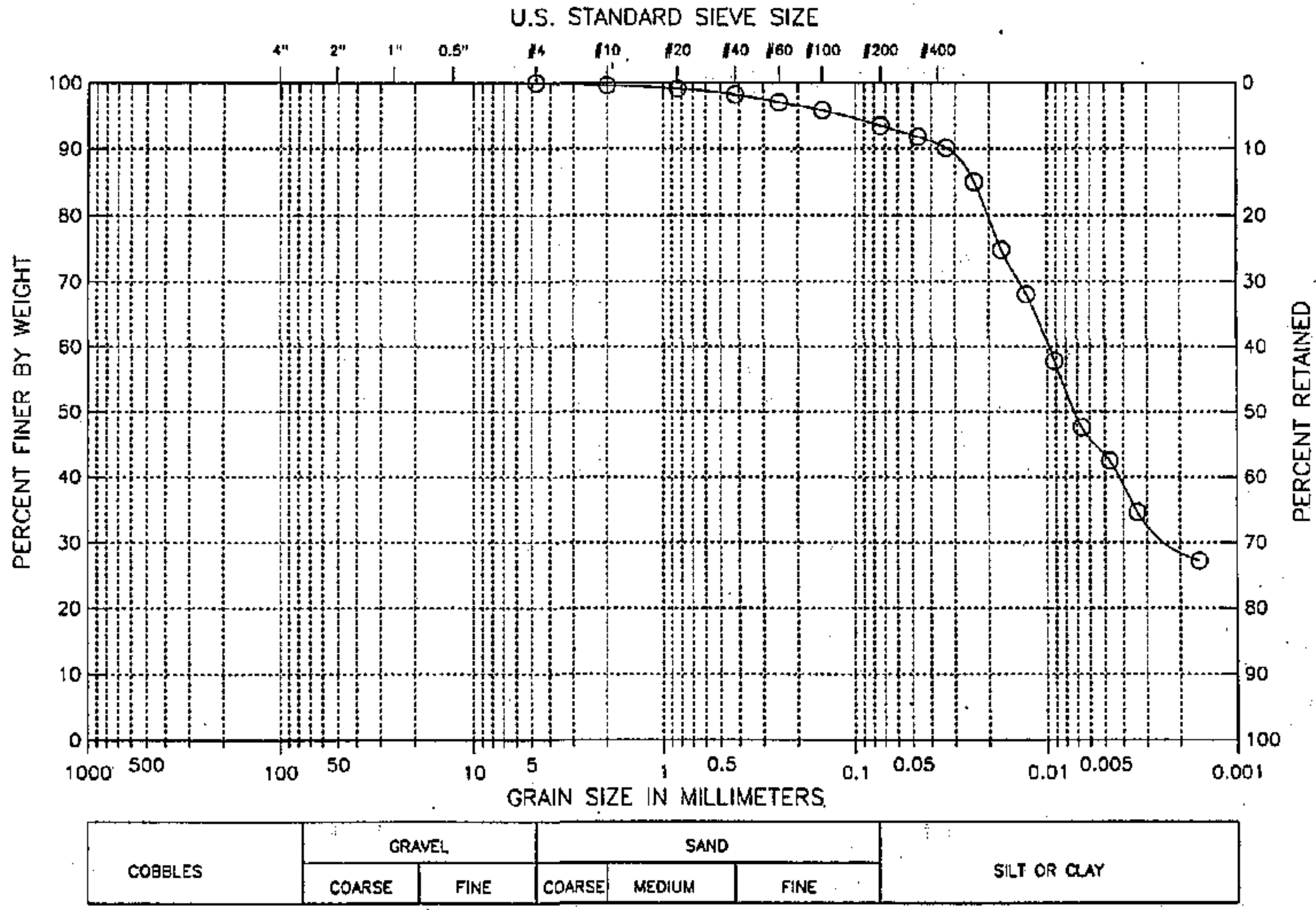
Classification :

Remarks :

Visual Description :
Wet, gray silty sand

Figure 3

Boring No.: FD-5 Sample No.: UO-1 (3-5) Test Method ASTM D 422 Filename : FD5U01	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Thu Oct 28 1999



Classification :
(OH) organic clay
Visual Description :
Moist, black organic clay

Remarks :

Figure 3

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ATTERBERG LIMITS

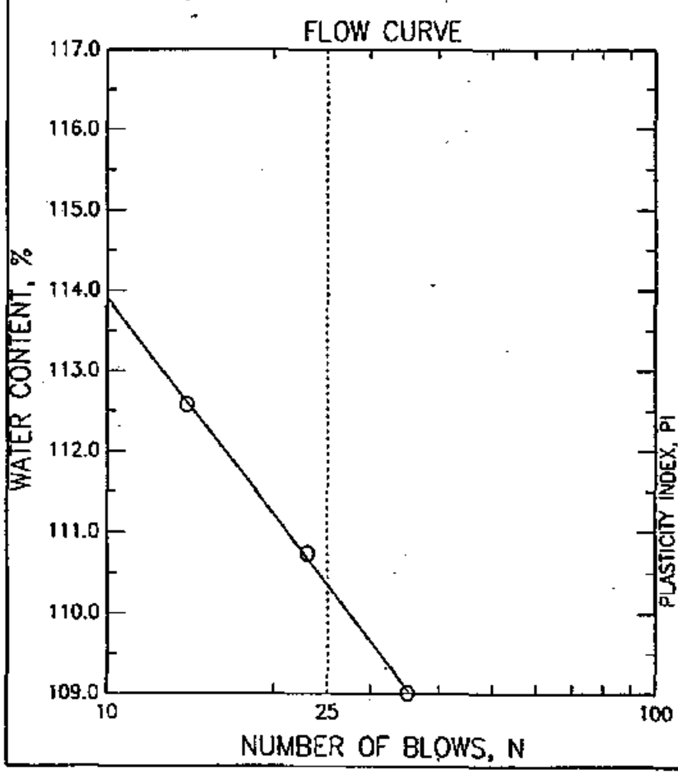
PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	gsg/rjw	FD-5
LOCATION New Bedford, MA		CHECKED BY gtl	SAMPLE NUMBER UO-1 (3-5)
SAMPLE DESCRIPTION Moist, black organic clay		DATE Thu Oct 28 1999	FILENAME FD5UO1

LIQUID LIMIT DETERMINATIONS

CONTAINER NUMBER	bk49	bk87	bk35		
WT. WET SOIL + TARE	37.45	35.45	37		
WT. DRY SOIL + TARE	33.82	32.15	33.42		
WT. WATER	3.63	3.3	3.58		
TARE WT.	30.49	29.17	30.24		
WT. DRY SOIL	3.33	2.98	3.18		
WATER CONTENT, W_N (%)	109.01	110.74	112.58		
NUMBER OF BLOWS, N	35	23	14		
ONE-POINT LIQUID LIMIT, LL	113.54	109.63	104.95		

PLASTIC LIMIT DETERMINATIONS

CONTAINER NUMBER	bk139	bk133			
WT. WET SOIL + TARE	34.26	34.62			
WT. DRY SOIL + TARE	32.48	32.57			
WT. WATER	1.78	2.05			
TARE WT.	28.16	27.55			
WT. DRY SOIL	4.32	5.02			
WATER CONTENT (%)	41.20	40.84			



SUMMARY OF RESULTS

NATURAL WATER CONTENT, W (%)	111.7
LIQUID LIMIT, LL	110.4
PLASTIC LIMIT, PL	41.0
PLASTICITY INDEX, PI	69.3
LIQUIDITY INDEX, LI*	1.02

*LI = (W − PL)/PI

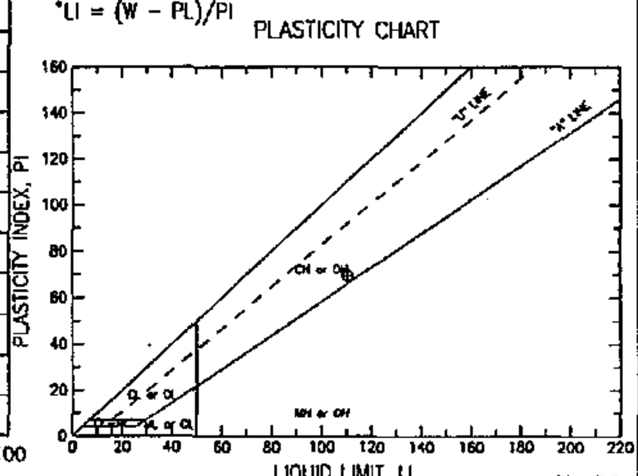


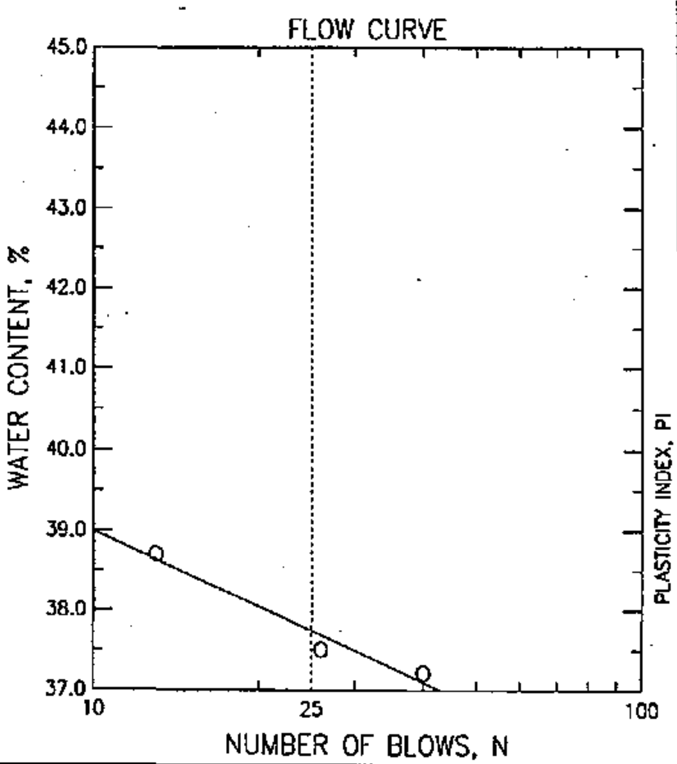
Fig. 3.0

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	gsg/rjw	FD-5
LOCATION		CHECKED BY	SAMPLE NUMBER
New Bedford, MA		gtt	U0-2 (6-8)
SAMPLE DESCRIPTION		DATE	FILENAME
Moist, very dark brown sandy organic clay		Thu Oct 28 1999	FD5U02

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk114	bk143	bk33		
WT. WET SOIL + TARE	36.64	36.32	39.75		
WT. DRY SOIL + TARE	34.24	33.89	37.06		
WT. WATER	2.4	2.43	2.69		
TARE WT.	27.84	27.36	30.11		
WT. DRY SOIL	6.4	6.53	6.95		
WATER CONTENT, W_N (%)	37.50	37.21	38.71		
NUMBER OF BLOWS, N	26	40	13		
ONE-POINT LIQUID LIMIT, LL	37.68	39.39	35.76		

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk144	bk43			
WT. WET SOIL + TARE	35.16	36.36			
WT. DRY SOIL + TARE	34.22	35.32			
WT. WATER	0.94	1.04			
TARE WT.	29.61	30.28			
WT. DRY SOIL	4.61	5.04			
WATER CONTENT (%)	20.39	20.63			



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	31.0
LIQUID LIMIT, LL	37.7
PLASTIC LIMIT, PL	20.5
PLASTICITY INDEX, PI	17.2
LIQUIDITY INDEX, LI*	0.61

*LI = (W − PL)/PI

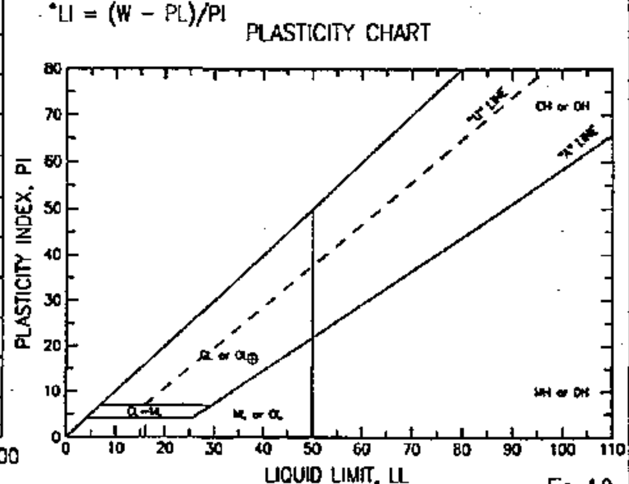
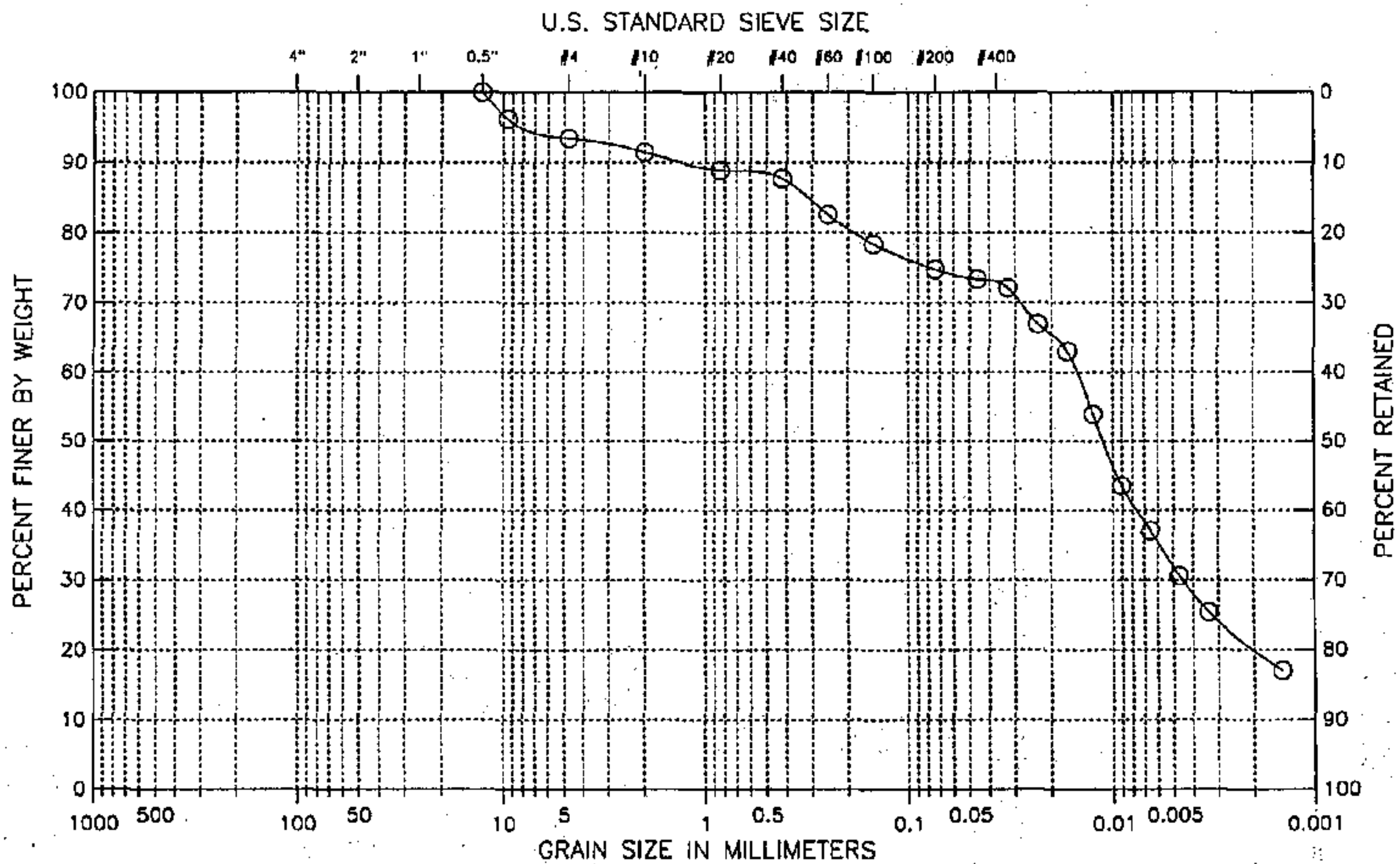


Fig. 4.0

	Boring No. : FD-6	Project : New Bedford Harbor Superfund Site
	Sample No.: U-1 (1-3)	Project No.: GTX-2409
	Test Method ASTM D 422	Location: New Bedford, MA
	Filename : FD6U1	Date : Fri Dec 17 1999



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(OH) organic clay with sand

Visual Description :
Moist, very dark gray organic clay with sand

Remarks :

Figure 1

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ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	GSG/MHM	FD-6
LOCATION		**CHECKED BY**	**SAMPLE NUMBER**
New Bedford, MA		GTT	U-3 (7-9)
SAMPLE DESCRIPTION		**DATE**	**FILENAME**
Moist, gray silty sand		Fri Dec 17 1999	FD6U3

LIQUID LIMIT DETERMINATIONS

CONTAINER NUMBER					
WT. WET SOIL + TARE					
WT. DRY SOIL + TARE					
WT. WATER					
TARE WT.					
WT. DRY SOIL					
WATER CONTENT, W_N (%)					
NUMBER OF BLOWS, N					
ONE-POINT LIQUID LIMIT, LL					

PLASTIC LIMIT DETERMINATIONS

CONTAINER NUMBER					
WT. WET SOIL + TARE					
WT. DRY SOIL + TARE					
WT. WATER					
TARE WT.					
WT. DRY SOIL					
WATER CONTENT (%)					

Determined to be Non-Plastic.

SUMMARY OF RESULTS

NATURAL WATER CONTENT, W (%)	21.6
LIQUID LIMIT, LL	
PLASTIC LIMIT, PL	
PLASTICITY INDEX, PI	
LIQUIDITY INDEX, LI*	

*LI = (W – PL)/PI

PLASTICITY CHART

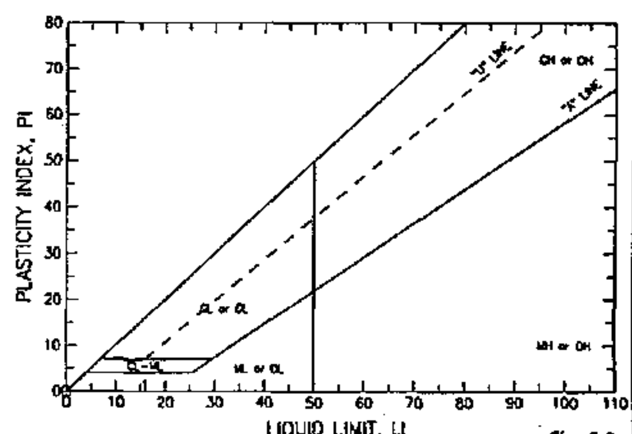

Fig. 3.0

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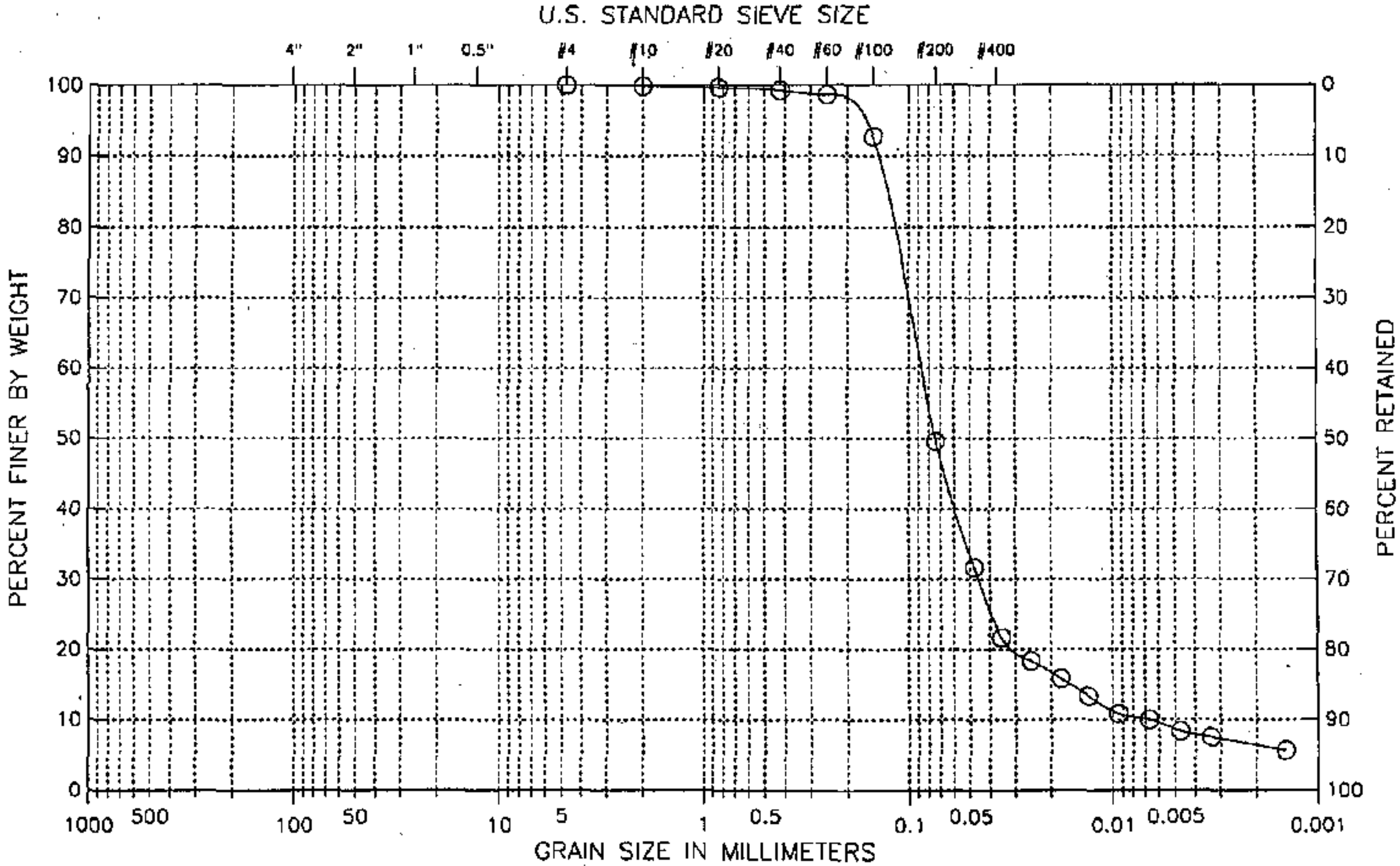
	Boring No. : FD-6 Sample No.: S-1 (10-12) Test Method ASTM D 422 Filename : FD6S1	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Wed Feb 02 2000



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

Remarks :

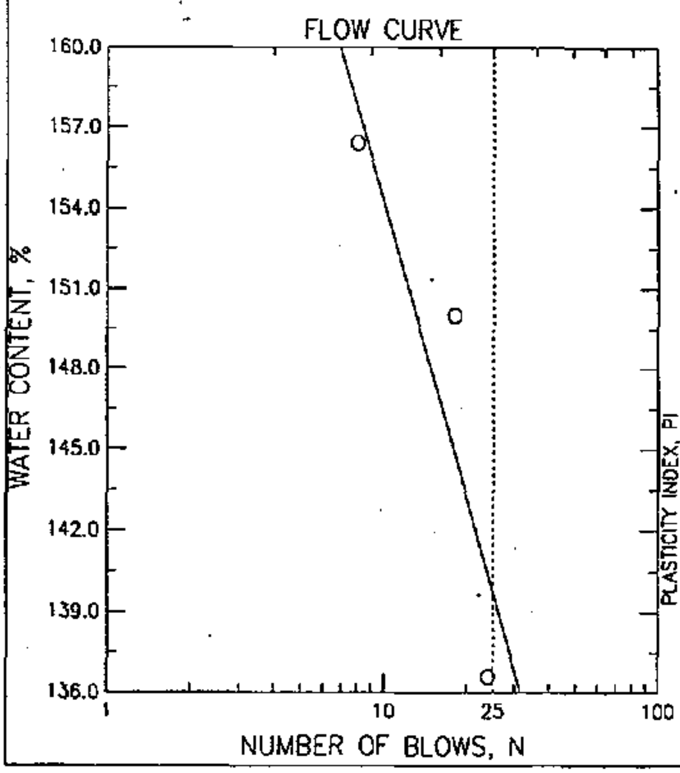
Visual Description :
Wet gray silty sand

Figure 3

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	GSG/MHM	FD-7
LOCATION New Bedford, MA		CHECKED BY GTT	SAMPLE NUMBER U-1 (1-3)
SAMPLE DESCRIPTION Moist, black organic clay with sand		DATE Fri Dec 17 1999	FILENAME FD7U1

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	64	59	134		
WT. WET SOIL + TARE	34.12	33.45	33.47		
WT. DRY SOIL + TARE	31.47	31.05	31.03		
WT. WATER	2.65	2.4	2.44		
TARE WT.	29.53	29.45	29.47		
WT. DRY SOIL	1.94	1.6	1.56		
WATER CONTENT, W_N (%)	136.60	150.00	156.41		
NUMBER OF BLOWS, N	24	18	8		
ONE-POINT LIQUID LIMIT, LL	135.92	144.15	136.27		
PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	68	92	43		
WT. WET SOIL + TARE	33.14	32.33	33.21		
WT. DRY SOIL + TARE	32.34	31.45	32.34		
WT. WATER	0.8	0.88	0.87		
TARE WT.	30.56	29.33	30.28		
WT. DRY SOIL	1.78	2.12	2.06		
WATER CONTENT (%)	44.94	41.51	42.23		



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	141.7
LIQUID LIMIT, LL	139.7
PLASTIC LIMIT, PL	42.9
PLASTICITY INDEX, PI	96.8
LIQUIDITY INDEX, LI*	1.02

*LI = (W − PL)/PI

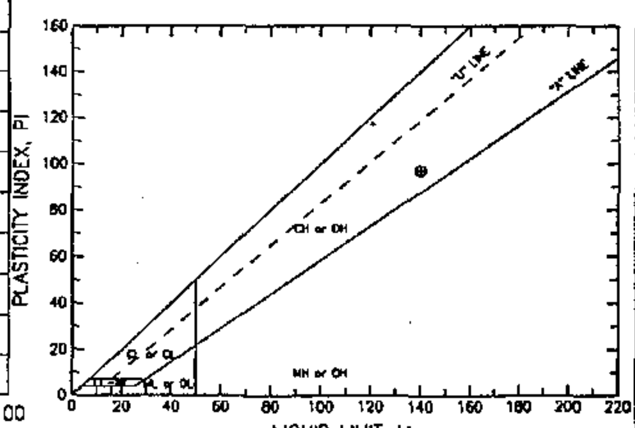


Fig. 4.0

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Filename : FD7U1
Project No. : GTX-2409
Depth : 1-3 ft
Elevation : ---
Boring No. : FD-7
Test Date : 11/30/99
Tested by : GSG/MHM
Sample No. : U-1 (1-3)
Test Method : ASTM D 2216
Checked by : GTT
Location : New Bedford, MA
Soil Description : Moist, black organic clay with sand
Remarks : ---

Natural Moisture Content

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) cr10	65.18	261.72	146.48	141.75

Average Moisture Content = 141.75

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-7
Sample No. : U-2 (3-5)
Location : New Bedford, MA
Soil Description : Moist, black organic clay
Remarks : ---

Depth : 3-5 ft
Test Date : 11/30/99
Test Method : ASTM D 4318

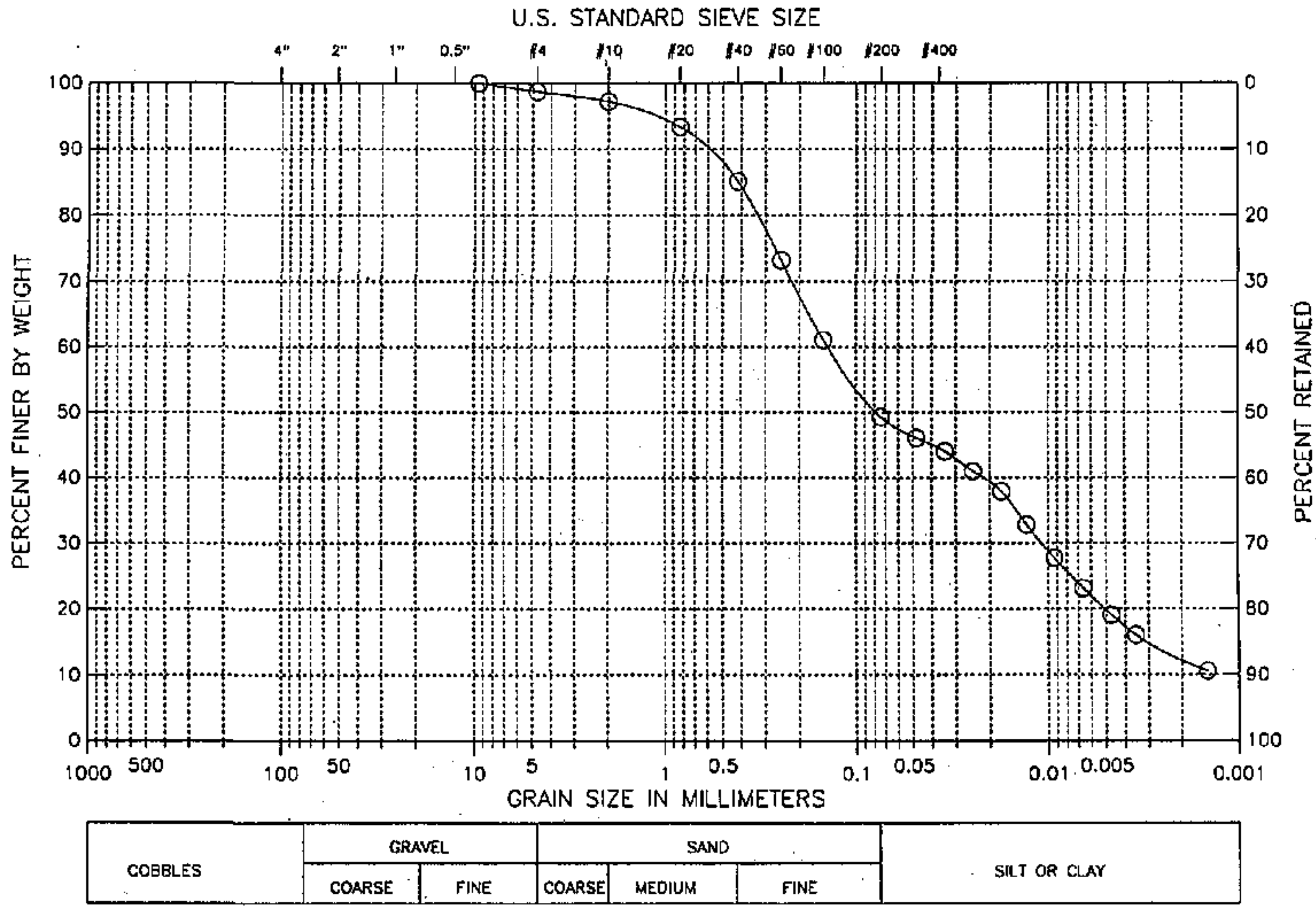
Filename : FD7U2
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

Liquid Limit for Organic

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Number of Drops	Moisture Content (%)
1) 43	30.28	34.98	33.13	28	64.91
2) 144	29.76	34.17	32.40	16	67.05
3) 108	27.93	32.12	30.39	8	70.33

Liquid Limit = 65.30

	Boring No. : FD-7 Sample No.: U-3 (5-7) Test Method ASTM D 422 Filename : FD7U3	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Fri Dec,17 1999



Classification :
(SC) Clayey sand

Visual Description :
Moist, dark gray clayey sand with organics

Remarks :

Figure 6

ATTERBERG LIMITS

PROJECT New Bedford Harbor Superfund Site	PROJECT NUMBER GTX-2409	TESTED BY GSG/MHM	BORING NUMBER FD-7
LOCATION New Bedford, MA		CHECKED BY GTT	SAMPLE NUMBER U-3 (5-7)
SAMPLE DESCRIPTION Moist, dark gray clayey sand with organics		DATE Fri Dec 17 1999	FILENAME FD7U3

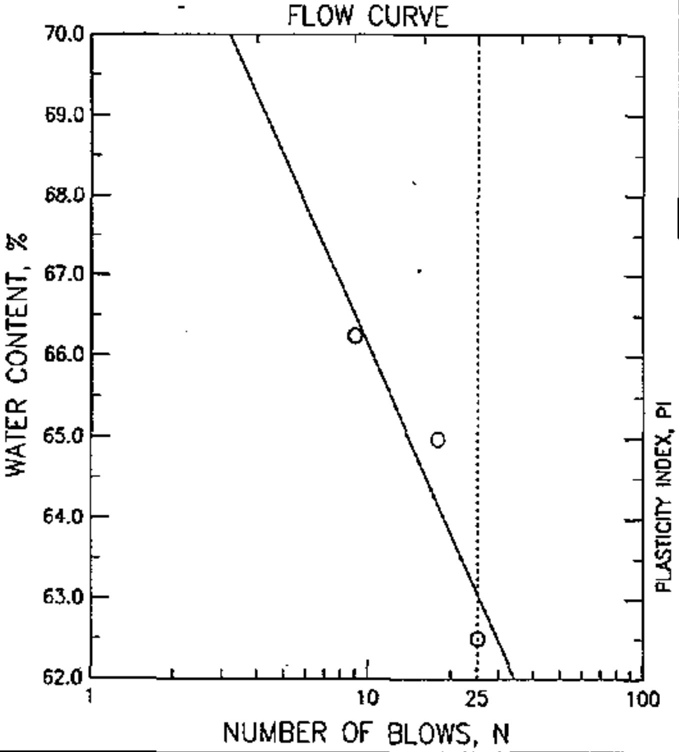
LIQUID LIMIT DETERMINATIONS

CONTAINER NUMBER	92	49	105		
WT. WET SOIL + TARE	36.35	35.41	36.61		
WT. DRY SOIL + TARE	33.65	33.48	34		
WT. WATER	2.7	1.93	2.61		
TARE WT.	29.33	30.51	30.06		
WT. DRY SOIL	4.32	2.97	3.94		
WATER CONTENT, W_N (%)	62.50	64.98	66.24		
NUMBER OF BLOWS, N	25	18	9		
ONE-POINT LIQUID LIMIT, LL	62.50	62.45	58.54		

PLASTIC LIMIT DETERMINATIONS

CONTAINER NUMBER	69	32			
WT. WET SOIL + TARE	34.96	33.93			
WT. DRY SOIL + TARE	33.99	33.14			
WT. WATER	0.97	0.79			
TARE WT.	30.16	30.06			
WT. DRY SOIL	3.83	3.08			
WATER CONTENT (%)	25.33	25.65			

FLOW CURVE



SUMMARY OF RESULTS

NATURAL WATER CONTENT, W (%)	50.1
LIQUID LIMIT, LL	63.1
PLASTIC LIMIT, PL	25.5
PLASTICITY INDEX, PI	37.6
LIQUIDITY INDEX, LI*	0.65

*LI = (W - PL)/PI

PLASTICITY CHART

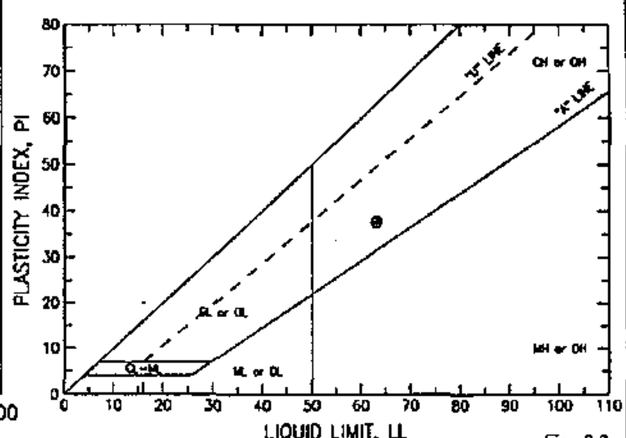


Fig. 6.0

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GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Filename : FD7U3
Project No. : GTX-2409
Depth : 5-7 ft
Elevation : ---
Boring No. : FD-7
Test Date : 11/30/99
Tested by : GSG/MHM
Sample No. : U-3 (5-7)
Test Method : ASTM D 2216
Checked by : GTT
Location : New Bedford, MA
Soil Description : Moist, dark gray clayey sand with organics
Remarks : ---

Natural Moisture Content

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) cr7	71.05	252.26	191.80	50.07

Average Moisture Content = 50.07

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-7
Sample No. : U-4 (7-9)
Location : New Bedford, MA
Depth : 7-9 ft
Test Date : 11/30/99
Test Method : ASTM D 422
Filename : FD7U4
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT
Soil Description : Moist, dark gray clayey sand with organics
Remarks : ---

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 59.94 gm
Specific Gravity = 2.68

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	27.00	18.00	22.13	0.048	31	0.048
2.00	26.00	18.00	21.13	0.034	30	0.034
4.00	21.50	18.00	16.63	0.025	23	0.025
8.00	20.00	18.00	15.13	0.018	21	0.018
15.00	19.00	18.00	14.13	0.013	20	0.013
30.00	17.00	18.00	12.13	0.009	17	0.009
60.00	15.00	18.00	10.13	0.007	14	0.007
120.00	13.00	18.00	8.13	0.005	11	0.005
210.00	12.00	18.00	7.13	0.004	10	0.004
1279.00	9.50	20.00	5.18	0.001	7	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.5"	0.500	12.70	0.00	0.00	100
0.375"	0.374	9.51	1.64	1.64	97
#4	0.187	4.75	4.05	5.69	90
#10	0.079	2.00	3.72	9.41	84
#20	0.033	0.84	4.98	14.39	76
#40	0.017	0.42	7.51	21.90	63
#60	0.010	0.25	7.70	29.60	50
#100	0.006	0.15	5.69	35.29	41
#200	0.003	0.07	5.12	40.41	32
Pan			18.94	59.35	0

Total Dry Weight of Sample = 69.02

D85 : 2.2505 mm
D60 : 0.3710 mm
D50 : 0.2483 mm
D30 : 0.0383 mm
D15 : 0.0074 mm
D10 : 0.0036 mm

Soil Classification
ASTM Group Symbol : SC
ASTM Group Name : Clayey sand
AASHTO Group Symbol : A-2-7(5)
AASHTO Group Name : *Clayey Gravel and Sand*

GEOTECHNICAL LABORATORY TEST DATA

Project : *New Bedford Harbor Superfund Site*
Project No. : GTX-2409
Boring No. : FD-7
Sample No. : U-4 (7-9)
Location : New Bedford, MA
Depth : 7-9 ft
Test Date : 11/30/99
Test Method : ASTM D 4318
Filename : FD7U4
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT
Soil Description : Moist, dark gray clayey sand with organics
Remarks : ---

Liquid Limit for Organic

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Number of Drops	Moisture Content (%)
1) 6	29.50	35.73	34.27	31	30.61
2) 137	29.62	35.97	34.40	23	32.85
3) 144	29.61	35.26	33.83	12	33.89

Liquid Limit = 31.81

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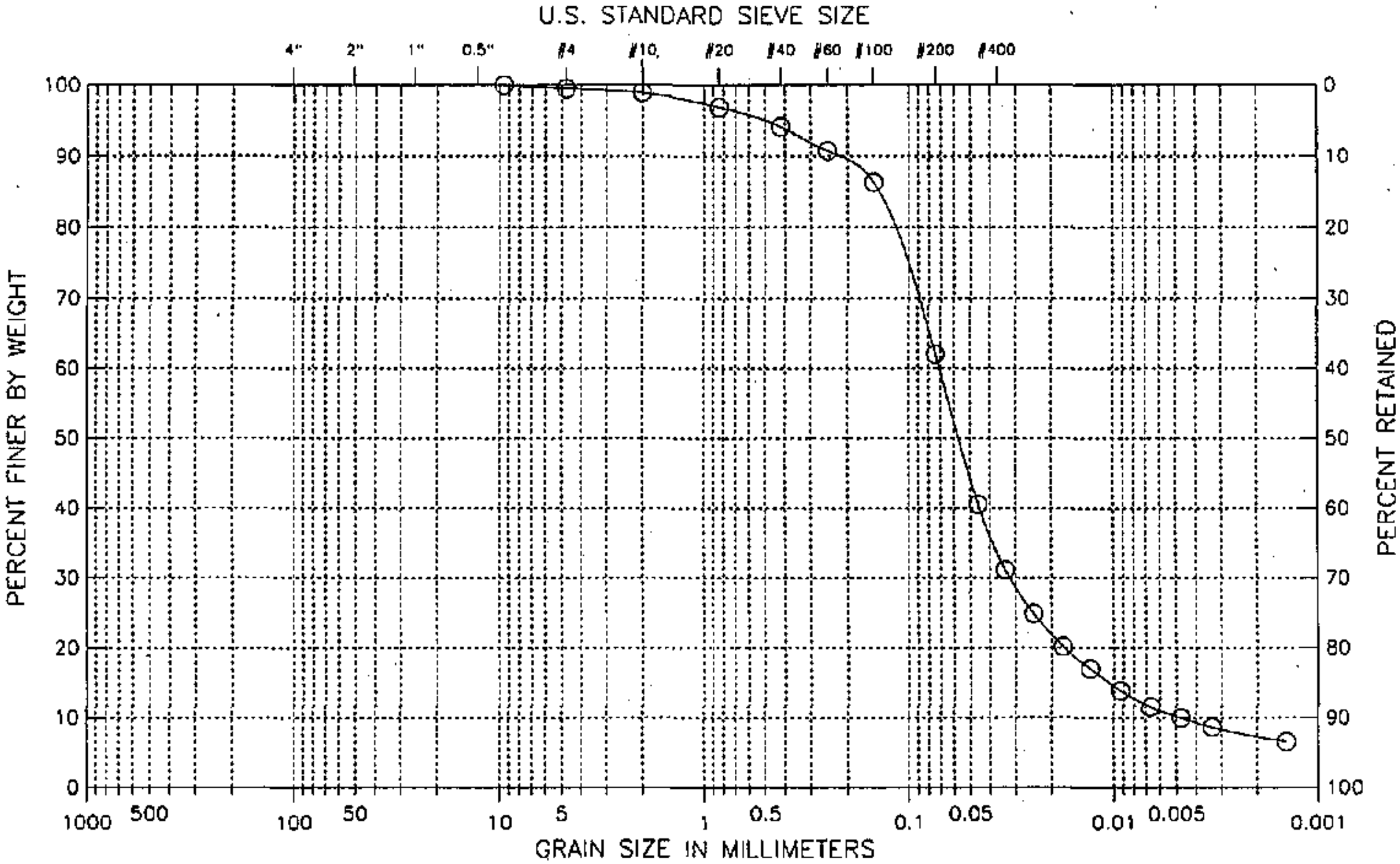
	Boring No. : FD-7 Sample No.: S-2 (11-13) Test Method ASTM D 422 Filename : FD7S2	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Wed Feb 02 2000



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

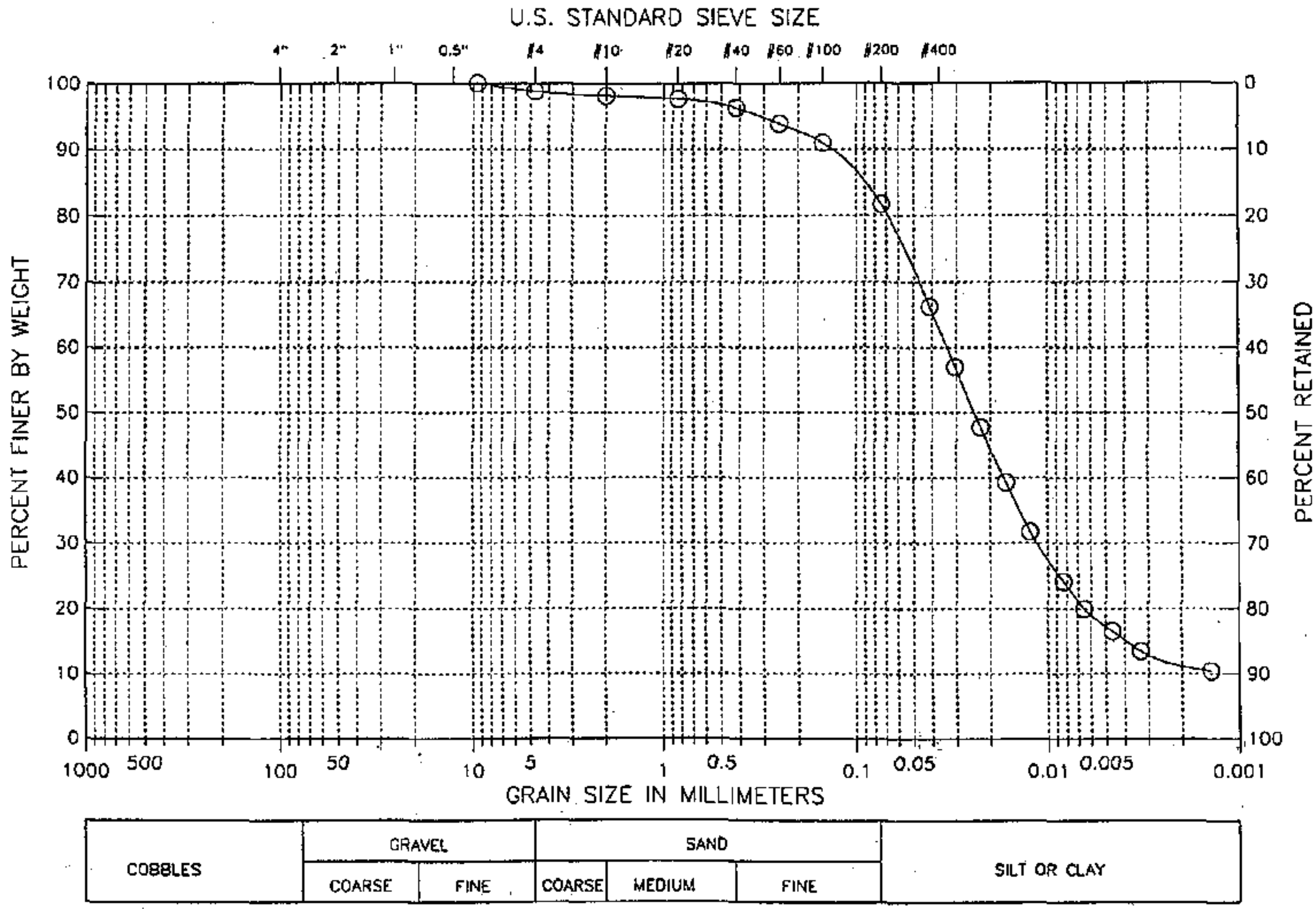
Classification :

Remarks :

Visual Description :
Moist greenish gray sandy, silty clay.

Figure 4

Boring No. : FD-7	Project : New Bedford Harbor Superfund Site
Sample No.: S-3 (13-15)	Project No.: GTX-2409
Test Method ASTM D 422	Location: New Bedford, MA
Filename : FD7S3	Date : Wed Feb 02 2000



Classification :

Remarks :

Visual Description :

Moist light olive brown silty clay with sand

Figure 5

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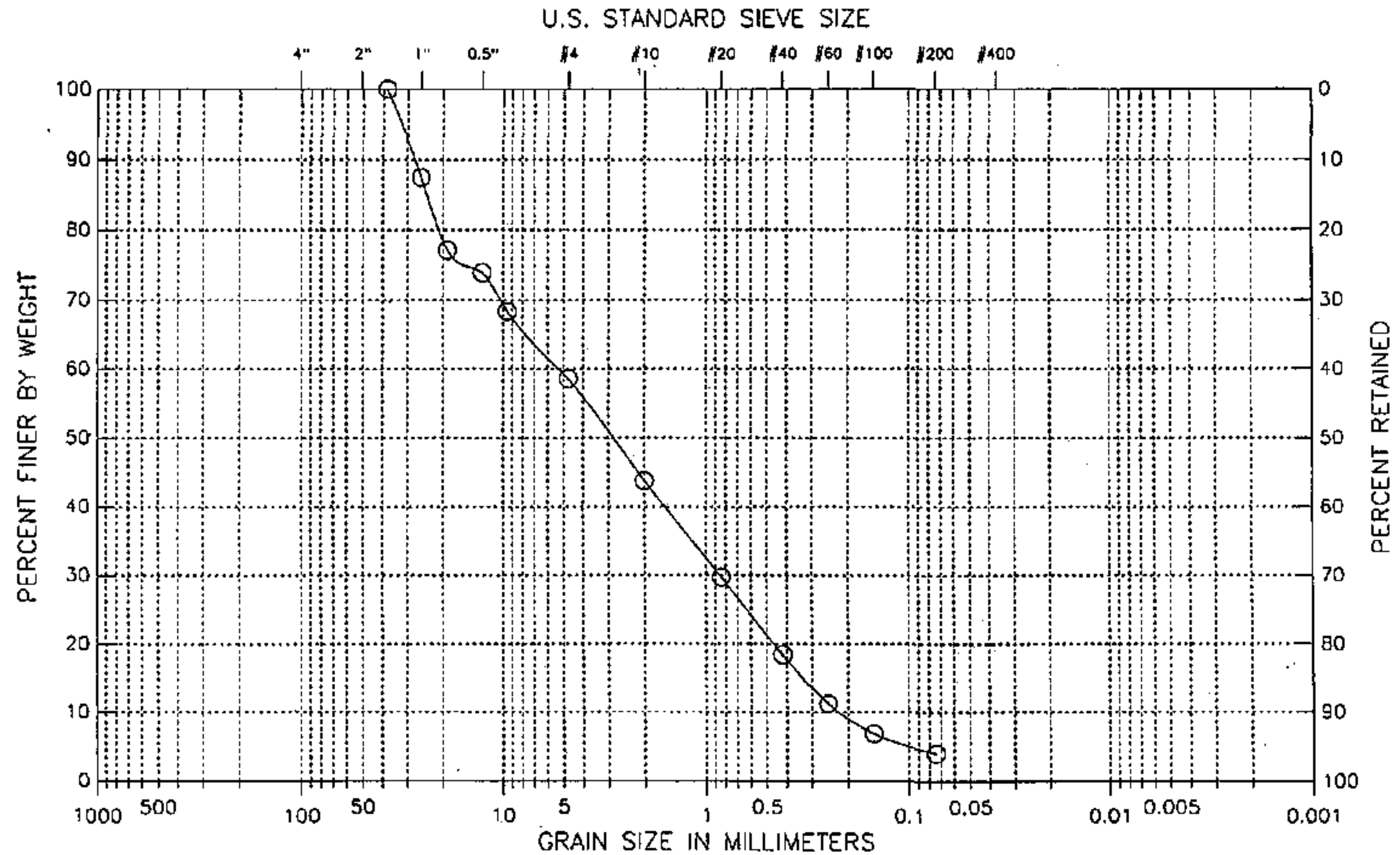
Boring No. : FD-7 Sample No.: S-6 (20-22) Test Method ASTM D 422 Filename : FD7S6	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Wed Feb 02 2000



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(SP) Poorly graded sand with gravel

Visual Description :
Moist yellowish brown sand with gravel

Remarks :
Hydrometer not required, fines <15%

Figure 6

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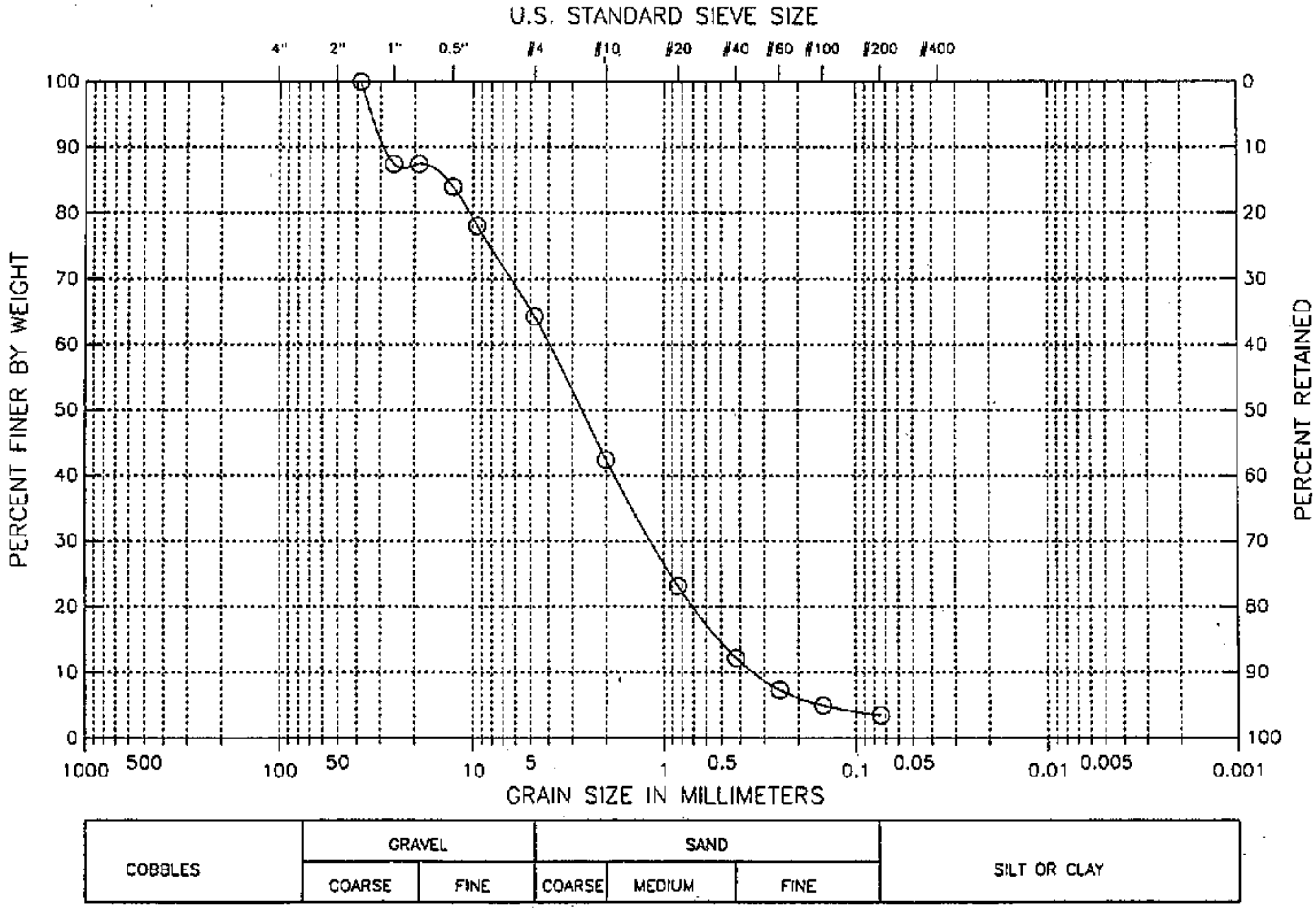
	Boring No.: FD-7 Sample No: S-7 (25-27) Test Method ASTM D 422 Filename : FD7S7	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Wed Feb 02 2000



Classification :
(SP) Poorly graded sand with gravel

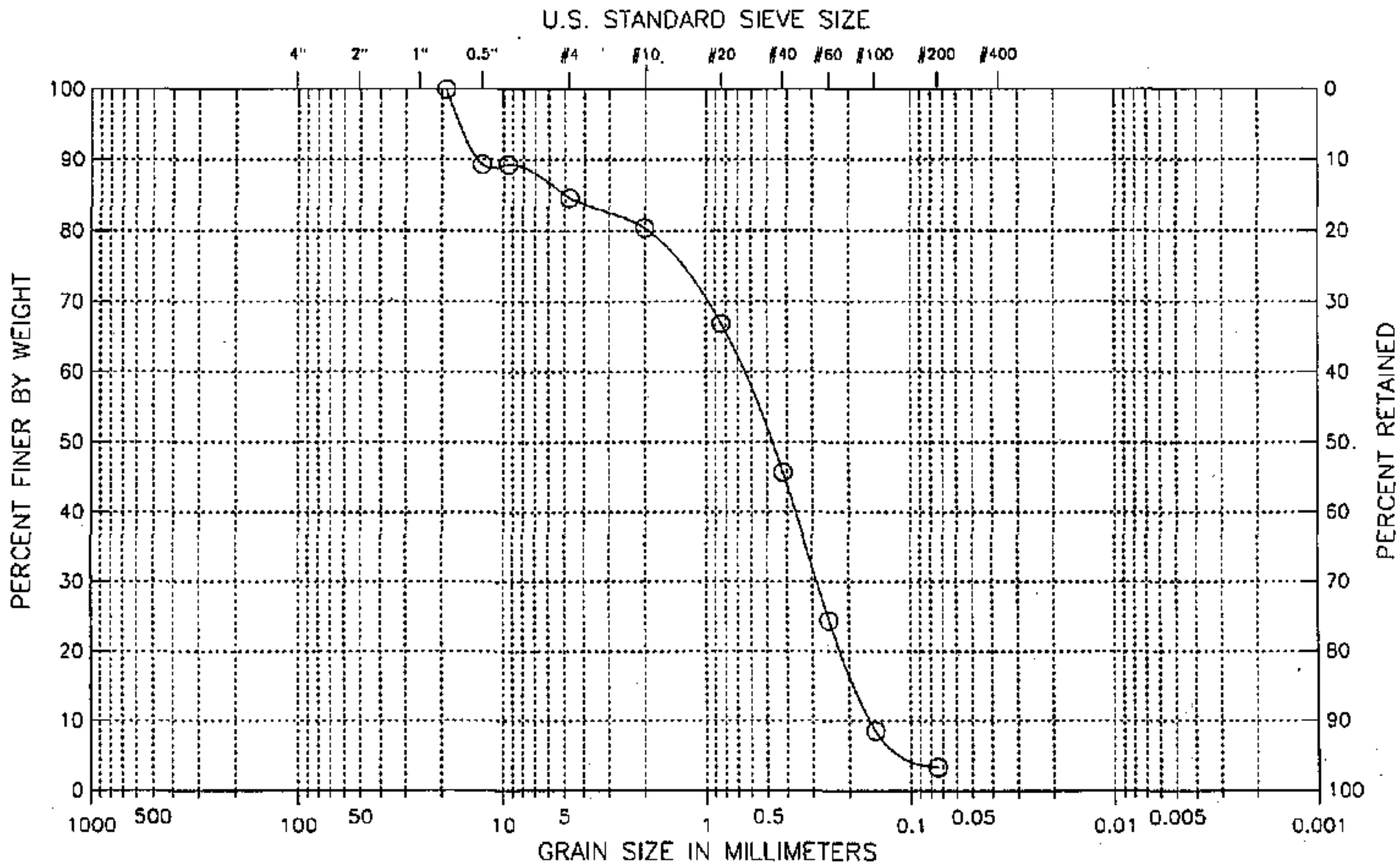
Visual Description:
Moist olive sand with gravel

Remarks :
Hydrometer not required, fines <15%

Figure 7

GeoTesting Express • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

Boring No. : FD-7 Sample No: S-9 (30-32) Test Method ASTM D 422 Filename : FD7S9	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Wed Feb 02 2000



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(SP) Poorly graded sand with gravel

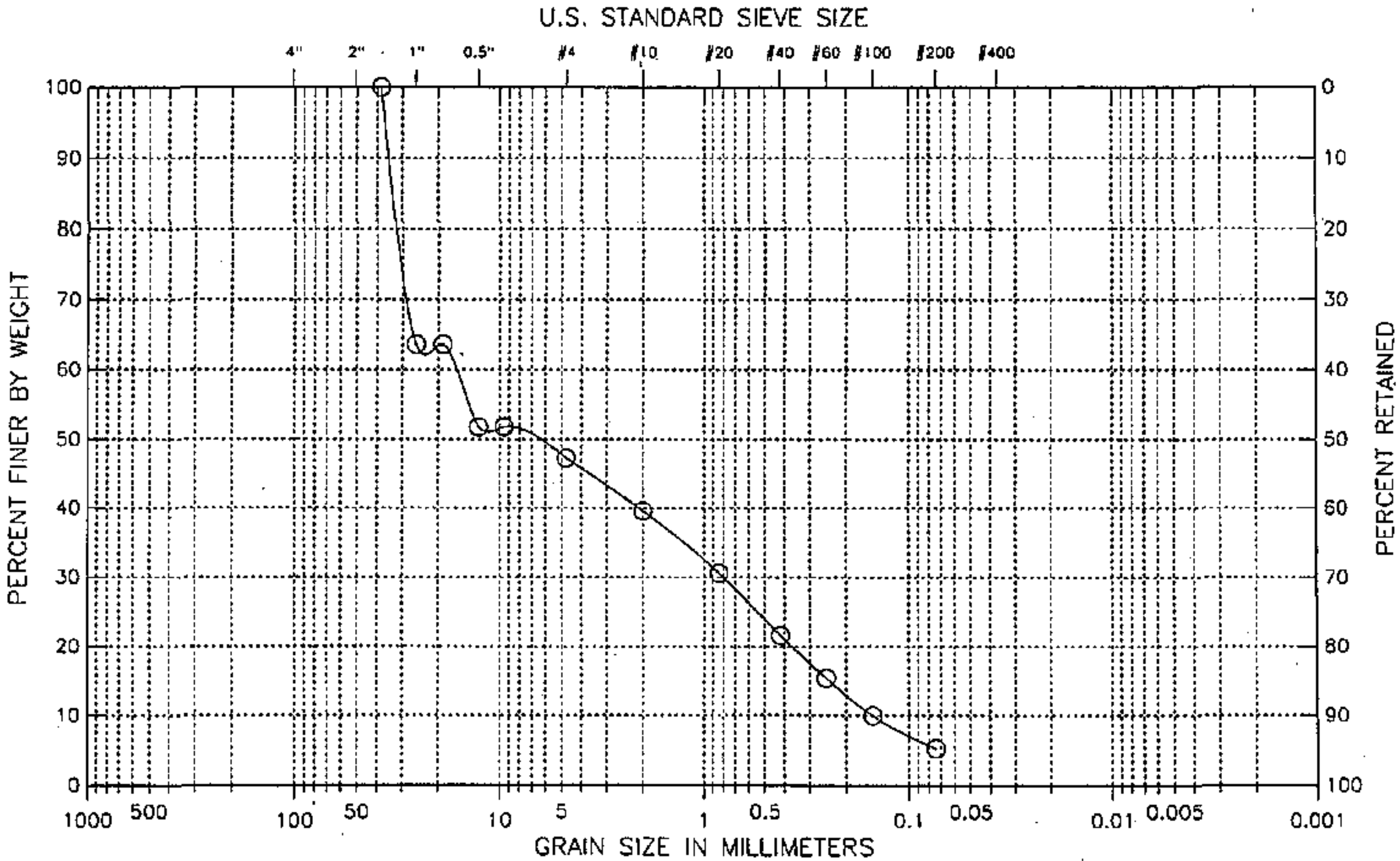
Visual Description :
Moist very dark gray sand

Remarks :
Hydrometer not required, fines <15%

Figure 8

GeoTesting Express • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

	Boring No. : FD-7 Sample No.: S-13B (38-39.9 Test Method ASTM D 422 Filename : FD7S13B	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Wed Feb 02 2000



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

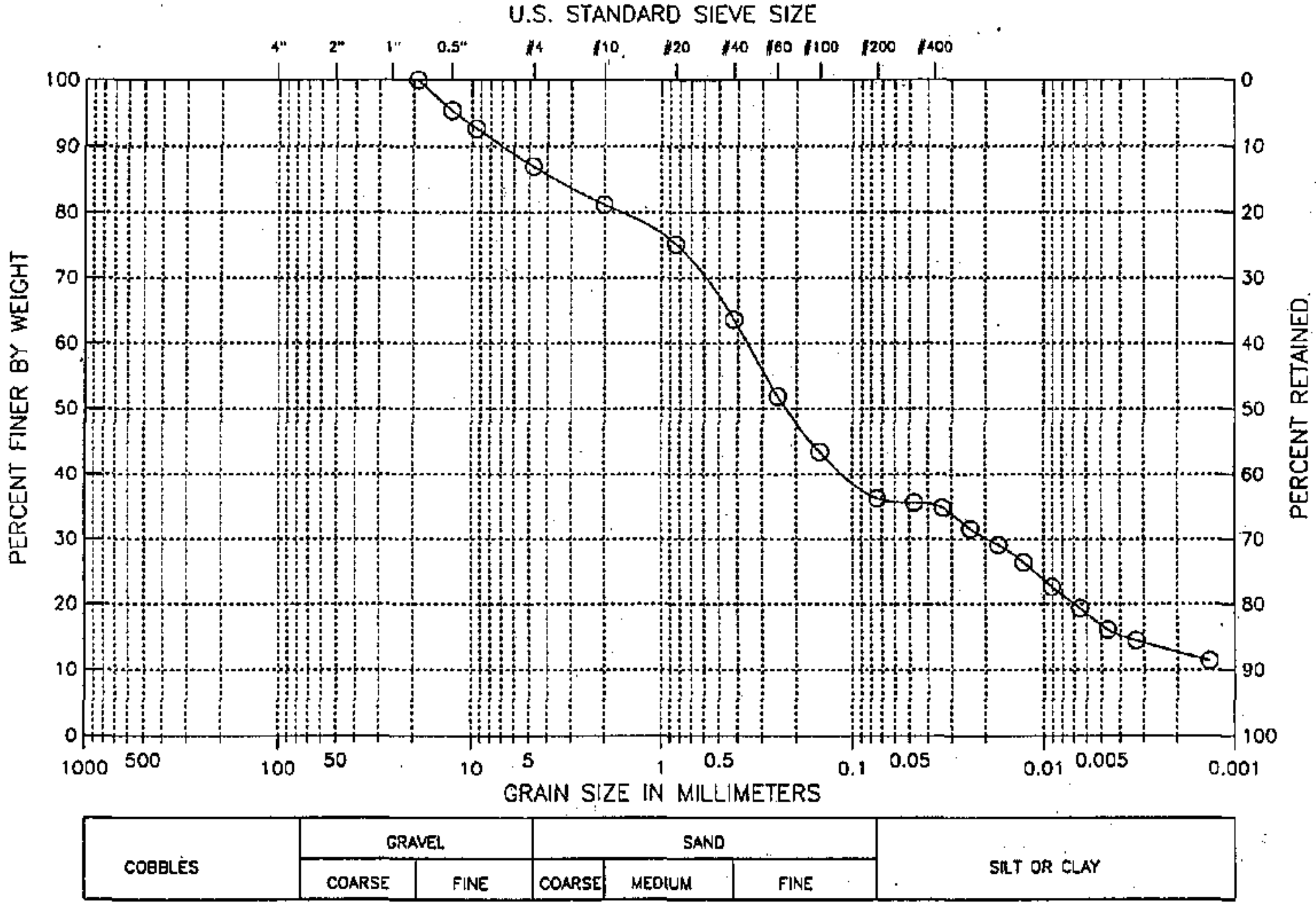
Visual Description :
Moist light olive gray sandy gravel

Remarks :
Hydrometer not required, fines <15%

Figure 9

GeoTesting Express • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

	Boring No. : FD-8 Sample No.: UO-2 (6-8) Test Method ASTM D 422 Filename : FD8UO2	*Project : New Bedford Harbor Superfund Site* Project No.: GTX-2409 Location: New Bedford, MA Date : Thu Oct 28 1999



Classification :
(SC) Clayey sand

Visual Description :
Moist, very dark gray clayey sand with organics

Remarks :

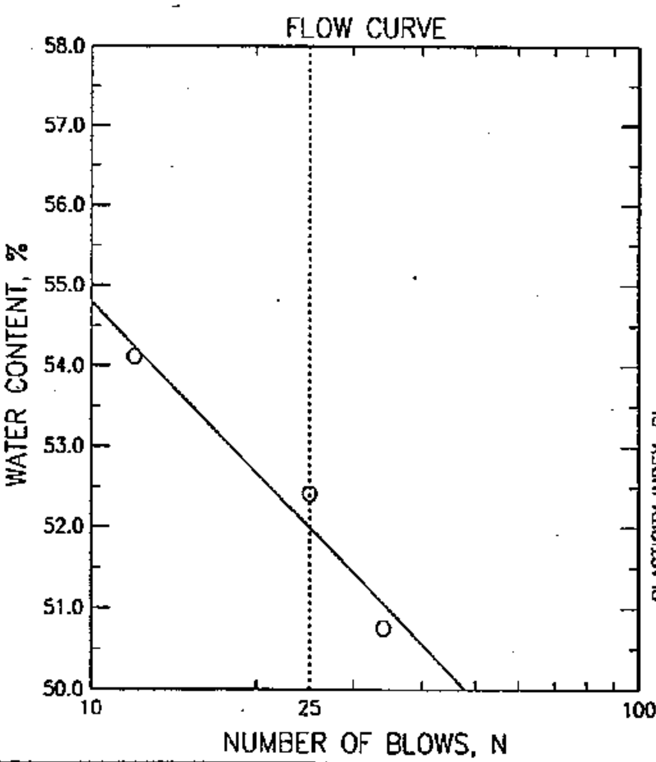
Figure 5

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	gsg/rjw	FD-8
LOCATION New Bedford, MA		CHECKED BY gtt	SAMPLE NUMBER UO-2 (6-8)
SAMPLE DESCRIPTION Moist, very dark gray clayey sand with organics		DATE Thu Oct 28 1999	FILENAME FDBUO2

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk91	bk120	bk41		
WT. WET SOIL + TARE	38.17	37.84	35.53		
WT. DRY SOIL + TARE	35.47	35.02	33.36		
WT. WATER	2.7	2.82	2.17		
TARE WT.	30.15	29.64	29.35		
WT. DRY SOIL	5.32	5.38	4.01		
WATER CONTENT, W_N (%)	50.75	52.42	54.11		
NUMBER OF BLOWS, N	34	25	12		
ONE-POINT LIQUID LIMIT, LL	52.68	52.42	49.52		

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk119	bk28			
WT. WET SOIL + TARE	33.7	34.8			
WT. DRY SOIL + TARE	32.46	33.82			
WT. WATER	1.24	0.98			
TARE WT.	27.7	30.1			
WT. DRY SOIL	4.76	3.72			
WATER CONTENT (%)	26.05	26.34			



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	41.7
LIQUID LIMIT, LL	52.0
PLASTIC LIMIT, PL	26.2
PLASTICITY INDEX, PI	25.8
LIQUIDITY INDEX, LI*	0.60

*LI = (W − PL)/PI

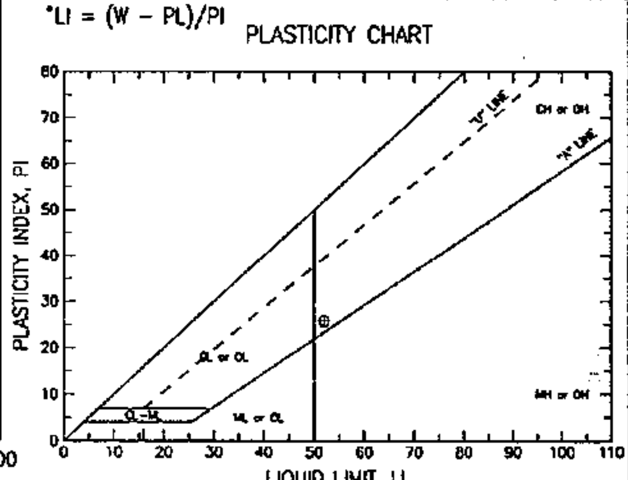


Fig. 5.0

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-8
Sample No. : UO-2 (6-8)
Location : New Bedford, MA
Soil Description : Moist, very dark gray clayey sand with organics
Remarks : ---

Depth : 6-8 ft
Test Date : 10/12/99
Test Method : ASTM D 2216

Filename : FD8UO2
Elevation : ---
Tested by : gsg/rjw
Checked by : gtt

Natural Moisture Content

	Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1)	fz4	9.53	174.35	125.83	41.72
2)		0.00	0.00	0.00	0.00

Average Moisture Content = 41.72

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-8
Sample No. : S-3 (15-17)
Location : New Bedford, MA
Soil Description : Moist, dark gray sandy silt
Remarks : ---

Depth : 15-17 ft
Test Date : 10/12/99
Test Method : ASTM D 422

Filename : FD8S3
Elevation : ---
Tested by : gsg
Checked by : gtt

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 70.74 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	30.00	21.50	26.18	0.045	37	0.045
2.00	24.00	21.50	20.18	0.033	28	0.033
4.00	20.00	21.50	16.18	0.024	23	0.024
8.00	17.00	21.50	13.18	0.017	18	0.017
15.00	15.00	21.50	11.18	0.013	16	0.013
30.00	13.00	21.50	9.18	0.009	13	0.009
60.00	11.00	21.50	7.18	0.007	10	0.007
120.00	10.00	21.50	6.18	0.005	9	0.005
240.00	9.00	22.00	5.36	0.003	7	0.003
1467.00	8.50	21.00	4.50	0.001	6	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	1.02	1.02	99
#20	0.033	0.84	0.29	1.31	98
#40	0.017	0.42	0.26	1.57	98
#60	0.010	0.25	0.63	2.20	97
#100	0.006	0.15	2.51	4.71	93
#200	0.003	0.07	19.73	24.44	66
Pan			47.32	71.76	0

Total Dry Weight of Sample = 80.83

D85 : 0.1202 mm
D60 : 0.0670 mm
D50 : 0.0567 mm
D30 : 0.0356 mm
D15 : 0.0120 mm
D10 : 0.0065 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-4(0)
AASHTO Group Name : Silty Soils

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Filename : FD9S7
Project No. : GTX-2409
Depth : 16-18 ft
Elevation : ---
Boring No. : FD-9
Test Date : 11/03/99
Tested by : al
Sample No. : S-7 (16-18)
Test Method : ASTM D 422
Checked by : gtt
Location : New Bedford, MA
Soil Description : Wet, gray silty sand
Remarks : ---

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 54.9 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	13.00	20.50	8.84	0.051	16	0.051
2.00	11.50	20.50	7.34	0.036	13	0.036
4.00	10.00	20.50	5.84	0.026	11	0.026
8.00	9.00	20.50	4.84	0.018	9	0.018
15.00	9.00	20.50	4.84	0.013	9	0.013
30.00	8.00	21.00	4.00	0.010	7	0.010
60.00	7.50	21.00	3.50	0.007	6	0.007
120.00	7.00	21.00	3.00	0.005	5	0.005
240.00	6.50	21.50	2.68	0.003	5	0.003
1131.00	6.00	20.00	1.68	0.002	3	0.002

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	0.48	0.48	100
#20	0.033	0.84	0.83	1.31	99
#40	0.017	0.42	2.98	4.29	97
#60	0.010	0.25	5.34	9.63	93
#100	0.006	0.15	24.17	33.80	75
#200	0.003	0.07	63.01	96.81	29
Pan			38.90	135.71	0

Total Dry Weight of Sample = 144.92

D85 : 0.1987 mm
D60 : 0.1187 mm
D50 : 0.1021 mm
D30 : 0.0755 mm
D15 : 0.0447 mm
D10 : 0.0231 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-9
Sample No. : S-14 (45-47)
Location : New Bedford, MA
Soil Description : Moist, gray sand with gravel
Remarks : Hydrometer not required, fines < 15%

Depth : 45-47 ft
Test Date : 11/30/99
Test Method : ASTM D 422

Filename : FD9S14
Elevation : ---
Tested by : GSG
Checked by : GTT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1.5"	1.500	38.10	0.00	0.00	100
1"	1.012	25.70	23.35	23.35	79
0.75"	0.748	19.00	0.00	23.35	79
0.5"	0.500	12.70	2.46	25.81	77
0.375"	0.374	9.51	9.00	34.81	69
#4	0.187	4.75	12.53	47.34	58
#10	0.079	2.00	13.21	60.55	47
#20	0.033	0.84	15.62	76.17	33
#40	0.017	0.42	12.97	89.14	22
#60	0.010	0.25	9.63	98.77	13
#100	0.006	0.15	6.42	105.19	7
#200	0.003	0.07	6.38	111.57	2
Pan			2.06	113.63	0

Total Dry Weight of Sample = 123.27

D85 : 28.5830 mm
D60 : 5.2738 mm
D50 : 2.5541 mm
D30 : 0.7021 mm
D15 : 0.2812 mm
D10 : 0.1886 mm

Soil Classification
ASTM Group Symbol : SP
ASTM Group Name : Poorly graded sand with gravel
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-12
Sample No. : S-4A (15-17)
Location : New Bedford, MA
Soil Description : Moist, light gray sandy silt
Remarks : ---

Depth : 15-17 ft
Test Date : 10/12/99
Test Method : ASTM D 422

Filename : FD12S4A
Elevation : ---
Tested by : gsg
Checked by : gtt

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 74.14 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	28.50	22.00	24.86	0.045	33	0.045
2.00	23.00	22.00	19.36	0.033	26	0.033
4.00	19.50	22.00	15.86	0.024	21	0.024
8.00	17.00	22.00	13.36	0.017	18	0.017
15.00	15.50	22.00	11.86	0.013	16	0.013
30.00	13.50	22.00	9.86	0.009	13	0.009
60.00	12.00	22.00	8.36	0.007	11	0.007
120.00	10.50	22.00	6.86	0.005	9	0.005
240.00	10.00	22.00	6.36	0.003	9	0.003
1503.00	9.00	21.00	5.00	0.001	7	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	0.35	0.35	100
#20	0.033	0.84	0.25	0.60	99
#40	0.017	0.42	0.61	1.21	98
#60	0.010	0.25	1.49	2.70	96
#100	0.006	0.15	6.79	9.49	87
#200	0.003	0.07	16.22	25.71	65
Pan			48.78	74.49	0

Total Dry Weight of Sample = 83.56

D85 : 0.1386 mm
D60 : 0.0681 mm
D50 : 0.0585 mm
D30 : 0.0394 mm
D15 : 0.0113 mm
D10 : 0.0053 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-4(0)
AASHTO Group Name : Silty Soils

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-12
Sample No. : S-7 (22-24)
Location : New Bedford, MA
Soil Description : Moist, light yellowish brown sandy silt
Remarks : ---

Depth : 22-24 ft
Test Date : 10/12/99
Test Method : ASTM D 422

Filename : FD12S7
Elevation : ---
Tested by : gsg
Checked by : gtt

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 71.84 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	34.00	22.00	30.36	0.044	42	0.044
2.00	31.00	22.00	27.36	0.032	38	0.032
4.00	27.50	22.00	23.86	0.023	33	0.023
8.00	24.50	22.00	20.86	0.017	29	0.017
15.00	21.50	22.00	17.86	0.012	25	0.012
30.00	19.00	22.00	15.36	0.009	21	0.009
61.00	17.00	22.00	13.36	0.006	19	0.006
120.00	14.50	22.00	10.86	0.005	15	0.005
240.00	13.00	22.00	9.36	0.003	13	0.003
1494.00	11.00	21.00	7.00	0.001	10	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#10	0.079	2.00	0.00	0.00	100
#20	0.033	0.84	0.46	0.46	99
#40	0.017	0.42	2.73	3.19	96
#60	0.010	0.25	4.35	7.54	90
#100	0.006	0.15	7.11	14.65	80
#200	0.003	0.07	18.42	33.07	54
Pan			38.77	71.84	0

Total Dry Weight of Sample = 80.9

D85 : 0.1975 mm
D60 : 0.0872 mm
D50 : 0.0618 mm
D30 : 0.0177 mm
D15 : 0.0044 mm
D10 : 0.0014 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-4(0)
AASHTO Group Name : Silty Soils

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-13
Sample No. : U-2 (6-8)
Location : New Bedford, MA
Soil Description : Moist, dark gray sandy organic clay
Remarks : ---

Depth : 6-8 ft
Test Date : 11/30/99
Test Method : ASTM D 2216

Filename : FD13U2
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

Natural Moisture Content

	Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1)	025	70.80	263.44	180.09	76.26

Average Moisture Content = 76.26

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-23
Sample No. : U-3 (9-11)
Location : New Bedford, MA
Soil Description : Moist, dark gray clayey sand with gravel, organics
Remarks : ---

Depth : 9-11 ft
Test Date : 11/30/99
Test Method : ASTM D 422

Filename : FD13U3
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

HYDROMETER

Hydrometer ID : 87130
Weight of air-dried soil = 41.35 gm
Specific Gravity = 2.63

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	26.00	22.00	21.35	0.046	46	0.046
2.00	24.00	22.00	19.35	0.033	41	0.033
4.00	22.50	22.00	17.85	0.024	38	0.024
8.00	21.50	22.00	16.85	0.017	36	0.017
15.00	20.00	22.00	15.35	0.012	33	0.012
30.00	17.00	22.00	12.35	0.009	26	0.009
60.00	16.00	22.00	11.35	0.006	24	0.006
120.00	14.00	22.00	9.35	0.005	20	0.005
240.00	13.00	22.00	8.35	0.003	18	0.003
1261.00	12.00	22.00	7.35	0.001	16	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	5.40	5.40	89
0.375"	0.374	9.51	0.00	5.40	89
#4	0.187	4.75	0.15	5.55	88
#10	0.079	2.00	0.22	5.77	88
#20	0.033	0.84	0.58	6.35	87
#40	0.017	0.42	1.22	7.57	84
#60	0.010	0.25	2.35	9.92	79
#100	0.006	0.15	6.47	16.39	65
#200	0.003	0.07	8.10	24.49	48
Pan			22.63	47.12	0

Total Dry Weight of Sample = 56.77

D85 : 0.5589 mm
D60 : 0.1205 mm
D50 : 0.0802 mm
D30 : 0.0108 mm
D15 : N/A
D10 : N/A

Soil Classification
ASTM Group Symbol : SC
ASTM Group Name : Clayey sand
AASHTO Group Symbol : A-7-6(10)
AASHTO Group Name : Clayey Soils

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409 Depth : 9-11 ft
Boring No. : FD-13 Test Date : 11/30/99
Sample No. : U-3 (9-11) Test Method : ASTM D 4318
Location : New Bedford, MA
Soil Description : Moist, dark gray clayey sand with gravel, organics
Remarks : ---

Filename : FD13U3
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

Liquid Limit for Organic

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Number of Drops	Moisture Content (%)
1) 43	30.39	35.46	34.36	31	27.71
2) 110	28.02	34.49	32.99	22	30.18
3) 24	30.28	36.10	34.76	11	29.91

Liquid Limit = 28.84

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Filename : FD13U4
Project No. : GTX-2409
Depth : 12-14 ft
Elevation : ---
Boring No. : FD-13
Test Date : 11/30/99
Tested by : GSG/MHM
Sample No. : U-4 (12-14)
Test Method : ASTM D 2216
Checked by : GTT
Location : New Bedford, MA
Soil Description : Moist, dark brown organic silt
Remarks : ---

Natural Moisture Content

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) t	63.74	207.05	128.00	123.02

Average Moisture Content = 123.02

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-13
Sample No. : S-3 (17-19)
Location : New Bedford, MA
Soil Description : Moist, gray sand with silt
Remarks : ---

Depth : 17-19 ft
Test Date : 01/24/00
Test Method : ASTM D 422

Filename : FD1353
Elevation : ---
Tested by : MCH/NJH
Checked by : GTT

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 78.26 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	18.00	21.00	14.00	0.049	16	0.049
2.00	13.50	21.00	9.50	0.036	11	0.036
4.00	12.00	21.00	8.00	0.026	9	0.026
8.00	11.00	21.00	7.00	0.018	8	0.018
15.00	10.00	21.00	6.00	0.013	7	0.013
30.00	9.00	21.00	5.00	0.009	6	0.009
60.00	8.50	21.00	4.50	0.007	5	0.007
122.00	8.00	21.00	4.00	0.005	5	0.005
240.00	7.00	22.50	3.55	0.003	4	0.003
1268.00	7.00	21.50	3.18	0.001	4	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	8.95	8.95	95
0.375"	0.374	9.51	2.52	11.47	94
#4	0.187	4.75	3.21	14.68	92
#10	0.079	2.00	3.98	18.66	90
#20	0.033	0.84	4.61	23.27	88
#40	0.017	0.42	9.24	32.51	83
#60	0.010	0.25	16.94	49.45	75
#100	0.006	0.15	45.31	94.76	51
#200	0.003	0.07	59.19	153.95	21
Pan			40.95	194.90	0

Total Dry Weight of Sample = 204.01

D85 : 0.5372 mm
D60 : 0.1805 mm
D50 : 0.1443 mm
D30 : 0.0910 mm
D15 : 0.0457 mm
D10 : 0.0295 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-13
Sample No. : S-5A (25-27)
Location : New Bedford, MA
Soil Description : Wet, olive silty clay with sand
Remarks : ---

Depth : 25-27 ft
Test Date : 01/24/00
Test Method : ASTM D 422

Filename : FD13S-5A
Elevation : ---
Tested by : MCH/NJH
Checked by : GTT

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 87.87 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	46.50	21.00	42.50	0.040	48	0.040
2.00	42.00	21.00	38.00	0.029	43	0.029
4.00	38.50	21.00	34.50	0.021	39	0.021
8.00	34.50	21.00	30.50	0.016	35	0.016
15.00	30.50	21.00	26.50	0.012	30	0.012
30.00	26.00	21.00	22.00	0.009	25	0.009
60.00	22.00	21.00	18.00	0.006	20	0.006
120.00	19.50	21.00	15.50	0.004	18	0.004
240.00	17.00	21.00	13.00	0.003	15	0.003
1345.00	12.50	22.50	9.05	0.001	10	0.001

FINE SIEVE SET

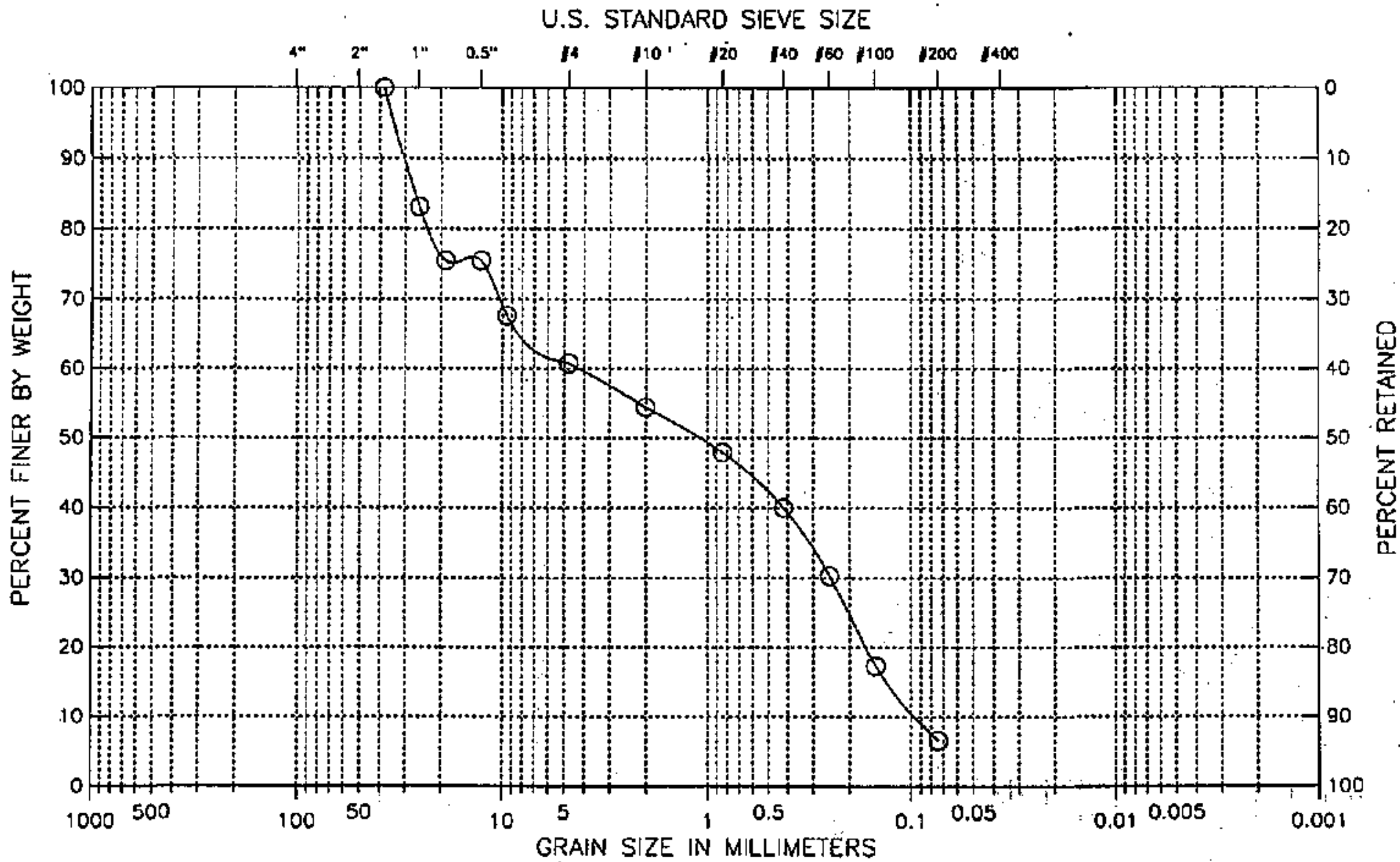
Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	0.21	0.21	100
#20	0.033	0.84	0.34	0.55	99
#40	0.017	0.42	1.46	2.01	98
#60	0.010	0.25	1.79	3.80	96
#100	0.006	0.15	2.44	6.24	93
#200	0.003	0.07	11.87	18.11	80
Pan			71.96	90.07	0

Total Dry Weight of Sample = 218.04

D85 : 0.0971 mm
D60 : 0.0500 mm
D50 : 0.0411 mm
D30 : 0.0116 mm
D15 : 0.0033 mm
D10 : 0.0013 mm

Soil Classification
ASTM Group Symbol : CL
ASTM Group Name : lean clay with sand
AASHTO Group Symbol : A-4(4)
AASHTO Group Name : Silty Soils

Boring No. : FD-13 Sample No.: S-12 (54-56) Test Method ASTM D 422 Filename : FD13S12	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Tue Nov, 23 1999



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

Visual Description :
Wet, tan sand with gravel, some silt

Remarks :
Hydrometer not required fines < 15%

Figure 7

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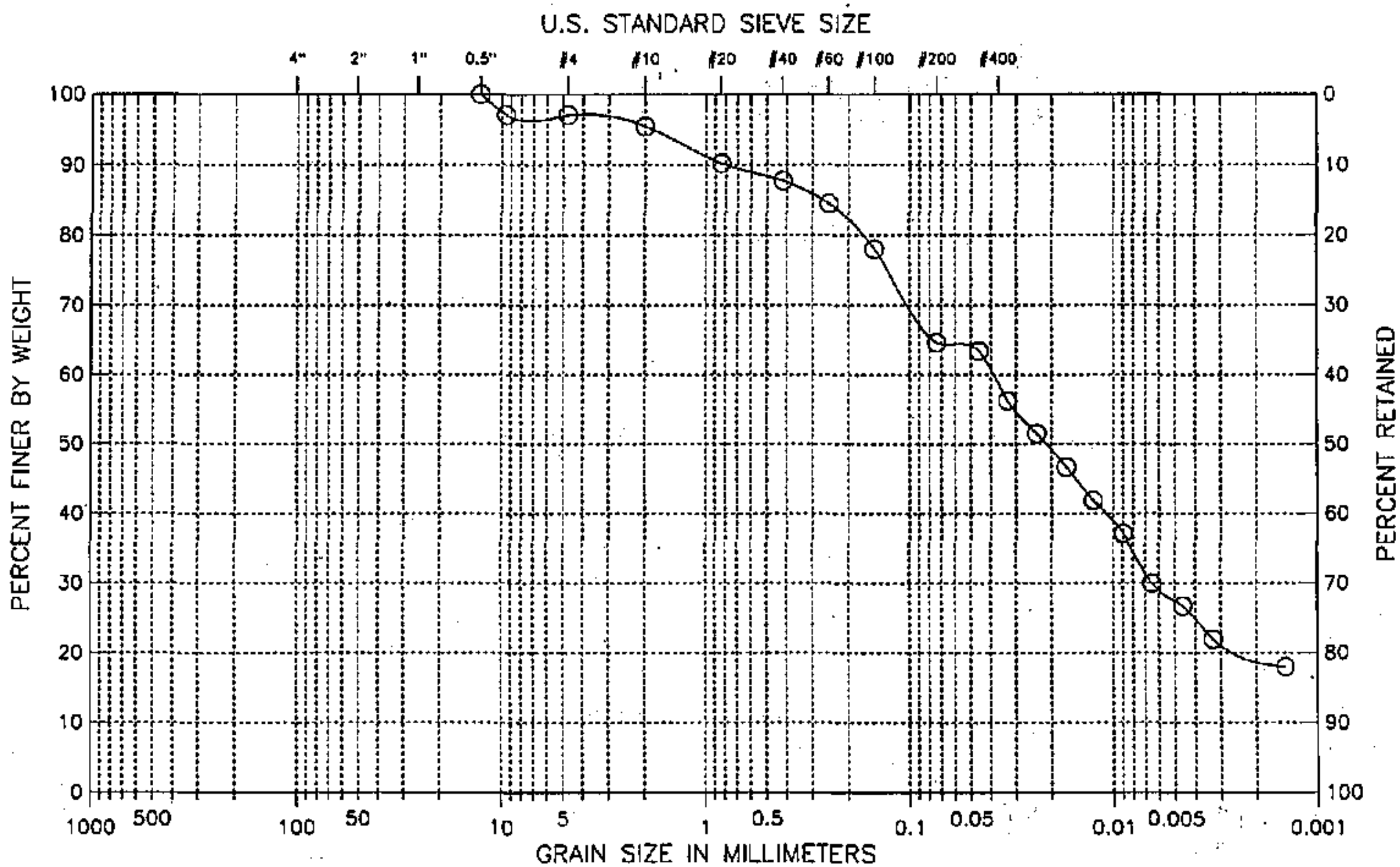
	Boring No. : FD-18 Sample No: U-1 (1-3) Test Method ASTM D 422 Filename : FD18U1	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Fri Dec,17 1999



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(OH) Sandy organic clay

Visual Description :
Moist, very dark gray sandy organic clay w/ shells

Remarks :

Figure 11

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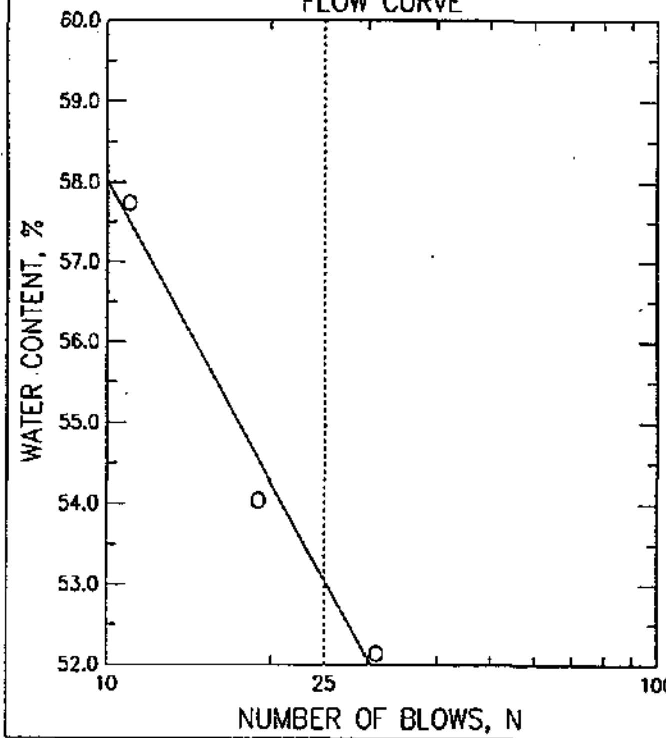
ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	GSG/MHM	FD-18
LOCATION		CHECKED BY	SAMPLE NUMBER
New Bedford, MA		GTT	U-1 (1-3)
SAMPLE DESCRIPTION		DATE	FILENAME
Moist, very dark gray sandy organic clay w/ shells		Fri Dec 17 1999	FD18U1

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	44	133	97		
WT. WET SOIL + TARE	35.86	33.66	32.78		
WT. DRY SOIL + TARE	33.91	31.52	30.99		
WT. WATER	1.95	2.14	1.79		
TARE WT.	30.17	27.56	27.89		
WT. DRY SOIL	3.74	3.96	3.1		
WATER CONTENT, W_N (%)	52.14	54.04	57.74		
NUMBER OF BLOWS, N	31	19	11		
ONE-POINT LIQUID LIMIT, LL	53.51	52.28	52.28		
PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	11	6			
WT. WET SOIL + TARE	35.48	35.5			
WT. DRY SOIL + TARE	34.36	34.25			
WT. WATER	1.12	1.25			
TARE WT.	30.1	29.47			
WT. DRY SOIL	4.26	4.78			
WATER CONTENT (%)	26.29	26.15			

FLOW CURVE



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	72.8
LIQUID LIMIT, LL	53.0
PLASTIC LIMIT, PL	26.2
PLASTICITY INDEX, PI	26.8
LIQUIDITY INDEX, LI*	1.74

*LI = (W - PL)/PI

PLASTICITY CHART

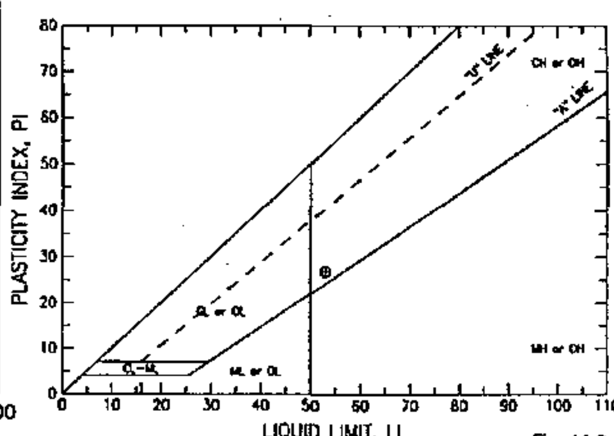


Fig. 11.0

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GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-18
Sample No. : U-1 (1-3)
Location : New Bedford, MA
Soil Description : Moist, very dark gray sandy organic clay w/ shells
Remarks : ---

Depth : 1-3 ft
Test Date : 11/30/99
Test Method : ASTM D 2216

Filename : FD18U1
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

Natural Moisture Content

	Moisture Content ID	*Mass of Container* (gm)	*Mass of Container and Moist Soil* (gm)	*Mass of Container and Dried Soil* (gm)	*Moisture Content* (%)
1)	03	75.23	270.93	188.45	72.85
2)		0.00	0.00	0.00	0.00

Average Moisture Content = 72.85

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-18
Sample No. : U-2 (4-6)
Location : New Bedford, MA
Soil Description : Moist, dark gray clayey sand with organics
Remarks : ---

Depth : 4-6 ft
Test Date : 11/30/99
Test Method : ASTM D 422

Filename : FD18U2
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 46.45 gm
Specific Gravity = 2.68

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	26.00	19.50	21.52	0.047	43	0.047
2.00	25.00	19.50	20.52	0.034	41	0.034
4.00	22.00	19.50	17.52	0.024	35	0.024
8.00	20.00	19.50	15.52	0.017	31	0.017
15.00	18.00	19.50	13.52	0.013	27	0.013
30.00	15.00	19.50	10.52	0.009	21	0.009
60.00	13.00	19.50	8.52	0.007	17	0.007
120.00	11.50	20.00	7.18	0.005	14	0.005
246.00	10.00	20.00	5.68	0.003	11	0.003
1301.00	9.00	19.50	4.52	0.001	9	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.375"	0.374	9.51	0.00	0.00	100
#4	0.187	4.75	1.21	1.21	97
#10	0.079	2.00	2.18	3.39	93
#20	0.033	0.84	2.47	5.86	87
#40	0.017	0.42	3.85	9.71	79
#60	0.010	0.25	4.22	13.93	70
#100	0.006	0.15	5.55	19.48	58
#200	0.003	0.07	5.88	25.36	46
Pan			21.48	46.84	0

Total Dry Weight of Sample = 163.89

D85 : 0.6815 mm
D60 : 0.1597 mm
D50 : 0.0932 mm
D30 : 0.0163 mm
D15 : 0.0052 mm
D10 : 0.0021 mm

Soil Classification
ASTM Group Symbol : SC
ASTM Group Name : Clayey sand
AASHTO Group Symbol : A-6(3)
AASHTO Group Name : Clayey Soils

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-18
Sample No. : U-2 (4-6)
Location : New Bedford, MA
Soil Description : Moist, dark gray clayey sand with organics
Remarks : ---

Depth : 4-6 ft
Test Date : 11/30/99
Test Method : ASTM D 4318

Filename : FD18U2
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

Liquid Limit for Organic

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Number of Drops	Moisture Content (%)
1) 6	29.47	38.52	36.72	35	24.83
2) 32	30.07	37.54	35.95	19	27.04
3) 52	30.43	37.51	35.97	12	27.80

Liquid Limit = 25.92

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Filename : FD18U3
Project No. : GTX-2409
Depth : 7-9 ft
Elevation : ---
Boring No. : FD-18
Test Date : 11/30/99
Tested by : GSG/MHM
Sample No. : U-3 (7-9)
Test Method : ASTM D 2216
Checked by : GTT
Location : New Bedford, MA
Soil Description : Moist, dark brown sandy silt
Remarks : ---

Natural Moisture Content

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) 008	72.23	253.73	218.28	24.27

Average Moisture Content = 24.27

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-30
Sample No. : UO-1 (1-3)
Location : New Bedford, MA
Soil Description : Moist, very dark gray sandy organic silt
Remarks : ---

Depth : 1-3 ft
Test Date : 10/12/99
Test Method : ASTM D 422

Filename : FD30UO1
Elevation : ---
Tested by : gsg/rjw
Checked by : gtt

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 36.57 gm
Specific Gravity = 2.6

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	23.50	21.50	19.68	0.048	54	0.048
2.00	22.00	21.50	18.18	0.034	50	0.034
4.00	21.00	21.50	17.18	0.024	47	0.024
8.00	19.00	21.50	15.18	0.017	42	0.017
15.00	18.00	21.50	14.18	0.013	39	0.013
30.00	15.50	22.00	11.86	0.009	33	0.009
60.00	14.50	22.00	10.86	0.007	30	0.007
120.00	13.00	22.50	9.55	0.005	26	0.005
240.00	12.00	22.00	8.36	0.003	23	0.003
1117.00	11.00	21.00	7.00	0.002	19	0.002

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	0.14	0.14	100
#20	0.033	0.84	0.58	0.72	98
#40	0.017	0.42	1.55	2.27	94
#60	0.010	0.25	2.62	4.89	87
#100	0.006	0.15	5.45	10.34	72
#200	0.003	0.07	5.65	15.99	56
Pan			20.72	36.71	0

Total Dry Weight of Sample = 45.96

D85 : 0.2358 mm
D60 : 0.0870 mm
D50 : 0.0338 mm
D30 : 0.0066 mm
D15 : N/A
D10 : N/A

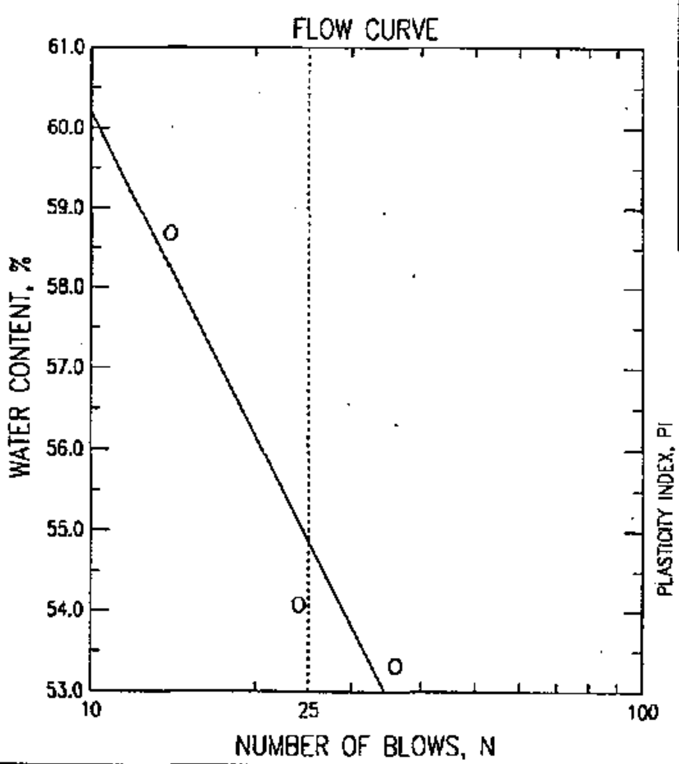
Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-4(0)
AASHTO Group Name : Silty Soils

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	GSG/MHM	FD-30
LOCATION		CHECKED BY	SAMPLE NUMBER
New Bedford, MA		GTT	U-1 (1-3)
SAMPLE DESCRIPTION		DATE	FILENAME
Moist, dark gray organic silt		Fri Dec 17 1999	FD30U1

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	107	96	33		
WT. WET SOIL + TARE	34.71	36.35	35.87		
WT. DRY SOIL + TARE	32.3	34.03	33.74		
WT. WATER	2.41	2.32	2.13		
TARE WT.	27.78	29.74	30.11		
WT. DRY SOIL	4.52	4.29	3.63		
WATER CONTENT, W_N (%)	53.32	54.08	58.68		
NUMBER OF BLOWS, N	36	24	14		
ONE-POINT LIQUID LIMIT, LL	55.72	53.81	54.70		

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	55	78			
WT. WET SOIL + TARE	35.71	36.3			
WT. DRY SOIL + TARE	34.6	35.2			
WT. WATER	1.11	1.1			
TARE WT.	29.55	30.48			
WT. DRY SOIL	5.05	4.72			
WATER CONTENT (%)	21.98	23.31			



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	59.8
LIQUID LIMIT, LL	54.9
PLASTIC LIMIT, PL	22.6
PLASTICITY INDEX, PI	32.2
LIQUIDITY INDEX, LI*	1.15

*LI = (W − PL)/PI

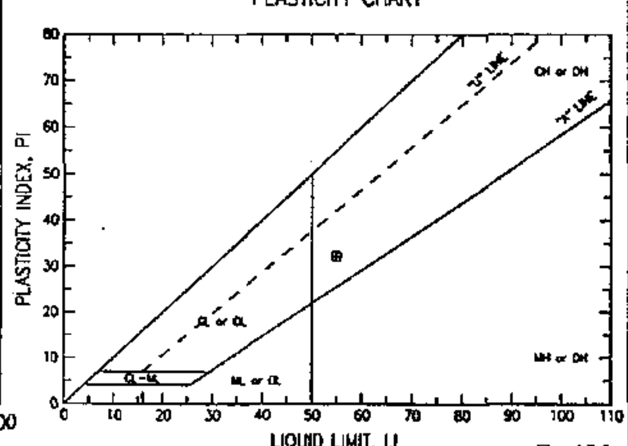


Fig. 13.0

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site Filename : FD30U1
Project No. : GTX-2409 Depth : 1-3 ft Elevation : ---
Boring No. : FD-30 Test Date : 11/30/99 Tested by : GSG/MHM
Sample No. : U-1 (1-3) Test Method : ASTM D 2216 Checked by : GTT
Location : New Bedford, MA
Soil Description : Moist, dark gray organic silt
Remarks : ---

Natural Moisture Content

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) bk86	30.29	96.00	71.41	59.80

Average Moisture Content = 59.80

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-30
Sample No. : UO-2 (4-6)
Location : New Bedford, MA
Soil Description : Moist, dark gray clayey sand with organics
Remarks : ---

Depth : 4-6 ft
Test Date : 10/12/99
Test Method : ASTM D 422

Filename : FD30UO2
Elevation : ---
Tested by : gsg/rjw
Checked by : gtt

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 51.34 gm
Specific Gravity = 2.63

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	24.00	21.00	20.00	0.048	38	0.048
2.00	23.00	21.00	19.00	0.034	36	0.034
4.00	21.00	21.00	17.00	0.024	32	0.024
8.00	19.00	21.00	15.00	0.017	29	0.017
15.00	17.00	21.00	13.00	0.013	25	0.013
30.00	15.50	21.00	11.50	0.009	22	0.009
60.00	13.50	21.00	9.50	0.007	18	0.007
120.00	12.50	21.00	8.50	0.005	16	0.005
240.00	11.00	22.50	7.55	0.003	14	0.003
1126.00	11.00	21.00	7.00	0.002	13	0.002

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.375*	0.374	9.51	0.00	0.00	100
#4	0.187	4.75	0.50	0.50	99
#10	0.079	2.00	0.95	1.45	97
#20	0.033	0.84	4.23	5.68	89
#40	0.017	0.42	4.48	10.16	80
#60	0.010	0.25	9.37	19.53	62
#100	0.006	0.15	7.48	27.01	48
#200	0.003	0.07	3.81	30.82	40
Pan			20.97	51.79	0

Total Dry Weight of Sample = 60.79

D85 : 0.6084 mm
D60 : 0.2303 mm
D50 : 0.1609 mm
D30 : 0.0198 mm
D15 : 0.0037 mm
D10 : 0.0001 mm

Soil Classification
ASTM Group Symbol : SC
ASTM Group Name : Clayey sand
AASHTO Group Symbol : A-6(3)
AASHTO Group Name : Clayey Soils

Thu Oct 28 11:23:00 1999

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-30
Sample No. : UO-2 (4-6)
Location : New Bedford, MA
Soil Description : Moist, dark gray clayey sand with organics
Remarks : ---

Depth : 4-6 ft
Test Date : 10/12/99
Test Method : ASTM D 2216

Filename : FD30UO2
Elevation : ---
Tested by : gsg/rjw
Checked by : gtt

Natural Moisture Content

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) nh119	8.96	121.81	92.24	35.51
2)	0.00	0.00	0.00	0.00

Average Moisture Content = 35.51

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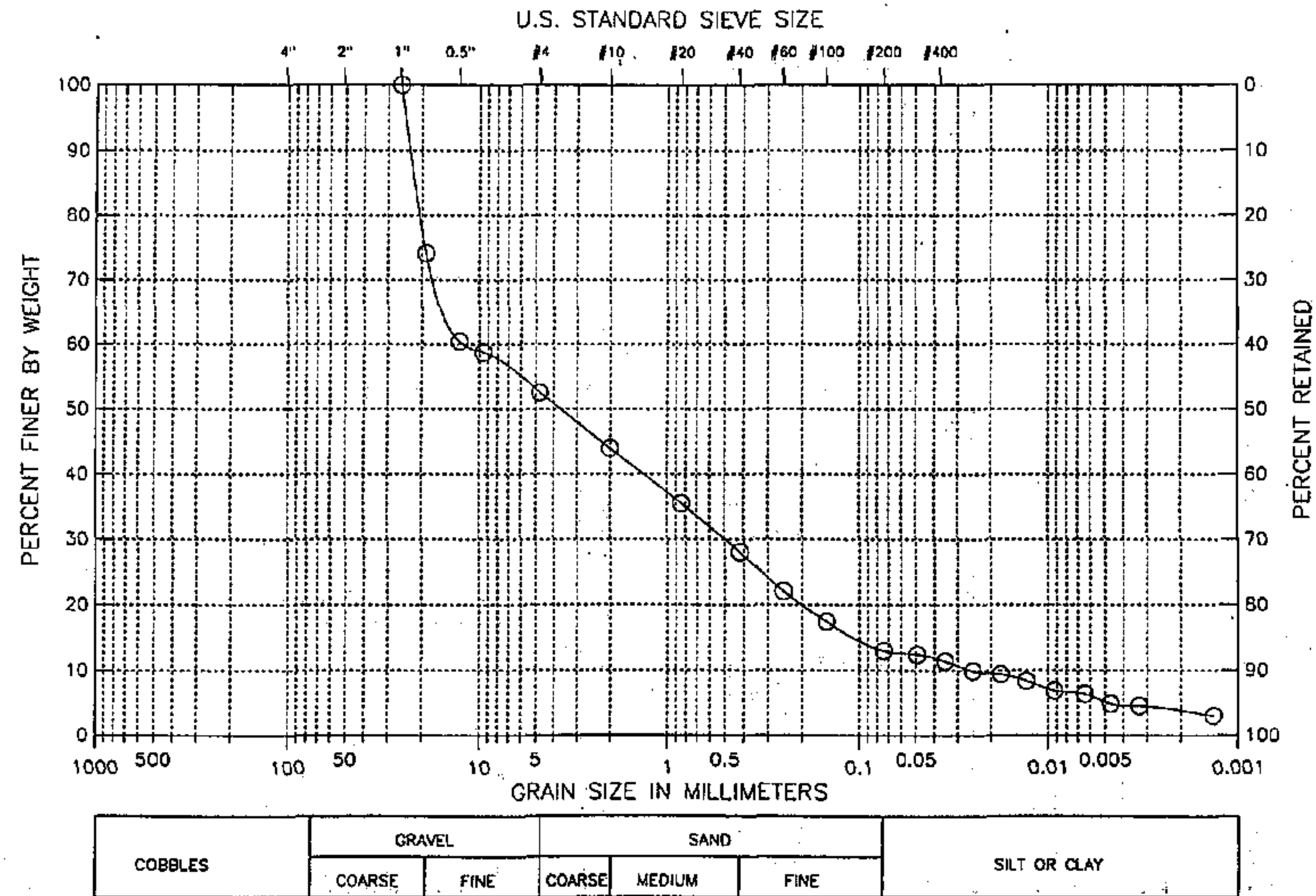
Boring No. : FD-30	Project : New Bedford Harbor Superfund Site
Sample No.: S-4 (25-27)	Project No.: GTX-2409
Test Method ASTM D 422	Location: New Bedford, MA
Filename : FD30S4	Date : Thu Oct, 28 1999



Classification :

Remarks :

Visual Description :
Moist, light yellowish brown silty sand w/ gravel

Figure 8

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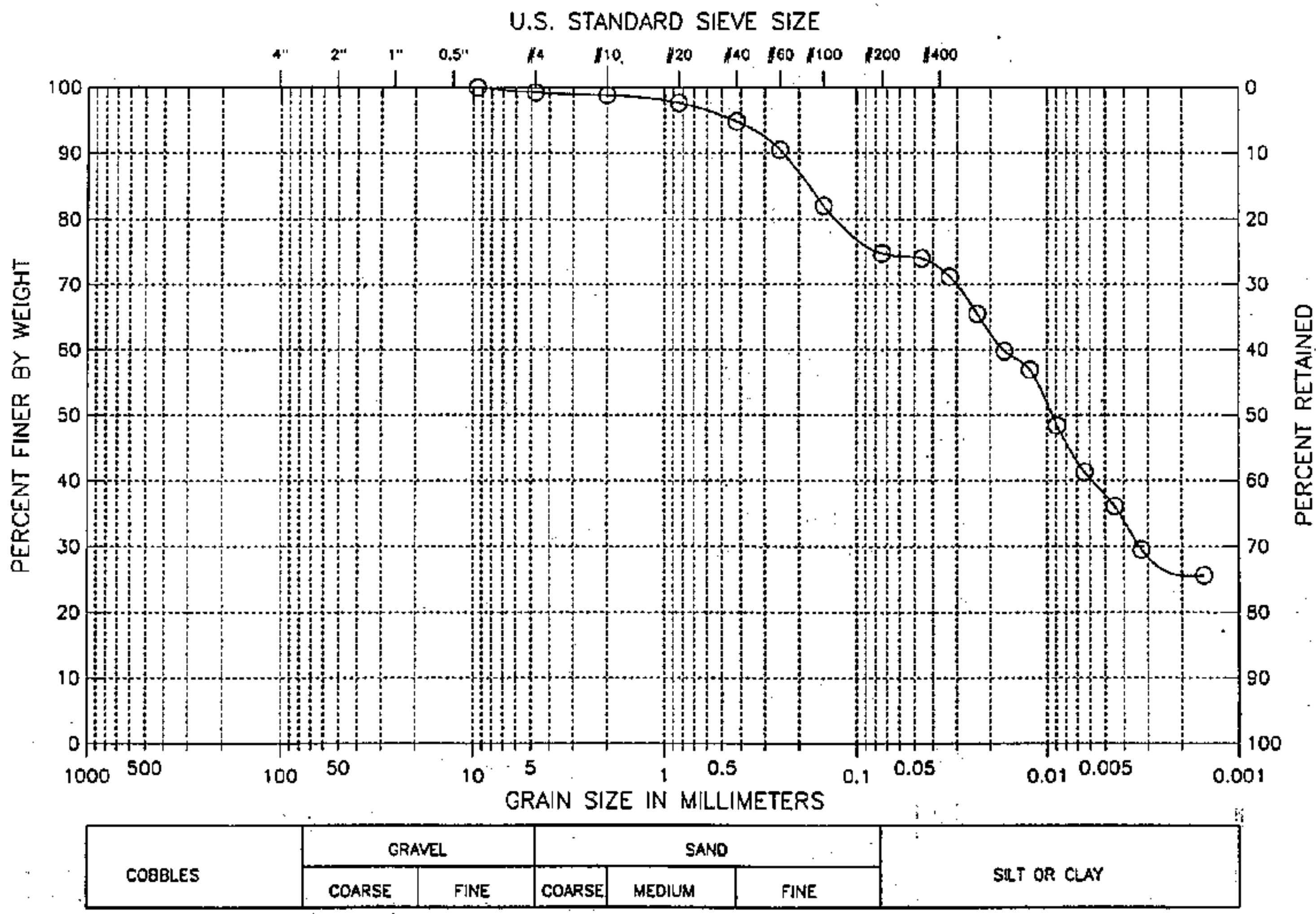
	Boring No. : FD-31 Sample No.: UO-1 (3-5) Test Method ASTM D 422 Filename : FD31UO1	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Thu Oct 28 1999



Classification :
(OH) organic clay with sand

Visual Description :
Moist, dark gray organic clay with sand

Remarks :

Figure 8

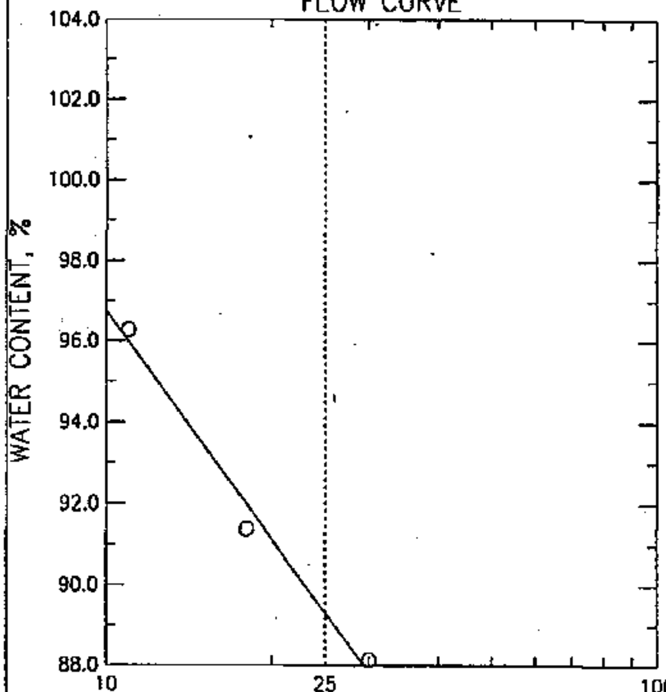
ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	gsg/rjw	FD-31
LOCATION New Bedford, MA		CHECKED BY gtt	SAMPLE NUMBER UO-1 (3-5)
SAMPLE DESCRIPTION Moist, dark gray organic clay with sand		DATE Thu Oct 28 1999	FILENAME FD31UO1

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk10	bk82	bk71		
WT. WET SOIL + TARE	35.12	36.17	35.61		
WT. DRY SOIL + TARE	32.37	32.99	32.5		
WT. WATER	2.75	3.18	3.11		
TARE WT.	29.25	29.51	29.27		
WT. DRY SOIL	3.12	3.48	3.23		
WATER CONTENT, W_N (%)	88.14	91.38	96.28		
NUMBER OF BLOWS, N	30	18	11		
ONE-POINT LIQUID LIMIT, LL	90.11	87.82	87.18		

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk76	bk37			
WT. WET SOIL + TARE	34.31	35.33			
WT. DRY SOIL + TARE	33.03	33.83			
WT. WATER	1.28	1.5			
TARE WT.	29.19	29.14			
WT. DRY SOIL	3.84	4.69			
WATER CONTENT (%)	33.33	31.98			

FLOW CURVE



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	90.3
LIQUID LIMIT, LL	89.3
PLASTIC LIMIT, PL	32.7
PLASTICITY INDEX, PI	56.7
LIQUIDITY INDEX, LI*	1.02

*LI = (W − PL)/PI

PLASTICITY CHART

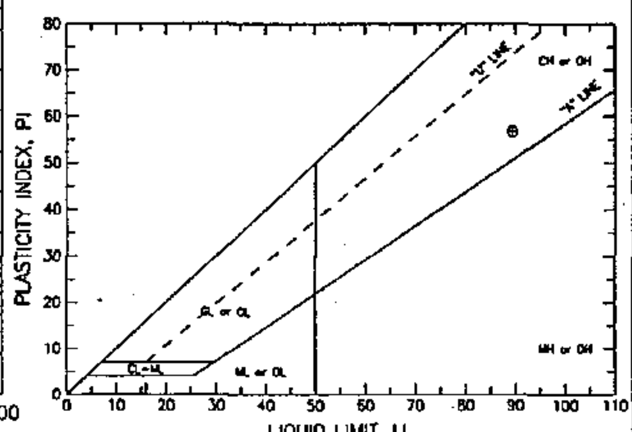


Fig. 8.0

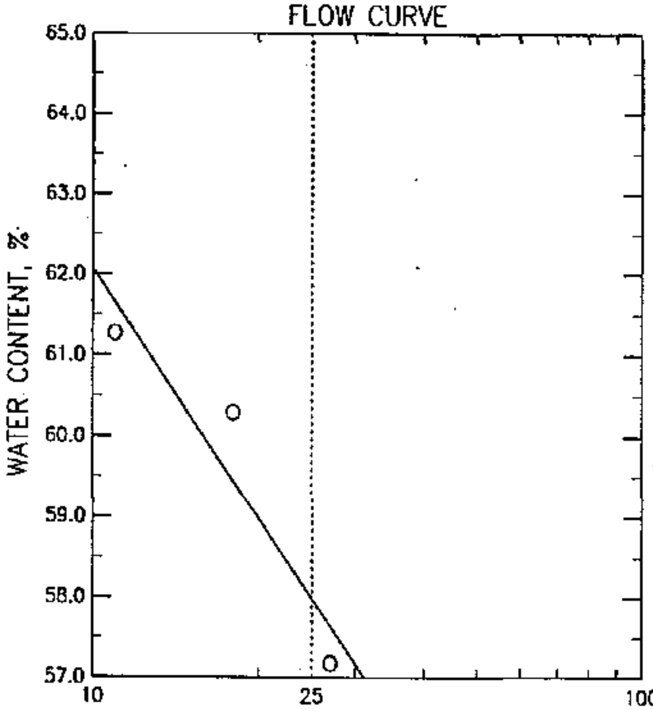
ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	gsg/rjw	FD-31
LOCATION New Bedford, MA		CHECKED BY gtt	SAMPLE NUMBER U0-2 (8-10)
SAMPLE DESCRIPTION Moist, dark gray organic clay with sand		DATE Thu Oct 28 1999	FILENAME FD31U02

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk91	bk84	bk120		
WT. WET SOIL + TARE	37.82	38.08	36.99		
WT. DRY SOIL + TARE	35.03	35.18	34.19		
WT. WATER	2.79	2.9	2.8		
TARE WT.	30.15	30.37	29.62		
WT. DRY SOIL	4.88	4.81	4.57		
WATER CONTENT, W_N (%)	57.17	60.29	61.27		
NUMBER OF BLOWS, N	27	18	11		
ONE-POINT LIQUID LIMIT, LL	57.71	57.94	55.48		

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	bk99	bk1			
WT. WET SOIL + TARE	34.03	35.66			
WT. DRY SOIL + TARE	32.76	34.55			
WT. WATER	1.27	1.11			
TARE WT.	27.63	30.14			
WT. DRY SOIL	5.13	4.41			
WATER CONTENT (%)	24.76	25.17			

FLOW CURVE



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	60.3
LIQUID LIMIT, LL	58.0
PLASTIC LIMIT, PL	25.0
PLASTICITY INDEX, PI	33.0
LIQUIDITY INDEX, LI*	1.07

*LI = (W − PL)/PI

PLASTICITY CHART

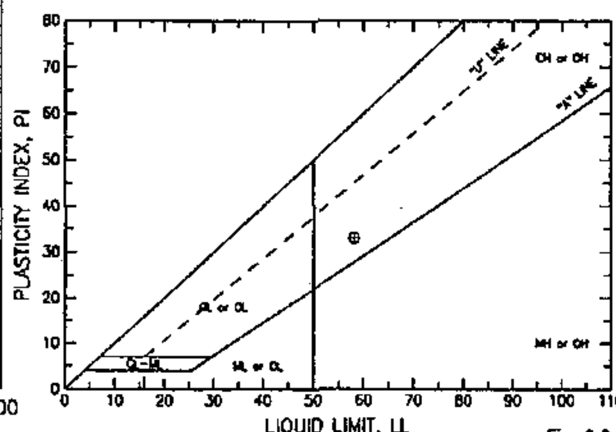


Fig. 9.0

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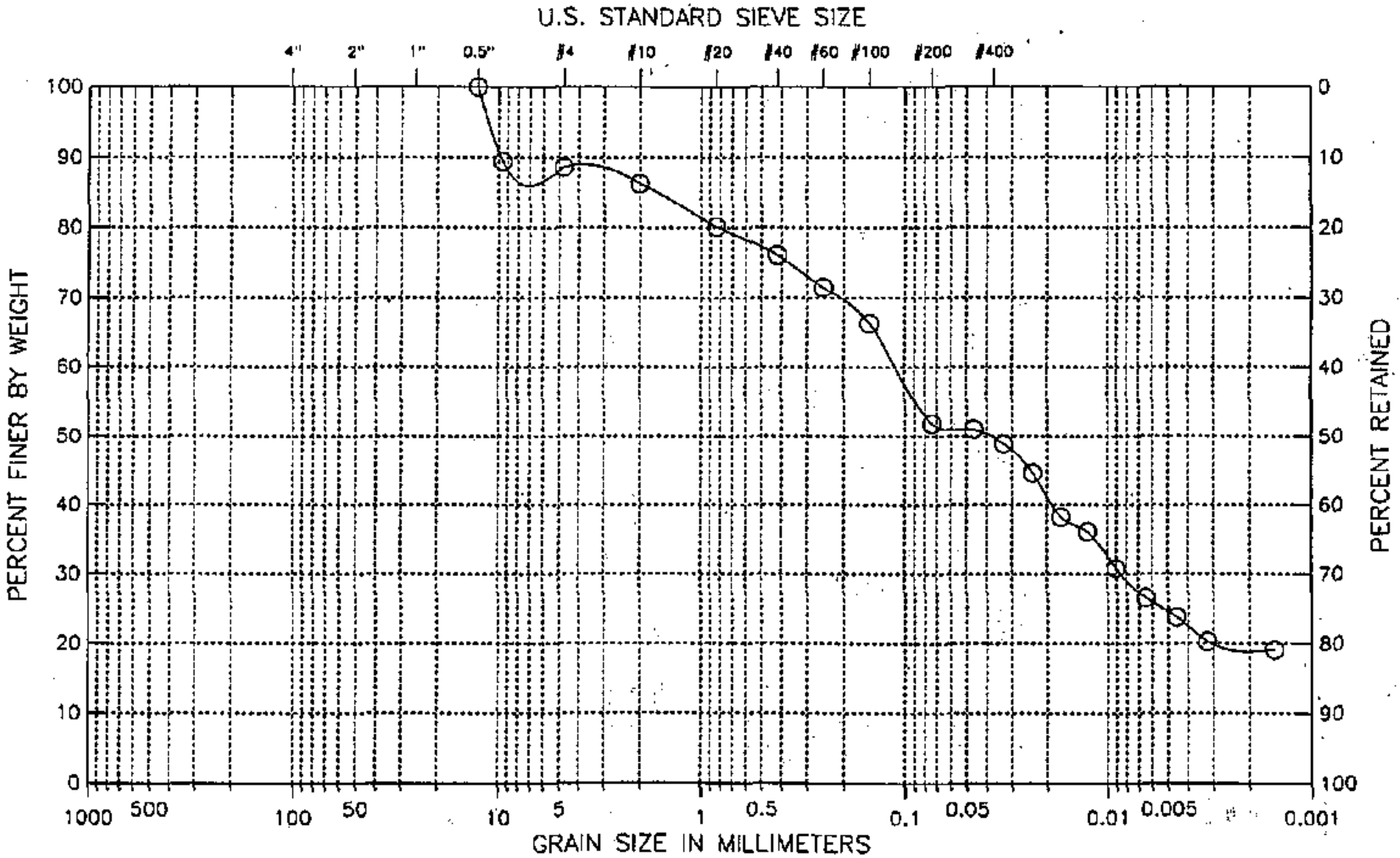
	Boring No. : FD-31 Sample No: UO-3 (12-14) Test Method ASTM D 422 Filename : FD31U03	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Thu Oct 28 1999



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(OH) Sandy organic clay

Visual Description :
Moist, dark gray sandy organic clay

Remarks :

Figure 10

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	gsg/rjw	FD-31
LOCATION		CHECKED BY	SAMPLE NUMBER
New Bedford, MA		glt	U0-3 (12-14)
SAMPLE DESCRIPTION		DATE	FILENAME
Moist, dark gray sandy organic clay		Thu Oct 28 1999	FD31U03

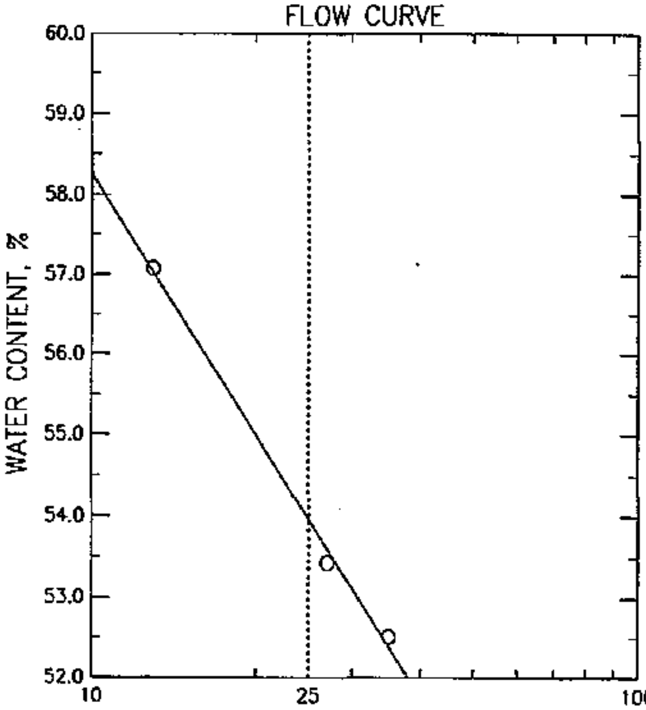
LIQUID LIMIT DETERMINATIONS

CONTAINER NUMBER	bk126	bk10	bk76		
WT. WET SOIL + TARE	36.05	36.84	35.74		
WT. DRY SOIL + TARE	33.33	34.19	33.36		
WT. WATER	2.72	2.65	2.38		
TARE WT.	28.15	29.23	29.19		
WT. DRY SOIL	5.18	4.96	4.17		
WATER CONTENT, W_N (%)	52.51	53.43	57.07		
NUMBER OF BLOWS, N	35	27	13		
ONE-POINT LIQUID LIMIT, LL	54.69	53.93	52.73		

PLASTIC LIMIT DETERMINATIONS

CONTAINER NUMBER	bk99	bk1			
WT. WET SOIL + TARE	32.56	34.85			
WT. DRY SOIL + TARE	31.49	33.81			
WT. WATER	1.07	1.04			
TARE WT.	27.66	30.14			
WT. DRY SOIL	3.83	3.67			
WATER CONTENT (%)	27.94	28.34			

FLOW CURVE



SUMMARY OF RESULTS

NATURAL WATER CONTENT, W (%)	52.3
LIQUID LIMIT, LL	54.0
PLASTIC LIMIT, PL	28.1
PLASTICITY INDEX, PI	25.8
LIQUIDITY INDEX, LI*	0.94

*LI = (W − PL)/PI

PLASTICITY CHART

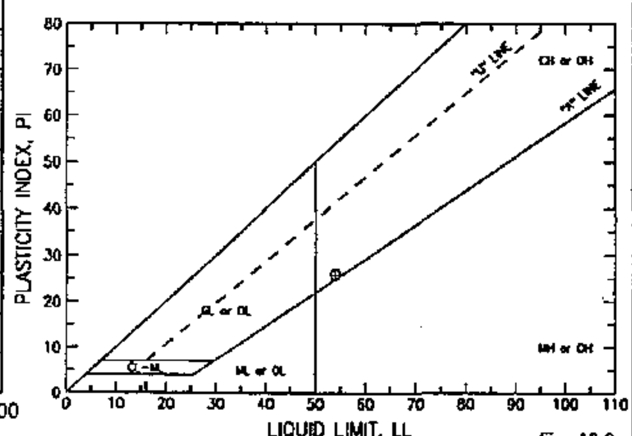


Fig. 10.0

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-31
Sample No. : UO-4 (15-17)
Location : New Bedford, MA
Soil Description : Moist, dark gray organic silt
Remarks : ---

Depth : 15-17 ft
Test Date : 10/12/99
Test Method : ASTM D 2216

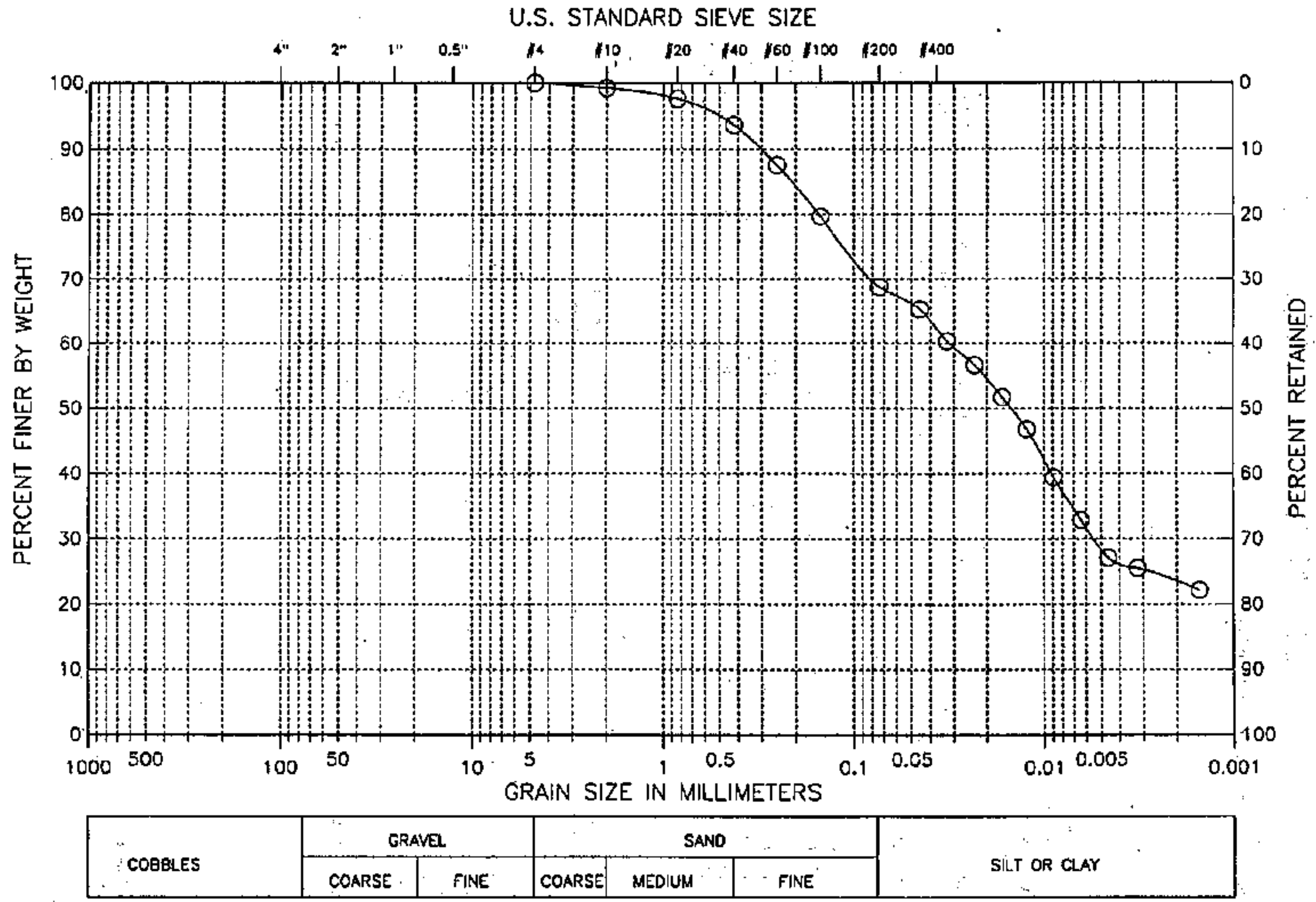
Filename : FD31UO4
Elevation : ---
Tested by : gsg
Checked by : gtt

Natural Moisture Content

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) sha3	9.22	163.61	108.05	56.22
2)	0.00	0.00	0.00	0.00

Average Moisture Content = 56.22

	Boring No.: FD-32 Sample No.: UO-1 (6-8) Test Method ASTM D 422 Filename : FD32UO1	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Thu Oct 28 1999



Classification :
(OH) Sandy organic clay
Visual Description :
Moist, dark gray sandy organic clay

Remarks :

Figure 11

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ATTERBERG LIMITS

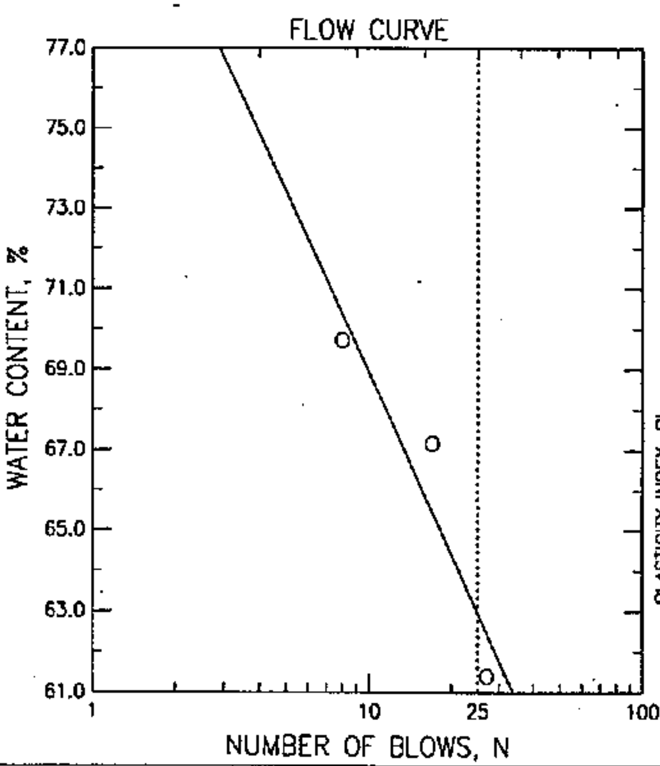
PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	gsg/rjw	FD-32
LOCATION New Bedford, MA		CHECKED BY gtt	SAMPLE NUMBER U0-1 (6-8)
SAMPLE DESCRIPTION Moist, dark gray sandy organic clay		DATE Thu Oct 28 1999	FILENAME FD32U01

LIQUID LIMIT DETERMINATIONS

CONTAINER NUMBER	bk84	bk1	bk99		
WT. WET SOIL + TARE	37.94	36.81	35.03		
WT. DRY SOIL + TARE	35.06	34.13	31.99		
WT. WATER	2.88	2.68	3.04		
TARE WT.	30.37	30.14	27.63		
WT. DRY SOIL	4.69	3.99	4.36		
WATER CONTENT, W_N (%)	61.41	67.17	69.72		
NUMBER OF BLOWS, N	27	17	8		
ONE-POINT LIQUID LIMIT, LL	61.98	64.11	60.74		

PLASTIC LIMIT DETERMINATIONS

CONTAINER NUMBER	bk126	bk82			
WT. WET SOIL + TARE	32.01	34.8			
WT. DRY SOIL + TARE	31.28	33.81			
WT. WATER	0.73	0.99			
TARE WT.	28.15	29.52			
WT. DRY SOIL	3.13	4.29			
WATER CONTENT (%)	23.32	23.08			



SUMMARY OF RESULTS

NATURAL WATER CONTENT, W (%)	73.0
LIQUID LIMIT, LL	63.0
PLASTIC LIMIT, PL	23.2
PLASTICITY INDEX, PI	39.8
LIQUIDITY INDEX, LI*	1.25

*LI = (W − PL)/PI

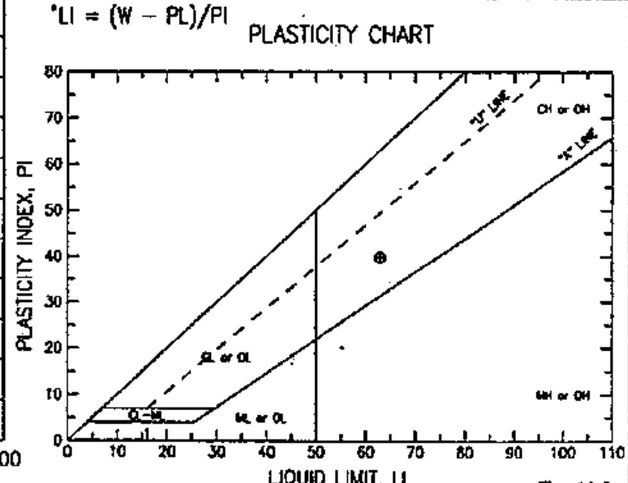


Fig. 11.0

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-32
Sample No. : UO-2 (10-12)
Location : New Bedford, MA
Soil Description : Moist, dark gray organic silt
Remarks : ---

Depth : 10-12 ft
Test Date : 10/12/99
Test Method : ASTM D 2216

Filename : FD32U02
Elevation : ---
Tested by : gsg
Checked by : gtt

Natural Moisture Content

	Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1)	hg26	8.90	190.11	128.82	51.11
2)		0.00	0.00	0.00	0.00

Average Moisture Content = 51.11

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-50
Sample No. : U-1 (1-3)
Location : New Bedford, MA
Soil Description : Moist, black sandy organic clay
Remarks : ---

Depth : 1-3 ft
Test Date : 11/30/99
Test Method : ASTM D 422

Filename : FD50U1
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

HYDROMETER

Hydrometer ID : 87130
Weight of air-dried soil = 25.71 gm
Specific Gravity = 2.58

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	23.50	21.00	18.30	0.049	57	0.049
2.00	23.00	21.00	17.80	0.034	55	0.034
4.00	22.00	21.00	16.80	0.025	52	0.025
8.00	18.00	21.00	12.80	0.018	40	0.018
15.00	16.00	21.00	10.80	0.013	34	0.013
30.00	14.00	21.00	8.80	0.009	27	0.009
60.00	12.00	21.00	6.80	0.007	21	0.007
120.00	11.00	21.00	5.80	0.005	18	0.005
240.00	10.50	20.00	4.58	0.003	14	0.003
1387.00	9.00	20.00	3.08	0.001	10	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	6.48	6.48	79
#20	0.033	0.84	1.29	7.77	74
#40	0.017	0.42	1.75	9.52	68
#60	0.010	0.25	1.19	10.71	65
#100	0.006	0.15	1.57	12.28	59
#200	0.003	0.07	0.11	12.39	59
Pan			17.80	30.19	0

Total Dry Weight of Sample = 39.82

D85 : 2.5952 mm
D60 : 0.1594 mm
D50 : 0.0232 mm
D30 : 0.0109 mm
D15 : 0.0037 mm
D10 : 0.0016 mm

Soil Classification
ASTM Group Symbol : OH
ASTM Group Name : Sandy organic clay
AASHTO Group Symbol : A-7-5(35)
AASHTO Group Name : Clayey Soils

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-50
Sample No. : U-1 (1-3)
Location : New Bedford, MA
Soil Description : Moist, black sandy organic clay
Remarks : ---

Depth : 1-3 ft
Test Date : 11/30/99
Test Method : ASTM D 4318

Filename : FD50U1
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

Liquid Limit for Organic

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Number of Drops	Moisture Content (%)
1) 69	30.29	38.66	36.57	27	33.28
2) 3	30.19	36.58	34.90	15	35.67
3) 32	30.10	35.30	33.91	9	36.48

Liquid Limit = 33.72

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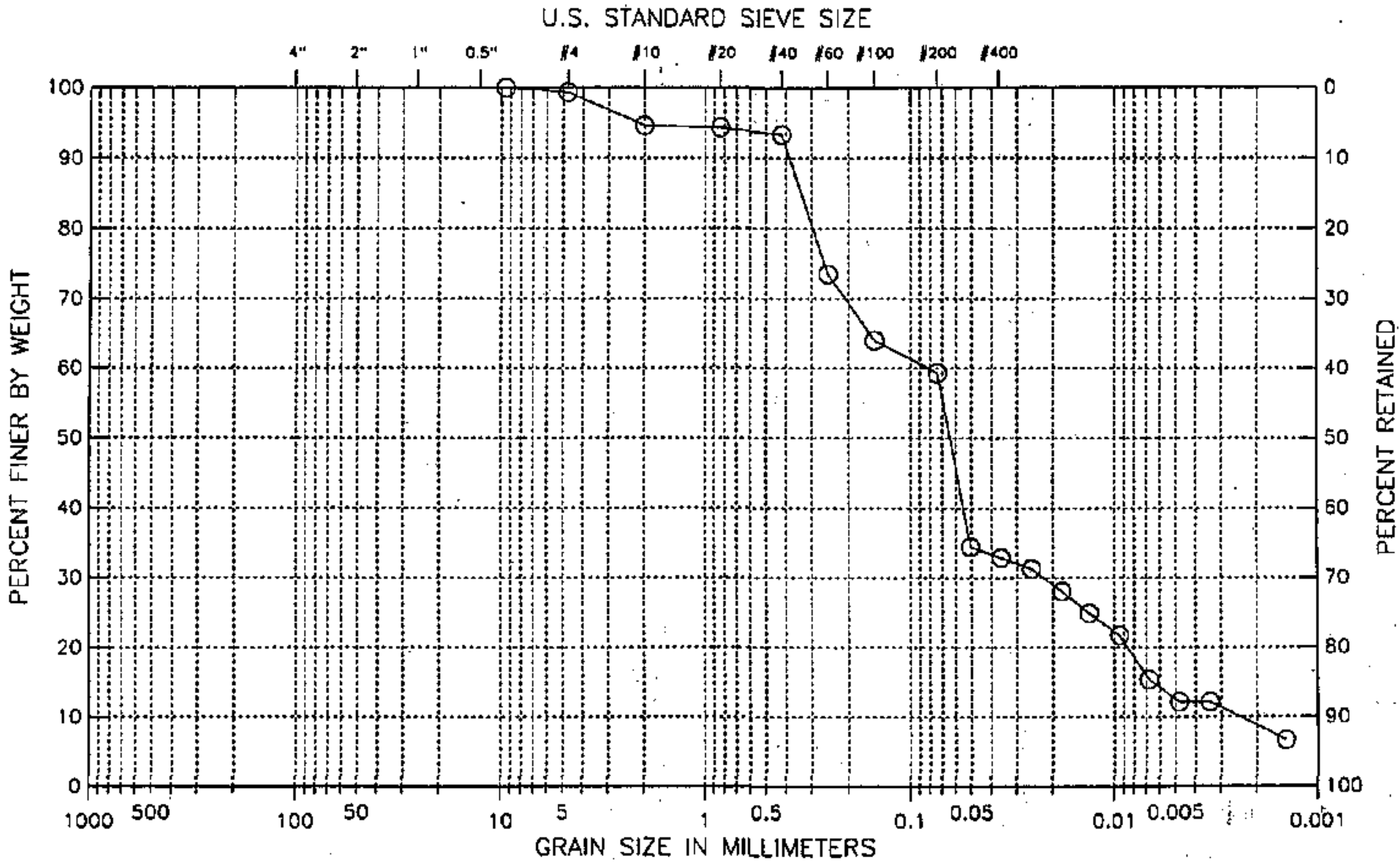
	Boring No. : FD-50 Sample No.: U-2 (4-6) Test Method ASTM D 422 Filename : FD50U2	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Mon Dec 20 1999



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

Remarks :

Visual Description :
Moist, black sandy organic clay

Figure 15

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Filename : FD50U2
Project No. : GTX-2409
Depth : 4-6 ft
Elevation : ---
Boring No. : FD-50
Test Date : 11/30/99
Tested by : GSG/MHM
Sample No. : U-2 (4-6)
Test Method : ASTM D 2216
Checked by : GTT
Location : New Bedford, MA
Soil Description : Moist, black sandy organic clay
Remarks : ---

Natural Moisture Content

	Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1)	ee14	9.37	196.61	136.74	47.00
2)		0.00	0.00	0.00	0.00

Average Moisture Content = 47.00

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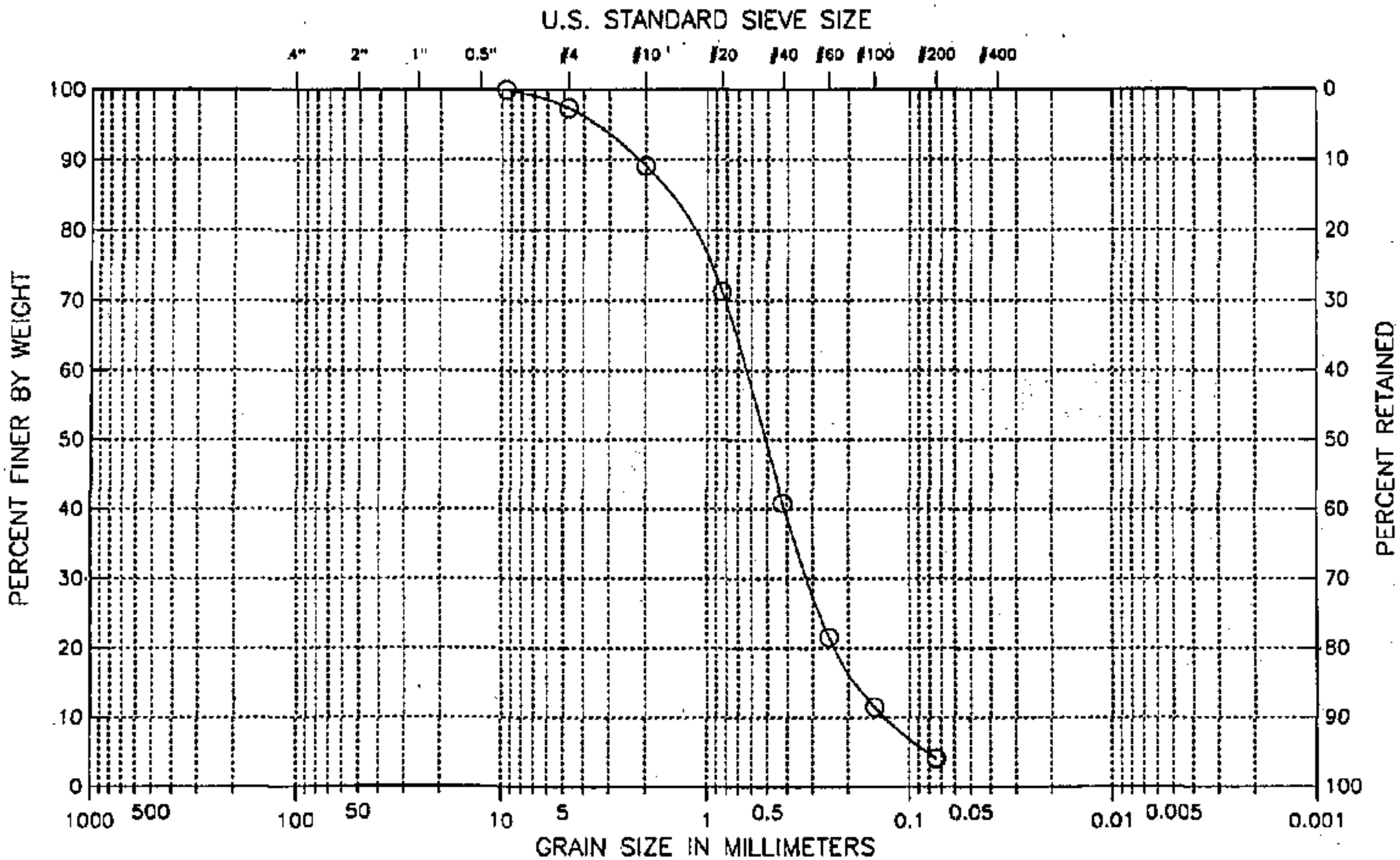
	Boring No. : FD-50 Sample No.: S-7 (27-29) Test Method ASTM D 422 Filename : FD50S7	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Tue Nov 23 1999



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(SP) Poorly graded sand

Visual Description :
Wet, light olive brown sand with some silt

Remarks :
Hydrometer not required fines < 15%

Figure 8

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Filename : FD51U1
Project No. : GTX-2409
Depth : 1-3 ft
Elevation : ---
Boring No. : FD-51
Test Date : 11/30/99
Tested by : GSG/MHM
Sample No. : U-1 (1-3)
Test Method : ASTM D 2216
Checked by : GTT
Location : New Bedford, MA
Soil Description : Moist, black organic clay with sand
Remarks : ---

Natural Moisture Content

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) ny9	7.99	165.34	75.74	132.25
2)	0.00	0.00	0.00	0.00

Average Moisture Content = 132.25

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Filename : FDS1U2
Project No. : GTX-2409
Depth : 4-6 ft
Elevation : ---
Boring No. : FD-51
Test Date : 11/30/99
Tested by : GSG/MHM
Sample No. : U-2 (4-6)
Test Method : ASTM D 422
Checked by : GTT
Location : New Bedford, MA
Soil Description : Moist, dark gray silty sand with some organics
Remarks : ---

HYDROMETER

Hydrometer ID : 87130
Weight of air-dried soil = 66.93 gm
Specific Gravity = 2.67

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	19.00	21.00	13.80	0.049	20	0.049
2.00	17.00	21.00	11.80	0.035	17	0.035
4.00	16.50	21.00	11.30	0.025	16	0.025
8.00	16.00	21.00	10.80	0.018	15	0.018
15.00	15.50	21.00	10.30	0.013	15	0.013
30.00	14.00	21.00	8.80	0.009	13	0.009
60.00	13.00	21.00	7.80	0.007	11	0.007
120.00	12.00	21.00	6.80	0.005	10	0.005
240.00	11.00	20.00	5.08	0.003	7	0.003
1405.00	9.00	20.00	3.08	0.001	4	0.001

FINE SIEVE SET

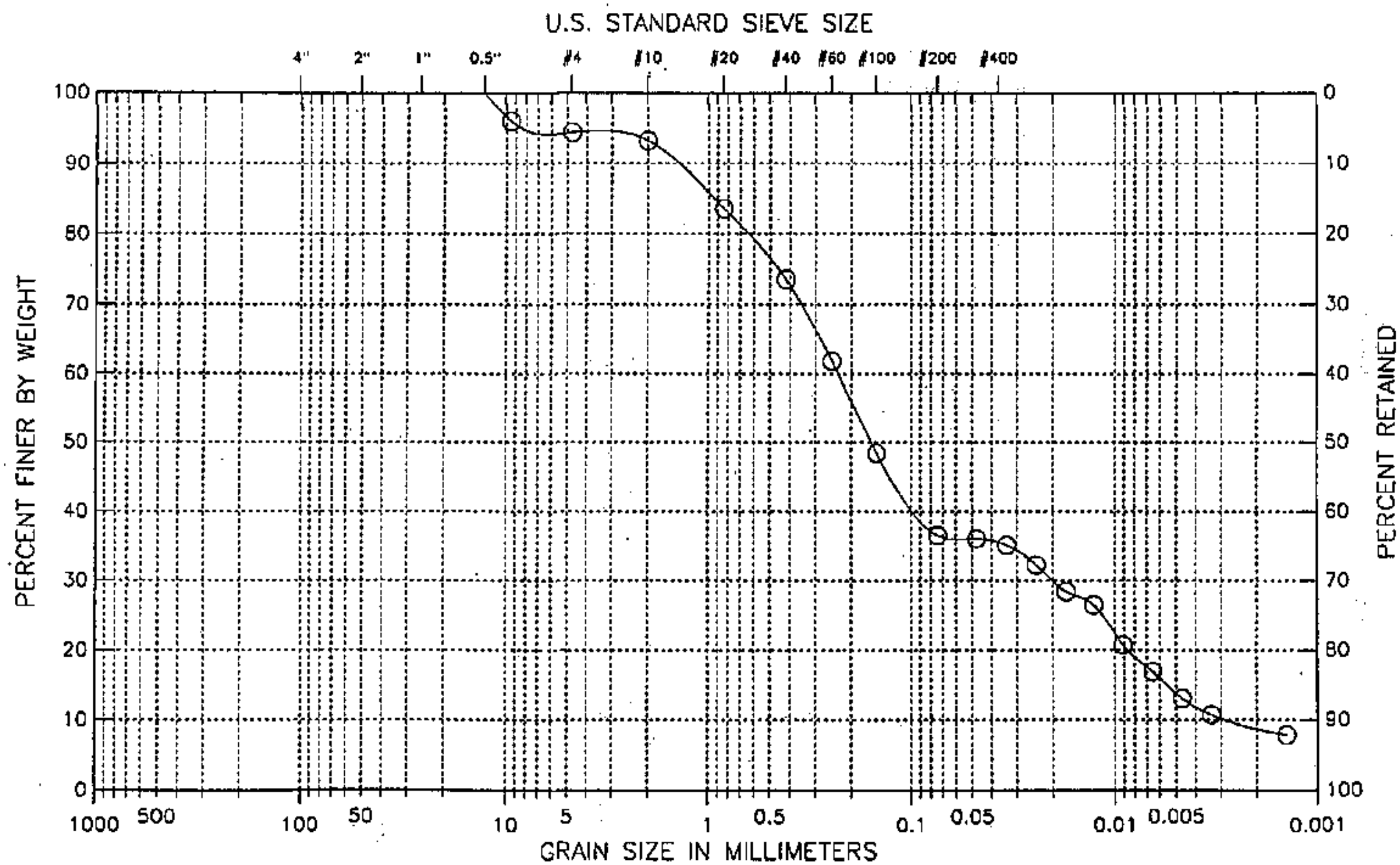
Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.375"	0.374	9.51	0.00	0.00	100
#4	0.187	4.75	1.06	1.06	98
#10	0.079	2.00	2.15	3.21	95
#20	0.033	0.84	5.35	8.56	88
#40	0.017	0.42	17.42	25.98	63
#60	0.010	0.25	15.02	41.00	42
#100	0.006	0.15	7.05	48.05	31
#200	0.003	0.07	3.95	52.00	26
Pan			18.14	70.14	0

Total Dry Weight of Sample = 79.78

D85 : 0.7778 mm
D60 : 0.3909 mm
D50 : 0.3068 mm
D30 : 0.1237 mm
D15 : 0.0150 mm
D10 : 0.0050 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

Boring No. : FD-51	Project : New Bedford Harbor Superfund Site
Sample No.: U-3 (7-9)	Project No.: GTX-2409
Test Method ASTM D 422	Location: New Bedford, MA
Filename : FD51U3	Date : Mon Dec 20 1999



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(SC) Clayey sand
Visual Description :
Moist, dark gray clayey sand with organics

Remarks :

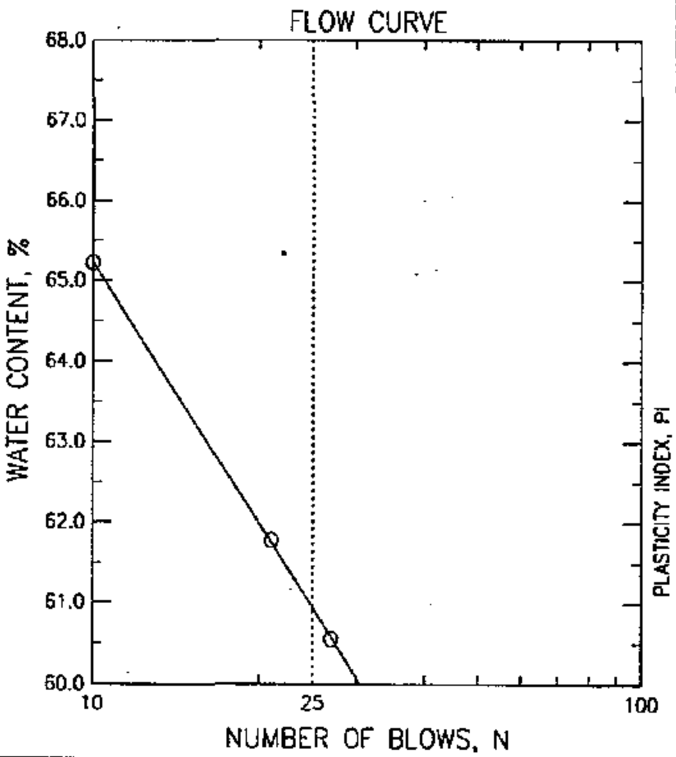
Figure 18

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Harbor Superfund Site	GTX-2409	GSG/MHM	FD-51
LOCATION		CHECKED BY	SAMPLE NUMBER
New Bedford, MA		GTT	U-3 (7-9)
SAMPLE DESCRIPTION		DATE	FILENAME
Moist, dark gray clayey sand with organics		Mon Dec 20 1999	FD51U3

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	126	144	87		
WT. WET SOIL + TARE	33.96	34.3	35.25		
WT. DRY SOIL + TARE	31.75	32.49	32.85		
WT. WATER	2.21	1.81	2.4		
TARE WT.	28.1	29.56	29.17		
WT. DRY SOIL	3.65	2.93	3.68		
WATER CONTENT, W_N (%)	60.55	61.77	65.22		
NUMBER OF BLOWS, N	27	21	10		
ONE-POINT LIQUID LIMIT, LL	61.11	60.49	58.37		

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	95	64			
WT. WET SOIL + TARE	35.92	34.4			
WT. DRY SOIL + TARE	34.57	33.36			
WT. WATER	1.35	1.04			
TARE WT.	29.5	29.37			
WT. DRY SOIL	5.07	3.99			
WATER CONTENT (%)	26.63	26.07			



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	46.7
LIQUID LIMIT, LL	60.9
PLASTIC LIMIT, PL	26.3
PLASTICITY INDEX, PI	34.6
LIQUIDITY INDEX, LI*	0.59

*LI = (W − PL)/PI

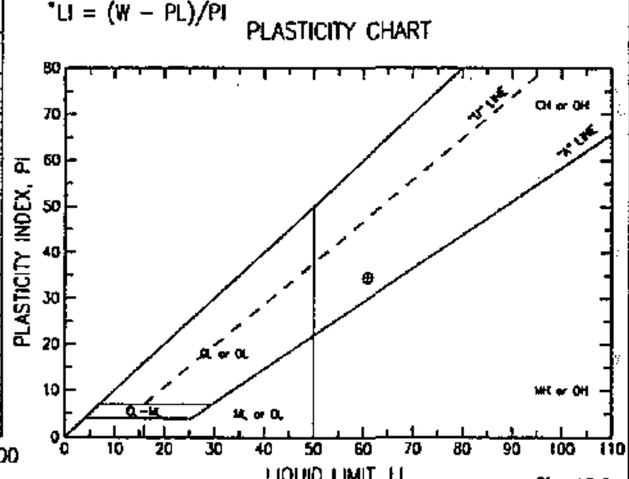


Fig. 18.0

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GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409
Boring No. : FD-51
Sample No. : U-3 (7-9)
Location : New Bedford, MA
Soil Description : Moist, dark gray clayey sand with organics
Remarks : ---

Depth : 7-9 ft
Test Date : 11/30/99
Test Method : ASTM D 2216

Filename : FD51U3
Elevation : ---
Tested by : GSG/MHM
Checked by : GTT

Natural Moisture Content

	Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1)	geo13	9.13	156.54	109.63	46.68
2)		0.00	0.00	0.00	0.00

Average Moisture Content = 46.68

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Harbor Superfund Site
Project No. : GTX-2409 Depth : 12-14 ft
Boring No. : FD-51 Test Date : 01/24/00
Sample No. : S-2 (12-14) Test Method : ASTM D 422
Location : New Bedford, MA
Soil Description : Wet, gray silt with sand
Remarks : ---

Filename : FD51S2
Elevation : ---
Tested by : MCR/NJH
Checked by : GTT

HYDROMETER

Hydrometer ID : 257525
Weight of air-dried soil = 61.05 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	30.00	20.50	25.84	0.046	42	0.046
2.00	22.00	20.50	17.84	0.034	29	0.034
4.00	19.00	20.50	14.84	0.025	24	0.025
8.00	16.00	20.50	11.84	0.018	19	0.018
15.00	14.00	20.50	9.84	0.013	16	0.013
30.00	12.00	20.50	7.84	0.009	13	0.009
60.00	10.50	20.50	6.34	0.007	10	0.007
120.00	9.50	20.50	5.34	0.005	9	0.005
240.00	9.00	21.00	5.00	0.003	8	0.003
1309.00	9.00	20.00	4.68	0.001	8	0.001

FINE SIEVE SET

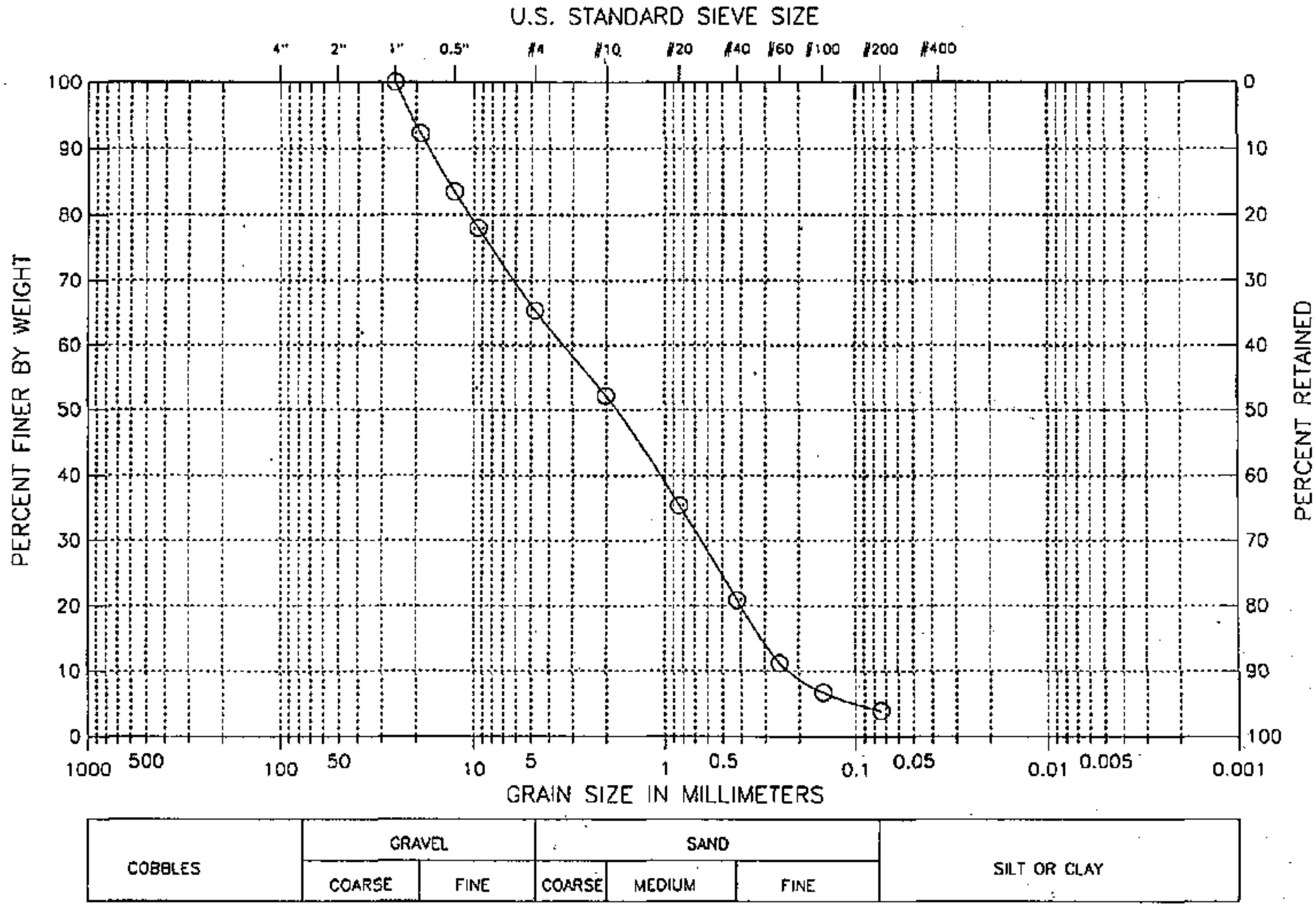
Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	0.16	0.16	100
#20	0.033	0.84	0.28	0.44	99
#40	0.017	0.42	0.40	0.84	99
#60	0.010	0.25	0.39	1.23	98
#100	0.006	0.15	1.54	2.77	95
#200	0.003	0.07	14.26	17.03	72
Pan			44.18	61.21	0

Total Dry Weight of Sample = 179.7

D85 : 0.1088 mm
D60 : 0.0608 mm
D50 : 0.0518 mm
D30 : 0.0348 mm
D15 : 0.0117 mm
D10 : 0.0062 mm

Soil Classification
ASTM Group Symbol : ML
ASTM Group Name : silt with sand
AASHTO Group Symbol : A-4(0)
AASHTO Group Name : Silty Soils

Boring No. : FD-51 Sample No.: S-12 (33-35) Test Method ASTM D 422 Filename : FD51S12	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Wed Feb 02 2000



Classification :
(SP) Poorly graded sand with gravel
Visual Description :
Moist, pale olive sand with gravel

Remarks :
Hydrometer not required, fines < 15%

Figure 13

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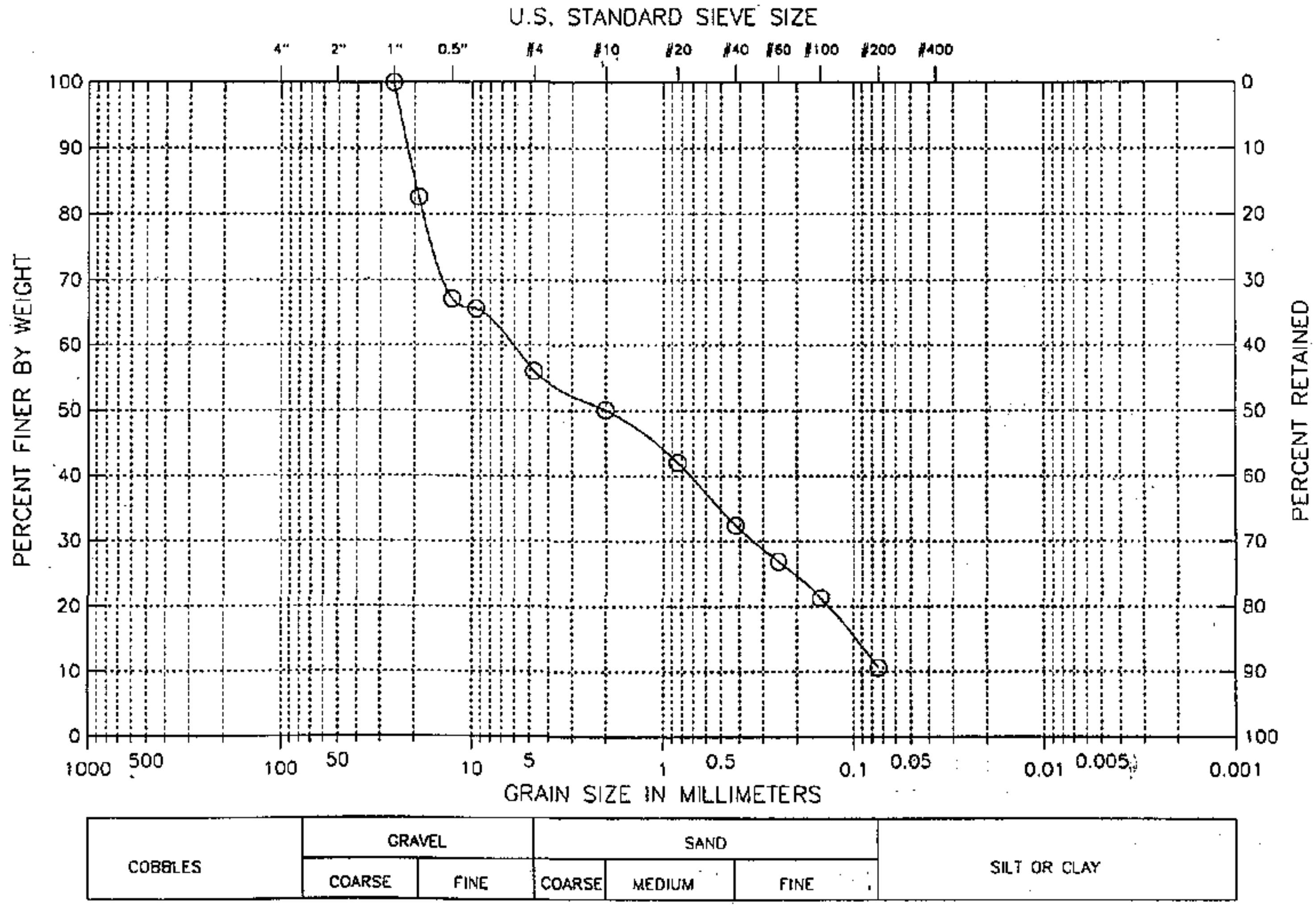
	Boring No. : FD-51 Sample No.: S-15B (40-42) Test Method ASTM D 422 Filename : FD51S15B	Project : New Bedford Harbor Superfund Site Project No.: GTX-2409 Location: New Bedford, MA Date : Wed Feb 02 2000



Classification :

Visual Description :
Moist, olive gravel with sand

Remarks :
Hydrometer not required, fines < 15%

Figure 14

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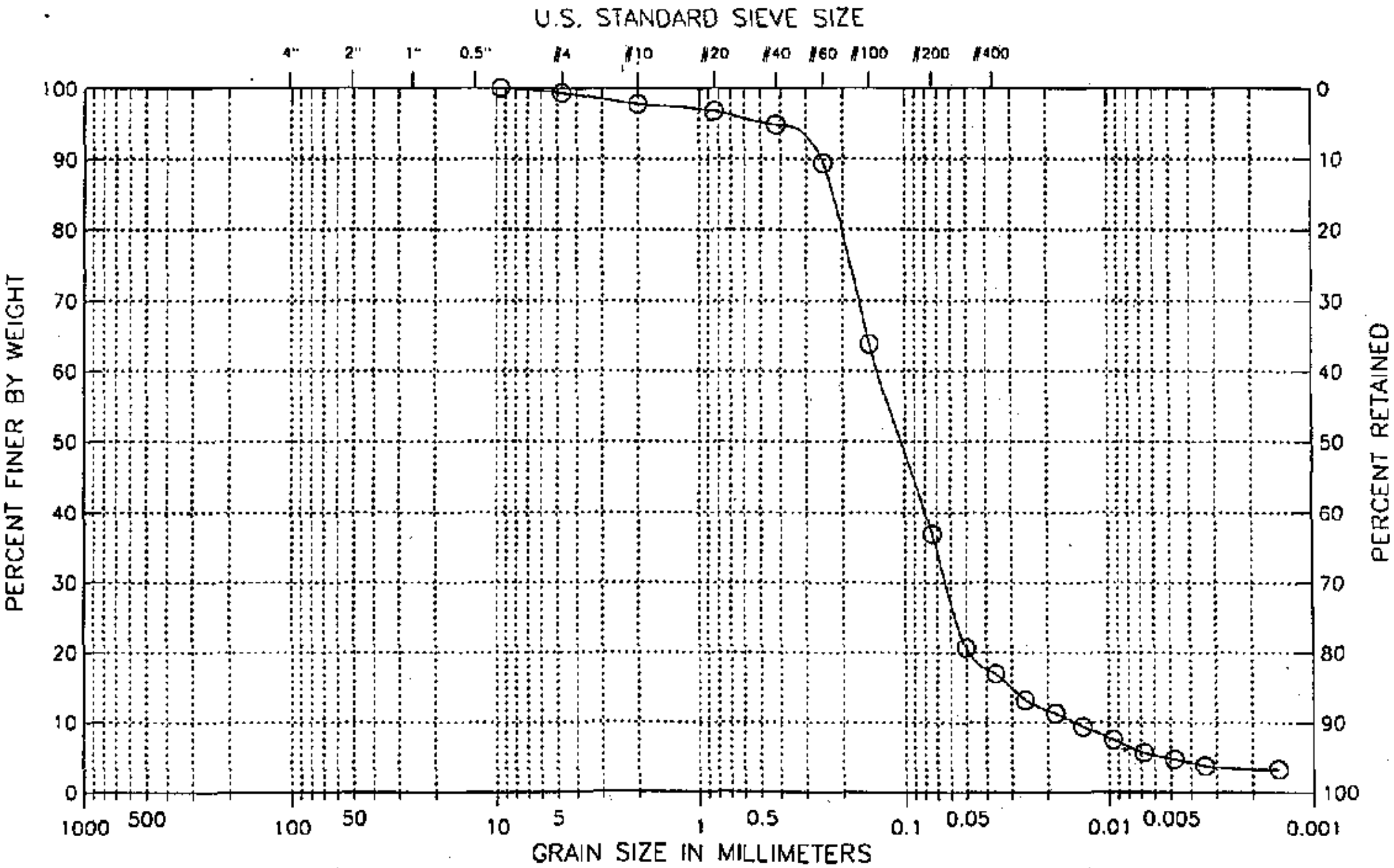
	Boring No. : FD-101 Sample No: S-5 Test Method ASTM D 422 Filename : FD101S5	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

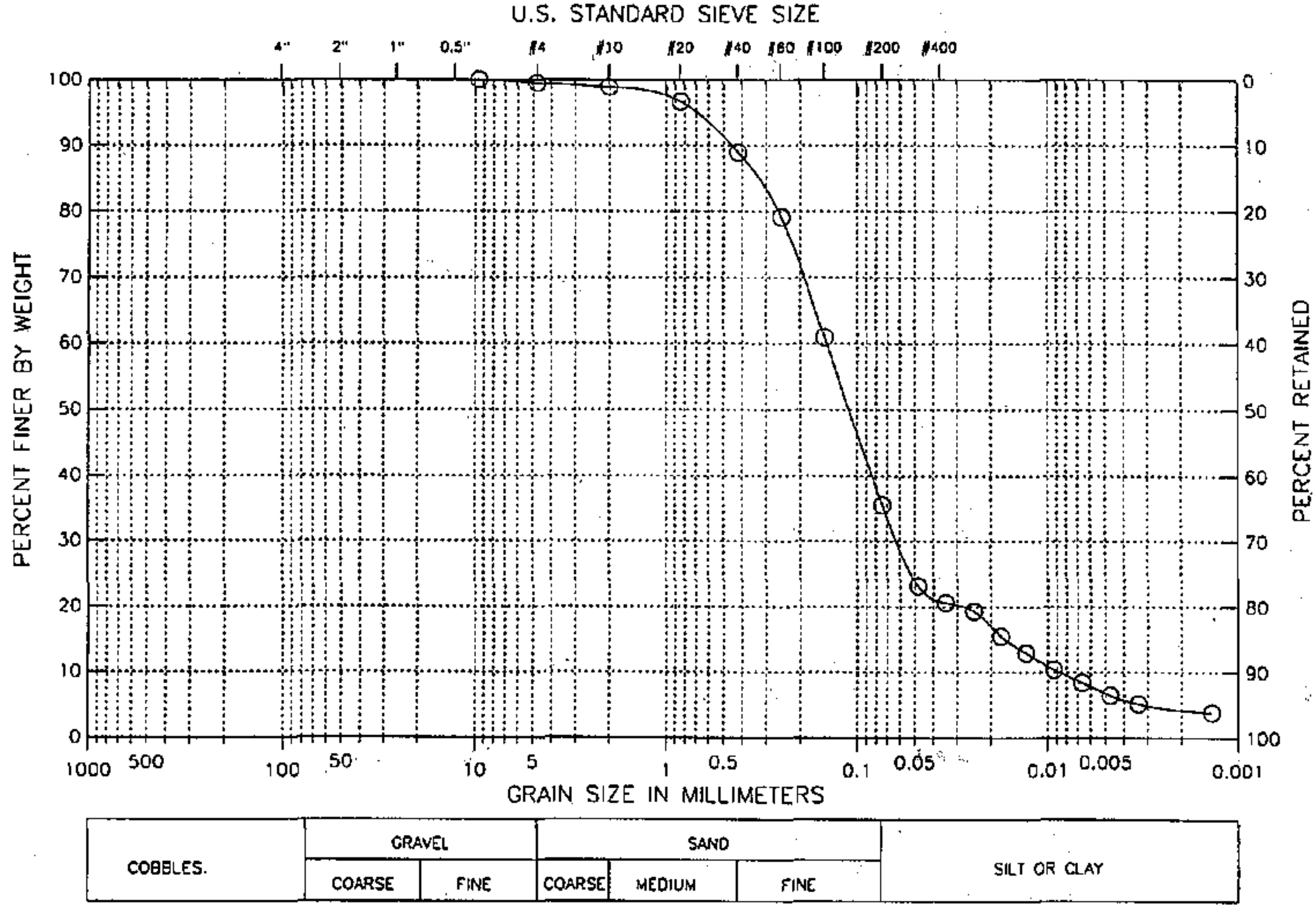
Classification :

Remarks :

Visual Description :
Wet, grayish brown silty sand

Figure 1

	Boring No. : FD-101 Sample No.: S-8 Test Method ASTM D 422 Filename : FD101S8	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



Classification :

Remarks :

Visual Description :
Wet, brown, red & gray silty sand.

Figure 2

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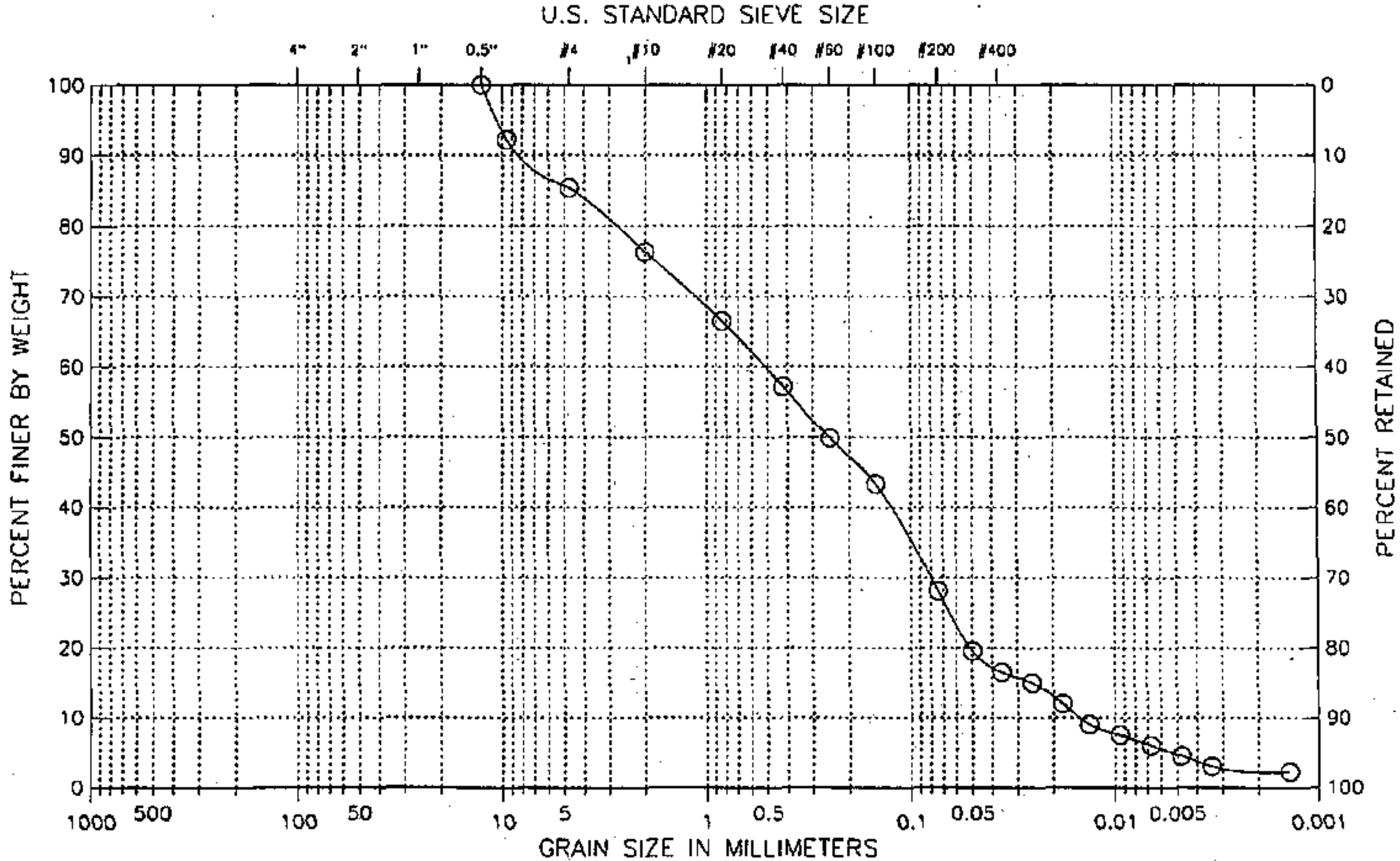
	Boring No.: FD-101 Sample No.: S-9 Test Method ASTM D 422 Filename : FD101S9	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

Remarks :

Visual Description :
Wet, brown silty sand with gravel

Figure 3

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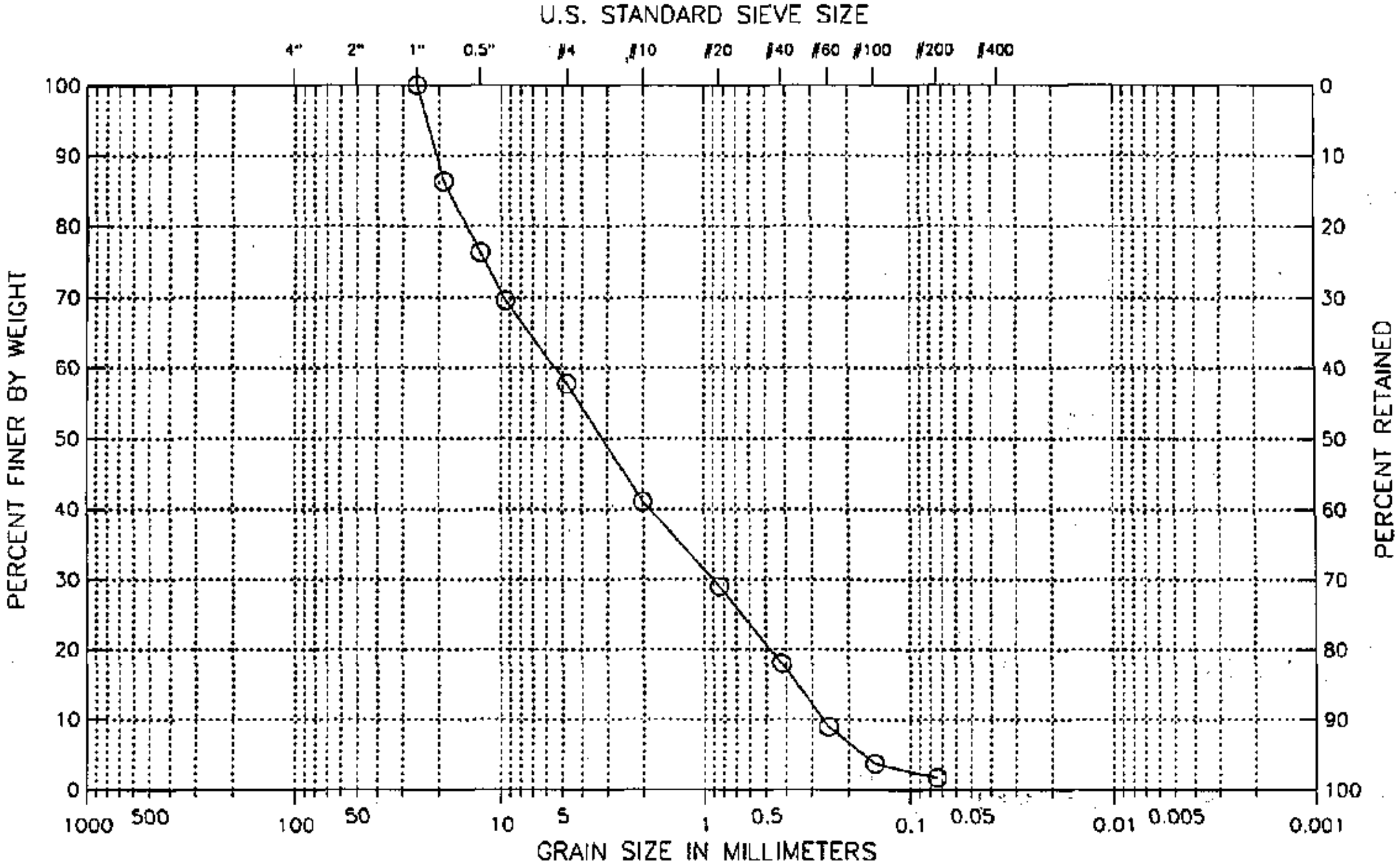
	Boring No. : FD-101 Sample No.: S-10 Test Method ASTM D 422 Filename : FD101S10	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

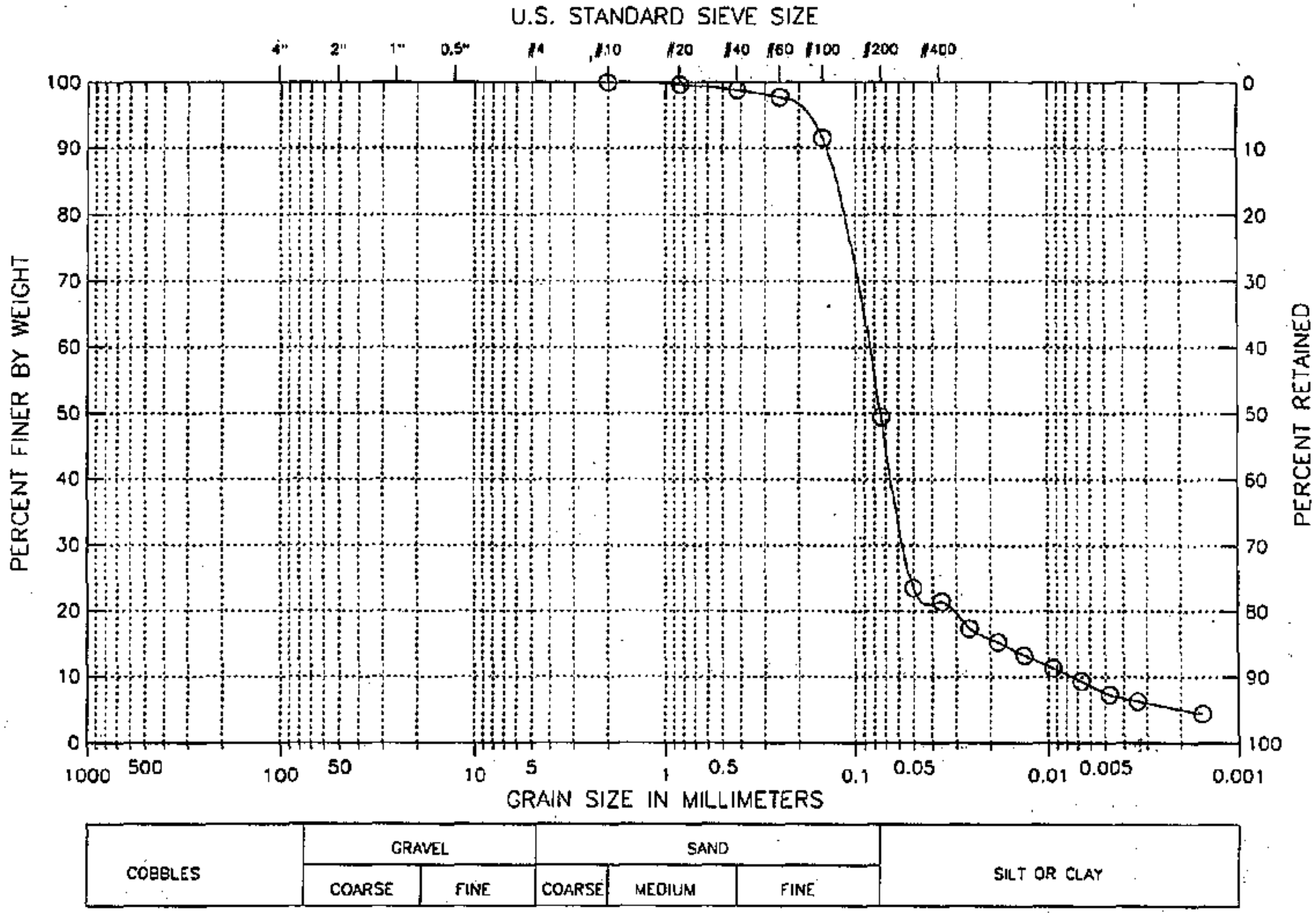
Classification :
(SP) Poorly graded sand with gravel

Visual Description :
Wet, brown sand with gravel

Remarks :

Figure 4

Boring No. : FD-102	Project : New Bedford Superfund Site
Sample No.: S3B	Project No.: GTX-3289
Test Method ASTM D 422	Location: New Bedford, MA
Filename : FD102S3B	Date : Mon Mar 05 2001



Classification :

Remarks :

Visual Description :
Wet, gray silt and fine sand

Figure 5

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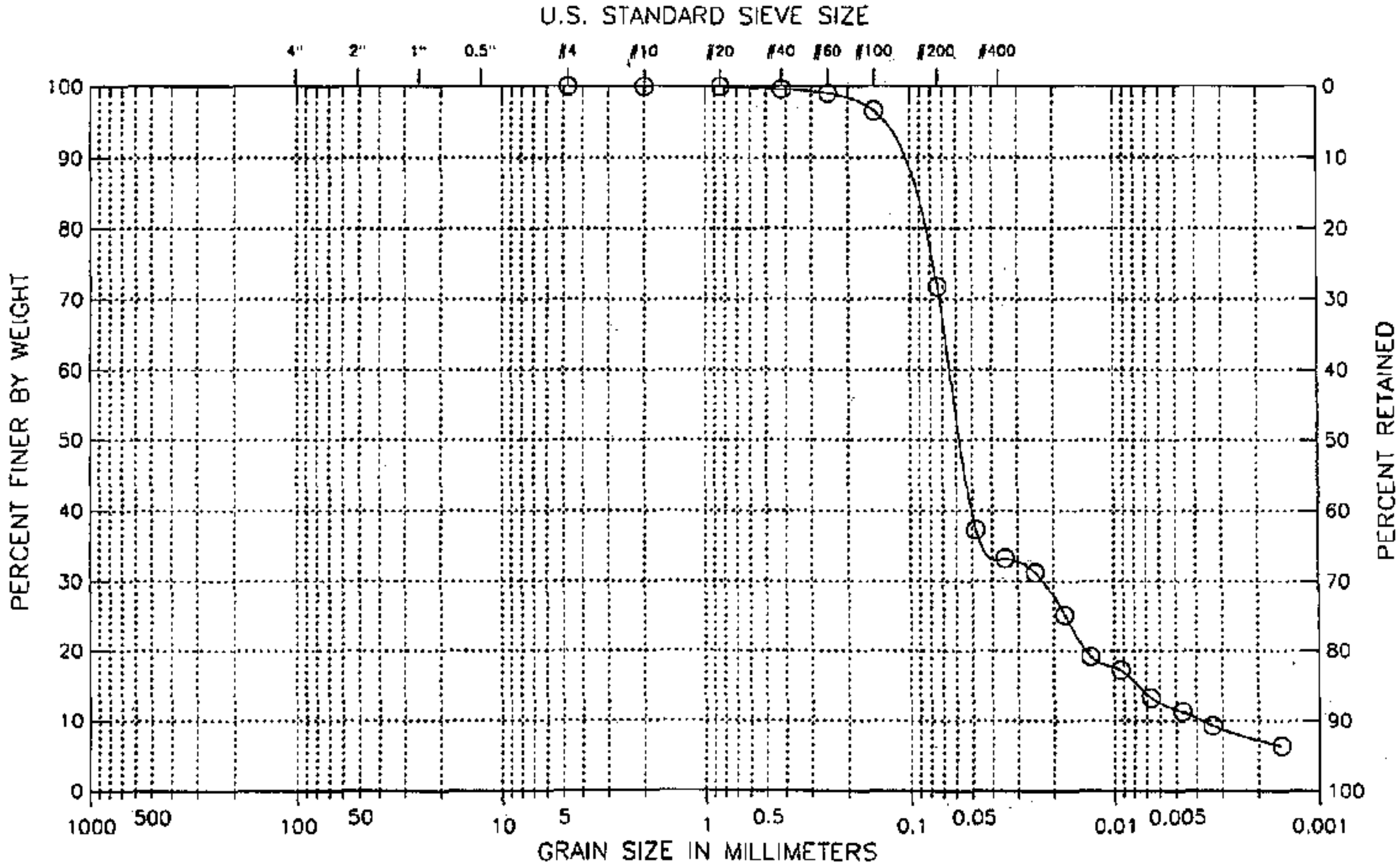
	Boring No. : FD-102 Sample No: S-5 Test Method ASTM D 422 Filename : FD102S5	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

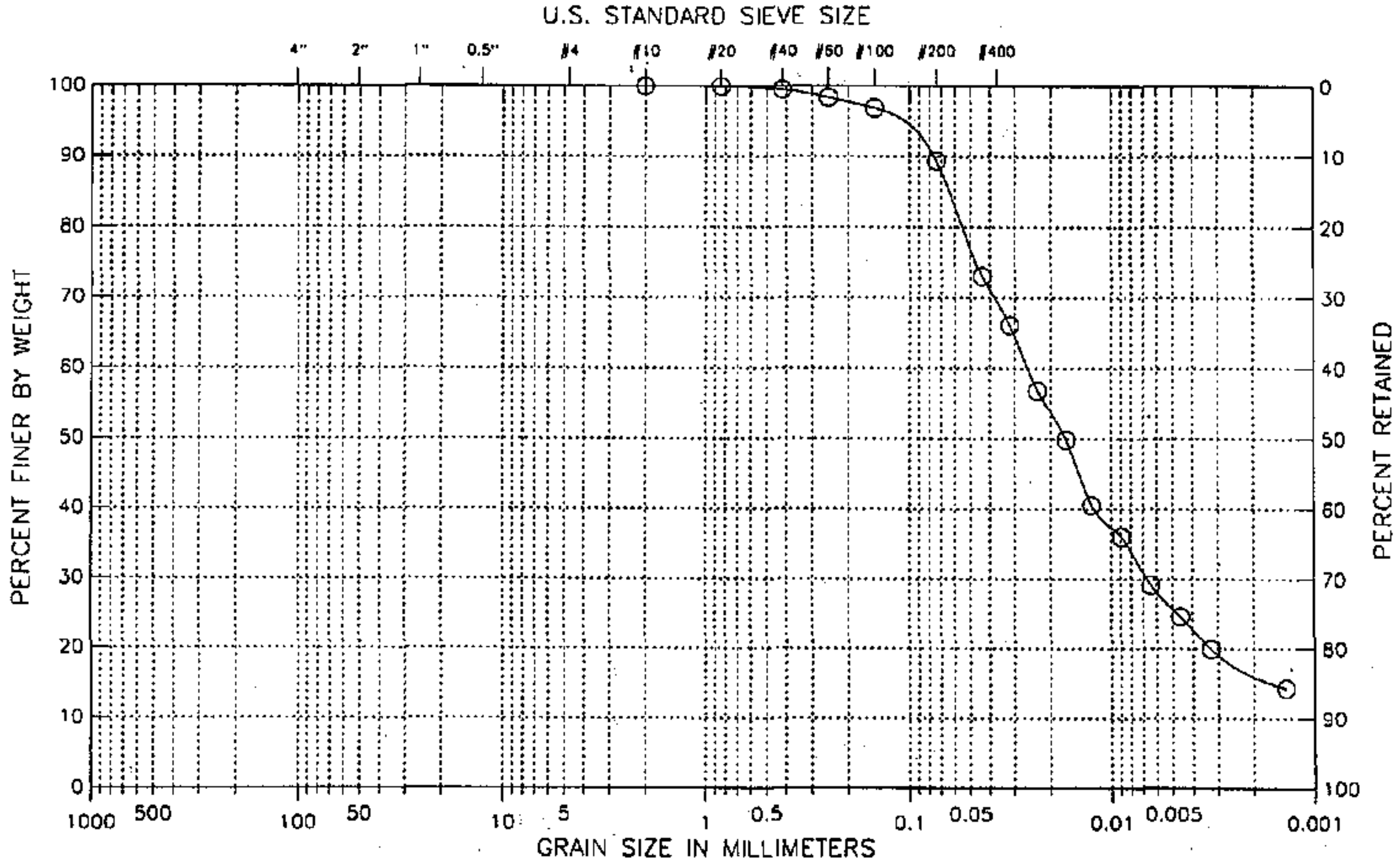
Classification :

Remarks :

Visual Description :
Wet, gray silty clay with sand

Figure 6

	Boring No. : FD-102 Sample No.: S6A Test Method ASTM D 422 Filename : FD102S6A	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(CL-ML) silty clay
Visual Description :
Wet, grayish brown silty clay

Remarks :

Figure 7

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ATTERBERG LIMITS

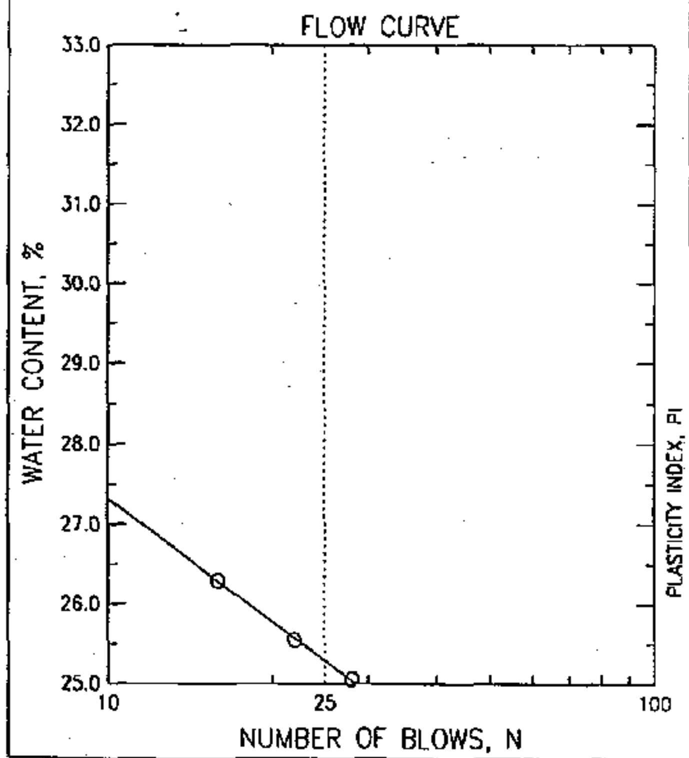
PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Superfund Site	GTX-3289	HB	FD-102
LOCATION: New Bedford, MA		CHECKED BY: JDT	SAMPLE NUMBER: S6A
SAMPLE DESCRIPTION: Wet, grayish brown silty clay		DATE: Mon Mar 05 2001	FILENAME: FD102S6A

LIQUID LIMIT DETERMINATIONS

CONTAINER NUMBER	BK133	BK55	BK27		
WT. WET SOIL + TARE	33.19	35.24	35.15		
WT. DRY SOIL + TARE	32.06	34.08	33.93		
WT. WATER	1.13	1.16	1.22		
TARE WT.	27.55	29.54	29.29		
WT. DRY SOIL	4.51	4.54	4.64		
WATER CONTENT, W_N (%)	25.06	25.55	26.29		
NUMBER OF BLOWS, N	28	22	16		
ONE-POINT LIQUID LIMIT, LL	25.40	25.16	24.91		

PLASTIC LIMIT DETERMINATIONS

CONTAINER NUMBER	BK114	BK95			
WT. WET SOIL + TARE	34.62	35.15			
WT. DRY SOIL + TARE	33.51	34.18			
WT. WATER	1.11	0.97			
TARE WT.	27.78	29.35			
WT. DRY SOIL	5.73	4.83			
WATER CONTENT (%)	19.37	20.08			



SUMMARY OF RESULTS

NATURAL WATER CONTENT, W (%)	26.5
LIQUID LIMIT, LL	25.3
PLASTIC LIMIT, PL	19.7
PLASTICITY INDEX, PI	5.6
LIQUIDITY INDEX, LI*	1.21

*LI = (W − PL)/PI

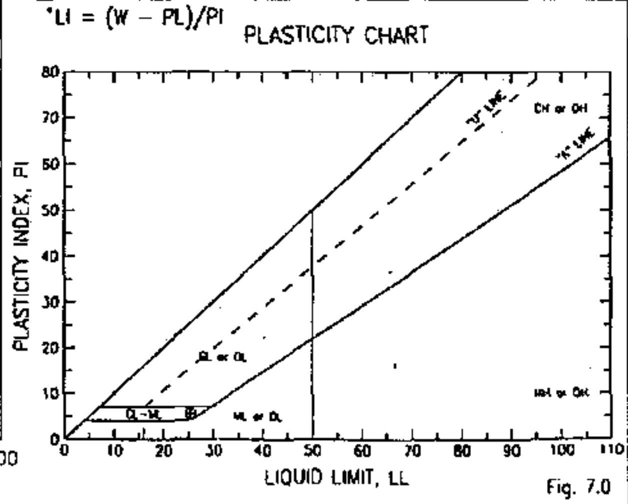


Fig. 7.0

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-102
Sample No. : S7A
Location : New Bedford, MA
Depth : --
Test Date : 03/01/01
Test Method : ASTM D 422
Filename : FD102S7A
Elevation : ---
Tested by : KAH
Checked by : JDT
Soil Description : Moist, grayish brown silt with sand
Remarks : ---

HYDROMETER

Hydrometer ID : 649262
Weight of air-dried soil = 43.96 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	25.00	20.00	20.44	0.048	47	0.048
2.00	22.00	20.00	17.44	0.034	40	0.034
4.00	19.00	20.00	14.44	0.025	33	0.025
8.00	16.00	20.00	11.44	0.018	26	0.018
15.00	15.00	20.25	10.47	0.013	24	0.013
30.00	13.00	20.50	8.50	0.009	19	0.009
60.00	11.00	20.75	6.54	0.007	15	0.007
120.00	10.00	21.25	5.60	0.005	13	0.005
240.00	9.00	21.25	4.60	0.003	10	0.003
1440.00	8.00	19.00	3.15	0.001	7	0.001

FINE SIEVE SET

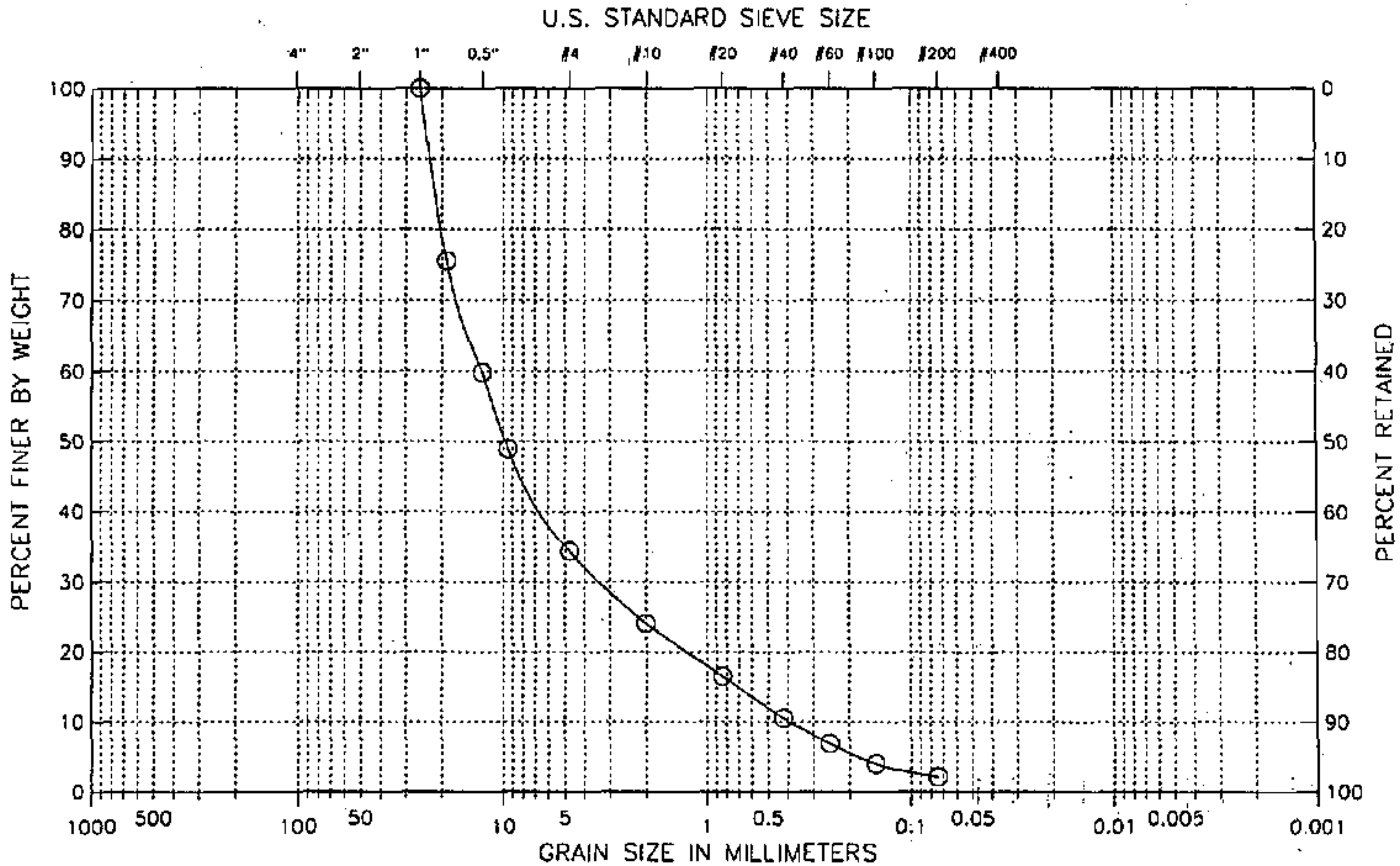
Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#10	0.079	2.00	0.00	0.00	100
#20	0.033	0.84	0.13	0.13	100
#40	0.017	0.42	0.59	0.72	98
#60	0.010	0.25	1.53	2.25	95
#100	0.006	0.15	2.87	5.12	88
#200	0.003	0.07	7.79	12.91	71
Pan			31.05	43.96	0

Total Dry Weight of Sample = 148.62

D85 : 0.1305 mm
D60 : 0.0609 mm
D50 : 0.0508 mm
D30 : 0.0216 mm
D15 : 0.0067 mm
D10 : 0.0029 mm

Soil Classification
ASTM Group Symbol : ML
ASTM Group Name : silt with sand
AASHTO Group Symbol : A-4(0)
AASHTO Group Name : Silty Soils

	Boring No. : FD-102 Sample No.: S8B Test Method ASTM D 422 Filename : FD102S8B	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(GW) Well-graded gravel with sand
Visual Description :
Wet, yellowish brown gravel with sand

Remarks :

Figure 9

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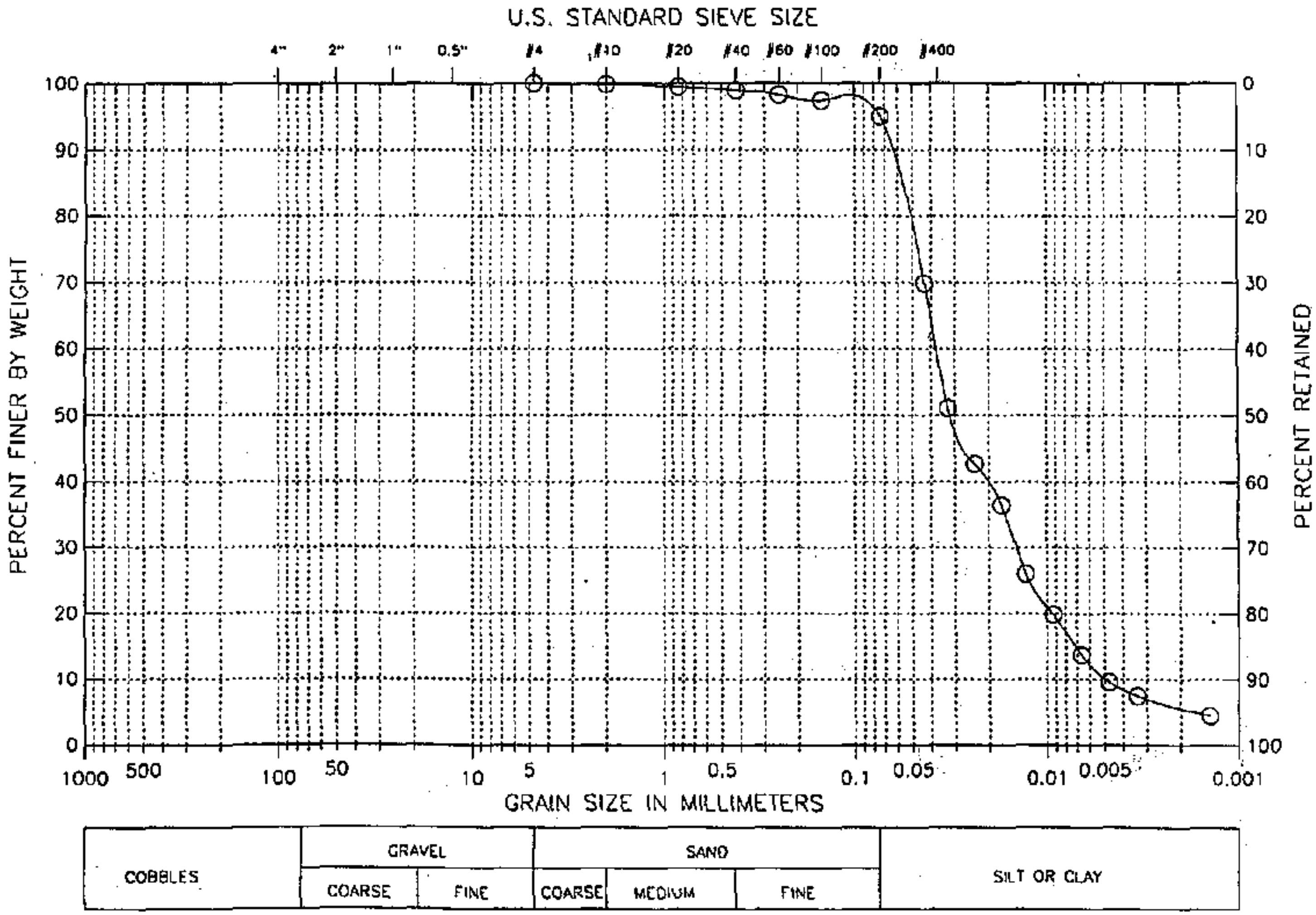
Boring No. : FD-102	Project : New Bedford Superfund Site
Sample No.: S10A	Project No.: GTX-3289
Test Method ASTM D 422	Location: New Bedford, MA
Filename : FD102S10	Date : Mon Mar 05 2001



Classification :

Remarks :

Visual Description :
Moist, light brown silt

Figure 10

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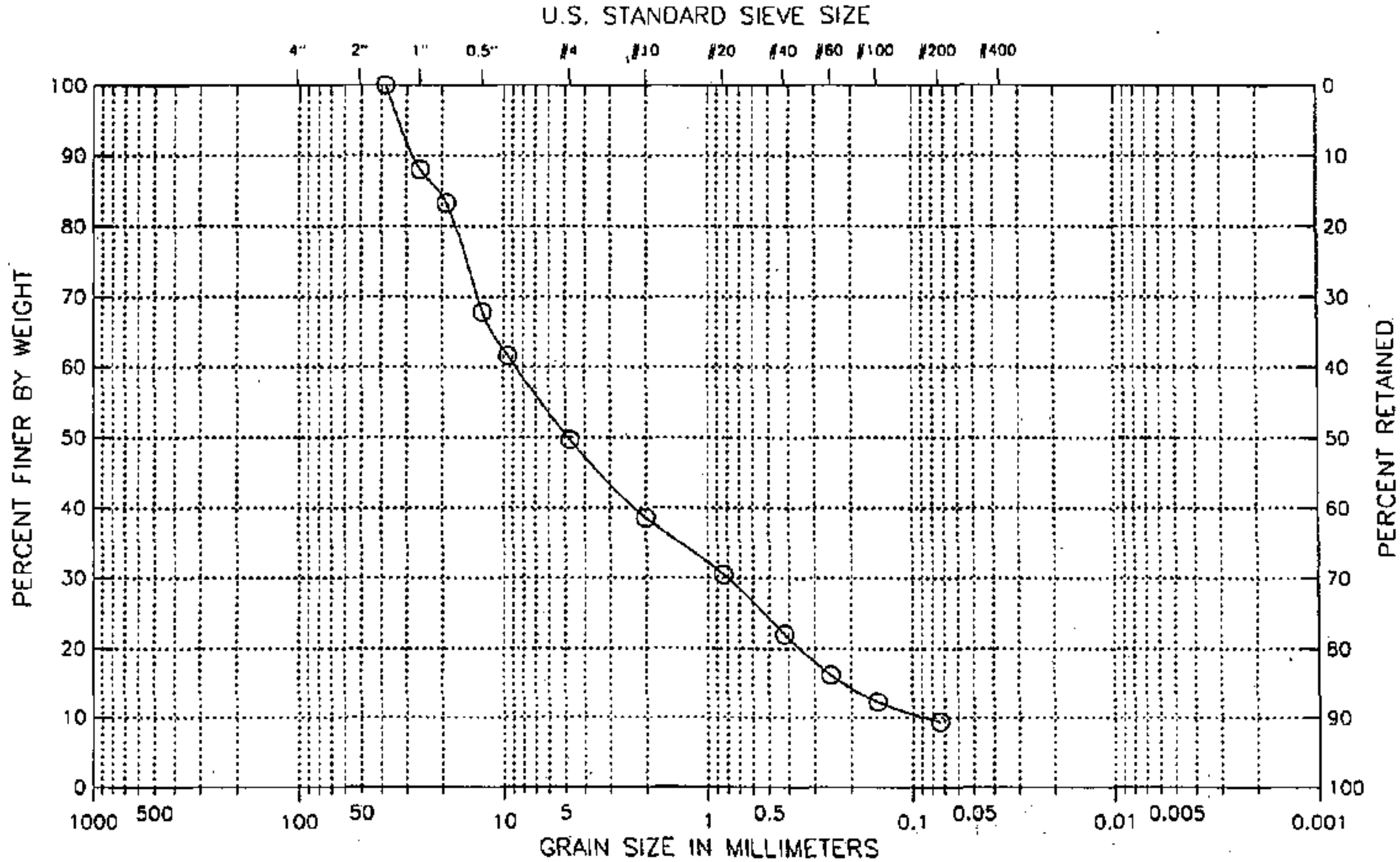
	Boring No. : FD-102 Sample No.: S11 Test Method ASTM D 422 Filename : FD102S11	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

Remarks :

Visual Description :
Wet, brown gravel with sand and some silt

Figure 11

ATTERBERG LIMITS

PROJECT New Bedford Superfund Site	PROJECT NUMBER GTX-3289	TESTED BY KAH	BORING NUMBER FD-103
LOCATION New Bedford, MA		CHECKED BY JDT	SAMPLE NUMBER S2
SAMPLE DESCRIPTION Wet, brown silty clay with sand		DATE Mon Mar 05 2001	FILENAME FD103S2

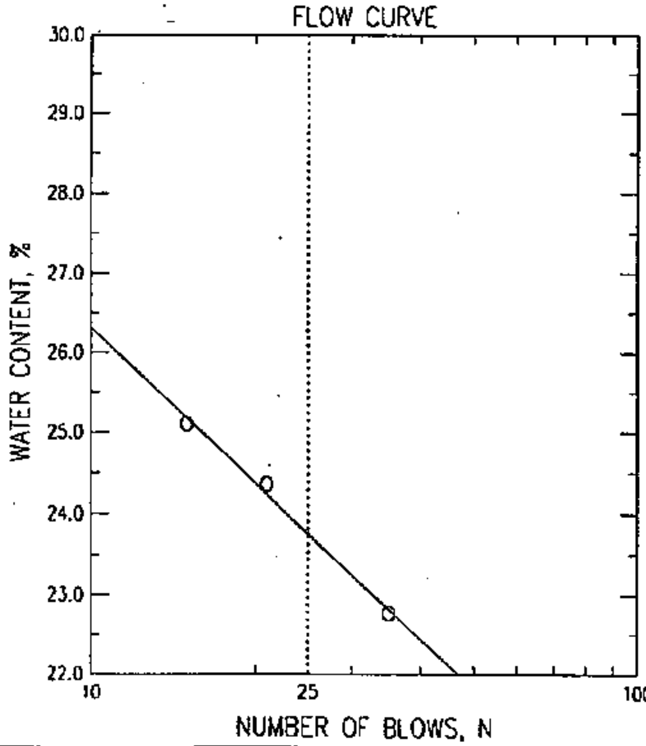
LIQUID LIMIT DETERMINATIONS

CONTAINER NUMBER	BK57	BK45	BK121		
WT. WET SOIL + TARE	35.38	35.68	35.51		
WT. DRY SOIL + TARE	34.23	34.43	34.37		
WT. WATER	1.15	1.25	1.14		
TARE WT.	29.18	29.3	29.83		
WT. DRY SOIL	5.05	5.13	4.54		
WATER CONTENT, W_N (%)	22.77	24.37	25.11		
NUMBER OF BLOWS, N	35	21	15		
ONE-POINT LIQUID LIMIT, LL	23.72	23.86	23.61		

PLASTIC LIMIT DETERMINATIONS

CONTAINER NUMBER	BK67	BK32			
WT. WET SOIL + TARE	35.55	36.41			
WT. DRY SOIL + TARE	34.55	35.38			
WT. WATER	1	1.03			
TARE WT.	29.29	30.07			
WT. DRY SOIL	5.26	5.31			
WATER CONTENT (%)	19.01	19.40			

FLOW CURVE



SUMMARY OF RESULTS

NATURAL WATER CONTENT, W (%)	23.3
LIQUID LIMIT, LL	23.8
PLASTIC LIMIT, PL	19.2
PLASTICITY INDEX, PI	4.6
LIQUIDITY INDEX, LI*	0.89

*LI = (W − PL)/PI

PLASTICITY CHART

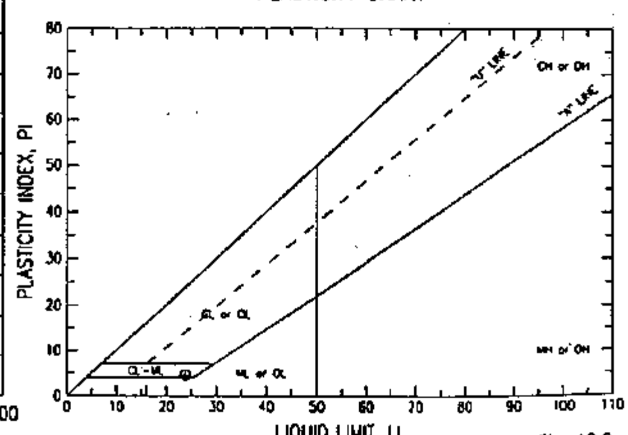


Fig. 12.0

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-103
Sample No. : S3B
Location : New Bedford, MA
Soil Description : Wet, brown silty sand
Remarks : ---

Depth : ---
Test Date : 03/01/01
Test Method : ASTM D 422

Filename : FD103S3B
Elevation : ---
Tested by : KAH
Checked by : JDT

HYDROMETER

Hydrometer ID : 649262
Weight of air-dried soil = 44.3 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	12.00	20.30	7.48	0.051	15	0.051
2.00	11.00	20.30	6.48	0.037	13	0.037
4.00	10.00	20.30	5.48	0.026	11	0.026
8.00	9.00	20.30	4.48	0.018	9	0.018
15.00	8.00	20.30	3.48	0.014	7	0.014
30.00	7.50	20.50	3.00	0.010	6	0.010
60.00	7.00	20.50	2.50	0.007	5	0.007
120.00	6.00	20.50	1.50	0.005	3	0.005
240.00	5.50	20.50	1.00	0.003	2	0.003
1212.00	5.00	20.00	0.44	0.002	1	0.002

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.375"	0.374	9.51	0.00	0.00	100
#4	0.187	4.75	1.20	1.20	98
#10	0.079	2.00	4.50	5.70	89
#20	0.033	0.84	6.21	11.91	76
#40	0.017	0.42	8.19	20.10	60
#60	0.010	0.25	8.31	28.41	43
#100	0.006	0.15	5.60	34.01	32
#200	0.003	0.07	4.19	38.20	24
Pan			11.80	50.00	0

Total Dry Weight of Sample = 58.04

D85 : 1.5559 mm
D60 : 0.4236 mm
D50 : 0.3093 mm
D30 : 0.1263 mm
D15 : 0.0515 mm
D10 : 0.0221 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-103
Sample No. : S6
Location : New Bedford, MA
Soil Description : Wet, brown gravel with sand and silt
Remarks : ---

Depth : ---
Test Date : 02/28/01
Test Method : ASTM D 422

Filename : FD103S6
Elevation : ---
Tested by : KAH
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	26.57	26.57	83
0.5"	0.500	12.70	20.45	47.02	69
0.375"	0.374	9.51	9.43	56.45	63
#4	0.187	4.75	9.91	66.36	57
#10	0.079	2.00	15.83	82.19	46
#20	0.033	0.84	15.83	98.02	36
#40	0.017	0.42	15.83	113.85	26
#60	0.010	0.25	11.23	125.08	19
#100	0.006	0.15	8.89	133.97	13
#200	0.003	0.07	5.82	139.79	9
Pan			13.80	153.59	0

Total Dry Weight of Sample = 161.62

D85 : 19.7783 mm
D60 : 6.7065 mm
D50 : 2.6857 mm
D30 : 0.5546 mm
D15 : 0.1818 mm
D10 : 0.0893 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-104
Sample No. : S3A
Location : New Bedford, MA
Soil Description : Wet, olive brown silty sand
Remarks : ---

Depth : ---
Test Date : 02/28/01
Test Method : ASTM D 422

Filename : FD104S3A
Elevation : ---
Tested by : KAH
Checked by : JDT

HYDROMETER

Hydrometer ID : 583901
Weight of air-dried soil = 53.06 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	17.00	20.00	12.01	0.050	20	0.050
2.00	15.00	20.00	10.01	0.036	16	0.036
4.00	14.00	20.00	9.01	0.026	15	0.026
8.00	13.00	20.00	8.01	0.018	13	0.018
15.00	12.00	20.30	7.03	0.013	12	0.013
30.00	10.00	20.50	5.03	0.009	8	0.009
60.00	9.00	20.50	4.03	0.007	7	0.007
120.00	8.00	20.50	3.03	0.005	5	0.005
240.00	7.50	20.50	2.53	0.003	4	0.003
1230.00	7.00	20.00	2.01	0.002	3	0.002

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	5.85	5.85	90
0.375"	0.374	9.51	0.00	5.85	90
#4	0.187	4.75	1.27	7.12	88
#10	0.079	2.00	1.00	8.12	87
#20	0.033	0.84	3.81	11.93	81
#40	0.017	0.42	15.52	27.45	55
#60	0.010	0.25	9.63	37.08	39
#100	0.006	0.15	3.48	40.56	34
#200	0.003	0.07	4.19	44.75	27
Pan			16.43	61.18	0

Total Dry Weight of Sample = 69.34

D85 : 1.5727 mm
D60 : 0.4799 mm
D50 : 0.3546 mm
D30 : 0.1020 mm
D15 : 0.0269 mm
D10 : 0.0114 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

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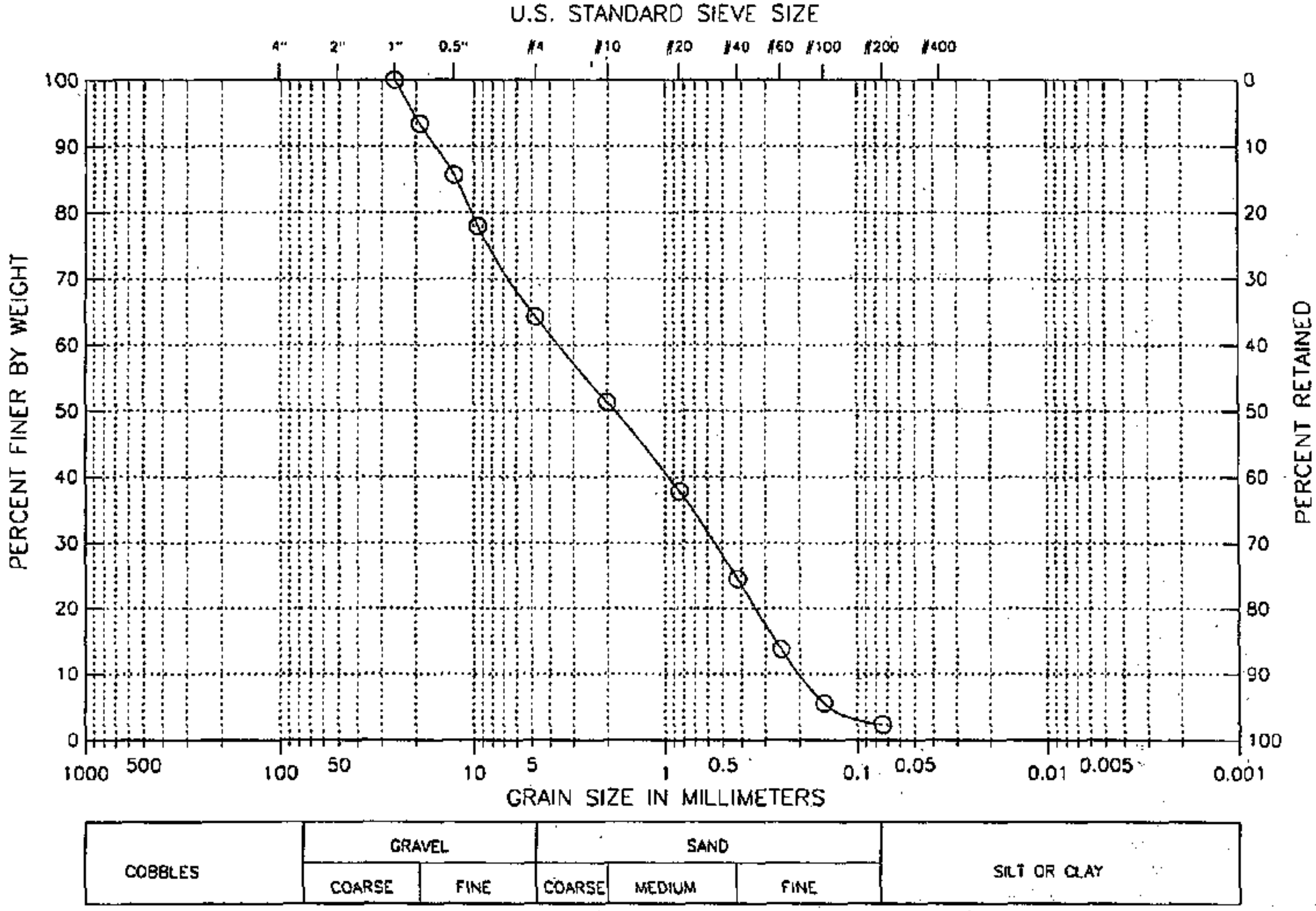
Boring No. : FD-104 Sample No.: S7 Test Method ASTM D 422 Filename : FD104S7	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



Classification :
(SP) Poorly graded sand with gravel

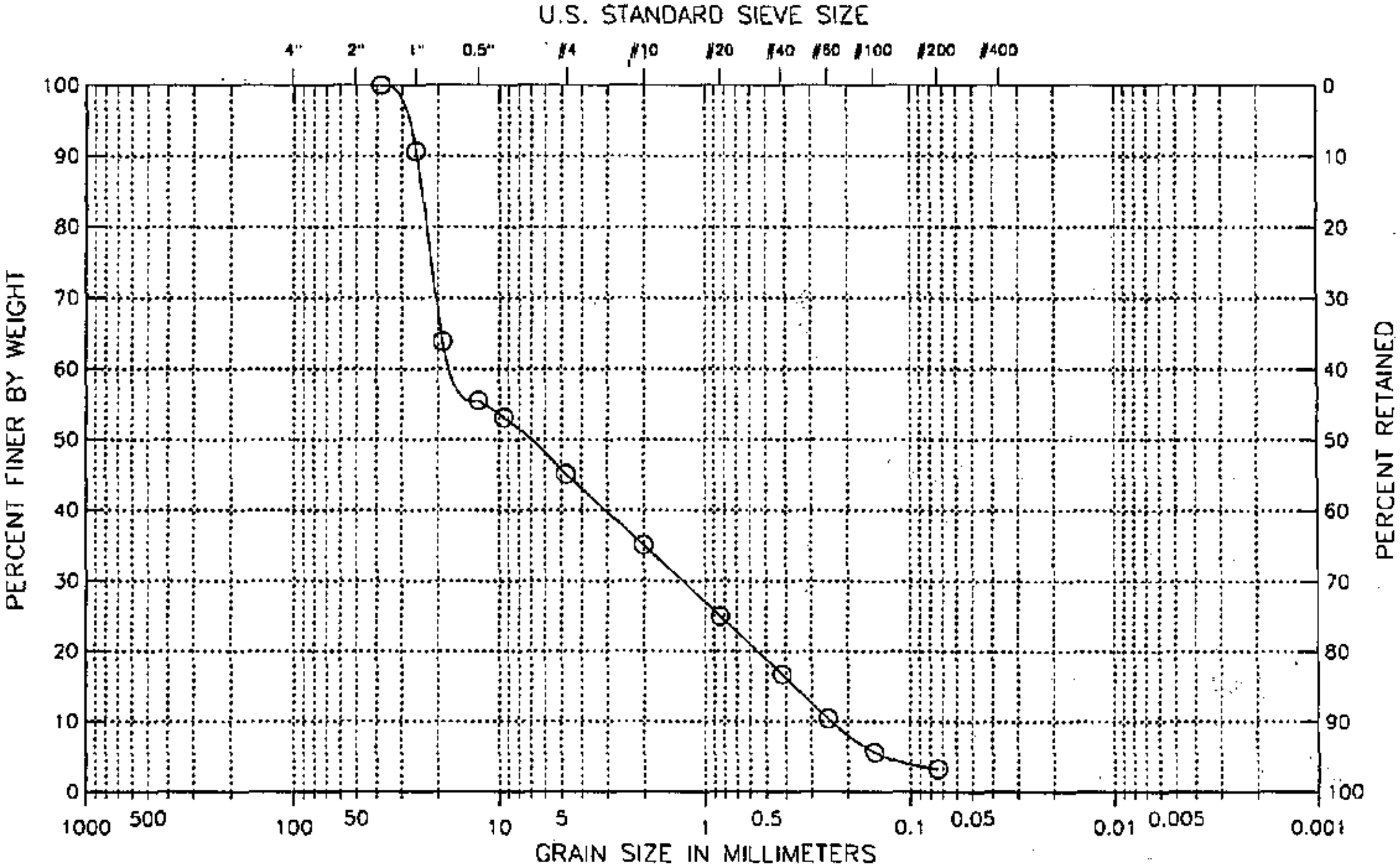
Visual Description :
Wet, brown sand with gravel

Remarks :

Figure 20

GeoTesting Express, Inc. • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

Boring No. : FD-104	Project : New Bedford Superfund Site
Sample No.: S10	Project No.: GTX-3289
Test Method ASTM D 422	Location: New Bedford, MA
Filename : FD104S10	Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(GP) Poorly graded gravel with sand

Visual Description :
Wet, gray gravel with sand

Remarks :

Figure 21

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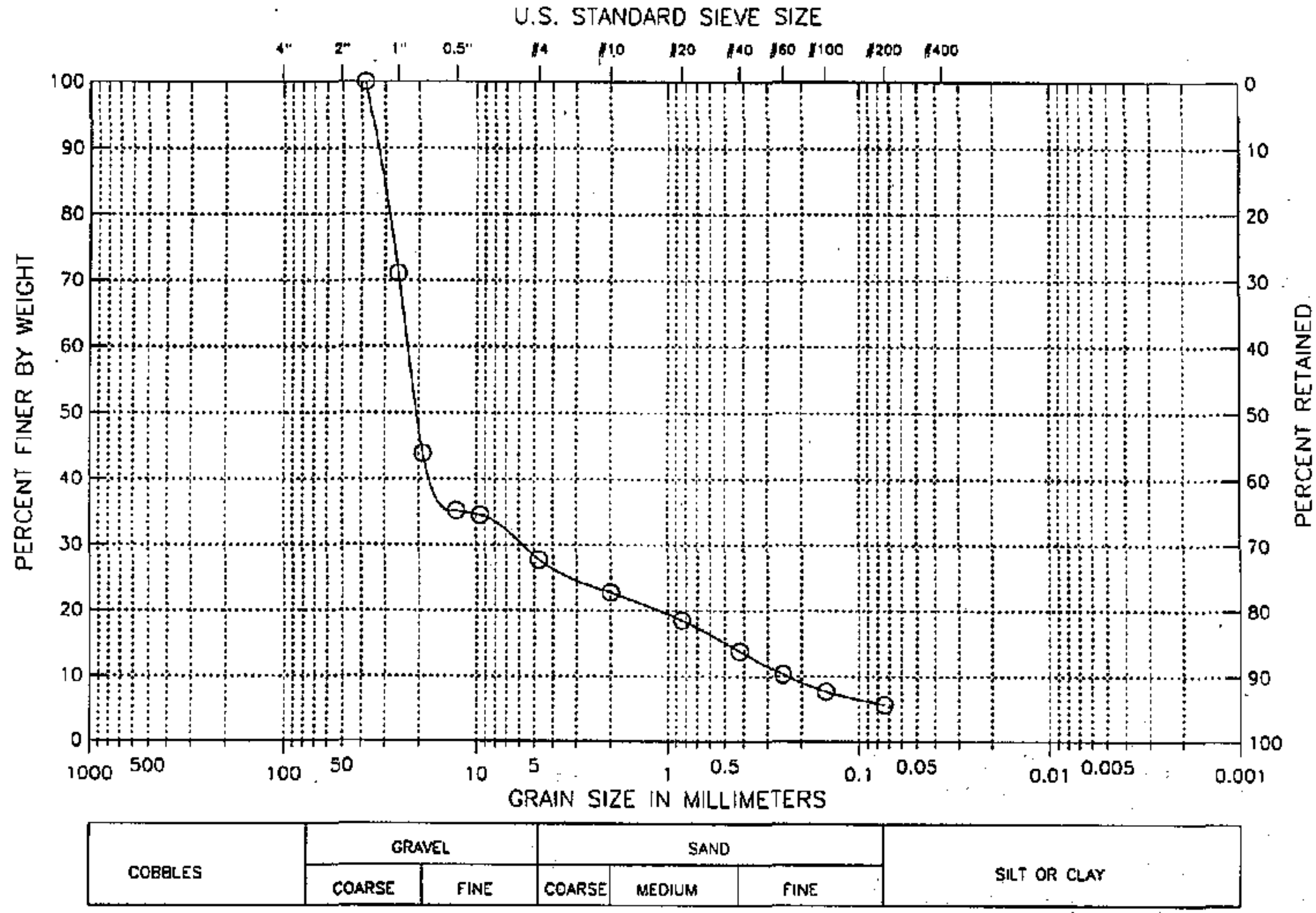
Boring No. : FD−104	Project : New Bedford Superfund Site
Sample No.: S12	Project No.: GTX−3289
Test Method ASTM D 422	Location: New Bedford, MA
Filename : FD104S12	Date : Mon Mar 05 2001



Classification :

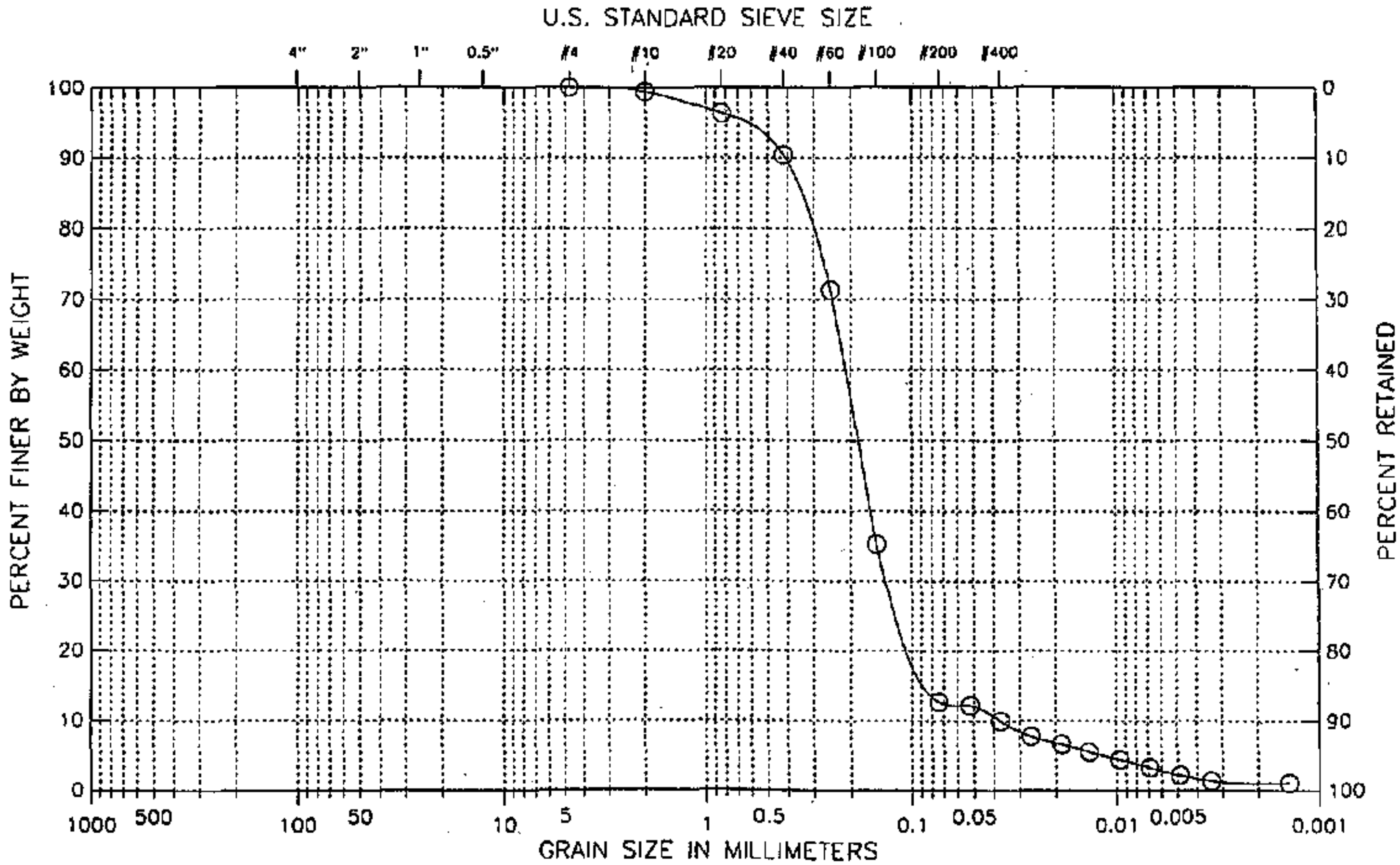
Remarks :

Visual Description :
Wet, gray gravel with sand and silt

Figure 23

GeoTesting Express, Inc. • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

	Boring No. : FD-105 Sample No.: S2 Test Method ASTM D 422 Filename : FD105S2	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

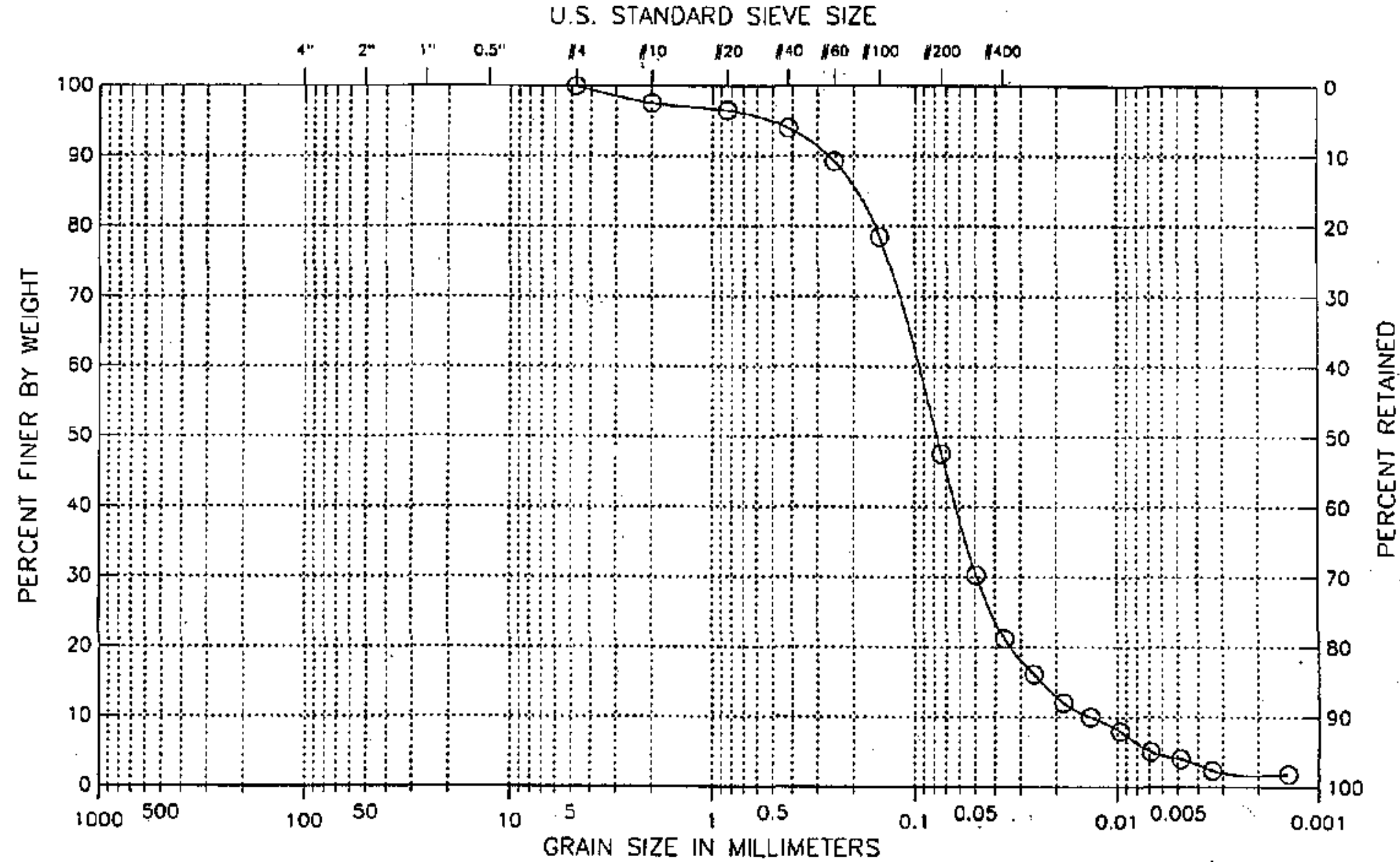
Classification :

Remarks :

Visual Description :
Moist, brownish gray silty fine sand

Figure 24

	Boring No. : FD-105 Sample No.: S3 Test Method ASTM D 422 Filename : FD105S3	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

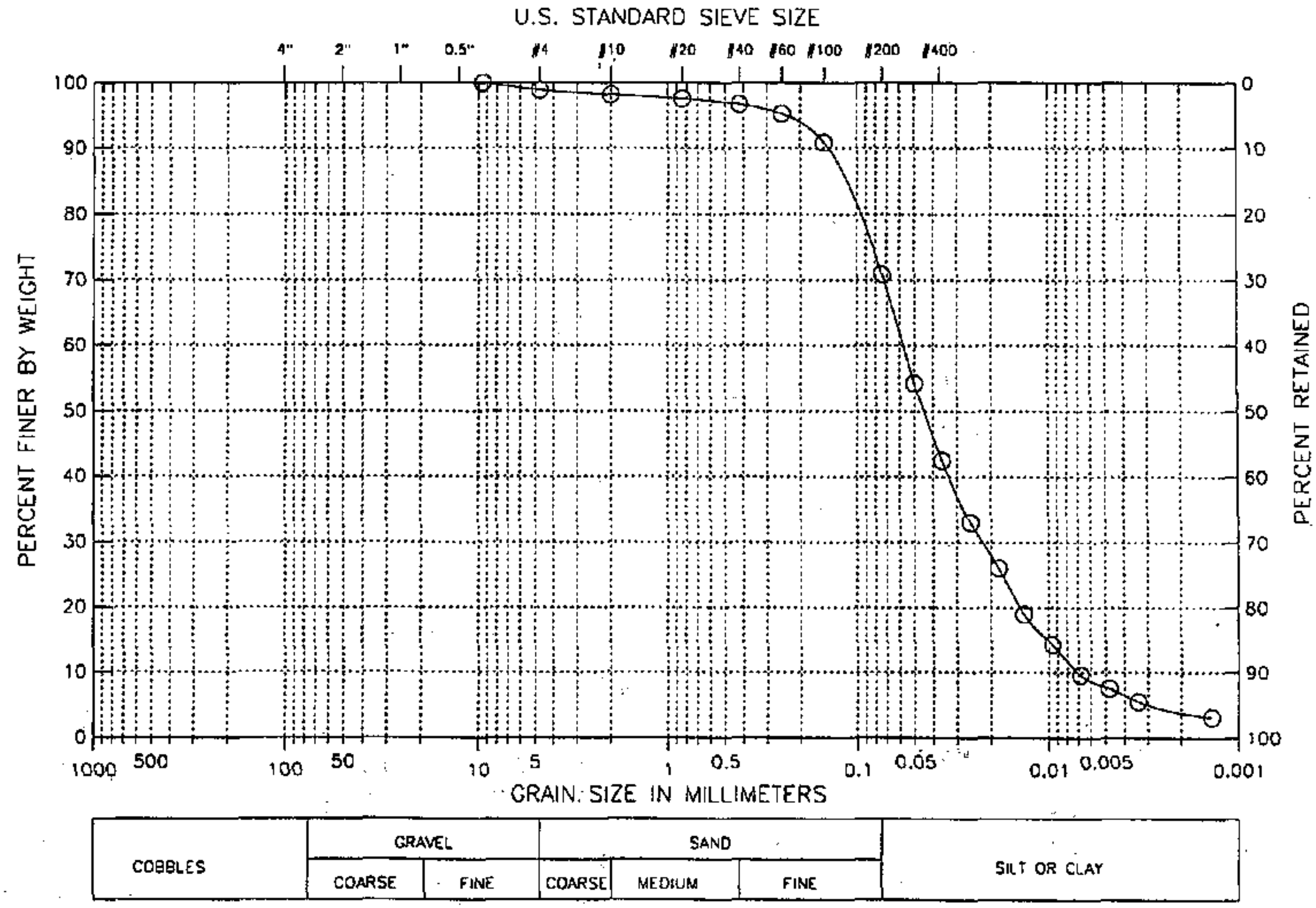
Remarks :

Visual Description :
Moist, light gray silty sand

Figure 25

GeoTesting Express, Inc. • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

	Boring No. : FD-105 Sample No.: S4B Test Method ASTM D 422 Filename : FD105S4B	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



Classification :
(ML) silt with sand
Visual Description :
Saturated, grayish brown silt with sand

Remarks :

Figure 26

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Superfund Site	GTX-3289	KAH	FD-105
LOCATION New Bedford, MA		CHECKED BY JDT	SAMPLE NUMBER S4B
SAMPLE DESCRIPTION Saturated, grayish brown silt with sand		DATE Mon Mar 05 2001	FILENAME FD105S4B

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER					
WT. WET SOIL + TARE					
WT. DRY SOIL + TARE					
WT. WATER					
TARE WT.					
WT. DRY SOIL					
WATER CONTENT, W_N (%)					
NUMBER OF BLOWS, N					
ONE-POINT LIQUID LIMIT, LL					

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER					
WT. WET SOIL + TARE					
WT. DRY SOIL + TARE					
WT. WATER					
TARE WT.					
WT. DRY SOIL					
WATER CONTENT (%)					

Determined to be Non-plastic.

SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	28.0
LIQUID LIMIT, LL	
PLASTIC LIMIT, PL	
PLASTICITY INDEX, PI	
LIQUIDITY INDEX, LI*	

*LI = (W − PL)/PI

PLASTICITY CHART

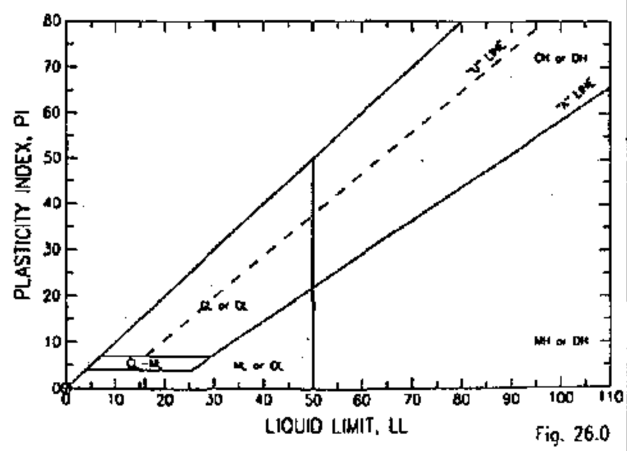


Fig. 26.0

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-105
Sample No. : SSB
Location : New Bedford, MA
Soil Description : Wet, grayish brown sandy silt
Remarks : ---

Depth : --
Test Date : 02/26/01
Test Method : ASTM D 422

Filename : FD105SSB
Elevation : ---
Tested by : HB
Checked by : JDT

HYDROMETER

Hydrometer ID : 649262
Weight of air-dried soil = 45.34 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	22.00	20.50	17.50	0.048	39	0.048
2.00	20.00	20.50	15.50	0.035	34	0.035
4.00	18.00	20.50	13.50	0.025	30	0.025
8.00	15.50	20.50	11.00	0.018	24	0.018
15.00	13.50	20.50	9.00	0.013	20	0.013
30.00	12.00	20.50	7.50	0.009	17	0.009
60.00	10.00	20.75	5.54	0.007	12	0.007
120.00	9.00	20.75	4.54	0.005	10	0.005
240.00	8.00	20.75	3.54	0.003	8	0.003
1440.00	7.00	20.25	2.47	0.001	5	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	0.08	0.08	100
#20	0.033	0.84	0.23	0.31	99
#40	0.017	0.42	0.40	0.71	98
#60	0.010	0.25	0.69	1.40	97
#100	0.006	0.15	4.03	5.43	88
#200	0.003	0.07	14.38	19.81	56
Pan			25.61	45.42	0

Total Dry Weight of Sample = 53.45

D85 : 0.1393 mm
D60 : 0.0802 mm
D50 : 0.0635 mm
D30 : 0.0252 mm
D15 : 0.0083 mm
D10 : 0.0047 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-4(0)
AASHTO Group Name : Silty Soils

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Filename : FD105S9
Project No. : GTX-3289
Depth : ---
Elevation : ---
Boring No. : FD-105
Test Date : 02/27/01
Tested by : KAH
Sample No. : S9
Test Method : ASTM D 422
Checked by : JDT
Location : New Bedford, MA
Soil Description : Saturated, gravel with sand
Remarks : ---

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1.5"	1.500	38.10	0.00	0.00	100
1"	1.012	25.70	33.34	33.34	83
0.75"	0.748	19.00	0.00	33.34	83
0.5"	0.500	12.70	4.60	37.94	81
0.375"	0.374	9.51	8.67	46.61	77
#4	0.187	4.75	38.86	85.47	57
#10	0.079	2.00	83.27	168.74	15
#20	0.033	0.84	15.86	184.60	7
#40	0.017	0.42	4.64	189.24	5
#60	0.010	0.25	2.03	191.27	4
#100	0.006	0.15	1.46	192.73	3
#200	0.003	0.07	1.13	193.86	2
Pan			4.89	198.75	0

Total Dry Weight of Sample = 206.79

D85 : 26.7932 mm
D60 : 5.2846 mm
D50 : 4.1111 mm
D30 : 2.7204 mm
D15 : 1.9785 mm
D10 : 1.1498 mm

Soil Classification
ASTM Group Symbol : SP
ASTM Group Name : Poorly graded sand with gravel
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-106
Sample No. : S3
Location : New Bedford, MA
Soil Description : Wet, gray sand with silt
Remarks : ---

Depth : ---
Test Date : 02/20/01
Test Method : ASTM D 422

Filename : FD106S3
Elevation : ---
Tested by : HB
Checked by : JDT

HYDROMETER

Hydrometer ID : 583901
Weight of air-dried soil = 67.39 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	11.00	20.00	6.01	0.052	8	0.052
2.00	10.00	20.00	5.01	0.037	6	0.037
4.00	9.00	20.00	4.01	0.026	5	0.026
8.00	8.00	20.00	3.01	0.019	4	0.019
15.00	7.50	20.25	2.52	0.014	3	0.014
30.00	7.00	20.50	2.03	0.010	3	0.010
60.00	6.00	21.00	1.06	0.007	1	0.007
120.00	6.00	21.00	1.06	0.005	1	0.005
240.00	5.00	21.25	0.07	0.003	0	0.003

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	3.47	3.47	96
0.375"	0.374	9.51	2.93	6.40	92
#4	0.187	4.75	2.02	8.42	89
#10	0.079	2.00	4.06	12.48	84
#20	0.033	0.84	3.39	15.87	80
#40	0.017	0.42	11.27	27.14	66
#60	0.010	0.25	17.05	44.19	45
#100	0.006	0.15	15.57	59.76	25
#200	0.003	0.07	11.87	71.63	10
Pan			8.24	79.87	0

Total Dry Weight of Sample = 187.26

D85 : 2.2246 mm
D60 : 0.3628 mm
D50 : 0.2846 mm
D30 : 0.1693 mm
D15 : 0.0923 mm
D10 : 0.0711 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-106
Sample No. : S4
Location : New Bedford, MA
Soil Description : Wet, light gray silty sand with gravel
Remarks : ---

Depth : ---
Test Date : 02/20/01
Test Method : ASTM D 422

Filename : FD106S4
Elevation : ---
Tested by : HB
Checked by : JDT

HYDROMETER

Hydrometer ID : 583901
Weight of air-dried soil = 63.48 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	21.00	20.00	16.01	0.049	17	0.049
2.00	20.00	20.00	15.01	0.035	16	0.035
4.00	17.00	20.00	12.01	0.025	12	0.025
8.00	16.00	20.00	11.01	0.018	11	0.018
15.00	15.00	20.25	10.02	0.013	10	0.013
30.00	13.00	20.50	8.03	0.009	8	0.009
60.00	12.00	21.00	7.06	0.007	7	0.007
120.00	10.00	21.25	5.07	0.005	5	0.005
240.00	9.00	21.50	4.08	0.003	4	0.003
1440.00	8.00	19.00	3.00	0.001	3	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	11.76	11.76	88
0.5"	0.500	12.70	0.00	11.76	88
0.375"	0.374	9.51	4.08	15.84	84
#4	0.187	4.75	6.39	22.23	77
#10	0.079	2.00	10.62	32.85	66
#20	0.033	0.84	11.16	44.01	54
#40	0.017	0.42	11.04	55.05	43
#60	0.010	0.25	8.97	64.02	34
#100	0.006	0.15	8.35	72.37	25
#200	0.003	0.07	6.04	78.41	19
Pan			17.92	96.33	0

Total Dry Weight of Sample = 218.1

D85 : 10.4953 mm
D60 : 1.2867 mm
D50 : 0.6476 mm
D30 : 0.2024 mm
D15 : 0.0327 mm
D10 : 0.0122 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-106
Sample No. : S7A
Location : New Bedford, MA
Soil Description : Saturated, brown sand with gravel
Remarks : ---

Depth : --
Test Date : 02/27/01
Test Method : ASTM D 422

Filename : FD106S7A
Elevation : ---
Tested by : KAH
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	50.65	50.65	78
0.5"	0.500	12.70	13.44	64.09	72
0.375"	0.374	9.51	13.58	77.67	66
#4	0.187	4.75	25.98	103.65	55
#10	0.079	2.00	44.05	147.70	35
#20	0.033	0.84	27.87	175.57	23
#40	0.017	0.42	19.22	194.79	15
#60	0.010	0.25	14.52	209.31	8
#100	0.006	0.15	9.48	218.79	4
#200	0.003	0.07	4.83	223.62	2
Pan			4.30	227.92	0

Total Dry Weight of Sample = 235.93

D85 : 20.9599 mm
D60 : 6.6304 mm
D50 : 3.8794 mm
D30 : 1.3840 mm
D15 : 0.4364 mm
D10 : 0.2903 mm

Soil Classification
ASTM Group Symbol : SP
ASTM Group Name : Poorly graded sand with gravel
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-106
Sample No. : S7B
Location : New Bedford, MA
Soil Description : Wet, brownish gray silty sand with gravel
Remarks : ---

Depth : --
Test Date : 02/21/01
Test Method : ASTM D 422

Filename : FD106S7B
Elevation : ---
Tested by : KAH
Checked by : JDT

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 52.7 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	22.00	19.00	15.92	0.049	16	0.049
2.00	18.00	19.00	11.92	0.036	12	0.036
4.00	14.50	19.00	8.42	0.026	8	0.026
8.00	13.00	19.00	6.92	0.018	7	0.018
15.00	11.00	19.00	4.92	0.014	5	0.014
30.00	9.50	19.00	3.42	0.010	3	0.010
60.00	8.00	19.00	1.92	0.007	2	0.007
120.00	8.00	19.50	1.98	0.005	2	0.005
240.00	6.50	21.00	0.67	0.003	1	0.003
1440.00	6.50	19.00	0.42	0.001	0	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	15.14	15.14	85
0.375"	0.374	9.51	7.00	22.14	78
#4	0.187	4.75	17.92	40.06	60
#10	0.079	2.00	8.63	48.69	52
#20	0.033	0.84	7.25	55.94	45
#40	0.017	0.42	6.81	62.75	38
#60	0.010	0.25	4.83	67.58	33
#100	0.006	0.15	6.03	73.61	27
#200	0.003	0.07	8.58	82.19	19
Pan			19.20	101.39	0

Total Dry Weight of Sample = 206.04

D85 : 12.6641 mm
D60 : 4.5196 mm
D50 : 1.5739 mm
D30 : 0.1868 mm
D15 : 0.0464 mm
D10 : 0.0302 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

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GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-107
Sample No. : S2
Location : New Bedford, MA
Soil Description : Wet, brown silty sand
Remarks : ---

Depth : --
Test Date : 02/23/01
Test Method : ASTM D 422

Filename : FD107S2
Elevation : ---
Tested by : KAH
Checked by : JDT

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 61.78 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	15.00	20.00	9.04	0.051	14	0.051
2.00	12.00	20.00	6.04	0.037	9	0.037
4.00	11.00	20.00	5.04	0.026	8	0.026
8.00	10.00	20.00	4.04	0.018	6	0.018
15.00	9.50	20.00	3.54	0.014	5	0.014
30.00	8.50	20.00	2.54	0.010	4	0.010
60.00	7.50	20.00	1.54	0.007	2	0.007
120.00	7.00	20.00	1.04	0.005	2	0.005
240.00	6.50	21.00	0.67	0.003	1	0.003
1440.00	6.50	20.50	0.60	0.001	1	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.5"	0.500	12.70	0.00	0.00	100
0.375"	0.374	9.51	3.29	3.29	95
#4	0.187	4.75	0.00	3.29	95
#10	0.079	2.00	1.03	4.32	93
#20	0.033	0.84	1.96	6.28	90
#40	0.017	0.42	8.25	14.53	78
#60	0.010	0.25	11.76	26.29	60
#100	0.006	0.15	14.13	40.42	39
#200	0.003	0.07	14.79	55.21	16
Pan			10.89	66.10	0

Total Dry Weight of Sample = 188.96

D85 : 0.6193 mm
D60 : 0.2486 mm
D50 : 0.1952 mm
D30 : 0.1130 mm
D15 : 0.0606 mm
D10 : 0.0388 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-107
Sample No. : S4
Location : New Bedford, MA
Soil Description : Wet, brown silty sand with gravel
Remarks : ---

Depth : --
Test Date : 02/23/01
Test Method : ASTM D 422

Filename : FD107S4
Elevation : ---
Tested by : KAH
Checked by : JDT

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 41.97 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	13.00	20.00	7.04	0.051	10	0.051
2.00	10.50	20.00	4.54	0.037	7	0.037
4.00	9.50	20.00	3.54	0.026	5	0.026
8.00	9.00	20.00	3.04	0.019	4	0.019
15.00	8.50	20.00	2.54	0.014	4	0.014
30.00	7.50	20.00	1.54	0.010	2	0.010
60.00	7.00	20.00	1.04	0.007	2	0.007
120.00	6.50	20.50	0.60	0.005	1	0.005
240.00	6.50	21.00	0.67	0.003	1	0.003
1440.00	6.00	21.00	0.17	0.001	0	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	10.73	10.73	84
0.5"	0.500	12.70	7.84	18.57	73
0.375"	0.374	9.51	0.00	18.57	73
#4	0.187	4.75	4.35	22.92	66
#10	0.079	2.00	3.12	26.04	62
#20	0.033	0.84	2.65	28.69	58
#40	0.017	0.42	3.30	31.99	53
#60	0.010	0.25	3.84	35.83	47
#100	0.006	0.15	7.46	43.29	36
#200	0.003	0.07	14.26	57.55	15
Pan			10.46	68.01	0

Total Dry Weight of Sample = 170.46

D85 : 19.2848 mm
D60 : 1.3670 mm
D50 : 0.3199 mm
D30 : 0.1206 mm
D15 : 0.0720 mm
D10 : 0.0497 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-107
Sample No. : S5
Location : New Bedford, MA
Soil Description : Wet, light brown silty sand with gravel
Remarks : ---

Depth : --
Test Date : 02/23/01
Test Method : ASTM D 422

Filename : FD107S5
Elevation : ---
Tested by : KAH
Checked by : JDT

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 49.75 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	26.00	20.00	20.04	0.047	24	0.047
2.00	22.00	20.00	16.04	0.034	20	0.034
4.00	19.00	20.00	13.04	0.025	16	0.025
8.00	17.00	20.00	11.04	0.018	13	0.018
15.00	14.50	20.00	8.54	0.013	10	0.013
30.00	12.00	20.00	6.04	0.009	7	0.009
60.00	11.00	20.00	5.04	0.007	6	0.007
120.00	10.00	20.00	4.04	0.005	5	0.005
240.00	9.00	21.00	3.17	0.003	4	0.003
1440.00	8.00	21.00	2.17	0.001	3	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	22.41	22.41	73
0.375"	0.374	9.51	4.19	26.60	68
#4	0.187	4.75	2.27	28.87	65
#10	0.079	2.00	3.60	32.47	61
#20	0.033	0.84	4.61	37.08	55
#40	0.017	0.42	5.12	42.20	49
#60	0.010	0.25	4.90	47.10	43
#100	0.006	0.15	5.82	52.92	36
#200	0.003	0.07	6.37	59.29	28
Pan			22.93	82.22	0

Total Dry Weight of Sample = 200.66

D85 : 15.2220 mm
D60 : 1.8489 mm
D50 : 0.4869 mm
D30 : 0.0896 mm
D15 : 0.0219 mm
D10 : 0.0126 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-107
Sample No. : S6
Location : New Bedford, MA
Soil Description : Wet, brown gravel with sand
Remarks : ---

Depth : --
Test Date : 02/26/01
Test Method : ASTM D 422

Filename : FD107S6
Elevation : ---
Tested by : KAH
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	34.60	34.60	88
0.5"	0.500	12.70	55.63	90.23	69
0.375"	0.374	9.51	19.88	110.11	63
#4	0.187	4.75	42.08	152.19	48
#10	0.079	2.00	46.31	198.50	33
#20	0.033	0.84	59.48	257.98	12
#40	0.017	0.42	14.03	272.01	8
#60	0.010	0.25	6.81	278.82	5
#100	0.006	0.15	3.21	282.03	4
#200	0.003	0.07	3.14	285.17	3
Pan			9.21	294.38	0

Total Dry Weight of Sample = 304.02

D85 : 17.7296 mm
D60 : 8.3836 mm
D50 : 5.1584 mm
D30 : 1.7913 mm
D15 : 0.9416 mm
D10 : 0.5959 mm

Soil Classification
ASTM Group Symbol : GP
ASTM Group Name : Poorly graded gravel with sand
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Filename : FD107S8
Project No. : GTX-3289
Depth : --
Elevation : ---
Boring No. : FD-107
Test Date : 02/26/01
Tested by : KAH
Sample No. : S8
Test Method : ASTM D 422
Checked by : JDT
Location : New Bedford, MA
Soil Description : Wet, yellowish brown gravel with sand
Remarks : ---

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	33.03	33.03	87
0.5"	0.500	12.70	55.15	88.18	66
0.375"	0.374	9.51	26.35	114.53	56
#4	0.187	4.75	44.38	158.91	39
#10	0.079	2.00	35.95	194.86	25
#20	0.033	0.84	24.92	219.78	15
#40	0.017	0.42	18.39	238.17	8
#60	0.010	0.25	12.16	250.33	3
#100	0.006	0.15	4.94	255.27	1
#200	0.003	0.07	1.94	257.21	1
Pan			1.62	258.83	0

Total Dry Weight of Sample = 268.44

D85 : 18.2126 mm
D60 : 10.7303 mm
D50 : 7.5346 mm
D30 : 2.7795 mm
D15 : 0.8339 mm
D10 : 0.5116 mm

Soil Classification
ASTM Group Symbol : GW
ASTM Group Name : Well-graded gravel with sand
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-108
Sample No. : S2
Location : New Bedford, MA
Soil Description : Moist, brown sandy silt
Remarks : ---

Depth : --
Test Date : 02/23/01
Test Method : ASTM D 422

Filename : FD108S2
Elevation : ---
Tested by : KAH
Checked by : JDT

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 49.92 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	25.00	20.00	19.04	0.048	38	0.048
2.00	19.50	20.00	13.54	0.035	27	0.035
4.00	16.50	20.00	10.54	0.025	21	0.025
8.00	14.00	20.00	8.04	0.018	16	0.018
15.00	13.00	20.00	7.04	0.013	14	0.013
30.00	11.00	20.00	5.04	0.009	10	0.009
60.00	10.00	20.00	4.04	0.007	8	0.007
120.00	9.00	20.50	3.10	0.005	6	0.005
240.00	8.50	21.00	2.67	0.003	5	0.003
1440.00	7.50	21.00	1.67	0.001	3	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	0.13	0.13	100
#20	0.033	0.84	0.09	0.22	100
#40	0.017	0.42	0.71	0.93	98
#60	0.010	0.25	1.80	2.73	95
#100	0.006	0.15	3.52	6.25	88
#200	0.003	0.07	14.99	21.24	58
Pan			28.81	50.05	0

Total Dry Weight of Sample = 167.11

D85 : 0.1405 mm
D60 : 0.0783 mm
D50 : 0.0624 mm
D30 : 0.0379 mm
D15 : 0.0153 mm
D10 : 0.0094 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-4(0)
AASHTO Group Name : Silty Soils

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-108
Sample No. : S-3
Location : New Bedford, MA
Depth : --
Test Date : 02/27/01
Test Method : ASTM D 422
Filename : FD108S3
Elevation : ---
Tested by : KAH
Checked by : JDT
Soil Description : Wet, reddish brown gravel with sand and silt
Remarks : ---

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1.5"	1.500	38.10	0.00	0.00	100
1"	1.012	25.70	53.14	53.14	64
0.75"	0.748	19.00	0.00	53.14	64
0.5"	0.500	12.70	8.18	61.32	58
0.375"	0.374	9.51	1.46	62.78	57
#4	0.187	4.75	12.71	75.49	48
#10	0.079	2.00	16.35	91.84	37
#20	0.033	0.84	14.90	106.74	27
#40	0.017	0.42	11.14	117.88	19
#60	0.010	0.25	7.48	125.36	14
#100	0.006	0.15	6.23	131.59	10
#200	0.003	0.07	4.81	136.40	7
Pan			9.87	146.27	0

Total Dry Weight of Sample = 154.32

D85 : 32.3836 mm
D60 : 14.5863 mm
D50 : 5.4020 mm
D30 : 1.0831 mm
D15 : 0.2685 mm
D10 : 0.1479 mm

Soil Classification -
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-108
Sample No. : S5
Location : New Bedford, MA
Soil Description : Wet, light brown silty sand with gravel
Remarks : ---

Depth : --
Test Date : 02/26/01
Test Method : ASTM D 422

Filename : FD108S5
Elevation : ---
Tested by : HB
Checked by : JDT

HYDROMETER

Hydrometer ID : 583901
Weight of air-dried soil = 67.39 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	20.00	20.25	15.02	0.049	13	0.049
2.00	19.00	20.25	14.02	0.035	13	0.035
4.00	17.00	20.25	12.02	0.025	11	0.025
8.00	16.00	20.25	11.02	0.018	10	0.018
15.00	14.00	20.25	9.02	0.013	8	0.013
30.00	12.00	20.25	7.02	0.009	6	0.009
60.00	10.00	20.50	5.03	0.007	5	0.007
120.00	8.00	20.50	3.03	0.005	3	0.005
240.00	7.50	20.50	2.53	0.003	2	0.003
1440.00	6.75	20.25	1.77	0.001	2	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	16.12	16.12	86
0.5"	0.500	12.70	10.54	26.66	76
0.375"	0.374	9.51	1.50	28.16	75
#4	0.187	4.75	5.92	34.08	70
#10	0.079	2.00	10.40	44.48	60
#20	0.033	0.84	11.83	56.31	50
#40	0.017	0.42	11.83	68.14	39
#60	0.010	0.25	9.69	77.83	30
#100	0.006	0.15	7.86	85.69	23
#200	0.003	0.07	6.26	91.95	18
Pan			19.92	111.87	0

Total Dry Weight of Sample = 121.46

D85 : 18.5264 mm
D60 : 1.9611 mm
D50 : 0.8644 mm
D30 : 0.2422 mm
D15 : 0.0568 mm
D10 : 0.0187 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-109
Sample No. : S3
Location : New Bedford, MA
Soil Description : Wet, light brown silty sand with gravel
Remarks : --- *

Depth : --
Test Date : 02/22/01
Test Method : ASTM D 422

Filename : FD109S3
Elevation : ---
Tested by : KAH
Checked by : JDT

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 47 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	21.00	19.50	14.98	0.049	18	0.049
2.00	18.50	19.50	12.48	0.035	15	0.035
4.00	17.00	19.50	10.98	0.025	13	0.025
8.00	15.50	19.50	9.48	0.018	12	0.018
15.00	14.50	19.50	8.48	0.013	10	0.013
30.00	13.00	19.50	6.98	0.009	8	0.009
60.00	12.00	19.50	5.98	0.007	7	0.007
120.00	11.00	19.50	4.98	0.005	6	0.005
240.00	10.00	21.00	4.17	0.003	5	0.003
1358.00	9.00	20.00	3.04	0.001	4	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	11.49	11.49	86
0.5"	0.500	12.70	9.27	20.76	75
0.375"	0.374	9.51	0.87	21.63	74
#4	0.187	4.75	5.39	27.02	67
#10	0.079	2.00	8.50	35.52	57
#20	0.033	0.84	8.91	44.43	46
#40	0.017	0.42	7.70	52.13	37
#60	0.010	0.25	6.08	58.21	29
#100	0.006	0.15	4.68	62.89	24
#200	0.003	0.07	4.52	67.41	18
Pan			15.11	82.52	0

Total Dry Weight of Sample = 209.52

D85 : 18.2808 mm
D60 : 2.5826 mm
D50 : 1.1446 mm
D30 : 0.2597 mm
D15 : 0.0344 mm
D10 : 0.0125 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Filename : FD109S4
Project No. : GTX-3289
Depth : --
Elevation : ---
Boring No. : FD-109
Test Date : 02/26/01
Tested by : KAH
Sample No. : S4
Test Method : ASTM D 422
Checked by : JDT
Location : New Bedford, MA
Soil Description : Wet, brown sand with gravel and silt
Remarks : ---

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	36.47	36.47	79
0.375"	0.374	9.51	20.36	56.83	68
#4	0.187	4.75	32.15	88.98	50
#10	0.079	2.00	22.97	111.95	37
#20	0.033	0.84	18.86	130.81	26
#40	0.017	0.42	12.62	143.43	19
#60	0.010	0.25	9.23	152.66	14
#100	0.006	0.15	6.70	159.36	10
#200	0.003	0.07	6.05	165.41	7
Pan			11.56	176.97	0

Total Dry Weight of Sample = 184.95

D85 : 14.1714 mm
D60 : 7.0354 mm
D50 : 4.8010 mm
D30 : 1.1563 mm
D15 : 0.2835 mm
D10 : 0.1500 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-109
Sample No. : S6
Location : New Bedford, MA
Soil Description : Wet, brown gravel with sand and silt
Remarks : ---

Depth : --
Test Date : 02/26/01
Test Method : ASTM D 422

Filename : FD109S6
Elevation : ---
Tested by : KAH
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	58.94	58.94	69
0.5"	0.500	12.70	22.77	81.71	58
0.375"	0.374	9.51	11.70	93.41	51
#4	0.187	4.75	26.07	119.48	38
#10	0.079	2.00	11.76	131.24	32
#20	0.033	0.84	11.82	143.06	26
#40	0.017	0.42	12.44	155.50	19
#60	0.010	0.25	8.98	164.48	14
#100	0.006	0.15	7.18	171.66	11
#200	0.003	0.07	6.99	178.65	7
Pan			13.63	192.28	0

Total Dry Weight of Sample = 200.24

D85 : 22.1687 mm
D60 : 13.8251 mm
D50 : 8.8432 mm
D30 : 1.5639 mm
D15 : 0.2655 mm
D10 : 0.1296 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-109
Sample No. : S7
Location : New Bedford, MA
Soil Description : Wet, brown gravel with sand and silt
Remarks : ---

Depth : --
Test Date : 02/26/01
Test Method : ASTM D 422

Filename : FD109S7
Elevation : ---
Tested by : KAH
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	36.49	36.49	79
0.5"	0.500	12.70	9.23	45.72	73
0.375"	0.374	9.51	9.44	55.16	68
#4	0.187	4.75	27.62	82.78	52
#10	0.079	2.00	19.27	102.05	40
#20	0.033	0.84	13.67	115.72	32
#40	0.017	0.42	13.80	129.52	24
#60	0.010	0.25	9.73	139.25	19
#100	0.006	0.15	7.90	147.15	14
#200	0.003	0.07	7.96	155.11	9
Pan			16.21	171.32	0

Total Dry Weight of Sample = 179.47

D85 : 20.7754 mm
D60 : 6.7961 mm
D50 : 4.1740 mm
D30 : 0.6807 mm
D15 : 0.1647 mm
D10 : 0.0802 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

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GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-110
Sample No. : S4
Location : New Bedford, MA
Soil Description : Wet, light brown silty sand
Remarks : ---

Depth : ---
Test Date : 02/26/01
Test Method : ASTM D 422

Filename : FD110S4
Elevation : ---
Tested by : NB
Checked by : JDT

HYDROMETER

Hydrometer ID : 649262
Weight of air-dried soil = 56.23 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	10.00	20.50	5.50	0.052	10	0.052
2.00	9.00	20.50	4.50	0.037	8	0.037
4.00	8.00	20.50	3.50	0.026	6	0.026
8.00	7.50	20.50	3.00	0.019	5	0.019
15.00	7.00	20.50	2.50	0.014	4	0.014
30.00	6.00	20.75	1.54	0.010	3	0.010
60.00	6.00	20.75	1.54	0.007	3	0.007
120.00	5.50	20.75	1.04	0.005	2	0.005
240.00	5.00	20.75	0.54	0.003	1	0.003

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#10	0.079	2.00	0.00	0.00	100
#20	0.033	0.84	0.01	0.01	100
#40	0.017	0.42	0.14	0.15	100
#60	0.010	0.25	4.20	4.35	92
#100	0.006	0.15	20.30	24.65	56
#200	0.003	0.07	15.47	40.12	29
Pan			16.11	56.23	0

Total Dry Weight of Sample = 64.34

D85 : 0.2253 mm
D60 : 0.1574 mm
D50 : 0.1274 mm
D30 : 0.0766 mm
D15 : 0.0572 mm
D10 : 0.0521 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-110
Sample No. : S6
Location : New Bedford, MA
Soil Description : Wet, yellowish brown sand
Remarks : ---

Depth : ---
Test Date : 03/01/01
Test Method : ASTM D 422

Filename : FD110S6
Elevation : ---
Tested by : NB
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.375"	0.374	9.51	0.00	0.00	100
#4	0.187	4.75	0.19	0.19	100
#10	0.079	2.00	0.54	0.73	99
#20	0.033	0.84	0.30	1.03	99
#40	0.017	0.42	5.43	6.46	92
#60	0.010	0.25	25.04	31.50	60
#100	0.006	0.15	32.12	63.62	19
#200	0.003	0.07	11.82	75.44	4
Pan			3.36	78.80	0

Total Dry Weight of Sample = 86.77

D85 : 0.3759 mm
D60 : 0.2499 mm
D50 : 0.2201 mm
D30 : 0.1708 mm
D15 : 0.1221 mm
D10 : 0.0967 mm

Soil Classification
ASTM Group Symbol : SP
ASTM Group Name : Poorly graded sand
AASHTO Group Symbol : A-3(0)
AASHTO Group Name : Fine Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-110
Sample No. : S9
Location : New Bedford, MA
Soil Description : Wet, grayish brown sand with gravel
Remarks : ---

Depth : ---
Test Date : 02/27/01
Test Method : ASTM D 422

Filename : FD110S9
Elevation : ---
Tested by : KAH
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	10.99	10.99	95
0.5"	0.500	12.70	31.20	42.19	81
0.375"	0.374	9.51	6.12	48.31	79
#4	0.187	4.75	23.94	72.25	68
#10	0.079	2.00	31.99	104.24	54
#20	0.033	0.84	21.73	125.97	44
#40	0.017	0.42	28.41	154.38	32
#60	0.010	0.25	31.19	185.57	18
#100	0.006	0.15	21.86	207.43	8
#200	0.003	0.07	8.38	215.81	4
Pan			10.09	225.90	0

Total Dry Weight of Sample = 235.54

D85 : 14.1375 mm
D60 : 2.9109 mm
D50 : 1.4133 mm
D30 : 0.3946 mm
D15 : 0.2146 mm
D10 : 0.1643 mm

Soil Classification
ASTM Group Symbol : SP
ASTM Group Name : Poorly graded sand with gravel
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-111
Sample No. : S4
Location : New Bedford, MA
Soil Description : Wet, yellowish brown sand
Remarks : Composite of samples S4A & S4B

Depth : --
Test Date : 03/01/01
Test Method : ASTM D 422

Filename : FD111S4
Elevation : ---
Tested by : HB
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.375"	0.374	9.51	0.00	0.00	100
#4	0.187	4.75	0.17	0.17	100
#10	0.079	2.00	0.36	0.53	99
#20	0.033	0.84	0.14	0.67	99
#40	0.017	0.42	3.71	4.38	94
#60	0.010	0.25	24.13	28.51	62
#100	0.006	0.15	33.04	61.55	18
#200	0.003	0.07	11.05	72.60	3
Pan			2.27	74.87	0

Total Dry Weight of Sample = 179.68

D85 : 0.3625 mm
D60 : 0.2444 mm
D50 : 0.2174 mm
D30 : 0.1719 mm
D15 : 0.1305 mm
D10 : 0.1030 mm

Soil Classification
ASTM Group Symbol : SP
ASTM Group Name : Poorly graded sand
AASHTO Group Symbol : A-3(0)
AASHTO Group Name : Fine Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-111
Sample No. : S6
Location : New Bedford, MA
Soil Description : Wet, yellowish brown sand with silt
Remarks : ---

Depth : --
Test Date : 03/01/01
Test Method : ASTM D 422

Filename : FD111S6
Elevation : ---
Tested by : HB
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.375"	0.374	9.51	0.00	0.00	100
#4	0.187	4.75	0.77	0.77	99
#10	0.079	2.00	3.03	3.80	95
#20	0.033	0.84	6.32	10.12	88
#40	0.017	0.42	15.44	25.56	69
#60	0.010	0.25	19.98	45.54	44
#100	0.006	0.15	18.37	63.91	22
#200	0.003	0.07	11.61	75.52	8
Pan			6.35	81.87	0

Total Dry Weight of Sample = 185.73

D85 : 0.7631 mm
D60 : 0.3485 mm
D50 : 0.2818 mm
D30 : 0.1795 mm
D15 : 0.1058 mm
D10 : 0.0827 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-3(0)
AASHTO Group Name : Fine Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-111
Sample No. : S7
Location : New Bedford, MA
Soil Description : Wet, yellowish brown sand with silt and gravel
Remarks : ---

Depth : --
Test Date : 03/01/01
Test Method : ASTM D 422

Filename : FD111S7
Elevation : ---
Tested by : HB
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	9.42	9.42	89
0.375"	0.374	9.51	3.48	12.90	85
#4	0.187	4.75	8.50	21.40	75
#10	0.079	2.00	9.36	30.76	65
#20	0.033	0.84	9.31	40.07	54
#40	0.017	0.42	11.53	51.60	41
#60	0.010	0.25	11.47	63.07	28
#100	0.006	0.15	9.67	72.74	17
#200	0.003	0.07	7.00	79.74	9
Pan			7.94	87.68	0

Total Dry Weight of Sample = 192.05

D85 : 9.3163 mm
D60 : 1.3390 mm
D50 : 0.6702 mm
D30 : 0.2699 mm
D15 : 0.1246 mm
D10 : 0.0804 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-111
Sample No. : S12
Location : New Bedford, MA
Depth : ---
Test Date : 02/23/01
Test Method : ASTM D 422
Filename : FD111S12
Elevation : ---
Tested by : KAH
Checked by : JDT
Soil Description : Moist, light gray silty sand
Remarks : ---

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 49.4 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	18.00	20.00	12.04	0.050	19	0.050
2.00	15.00	20.00	9.04	0.036	15	0.036
4.00	12.50	20.00	6.54	0.026	11	0.026
8.00	11.00	20.00	5.04	0.018	8	0.018
15.00	10.00	20.00	4.04	0.013	7	0.013
30.00	8.50	20.00	2.54	0.010	4	0.010
60.00	8.00	20.50	2.10	0.007	3	0.007
120.00	7.00	20.50	1.10	0.005	2	0.005
240.00	6.50	21.00	0.67	0.003	1	0.003
1440.00	6.00	21.00	0.17	0.001	0	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.5"	0.500	12.70	0.00	0.00	100
0.375"	0.374	9.51	1.93	1.93	97
#4	0.187	4.75	7.78	9.71	84
#10	0.079	2.00	2.92	12.63	80
#20	0.033	0.84	3.25	15.88	74
#40	0.017	0.42	2.82	18.70	70
#60	0.010	0.25	3.62	22.32	64
#100	0.006	0.15	9.64	31.96	48
#200	0.003	0.07	13.05	45.01	27
Pan			17.02	62.03	0

Total Dry Weight of Sample = 184.85

D85 : 4.9250 mm
D60 : 0.2187 mm
D50 : 0.1568 mm
D30 : 0.0806 mm
D15 : 0.0369 mm
D10 : 0.0238 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Filename : FD112S3
Project No. : GTX-3289
Depth : --
Elevation : ---
Boring No. : FD-112
Test Date : 03/01/01
Tested by : KAH/NB/HB
Sample No. : S3
Test Method : ASTM D 422
Checked by : JDT
Location : New Bedford, MA
Soil Description : Saturated, yellowish brown sand with gravel & silt
Remarks : ---

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	7.97	7.97	90
0.375"	0.374	9.51	1.96	9.93	88
#4	0.187	4.75	5.55	15.48	81
#10	0.079	2.00	7.44	22.92	71
#20	0.033	0.84	8.51	31.43	61
#40	0.017	0.42	10.95	42.38	47
#60	0.010	0.25	13.64	56.02	30
#100	0.006	0.15	14.03	70.05	13
#200	0.003	0.07	5.67	75.72	6
Pan			4.48	80.20	0

Total Dry Weight of Sample = 197.71

D85 : 7.3131 mm
D60 : 0.8070 mm
D50 : 0.4853 mm
D30 : 0.2489 mm
D15 : 0.1597 mm
D10 : 0.1146 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-112
Sample No. : S6
Location : New Bedford, MA
Soil Description : Wet, light brown sand with gravel and silt
Remarks : ---

Depth : --
Test Date : 02/21/01
Test Method : ASTM D 422

Filename : FD112S6
Elevation : ---
Tested by : KAH/NB/HB
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	15.97	15.97	84
0.375"	0.374	9.51	7.30	23.27	76
#4	0.187	4.75	8.94	32.21	67
#10	0.079	2.00	11.66	43.87	55
#20	0.033	0.84	11.51	55.38	44
#40	0.017	0.42	12.38	67.76	31
#60	0.010	0.25	9.67	77.43	21
#100	0.006	0.15	7.90	85.33	13
#200	0.003	0.07	4.61	89.94	8
Pan			8.26	98.20	0

Total Dry Weight of Sample = 198.87

D85 : 13.1035 mm
D60 : 2.8113 mm
D50 : 1.3492 mm
D30 : 0.3985 mm
D15 : 0.1683 mm
D10 : 0.0938 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-112
Sample No. : S7
Location : New Bedford, MA
Depth : --
Test Date : 02/22/01
Test Method : ASTM D 422
Filename : FD112S7
Elevation : ---
Tested by : KAH
Checked by : JDT
Soil Description : Wet, light brown silty sand with gravel
Remarks : ---

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 41.63 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	18.00	19.00	11.92	0.050	13	0.050
2.00	16.00	19.00	9.92	0.036	11	0.036
4.00	14.50	19.00	8.42	0.026	9	0.026
8.00	13.00	19.00	6.92	0.018	7	0.018
15.00	11.50	19.00	5.42	0.014	6	0.014
30.00	10.00	19.00	3.92	0.010	4	0.010
60.00	9.50	19.50	3.48	0.007	4	0.007
120.00	8.00	19.50	1.98	0.005	2	0.005
240.00	7.00	21.00	1.17	0.003	1	0.003
1338.00	7.00	20.00	1.04	0.001	1	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	33.95	33.95	64
0.5"	0.500	12.70	0.00	33.95	64
0.375"	0.374	9.51	3.18	37.13	60
#4	0.187	4.75	5.64	42.77	54
#10	0.079	2.00	8.63	51.40	45
#20	0.033	0.84	9.32	60.72	35
#40	0.017	0.42	6.84	67.56	27
#60	0.010	0.25	5.01	72.57	22
#100	0.006	0.15	4.14	76.71	18
#200	0.003	0.07	3.91	80.62	13
Pan			12.41	93.03	0

Total Dry Weight of Sample = 224.12

D85 : 22.6994 mm
D60 : 9.4145 mm
D50 : 3.2634 mm
D30 : 0.5380 mm
D15 : 0.0976 mm
D10 : 0.0314 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Filename : FD112S10
Project No. : GTX-3289
Depth : ---
Elevation : ---
Boring No. : FD-112
Test Date : 02/21/01
Tested by : KAH
Sample No. : S10
Test Method : ASTM D 422
Checked by : JDT
Location : New Bedford, MA
Soil Description : Wet, yellow brown sand with silt and gravel
Remarks : ---

HYDROMETER

Hydrometer ID : 583901
Weight of air-dried soil = 44.81 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	13.00	19.25	8.00	0.052	8	0.052
2.00	12.00	19.25	7.00	0.037	7	0.037
4.00	11.00	19.25	6.00	0.026	6	0.026
8.00	10.00	19.25	5.00	0.019	5	0.019
15.00	9.50	19.25	4.50	0.014	5	0.014
30.00	9.00	19.75	4.00	0.010	4	0.010
60.00	8.00	20.00	3.01	0.007	3	0.007
120.00	7.00	20.25	2.02	0.005	2	0.005
240.00	7.00	20.50	2.03	0.003	2	0.003
1440.00	6.00	19.50	1.00	0.001	1	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	9.34	9.34	90
0.5"	0.500	12.70	3.30	12.64	87
0.375"	0.374	9.51	9.18	21.82	77
#4	0.187	4.75	17.56	39.38	59
#10	0.079	2.00	10.99	50.37	47
#20	0.033	0.84	8.76	59.13	38
#40	0.017	0.42	8.74	67.87	29
#60	0.010	0.25	6.18	74.05	22
#100	0.006	0.15	5.52	79.57	16
#200	0.003	0.07	4.56	84.13	12
Pan			11.05	95.18	0

Total Dry Weight of Sample = 195.29

D85 : 12.0615 mm
D60 : 5.0021 mm
D50 : 2.4892 mm
D30 : 0.4636 mm
D15 : 0.1214 mm
D10 : 0.0618 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-112
Sample No. : S11A
Location : New Bedford, MA
Soil Description : Wet, light brown sand with silt and gravel
Remarks : ---

Depth : ---
Test Date : 02/22/01
Test Method : ASTM D 422

Filename FD112S11
Elevation : ---
Tested by : KAH
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	10.51	10.51	89
0.375"	0.374	9.51	8.75	19.26	80
#4	0.187	4.75	20.10	39.36	59
#10	0.079	2.00	13.22	52.58	45
#20	0.033	0.84	10.45	63.03	34
#40	0.017	0.42	9.37	72.40	24
#60	0.010	0.25	6.29	78.69	18
#100	0.006	0.15	4.71	83.40	13
#200	0.003	0.07	4.32	87.72	8
Pan			7.74	95.46	0

Total Dry Weight of Sample = 200.08

D85 : 11.1974 mm
D60 : 4.9469 mm
D50 : 2.7469 mm
D30 : 0.6350 mm
D15 : 0.1910 mm
D10 : 0.0992 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-113
Sample No. : S5
Location : New Bedford, MA
Soil Description : Wet, yellowish brown sand with silt and gravel
Remarks : ---

Depth : --
Test Date : 03/02/01
Test Method : ASTM D 422

Filename : FD113S5
Elevation : ---
Tested by : HB
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.5"	0.500	12.70	0.00	0.00	100
0.375"	0.374	9.51	2.50	2.50	97
#4	0.187	4.75	9.32	11.82	87
#10	0.079	2.00	9.71	21.53	76
#20	0.033	0.84	9.96	31.49	65
#40	0.017	0.42	13.01	44.50	50
#60	0.010	0.25	13.86	58.36	34
#100	0.006	0.15	13.43	71.79	19
#200	0.003	0.07	9.67	81.46	8
Pan			7.36	88.82	0

Total Dry Weight of Sample = 96.91

D85 : 4.1548 mm
D60 : 0.6780 mm
D50 : 0.4220 mm
D30 : 0.2158 mm
D15 : 0.1139 mm
D10 : 0.0826 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Filename : FD113S7
Project No. : GTX-3289
Depth : --
Elevation : ---
Boring No. : FD-113
Test Date : 02/26/01
Tested by : NB
Sample No. : S7
Test Method : ASTM D 422
Checked by : JDT
Location : New Bedford, MA
Soil Description : Saturated, brown silty sand and gravel
Remarks : ---

HYDROMETER

Hydrometer ID : 583901
Weight of air-dried soil = 47.41 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	13.00	20.25	8.02	0.051	8	0.051
2.00	12.00	20.25	7.02	0.036	7	0.036
4.00	10.00	20.25	5.02	0.026	5	0.026
8.00	9.00	20.25	4.02	0.019	4	0.019
15.00	8.50	20.25	3.52	0.014	3	0.014
30.00	7.50	20.50	2.53	0.010	2	0.010
60.00	6.50	20.50	1.53	0.007	1	0.007
120.00	6.00	20.75	1.05	0.005	1	0.005
240.00	5.50	20.75	0.55	0.003	1	0.003

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	19.18	19.18	82
0.375"	0.374	9.51	9.22	28.40	73
#4	0.187	4.75	14.56	42.96	59
#10	0.079	2.00	13.73	56.69	46
#20	0.033	0.84	8.64	65.33	37
#40	0.017	0.42	6.46	71.79	31
#60	0.010	0.25	5.69	77.48	26
#100	0.006	0.15	4.11	81.59	22
#200	0.003	0.07	5.55	87.14	16
Pan			16.96	104.10	0

Total Dry Weight of Sample = 112.23

D85 : 13.6874 mm
D60 : 5.0586 mm
D50 : 2.6791 mm
D30 : 0.3806 mm
D15 : 0.0700 mm
D10 : 0.0565 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-113
Sample No. : S9
Location : New Bedford, MA
Soil Description : Wet, brown silty sand with gravel
Remarks : ---

Depth : ---
Test Date : 02/23/01
Test Method : ASTM D 422

Filename : FD113S9
Elevation : ---
Tested by : KAH
Checked by : JDT

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 51.2 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	23.00	20.00	17.04	0.048	21	0.048
2.00	19.50	20.00	13.54	0.035	16	0.035
4.00	17.00	20.00	11.04	0.025	13	0.025
8.00	15.00	20.00	9.04	0.018	11	0.018
15.00	13.00	20.00	7.04	0.013	9	0.013
30.00	11.00	20.00	5.04	0.009	6	0.009
60.00	9.50	20.00	3.54	0.007	4	0.007
120.00	8.50	20.50	2.60	0.005	3	0.005
240.00	7.50	21.00	1.67	0.003	2	0.003
1440.00	7.00	21.00	1.17	0.001	1	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.75"	0.748	19.00	0.00	0.00	100
0.5"	0.500	12.70	13.26	13.26	84
0.375"	0.374	9.51	3.04	16.30	80
#4	0.187	4.75	6.21	22.51	73
#10	0.079	2.00	8.90	31.41	62
#20	0.033	0.84	8.16	39.57	52
#40	0.017	0.42	8.31	47.88	42
#60	0.010	0.25	6.29	54.17	34
#100	0.006	0.15	5.41	59.58	28
#200	0.003	0.07	5.35	64.93	21
Pan			17.68	82.61	0

Total Dry Weight of Sample = 201.39

D85 : 13.0395 mm
D60 : 1.6815 mm
D50 : 0.7275 mm
D30 : 0.1762 mm
D15 : 0.0299 mm
D10 : 0.0159 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-114
Sample No. : S5
Location : New Bedford, MA
Soil Description : Moist, light brown silt with sand
Remarks : ---

Depth : --
Test Date : 02/26/01
Test Method : ASTM D 422

Filename : FD114S5
Elevation : ---
Tested by : HB
Checked by : JDT

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 37.3 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	23.00	21.50	17.23	0.047	46	0.047
2.00	21.00	21.50	15.23	0.034	41	0.034
4.00	20.00	21.50	14.23	0.024	38	0.024
8.00	18.00	21.50	12.23	0.017	33	0.017
15.00	15.50	21.50	9.73	0.013	26	0.013
30.00	13.50	21.50	7.73	0.009	21	0.009
60.00	11.50	21.50	5.73	0.007	15	0.007
120.00	10.00	21.50	4.23	0.005	11	0.005
240.00	8.50	21.50	2.73	0.003	7	0.003
1440.00	7.00	20.50	1.10	0.001	3	0.001

FINE SIEVE SET

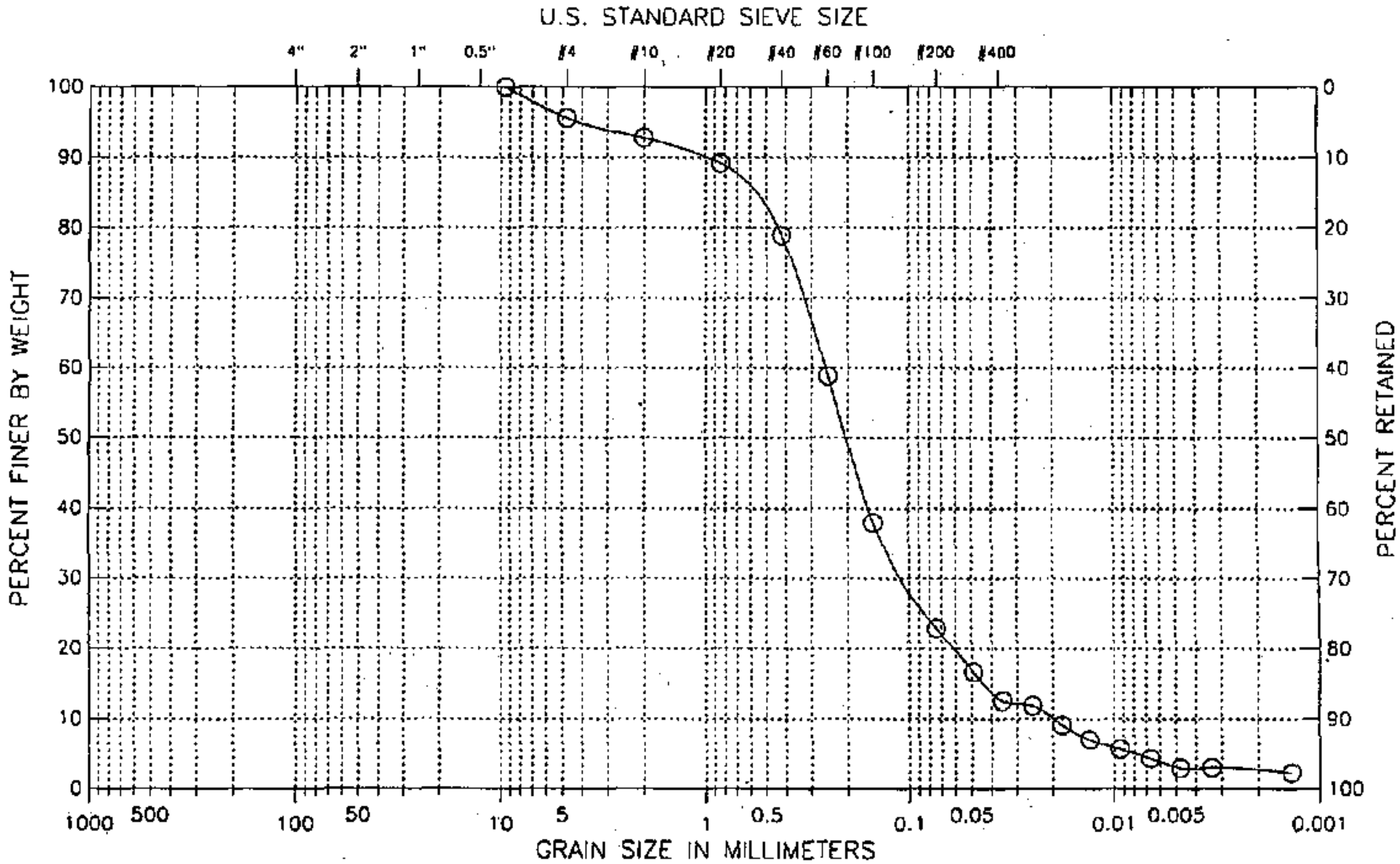
Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	0.03	0.03	100
#20	0.033	0.84	0.21	0.24	99
#40	0.017	0.42	0.98	1.22	97
#60	0.010	0.25	1.23	2.45	93
#100	0.006	0.15	2.00	4.45	88
#200	0.003	0.07	5.42	9.87	74
Pan			27.46	37.33	0

Total Dry Weight of Sample = 138.8

D85 : 0.1284 mm
D60 : 0.0593 mm
D50 : 0.0504 mm
D30 : 0.0153 mm
D15 : 0.0064 mm
D10 : 0.0042 mm

Soil Classification
ASTM Group Symbol : ML
ASTM Group Name : silt with sand
AASHTO Group Symbol : A-4(0)
AASHTO Group Name : Silty Soils

	Boring No. : FD-114 Sample No: S6 Test Method ASTM D 422 Filename : FD114S6	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

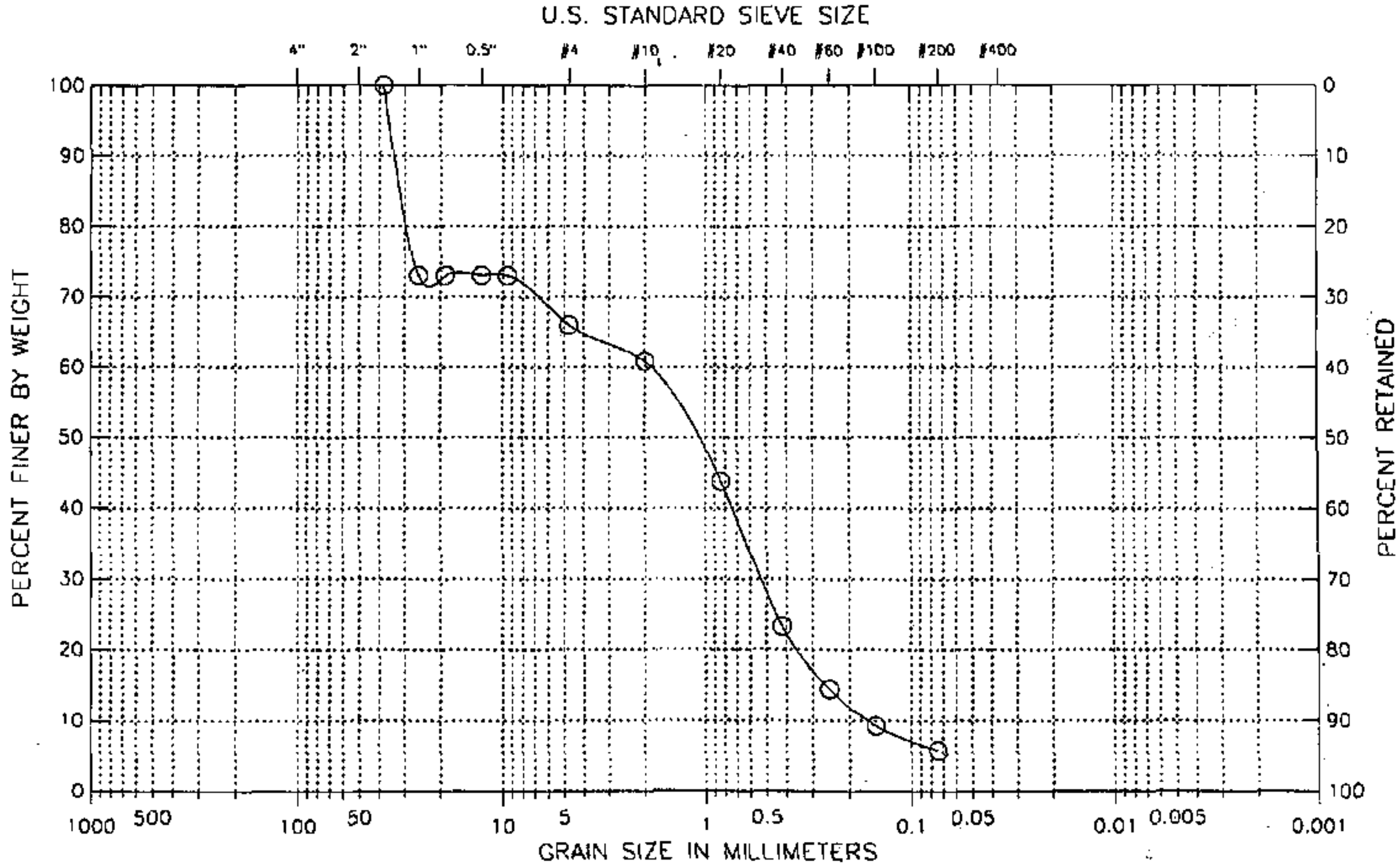
Remarks :

Visual Description :
Wet brown silty sand

Figure 63

GeoTesting Express, Inc. • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

Boring No. : FD-114 Sample No.: S9 Test Method ASTM D 422 Filename : FD114S9	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

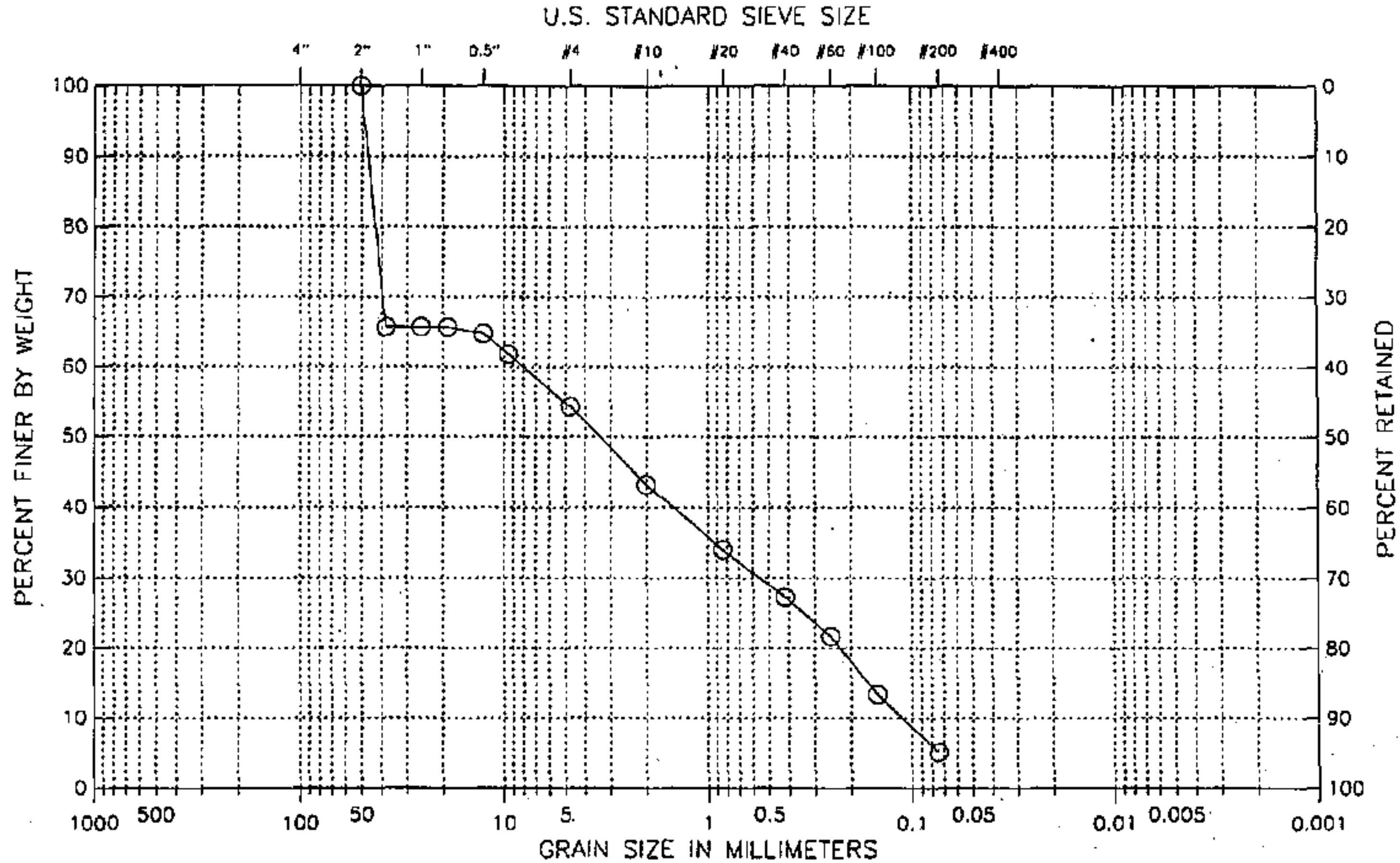
Remarks :

Visual Description :
Wet brown sand with gravel and silt

Figure 64

GeoTesting Express, Inc. • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

Boring No. : FD-114 Sample No.: S10 Test Method ASTM D 422 Filename : FD114S10	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

Remarks :

Visual Description :
Wet, brown sand and gravel with silt

Figure 65

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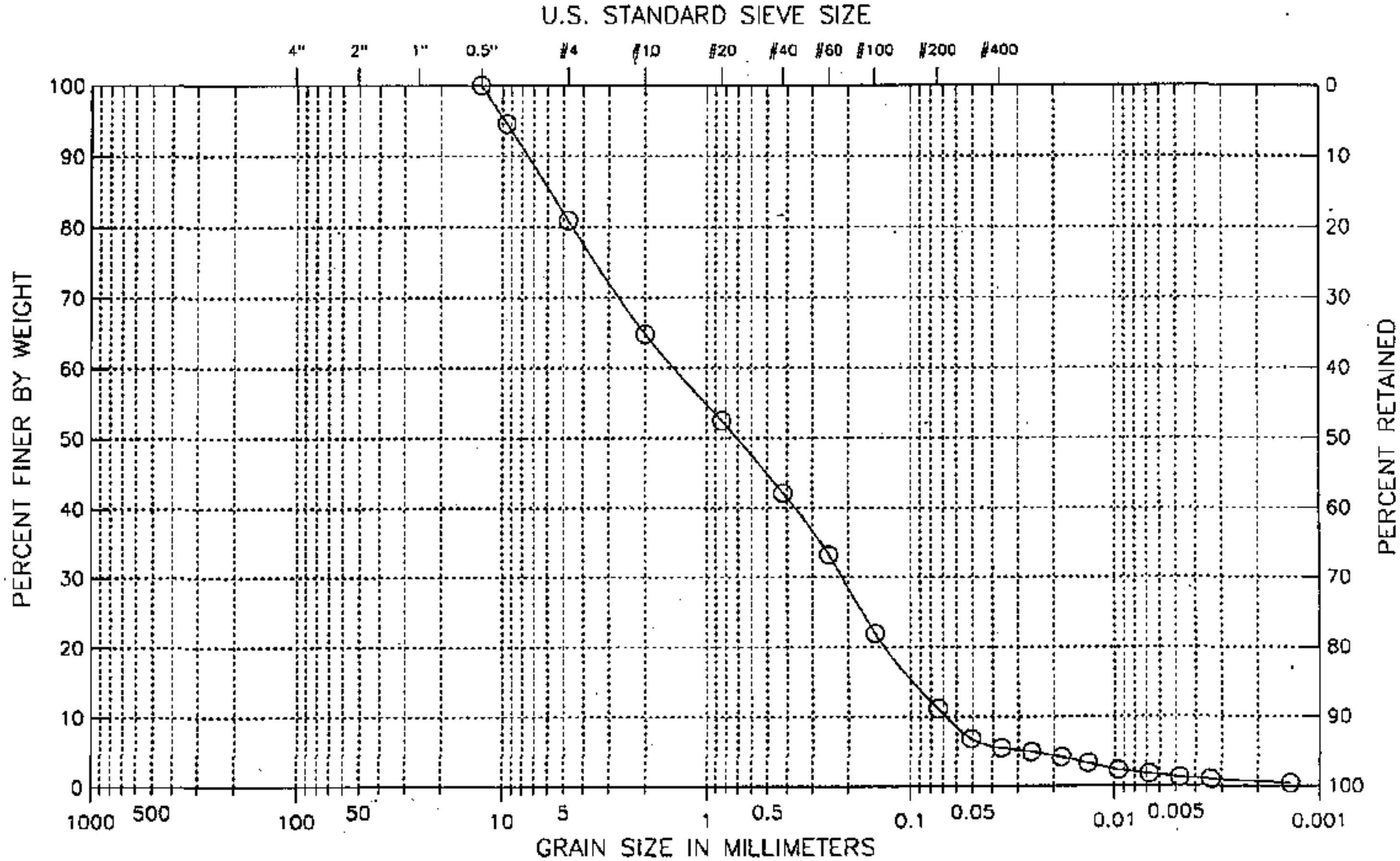
GeoTesting Express, Inc. • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

Boring No. : FD-114 Sample No.: S12 Test Method ASTM D 422 Filename : FD114S12	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Tue Mar 27 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :

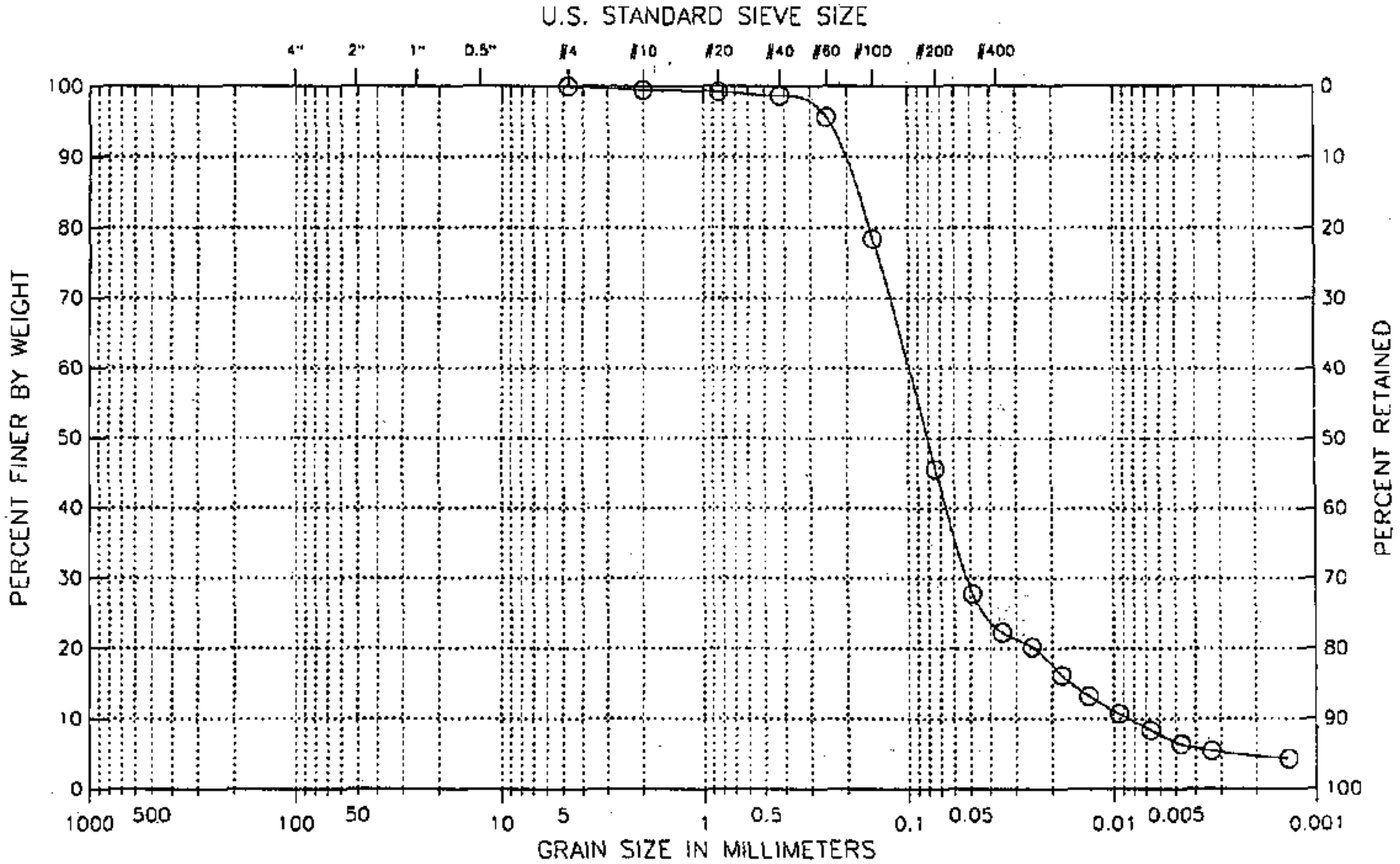
Remarks :

Visual Description :
Moist, brown sand with silt and gravel

Figure 1

GeoTesting Express, Inc. • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

	Boring No. : FD-115	Project : New Bedford Superfund Site
	Sample No.: S3	Project No.: GTX-3289
	Test Method ASTM D 422	Location: New Bedford, MA
	Filename : FD115S3	Date : Mon Mar 05 2001



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Classification :
(SM) Silty sand

Visual Description :
Moist, light brown silty sand

Remarks :

Figure 66

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
New Bedford Superfund Site	GTX-3289	XAH	FD-115
LOCATION		CHECKED BY	SAMPLE NUMBER
New Bedford, MA		JDT	S3
SAMPLE DESCRIPTION		DATE	FILENAME
Moist, light brown silty sand		Mon Mar 05 2001	FD115S3

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER					
WT. WET SOIL + TARE					
WT. DRY SOIL + TARE					
WT. WATER					
TARE WT.					
WT. DRY SOIL					
WATER CONTENT, W_N (%)					
NUMBER OF BLOWS, N					
ONE-POINT LIQUID LIMIT, LL					

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER					
WT. WET SOIL + TARE					
WT. DRY SOIL + TARE					
WT. WATER					
TARE WT.					
WT. DRY SOIL					
WATER CONTENT (%)					

Determined to be Non-plastic.

SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	19.8
LIQUID LIMIT, LL	
PLASTIC LIMIT, PL	
PLASTICITY INDEX, PI	
LIQUIDITY INDEX, LI*	

*LI = (W - PL)/PI

PLASTICITY CHART

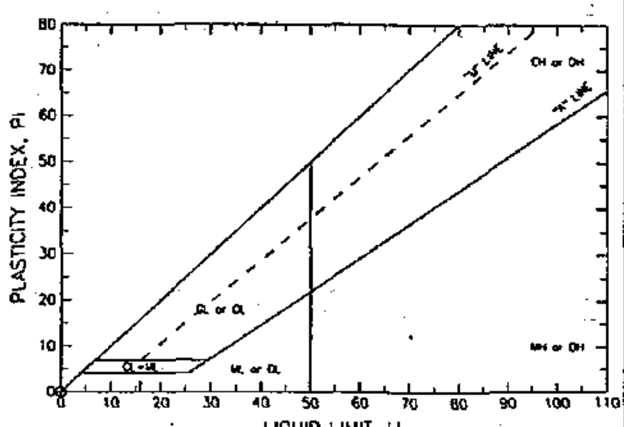


Fig. 66.0

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-115
Sample No. : S5
Location : New Bedford, MA
Soil Description : Wet, brown sand
Remarks : ---

Depth : --
Test Date : 03/02/01
Test Method : ASTM D 422

Filename : FD115S5
Elevation : ---
Tested by : HB
Checked by : JDT

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
#4	0.187	4.75	0.00	0.00	100
#10	0.079	2.00	0.04	0.04	100
#20	0.033	0.84	0.09	0.13	100
#40	0.017	0.42	3.61	3.74	95
#60	0.010	0.25	24.23	27.97	60
#100	0.006	0.15	27.52	55.49	20
#200	0.003	0.07	11.69	67.18	3
Pan			2.35	69.53	0

Total Dry Weight of Sample = 196.53

D85 : 0.3640 mm
D60 : 0.2508 mm
D50 : 0.2200 mm
D30 : 0.1694 mm
D15 : 0.1200 mm
D10 : 0.0975 mm

Soil Classification
ASTM Group Symbol : SP
ASTM Group Name : Poorly graded sand
AASHTO Group Symbol : A-3(0)
AASHTO Group Name : Fine Sand

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site Filename : FD115S7
Project No. : GTX-3289 Depth : -- Elevation : ---
Boring No. : FD-115 Test Date : 03/01/01 Tested by : HB
Sample No. : S7 Test Method : ASTM D 422 Checked by : JDT
Location : New Bedford, MA
Soil Description : Wet, brown sand with silt
Remarks : ---

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.375"	0.374	9.51	0.00	0.00	100
#4	0.187	4.75	2.44	2.44	97
#10	0.079	2.00	2.00	4.44	95
#20	0.033	0.84	4.54	8.98	90
#40	0.017	0.42	14.42	23.40	73
#60	0.010	0.25	23.56	46.96	46
#100	0.006	0.15	23.48	70.44	19
#200	0.003	0.07	10.63	81.07	7
Pan			6.19	87.26	0

Total Dry Weight of Sample = 95.41

D85 : 0.6900 mm
D60 : 0.3260 mm
D50 : 0.2690 mm
D30 : 0.1831 mm
D15 : 0.1165 mm
D10 : 0.0874 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-3(0)
AASHTO Group Name : Fine Sand

Mon Mar 05 09:11:59 2001 Page : 1

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford Superfund Site
Project No. : GTX-3289
Boring No. : FD-115
Sample No. : S9
Location : New Bedford, MA
Soil Description : Wet, brown silty sand with gravel
Remarks : ---

Depth : --
Test Date : 02/27/01
Test Method : ASTM D 422

Filename : FD115S9
Elevation : ---
Tested by : HB
Checked by : JDT

HYDROMETER

Hydrometer ID : 88-18231
Weight of air-dried soil = 57.52 gm
Specific Gravity = 2.65

Hydroscopic Moisture Content :
Weight of Wet Soil = 0 gm
Weight of Dry Soil = 0 gm
Moisture Content = 0

Elapsed Time (min)	Reading	Temperature (deg. C)	Corrected Reading	Particle Size (mm)	Percent Finer (%)	Adjusted Particle Size
1.00	18.50	20.25	12.57	0.050	16	0.050
2.00	16.00	20.25	10.07	0.036	13	0.036
4.00	13.50	20.50	7.60	0.025	10	0.025
8.00	12.00	20.25	6.07	0.018	8	0.018
15.00	10.50	20.25	4.57	0.013	6	0.013
30.00	9.75	20.50	3.85	0.009	5	0.009
60.00	8.50	20.75	2.64	0.007	3	0.007
120.00	8.00	21.00	2.17	0.005	3	0.005
240.00	7.00	21.25	1.20	0.003	2	0.003
1440.00	7.00	20.75	1.14	0.001	1	0.001

FINE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
0.5"	0.500	12.70	0.00	0.00	100
0.375"	0.374	9.51	8.23	8.23	89
#4	0.187	4.75	4.88	13.11	83
#10	0.079	2.00	6.34	19.45	75
#20	0.033	0.84	7.36	26.81	65
#40	0.017	0.42	9.17	35.98	53
#60	0.010	0.25	8.17	44.15	43
#100	0.006	0.15	7.39	51.54	33
#200	0.003	0.07	8.09	59.63	23
Pan			17.34	76.97	0

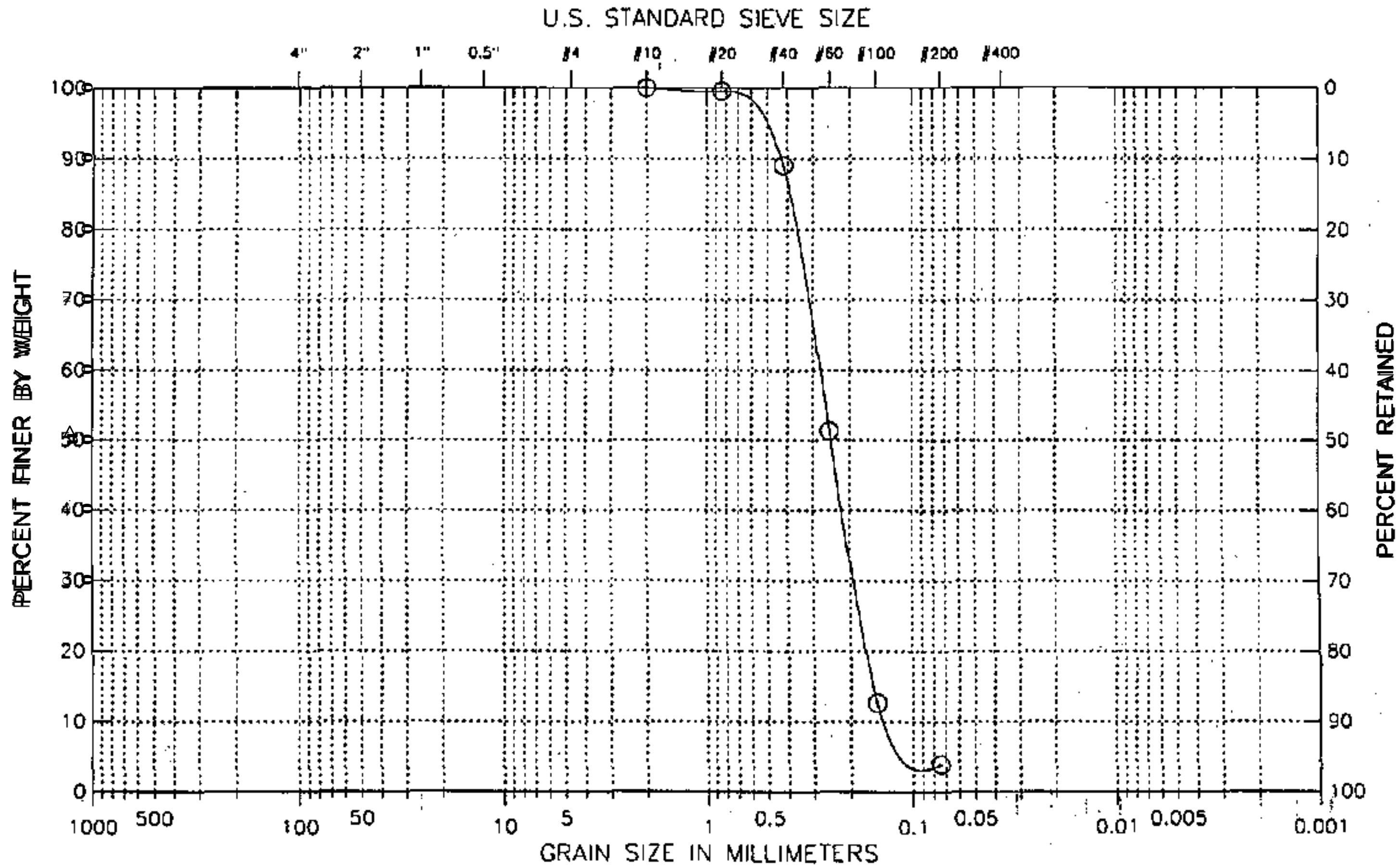
Total Dry Weight of Sample = 85.04

D85 : 5.9340 mm
D60 : 0.6223 mm
D50 : 0.3582 mm
D30 : 0.1217 mm
D15 : 0.0431 mm
D10 : 0.0257 mm

Soil Classification
ASTM Group Symbol : N/A
ASTM Group Name : N/A
AASHTO Group Symbol : A-2-4(0)
AASHTO Group Name : Silty Gravel and Sand

GeoTesting Express, Inc. • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

	Boring No. : FD-116 Sample No.: S6 Test Method ASTM D 422 Filename : FD116S6	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 06 2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

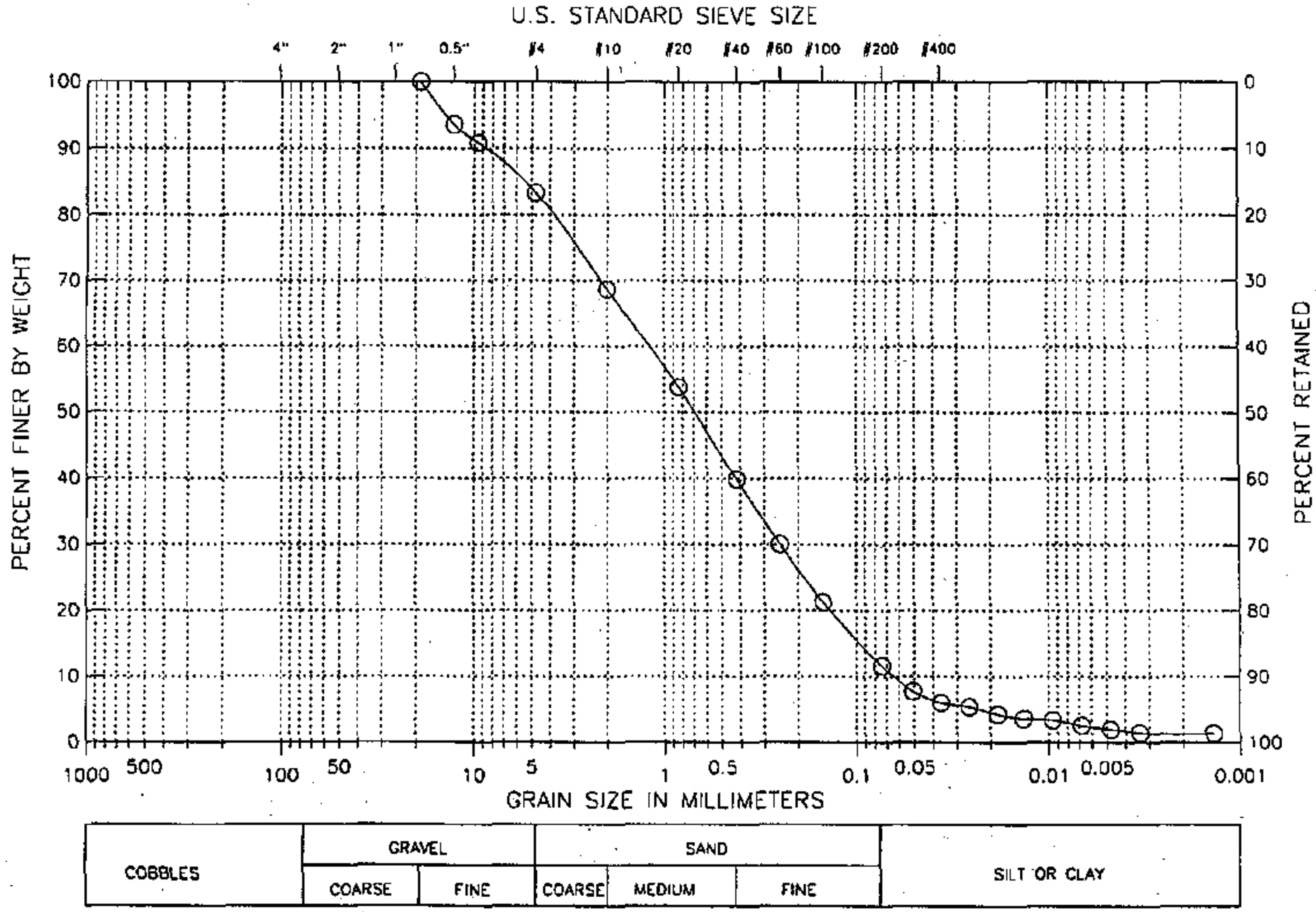
Classification :
(SP) Poorly graded sand

Visual Description :
Wet, brown sand

Remarks :

Figure 71

	Boring No. : FD-116 Sample No.: S8 Test Method ASTM D 422 Filename : FD116S8	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



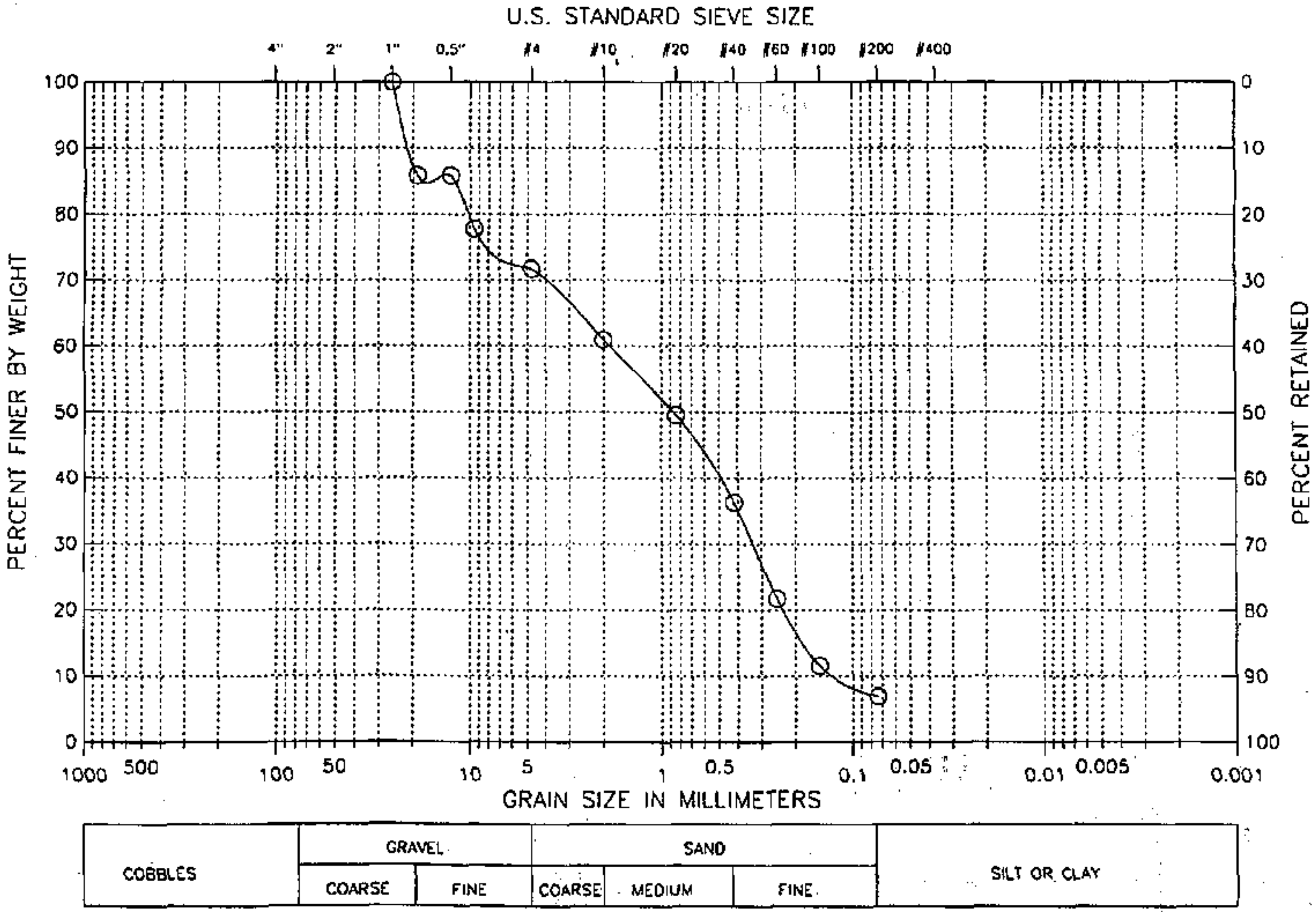
Classification :

Remarks :

Visual Description :
Wet, grayish brown silty sand with gravel

Figure 72

Boring No. : FD-116 Sample No.: S10 Test Method ASTM D 422 Filename : FD116S10	Project : New Bedford Superfund Site Project No.: GTX-3289 Location: New Bedford, MA Date : Mon Mar 05 2001



Classification :

Remarks :

Visual Description :
Wet, brownish gray sand with gravel and silt

Figure 73

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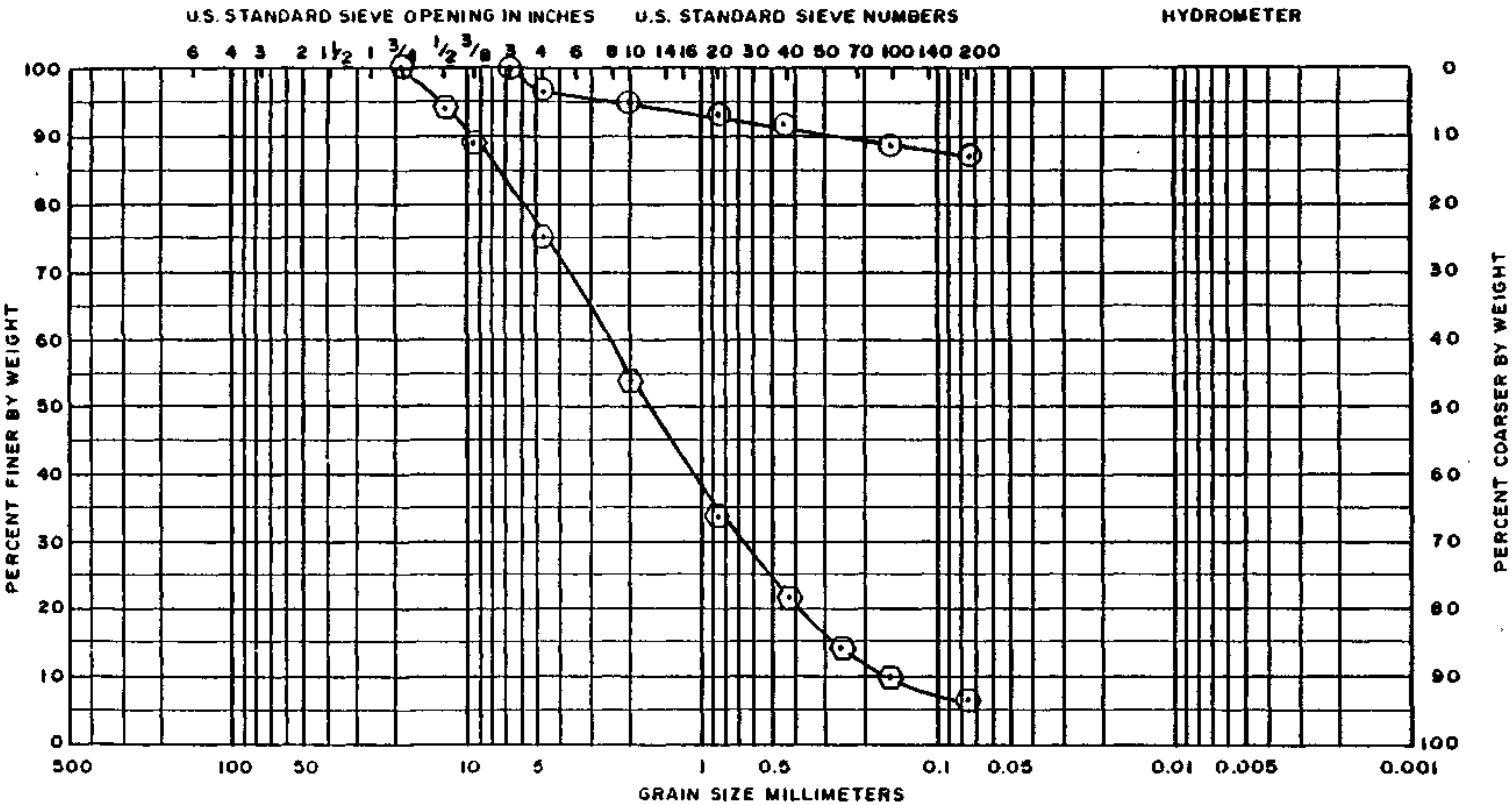


COBBLES	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

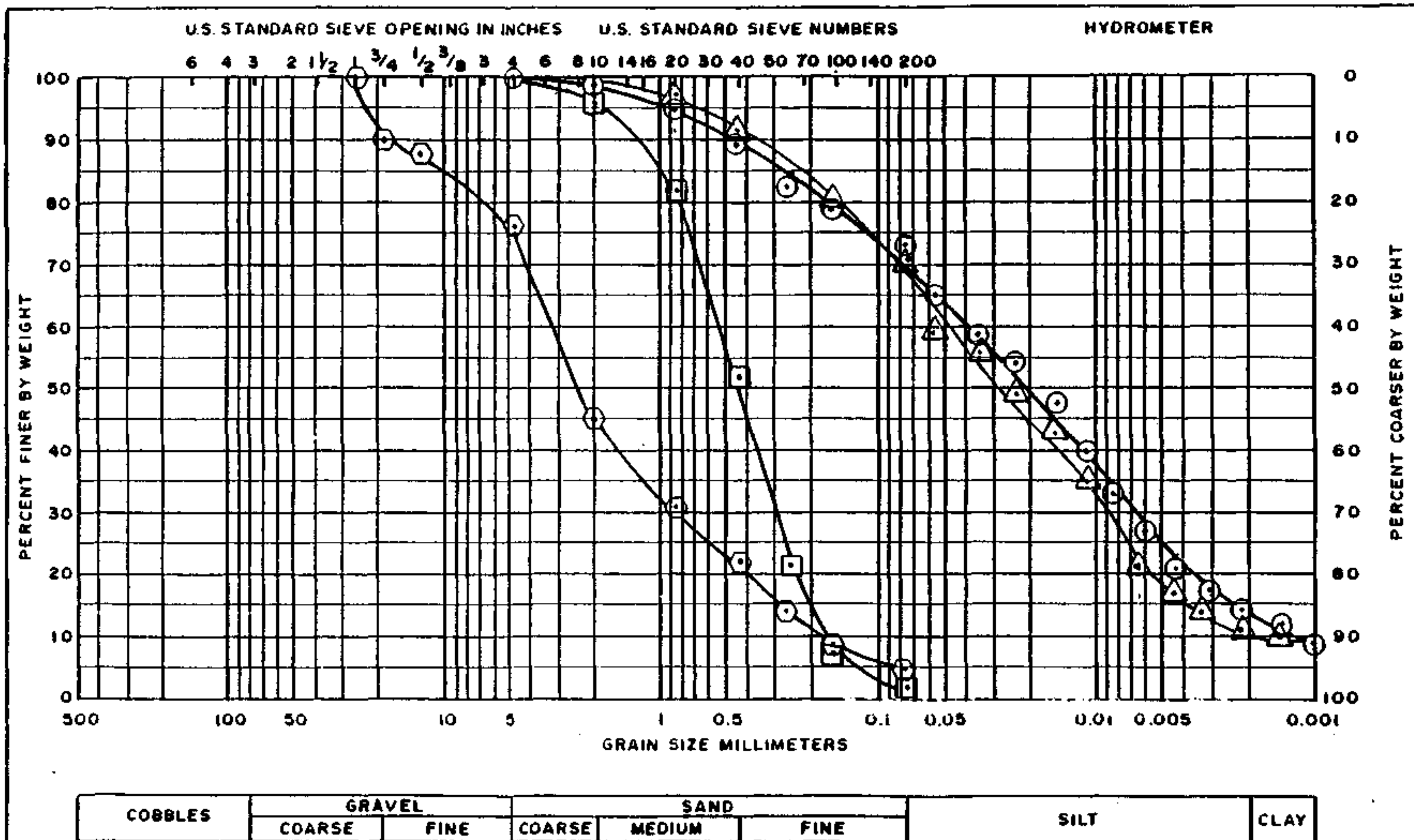
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW109 S2	⊙ 4-6'	Gray silt, trace sand & gravel	114.9			
BW 109 S7	⊙ 14-16'	SW-SM Gray sand, some gravel, trace silt	12.5			

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO
TS	PD	4959-19
	DATE 4-1-88	B-9

JGA 003
1 APR 82



SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW110 S9	⊙ 34-36'	SW-SM Gray sand, some gravel, trace silt	10.9			
BW 110 C1	⊙ 2-4'	OH Gray silt, some sand	88.5	85.2	34.4	50.8
BW 110 C2	△ 6-8'	OH Gray silt, some sand	59.7	57.0	26.4	30.6
BW 110 C4	⊡ 14-16'	SP Gray sand, trace silt	14.0			

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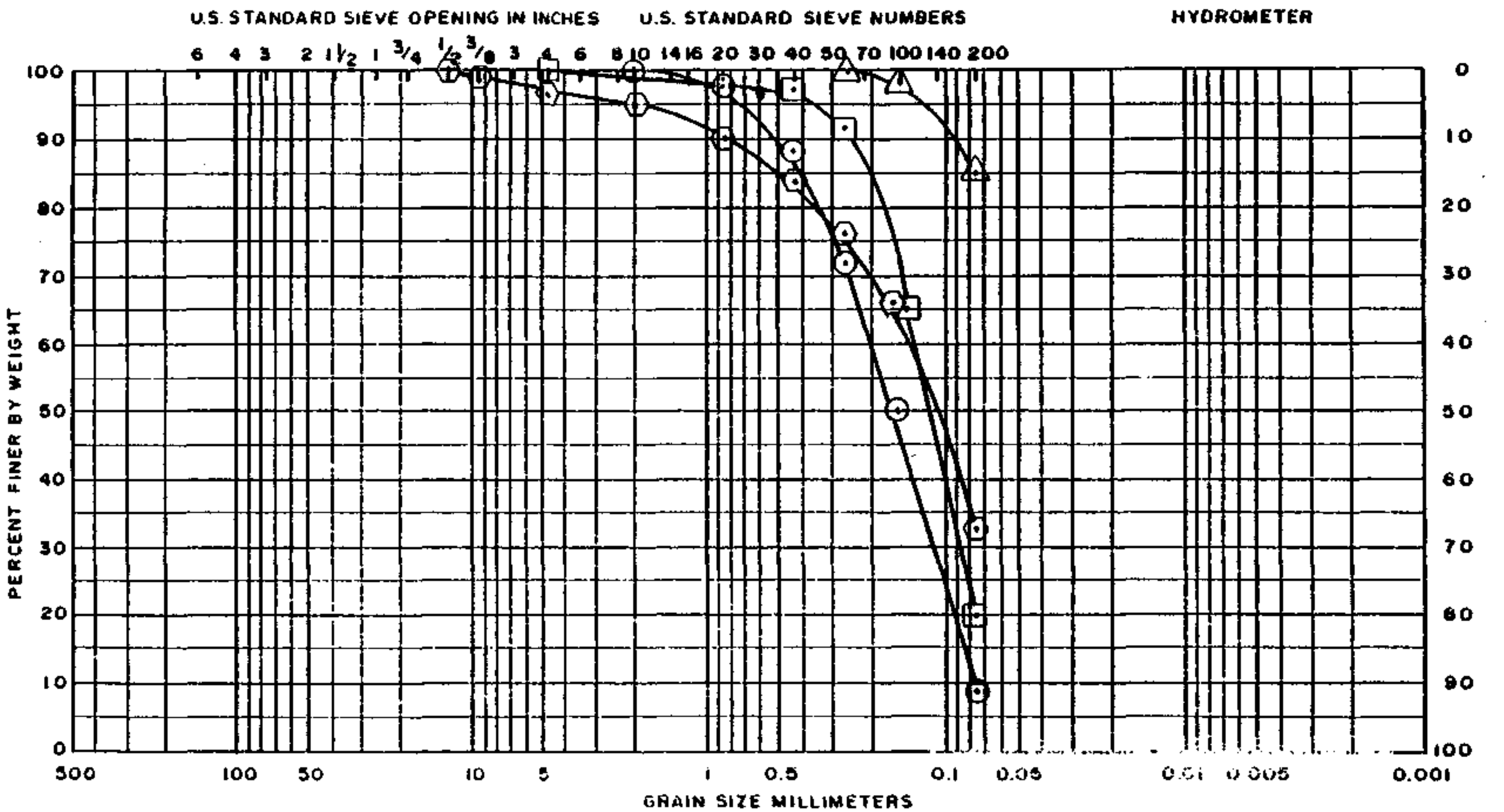
1 APR 82

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ. NO.
TS	PD	4959-19
	DATE 4-1-88	B-10



COBBLES	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

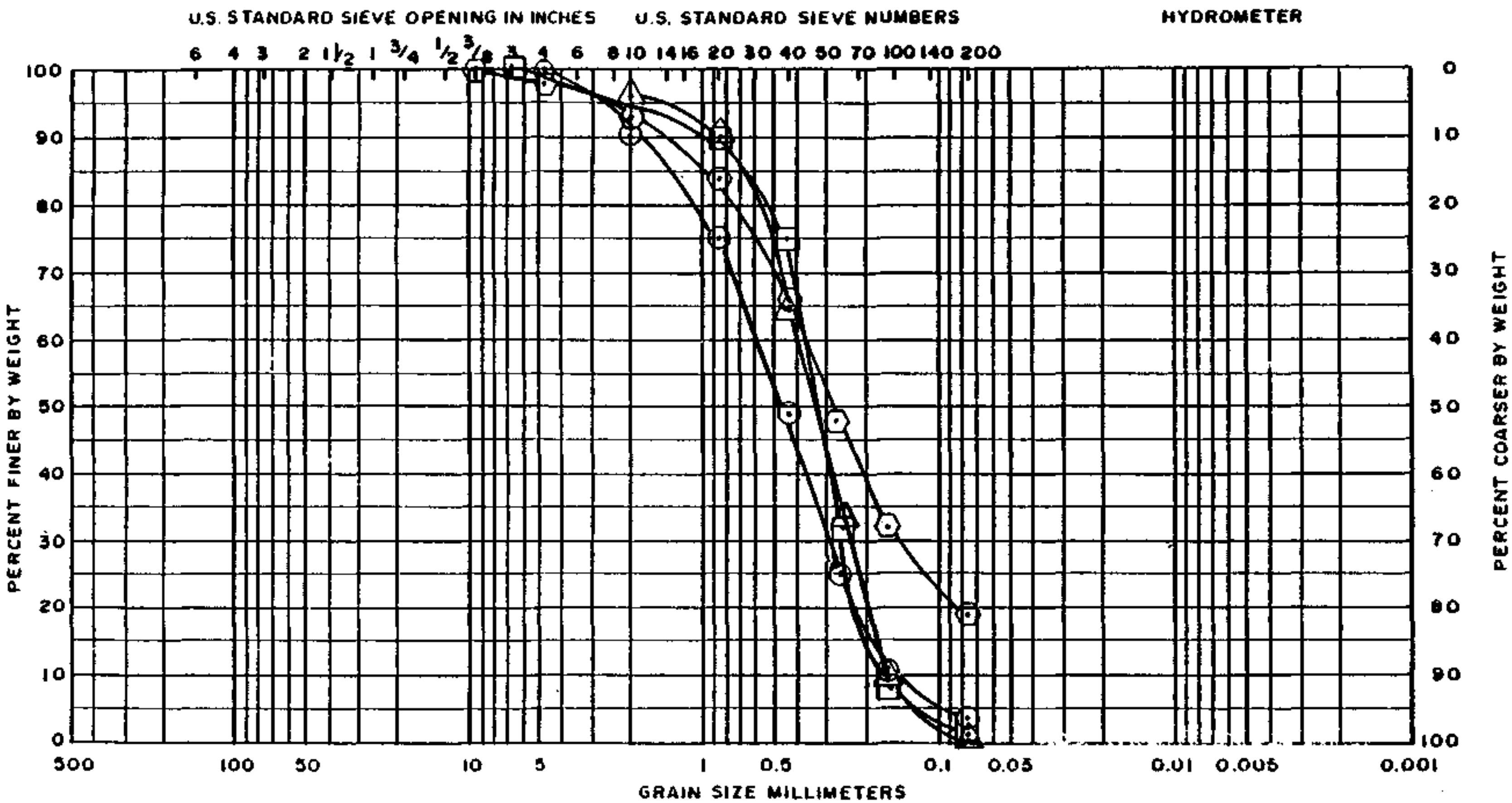
SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW111 S1	⬡ 2-4'	SM Brown sand, some silt, trace gravel	18.0			
BW111 S3	⊙ 6-8'	SP-SM Brown sand, trace silt	33.7			
BW111 S11	⊡ 33-35'	SM Browish-gray sand, little silt	18.6			
BW111 S14	△ 48-50'	Gray silt, little sand	29.6			

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ. NO
TS	PD	4959-19
	DATE 4-1-88	B-11

JGA 003
1 APR 82



COBBLES	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW 112 S1	⬡ 2-4'	SM Gray sand, little silt, trace gravel	38.0			
BW 112 S3	⊙ 6-8'	SP Brown sand, trace silt	22.6			
BW 112 S8	⊡ 19-21'	SP Brown sand, trace gravel + silt	17.9			
BW 112 S10	△ 28-30'	SP Grayish brown sand, trace gravel + silt	17.6			

JGA 003
1 APR 82

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO
TS	PD	4959-19
	DATE 4-1-88	B-12

PROJECT	COMP. BY	JOB NO.
NEW BEDFORD GEOTECHNICAL	RS	4959-19
	CHK. BY	DATE
BW 110 C1 2-4'	PD	3-22-88

ATTERBERG LIMITS

WATER CONTENT (W_n)

DETERMINATION NO.			1
TARE NO.			170
WT. IN GRAMS	TARE PLUS WET SOIL		39.1
	TARE PLUS DRY SOIL		28.93
	WATER	W_w	10.2
	TARE		17.5
	DRY SOIL	W_s	11.4
WATER CONTENT, %		W	89.0

PLASTIC LIMIT (W_p)

1	
158	118
20.5	22.2
19.77	21.27
0.7	0.9
17.7⁻	18.5⁺
2.1	2.8
35.3	33.6

AVG=34.4

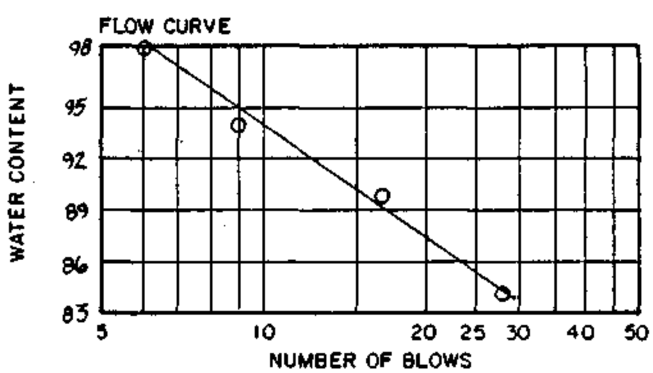
LIQUID LIMIT (W_l)

DETERMINATION NO.			1	2	3	4	5
NO. OF BLOWS			28	17	9	6	
TARE NO.			131	103	134	167	
WT. IN GRAMS	TARE PLUS WET SOIL		25.32	24.3⁻	27.3	27.3	
	TARE PLUS DRY SOIL		21.4	20.07	22.7	22.35	
	WATER	W_w	3.9	4.2	4.6	5.0	
	TARE		16.73	15.35	17.8⁺	17.3⁺	
	DRY SOIL	W_s	4.7	4.7	4.9	5.1	
WATER CONTENT, %		W	83.9	89.6	93.9	98.0	

RESULT SUMMARY

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
89.0	85.2	34.4	50.8

REMARKS ______



SHEET C-5

E.C.JORDAN CO. ENGINEERS & SCIENTISTS

PROJECT	COMP. BY	JOB NO.
NEW BEDFORD GEOTECHNICAL	RS	4959-19
BW 110 C2 6-8'	CHK. BY PD	DATE 3-22-88

ATTERBERG LIMITS

WATER CONTENT (W_n)

DETERMINATION NO.			1
TARE NO.			151
WT. IN GRAMS	TARE PLUS WET SOIL		47.3
	TARE PLUS DRY SOIL		35.03
	WATER	W_w	12.3
	TARE		17.2
	DRY SOIL	W_s	17.8
WATER CONTENT, %		w	68.8

PLASTIC LIMIT (W_p)

	1	
TARE NO.	113	156
TARE PLUS WET SOIL	23.55	22.05
TARE PLUS DRY SOIL	22.63	21.0
WATER	0.9	1.1
TARE	19.15	17.0
DRY SOIL	3.5	4.0
WATER CONTENT, %	26.4	26.3

LIQUID LIMIT (W_l)

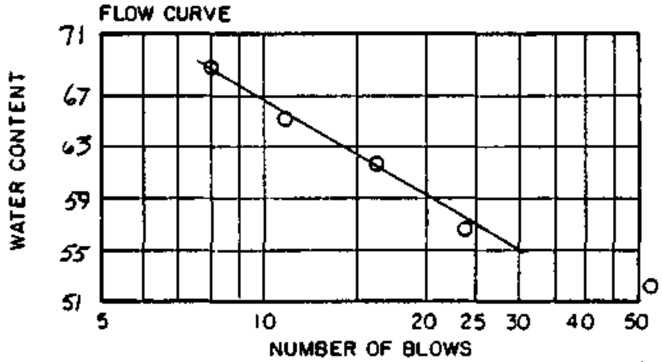
DETERMINATION NO.			1	2	3	4	5
NO. OF BLOWS			16	11	8	55	24
TARE NO.			155	171	109	135	152
WT. IN GRAMS	TARE PLUS WET SOIL		30.13	29.0	27.9	25.83	29.0
	TARE PLUS DRY SOIL		25.27	24.1	22.93	23.1	25.0
	WATER	W_w	4.9	4.9	5.0	2.7	4.0
	TARE		17.37	16.55	15.75	17.83	18.0
	DRY SOIL	W_s	7.9	7.6	7.2	5.3	7.0
WATER CONTENT, %		w	61.5	64.9	69.2	51.8	57.1

RESULT SUMMARY

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
68.8	57.0	26.4	30.6

REMARKS

FLOW CURVE



E.C. JORDAN CO. ENGINEERS & SCIENTISTS

Apex Companies, LLC.

184 HIGH STREET
SUITE 502
BOSTON MA 02110
(617) 728-0070

REVISIONS

#	DATE	DESCRIPTION

PREPARED FOR:

NEW BEDFORD HARBOR DEVELOPMENT COMMISSION

DRAWING TITLE:

HISTORIC ORGANIC SILT/CLAY HYDRAULIC CONDUCTIVITY SAMPLE LOCATIONS

Scale: 1"=750'

0 375 750 1500 2250 FEET

Date 1/16/12	Drawing No.
Proj. Mgr.	
Design	
Check	FIG. 1
Drawn	
Job. No. 6724	
Last Rev.	

Average Hydraulic Conductivity of Organic Silt/Clay	
Sample	**Hydraulic Conductivity**
S. Terminal #5 0-2	2.80E-07 cm/sec
S. Terminal #6 0-2	7.30E-08 cm/sec
FB-15 0-2	6.10E-07 cm/sec
FB-26 3-5	9.70E-07 cm/sec
FA-9 2-4	2.70E-07 cm/sec
FD-7 1-3	3.00E-07 cm/sec
FD-6 4-6	2.90E-07 cm/sec
FC-19 4-6	3.30E-07 cm/sec
Average Hydraulic Conductivity:	**3.9E-07 cm/sec**
Typically Landfill Liner Criteria:	**1.0E-07 cm/sec**

GeoTesting EXPRESS

Client:	Apex Companies, LLC		
Project Name:	South Terminal Extension		
Project Location:	New Bedford, MA		
GTX #:	10697		
Start Date:	4/15/2011	Tested By:	ema
End Date:	4/19/2011	Checked By:	njh
Boring #:	---	Test #:	k
Sample #:	#5		
Depth:	---		
Visual Description:	Wet, black silt		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084
Constant Volume

Sample Type: Remolded   Permeant Fluid: de-aired tap water
Orientation: Vertical   Cell #: 16/5/12

Sample Preparation: Compacted at moderate effort. Trimmings moisture content = 145%

Parameter	Initial	Final
Height, in	2.60	2.42
Diameter, in	2.87	2.59
Area, in^2	6.47	5.27
Volume, in^3	16.8	12.7
Mass, g	379	295
Bulk Density, pcf	85.7	88.0
Moisture Content, %	146.2	91.8
Dry Density, pcf	34.8	45.9
Degree of Saturation, %	---	93

B COEFFICIENT DETERMINATION

Cell Pressure, psi: 95.42   Pressure Increment, psi: 4.946
Sample Pressure, psi: 90.05   B Coefficient: 0.99

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
4/18	1	90	85	8.0	7.8	0.2	36	16.4	3.2E-07	20	1.000	3.2E-07
4/18	2	90	85	8.0	7.8	0.2	38	16.4	3.0E-07	20	1.000	3.0E-07
4/18	3	90	85	8.0	7.8	0.2	44	16.4	2.6E-07	20	1.000	2.6E-07
4/18	4	90	85	8.0	7.8	0.2	48	16.4	2.4E-07	20	1.000	2.4E-07

PERMEABILITY AT 20° C: 2.8×10^{-7} cm/sec (@ 5 psi effective stress)

GeoTesting EXPRESS

Client:	Apex Companies, LLC		
Project Name:	South Terminal Extension		
Project Location:	New Bedford, MA		
GTX #:	10697		
Start Date:	4/15/2011	Tested By:	ema
End Date:	4/19/2011	Checked By:	njh
Boring #:	---	Test #:	k
Sample #:	#6		
Depth:	---		
Visual Description:	Wet, black silt		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084

Constant Volume

Sample Type:	Remolded	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	8/3

Sample Preparation: Compacted at moderate effort. Trimmings moisture content = 65.3%

Parameter	Initial	Final
Height, in	2.39	2.13
Diameter, in	2.87	2.69
Area, in^2	6.47	5.68
Volume, in^3	15.5	12.1
Mass, g	376	329
Bulk Density, pcf	92.4	103
Moisture Content, %	77.0	55.0
Dry Density, pcf	52.2	66.7
Degree of Saturation, %	---	97

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	95.27	Pressure Increment, psi:	5.004
Sample Pressure, psi:	90.37	B Coefficient:	0.98

FLOW DATA

Date	Trial #	Pressure, psi Cell	Pressure, psi Sample	Manometer Readings Z_1	Manometer Readings Z_2	Manometer Readings Z_1-Z_2	Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
4/18	2	90	85	8.0	7.9	0.1	60	18.6	7.7E-08	20	1.000	7.7E-08
4/18	3	90	85	8.0	7.9	0.1	63	18.6	7.3E-08	20	1.000	7.3E-08
4/18	4	90	85	8.0	7.9	0.1	66	18.6	7.0E-08	20	1.000	7.0E-08
4/18	5	90	85	8.0	7.9	0.1	66	18.6	7.0E-08	20	1.000	7.0E-08

PERMEABILITY AT 20° C: 7.3×10^{-8} cm/sec (@ 5 psi effective stress)

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084

Constant Gradient

Client:	Nobis Engineering	**Start Date:**	02/01/00
Project Name:	New Bedford Harbor Superfund Site	**End Date:**	2/4/00
Project Location:	New Bedford, MA	**Tested By:**	SWJ
GTX #:	2409	**Checked By:**	GTT
Boring #:	FB-15	**Sample Type:**	Undisturbed
Sample #:	UO-1	**Orientation:**	Vertical
Depth:	0-2 ft	**Test #:**	K8
Visual Description:	Moist, dark gray organic silt		

Sample Preparation: Extruded from Shelby tube, cut, trimmed and placed into permeameter at as received density and moisture content; trimmings moisture content = 121%

Permeant Fluid: de-aired tap water **Cell #:** —

Parameter	Initial	Final
Height, in	3.22	3.04
Diameter, in	2.90	2.71
Area, in^2	6.61	5.77
Volume, in^3	21.27	17.53
Mass, g	454	406
Bulk Density, pcf	81.1	88.0
Moisture Content, %	110	87.6
Dry Density, pcf	38.7	46.9

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	27.9	**Press. Increment, psi:**	5
Sample Pressure, psi:	25.9	**B Coefficient:**	0.96

FLOW DATA

Date	Elapsed Time, sec	Cell Pressure, psi	Inlet Pressure, psi	Outlet Pressure, psi	Gradient	Inflow V, cc	Outflow V, cc	Δ Inflow V, cc	Δ Outflow V, cc	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
02/03	—	27.9	26.9	24.9	18.2	10.20	14.95	—	—	—	—	—
02/03	11280	27.9	26.9	24.9	18.2	14.80	10.15	4.60	4.80	20	1.000	6.15E-07
02/03	—	27.9	26.9	24.9	18.2	11.30	14.10	—	—	—	—	—
02/03	5160	27.9	26.9	24.9	18.2	13.40	11.90	2.10	2.20	20	1.000	6.15E-07
02/04	—	27.9	26.9	24.9	18.2	9.80	15.55	—	—	—	—	—
02/04	12480	27.9	26.9	24.9	18.2	15.10	10.40	5.30	5.15	20	1.000	6.18E-07
02/04	—	27.9	26.9	24.9	18.2	10.95	14.00	—	—	—	—	—
02/04	10560	27.9	26.9	24.9	18.2	15.10	9.80	4.15	4.20	20	1.000	5.83E-07

PERMEABILITY AT 20 °C: 6.1 x 10^{-7} cm/sec (@ 2 psi effective stress)

Hydraulic Conductivity of Saturated Porous Materials
Using a Flexible Wall Permeameter by ASTM D 5084
Constant Gradient

Client:	Nobis Engineering	**Start Date:**	01/06/00
Project Name:	New Bedford Harbor Superfund Site	**End Date:**	1/17/00
Project Location:	New Bedford, MA	**Tested By:**	SWJ
GTX #:	2409	**Checked By:**	GTT

Boring #:	FB-26	**Sample Type:**	Undisturbed
Sample #:	UO-1	**Orientation:**	Vertical
Depth:	3-5 ft	**Test #:**	K9

Visual Description: Moist, soft, dark gray organic silt with shells

Sample Preparation: Extruded from Shelby tube, cut, trimmed and placed into permeameter at as received density and moisture content; trimmings moisture content = 122%

Permeant Fluid: de-aired tap water **Cell #:** ---

Parameter	Initial	Final
Height, in	4.16	4.01
Diameter, in	2.84	2.67
Area, in^2	6.33	5.60
Volume, in^3	26.35	22.45
Mass, g	577	513
Bulk Density, pcf	83.2	86.9
Moisture Content, %	119	95.0
Dry Density, pcf	37.9	44.5

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	21.3	**Press. Increment, psi:**	5
Sample Pressure, psi:	19.2	**B Coefficient:**	0.98

FLOW DATA

Date	Elapsed Time, sec	Cell Pressure, psi	Inlet Pressure, psi	Outlet Pressure, psi	Grad-ient	Inflow V, cc	Outflow V, cc	Δ Inflow V, cc	Δ Outflow V, cc	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
01/14	---	21.1	20.1	18.1	13.8	10.40	14.70	---	---	---	---	---
01/14	8940	21.1	20.1	18.1	13.8	14.70	10.60	4.30	4.10	20	1.000	9.42E-07
01/15	---	21.1	20.1	18.1	13.8	10.00	15.10	---	---	---	---	---
01/15	8220	21.1	20.1	18.1	13.8	14.00	10.95	4.00	4.15	20	1.000	9.94E-07
01/17	---	21.1	20.1	18.1	13.8	11.55	13.35	---	---	---	---	---
01/17	6840	21.1	20.1	18.1	13.8	14.90	10.00	3.35	3.35	20	1.000	9.82E-07
01/17	---	21.1	20.1	18.1	13.8	10.60	14.85	---	---	---	---	---
01/17	7680	21.1	20.1	18.1	13.8	14.35	11.10	3.75	3.75	20	1.000	9.79E-07

PERMEABILITY AT 20 °C: 9.7×10^{-7} cm/sec (@ 2 psi effective stress)

Note: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084

Constant Gradient

Client:	Nobis Engineering	**Start Date:**	12/29/99
Project Name:	New Bedford Harbor Superfund Site	**End Date:**	1/10/00
Project Location:	New Bedford, MA	**Tested By:**	SWJ
GTX #:	2409	**Checked By:**	GTT

Boring #:	FA-9	**Sample Type:**	Undisturbed
Sample #:	UO-1	**Orientation:**	Vertical
Depth:	2-4 ft	**Test #:**	K5
Visual Description:	Moist, brown silty sand with gravel, organics		

Sample Preparation: *Extruded from Shelby tube, cut, trimmed and placed into permeameter at as received density and moisture content; trimmings moisture content = 104%*

Permeant Fluid: de-aired tap water **Cell #:** —

Parameter	Initial	Final
Height, in	2.50	2.42
Diameter, in	2.85	2.73
Area, in^2	6.38	5.85
Volume, in^3	15.95	14.17
Mass, g	363	328
Bulk Density, pcf	86.5	88.0
Moisture Content, %	117	96.2
Dry Density, pcf	39.8	44.9

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	27.9	**Press. Increment, psi:**	5
Sample Pressure, psi:	25.8	**B Coefficient:**	0.96

FLOW DATA

Date	Elapsed Time, sec	Cell Pressure, psi	Inlet Pressure, psi	Outlet Pressure, psi	Grad-ient	Inflow V, cc	Outflow V, cc	Δ Inflow V, cc	Δ Outflow V, cc	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
01/10	—	29.0	27.5	26.5	11.4	9.75	15.00	—	—	—	—	—
01/10	3540	29.0	27.5	26.5	11.4	10.15	14.50	0.40	0.50	20	1.000	2.94E-07
01/10	7920	29.0	27.5	26.5	11.4	10.60	14.00	0.85	1.00	20	1.000	2.70E-07
01/10	7140	29.0	27.5	26.5	11.4	10.90	13.65	0.75	0.85	20	1.000	2.59E-07
01/10	7260	29.0	27.5	26.5	11.4	11.30	13.10	0.70	0.90	20	1.000	2.55E-07

PERMEABILITY AT 20 °C: 2.7 x 10^{-7} cm/sec (@ 2 psi effective stress)

Note: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084

Constant Gradient

Client:	Nobis Engineering	**Start Date:**	12/15/99
Project Name:	New Bedford Harbor Superfund Site	**End Date:**	12/28/99
Project Location:	New Bedford, MA	**Tested By:**	SWJ
GTX #:	2409	**Checked By:**	GTT

Boring #:	FD-7	**Sample Type:**	Undisturbed
Sample #:	U-1	**Orientation:**	Vertical
Depth:	1-3	**Test #:**	K4
Visual Description:	Moist, black organic clay with sand		

Sample Preparation: Extruded from Shelby tube, cut, trimmed and placed into permeameter at as received density and moisture content; trimmings moisture content = 136%

Permeant Fluid: de-aired tap water **Cell #:** —

Parameter	Initial	Final
Height, in	2.05	1.85
Diameter, in	2.82	2.56
Area, in^2	6.22	5.15
Volume, in^3	12.76	9.52
Mass, g	265	205
Bulk Density, pcf	79.0	81.8
Moisture Content, %	144.3	89.0
Dry Density, pcf	32.3	43.3

B COEFFICIENT DETERMINATION

Cell Pressure, psi: 105 **Press. Increment, psi:** 5

Sample Pressure, psi: 103 **B Coefficient:** 0.98

FLOW DATA

Date	Elapsed Time, sec	Cell Pressure, psi	Inlet Pressure, psi	Outlet Pressure, psi	Gradient	Inflow V, cc	Outflow V, cc	Δ Inflow V, cc	Δ Outflow V, cc	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
12/28	—	105.0	103.5	102.5	15.0	9.70	15.50	—	—	—	—	—
12/28	4140	105.0	103.5	102.5	15.0	10.35	14.80	0.65	0.70	20	1.000	3.28E-07
12/28	—	105.0	103.5	102.5	15.0	10.05	15.10	—	—	—	—	—
12/28	4620	105.0	103.5	102.5	15.0	10.75	14.40	0.70	0.70	20	1.000	3.05E-07
12/28	—	105.0	103.5	102.5	15.0	11.35	14.15	—	—	—	—	—
12/28	5040	105.0	103.5	102.5	15.0	12.05	13.45	0.70	0.70	20	1.000	2.80E-07
12/28	—	105.0	103.5	102.5	15.0	10.25	15.00	—	—	—	—	—
12/28	4500	105.0	103.5	102.5	15.0	10.90	14.35	0.65	0.65	20	1.000	2.91E-07

PERMEABILITY AT 20 °C: 3.0×10^{-7} cm/sec (@ 2 psi effective stress)

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084

Constant Gradient

Client:	Nobis Engineering	**Start Date:**	12/15/99
Project Name:	New Bedford Harbor Superfund Site	**End Date:**	12/28/99
Project Location:	New Bedford, MA	**Tested By:**	SWJ
GTX #:	2409	**Checked By:**	GTT

Boring #:	FD-6	**Sample Type:**	Undisturbed
Sample #:	U-2	**Orientation:**	Vertical
Depth:	4-6	**Test #:**	K3

Visual Description: Moist, very dark gray clayey sand with orgnics, shells

Sample Preparation: Extruded from Shelby tube, cut, trimmed and placed into permeameter at as received density and moisture content; trimmings moisture content = 103%

Permeant Fluid: de-aired tap water **Cell #:** —

Parameter	Initial	Final
Height, in	4.15	4.00
Diameter, in	2.87	2.71
Area, in^2	6.47	5.77
Volume, in^3	26.85	23.07
Mass, g	599	545
Bulk Density, pcf	84.8	89.8
Moisture Content, %	104.6	86.2
Dry Density, pcf	41.5	48.2

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	105	**Press. Increment, psi:**	5
Sample Pressure, psi:	103	**B Coefficient:**	0.95 assumed

FLOW DATA

Date	Elapsed Time, sec	Cell Pressure, psi	Inlet Pressure, psi	Outlet Pressure, psi	Grad-ient	Inflow V, cc	Outflow V, cc	Δ Inflow V, cc	Δ Outflow V, cc	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
12/27	—	105.0	104.0	102.0	13.8	10.25	17.45	—	—	—	—	—
12/27	3720	105.0	104.0	102.0	13.8	10.85	16.80	0.60	0.65	20	1.000	3.26E-07
12/27	3480	105.0	104.0	102.0	13.8	11.35	16.25	0.50	0.55	20	1.000	2.93E-07
12/27	6780	105.0	104.0	102.0	13.8	11.80	15.80	0.95	1.00	20	1.000	2.79E-07
12/27	7140	105.0	104.0	102.0	13.8	12.90	14.80	1.10	1.00	20	1.000	2.86E-07
12/27	—	105.0	104.0	102.0	13.8	11.00	14.20	—	—	—	—	—
12/27	3180	105.0	104.0	102.0	13.8	11.45	13.75	0.45	0.45	20	1.000	2.75E-07

PERMEABILITY AT 20 °C: 2.9 x 10^{-7} cm/sec (@ 2 psi effective stress)

Note: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084

Constant Gradient

Client:	Nobis Engineering	**Start Date:**	11/23/99
Project Name:	New Bedford Harbor Superfund Site	**End Date:**	11/26/99
Project Location:	New Bedford, MA	**Tested By:**	swj
GTX #:	2409	**Checked By:**	gtt
Boring #:	FC-19	**Sample Type:**	Undisturbed
Sample #:	UO-2	**Orientation:**	Vertical
Depth:	4-6	**Test #:**	K2
Visual Description:	Moist, dark gray organic silt		

Sample Preparation: Extruded from Shelby tube, cut, trimmed and placed into permeameter at as received density and moisture content; trimmings moisture content = 69.3%

Permeant Fluid: de-aired tap water **Cell #:** —

Parameter	Initial	Final
Height, in	2.27	2.14
Diameter, in	2.85	2.72
Area, in^2	6.38	5.81
Volume, in^3	14.48	12.43
Mass, g	363	327
Bulk Density, pcf	95.3	100.0
Moisture Content, %	74.8	57.5
Dry Density, pcf	54.5	63.5

B COEFFICIENT DETERMINATION

Cell Pressure, psi: 105 **Press. Increment, psi:** 5

Sample Pressure, psi: 100 **B Coefficient:** 0.95 assumed

FLOW DATA

Date	Elapsed Time, sec	Cell Pressure, psi	Inlet Pressure, psi	Outlet Pressure, psi	Gradient	Inflow V, cc	Outflow V, cc	Δ Inflow V, cc	Δ Outflow V, cc	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
11/26	—	105.0	100.8	99.2	20.7	10.30	14.75	—	—	—	—	—
11/26	1920	105.0	100.8	99.2	20.7	10.75	14.25	0.45	0.50	20	1.000	3.19E-07
11/26	3420	105.0	100.8	99.2	20.7	11.50	13.30	0.75	0.95	20	1.000	3.20E-07
11/26	—	105.0	100.8	99.2	20.7	10.65	14.15	—	—	—	—	—
11/26	4080	105.0	100.8	99.2	20.7	11.55	13.10	0.90	1.05	20	1.000	3.08E-07
11/26	2220	105.0	100.8	99.2	20.7	12.15	12.50	0.60	0.60	20	1.000	3.48E-07

PERMEABILITY AT 20 °C: 3.3×10^{-7} cm/sec (@ 5 psi effective stress)

Note: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

APEX

BORING LOG

Date:	12/13/2011		
Project: EPA LHCC	Project No: 6724.001	X:	815210
Location: New Bedford Harbor	North of Popes Island	Y:	2697039
Elevation at grade: -4.2	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -88	A2011-CAD4-B-1	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 1 of 4	
Driller: N. Studdard	Log By: GCD & GAD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
0 2		24.0" 6.0"	2,1,3,3	3" Black, organic SILT, some shell hash, some fine sand. 3" Dark grey, fine to medium SAND and organic SILT, trace shell hash.	-6.2
4		24.0" 12.0"	6,23,16, 12	Light grey, fine SAND, little inorganic SILT.	-8.2
6		24.0" 15.0"	14,8,9,12	Grey, inorganic SILT.	-10.2
8		24.0" 8.0"	6,6,4,6	Grey, inorganic SILT and fine SAND.	-12.2
10		24.0" 16.0"	5,4,10,24	Grey, inorganic SILT, little fine sand.	-14.2
12		24.0" 9.0"	6,4,7,10	Grey, inorganic SILT, little fine sand.	-16.2
14		24.0" 8.0"	7,4,5,5	Grey, inorganic SILT, little fine sand.	-18.2
16		24.0" 11.0"	6,5,5,7	Grey, inorganic SILT, little fine sand.	-20.2
18		24.0" 18.0"	6,4,4,6	Tan grey, SILT, little fine sand, grades to tan grey, fine SAND, little silt.	-22.2
20		24.0" 12.0"	9,9,12,9	Tan, fine SAND, grades to tan, SILT, little to some fine sand.	-24.2
22		24.0" 12.0"	4,6,6,9	Tan, fine SAND, little silt.	-26.2
24		24.0" 12.0"	9,9,12,9	Tan, fine SAND, little silt.	-28.2
26		24.0" 13.0"	8,5,7,7	Tan grey, SILT.	-30.2

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

	Date:	12/13/2011

APEX

BORING LOG

Project: EPA LHCC	Project No: 6724.001	X:	815210
Location: New Bedford Harbor	North of Popes Island	Y:	2697039
Elevation at grade: -4.2	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -88	A2011-CAD4-B-1	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 2 of 4	
Driller: N. Studdard	Log By: GCD & GAD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
26 28		24.0" 9.0"	3,3,5,9	Tan grey, SILT.	-32.2
30		24.0" 7.0"	7,4,6,8	Tan grey, SILT, little fine sand.	-34.2
32		24.0" 9.0"	8,9,14,14	Interbedded grey and tan, fine SAND and SILT.	-36.2
34		24.0" 15.0"	6,8,8,11	Interbedded grey and tan, fine SAND grades to SILT.	-38.2
36		24.0" 13.0"	2,2,5,8	Interbedded grey and tan, fine SAND grades to SILT.	-40.2
38		24.0" 12.0"	1,1,8,12	Interbedded grey and tan, fine SAND grades to SILT.	-42.2
40		24.0" 16.0"	6,6,8,6	2" Tan, fine SAND. 14" Grey, fine SAND, grades to SILT.	-44.2
42		24.0" 12.0"	3,5,5,7	Grey, fine SAND, little SILT.	-46.2
44		24.0" 9.0"	9,12,11, 11	Tan grey, SILT, some fine sand.	-48.2
46		24.0" 14.0"	18,16,18, 18	Grey, SILT.	-50.2
48		24.0" 12.0"	9,11,11,8	Grey, SILT, little fine sand.	-52.2
49		12.0" 6.0"	19,*	Grey, SILT, little fine sand. *Casing advancing with split spoon - casing dropped 4' on removal of split spoon.	-53.2
52		24.0" 11.0"	wor,wor, wor, 21	Grey, SILT - Casing penetrated through interval, split spoon driven inside of casing to collect sample.	-56.2

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX	Date: 12/13/2011

BORING LOG

Project: EPA LHCC	Project No: 6724.001	X:	815210
Location: New Bedford Harbor	North of Popes Island	Y:	2697039
Elevation at grade: -4.2	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -88	A2011-CAD4-B-1	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 3 of 4	
Driller: N. Studdard	Log By: GCD & GAD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
52 54		24.0" 9.0"	8,17,17, 10	7" Grey, fine SAND, little silt. 2" Grey fine to coarse SAND, some fine to coarse gravel, little silt.	-58.2
56		24.0" 2.0"	18,22,16, 23	Grey, fine to coarse GRAVEL, little silt, little fine to coarse sand - TILL.	-60.2
58		24.0" 0.0"	20,23,16, 33	Coarse GRAVEL plugging nose of spoon - probable TILL.	-62.2
60		24.0" 13.0"	28,33,72, 33	Grey, SILT, some fine to coarse sand, some fine to coarse gravel - TILL.	-64.2
62		24.0" 4.0"	20,25,17, 44	Grey, SILT, some fine to coarse sand, some fine to coarse gravel - TILL.	-66.2
64		24.0" 1.0"	8,13,18,2 3	Grey, fine to coarse GRAVEL, some fine to coarse sand, some silt - TILL.	-68.2
66		3.0" 1.5"	150/3"	Coarse GRAVEL. Obstruction encountered - drilled with roller bit through 6" cobble.	-70.2
68		24.0" 0.0"	30,21,33, 46	No Recovery	-72.2
70		24.0" 3.0"	46,26,33, 38	Grey, fine to coarse SAND, some silt, some fine to coarse gravel - TILL.	-74.2
72		24.0" 0.0"	33,26,27, 42	No Recovery	-76.2
72.4		5.0" 0.0"	150/5"	Grey, fine to coarse SAND, some silt, some fine to coarse gravel - TILL.	-76.6
73.8				Obstruction Encountered - 76.6' MLLW. Advanced roller bit to 78.0' MLLW and began coring.	-78.0
78.8	85%	5' 3.7'	5-4-5-4-8	Rock Core #1 -78.0 to -83.0 MLLW Grey, moderately fractured, GRANITE, slight gneissic banding. Pink granitic PEGMATITE 1.9'-2.3'.	-83.0

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX

BORING LOG

Date:	12/13/2011		
Project: EPA LHCC	Project No: 6724.001	X:	815210
Location: New Bedford Harbor	North of Popes Island	Y:	2697039
Elevation at grade: -4.2	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -88	A2011-CAD4-B-1	
Casing Diameter: 4"	Drill Rig: CME 55	Sheet: 4 of 4	
Drill Co: NH Boring	Method: Drive and Wash		
Driller: N. Studdard	Log By: GCD & GAD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
83.1	0%	4.3' 0.6'		Rock Core #2 -83.0 to -87.3 MLLW Grey, intensely fractured, GRANITE. Drill Rig stalling during core run - no drill times recorded.	-87.3
83.8	77%	0.7' 5.1'		Rock Core #3 -87.3 to -88.0 MLLW Grey, intensely to moderately fractured, GRANITE. Drill Rig stalling during core run - no drill times recorded.	-88.0

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

		Date:	12/19/2011

BORING LOG

Project: EPA LHCC		Project No: 6724.001	X: 815567
Location: New Bedford Harbor		North of Popes Island	Y: 2697300
Elevation at grade: -3.7	Datum:	MLLW	Boring No:
Casing Type: Steel	Boring Depth:	-82.7	A-2011-CAD4-B-2
Casing Diameter: 4"	Drill Rig:	CME 55	
Drill Co: NH Boring	Method:	Drive and Wash	Sheet: 1 of 3
Driller: N. Studdard	Log By:	CAS	

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
0 2		24.0" 12.0"	1, 1, 2, 2	Black, organic SILT, some fine sand, little silt, trace shell hash.	-3.7
4		24.0" 9.0"	1, 1, 1, 2	Gray brown, fine SAND, trace silt.	-7.7
6		24.0" 10.5"	1, 2, 4, 5	Brown, fine SAND, trace shell hash.	-9.7
8		24.0" 9.5"	3, 7, 11, 17	Brown, fine to medium SAND.	-11.7
10		24.0" 10.0"	4, 4, 8, 8	Brown, fine to medium SAND.	-13.7
12		24.0" 9.0"	2, 5, 11, 12	Brown, fine to coarse SAND, trace silt.	-15.7
14		21.0" 2.0"	12, 23, 30, 130-3	Brown, fine to coarse SAND, trace silt.	-17.7
16		24.0" 17.0"	39, 45, 39, 29	Light brown, fine to coarse SAND.	-19.7
18		24.0" 10.0"	23, 12, 19, 16	Light brown, fine to coarse SAND.	-21.7
20		24.0" 5.5"	11, 9, 11, 17	Light brown, fine to coarse SAND.	-23.7
22		24.0" 11.0"	12, 20, 37, 17	Light brown, fine to coarse SAND.	-25.7
24		24.0" 8.0"	15, 12, 10, 12,	Light brown, fine to coarse SAND.	-27.7
26		24.0" 5.0"	1, 3, 6, 7	Light brown, fine to coarse SAND.	-29.7

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

	Date:	12/19/2011

APEX

BORING LOG

Project: EPA LHCC		Project No: 6724.001	X: 815567
Location: New Bedford Harbor		North of Popes Island	Y: 2697300
Elevation at grade: -3.7	Datum:	MLLW	Boring No: A-2011-CAD4-B-2
Casing Type: Steel	Boring Depth:	-82.7	
Casing Diameter: 4"	Drill Rig:	CME 55	Sheet: 2 of 3
Drill Co: NH Boring	Method:	Drive and Wash	
Driller: N. Studdard	Log By:	CAS	

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
26 28		24.0" 12.0"	5, 6, 5, 5	Light brown, very fine to coarse SAND.	-29.7
30		24.0" 13.0"	1, 2, 4, 3	Light brown, very fine to coarse SAND.	-33.7
32		24.0" 13.0"	5, 14, 15, 13	Light brown reddish, fine to coarse SAND.	-35.7
34		24.0" 4.0"	16, 18, 11, 13	Light brown reddish fine to coarse SAND, some fine gravel.	-37.7
36		24.0" 8.0"	18, 15, 27, 40	Brown red, fine to coarse SAND and fine to coarse GRAVEL.	-39.7
38		24.0" 8.0"	50, 15, 26, 21	Dark brown, fine to coarse SAND, some medium gravel.	-41.7
40		24.0" 7.5"	90, 16, 10, 17	Dark brown, fine to coarse SAND, trace coarse gravel.	-43.7
42		24.0" 7.0"	20, 24, 15, 29	Light brown, fine to coarse SAND, trace gravel.	-45.7
44		20.0" 8.5"	32, 31, 47, 100-4	Gray, fine to coarse SAND, some gravel.	-47.7
44.25		3.0" 0.0"	120-3	Obstruction encountered, no recovery.	-48.0
48		0.0" 0.0"	100-0"	Advanced with roller bit through coarse gravel to -51.7' MLLW.	-51.7
50		0.0" 0.0"	100-0"	Advanced with roller bit through coarse gravel to 53.7' MLLW.	-53.7
51.1		11.0" 0.0"	50,120-5	Obstruction encountered at 54.8' MLLW, no recovery, roller bit to -55.7' MLLW.	-54.8

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX

BORING LOG

Date:	12/19/2011		
Project: EPA LHCC	Project No: 6724.001	X:	815567
Location: New Bedford Harbor	North of Popes Island	Y:	2697300
Elevation at grade: -3.7	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -82.7	A-2011-CAD4-B-2	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 3 of 3	
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
52 53		12" 4.5"	73, 100-6"	Gray/black, fine to coarse SAND, some gravel. Obstruction encountered at -56.7' MLLW, advanced with roller bit to -57.7' MLLW.	-56.7
54.75		9.0" 8.0"	15, 120-3"	Light gray, fine to coarse SAND and GRAVEL.	-58.5
56.2		2.0" 0.0"	120-2"	Obstruction Encountered: 59.9' MLLW.	-59.9
59				Advanced roller bit through cobbles and boulders to -62.7' MLLW and began core run.	-62.7
64		5' 4.8'	8-8-8-8-8	Rock Core #1: -62.7' to -67.7' MLLW Grey, moderately fractured, Granitic GNEISS.	-67.7
69		5' 5'	9-9-9-9-9	Rock Core #2: -67.7 to -72.7' MLLW Grey, moderately fractured, Granitic GNEISS.	-72.7

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX

BORING LOG

Date:	12/23/2011		
Project: EPA LHCC	Project No: 6724.001	X:	815854
Location: New Bedford Harbor	North of Popes Island	Y:	2696087
Elevation at grade: -6.7	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -94.3	A2011-CAD4-B-3	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 1 of 4	
Driller: N. Studdard	Log By: GCD & GAD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
0 2		24.0" 7.0"	WOR/24"	Black, organic SILT.	-8.7
4		24.0" 2.0"	WOH/24"	Black, organic SILT.	-10.7
6		24.0" 20.0"	WOH/24"	Black, organic SILT.	-12.7
8		24.0" 16.0"	1, WOH, 1, WOH	Black, organic SILT, grades to dark grey, organic SILT, trace shell hash.	-14.7
10		24.0" 21.0"	WOR/24"	Dark grey, organic SILT, trace shell hash.	-16.7
12		24.0" 7.0"	WOR/24"	Dark grey, organic SILT, trace shell hash.	-18.7
14		24.0" 19.0"	WOR/12" WOH/12"	Dark grey, organic SILT.	-20.7
16		24.0" 24.0"	WOR/12" WOH/12"	Dark grey, organic SILT.	-22.7
18		24.0" 12.0"	WOR/24"	Dark grey, organic SILT.	-24.7
20		24.0" 12.0"	WOR/24"	Dark grey, organic SILT.	-26.7
22		24.0" 9.0"	WOR/12" 3,2	Dark brown, PEAT and organic SILT	-28.7
24		24.0" 24.0"	WOR,2,2, 1	Dark brown to black, organic SILT, trace peat.	-30.7
26		24.0" 20.0"	WOR/12" 3,2	Dark grey, organic SILT, some plant fibers - PEAT.	-32.7

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

Date: 12/23/2011

BORING LOG

Project: EPA LHCC		Project No: 6724.001	X: 815854
Location: New Bedford Harbor		North of Popes Island	Y: 2696087
Elevation at grade: -6.7	Datum:	MLLW	Boring No:
Casing Type: Steel	Boring Depth:	-94.3	A2011-CAD4-B-3
Casing Diameter: 4"	Drill Rig:	CME 55	
Drill Co: NH Boring	Method:	Drive and Wash	Sheet: 2 of 4
Driller: N. Studdard	Log By:	GCD & GAD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
26 28		24.0" 3.0"	8,9,8,7	Grey, fine SAND, little inorganic silt.	-34.7
30		24.0" 10.0"	8,9,25,45	Grey, fine SAND, trace medium sand.	-36.7
32		24.0" 10.0"	3,4,8,12	Grey, fine SAND.	-38.7
34		24.0" 6.0"	5,8,7,8	Grey, fine SAND.	-40.7
36		24.0" 8.0"	3,4,8,9	Grey, fine SAND.	-42.7
38		24.0" 12.0"	4,6,6,10	Grey, fine to medium SAND.	-44.7
40		24.0" 6.0"	5,6,10,18	Grey, fine to coarse SAND.	-46.7
42		24.0" 2.0"	7,8,8,10	Grey, fine to coarse SAND and fine GRAVEL, trace silt.	-48.7
44		24.0" 9.0"	9,8,8,11	Grey, fine SAND. Grades to fine SAND, some silt.	-50.7
46		24.0" 6.0"	46,41,41, 30	Grey, fine to coarse SAND, trace silt	-52.7
48		24.0" 3.0"	30,28,26, 21	Greenish grey, fine to coarse SAND, trace silt - TILL.	-54.7
50				Obstruction Encountered - advanced with roller-bit to -57.7' MLLW.	-56.7
53		24.0" 0.0"	32,11,15, 23	rock fragment in nose of spoon	-59.7

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

		Date:	12/23/2011

BORING LOG

APEX

Project: EPA LHCC		Project No: 6724.001	X: 815854
Location: New Bedford Harbor		North of Popes Island	Y: 2696087
Elevation at grade: -6.7	Datum:	MLLW	Boring No: A2011-CAD4-B-3
Casing Type: Steel	Boring Depth:	-94.3	
Casing Diameter: 4"	Drill Rig:	CME 55	
Drill Co: NH Boring	Method:	Drive and Wash	Sheet: 3 of 4
Driller: N. Studdard	Log By:	GCD & GAD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
53 55		24.0" 4.0"	30,24,29, 46	Greenish grey, fine to coarse SAND, trace fine gravel, trace silt, TILL.	-61.7
57		24.0" 3.0"	28,14,12, 11	Greenish grey, fine to coarse SAND, trace fine gravel, trace silt, TILL.	-63.7
59		24.0" 6.0"	12,16,11, 15	Tan, fine to coarse SAND.	-65.7
61		24.0" 12.0"	52,38,21, 28	Tan, fine to coarse SAND.	-67.7
63		na na	na	Obstruction encountered at -67.7' MLLW. Advanced with roller bit to -69.7' MLLW.	-69.7
65		24.0" 18.0"	11,14,27, 39	Tan, fine to medium SAND, trace silt.	-71.7
67		24.0" 8.0"	12,14,28, 62	Olive green, fine to coarse SAND, trace silt, trace fine gravel, TILL	-73.7
68		na na	NA	Obstruction encountered at -73.7' MLLW. Advanced with roller bit to -74.7' MLLW.	-74.7
70		24.0" 4.0"	19,25,31, 77	Olive green, fine to coarse SAND, trace silt, trace fine gravel - TILL.	-76.7
72		24.0" 12.0"	20,25,30, 30	Olive green, fine to coarse SAND, trace silt, trace fine gravel - TILL.	-78.7
74		24.0" 8.0"	25,37,41, 66	Olive green, fine to coarse SAND, trace silt, trace fine gravel - TILL.	-80.7
75.3		16.0" 5.0"	25,39, 100/4"	Olive green, fine to coarse SAND, trace silt, trace fine gravel - TILL.	-82.0
				Obstruction Encountered - elevation -82.0' MLLW. Advanced roller bit to -84.3' MLLW and began core run.	

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX	**BORING LOG**	Date: 12/23/2011

Project: EPA LHCC	Project No: 6724.001	X: 815854
Location: New Bedford Harbor	North of Popes Island	Y: 2696087
Elevation at grade: -6.7	Datum: MLLW	Boring No: A2011-CAD4-B-3
Casing Type: Steel	Boring Depth: -94.3	
Casing Diameter: 4"	Drill Rig: CME 55	Sheet: 4 of 4
Drill Co: NH Boring	Method: Drive and Wash	
Driller: N. Studdard	Log By: GCD & GAD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
77.55 82.55	26%	5' 2.9'	8-7-8-7-7	Rock Core #1 -84.3 to -89.3 MLLW Grey, intensely fractured, granitic GNEISS	-89.3
87.55	63%	5' 4.8'	7-7-8-7-7	Rock Core #2 -89.3 to -94.3 MLLW Grey, intensely to moderately fractured, granitic GNEISS	-94.3

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX

BORING LOG

Date:	1/6/2012

Project: EPA LHCC	Project No: 6724.001	X:	816005
Location: New Bedford Harbor	North of Popes Island	Y:	2695847
Elevation at grade: -7.2	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -69.2	A-2011-CAD4-B-4	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 1 of 3	
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
0 2		24.0" 2.0"	WOR	Black, organic SILT.	-9.2
4		24.0" 8.0"	WOR	Black, organic SILT.	-11.2
6		24.0" 10.0"	WOR	Black, organic SILT.	-13.2
8		24.0" 12.0"	WOR	Black, organic SILT.	-15.2
10		24.0" 12.0"	WOR	Black, organic SILT.	-17.2
12		24.0" 8.0"	WOR	Black/grey, organic SILT.	-19.2
14		24.0" 24.0"	WOR, WOR, 1, 1	Black, organic SILT.	-21.2
16		24.0" 20.0"	WOR, 6, 12, 15	Black, organic SILT, some fine to medium sand.	-23.2
18		24.0" 4.0"	19, 21, 24, 30	Grey, fine to medium SAND.	-25.2
20		24.0" 12.0"	15, 15, 12, 11	Grey, inorganic SILT.	-27.2
22		24.0" 16.0"	6, 7, 14, 16	Grey, inorganic SILT.	-29.2
24		24.0" 19.0"	25, 22, 19, 11	Grey, inorganic SILT.	-31.2
26		24.0" 9.0"	10, 15, 19, 25	Grey, inorganic SILT.	-33.2

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX

BORING LOG

Date:	1/6/2012		
Project: EPA LHCC	Project No: 6724.001	X:	816005
Location: New Bedford Harbor	North of Popes Island	Y:	2695847
Elevation at grade: -7.2	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -69.2	A-2011-CAD4-B-4	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 2 of 3	
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
26 28		24.0" 11.0"	7, 14, 17, 21	Grey, inorganic SILT.	-35.2
30		24.0" 11.0"	19, 24, 25, 30	Grey, inorganic SILT.	-37.2
32		24.0" 11.0"	17, 23, 25, 31	Grey, inorganic SILT.	-39.2
34		24.0" 7.0"	4, 6, 7, 6	Grey, fine to medium SAND.	-41.2
36		NA NA	NA	Obstruction encountered at - 41.2' MLLW. Advanced Roller bit to -43.2 MLLW.	-43.2
38		24.0" 10.0"	21, 13, 16, 25	Grey, fine to coarse SAND - TILL.	-45.2
39		NA NA	NA	Obstruction encountered at --45.2 MLLW, Advanced with roller bit to -46.2 MLLW.	-46.2
41		24.0" 8.0"	30, 24, 21, 11	Grey, fine to coarse SAND, trace gravel - TILL.	-48.2
43		24.0" 6.0"	13, 13, 10, 19	Grey, fine to coarse SAND - TILL.	-50.2
45		24.0" 6.0"	24, 14, 18, 24	Brown, fine to medium SAND - TILL.	-52.2
47		24.0" 4.0"	23, 20, 38, 25	Brown, fine to medium SAND - TILL.	-54.2
49.8		22.0" 4.0"	37, 25, 15, 25/4"	Brown, fine to medium SAND - TILL.	-57.0
52				Obstruction encountered at -57.0 through -59.0 MLLW, advanced with roller bit to -59.2 MLLW and began coring.	-59.2

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX

BORING LOG

Date:	1/6/2012

Project: EPA LHCC	Project No: 6724.001	X:	816005
Location: New Bedford Harbor	North of Popes Island	Y:	2695847
Elevation at grade: -7.2	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -69.2	A-2011-CAD4-B-4	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 3 of 3	
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
52 57	76%	5' 4.5'	8-8-8-8-8	Rock Core #1 -59.2 to -64.2 MLLW Grey, moderate to intensily fractured granitic GNEISS.	-64.2
62	80%	5' 4.6'	8-8-8-8-8	Rock Core #2 -64.2 to -69.2 MLLW Grey, moderate to intensily fractured granitic GNEISS.	-69.2

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

BORING LOG

APEX

Date:	1/10/2012

Project: EPA LHCC	Project No: 6724.001	X:	815579
Location: New Bedford Harbor	North of Popes Island	Y:	2697429
Elevation at grade: -6.0	Datum: MLLW	Boring No:	A-2011-CAD4-B-5
Casing Type: Steel	Boring Depth: -56.0		
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 1 of 2	
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
2		24.0" 12.0"	WOR,12, 1, 1	Black, organic SILT, trace shell hash.	-8.0
4		24.0" 12.0"	WOR, 6, 1, 1	Black/brown, fine to medium SAND, some organic silt.	-10.0
6		24.0" 16.0"	18, 15, 14, 10	Black/brown, fine to medium SAND, some organic silt, trace shell hash.	-12.0
8		24.0" 7.0"	4, 4, 8, 10	Black/brown, fine to medium SAND, trace shell hash.	-14.0
10		24.0" 9.0"	14, 22, 23, 29	Brown, fine to medium SAND.	-16.0
12		24.0" 14.0"	5, 9, 7, 11	Brown, fine to medium SAND, little silt.	-18.0
14		24.0" 10.0"	15, 16, 22,	Brown red to grey, fine to medium SAND, trace silt.	-20.0
16		24.0" 8.0"	42, 25, 31, 47	Grey, fine to medium SAND, trace silt.	-22.0
18		24.0" 4."0	45, 9, 9, 15	Grey, medium to coarse gravel. Obstruction encountered at -24.0 MLLW. Advanced with roller bit to -25.0 MLLW.	-24.0
21		24.0" 8.0"	10, 14, 20, 19	Brown, fine to coarse SAND and GRAVEL.	-27.0
23		24.0" 6.0"	23, 21, 25, 25	Brown, medium to coarse SAND and GRAVEL.	-29.0
25		24.0" 5.0"	31, 30, 22, 25	Brown, fine to coarse SAND.	-31.0
27		24.0" 7.0"	35, 21, 12, 40	Brown, fine to coarse SAND, some gravel.	-33.0

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX	**BORING LOG**	Date: 1/10/2012

Project: EPA LHCC	Project No: 6724.001	X:	815579
Location: New Bedford Harbor	North of Popes Island	Y:	2697429
Elevation at grade: -6.0	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -56.0	A-2011-CAD4-B-5	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 2	of 2
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
27 30		NA NA	NA	Obstruction encountered at -33.0' MLLW. Advanced with rollerbit to -36.0' MLLW	-36.0
31.3		16.0" 4.0"	24, 11, 120/4"	Brown, fine to coarse SAND - TILL. Obstruction encountered at -37.3 MLLW, advanced with roller bit to -38.0 MLLW.	-37.3
33.3		16.0" 0.0"	30, 32, 140/4"	No recovery. Obstruction encountered at -39.3 MLLW, advanced with roller bit to -40.0' MLLW.	-39.3
36		24.0" 2.0"	40, 46, 42, 41	Brown, fine to coarse SAND - TILL.	-42.0
37		NA NA	NA	Obstruction encountered at -42.0 MLLW, advanced with roller bit to -43.0' MLLW.	-43.0
37.75		9.0" 6.0"	47, 125/3"	Red brown, fine to coarse SAND - TILL. Obstruction encountered at -43.8' MLLW.	-43.8
40			NA	Advanced with roller bit to -46.0' MLLW and began coring.	-46.0
45	90%	5.0' 5.0'	8-8-8-8-8	C1- Rock Core -46' to -51' MLLW Grey, moderately to slightly fractured granitic GNEISS.	-51.0
50	34%	5.0' 5.0'	8-8-8-8-8	C2- Rock Core -51' to -56' MLLW Grey, intensely fractured granitic GNEISS.	-56.0
			23, 21, 25, 25		

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

	Date: 1/16/2012

APEX

BORING LOG

Project: EPA LHCC		Project No: 6724.001	X: 816110
Location: New Bedford Harbor		North of Popes Island	Y: 2696504
Elevation at grade: -8.6	Datum:	MLLW	Boring No: A-2011-CAD4-B-6
Casing Type: Steel	Boring Depth:	-76.6	
Casing Diameter: 4"	Drill Rig:	CME 55	
Drill Co: NH Boring	Method:	Drive and Wash	Sheet: 1 of 3
Driller: N. Studdard	Log By:	CAS	

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
0 2		24.0" 10.0"	WOR/24"	Black, organic SILT.	-10.6
4		24.0" 7.0"	WOR/24"	Black, organic SILT.	-12.6
6		24.0" 22.0"	WOR/24"	Black, organic SILT.	-14.6
8		24.0" 22.0"	WOR/24"	Black, organic SILT.	-16.6
10		24.0" 18.0"	WOH/24"	Black, organic SILT.	-18.6
12		24.0" 20.0"	WOH/24"	Black, organic SILT.	-20.6
14		24.0" 24.0"	WOR, WOR, 7,14	Black, organic SILT, grades to grey, inorganic SILT.	-22.6
16		24.0" 7.0"	7, 6, 4, 4	Grey, inorganic SILT.	-24.6
18		24.0" 8.0"	6, 7, 6, 6	Grey, inorganic SILT.	-26.6
20		24.0" 8.0"	6, 7, 7, 10	Grey, inorganic SILT.	-28.6
22		24.0" 2.0"	17, 17, 32, 14	Grey, fine to medium SAND, trace silt.	-30.6
24		24.0" 13.0"	17, 20, 21, 7	Grey, fine to medium SAND.	-32.6
26		24.0" 6.0"	28, 14, 12, 12	Grey, fine to medium SAND.	-34.6

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX

BORING LOG

Date:	1/16/2012		
Project: EPA LHCC	Project No: 6724.001	X:	816110
Location: New Bedford Harbor	North of Popes Island	Y:	2696504
Elevation at grade: -8.6	Datum: MLLW	Boring No:	A-2011-CAD4-B-6
Casing Type: Steel	Boring Depth: -76.6		
Casing Diameter: 4"	Drill Rig: CME 55	Sheet: 2	of 3
Drill Co: NH Boring	Method: Drive and Wash		
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
26 28		24.0" 8.0"	22, 25, 38, 31	Brown/grey, fine to medium SAND, trace silt.	-36.6
30		24.0" 10.0"	WOH, 4, 3, 1	Brown, fine to medium SAND.	-38.6
32		24.0" 11.0"	5, 4, 6, 4	Brown, fine to medium SAND.	-40.6
34		24.0" 4.0"	24, 29, 24, 14	Brown, fine to coarse SAND, trace silt.	-42.6
36		24.0" 3.0"	WOR, 13, 21, 33	Brown, fine to coarse SAND, trace silt.	-44.6
38		24.0" 1.0"	11, 9, 7, 6	Brown, fine to coarse SAND, trace silt.	-46.6
40		24.0" 2.0"	17, 39, 46, 25	Brown, fine to coarse SAND, trace silt.	-48.6
42		24.0" 1.0"	9, 15, 18, 7	Brown, medium to coarse SAND, trace silt.	-50.6
44		24.0" 3.0"	12, 56, 6, 10	Brown, fine to coarse SAND, trace silt.	-52.6
46		NA NA	NA	Cobbles encountered at -52.6' MLLW. Advanced with roller bit to -54.6' MLLW.	-54.6
46.4		5.0" 1.0"	120/5"	Brown, fine to medium SAND. Obstruction encountered at -55.0' MLLW advanced with roller bit to -55.6' MLLW.	-55.0
49		24.0" 7.0"	35, 27, 70, 90	Brown, fine to medium SAND, some gravel- obstruction encountered at -57.6' MLLW, advanced with roller bit to -59.6' MLLW	-57.6
53		24.0 5.0	65, 28, 33, 43	Brown, fine to medium SAND, trace gravel	-61.6

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX	Date: 1/16/2012

BORING LOG

Project: EPA LHCC		Project No: 6724.001	X: 816110
Location: New Bedford Harbor		North of Popes Island	Y: 2696504
Elevation at grade: -8.6	Datum:	MLLW	Boring No:
Casing Type: Steel	Boring Depth:	-76.6	A-2011-CAD4-B-6
Casing Diameter: 4"	Drill Rig:	CME 55	
Drill Co: NH Boring	Method:	Drive and Wash	Sheet: 3 of 3
Driller: N. Studdard	Log By:	CAS	

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
53 53.2		2.0 0.0	120/2"	Obstruction encountered at 61.8 MLLW, advanced with roller bit to -64.6' MLLW.	-61.8
56.3		4.0 2.0	144/4"	Brown, very fine to medium SAND. Obstruction encountered -64.9' MLLW.	-64.9
58				Advanced with roller bit to -66.6' MLLW, and began coring	-66.6
63	40%	5' 4'	7-7-7-7-7	C1- Rock core -66.6 to -71.6 MLLW Grey, intensely fractured granitic GNEISS.	-71.6
68	34%	5' 5'	8-8-8-8-8	C2- Rock core -71.6 to -76.6 MLLW Grey, moderately fractured granitic GNEISS.	-76.6

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

	Date:	1/19/2012

APEX

BORING LOG

Project: EPA LHCC	Project No: 6724.001	X:	815079
Location: New Bedford Harbor	North of Popes Island	Y:	2697445
Elevation at grade: -8.1	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -70.1	A-2011-CAD4-B-7	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 1 of 3	
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
0 2		24.0" 20.0"	WOR/24"	Black, organic SILT.	-10.1
4		24.0" 10.0"	WOR/24"	Black, organic SILT.	-12.1
6		24.0" 23.0"	WOR/24"	Grey/Black, organic SILT.	-14.1
8		24.0" 22.0"	15, 12, 12, 10	6" Black, organic SILT. 16" Grey, fine SAND.	-16.1
10		24.0" 20.0"	6, 13, 10, 8	Brown, very fine to fine SAND, some inorganic silt.	-18.1
12		24.0" 13.0"	9, WOH/18"	Brown, very fine to fine SAND, some silt, trace red fine sand.	-20.1
14		24.0" 23.0"	WOH,8, 12, 8	Brown, very fine to fine SAND.	-22.1
16		24.0" 7.0"	13, 9, 14, 15	Red-brown, very fine to fine SAND.	-24.1
18		24.0" 7.0"	9, 10, 14, 14	Brown, fine to medium SAND.	-26.1
19.9		21.0" 19.0"	11, 17, 36, 160/5"	Brown, fine to medium SAND.	-28.0
20		NA NA	NA	Obstruction encountered - cobble. Advanced with roller bit to -29.1' MLLW.	-28.1
23		24.0" 19.0"	8, 8, 20, 30	Brown red, very fine to medium SAND, trace shell hash.	-31.1
25		24.0" 15.0"	12, 12, 13, 18	Brown, very fine to fine SAND, trace medium sand.	-33.1

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

Date:	1/19/2012

BORING LOG

Project: EPA LHCC	Project No: 6724.001	X:	815079
Location: New Bedford Harbor	North of Popes Island	Y:	2697445
Elevation at grade: -8.1	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -70.1	A-2011-CAD4-B-7	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 2 of 3	
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
25 27		24.0" 18.0"	7, 5, 5, 5	Brown, very fine to fine SAND.	-35.1
29		24.0" 22.0"	5, 18, 33, 28	Brown, very fine to medium SAND.	-37.1
31		24.0" 21.0"	14, 19, 26, 26	Brown grey, very fine to fine SAND.	-39.1
32		24.0" 20.0"	WOH/12" 3,2	Brown, fine to medium SAND.	-40.1
34		24.0" 20.0"	WOH/18", 2	Brown, very fine to fine SAND.	-42.1
36		24.0" 17.0"	4, 6, 8, 10	Brown, very fine to fine SAND.	-44.1
38		24.0" 24.0"	9, 11, 12, 14	Brown, very fine to fine SAND.	-46.1
40		24.0" 7.0"	6, 12, 15, 23	2" Red brown, very fine to fine SAND, trace gravel. 5" Red brown, fine to coarse SAND.	-48.1
42		24.0" 8.0"	3, 5, 11, 13	Red brown, fine to coarse SAND.	-50.1
44		24.0" 6.0"	42, 22, 14, 15	Brown grey, fine to coarse SAND.	-52.1
46		24.0" 0.0"	WOH, 5, 12, 13	No recovery.	-54.1
46.5		6.0" 1.0"	120/6"	Brown, fine to coarse SAND, trace gravel.	-54.6
48		NA NA	NA	Obstruction encountered at -54.6' MLLW, Advanced with roller bit to -56.1' MLLW.	-56.1

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

Date:	1/19/2012

APEX

BORING LOG

Project: EPA LHCC	Project No: 6724.001	X:	815079
Location: New Bedford Harbor	North of Popes Island	Y:	2697445
Elevation at grade: -8.1	Datum: MLLW	Boring No:	
Casing Type: Steel	Boring Depth: -70.1	A-2011-CAD4-B-7	
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drive and Wash	Sheet: 3 of 3	
Driller: N. Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
48 48.4		5.0" 5.0"	120/5"	Brown, fine to medium SAND. Obstruction encountered at -56.5' MLLW.	-56.5
52				Advanced with roller bit to -60.1' MLLW, and began coring.	-60.1
57	92%	5' 5'	7-8-8-7-8	C1- Rock core -60.1 to -65.1 MLLW Grey, slightly fractured granitic GNEISS.	-65.1
62	80%	5' 5'	7-7-7-7-7	C2- Rock core -65.1 to -70.1 MLLW Grey, slightly fractured granitic GNEISS.	-70.1

Notes/ Comments:

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3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

Date:	1/23/2012

BORING LOG

Project: EPA LHCC	Project No: 6724.001	X:	816040
Location: New Bedford Harbor	North of Popes Island	Y:	2696259
Elevation at grade: -7.9	Datum: MLLW	Boring No: A-2011-CAD4-B-8	
Casing Type: Steel	Boring Depth: -79.9		
Casing Diameter: 4"	Drill Rig: CME 55		
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 3	
Driller: N Studdard	Log By: CAS		

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
0 2		24.0" 12.0"	WOR/24"	Black, organic, SILT.	-9.9
4		24.0" 10.0"	WOH/24"	Black, organic, SILT.	-11.9
6		24.0" 24.0"	WOH/24"	Black, organic, SILT.	-13.9
8		24.0" 12.0"	WOH/12" 1, WOH	Black, organic, SILT.	-15.9
10		24.0" 7.0"	WOH/24"	Black, organic, SILT.	-17.9
12		24.0" 24.0"	WOH/24"	Dark grey to black, organic SILT.	-19.9
14		24.0" 24.0"	1,2,1,2	Dark grey to black, organic SILT.	-21.9
17		36.0" 24.0"	WOR/12" 2,2, WOH/12"	Dark grey to black, organic SILT.	-24.9
18		12.0" 12.0"	3,4	Dark grey to black, organic SILT, trace peat.	-25.9
20		24.0" 24.0"	WOR,12, 5,6	Dark grey to black, organic SILT and PEAT.	-27.9
22		24.0" 24.0"	WOR, 3,3,6	Black, organic SILT and PEAT.	-29.9
24		24.0" 23.0"	WOR, 2,8,9	Black to dark brown, organic SILT and PEAT.	-31.9
26		24.0" 24.0"	8,8,7,9	Dark brown, PEAT, trace to some organic silt.	-33.9

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

BORING LOG

APEX

Date:	1/23/2012

Project: EPA LHCC	Project No: 6724.001	X: 816040
Location: New Bedford Harbor	North of Popes Island	Y: 2696259
Elevation at grade: -7.9	Datum: MLLW	Boring No: A-2011-CAD4-B-8
Casing Type: Steel	Boring Depth: -79.9	
Casing Diameter: 4"	Drill Rig: CME 55	Sheet: 2 of 3
Drill Co: NH Boring	Method: Drill and Wash	
Driller: N Studdard	Log By: CAS	

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
26 28		24.0" 24.0"	7,8,9,7	Brown, PEAT, trace organic silt.	-35.9
30		24.0" 9.0"	7,7,8,7	Brown grey, very fine to coarse SAND and inorganic SILT, trace gravel.	-37.9
32		24.0" 7.0"	8,9,10,22	5" Grey, fine to coarse SAND. 2" Grey, inorganic SILT.	-39.9
34		24.0" 10.0"	25,18,19, 29	Grey, inorganic SILT.	-41.9
36		24.0" 8.0"	15,15,28, 24	Grey, inorganic SILT.	-43.9
38		24.0" 1.0"	13,17,16, 13	Grey, inorganic SILT.	-45.9
40		24.0" 10.0"	10,11,6,1 0	Grey, very fine to fine SAND.	-47.9
42		24.0" 15.0"	11,13,14, 9	Grey, very fine to fine SAND.	-49.9
44		24.0" 11.0"	16,10,16, 29	9" Grey, very fine to fine SAND. 2" Grey, inorganic SILT.	-51.9
46		24.0" 18.0"	4,11,12, 14	Grey, very fine to fine SAND.	-53.9
48		NA NA	NA	Obstruction Encountered. Advanced with roller bit to -55.9' MLLW.	-55.9
50		24.0" 18.0"	15,18,20, 17	Grey, very fine to medium SAND.	-57.9
51		NA NA	NA	Obstruction encountered. Advanced with roller bit to -58.9' MLLW.	-58.9

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

APEX		Date: 1/23/2012

BORING LOG

Project: EPA LHCC	Project No: 6724.001	X: 816040
Location: New Bedford Harbor	North of Popes Island	Y: 2696259
Elevation at grade: -7.9	Datum: MLLW	Boring No: A-2011-CAD4-B-8
Casing Type: Steel	Boring Depth: -79.9	
Casing Diameter: 4"	Drill Rig: CME 55	Sheet: 3 of 3
Drill Co: NH Boring	Method: Drill and Wash	
Driller: N Studdard	Log By: CAS	

Depth below mudline (ft)	RQD	Penetration/ Recovery	SPT Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
51 53		NA NA	NA	Obstruction encountered. Advanced with roller bit to -60.9' MLLW.	-60.9
55		24.0" 4.0"	23,18,20, 40	Grey, fine to coarse SAND. Coarse gravel in nose of spoon.	-62.9
57		24.0" 10.0"	46,70, 84,62	Grey, fine to medium SAND.	-64.9
59		NA NA	NA	Obstruction encountered. Advanced with roller bit to -66.9' MLLW.	-66.9
61		24.0" 7.0"	40,30, 30, 21	Grey, fine to medium SAND.	-68.9
61.8		10.0" 10.0"	47, 100/4"	Brown red, fine to coarse SAND. Obstruction Encountered -69.7' MLLW.	-69.7
62				Advanced with roller bit to -69.9' MLLW, and began coring.	-69.9
67	32%	5' 5'	7-7-7-7-7	C1 - Rock core -69.9 to -74.9' MLLW Grey, intensely to moderately fractured granitic GNEISS.	-74.9
72	80%	5' 5'	8-8-8-8-8	C2 - Rock core -74.9 to - 79.9' MLLW Grey, moderately fractured granitc GNEISS. Pink, PEGMATITE 2.4 to 2.8' and 3.8 to 5.0'.	-79.9

Notes/ Comments:

1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.

2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool.

3). SPT tests conducted using a 2" Split Spoon, driven with a 140 lb donut hammer dropped from a height of 30". In instances of poor sample recovery, a 2" or 3" split spoon was readvanced through the same interval for increased sample recovery only.

GeoTesting EXPRESS

Client:	Apex Companies, LLC
Project Name:	LHCC
Project Location:	New Bedford, MA
GTX #:	11493
Test Date:	02/02/12
Tested By:	jek
Checked By:	jdt

Density (Unit Weight) of Soil by ASTM D 7263

Boring ID	Sample ID	Depth, ft	Visual Description	Bulk Density, lb/ft^3	Moisture Content, %	Dry Density, lb/ft^3
B-1	A-2011-CAD4	0-2	Moist, dark grayish brown sand with silt and gravel	129	17.4	110
B-1	A-2011-CAD4	6-8	Moist, gray sandy silt	124	21.9	102
B-1	A-2011-CAD4	26-28	Moist, olive sandy silt	119	22.9	96.6
B-1	A-2011-CAD4	48-50	Moist, olive silt with sand	118	17.1	101
B-2	A-2011-CAD4	2-4	Moist, grayish brown sand with silt	121	19.9	101
B-2	A-2011-CAD4	14-16	Moist, brown sand with silt and gravel	132	7.1	123
B-2	A-2011-CAD4	30-32	Moist, olive sand with gravel	136	17.0	116
B-2	A-2011-CAD4	36-38	Moist, dark yellowish brown sand with silt and gravel	105	9.7	96.0
B-3	A-2011-CAD4	8-10	Wet, very dark gray clay	93.3	81.3	51.4
B-3	A-2011-CAD4	18-20	Wet, very dark brown silty sand	69.1	276.5	18.3
B-3	A-2011-CAD4	30-32	Moist, olive sand with silt	119	20.1	99.0
B-3	A-2011-CAD4	38-40	Moist, grayish green sand	118	11.2	107

GeoTesting EXPRESS

Client:	Apex Companies, LLC
Project Name:	LHCC
Project Location:	New Bedford, MA
GTX #:	11493
Test Date:	02/02/12
Tested By:	jek
Checked By:	jdt

Density (Unit Weight) of Soil by ASTM D 7263

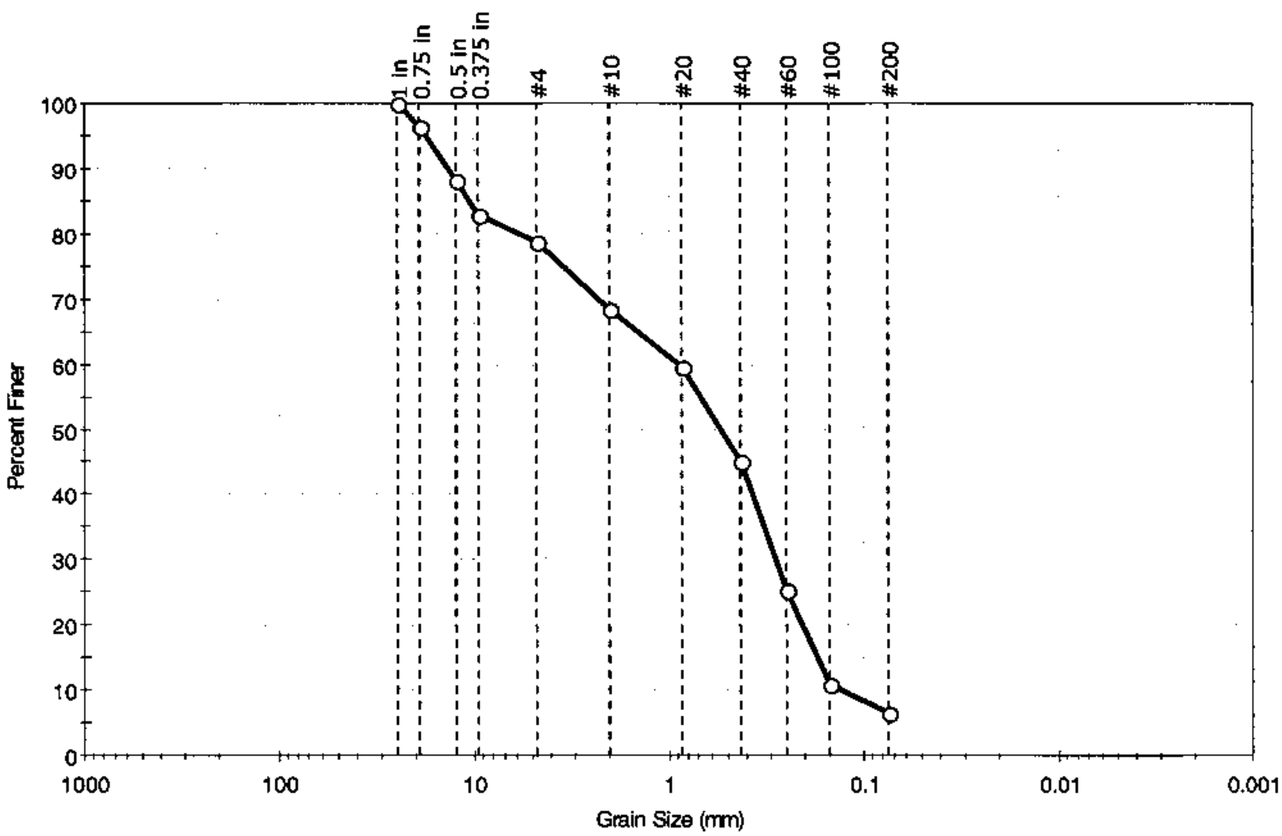
Boring ID	Sample ID	Depth, ft	Visual Description	Bulk Density, lb/ft^3	Moisture Content, %	Dry Density, lb/ft^3
B-4	A-2011-CAD4	2-4	Wet, very dark gray clay with sand	93.7	82.1	51.4
B-4	A-2011-CAD4	22-24	Moist, gray silt	117	26.9	92.0
B-4	A-2011-CAD4	41-43	Moist, gray sand with gravel	119	14.0	104
B-5	A-2011-CAD4	0-2	Moist, very dark gray sand with silt	134	19.4	112
B-5	A-2011-CAD4	8-10	Moist, brown sand	114	19.0	95.7
B-5	A-2011-CAD4	25-27	Moist, olive gravel with silt and sand	127	6.6	119
B-6	A-2011-CAD4	2-4	Wet, very dark grayish brown sandy silt	91.8	105.6	44.6
B-6	A-2011-CAD4	8-10	Wet, grayish brown sandy silt	101	60.5	62.7
B-6 (COMP)	A-2011-CAD4	20-44	Moist, yellowish brown sand with silt and gravel	125	9.8	114
B-6	A-2011-CAD4	36-38	Moist, olive sand	119	16.6	102
B-6	A-2011-CAD4	47-49	Moist, yellowish brown silty sand with gravel	118	7.8	109

Notes: Density determined on disturbed samples by hand compacting into a container of known volume, measuring mass of soil and calculating.

Moisture content determined by ASTM D 2216 at 110° C

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-1	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	0-2 ft	Test Id:	228105		
Test Comment:	---				
Sample Description:	Moist, dark grayish brown sand with silt and gravel				
Sample Comment:	Shells noted in sample				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	21.3	72.2	6.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	97		
0.5 in	12.50	88		
0.375 in	9.50	83		
#4	4.75	79		
#10	2.00	69		
#20	0.85	60		
#40	0.42	45		
#60	0.25	25		
#100	0.15	11		
#200	0.075	6		

Coefficients

D_{85} =10.6615 mm	D_{30} =0.2827 mm
D_{60} =0.8795 mm	D_{15} =0.1726 mm
D_{50} =0.5382 mm	D_{10} =0.1281 mm
C_u =6.866	C_c =0.709

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : SOFT

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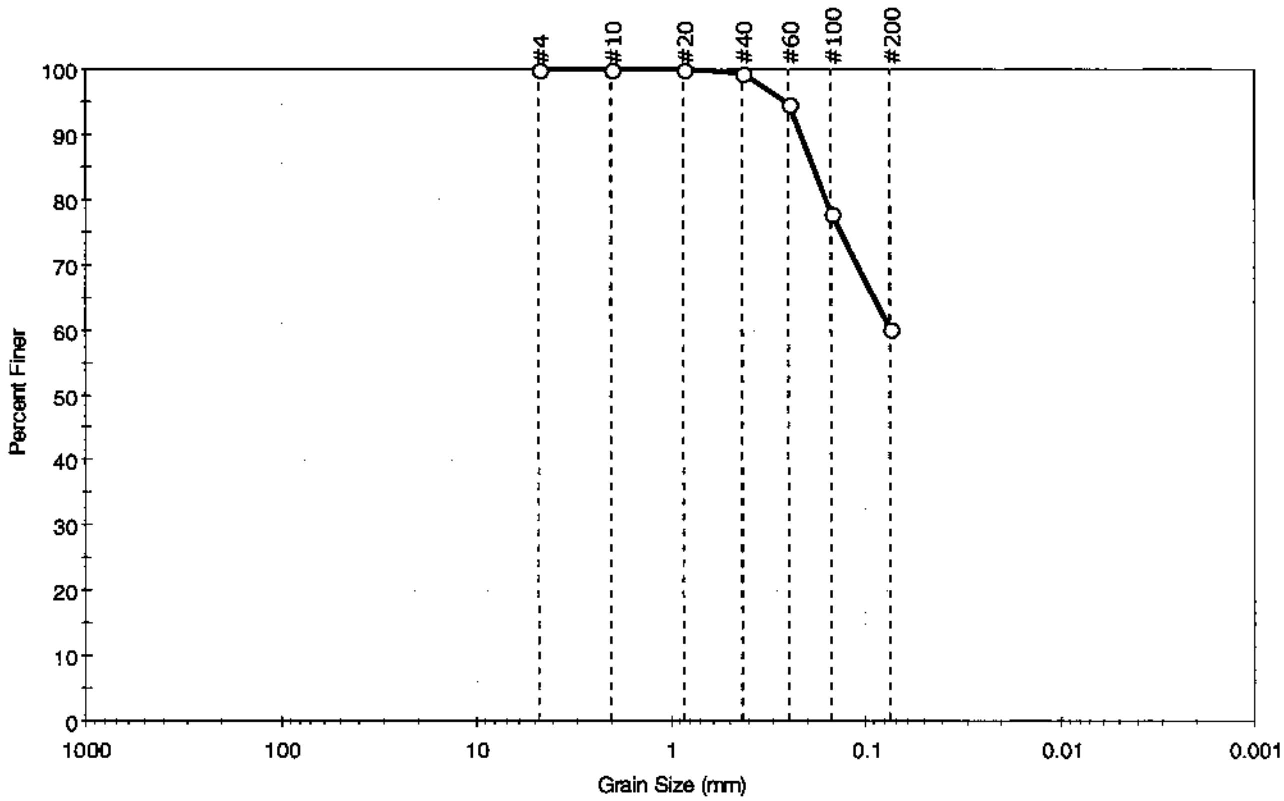
Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-1	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	6-8 ft	Test Id:	228106		
Test Comment:	---				
Sample Description:	Moist, gray sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	39.9	60.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	95		
#100	0.15	78		
#200	0.075	60		

Coefficients

D_{85} = 0.1859 mm
D_{30} = N/A
D_{60} = N/A
D_{15} = N/A
D_{50} = N/A
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

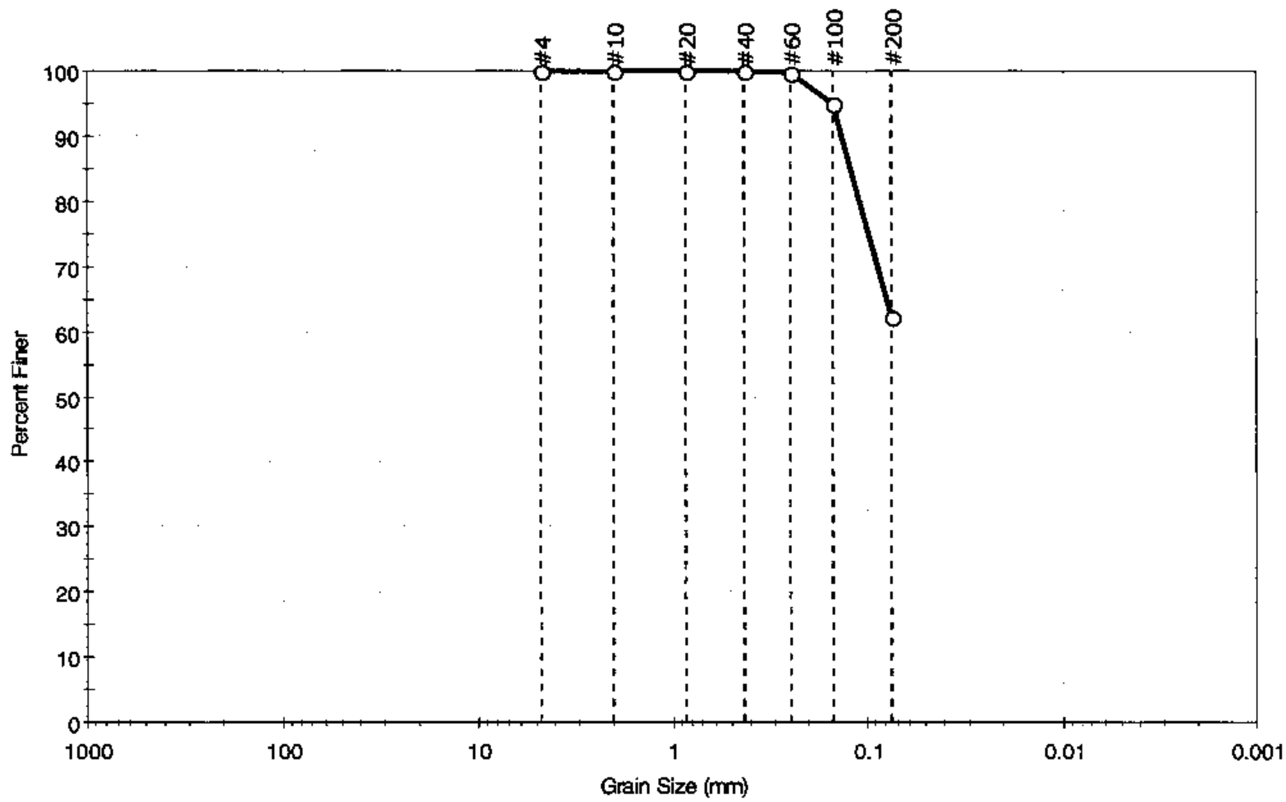
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID: B-1		Sample Type:	bag	Tested By:	jbr
Sample ID:A-2011-CAD4		Test Date:	01/27/12	Checked By:	jdt
Depth : 26-28 ft		Test Id:	228107		
Test Comment:	---				
Sample Description:	Moist, olive sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	37.7	62.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	95		
#200	0.075	62		

Coefficients

D_{85} =0.1211 mm D_{30} =N/A
D_{60} =N/A D_{15} =N/A
D_{50} =N/A D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

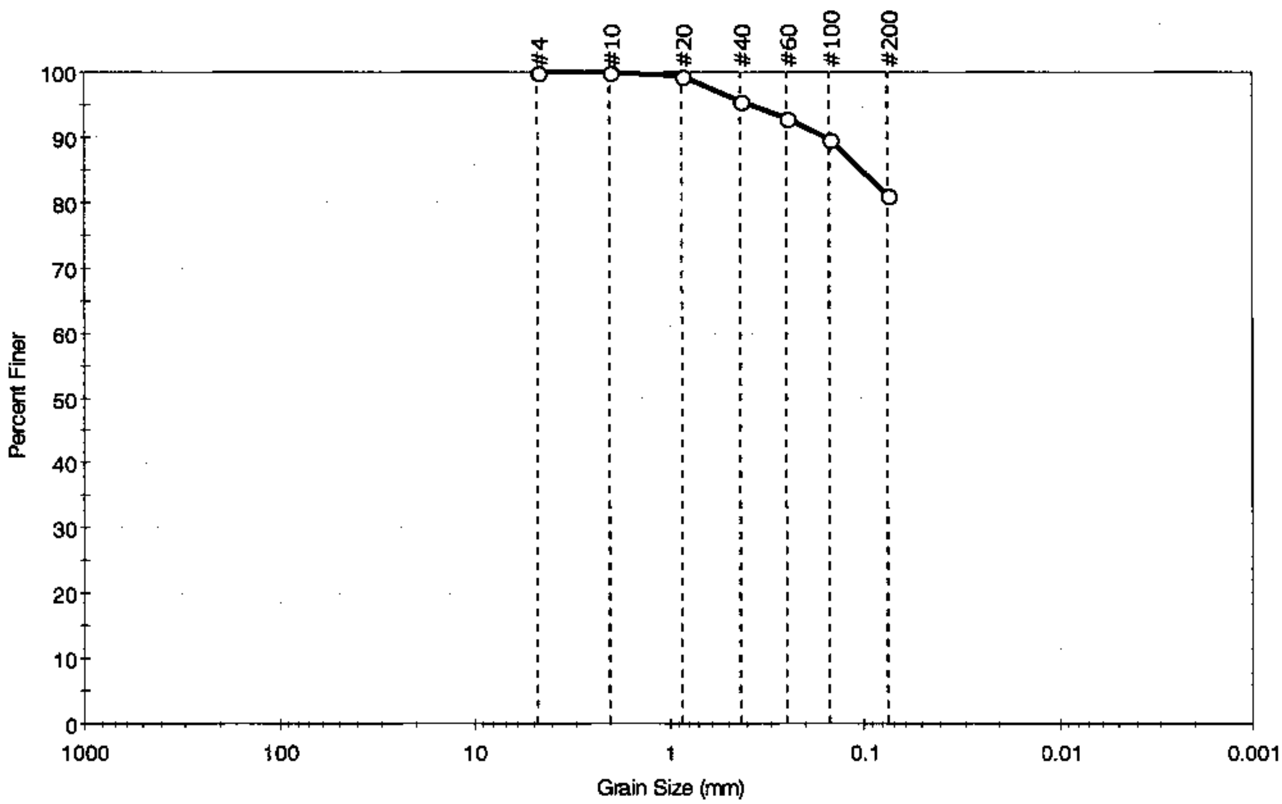
Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-1	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	48-50 ft	Test Id:	228108		

Test Comment: ---
Sample Description: Moist, olive silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	19.0	81.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	96		
#60	0.25	93		
#100	0.15	90		
#200	0.075	81		

Coefficients

D_{85} = 0.1038 mm	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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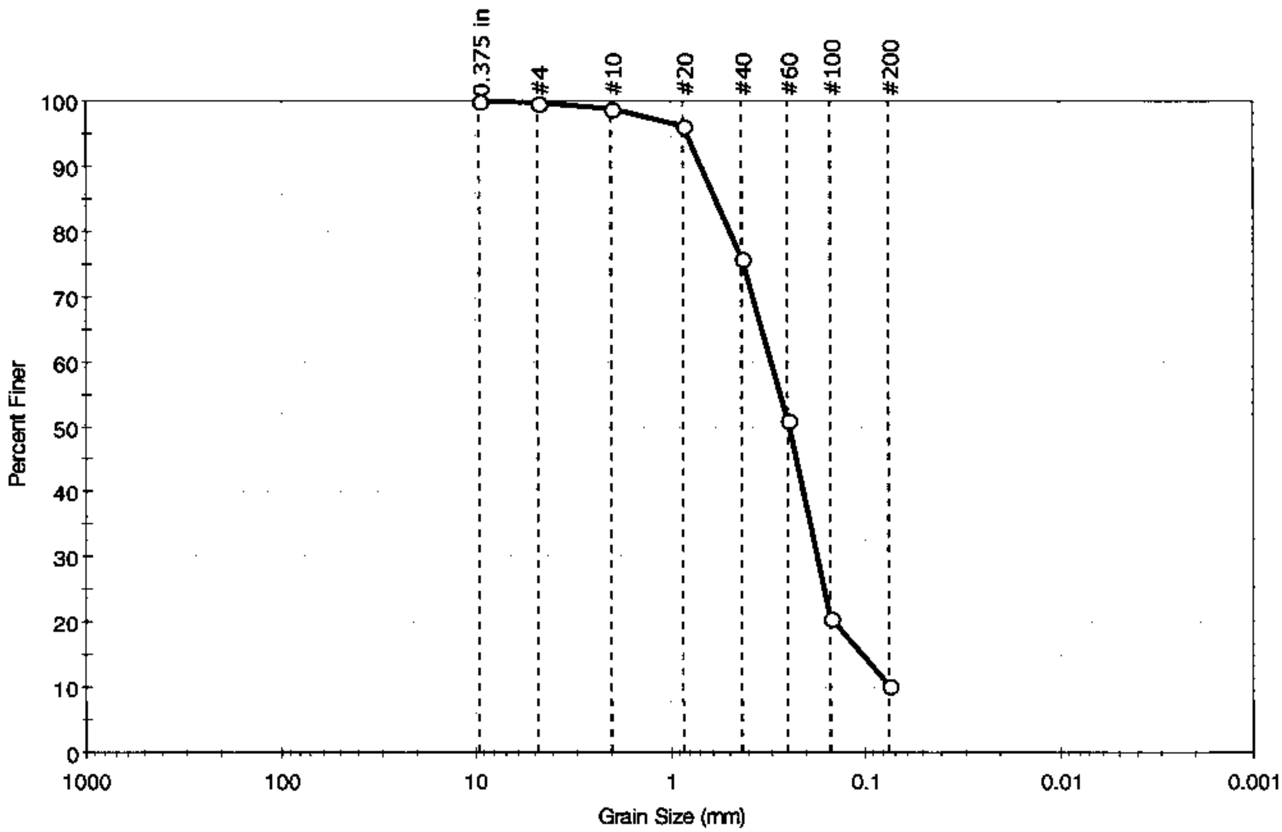
Client: Apex Companies, LLC			
Project: LHCC			
Location: New Bedford, MA		Project No:	GTX-11493
Boring ID: B-2	Sample Type: bag	Tested By:	jbr
Sample ID: A-2011-CAD4	Test Date: 01/30/12	Checked By:	jdt
Depth : 2-4 ft	Test Id: 228098		

Test Comment: ---
Sample Description: Moist, grayish brown sand with silt
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.3	89.3	10.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	99		
#20	0.85	96		
#40	0.42	76		
#60	0.25	51		
#100	0.15	21		
#200	0.075	10		

Coefficients

D_{85} =0.5824 mm | D_{30} =0.1756 mm
D_{60} =0.3026 mm | D_{15} =0.1025 mm
D_{50} =0.2453 mm | D_{10} =0.0729 mm
C_u =4.151 | C_c =1.398

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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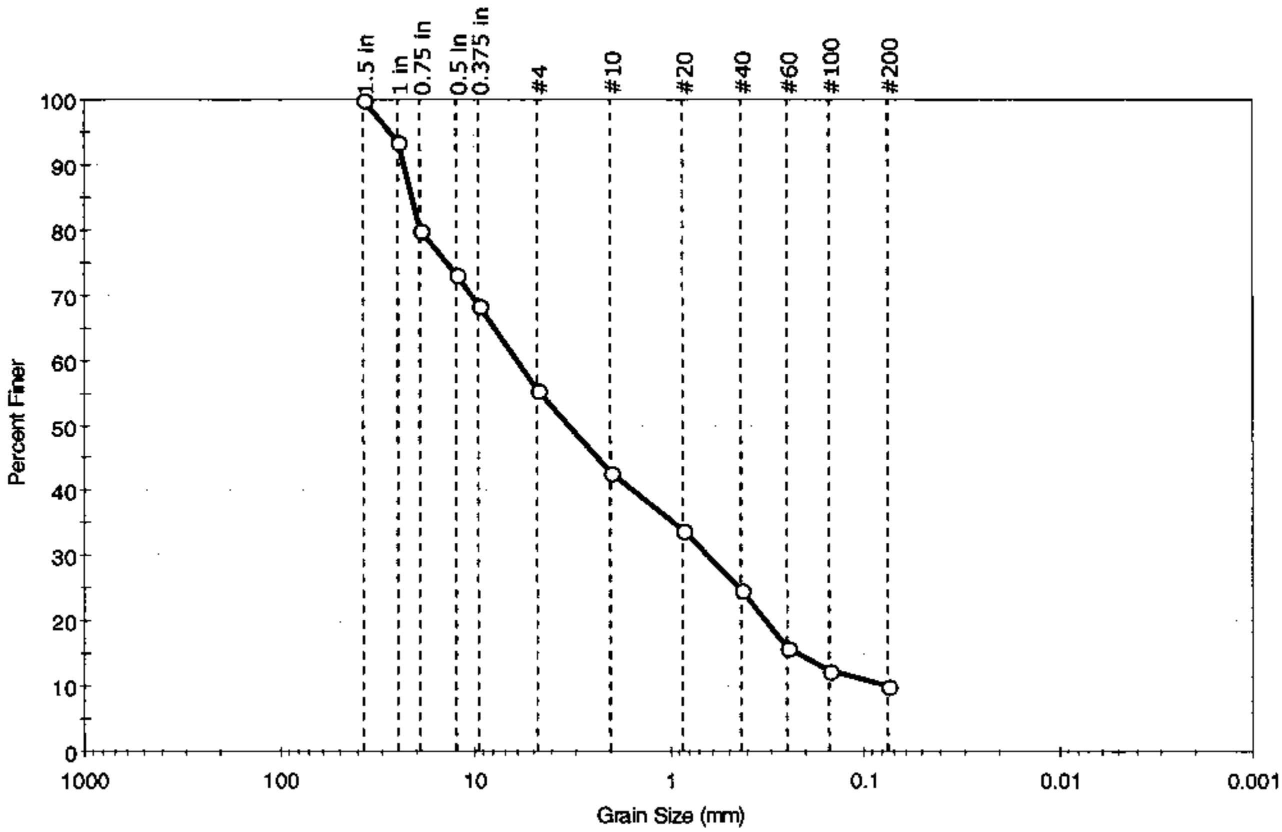
Client: Apex Companies, LLC			
Project: LHCC			
Location: New Bedford, MA		Project No:	GTX-11493
Boring ID: B-2	Sample Type: bag	Tested By:	jbr
Sample ID: A-2011-CAD4	Test Date: 01/30/12	Checked By:	jdt
Depth : 14-16 ft	Test Id: 228099		

Test Comment: ---
Sample Description: Moist, brown sand with silt and gravel
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	44.5	45.4	10.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	93		
0.75 in	19.00	80		
0.5 in	12.50	73		
0.375 in	9.50	68		
#4	4.75	55		
#10	2.00	43		
#20	0.85	34		
#40	0.42	25		
#60	0.25	16		
#100	0.15	13		
#200	0.075	10		

Coefficients

D_{85} =21.0785 mm
D_{30} =0.6327 mm
D_{60} =6.0496 mm
D_{15} =0.2146 mm
D_{50} =3.2695 mm
D_{10} =0.0728 mm
C_u =83.099
C_c =0.909

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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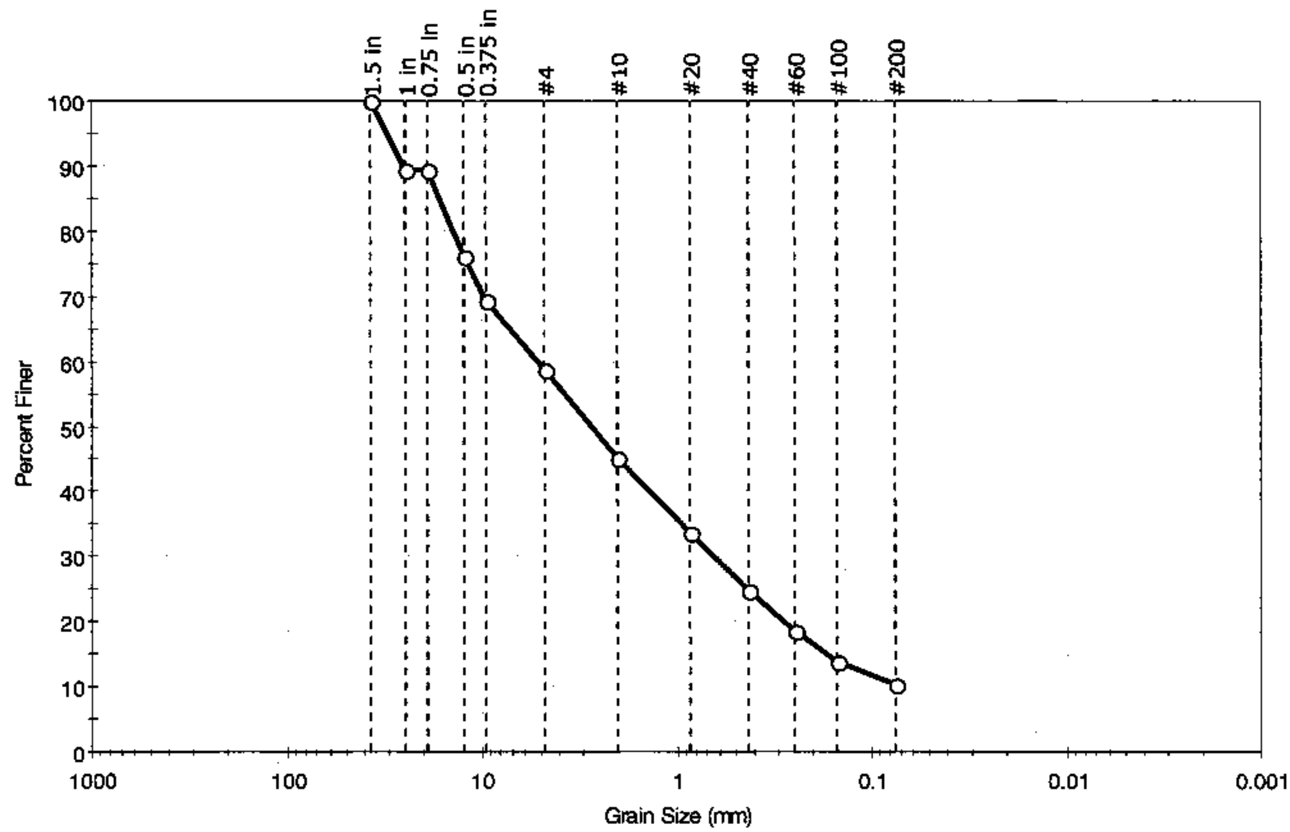
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-2	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	36-38 ft	Test Id:	228100		
Test Comment:	---				
Sample Description:	Moist, dark yellowish brown sand with silt and gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	41.4	48.2	10.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	89		
0.75 in	19.00	89		
0.5 in	12.50	76		
0.375 in	9.50	69		
#4	4.75	59		
#10	2.00	45		
#20	0.85	34		
#40	0.42	25		
#60	0.25	18		
#100	0.15	14		
#200	0.075	10		

Coefficients

D_{85} =16.5008 mm
D_{30} =0.6398 mm
D_{60} =5.2112 mm
D_{15} =0.1685 mm
D_{50} =2.7505 mm
D_{10} =0.0691 mm
C_u =75.415
C_c =1.137

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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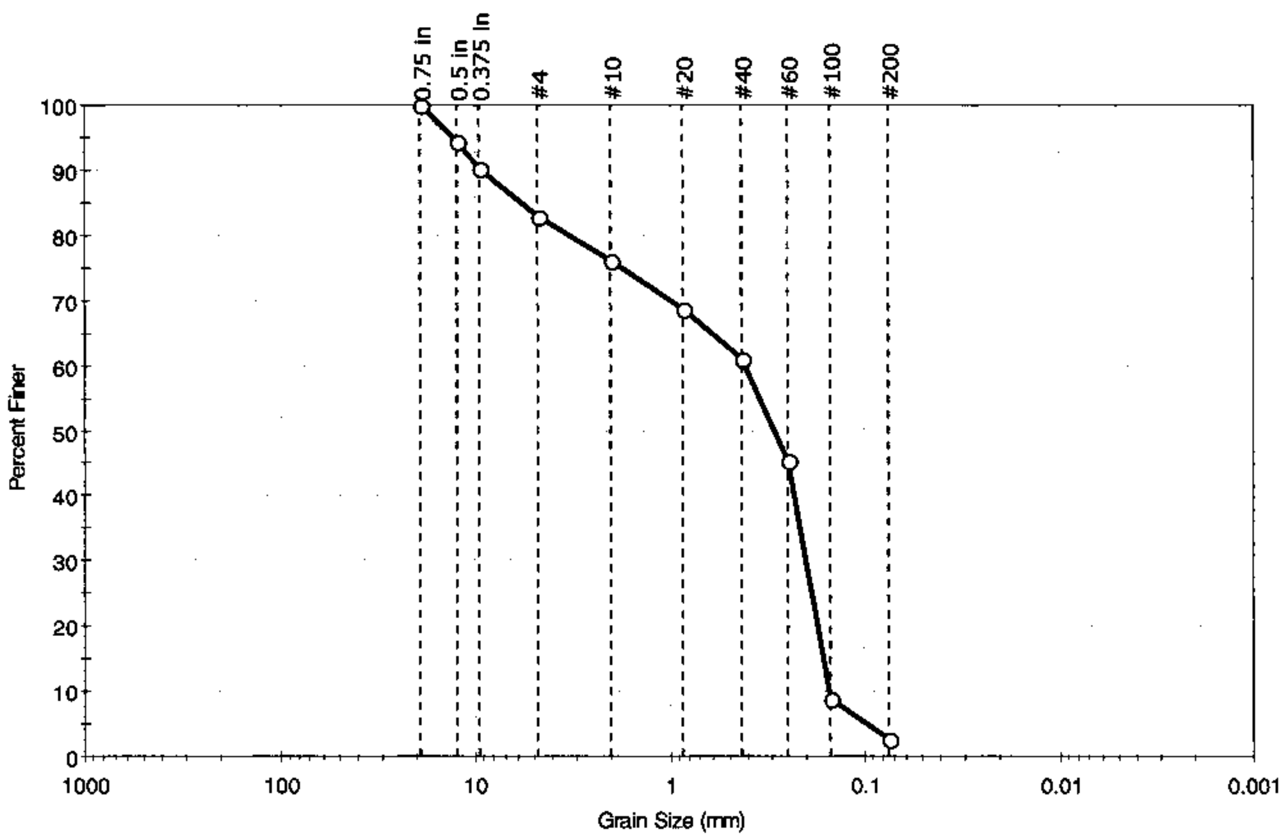
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-2	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	30-32 ft	Test Id:	228101		
Test Comment:	---				
Sample Description:	Moist, olive sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	17.1	80.2	2.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	94		
0.375 in	9.50	90		
#4	4.75	83		
#10	2.00	76		
#20	0.85	69		
#40	0.42	61		
#60	0.25	46		
#100	0.15	9		
#200	0.075	3		

Coefficients

D_{85} =5.7767 mm	D_{30} =0.2012 mm
D_{60} =0.4109 mm	D_{15} =0.1632 mm
D_{50} =0.2915 mm	D_{10} =0.1522 mm
C_u =2.700	C_c =0.647

Classification

ASTM Poorly graded sand with gravel (SP)

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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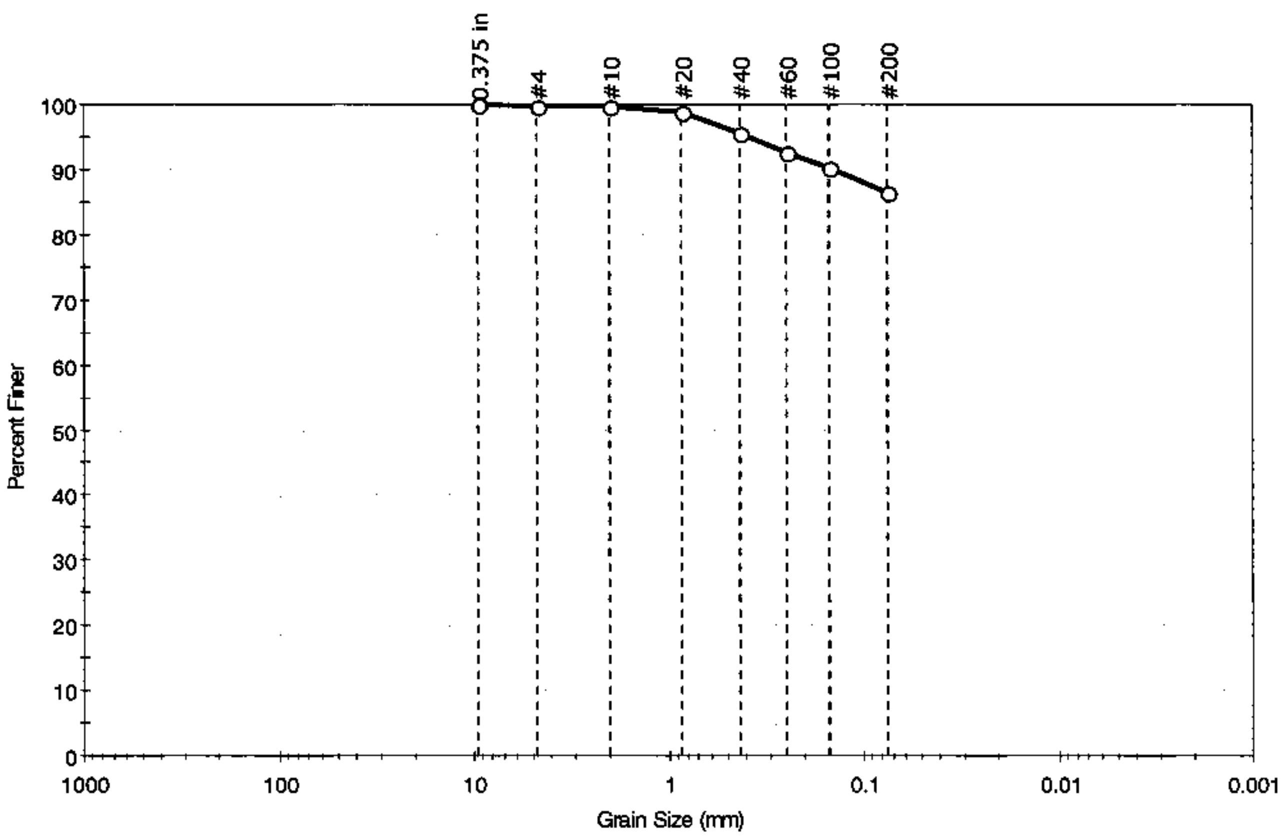
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID: B-3		Sample Type:	bag	Tested By:	jbr
Sample ID:A-2011-CAD4		Test Date:	01/30/12	Checked By:	jdt
Depth :	8-10 ft	Test Id:	228094		

Test Comment: ---
Sample Description: Wet, very dark gray clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.2	13.4	86.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	95		
#60	0.25	93		
#100	0.15	90		
#200	0.075	86		

Coefficients

D_{85} = N/A D_{30} = N/A
D_{60} = N/A D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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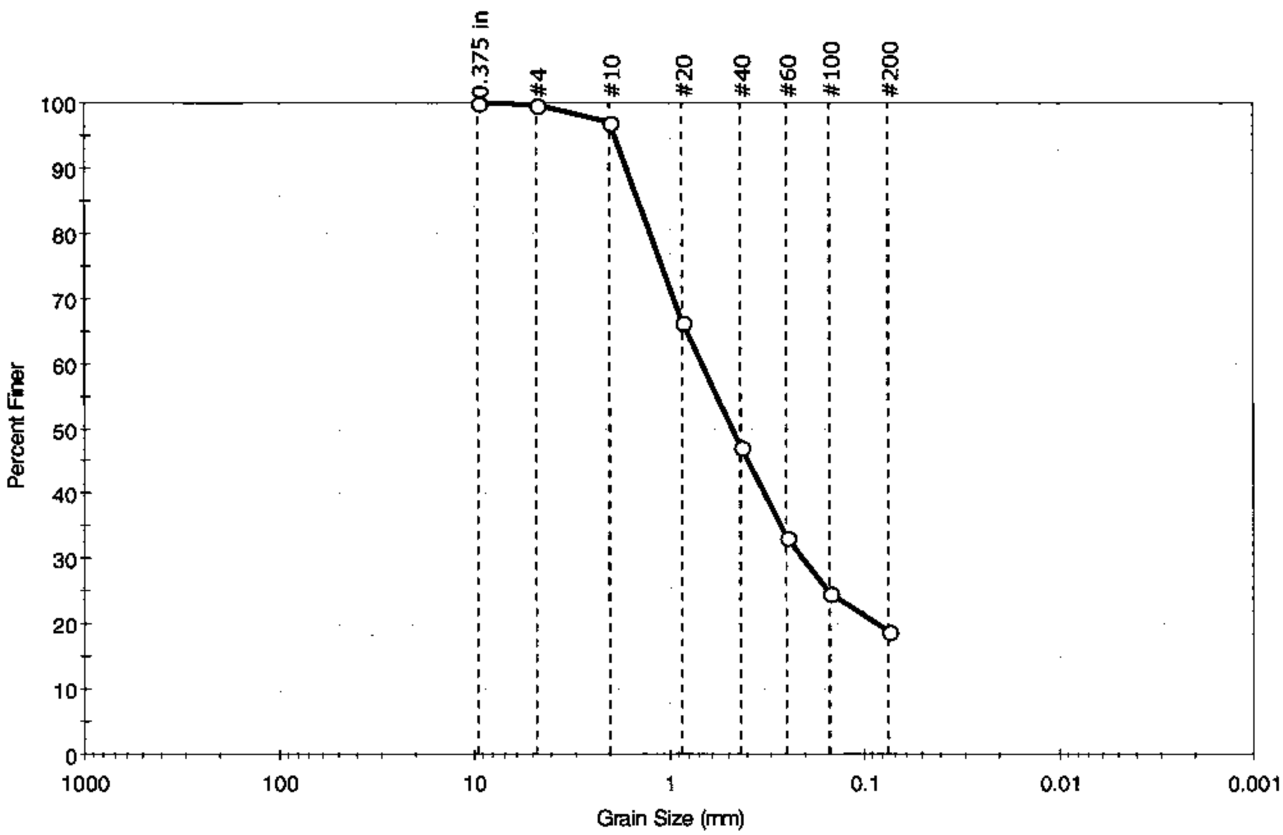
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-3	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	18-20 ft	Test Id:	228095		

Test Comment: ---
Sample Description: Wet, very dark brown silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.3	80.9	18.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	97		
#20	0.85	66		
#40	0.42	47		
#60	0.25	33		
#100	0.15	25		
#200	0.075	19		

Coefficients

D_{85} =1.4270 mm D_{30} =0.2049 mm
D_{60} =0.6736 mm D_{15} =N/A
D_{50} =0.4693 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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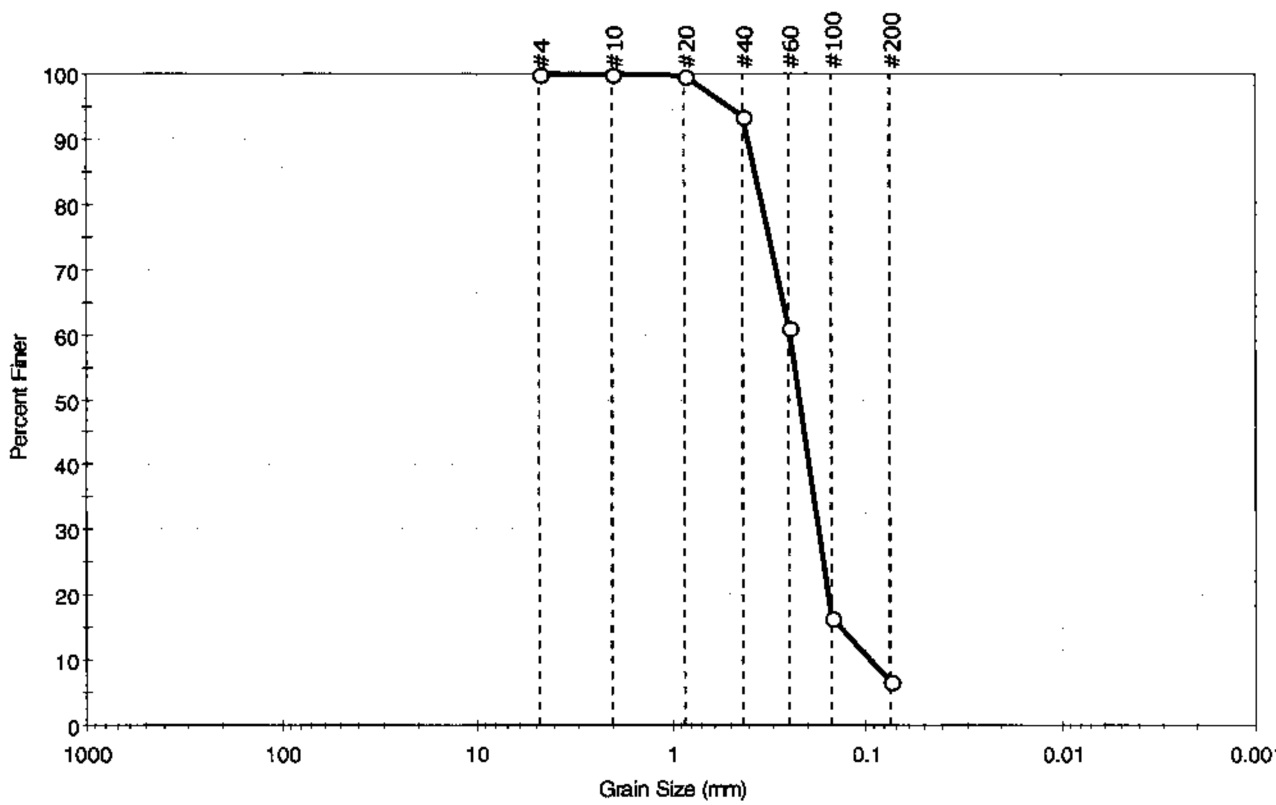
GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: LHCC			
Location: New Bedford, MA		Project No:	GTX-11493
Boring ID: B-3	Sample Type: bag	Tested By:	jbr
Sample ID:A-2011-CAD4	Test Date: 01/30/12	Checked By:	jdt
Depth : 30-32 ft	Test Id: 228096		

Test Comment: ---
Sample Description: Moist, olive sand with silt
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	93.3	6.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	94		
#60	0.25	61		
#100	0.15	16		
#200	0.075	7		

Coefficients

D_{85} = 0.3696 mm D_{30} = 0.1752 mm
D_{60} = 0.2467 mm D_{15} = 0.1358 mm
D_{50} = 0.2201 mm D_{10} = 0.0949 mm
C_u = 2.600 C_c = 1.311

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---

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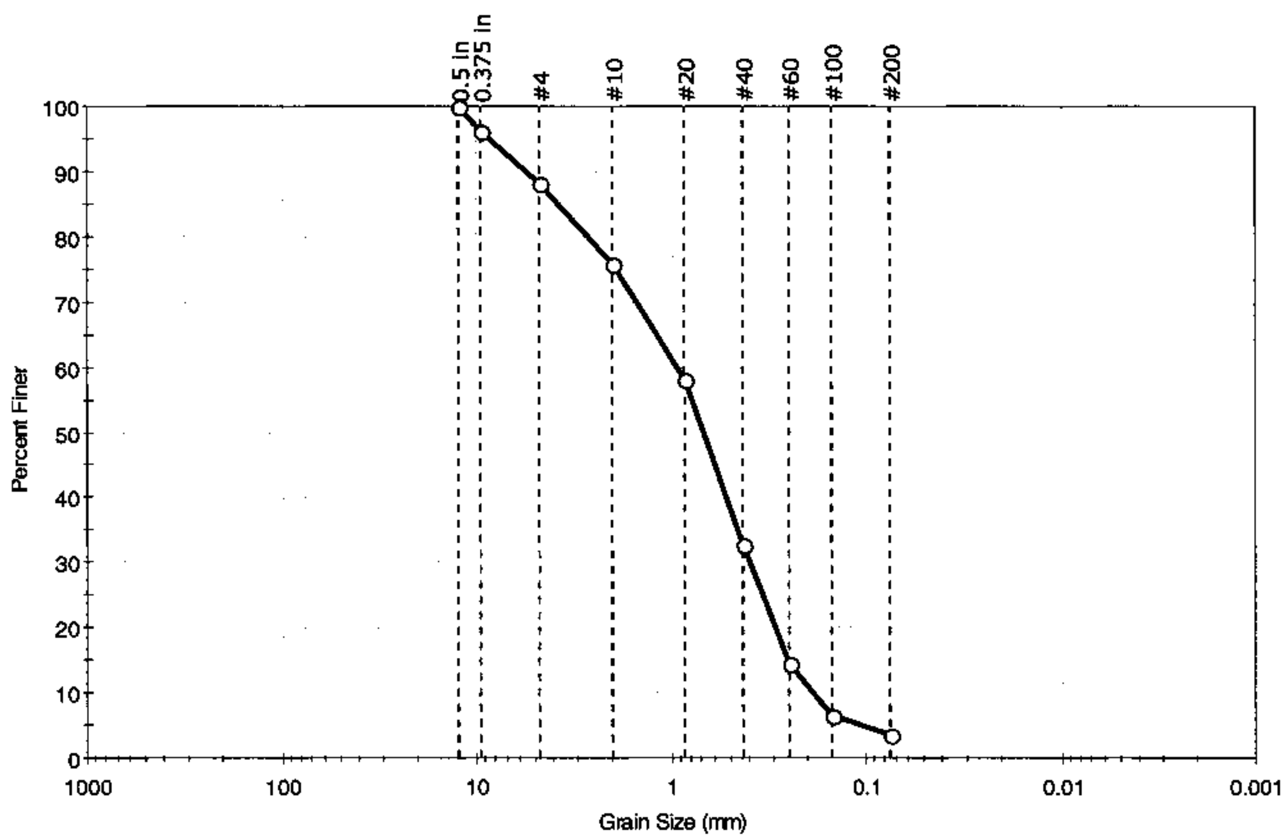
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-3	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	38-40 ft	Test Id:	228097		

Test Comment: ---
Sample Description: Moist, grayish green sand
Sample Comment:

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	11.7	84.8	3.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	96		
#4	4.75	88		
#10	2.00	76		
#20	0.85	58		
#40	0.42	33		
#60	0.25	14		
#100	0.15	7		
#200	0.075	4		

Coefficients

D_{85} =3.7865 mm D_{30} =0.3926 mm
D_{60} =0.9368 mm D_{15} =0.2541 mm
D_{50} =0.6828 mm D_{10} =0.1879 mm
C_u =4.986 C_c =0.876

Classification

ASTM   Poorly graded sand (SP)

AASHTO   Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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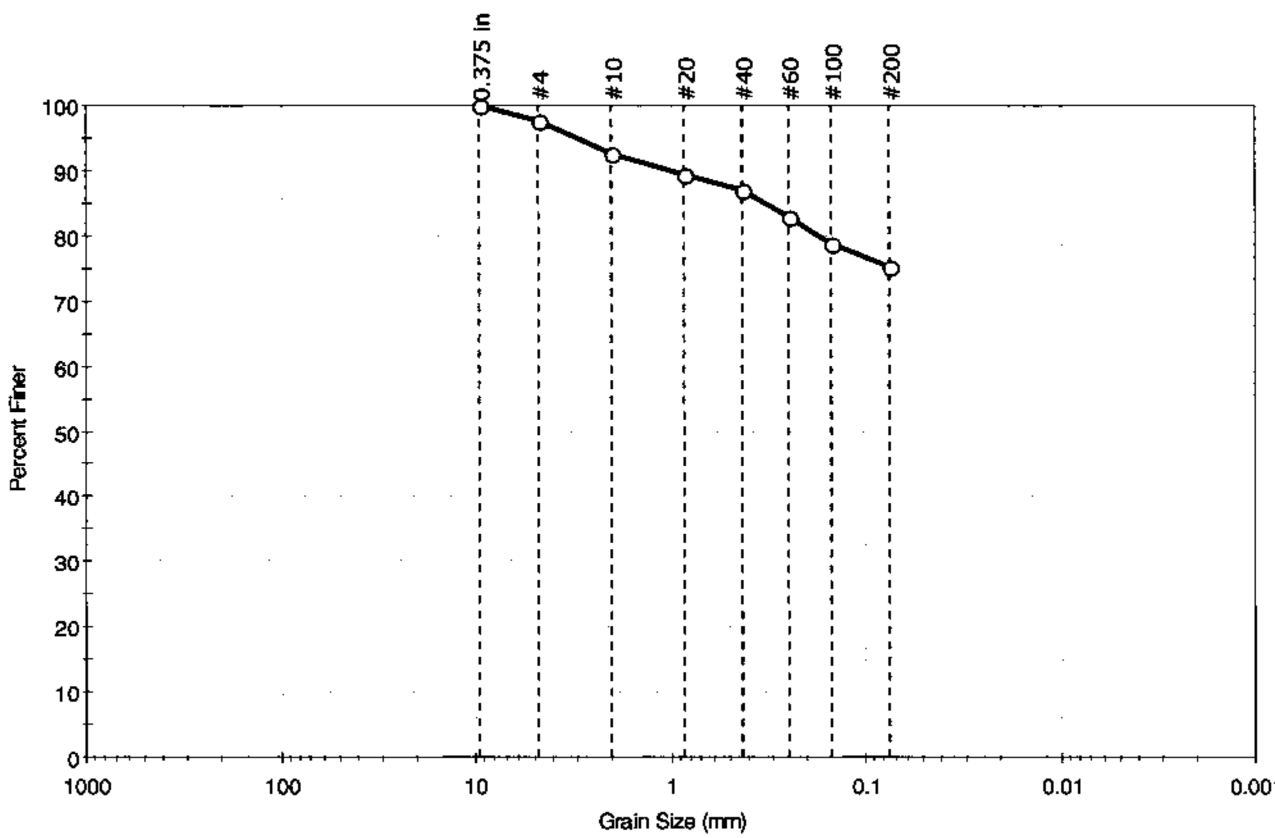
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-4	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	2-4 ft	Test Id:	228109		
Test Comment:	---				
Sample Description:	Wet, very dark gray clay with sand				
Sample Comment:	Shells noted in sample				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.3	22.5	75.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	93		
#20	0.85	89		
#40	0.42	87		
#60	0.25	83		
#100	0.15	79		
#200	0.075	75		

Coefficients

D_{85} = 0.3290 mm	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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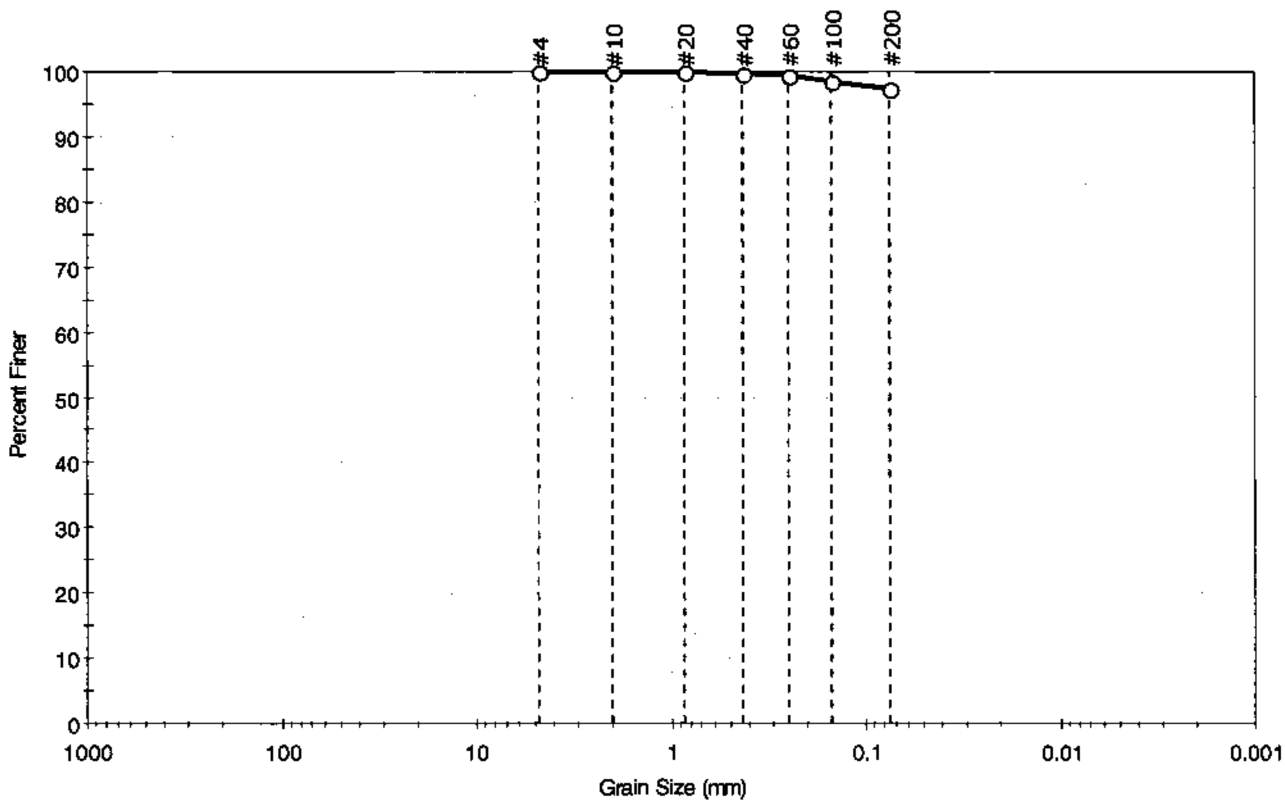
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-4	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	n/a
Depth :	22-24 ft	Test Id:	228110		

Test Comment: ---
Sample Description: Moist, gray silt
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	2.8	97.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	98		
#200	0.075	97		

Coefficients

D_{85} = N/A D_{30} = N/A
D_{60} = N/A D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM   N/A

AASHTO   Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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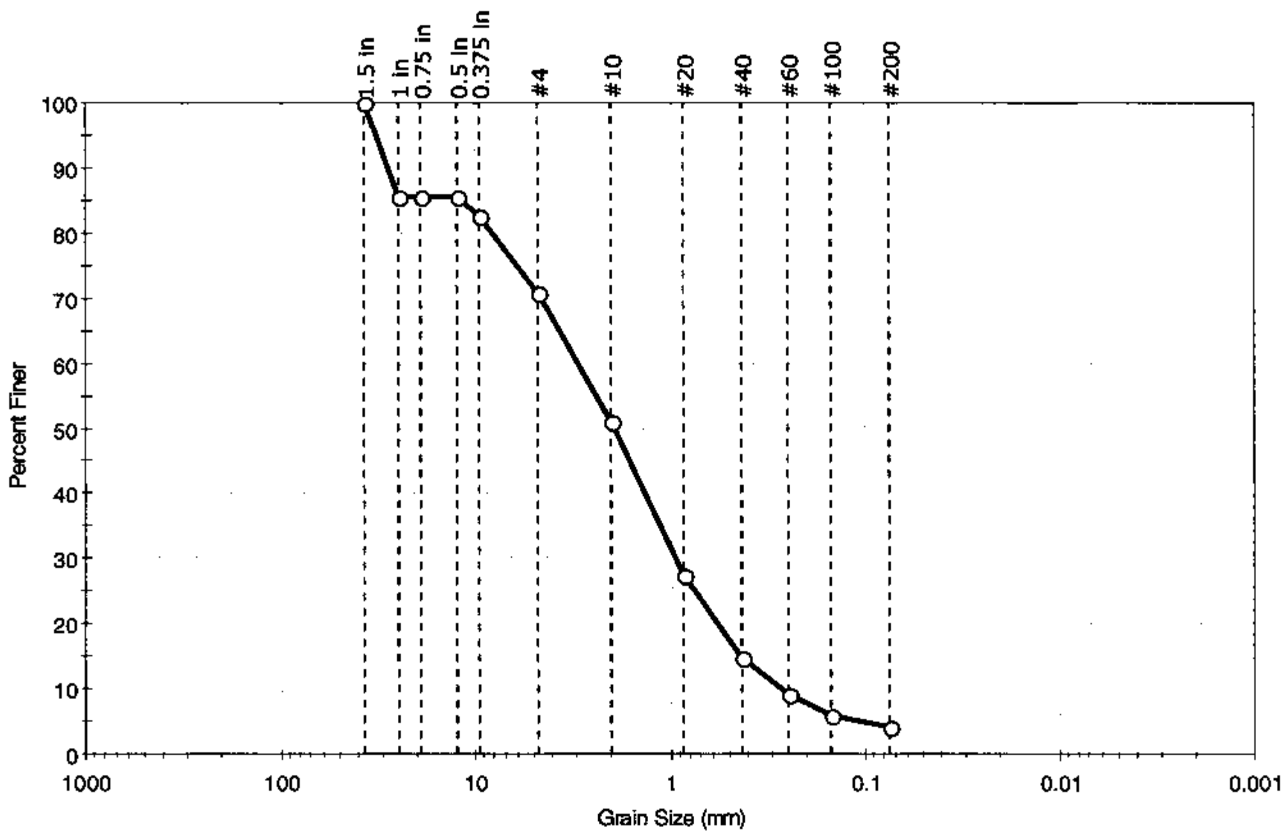
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-4	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	41-43 ft	Test Id:	228111		

Test Comment: ---
Sample Description: Moist, gray sand with gravel
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	29.1	66.8	4.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	86		
0.75 in	19.00	86		
0.5 in	12.50	86		
0.375 in	9.50	83		
#4	4.75	71		
#10	2.00	51		
#20	0.85	27		
#40	0.42	15		
#60	0.25	9		
#100	0.15	6		
#200	0.075	4		

Coefficients

D_{85} =11.7791 mm | D_{30} =0.9321 mm
D_{60} =2.9488 mm | D_{15} =0.4286 mm
D_{50} =1.9220 mm | D_{10} =0.2721 mm
C_u =10.837 | C_c =1.083

Classification

ASTM Well-graded sand with gravel (SW)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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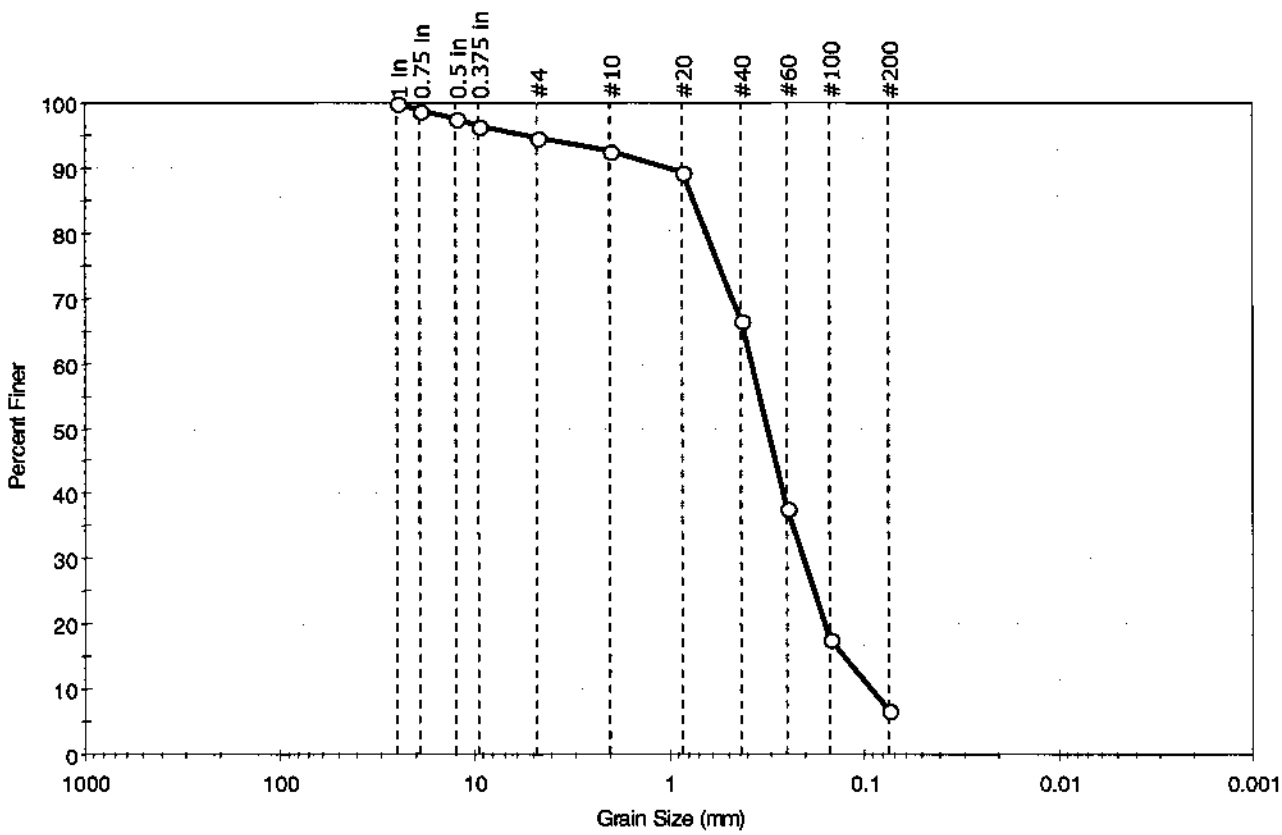
Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-5	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	0-2 ft	Test Id:	228102		
Test Comment:	---				
Sample Description:	Moist, very dark gray sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	5.3	88.0	6.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	99		
0.5 in	12.50	98		
0.375 in	9.50	97		
#4	4.75	95		
#10	2.00	93		
#20	0.85	89		
#40	0.42	67		
#60	0.25	38		
#100	0.15	18		
#200	0.075	7		

Coefficients

D_{85} =0.7440 mm
D_{30} =0.2056 mm
D_{60} =0.3765 mm
D_{15} =0.1265 mm
D_{50} =0.3135 mm
D_{10} =0.0924 mm
C_u =4.075
C_c =1.215

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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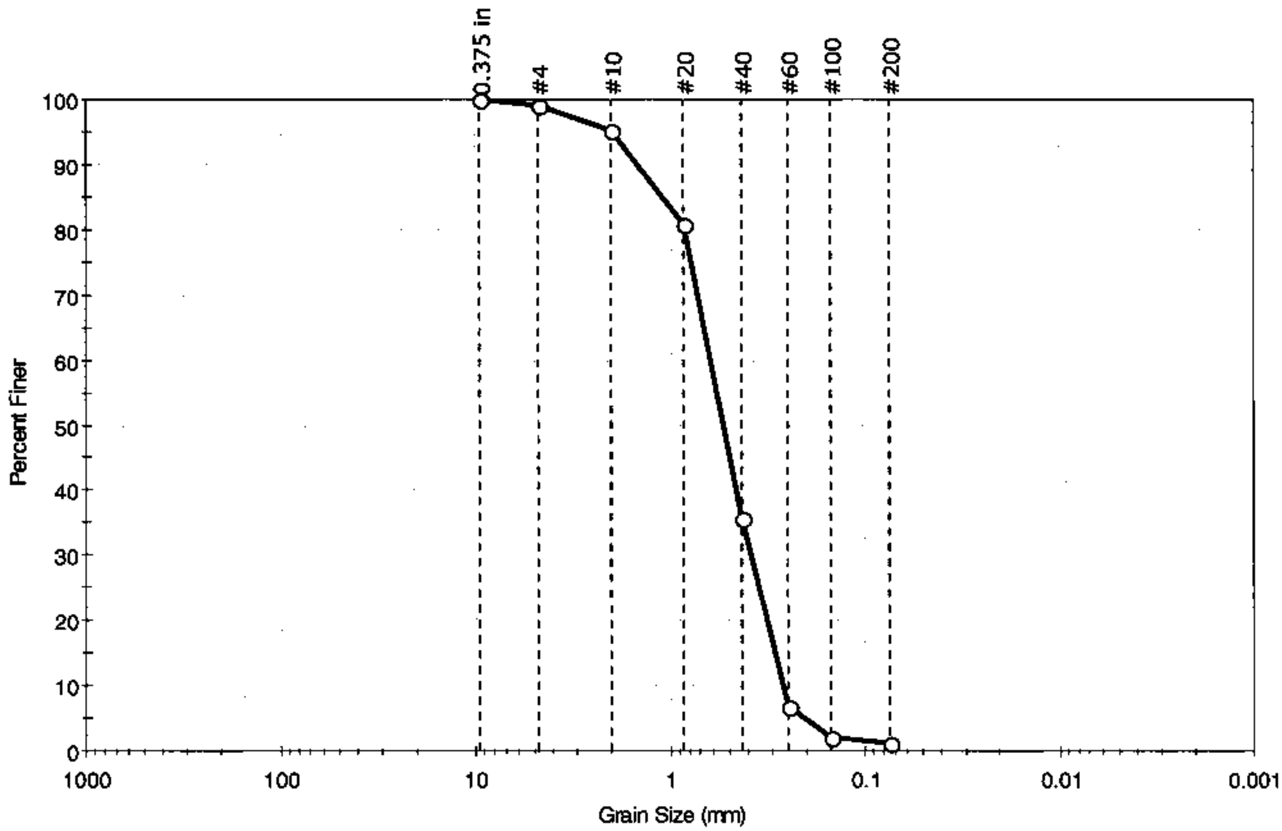
GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: LHCC			
Location: New Bedford, MA		Project No:	GTX-11493
Boring ID: B-5	Sample Type: bag	Tested By:	jbr
Sample ID:A-2011-CAD4	Test Date: 02/02/12	Checked By:	jdt
Depth : 8-10 ft	Test Id: 228103		
Test Comment: ---			
Sample Description: Moist, brown sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.8	98.0	1.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	95		
#20	0.85	81		
#40	0.42	36		
#60	0.25	7		
#100	0.15	2		
#200	0.075	1		

Coefficients

D_{85} =1.0883 mm D_{30} =0.3831 mm
D_{60} =0.6175 mm D_{15} =0.2904 mm
D_{50} =0.5297 mm D_{10} =0.2648 mm
C_u =2.332 C_c =0.898

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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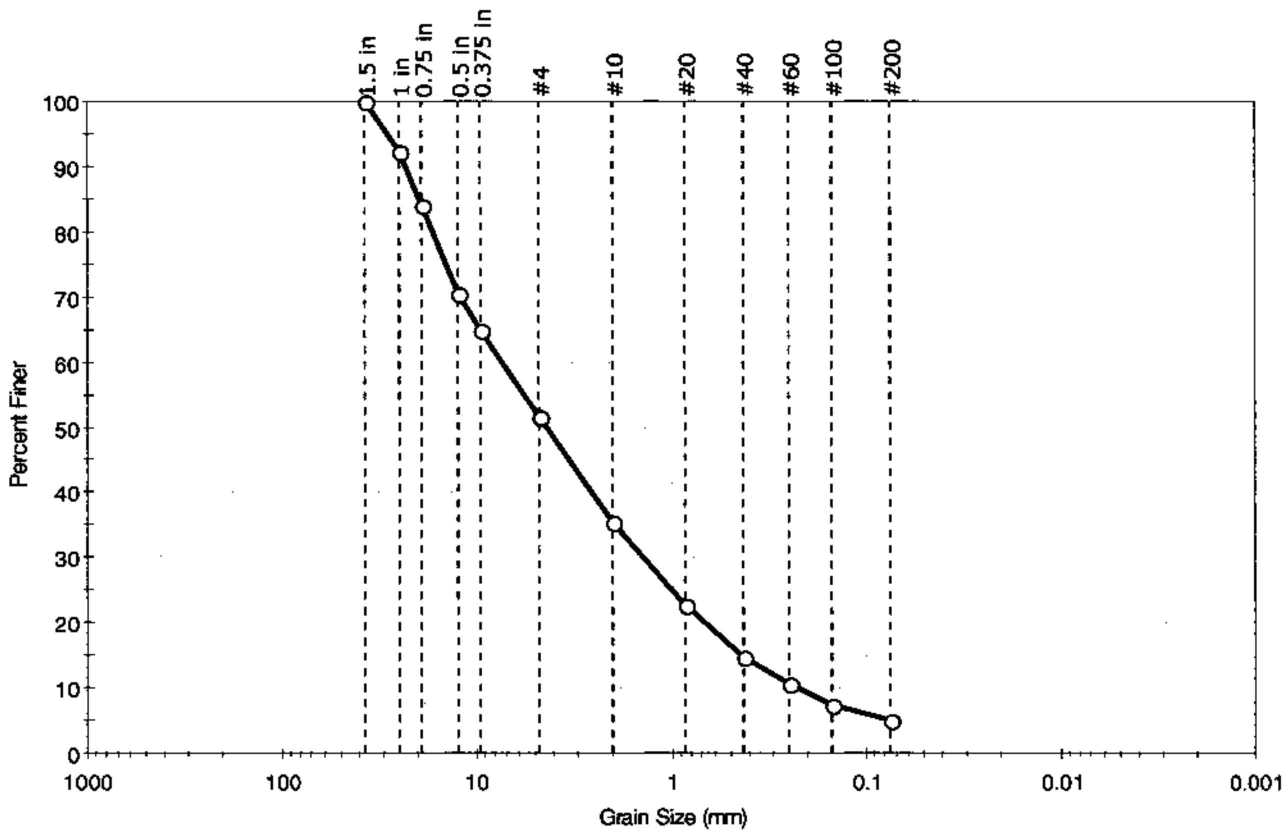
Client:	Apex Companies, LLC
Project:	LHCC
Location:	New Bedford, MA
Project No:	GTX-11493
Boring ID:	B-5
Sample Type:	bag
Tested By:	jbr
Sample ID:	A-2011-CAD4
Test Date:	01/30/12
Checked By:	jdt
Depth :	25-27 ft
Test Id:	228104
Test Comment:	---
Sample Description:	Moist, olive gravel with silt and sand
Sample Comment:	---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	48.5	46.4	5.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	92		
0.75 in	19.00	84		
0.5 in	12.50	70		
0.375 in	9.50	65		
#4	4.75	51		
#10	2.00	36		
#20	0.85	23		
#40	0.42	15		
#60	0.25	11		
#100	0.15	7		
#200	0.075	5		

Coefficients

D_{85} =19.6765 mm D_{30} =1.3863 mm
D_{60} =7.4045 mm D_{15} =0.4328 mm
D_{50} =4.3829 mm D_{10} =0.2306 mm
C_u =32.110 C_c =1.126

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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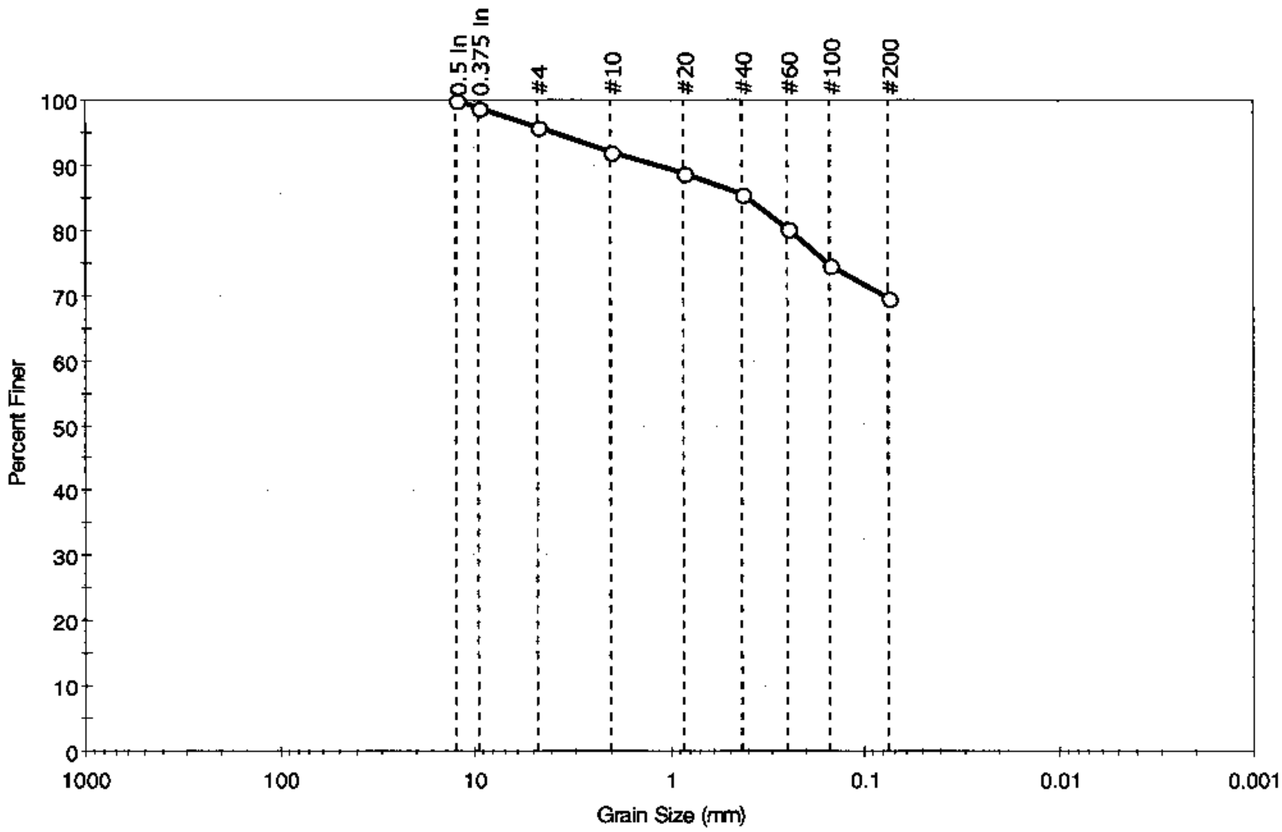
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-6	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/27/12	Checked By:	jdt
Depth :	2-4 ft	Test Id:	228089		
Test Comment:	---				
Sample Description:	Wet, very dark grayish brown sandy silt				
Sample Comment:	Shells noted in sample				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	4.2	26.3	69.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	99		
#4	4.75	96		
#10	2.00	92		
#20	0.85	89		
#40	0.42	85		
#60	0.25	80		
#100	0.15	75		
#200	0.075	70		

Coefficients

D_{85} = 0.4072 mm D_{30} = N/A
D_{60} = N/A D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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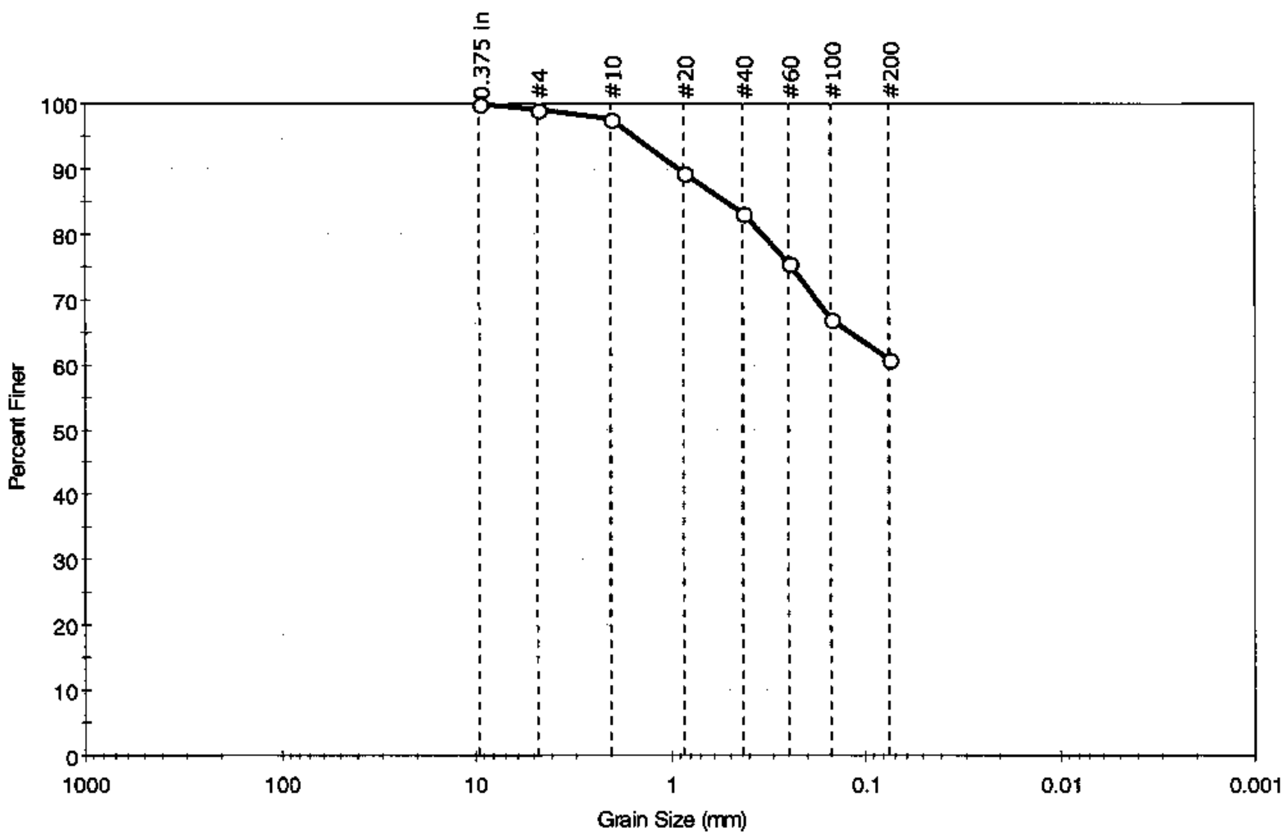
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-6	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	8-10 ft	Test Id:	228090		
Test Comment:	---				
Sample Description:	Wet, grayish brown sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.9	38.4	60.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	89		
#40	0.42	83		
#60	0.25	76		
#100	0.15	67		
#200	0.075	61		

Coefficients

D_{85} =0.5196 mm D_{30} =N/A

D_{60} =N/A D_{15} =N/A

D_{50} =N/A D_{10} =N/A

C_u =N/A C_c =N/A

Classification

ASTM   N/A

AASHTO   Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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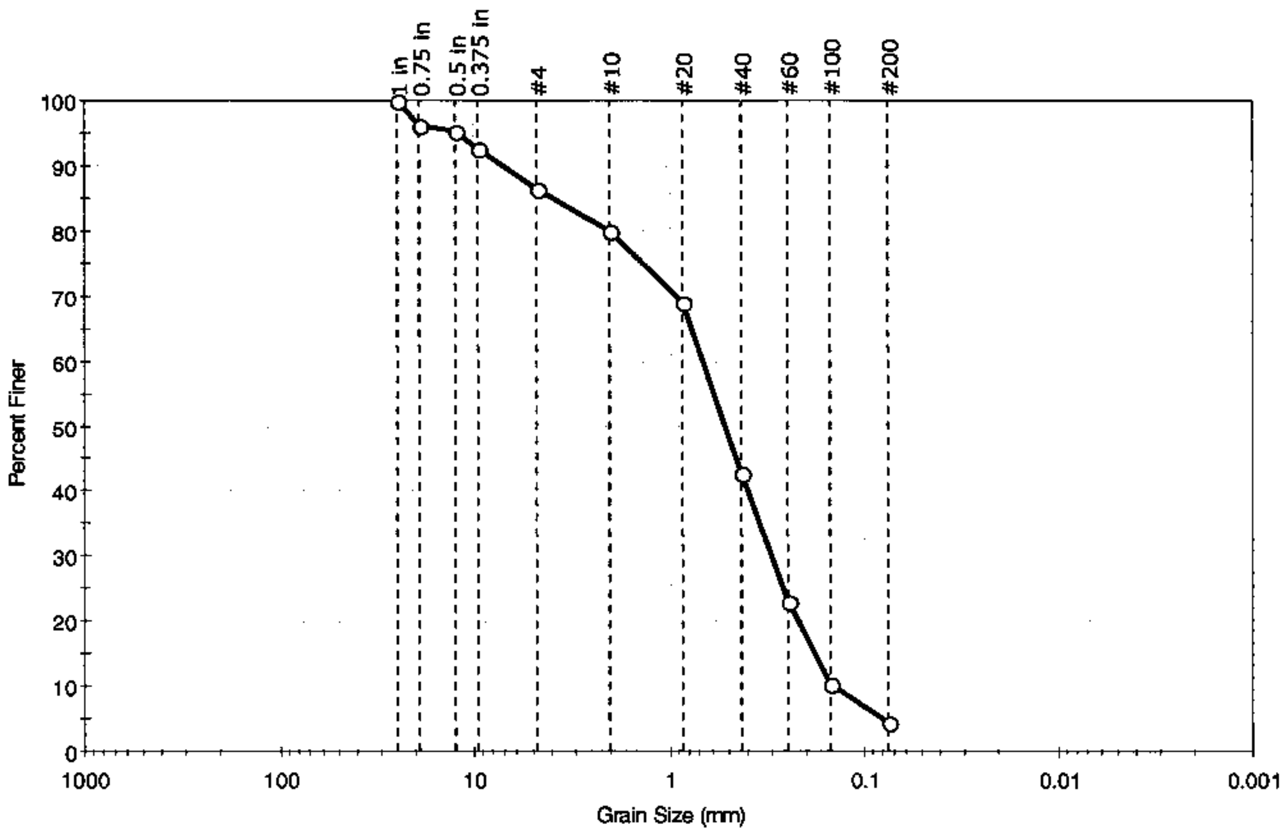
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-6	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	36-38 ft	Test Id:	228091		
Test Comment:	---				
Sample Description:	Moist, olive sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	13.6	82.0	4.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	96		
0.5 in	12.50	95		
0.375 in	9.50	93		
#4	4.75	86		
#10	2.00	80		
#20	0.85	69		
#40	0.42	43		
#60	0.25	23		
#100	0.15	10		
#200	0.075	4		

Coefficients

D_{85} = 3.9244 mm | D_{30} = 0.3023 mm

D_{60} = 0.6690 mm | D_{15} = 0.1808 mm

D_{50} = 0.5148 mm | D_{10} = 0.1427 mm

C_u = 4.688 | C_c = 0.957

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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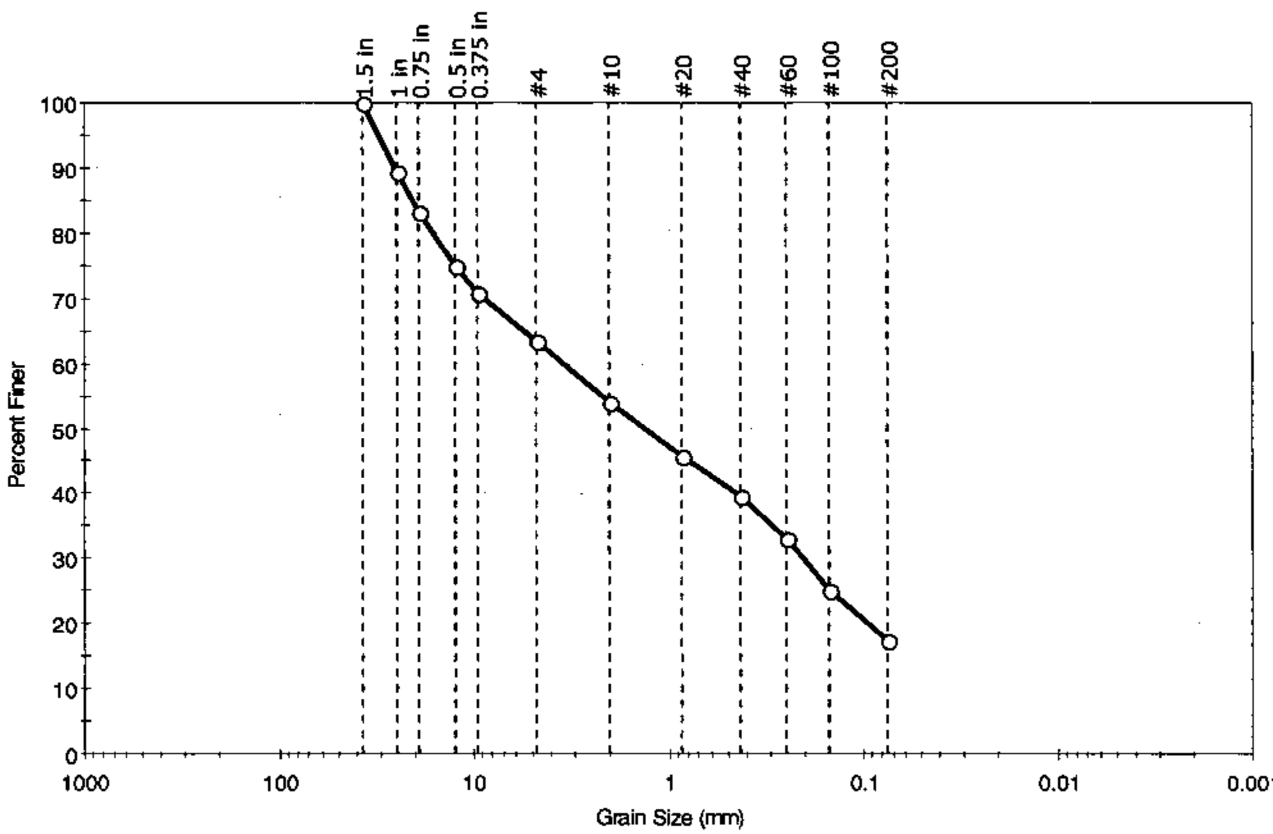
GeoTesting EXPRESS

Client:	Apex Companies, LLC				
Project:	LHCC				
Location:	New Bedford, MA			Project No:	GTX-11493
Boring ID:	B-6	Sample Type:	bag	Tested By:	jbr
Sample ID:	A-2011-CAD4	Test Date:	01/30/12	Checked By:	jdt
Depth :	47-49 ft	Test Id:	228092		
Test Comment:	---				
Sample Description:	Moist, yellowish brown silty sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	36.8	45.7	17.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	89		
0.75 in	19.00	83		
0.5 in	12.50	75		
0.375 in	9.50	71		
#4	4.75	63		
#10	2.00	54		
#20	0.85	46		
#40	0.42	39		
#60	0.25	33		
#100	0.15	25		
#200	0.075	18		

Coefficients

D_{85} = 20.5574 mm | D_{30} = 0.2053 mm

D_{60} = 3.5043 mm | D_{15} = N/A

D_{50} = 1.3268 mm | D_{10} = N/A

C_u = N/A | C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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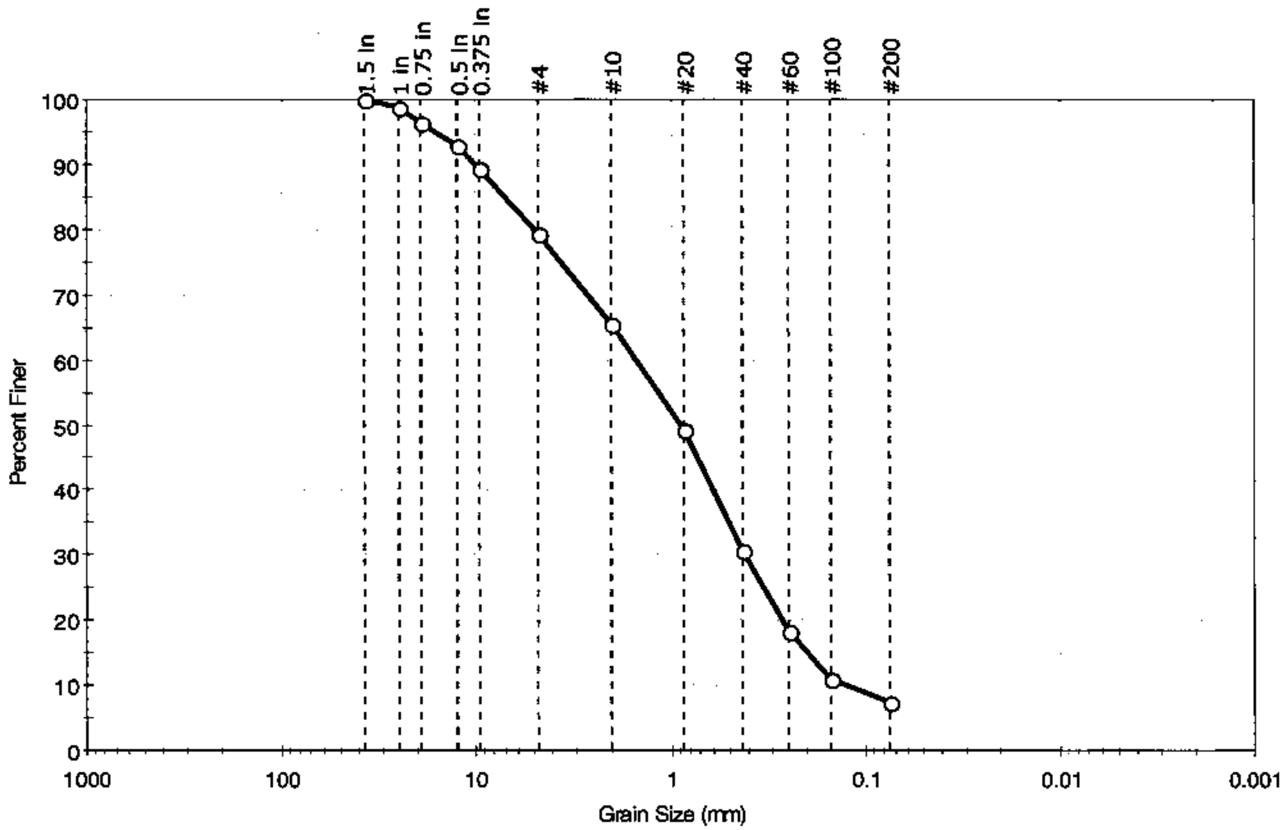
GeoTesting EXPRESS

Client: Apex Companies, LLC			
Project: LHCC			
Location: New Bedford, MA		Project No:	GTX-11493
Boring ID: B-6 (COMP)	Sample Type: bag	Tested By:	jbr
Sample ID: A-2011-CAD4	Test Date: 01/30/12	Checked By:	jdt
Depth : 20-44 ft	Test Id: 228093		
Test Comment: ---			
Sample Description: Moist, yellowish brown sand with silt and gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	20.7	72.0	7.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	99		
0.75 in	19.00	96		
0.5 in	12.50	93		
0.375 in	9.50	89		
#4	4.75	79		
#10	2.00	65		
#20	0.85	49		
#40	0.42	31		
#60	0.25	18		
#100	0.15	11		
#200	0.075	7		

Coefficients

D_{85} = 7.0701 mm — D_{30} = 0.4124 mm

D_{60} = 1.5013 mm — D_{15} = 0.1985 mm

D_{50} = 0.8807 mm — D_{10} = 0.1262 mm

C_u = 11.896 — C_c = 0.898

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Apex Companies LLC		
Project Name:	LHCC		
Project Location:	New Bedford, MA		
GTX #:	11493		
Start Date:	01/30/12	Tested By:	rm
End Date:	02/01/12	Checked By:	jdt
Boring #:	B-1 (COMP)		
Sample #:	A-2011-CAD4		
Depth:	20-32 ft.		
Visual Description:	Moist, light grayish brown silt with sand		

Permeability of Granular Soils (Constant Head) by ASTM D 2434

Sample Type: Remolded

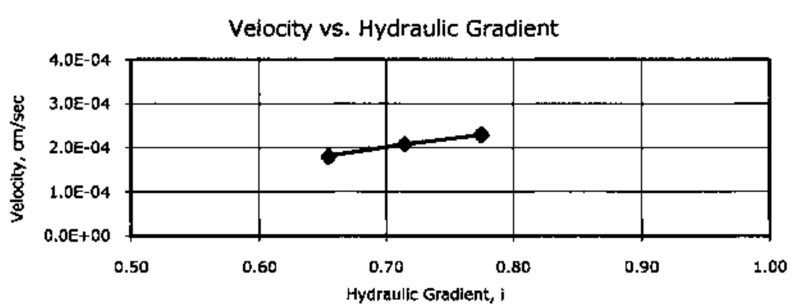
Sample Information:

Maximum Dry Density:	--- pcf
Optimum Moisture Content:	--- %
Compaction Test Method:	---
Classification (ASTM D 2487):	---
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Test specimen compacted with maximum effort at air-dried moisture content. Material >3/8-inch screened out of sample prior to testing (0% of sample). 5.27 lb surcharge

Parameter	Initial	Final
Height, in	4.03	4.03
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	50.1	50.1
Mass, g	1289	1606
Bulk Density, pcf	97.9	122
Moisture Content, %	1.3	26.2
Dry Density, pcf	96.7	96.7
Degree of Saturation, %	---	97.6
Void Ratio, e	---	0.71

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
1/31	1	0.9	60	0.01	0.66	2.7E-04	20.7	0.983	2.7E-04
1/31	2	0.9	60	0.01	0.66	2.7E-04	20.7	0.983	2.7E-04
1/31	3	0.9	60	0.01	0.66	2.8E-04	20.7	0.983	2.7E-04
1/31	4	1.0	60	0.02	0.72	2.9E-04	20.7	0.983	2.9E-04
1/31	5	1.0	60	0.02	0.72	2.9E-04	20.7	0.983	2.9E-04
1/31	6	1.0	60	0.02	0.72	2.9E-04	20.7	0.983	2.9E-04
1/31	7	1.1	60	0.02	0.78	3.0E-04	20.7	0.983	2.9E-04
1/31	8	1.1	60	0.02	0.78	3.0E-04	20.7	0.983	2.9E-04
1/31	9	1.1	60	0.02	0.78	3.0E-04	20.7	0.983	2.9E-04



PERMEABILITY @ 20 °C =

2.8×10^{-4} cm/sec

GeoTesting EXPRESS

Client:	Apex Companies, LLC		
Project Name:	LHCC		
Project Location:	New Bedford, MA		
GTX #:	11493		
Start Date:	01/30/12	Tested By:	rm
End Date:	01/31/12	Checked By:	jdt
Boring #:	B-2 (COMP)		
Sample #:	A-2011-CAD4		
Depth:	22-34 ft.		
Visual Description:	Moist, olive brown sand with silt		

Permeability of Granular Soils (Constant Head) by ASTM D 2434

Sample Type: Remolded

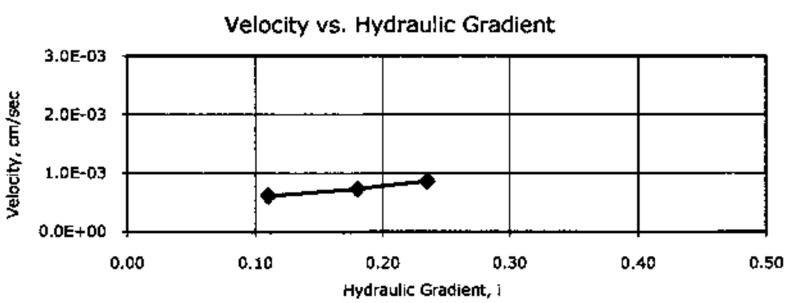
Sample Information:

Maximum Dry Density:	--- pcf
Optimum Moisture Content:	--- %
Compaction Test Method:	---
Classification (ASTM D 2487):	---
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Test specimen compacted with maximum effort at air-dried moisture content. Material >3/8-inch screened out of sample prior to testing (~4% of sample). 5.27 lb surcharge

Parameter	Initial	Final
Height, in	4.03	4.03
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	50.1	50.1
Mass, g	1435	1701
Bulk Density, pcf	109	129
Moisture Content, %	0.1	18.7
Dry Density, pcf	109	109
Degree of Saturation, %	---	95.4
Void Ratio, e	---	0.52

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
1/30	1	1.5	30	0.05	0.11	5.6E-03	20.7	0.983	5.5E-03
1/30	2	1.5	30	0.05	0.11	5.6E-03	20.7	0.983	5.5E-03
1/30	3	1.5	30	0.05	0.11	5.6E-03	20.7	0.983	5.5E-03
1/30	4	1.8	30	0.06	0.18	4.1E-03	20.7	0.983	4.0E-03
1/30	5	1.8	30	0.06	0.18	4.1E-03	20.7	0.983	4.0E-03
1/30	6	1.8	30	0.06	0.18	4.1E-03	20.7	0.983	4.0E-03
1/30	7	2.1	30	0.07	0.24	3.7E-03	20.7	0.983	3.6E-03
1/30	8	2.1	30	0.07	0.24	3.7E-03	20.7	0.983	3.6E-03
1/30	9	2.1	30	0.07	0.24	3.7E-03	20.7	0.983	3.6E-03



PERMEABILITY @ 20 °C =

4.4 x 10^{-3} cm/sec

GeoTesting EXPRESS

Client:	Apex Companies, LLC		
Project Name:	LHCC		
Project Location:	New Bedford, MA		
GTX #:	11493		
Start Date:	1/27/2012	Tested By:	ema
End Date:	1/31/2012	Checked By:	jdt
Boring #:	B-3 (COMP)		
Sample #:	A-2011-CAD4		
Depth:	0-18 ft.		
Visual Description:	Wet, grayish brown silty clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084

Constant Volume

Sample Type: Remolded Permeant Fluid: de-aired tap water

Orientation: Vertical Cell #: 2/2/4

Sample Preparation: Test specimen compacted with maximum effort at the as-received moisture content. Values specified by client. Trimmings moisture content = 86.3%

Parameter	Initial	Final
Height, in	2.37	2.08
Diameter, in	2.85	2.70
Area, in^2	6.38	5.73
Volume, in^3	15.1	11.9
Mass, g	377	323
Bulk Density, pcf	94.8	103
Moisture Content, %	87.6	60.4
Dry Density, pcf	50.5	64.2
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi: 95.1 Pressure Increment, psi: 5.02

Sample Pressure, psi: 90.4 B Coefficient: 0.96

FLOW DATA

Date	Trial #	Pressure, psi Cell	Pressure, psi Sample	Manometer Readings Z_1	Z_2	Z_1-Z_2	Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
1/30	1	90	85	8.0	7.9	0.1	39	19.1	1.2E-07	20	1.000	1.2E-07
1/30	2	90	85	8.0	7.9	0.1	44	19.1	1.0E-07	20	1.000	1.0E-07
1/30	3	90	85	8.0	7.9	0.1	44	19.1	1.0E-07	20	1.000	1.0E-07
1/30	4	90	85	8.0	7.9	0.1	45	19.1	1.0E-07	20	1.000	1.0E-07

PERMEABILITY AT 20° C: 1.1 x 10^{-7} cm/sec (@ 5 psi effective stress)

Client:	Apex Companies, LLC
Project Name:	LHCC
Project Location:	New Bedford, MA
GTX #:	11493

Start Date:	01/30/12	Tested By:	rm
End Date:	01/31/12	Checked By:	jdt

Boring #:	B-3 (COMP)
Sample #:	A-2011-CAD4
Depth:	26-38 ft.
Visual Description:	Moist, light grayish brown silty sand

Permeability of Granular Soils (Constant Head) by ASTM D 2434

Sample Type: Remolded

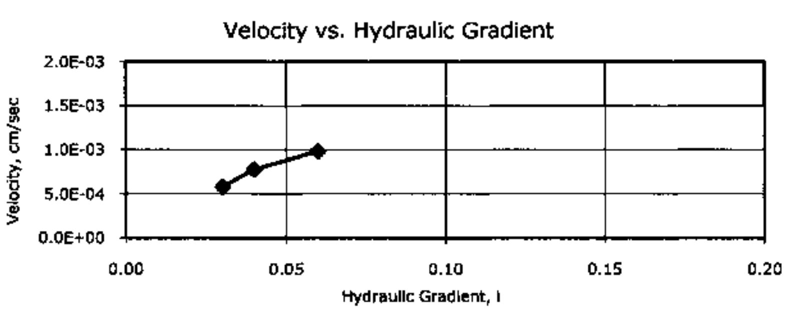
Sample Information:

Maximum Dry Density:	--- pcf
Optimum Moisture Content:	--- %
Compaction Test Method:	---
Classification (ASTM D 2487):	---
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Test specimen compacted with maximum effort at air-dried moisture content. Material >3/8-inch screened out of sample prior to testing (<1% of sample). 5.27 lb surcharge

Parameter	Initial	Final
Height, in	4.03	4.03
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	50.1	50.1
Mass, g	1407	1684
Bulk Density, pcf	107	128
Moisture Content, %	0.1	19.8
Dry Density, pcf	107	107
Degree of Saturation, %	---	95.6
Void Ratio, e	---	0.55

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
1/30	1	1.4	30	0.05	0.03	1.9E-02	19.4	1.015	2.0E-02
1/30	2	1.4	30	0.05	0.03	1.9E-02	19.4	1.015	2.0E-02
1/30	3	1.4	30	0.05	0.03	1.9E-02	19.4	1.015	2.0E-02
1/30	4	1.9	30	0.06	0.04	1.9E-02	19.4	1.015	2.0E-02
1/30	5	1.9	30	0.06	0.04	1.9E-02	19.4	1.015	2.0E-02
1/30	6	1.9	30	0.06	0.04	1.9E-02	19.4	1.015	2.0E-02
1/30	7	2.4	30	0.08	0.06	1.6E-02	19.4	1.015	1.7E-02
1/30	8	2.4	30	0.08	0.06	1.6E-02	19.4	1.015	1.7E-02
1/30	9	2.4	30	0.08	0.06	1.6E-02	19.4	1.015	1.7E-02



PERMEABILITY @ 20 °C =

1.9×10^{-2} cm/sec

GeoTesting EXPRESS

Client:	Apex Companies, LLC		
Project Name:	LHCC		
Project Location:	New Bedford, MA		
GTX #:	11493		
Start Date:	01/27/12	Tested By:	rm
End Date:	02/01/12	Checked By:	jdt
Boring #:	B-3/B-4 (COMP)		
Sample #:	A-2011-CAD4		
Depth:	32-50/65-72 ft.		
Visual Description:	Dry, light brown silty sand with gravel		

Permeability of Granular Soils (Constant Head) by ASTM D 2434

Sample Type: Remolded

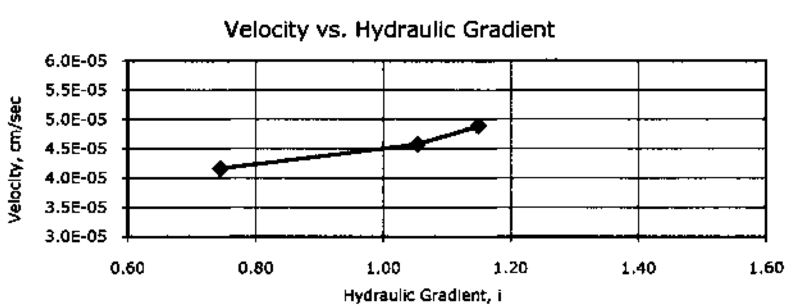
Sample Information:

Maximum Dry Density:	---	pcf
Optimum Moisture Content:	---	%
Compaction Test Method:	---	
Classification (ASTM D 2487):	---	
Assumed Specific Gravity:	2.65	

Sample Preparation / Test Setup: Test specimen compacted with maximum effort at air-dried moisture content. Material >3/8-inch screened out of sample prior to testing (~18% of sample). 5.27 lb surcharge

Parameter	Initial	Final
Height, in	4.03	4.03
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	50.1	50.1
Mass, g	1689	1868
Bulk Density, pcf	128	142
Moisture Content, %	0.2	10.8
Dry Density, pcf	128	128
Degree of Saturation, %	---	98.0
Void Ratio, e	---	0.29

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
1/31	1	0.4	120	0.00	0.75	5.6E-05	19.3	1.018	5.7E-05
1/31	2	0.4	120	0.00	0.75	5.6E-05	19.3	1.018	5.7E-05
1/31	3	0.4	120	0.00	0.75	5.6E-05	19.3	1.018	5.7E-05
1/31	4	0.4	120	0.00	1.06	4.3E-05	19.3	1.018	4.4E-05
1/31	5	0.4	120	0.00	1.06	4.3E-05	19.3	1.018	4.4E-05
1/31	6	0.4	120	0.00	1.06	4.3E-05	19.3	1.018	4.4E-05
1/31	7	0.5	120	0.00	1.15	4.3E-05	19.3	1.018	4.3E-05
1/31	8	0.5	120	0.00	1.15	4.3E-05	19.3	1.018	4.3E-05
1/31	9	0.5	120	0.00	1.15	4.3E-05	19.3	1.018	4.3E-05



PERMEABILITY @ 20 °C =

4.8×10^{-5} cm/sec

GeoTesting EXPRESS

Client:	Apex Companies, LLC		
Project Name:	LHCC		
Project Location:	New Bedford, MA		
GTX #:	11493		
Start Date:	1/27/2012	Tested By:	ema
End Date:	2/1/2012	Checked By:	jdt
Boring #:	B-4 (COMP)		
Sample #:	A-2011-CAD4		
Depth:	24-30 ft.		
Visual Description:	Moist, gray silt		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084
Constant Volume

Sample Type:	Remolded	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	19/5

Sample Preparation: Test specimen compacted with maximum effort at the as-received moisture content. Values specified by client. Trimmings moisture content = 20.1%

Parameter	Initial	Final
Height, in	2.29	2.23
Diameter, in	2.85	2.84
Area, in^2	6.38	6.33
Volume, in^3	14.6	14.1
Mass, g	492	486
Bulk Density, pcf	128	131
Moisture Content, %	21.6	20.1
Dry Density, pcf	105	109
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	95.2	Pressure Increment, psi:	5.01
Sample Pressure, psi:	90.2	B Coefficient:	0.96

FLOW DATA

	Trial	Pressure, psi		Manometer Readings			Elapsed Time,		Permeability K,	Temp,		Permeability K @ 20 °C,
Date	#	Cell	Sample	Z_1	Z_2	Z_1-Z_2	sec	Gradient	cm/sec	°C	R_t	cm/sec
1/31	1	90	85	8.0	7.0	1.0	14	17.8	3.3E-06	20	1.000	3.3E-06
1/31	2	90	85	8.0	7.0	1.0	14	17.8	3.3E-06	20	1.000	3.3E-06
1/31	3	90	85	8.0	7.0	1.0	15	17.8	3.1E-06	20	1.000	3.1E-06
1/31	4	90	85	8.0	7.0	1.0	18	17.8	2.6E-06	20	1.000	2.6E-06

PERMEABILITY AT 20° C: 3.1×10^{-6} cm/sec (@ 5 psi effective stress)

Client:	Apex Companies, LLC
Project Name:	LHCC
Project Location:	New Bedford, MA
GTX #:	11493
Start Date:	02/02/12
End Date:	02/03/12
Tested By:	rm
Checked By:	jdt
Boring #:	B-5 (COMP)
Sample #:	A-2011-CAD4
Depth:	19-39 ft.
Visual Description:	Dry light brown and tan silty sand

Permeability of Granular Soils (Constant Head) by ASTM D 2434

Sample Type: Remolded

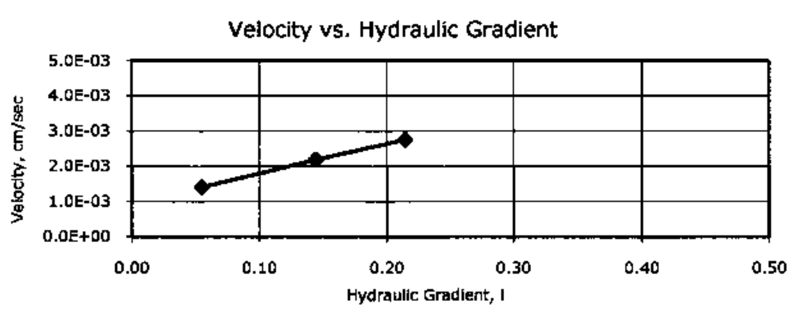
Sample Information:

Maximum Dry Density:	---	pcf
Optimum Moisture Content:	---	%
Compaction Test Method:	---	
Classification (ASTM D 2487):	---	
Assumed Specific Gravity:	2.65	

Sample Preparation / Test Setup: Test specimen compacted with maximum effort at air-dried moisture content. Material >3/8-inch screened out of sample prior to testing (31% of sample). 5.27 lb surcharge

Parameter	Initial	Final
Height, in	4.03	4.03
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	50.1	50.1
Mass, g	1616	1780
Bulk Density, pcf	123	135
Moisture Content, %	0.1	10
Dry Density, pcf	123	123
Degree of Saturation, %	---	77.4
Void Ratio, e	---	0.35

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
2/2	1	3.4	30	0.11	0.06	2.5E-02	23.8	0.914	2.3E-02
2/2	2	3.4	30	0.11	0.06	2.5E-02	23.8	0.914	2.3E-02
2/2	3	3.4	30	0.11	0.06	2.5E-02	23.8	0.914	2.3E-02
2/2	4	5.3	30	0.18	0.15	1.5E-02	23.8	0.914	1.4E-02
2/2	5	5.3	30	0.18	0.15	1.5E-02	23.8	0.914	1.4E-02
2/2	6	5.3	30	0.18	0.15	1.5E-02	23.8	0.914	1.4E-02
2/2	7	6.6	30	0.22	0.22	1.3E-02	23.8	0.914	1.2E-02
2/2	8	6.6	30	0.22	0.22	1.3E-02	23.8	0.914	1.2E-02
2/2	9	6.6	30	0.22	0.22	1.3E-02	23.8	0.914	1.2E-02



PERMEABILITY @ 20 °C =

1.6×10^{-2} cm/sec

GeoTesting EXPRESS

Client:	Apex Companies, LLC		
Project Name:	LHCC		
Project Location:	New Bedford, MA		
GTX #:	11493		
Start Date:	01/27/12	Tested By:	rm
End Date:	01/30/12	Checked By:	jdt
Boring #:	B-6 (COMP)		
Sample #:	A-2011-CAD4		
Depth:	20-44 ft.		
Visual Description:	Moist, yellowish brown sand with silt and gravel		

Permeability of Granular Soils (Constant Head) by ASTM D 2434

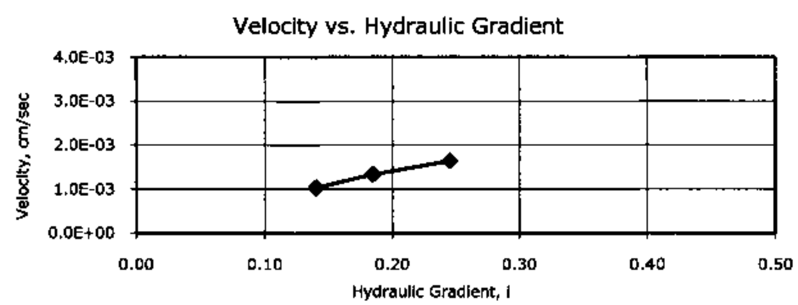
Sample Type: Remolded

Sample Information:
- Maximum Dry Density: --- pcf
- Optimum Moisture Content: --- %
- Compaction Test Method: ---
- Classification (ASTM D 2487): ---
- Assumed Specific Gravity: 2.65

Sample Preparation / Test Setup: Test specimen compacted with maximum effort at air-dried moisture content. Material >3/8-inch screened out of sample prior to testing (11% of sample). 5.27 lb surcharge

Parameter	Initial	Final
Height, in	4.03	4.03
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	50.1	50.1
Mass, g	1611	1806
Bulk Density, pcf	122	137
Moisture Content, %	0.9	13.1
Dry Density, pcf	121	121
Degree of Saturation, %	---	95.5
Void Ratio, e	---	0.36

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
1/27	1	2.5	30	0.08	0.14	7.4E-03	21.1	0.974	7.2E-03
1/27	2	2.5	30	0.08	0.14	7.4E-03	21.1	0.974	7.2E-03
1/27	3	2.5	30	0.08	0.14	7.3E-03	21.1	0.974	7.1E-03
1/27	4	3.2	30	0.11	0.19	7.2E-03	21.1	0.974	7.0E-03
1/27	5	3.2	30	0.11	0.19	7.2E-03	21.1	0.974	7.0E-03
1/27	6	3.2	30	0.11	0.19	7.2E-03	21.1	0.974	7.0E-03
1/27	7	4.0	30	0.13	0.25	6.7E-03	21.1	0.974	6.5E-03
1/27	8	4.0	30	0.13	0.25	6.7E-03	21.1	0.974	6.5E-03
1/27	9	3.9	30	0.13	0.25	6.7E-03	21.1	0.974	6.5E-03



PERMEABILITY @ 20 °C =

6.9×10^{-3} cm/sec

ANALYTICAL REPORT

Lab Number:	L1201485
Client:	Geo Testing Express 125 Nagog Park Acton, MA 01720
ATTN:	Joe Tomei
Phone:	(978) 893-1241
Project Name:	LHCC
Project Number:	GTX-11493
Report Date:	02/01/12

Certifications & Approvals: NY (11627), CT (PH-0141), NH (2206), NJ NELAP (MA015), RI (LAO00299), PA (68-02089), LA NELAP (03090), FL (E87814), TX (T104704419), WA (C954), DOD (L2217.01), USDA (Permit #P330-11-00109), US Army Corps of Engineers.

320 Forbes Boulevard, Mansfield, MA 02048-1806
508-822-9300 (Fax) 508-822-3288 800-624-9220 - www.alphalab.com

Project Name: LHCC
Project Number: GTX-11493

Lab Number: L1201485
Report Date: 02/01/12

Alpha Sample ID	Client ID	Sample Location	Collection Date/Time
L1201485-01	A-2011-CAD4, B-6, 47-49 FT	NEW BEDFORD, MA	01/27/12 00:00
L1201485-02	A-2011-CAD4, B-3, 30-32 FT	NEW BEDFORD, MA	01/27/12 00:00
L1201485-03	A-2011-CAD4, B-3, 38-40 FT	NEW BEDFORD, MA	01/27/12 00:00
L1201485-04	A-2011-CAD4, B-2, 36-38 FT	NEW BEDFORD, MA	01/27/12 00:00
L1201485-05	A-2011-CAD4, B-2, 30-32 FT	NEW BEDFORD, MA	01/27/12 00:00
L1201485-06	A-2011-CAD4, B-5, 47-49FT	NEW BEDFORD, MA	01/27/12 00:00
L1201485-07	A-2011-CAD4, B-1, 25-27 FT	NEW BEDFORD, MA	01/27/12 00:00
L1201485-08	A-2011-CAD4, B-1, 48-50 FT	NEW BEDFORD, MA	01/27/12 00:00
L1201485-09	A-2011-CAD4, B-4, 22-24 FT	NEW BEDFORD, MA	01/27/12 00:00
L1201485-10	A-2011-CAD4, B-4, 41-43 T	NEW BEDFORD, MA	01/27/12 00:00
L1201485-11	A-2011-CAD4, B-6, 36-38 FT	NEW BEDFORD, MA	01/27/12 00:00

Project Name:	LHCC	**Lab Number:**	L1201485
Project Number:	GTX-11493	**Report Date:**	02/01/12

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet all of the requirements of NELAC, for all NELAC accredited parameters. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively. When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

Please see the associated ADEx data file for a comparison of laboratory reporting limits that were achieved with the regulatory Numerical Standards requested on the Chain of Custody.

For additional information, please contact Client Services at 800-624-9220.

Total Organic Carbon

The WG515880-3 Laboratory Duplicate RPD, performed on L1201485-01, is outside the acceptance criteria for Total Organic Carbon (rep2) (32%). The elevated RPD has been attributed to the non-homogeneous nature of the sample utilized for the laboratory duplicate. An additional burn was run with similar results.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Peter Henriksen

Title: Technical Director/Representative

Date: 02/01/12

INORGANICS
&
MISCELLANEOUS

Project Name: LHCC **Lab Number:** L1201485
Project Number: GTX-11493 **Report Date:** 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-01
Client ID: A-2011-CAD4, B-6, 47-49 FT
Sample Location: NEW BEDFORD, MA
Matrix: Soil
Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.021		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.021		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC
Project Number: GTX-11493

Lab Number: L1201485
Report Date: 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-02
Client ID: A-2011-CAD4, B-3, 30-32 FT
Sample Location: NEW BEDFORD, MA
Matrix: Soil

Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.031		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.034		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC
Project Number: GTX-11493

Lab Number: L1201485
Report Date: 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-03
Client ID: A-2011-CAD4, B-3, 38-40 FT
Sample Location: NEW BEDFORD, MA
Matrix: Soil

Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.034		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.033		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC **Lab Number:** L1201485
Project Number: GTX-11493 **Report Date:** 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-04
Client ID: A-2011-CAD4, B-2, 36-38 FT
Sample Location: NEW BEDFORD, MA
Matrix: Soil

Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.046		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.042		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC **Lab Number:** L1201485
Project Number: GTX-11493 **Report Date:** 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-05
Client ID: A-2011-CAD4, B-2, 30-32 FT
Sample Location: NEW BEDFORD, MA
Matrix: Soil

Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.022		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.023		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC
Project Number: GTX-11493

Lab Number: L1201485
Report Date: 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-06
Client ID: A-2011-CAD4, B-5, 47-49FT
Sample Location: NEW BEDFORD, MA
Matrix: Soil

Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.031		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.034		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC **Lab Number:** L1201485
Project Number: GTX-11493 **Report Date:** 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-07
Client ID: A-2011-CAD4, B-1, 25-27 FT
Sample Location: NEW BEDFORD, MA
Matrix: Soil

Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.028		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.031		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC | **Lab Number:** L1201485
Project Number: GTX-11493 | **Report Date:** 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-08
Client ID: A-2011-CAD4, B-1, 48-50 FT
Sample Location: NEW BEDFORD, MA
Matrix: Soil

Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.044		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.037		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC
Project Number: GTX-11493

Lab Number: L1201485
Report Date: 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-09
Client ID: A-2011-CAD4, B-4, 22-24 FT
Sample Location: NEW BEDFORD, MA
Matrix: Soil

Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.146		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.137		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC
Project Number: GTX-11493

Lab Number: L1201485
Report Date: 02/01/12

SAMPLE RESULTS

Lab ID: L1201485-10
Client ID: A-2011-CAD4, B-4, 41-43 T
Sample Location: NEW BEDFORD, MA
Matrix: Soil

Date Collected: 01/27/12 00:00
Date Received: 01/27/12
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.039		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.035		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name:	LHCC	**Lab Number:**	L1201485
Project Number:	GTX-11493	**Report Date:**	02/01/12

SAMPLE RESULTS

Lab ID:	L1201485-11	Date Collected:	01/27/12 00:00
Client ID:	A-2011-CAD4, B-6, 36-38 FT	Date Received:	01/27/12
Sample Location:	NEW BEDFORD, MA	Field Prep:	Not Specified
Matrix:	Soil		

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.024		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	0.027		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Project Name: LHCC **Lab Number:** L1201485
Project Number: GTX-11493 **Report Date:** 02/01/12

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab for sample(s): 01-11 Batch: WG515880-1										
Total Organic Carbon (Rep1)	ND		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR
Total Organic Carbon (Rep2)	ND		%	0.010	--	1	-	01/31/12 04:00	1,9060	NR

Matrix Spike Analysis
Batch Quality Control

Project Name: LHCC
Project Number: GTX-11493

Lab Number: L1201485
Report Date: 02/01/12

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
Total Organic Carbon - Mansfield Lab Associated sample(s): 01-11 QC Batch ID: WG515880-4 QC Sample: L1201485-01 Client ID: A-2011-CAD4, B-6, 47-49 FT												
Total Organic Carbon (Rep1)	0.021	0.801	0.817	99		-	-		75-125	-		25
Total Organic Carbon (Rep2)	0.021	0.836	0.858	100		-	-		75-125	-		25

Project Name: LHCC
Project Number: GTX-11493

Lab Duplicate Analysis
Batch Quality Control

Lab Number: L1201485
Report Date: 02/01/12

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
Total Organic Carbon - Mansfield Lab Associated sample(s): 01-11 QC Batch ID: WG515880-3 QC Sample: L1201485-01 Client ID: A-2011-CAD4, B-6, 47-49 FT						
Total Organic Carbon (Rep1)	0.021	0.023	%	9		25
Total Organic Carbon (Rep2)	0.021	0.029	%	**32**	Q	25

Project Name:	LHCC	**Lab Number:**	L1201485
Project Number:	GTX-11493	**Report Date:**	02/01/12

S.R.M. Standard Quality Control

Standard Reference Material (SRM): WG515880-2

Parameter	% Recovery	Qual	QC Criteria
Total Organic Carbon (Rep1)	117		75-125
Total Organic Carbon (Rep2)	106		75-125

Project Name: LHCC
Project Number: GTX-11493

Lab Number: L1201485
Report Date: 02/01/12

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Reagent H2O Preserved Vials Frozen on: NA

Cooler Information Custody Seal

Cooler	
A	Absent

Container Information

Container ID	Container Type	Cooler	pH	Temp deg C	Pres	Seal	Analysis(*)
L1201485-01A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-02A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-03A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-04A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-05A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-06A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-07A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-08A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-09A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-10A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)
L1201485-11A	Glass 100ml unpreserved	A	N/A		Y	Absent	A2-TOC-9060-2REPS(28)

*Values in parentheses indicate holding time in days

Project Name: LHCC **Lab Number:** L1201485
Project Number: GTX-11493 **Report Date:** 02/01/12

GLOSSARY

Acronyms

EPA	- Environmental Protection Agency.
LCS	- Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LCSD	- Laboratory Control Sample Duplicate: Refer to LCS.
LFB	- Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
MDL	- Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
MS	- Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.
MSD	- Matrix Spike Sample Duplicate: Refer to MS.
NA	- Not Applicable.
NC	- Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.
NI	- Not Ignitable.
RL	- Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
RPD	- Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.
SRM	- Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Data Qualifiers

A	- Spectra identified as "Aldol Condensation Product".
B	- The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than five times (5x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit.
C	- Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.
D	- Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.
E	- Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.
G	- The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.
H	- The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.
I	- The RPD between the results for the two columns exceeds the method-specified criteria; however, the lower value has been reported due to obvious interference.
M	- Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.
NJ	- Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

Report Format: Data Usability Report

ALPHA ANALYTICAL

Project Name: LHCC **Lab Number:** L1201485
Project Number: GTX-11493 **Report Date:** 02/01/12

Data Qualifiers

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

J - Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

ND - Not detected at the reporting limit (RL) for the sample.

REFERENCES

1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - IIIA, 1997.

LIMITATION OF LIABILITIES

Certificate/Approval Program Summary

Last revised January 30, 2012 – Mansfield Facility

The following list includes only those analytes/methods for which certification/approval is currently held.
For a complete listing of analytes for the referenced methods, please contact your Alpha Customer Service Representative.

Connecticut Department of Public Health Certificate/Lab ID: PH-0141.

Wastewater/Non-Potable Water (Inorganic Parameters: pH, Turbidity, Conductivity, Alkalinity, Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Strontium, Thallium, Tin, Vanadium, Zinc, Total Residue (Solids), Total Suspended Solids (non-filterable), Total Cyanide. Organic Parameters: PCBs, Organochlorine Pesticides, Technical Chlordane, Toxaphene, Acid Extractables, Benzidines, Phthalate Esters, Nitrosamines, Nitroaromatics & Isophorone, PAHs, Haloethers, Chlorinated Hydrocarbons, Volatile Organics.)

Solid Waste/Soil (Inorganic Parameters: pH, Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Hexavalent Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, Zinc, Total Organic Carbon, Total Cyanide, Corrosivity, TCLP 1311. Organic Parameters: PCBs, Organochlorine Pesticides, Technical Chlordane, Toxaphene, Volatile Organics, Acid Extractables, Benzidines, Phthalates, Nitrosamines, Nitroaromatics & Cyclic Ketones, PAHs, Haloethers, Chlorinated Hydrocarbons.)

Florida Department of Health Certificate/Lab ID: E87814. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: SM2320B, SM2540D, SM2540G.)

Solid & Chemical Materials (Inorganic Parameters: 6020, 7470, 7471, 9045. Organic Parameters: EPA 8260, 8270, 8082, 8081.)

Air & Emissions (EPA TO-15.)

Louisiana Department of Environmental Quality Certificate/Lab ID: 03090. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: EPA 180.1, 245.7, 1631E, 3020, 6020A, 7470A, 9040, 9050A, SM2320B, 2540D, 2540G, 4500H-B, Organic Parameters: EPA 3510C, 3580A, 3630C, 3640A, 3660B, 3665A, 5030B, 8015D, 3570, 8081B, 8082A, 8260B, 8270C, 8270D.)

Solid & Chemical Materials (Inorganic Parameters: EPA 1311, 3050, 3051A, 3060A, 6020A, 7196A, 7470A, 7471B, 7474, 9040B, 9045C, 9060. Organic Parameters: EPA 3540C, 3570B, 3580A, 3630C, 3640A, 3660, 3665A, 5035, 8015D, 8081B, 8082A, 8260B, 8270C, 8270D.)

Biological Tissue (Inorganic Parameters: EPA 6020A. Organic Parameters: EPA 3570, 3510C, 3610B, 3630C, 3640A, 8270C, 8270D.)

Air & Emissions (EPA TO-15.)

New Hampshire Department of Environmental Services Certificate/Lab ID: 2206. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: EPA 245.7, 1631E, 6020A, 7470A, 9040B, 9050A, SM2540D, 2540G, 4500H+B, 2320B. Organic Parameters: EPA 8081B, 8082A, 8260B, 8270C, 8015D.)

Solid & Chemical Materials (Inorganic Parameters: SW-846 1311, 1312, 3050B, 3051A, 3060A, 6020A, 7471A, 9040B, 9045C, 7196A. Organic Parameters: SW-846 3540C, 3580A, 3630C, 3640A, 3660B, 3665A, 5035, 8260B, 8270C, 8015D, 8082A, 8081B.)

New Jersey Department of Environmental Protection Certificate/Lab ID: MA015. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: SW-846 1312, 3010, 3020A, SM2320B, SM2540D, 2540G, EPA 180.1, 1631E, SW-846 7470A, 9040B, 6020, 9050A. Organic Parameters: SW-846 3510C, 3580A, 5030B, 5035L, 5035H, 3630C, 3640A, 3660B, 3665A, 8015B 8081A, 8082, 8260B, 8270C)

Solid & Chemical Materials (Inorganic Parameters: SW-846 6020, 1311, 1312, 3050B, 3051, 3060A, 7196A, 7470A, 7471A, 7474, 9040B, 9045C, 9060. Organic Parameters: SW-846 3540C, 3570, 3580A, 5030B, 5035L, 5035H, 3630C, 3640A, 3660B, 3665A, 8081A, 8082, 8260B, 8270C, 8015B.)

Atmospheric Organic Parameters (EPA TO-15)

Biological Tissue (Inorganic Parameters: SW-846 6020 Organic Parameters: SW-846 8270C, 3510C, 3570, 3610C, 3630C, 3640A)

New York Department of Health Certificate/Lab ID: 11627. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: SM2320B, SM2540D, EPA 200.8, 6020, 1631E, 245.1, 245.7, 7470A, 9014, 9040B, 9050, 120.1, 4500CN-E, 4500H-B, EPA 376.2, 180.1, 3020A. Organic Parameters: EPA 8260B, 8270C, 8081A, 8082, 3510C, 5030B.)

Solid & Hazardous Waste (Inorganic Parameters: EPA 6020, 7196A, 3060A, 7471A, 7474, 9014, 9040B, 9045C, 9010B. Organic Parameters: EPA 8260B, 8270C, 8081A, DRO 8015B, 8082, 1311, 1312, 3050B, 3580, 3570, 3051, 5035, 5030B.)

Air & Emissions (EPA TO-15.)

Pennsylvania Certificate/Lab ID: 68-02089 ***NELAP Accredited***

Solid & Hazardous Waste (Inorganic Parameters: EPA 6020A,7471B, 7474. Organic Parameters: EPA3050B, 3540C, 3630C, 8270C, 8081B, 8082A.)

Rhode Island Department of Health Certificate/Lab ID: LAO00299. ***NELAP Accredited via LA-DEQ.***

Refer to LA-DEQ Certificate for Non-Potable Water.

Texas Commission of Environmental Quality Certificate/Lab ID: T104704419-08-TX. ***NELAP Accredited.***

Solid & Chemical Materials (Inorganic Parameters: EPA 6020, 7470, 7471, 1311, 7196, 9040, 9045, 9060. Organic Parameters: EPA 8015, 8270, 8260, 8081, 8082.)

Air (Organic Parameters: EPA TO-15)

Washington State Department of Ecology Certificate/Lab ID: C954. *Non-Potable Water* (Inorganic Parameters: SM2540D, 180.1, 1631E.)

Solid & Chemical Materials (Inorganic Parameters: EPA 6020, 7470, 7471, 7474, 9045C, 9050A, 9060. Organic Parameters: EPA 8081, 8082, 8015 Mod, 8270.)

Virginia Division of Consolidated Laboratory Services Certificate/Lab ID:460194. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters:EPA 3020A,6020A,245.7,9040B,SM4500H-B. Organic Parameters: EPA 3510C,3640A,3660B,3665A,8270C,8270D,8082A,8081B.)

Solid & Chemical Materials (Inorganic Parameters: EPA 6020A,7470A,7471B,9040B,9045C,3050B,3051. Organic Parameters: EPA 3540C, 3580A, 3630C, 3640A, 3660B, 3665A, 3570, 8270C, 8270D, 8081B, 8082A, 8015D.)

U.S. Army Corps of Engineers

Department of Defense, L-A-B Certificate/Lab ID: L2217.01.

Non-Potable Water (Inorganic Parameters: EPA 6020A, SM4500H-B. Organic Parameters: 3020A, 3510C, 5030B, 8260B, 8270C, 8270C-ALK-PAH, 8082, 8081A, 8015D-SHC, 8015D.)

Solid & Hazardous Waste (Inorganic Parameters: EPA 1311, 1312, 3050B, 6020A, 7471A, 9045C, 9060, SM 2540G, ASTM D422-63. Organic Parameters: EPA 3580A, 3570, 3540C, 5035A, 8260B, 8270C, 8270-ALK-PAH, 8082, 8081A, 8015D-SHC, 8015D.

Air & Emissions (EPA TO-15.)

Analytes Not Accredited by NELAP

Certification is not available by NELAP for the following analytes: **8270C:** Biphenyl. **TO-15:** Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 2-Methylnaphthalene, 1-Methylnaphthalene.

Serial_No:02011213:01

CHAIN OF CUSTODY

PAGE 1 OF 1

ALPHA ANALYTICAL
WESTBORO, MA TEL: 508-898-9220 FAX: 508-898-9193
MANSFIELD, MA TEL: 508-822-9300 FAX: 508-822-3288

Date Rec'd in Lab:

ALPHA Job #: L1201485

Project Information
Project Name: LHCC
Project Location: New Bedford, MA
Project #: GTX-11493
Project Manager: Joe Tomei
ALPHA Quote #:

Client Information
Client: GeoTesting Express
Address: 125 Nagog Park Acton, MA
Phone: 978 635 0424
Fax: ————
Email: jdt@geotesting.com
☐ These samples have been previously analyzed by Alpha

Report Information - Data Deliverables
☐ FAX ☐ EMAIL
☐ ADEx ☐ Add'l Deliverables

Billing Information
☐ Same as Client info PO #:

Regulatory Requirements/Report Limits
State /Fed Program | Criteria

MA MCP PRESUMPTIVE CERTAINTY --- CT REASONABLE CONFIDENCE PROTO
☐ Yes ☐ No Are MCP Analytical Methods Required?
☐ Yes ☐ No Is Matrix Spike (MS) Required on this SDG? (If yes see note in Comments)
☐ Yes ☐ No Are CT RCP (Reasonable Confidence Protocols) Required?

Turn-Around Time
☐ Standard ☐ RUSH (only confirmed if pre-approved!)
Date Due: 2/2/12 Time:

Other Project Specific Requirements/Comments/Detection Limits:
If MS is required, indicate in Sample Specific Comments which samples and what tests MS to be performed.
(Note: All *CAM* methods for inorganic analyses require MS every 20 soil samples)

ANALYSIS: EPA 9060 - TOC

SAMPLE HANDLING
Filtration
☐ Done
☐ Not needed
☐ Lab to do
Preservation
☐ Lab to do
(Please specify below)

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler's Initials	EPA 9060 - TOC	Sample Specific Comments	TOTAL # BOTTLES
-01	A-2011-CAD4, B-6, 47-49ft					X		
-02	" ", B-3, 30-32 ft					X		
-03	" ", B-5, 38-40 ft					X		
-04	" ", B-2, 36-38 ft					X		
-05	" ", B-2, 30-32 ft					X		
-06	" ", B-5, 25-27 ft					X		
-07	" ", B-1, 26-28 ft					X		
-08	" ", B-1, 48-50 ft					X		
-09	" ", B-4, 22-24 ft					X		
-10	" ", B-4, 41-43 ft					X		
-11	" ", B-6, 36-38 ft					X		

MGD 1/27/12
MGD 1/27/12

PLEASE ANSWER QUESTIONS ABOVE!

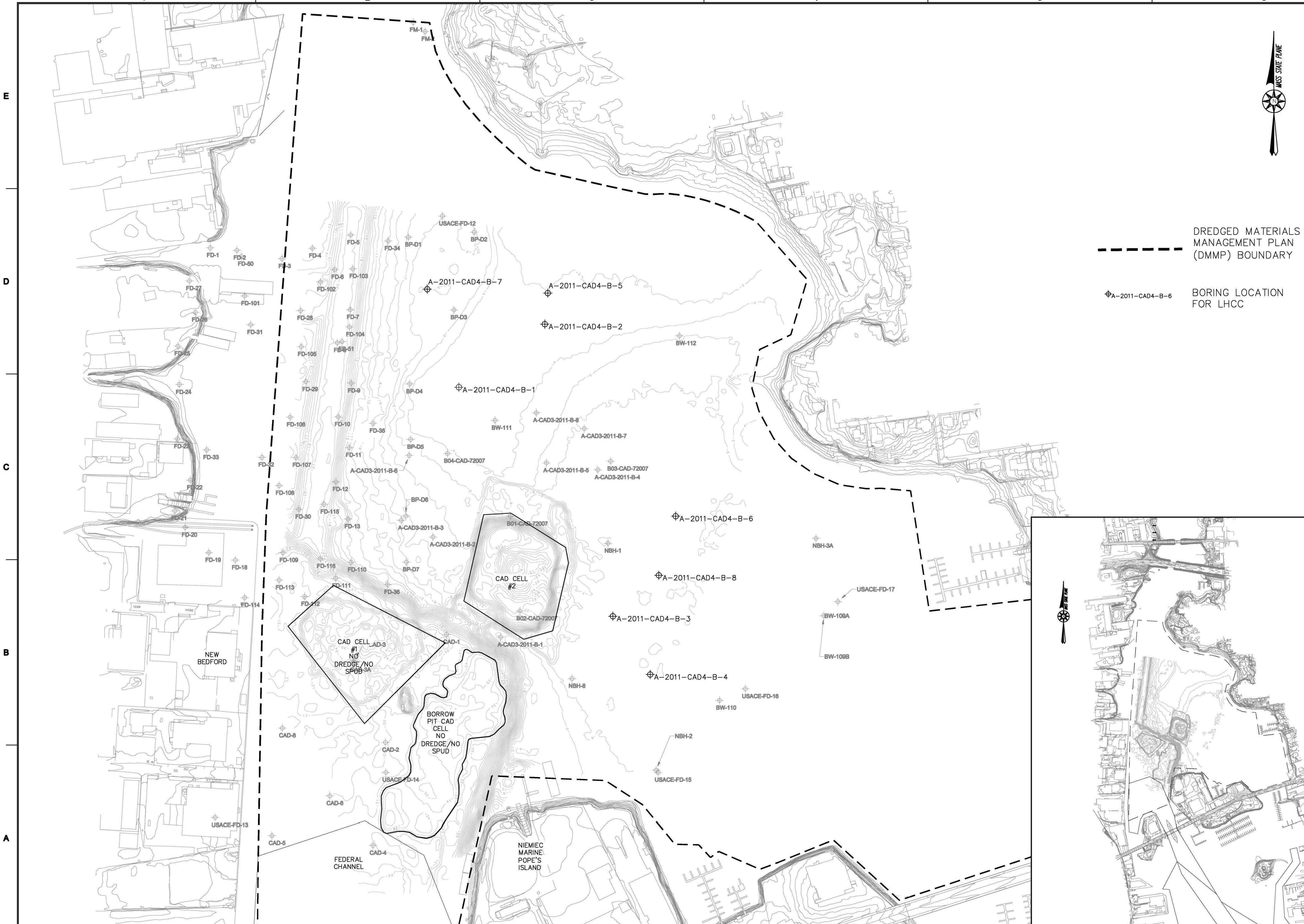
~~Container Type~~	X
Preservative	

IS YOUR PROJECT MA MCP or CT RCP?

Relinquished By:	Date/Time	Received By:	Date/Time
[signature] GTX	1/27/12 1230	[signature]	1/27/12 1225
[signature]	1/27/12 1350	[signature]	1/27/12 1350
[signature]	1/27/12 1350	P. Gilbert	1/27/12 1655
P. Gilbert	1/27/12 1755	Eileen Sullivan	1/27/12 17:55

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 18-Jan-2010)



1	2	3	4	5	6

APEX

ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA - NEW BEDFORD, MA - HOLYOKE, MA

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

55H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

This drawings prepared by Apex for this project are instruments of Apex's service for use solely with respect to this project, and Apex shall be deemed the author of the Drawing and shall retain all common law, statutory and other reserved rights with respect thereto, including the copyright. The Documents shall not be used on other projects, for additions to this project or for completion of this project by others, except by agreement in writing and with appropriate compensation to Apex.

PROJECT
NEW BEDFORD HARBOR
USEPA LOWER HARBOR CAD CELL
CFDA NO.:66.802

OWNER
NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
52 FISHERMAN'S WHARF
NEW BEDFORD, MA 02745

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	6724
CADD FILE	SAP FIGURE2-6
DESIGNED BY	GCD
DRAWN BY	GCD
CHECKED BY	CMM
DATE	1/24/12
DRAWING SCALE	1"=175'

GRAPHIC SCALE
SCALE: 1"=175'
0 175 350 FEET

SHEET TITLE

BORING LOCATION PLAN

DRAWING NO.

FIG-2

1 OF 9

P:\Jobs\5724 EPA CAD Cell\PLANS\SAP FIGURE2-6.dwg

JACOBS

US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT

Total Environmental Restoration Contract
USACE CONTRACT NUMBER: DACW33-03-D-0006
Task Order No. 0007

FINAL
EVALUATION OF THE IMPACT OF DREDGING AND CAD CELL DISPOSAL ON AIR QUALITY

NEW BEDFORD HARBOR SUPERFUND SITE, NEW BEDFORD, MA

New Bedford Harbor Superfund Site
New Bedford, MA

June 2010

Prepared by:
Jacobs Engineering Group
103 Sawyer Street
New Bedford, MA 02746

ACE-J23-35BG0702-M17-0011

TABLE OF CONTENTS

Figures

<u>Tables</u>

<u>Appendices</u>

ACRONYMS AND ABBREVIATIONS

CAD	confined aquatic disposal
City	City of New Bedford
cy	cubic yards
EPA	U.S. Environmental Protection Agency
FW	Foster Wheeler Environmental Corporation
ISC3	Industrial Source Complex Model
ISCLT3	Long Term Industrial Source Complex Model
ISCST3	Short Term Industrial Source Complex Model
Jacobs	Jacobs Engineering Group, Inc.
LHCC	lower harbor CAD cell
MU	management unit
NAE	U.S. Army Corps of Engineers – New England District
NBH Site	New Bedford Harbor Superfund Site
ng/m^3	nanograms per cubic meter
PCB	polychlorinated biphenyl
ppm	parts per million

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1.0 INTRODUCTION

This report describes the air modeling investigation for the dredging, transport, and disposal activities associated with the proposed lower harbor confined aquatic disposal (CAD) cell (LHCC) at the New Bedford Harbor Superfund Site in New Bedford, Massachusetts (NBH Site). For the purposes of this modeling effort, and to represent high dredging and disposal rates, an $80 million per year funding scenario was used for activity sequence, sediment removal rates, and project duration. Polychlorinated biphenyl (PCB) sediment concentrations were obtained from the *Air Dispersion Modeling of 2009 Dredging Operations* (Jacobs 2009). For this $80 million per year funding scenario, years four and five would involve placement of PCB-contaminated material into the LHCC.

Removal of PCB-contaminated sediments in the harbor was the remedial action selected for operable unit #1 of the NBH Site. The current approach consists of hydraulic dredging, desanding and dewatering of dredged sediments, treatment of the wastewater generated in the dewatering process, and disposal of desanded and dewatered sediment at an approved off-site landfill. The U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers – New England District (NAE) are considering use of an LHCC to shorten the remediation timeframe and lower the overall harbor remediation cost. The investigation documented by this report evaluates the impact to air quality from the mechanical dredging and proposed CAD cell disposal activities.

CAD is the process where dredged material that is unsuitable for unconfined open water disposal is deposited into a marine environment within a confined area or excavation, and then capped with a suitable material. CAD cells are increasingly becoming the selected option for the management of unsuitable dredged material (UDM).

The sediments slated for the proposed LHCC are the relatively lower concentration level PCB-contaminated sediments from approximately the Sawyer Street area south to the Route 6 Bridge. Air dispersion modeling was conducted to estimate the air quality impacts of mechanically dredging, transporting by scow, and disposing these sediments into the proposed LHCC.

Evaluation of the air quality impacts from dredging operations has been conducted since 2005 using air dispersion modeling efforts (Jacobs 2005, 2006, 2007, 2008, and 2009). The previous modeling efforts have been validated and improved by comparing with field data. This modeling analysis used the same model domain of the previous studies and incorporated the latest site-specific meteorological and design data to predict future impacts.

2.0 BACKGROUND

2.1 SITE INFORMATION

The NBH Site is located in Bristol County, Massachusetts, approximately 55 miles south of Boston, and is bordered by the Towns of Acushnet and Fairhaven on the east side, and by the City of New Bedford (City) on the west. From north to south, the NBH Site extends from the upper reaches of the Acushnet River estuary, through New Bedford's commercial port, and into Buzzards Bay (Figure 1).

Industrial and urban activities surrounding the NBH Site have resulted in sediments becoming contaminated with PCBs and heavy metals, with concentration gradients generally decreasing from north to south. PCB-contaminated sediments and seafood in and around New Bedford Harbor were first identified in the mid-1970s as a result of EPA region-wide sampling programs. Based on these sampling programs, the principle sources of PCB contamination were determined from two electric capacitor manufacturing facilities located adjacent to the Acushnet River/New Bedford Harbor water way. The Aerovox facility was the primary source of PCB contamination and was located near the northern boundary of the site. PCB wastes were discharged from Aerovox's operations directly into the Upper Harbor through open trenches and discharge pipes, or indirectly throughout the site via the City's sewage system. Additional inputs of PCBs were also made from the Cornell Dubilier Electronics, Inc. facility just south of the New Bedford Hurricane Barrier. PCB use at these electric capacitor manufacturing facilities occurred from the 1940s into the 1970s. The NBH Site was added to the Superfund National Priorities List (NPL) in September 1983.

The NBH Site has been divided into three areas - the Upper Harbor, the Lower Harbor, and the Outer Harbor - consistent with geographical features of the area and gradients of contamination (Figure 1). The Upper Harbor, above the Interstate-195 Bridge, comprises approximately 187 acres, with a wide range of PCB concentrations in sediments [below detection to approximately 10,000 parts per million (ppm)]. Prior to the removal of the most contaminated hot spot sediments in 1994 and 1995 as part of the NBH Site's first cleanup phase, sediment PCB levels were reported higher than 100,000 ppm at isolated locations in the Upper Harbor. The Lower Harbor, from the interstate bridge to the hurricane barrier, comprises approximately 750 acres. In portions of the Lower Harbor, sediment PCB levels range from below detection to over 100 ppm. Sediment PCB levels in the Outer Harbor are generally low, with only localized areas of PCBs in the 50 to 100 ppm range near the Cornell-Dubilier plant and the City's sewage treatment plant outfall pipes (the highest areas of PCB contamination in the Outer Harbor were capped in 2005).

For modeling purposes, the three areas of the NBH Site (Upper Harbor, Lower Harbor, and Outer Harbor), were subdivided into six zones based on PCB concentrations detected in sediment samples during investigation activities. These investigations were performed by Foster Wheeler Environmental Corporation (FW) as part of its pre-design field activities (FW 2001). The six zones, with Zone 1 in the northern portion of the NBH Site and Zone 6 in the southern portion of the NBH Site, are illustrated on Figure 2.

Remedial action at the NBH Site is currently being completed by Jacobs Engineering Group, Inc. (Jacobs) under a Total Environmental Restoration Contract (TERC) from NAE.

2.2 DREDGING AND CAD CELL DESIGN

Since 2004, several of the highly contaminated management units (MU) in Zones 1, 2, and 3 have been hydraulically dredged. The funding and work-sequencing scenario for this modeling exercise includes a five-year dredging plan that incorporates the current hydraulic dredging and off-site disposal for the first three years for the MUs in Zones 1 through 3, and proposed mechanical dredging and LHCC disposal for the last two years for the MUs in Zones 4 and 5. It is these last two years that are the subject of this air modeling investigation.

Figure 3 shows the MUs in the harbor and the dredging composite areas used for LHCC modeling purposes (for both air and water quality). Table 1 lists the MUs and their dredging concentrations, volumes, and relative time frames.

The proposed CAD cell disposal and associated dredging areas are all located in the lower part of the Upper Harbor (Composite Area 4) and Lower Harbor (Composite Area 5) of the NBH Site (Figure 3). The sediment from these areas would be dredged using a mechanical dredging bucket to an open top barge to transport to the CAD cell.

The proposed LHCC would be sited south of the Route 195 Bridge and north of Popes Island (Figure 3). The cell would have a design capacity of about 300,000 cubic yards (cy) to accommodate the dredging volume. An engineered excavation would be created and filled with sediment dredged from an area extending from Sawyer Street south to the Route 6 Bridge. It is assumed that an open top scow would be towed to the CAD cell, and that the dredged sediment would be placed into the LHCC by either a) opening a split-hull scow or b) using a clam shell bucket. After the CAD is filled to its design depth, a cover of clean sandy material would be placed to prevent contact with aquatic life and to prevent migration of contaminants out of the cell. Figure 4 shows the planned dredging scenarios and the assumed LHCC location.

2.3 PREVIOUS EMISSION CALCULATIONS AND AIR DISPERSION MODELING

Mechanical dredging, transport, and CAD cell disposal operations have the potential to expose the sediments to the open air for limited periods of time. As a consequence, vapor phase PCBs (especially lighter, lower molecular weight PCBs) could be released into the atmosphere. These releases would be in addition to on-going "natural" PCB emissions from the NBH Site's contaminated sediments, especially from contaminated mudflats exposed to open air at low tide.

Air dispersion modeling activities have been conducted by FW (2001) and Jacobs (2005, 2006, 2007, 2008, and 2009). Both FW and Jacobs performed air dispersion modeling using the Industrial Source Complex Model (ISC3) code (EPA 1995a, b) to estimate the air concentrations of PCBs generated by dredging and treatment facilities for the current remedial dredging activity (i.e., dredging, desanding, dewatering, and offsite disposal). Since 2005, Jacobs has utilized time-specific dredging data and on-site meteorological data to model and estimate the air quality impacts from the dredging operations (Jacobs 2005, 2006, 2007, 2008, and 2009). Air quality monitoring data over the past five years has also been used to substantiate the model assumptions and input parameters. This is done to improve the accuracy of the model predictions.

3.0 AIR DISPERSION MODELING

This section describes the assumptions and input parameter selections used for the proposed dredging and CAD activity air modeling investigation.

3.1 ISC3 MODEL

The ISC3 used for the air dispersion modeling efforts is a steady-state Gaussian plume model that can be used to assess pollutant concentrations from a wide variety of sources associated with industrial and environmental activities. ISC3 models are specifically designed to support the EPA's regulatory modeling programs.

The ISC3 model can be operated in both long-term (ISCLT3) and short-term (ISCST3) modes. The ISCST3 model utilizes hourly meteorological data to model emissions for a given period. The ISCLT3 model is only used to model emissions with long-term averaging periods by utilizing standard stability array meteorological data. The ISC3 model is capable of handling multiple sources; including point, volume, area, and open pit source types. Line sources may also be modeled as a string of volume sources or as elongated area sources. Several source groups may be specified in a single run, with the source contributions combined for each group. The model also contains algorithms for modeling the effects of aerodynamic downwash due to nearby buildings on point source emissions, and algorithms for modeling the effects of settling and removal (through dry deposition) of particulates. The model user may select either rural or urban dispersion parameters, depending on the characteristics of the source location.

Source emission rates can be treated as constant throughout the modeling period, or may be varied by month, season, hour-of-day, or other periods. These variable emission rate factors may be specified for a single source or for a group of sources. For the ISCST3 model, the user may also specify separate, hourly emission rates for some or all of the sources included in a particular model run.

The ISCST3 model accepts hourly meteorological data records to define the conditions for plume rise, transport, diffusion, and deposition. The model estimates the concentration or deposition value for each source and receptor combination for each hour of input meteorology, and calculates user-selected short-term averages.

The ISCST3 model has considerable flexibility in the specification of receptor locations. The user of the model has the capability of specifying multiple receptor networks in a single run, and may also mix Cartesian grid receptor networks and polar grid receptor networks in the same run.

The ISCST3 model is appropriate for the following air dispersion applications:

- Multiple area or point industrial source complexes;
- Rural or urban areas;
- Flat or rolling terrain;
- Transport distances less than 50 kilometers;
- One hour to annual averaging of exposure duration; and
- Continuous toxic air emissions.

The ISCST3 model includes a wide range of options for modeling air quality impacts of pollution sources, making them popular choices among the modeling community for a variety of applications.

The ISCST3 (version 3) model was used for this air dispersion modeling.

3.2 PCB SEDIMENT SOURCES CHARACTERIZATION

As discussed in Section 2.1, the sediments in the Harbor have been extensively sampled during the pre-design field activities (FW 2001) and the investigation has lead to the grouping of six zones (Figure 2). Zones 1, 2, and 3 in the northern portion of the NBH Site have the highest PCB concentrations (>100 ppm) and are being remediated using hydraulic dredging, on-site treatment, and off-site disposal to lessen the impact to the environment. Zones 4 and 5 have much lower PCB concentrations and are being proposed for mechanical dredging and CAD disposal.

During the remediation process, the Harbor was also divided into many MUs as shown in Figure 3. The PCB concentrations for the MUs proposed for mechanical dredging and CAD disposal are summarized in Table 4.

3.3 MODEL PARAMETERS AND ASSUMPTIONS

ISCST3 allows a wide variety of sources to be presented in a complex terrain setting. Because the Harbor and its surroundings are in a relatively flat area, a flat terrain height option was used for the air dispersion modeling. The modeling was further conducted in a no plume depletion option (no dry or wet deposition) and used a rural dispersion coefficient. All these selected modeling processes and parameters were fairly conservative and would result in higher model predicted values.

Two types of sources were modeled. Area sources were used to represent the MUs, CAD, and background mudflats. Line sources were used to represent barge transport routes. The dredging processes, including bucket and barge exposure, are multiple point sources in the field. However, because the point sources are distributed within the whole MU area during the remediation period in the model, the dredging processes were also represented as area sources adding more conservatism to the model as discussed in later sections.

3.4 PCB EMISSION SOURCES

There are several types of PCB emission sources that could contribute to the air quality at the NBH Site. These sources can be classified into two categories: 1) background emission sources and 2) remediation emission sources. The background emission sources are the relatively long-term, consistent sources that regularly contribute some level of contaminants to the atmosphere. The identified background sources included the following:

- harbor mudflats and inter-tidal sediments, and
- point or area land sources with previous PCB contamination.

All background sources contribute to the baseline air quality.

Remediation emission sources are those sources that only contribute potential emissions during periods of active remediation. For a CAD-based approach this would include the mechanical dredging, transport of sediment, and CAD cell disposal activities. The remediation emission sources are short-term compared to background. Table 2 lists the PCB emission sources that may contribute to aerosol dispersion of contaminants during dredging and CAD activities.

3.5 SOURCE EMISSION MECHANISM AND RATE

There are three potential sources of PCB air emissions that may occur during mechanical dredging:

- the exposed dredge bucket,
- the surface of the open barge, and
- the disturbed water surface.

The contaminated sediment will be dredged by the mechanical arm bucket and dumped into an open barge. During the dredging process, PCBs may be emitted from the disturbed water surface caused by the dredging bucket. PCBs may also be emitted from exposed sediment within the dredging bucket during the transferal of sediment from the water surface to the barge. Because the barge is open to the air, PCBs may be emitted from exposed sediments on the barge during the dredging activity.

After the open barge is filled using the mechanical dredging device, the open barge would be towed to the CAD cell location for sediment disposal. During the transport process, there may be PCBs emitted from the barge along the transport routes.

At the CAD cell location, it is assumed that the dredged sediments would be placed into the CAD cell by either a) releasing them from the bottom of a split-hull scow or b) using a clam shell bucket. Both of these methods have the potential to emit additional airborne

PCBs. There are four potential sources of airborne PCBs that may occur during the filling of the CAD cell:

- the exposed dredge bucket,
- the surface of the open barge,
- the disturbed water surface due to disposal, and
- ponded water/sediment within the CAD cell before capping.

The emission from each of the dredging, transport, and disposal processes will depend on the PCB concentration of the sediment and length of the exposure due to the activity.

Thibodeaux and FW estimated PCB emission rates for activities associated with some remediation scenario operations. The emission rates were derived based on emission calculations using sediment concentrations, field measurements, bench-scale tests, and theoretical calculations (Thibodeaux 1989; FW 2001). The emission rates are important model input parameters to evaluate potential air impacts from remediation activities.

Table 3 lists the theoretical PCB flux rates for background emission sources and remediation emission sources associated with dredging and CAD activities. The theoretical flux rates for processes associated with dredging and disposal activities are based on sediment with a PCB concentration of 432 ppm (Thibodeaux 1989) and 1,031 ppm for ponded sediment (FW 2001). The flux rates for background mudflat areas and Aerovox areas are based on previous modeling calibrations (Jacobs 2005).

To get the proper emission rates for each MU, PCB emission rates for each MU were calculated based on Thibodeaux's PCB emission rate for 432 ppm sediment using the MU-specific PCB concentrations assuming a linear concentration-flux rate relationship for this modeling effort. For example, for exposed sediment with a PCB concentration of 1,000 ppm, the theoretical emission rate would be calculated as the flux from 432 ppm sediment × (1,000 ppm ÷ 432 ppm). Similarly, the yearly-specific emission rates based on composite PCB concentrations for the water body within the CAD were calculated.

The calculated MU-specific emission rates associated with various processes and total emission rate applied in the model are presented in Table 4.

3.6 METEOROLOGICAL DATA

ISCST3 uses hourly meteorological data records to define conditions for plume ascension, transport, diffusion, and deposition and to estimate the concentration or deposition value for receptors. Therefore, site-specific meteorological data are important input parameters for the model.

An initial meteorological monitoring program was conducted at the NBH Site. The on-site meteorological station is located on the confined disposal facility (CDF) site (end of Sawyer Street) adjacent to the harbor. Meteorological data collected from 1996 to 1999 were processed and used in the previous air dispersion modeling (FW 2001).

The on-site meteorological station was restored in 2006. The data collected at the on-site station includes wind speed, wind direction, temperature (2 meters and 10 meters aboveground), relative humidity, barometric pressure, solar radiation, and precipitation. The wind speed and direction are recorded at five-minute intervals. The remaining parameters are recorded at 60-minute intervals.

Figure 5 shows the data summaries of meteorological parameters in 2006, 2007, and 2008. Figure 6 shows the wind rose diagrams summarizing the wind speed and direction at the site for those three years.

3.7 DISCRETE RECEPTORS AND MODELING GRID

Discrete receptors are used in the air dispersion model to represent the air monitoring stations and sensitive residential, school, and industrial locations. The air monitoring locations used in 2008, along with the discrete receptor locations, as previously identified in earlier studies (FW 2001), are presented on Figure 7.

A 100 meter × 100 meter grid system is used to cover the NBH Site for the model. The grid system is used to generate model-predicted PCB concentration contours. This approach is necessary to construct a more precise contour map because the discrete receptors do not have adequate density or distribution. Figure 8 shows the grid system for the NBH Site.

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4.0 SIMULATION OF DREDGING AND CAD ACTIVITIES

Air modeling based on the 2008 meteorological data was used to predict the air quality impact for the proposed dredging and CAD activities. ISC-AERMOD View version 5, an air dispersion modeling software package that incorporates the ISC3 model, was used for this modeling effort (Lake Environmental Software 2006).

All the modeling runs conducted are summarized in Appendix A and the modeling input and output files for these runs are provided on a compact disc (CD) in Appendix B.

4.1 SOURCE-SPECIFIC EMISSION REPRESENTATION AND APPLIED EMISSION RATE

As discussed in Section 3.2, the PCB emission sources include the following:

- harbor mudflats and inter-tidal sediments,
- point or area land sources with previous PCB contamination from former operations, and
- dredging operations and associated transport and disposal processes.

Emission rates from these sources can be constant, intermittent, or singular. The point or area land sources are assumed to be constant, continuous sources. The mudflats are intermittent sources, and are only exposed during low tide periods. Dredging and disposal result in potential point, line, and area sources for which emissions only occur during the hours of the dredging, transport, and disposal activities.

The ISC3 model source input allows great flexibility in the representation of the sources. The ISC3 model provides many source emission options by using an emission factor and/or variable emission rate in the source term. Emission factors or rates may be specified for either individual sources or groups of sources. The factors may vary for different time and wind scales; as a function of season, month, and hour of day; and by wind speed and stability category.

The total emission from a particular source is a function of emission flux rate and emission duration for the modeled period. Because the ISCST3 model is a steady-state Gaussian plume model that incorporates either hourly or periodic meteorological data for its predictions, emission factors are used to account for the total emission for a specific period modeled for a one-time dredge source. The emission factor for a single dredging operation occurring over a specific area and duration is derived as follows:

Emission Mass Released (g) = Flux rate in grams per square meter-hour (g/m^2-h) × Area in square meters (m^2) × Emission duration in hours (h) × Emission factor

Where

Flux rate = PCB mass emitted over a specific time per area

Emission duration = Actual total time of a source emission in the field

Source duration = Source emission time applied in the model

Emission factor = Emission duration/Source duration applied in the modeling

The period of time applied to the model and the calculated result for the modeling period requires consideration. For example, if the one day dredge area is used as a continuous source for a 24 hour simulation and the dredge emission hours are only 12 hours per day, an emission factor of 0.50 days (12 hrs per day) is used to derive the dredging day 24-hour average concentration. However, if the same 12 hour dredging period is used as a source for an annual simulation period in the model, an emission factor of 0.00139 years [12 hrs × (1 day per 24 hrs) × (1 month per 30 days) × (1 year per 12 months)] is used to calculate the annual average concentration.

Table 3 shows the emission duration assumed for the processes used for modeling in terms of total hours for each particular location. For each dredging location, a 12-hour PCB emission from water is assumed to represent the total time of water disturbance associated with dredging activity for a particular area. For the exposed sediment in a dredging bucket, a one-hour emission is assumed as multiple sediment exposures from multiple buckets for a particular location. The open barge is assumed to have a two-hour emission time for each location for the whole footprint of the dredged area. In reality, the barge will likely be in many locations within the footprint during the dredging operation with longer emission time. However, using the whole dredging area as an emission source for the barge eliminates the specification of the locations and provides a more reliable yearly average estimate. All the durations used for the modeled dredging activities are likely longer than actual dredging activities and will result in more conservative (higher) estimation of emissions.

For barge transport, the emission duration will be extremely short along the transport paths. For the Upper and Lower Harbor, the barge size is assumed to be 1,000 cy and the barge will take about one hour to travel from the MUs to the CAD cell. The total emission durations along the transport paths then are calculated based on the speed and numbers of trips the barges make over the project period.

For the CAD cell disposal, each disposal option by either opening a split-hull scow or using a clam shell bucket only occurs for a particular location and emission duration is very short. For the dredging season emission, a 16-hour and a 12-hour emission duration is assumed for each dump during the two dredging seasons, respectively. Similar to open barge, the whole CAD cell footprint is used as a continuous emission source for the dredging season. Using the whole CAD cell area as an emission source for the disposal will eliminate the specification of the locations and provide a more reliable and conservative yearly average estimate.

The remediation activities are assumed to be 180 and 156 days for the two years of dredging and CAD placement. For the first year, a May to October dredging and disposal season is assumed. The dredging MU and CAD sources are assumed to be continuous area sources for the entire remediation period (180 days). For the second year, a June to October dredging and operation season is assumed (156 days) for the respective dredging MUs and CAD site.

It is assumed that water in the CAD cell is in equilibrium with the disposed sediment. PCBs will be emitted into the air from the CAD cell during the disposal period before the cap is placed. Therefore, for the model simulation, it is assumed that there will be a 270 day CAD cell emission period for the first year (May - December) from start of the disposal activities to end of the year and a 365 day emission period for the second year (January - December). For the second year, it is assumed that cap will not be placed immediately after end of disposal activities.

For the dredging and CAD activity modeling, the MU-specific emission flux rates for all emission processes are calculated based on the average PCB concentrations in the sediment for each MU. Table 4 shows the detailed emission rates for each process for all the locations. For the transport and CAD disposal process, the composite concentrations for the MUs for each year are used to calculate the emission flux rates for each process. The emission flux rates from the two CAD disposal options are presented in Table 4.

The whole dredging area for each year is used as a continuous emission source during the dredging season for the annual average PCB calculation. The applicable emission rates (total emission rate applied in the model for the activity duration in the year) for dredging at each MU and associated transport and CAD disposal activities are presented in Table 4.

For annual average emission calculations, the remaining intermittent yearly emission from the mud flats in the Upper Harbor is modeled using an hourly intermittent source with the full emission rate occurring in two periods (corresponding with the low tide) per day (12am to 2pm and 12pm to 2am for a four-hour-per-day exposure scenario). It is assumed that all of the contaminated mudflats will be removed during the first year of the operation and they will only contribute to airborne emission during the first half of that year. In addition to the hour emission periods for the mudflats, a 0.5 emission factor is used to represent the total emission for the whole year. This is done because ISC3 does not define hourly and monthly at the same time for a source. The on-land Aerovox source is assumed to be present for the simulation. However, it has no impact to the air quality of the Lower Harbor area.

4.2 CAD CELL DISPOSAL AND DREDGING SIMULATION RESULTS

The modeling runs were set up to provide estimates of total annual average PCB concentrations in air from the remediation activities (dredging, transport, and CAD disposal/deposition contributions) and the combined background and remediation related sources for each of the two years of operation. The total annual average concentration is the total mass received in a location over a one-year period. It is calculated in the model by the average of the daily (24 hour) maximum concentrations over the one-year period for a location. The 24 hour maximum concentration is the maximum concentration of any defined continuous 24-hour slot for the period considered. The model runs were also performed for the two CAD disposal options: opening a split-hull scow (bottom dump) or using a clam shell bucket.

Isocontours of the model-predicted total annual average PCB concentration at the NBH Site (i.e., including background sources) for the first year are shown in Figure 9. The maximum concentration from all dredging and CAD sources (i.e., excluding the on-land Aerovox site) occurs near the mudflats of the dredging area (MU-25 to MU-30) with a high of about 60 nanograms per cubic meter (ng/m^3). The contribution from the dredging, transporting, and disposal activities (i.e., not including background sources) is shown in the isocontours in Figure 10. The predicted maximum concentration at the dredging area from dredging activities is less than 10 ng/m^3. The predicted maximum concentration from CAD cell disposal is less than 25 ng/m^3. Along the transport paths, the predicted PCB concentration is less than 0.25 ng/m^3. The on-land Aerovox contamination is not related to dredging operations.

Isocontours of the model-predicted total annual average PCB concentration at the NBH Site (i.e., including background sources) for the second year is shown in Figure 11. The maximum concentrations (excluding the on-land Aerovox site) occur near the center of the dredging area (MU-31 and MU-32) with a maximum concentration less than 10 ng/m^3 and at the CAD cell with a maximum concentration less than 25 ng/m^3. Because the background Upper Harbor mudflat sources are assumed to have been remediated in Year 1 (with the exception of the on-land Aerovox site) and none exist in the Lower Harbor, the PCB source is solely from the dredging, transporting, and disposal activities. The detailed distribution for the PCB concentration from dredging and CAD disposal in the second year (i.e., not including background sources) is shown in Figure 12.

Note that Figures 9 through 12 assume an excavator-bucket placement method; Figures 13 and 14 show the similar (low) impacts of this approach versus split-hull scow placement.

The model predicts that the second year will have lower concentrations than the first year because of the lower PCB concentrations in the dredged sediments and a shorter remediation time (156 days vs. 180 days).

Figure 13 shows comparison of the two CAD disposal options for the first year of the operation. The long-term emission from the CAD water surface is not included in the figure as it is the same for both options. The resulting contours are very similar for the two options with the bucket disposal resulting in a slightly larger 2 ng/m^3 contour due to its higher PCB emission rate.

Figure 14 shows the resulting contours of the two CAD disposal options for the second year of the operation. Similarly, the long-term emission from the CAD water surface is not included in the figure as it is the same for both options. The bucket disposal option results in a slightly larger 1 ng/m^3 contour near the CAD footprint. However, the overall impact and extents are about the same for the two disposal options.

Table 5 presents the model-predicted average PCB concentrations for all the discrete receptor locations (Figure 7) for the specific year. The predicted annual average concentrations due to emissions from the dredging and CAD disposal operations are also presented in Table 5.

4.3 CONCLUSIONS

FW (2001) described an approach to track potential cumulative public exposures to PCB concentrations in ambient air during remedial activities at New Bedford Harbor. That document describes the exposure budget as a target ambient air concentration over time that, if achieved, will document that public exposures to PCBs are below acceptable health-based target levels. The slope of the cumulative exposure budget line is the allowable ambient PCB concentration at the sampling station that is protective of the most sensitive target receptor.

The health endpoint is cancer associated with long term or chronic exposure to PCBs associated with inhalation (FW 2001). FW defined the slope as being quantitatively dependent on the three following primary risk assessment criteria factors:

- The allowable ambient limit assuming a target risk of 1 $x10^{-5}$ (one incremental cancer in 100,000); a cancer slope factor of 0.4 milligrams per kilogram per day $(mg/kg/day)^{-1}$; and the exposure duration of the remediation activity;
- The annual average background concentration of airborne PCBs at the point of potential exposure; and
- The air dispersion factor between the sampling station and the assumed point of exposure.

This approach to measuring ambient air PCB concentrations and tracking the cumulative exposures relative to the health-based target levels has been used by the project since 2004. The allowable ambient PCB concentration limits are 409, 639, and 894 ng/m^3 for children, adult residents, and commercial/industrial workers, respectively, in the communities abutting New Bedford Harbor for a 10-year exposure duration scenario (FW 2001).

Results of the air dispersion modeling of the proposed dredging and CAD activities indicate that the maximum annual impacts from the planned operations, even with background sources included, would remain far below these risk-based ambient air concentrations developed for the NBH Site at any of the locations evaluated, even given the large areas planned for dredging. The two CAD cell disposal options will have minimal impact on airborne PCB levels.

These air dispersion modeling results also point to the significant role that remaining, unremediated PCB-contaminated mudflats (included in the MUs) have on local airborne PCB levels. These unremediated sources are shown to be a larger contributor of airborne PCBs than the proposed dredging and CAD cell disposal operations due to their locations and wide distribution. Any remedial approach that accelerates the overall schedule of the Superfund harbor cleanup will thus have a positive impact on reducing background airborne PCB levels.

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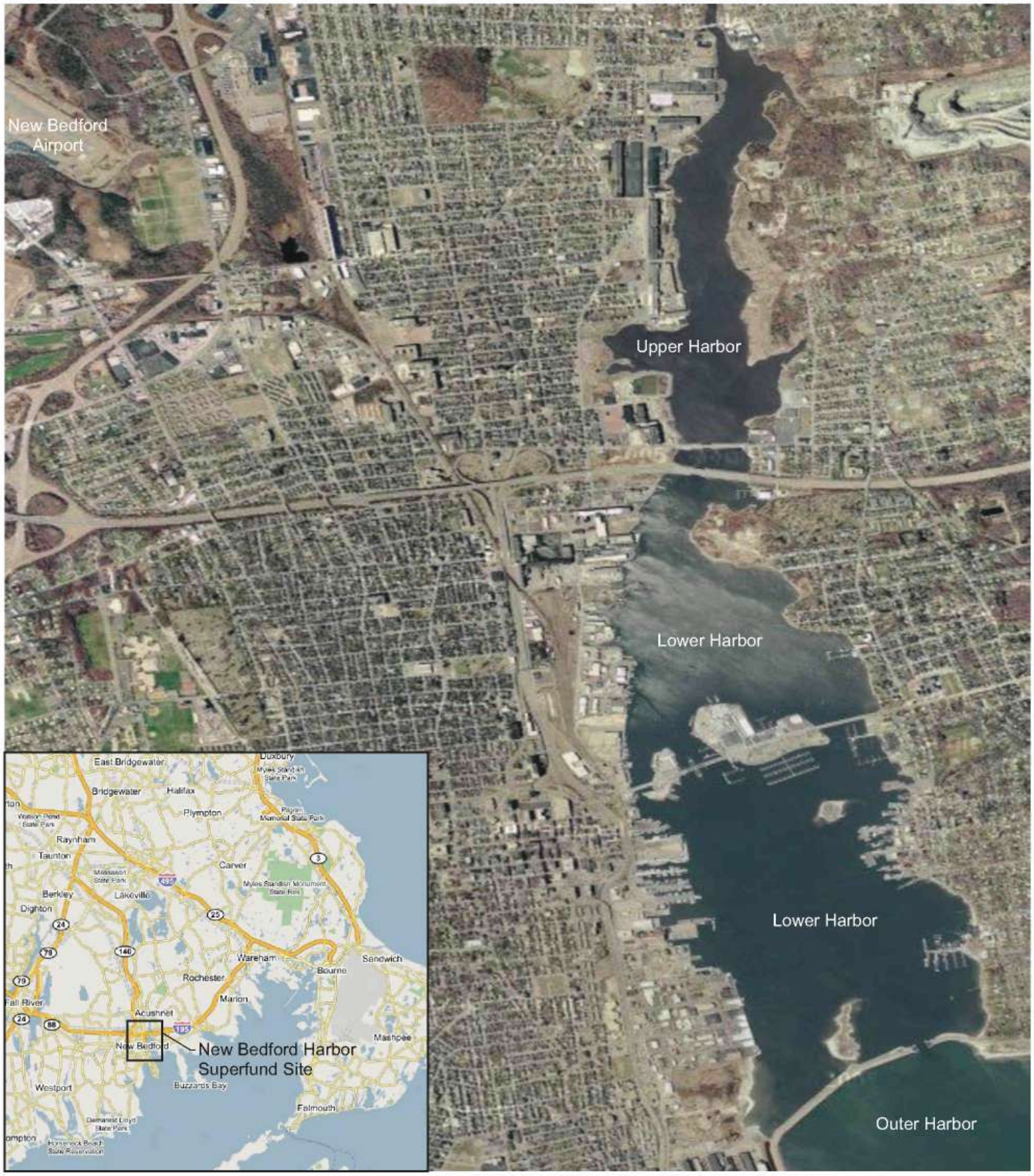
FIGURES



Note:
Aerial photograph source MASSGIS 2003.

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0 1000
Scale in Meters

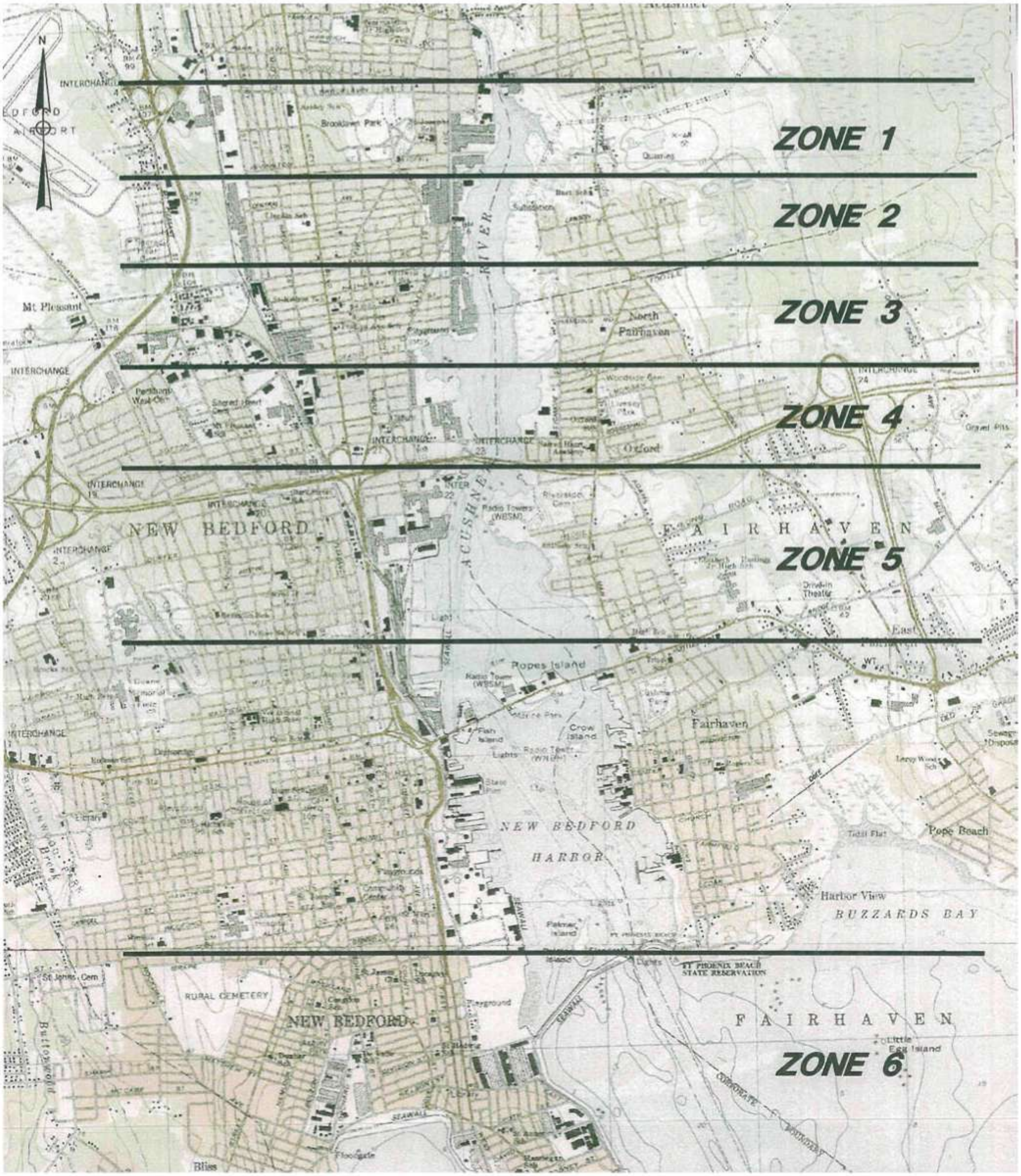
JACOBS

New Bedford Harbor
Site Location Map

New Bedford Harbor Superfund Site
New Bedford, Massachusetts

02/24/10 dmf Fig01 NBH Loc.cdr

Figure 1



Legend

CDF - Previously Proposed Combined Disposal Facility

Sediment PCB Average Concentration

- Zone 1 - 1031 ppm
- Zone 2 - 843 ppm
- Zone 3 - 256 ppm
- Zone 4 - 89 ppm
- Zone 5 - 155 ppm
- Zone 6 - 150 ppm

Note: Adapted from Foster Wheeler Report (2001).

N

0 1000

Scale in Meters

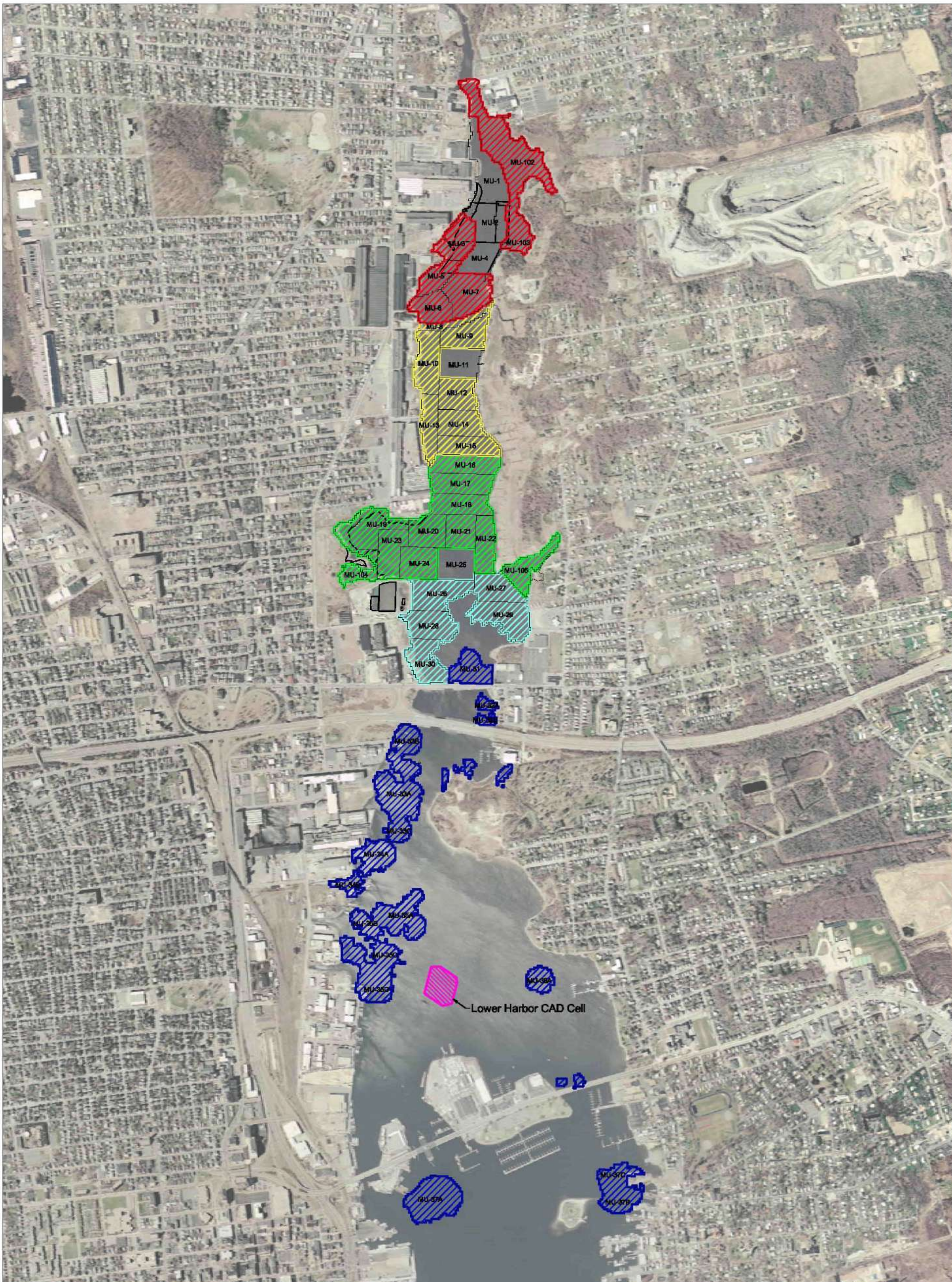
JACOBS

NBH Sediment Zonation Map

New Bedford Harbor Superfund Site
New Bedford, Massachusetts

06/02/10 dmf
Fig02 NBH Sediment.cdr

Figure 2



Legend

Hydraulic Dredging and Off-Site Disposal

- Composite Area 1
- Composite Area 2
- Composite Area 3

Mechanical Dredging and CAD Disposal

- Composite Area 4
- Composite Area 5

Approximate Location of Proposed Lower Harbor CAD Cell

N

0 400

Scale in Meters

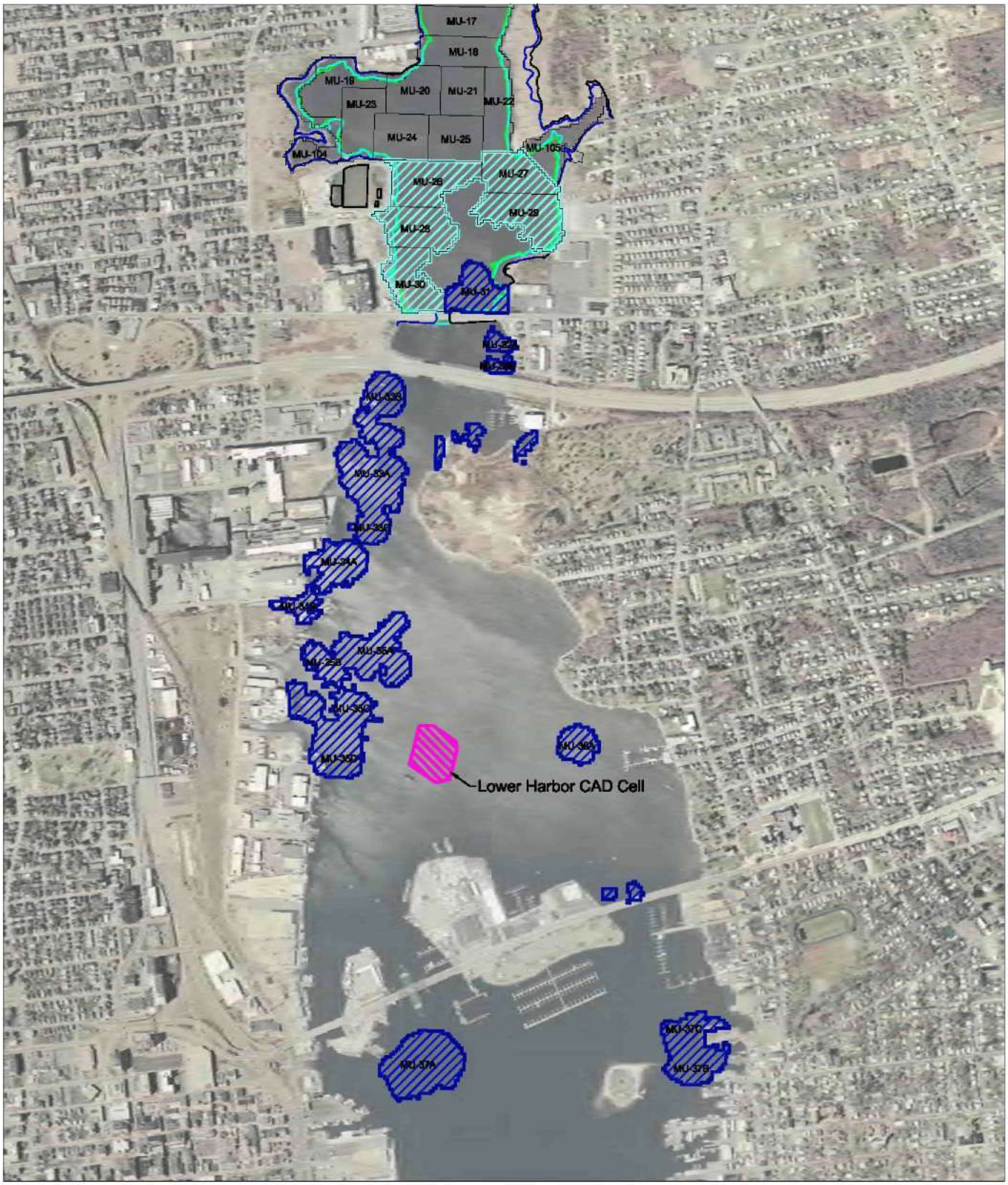
JACOBS

2009 New Bedford Harbor Dredging Plan

New Bedford Harbor Superfund Site
New Bedford, Massachusetts

02/24/10 DF
Fig03 ERDC Locs.dwg

Figure 3



Legend

- Dredging Operations - Year 4
- Dredging Operations - Year 5
- Approximate Location of Proposed Lower Harbor CAD Cell

0 — 400

Scale in Meters

JACOBS

Proposed Dredging and CAD Activities

New Bedford Harbor Superfund Site
New Bedford, Massachusetts

02/24/10 DF
Fig04 Dredging-LHCAD.dwg

Figure 4

2006 NBH On-Site Data

Statistics	Wind Speed (mph)	Temperature at 10-meters (°F)	Temperature at 2-meters (°F)	Delta-T (°F)	Relative Humidity (%)	Barometric Pressure (inches)	Solar Radiation (Watts/m^2)	Hourly Precipitation (inches)
Max	34.53	97.07	97.87	5.64	100.10	30.66	981.89	0.80
Min	0.78	10.71	11.03	-5.00	13.39	28.99	-5.59	0.00
Average	8.43	52.73	52.83	-0.10	71.83	29.94	154.73	

2007 NBH On-Site Data

Statistics	Wind Speed (mph)	Temperature at 10-meters (°F)	Temperature at 2-meters (°F)	Delta-T (°F)	Relative Humidity (%)	Barometric Pressure (inches)	Solar Radiation (Watts/m^2)	Hourly Precipitation (inches)
Max	35.15	88.33	89.35	3.99	100.34	30.75	960.99	0.77
Min	0.50	4.02	4.43	-9.12	10.59	28.83	-6.00	0.00
Average	8.59	50.77	50.93	-0.15	70.94	29.96	165.28	

2008 NBH On-Site Data

Statistics	Wind Speed (mph)	Temperature at 10-meters (°F)	Temperature at 2-meters (°F) #	Delta-T (°F)	Relative Humidity (%)	Barometric Pressure (inches)	Solar Radiation (Watts/m^2)	Hourly Precipitation (inches)
Max	29.56	94.40	95.30	3.99	102.10	30.59	984.00	2.10
Min	0.59	7.68	8.07	-11.53	13.92	29.08	-8.13	0.00
Average	8.02 *	51.05 *	51.79 *	-0.9 *	73.22 *	29.88 *	179.24*	

* - 2008 data is from 1/1/2008 to 10/29/2008.

- There were errorrous readings after July 6, 2008 due to defective recording device

JACOBS

Meteorological Data for
NBH On-Site Location

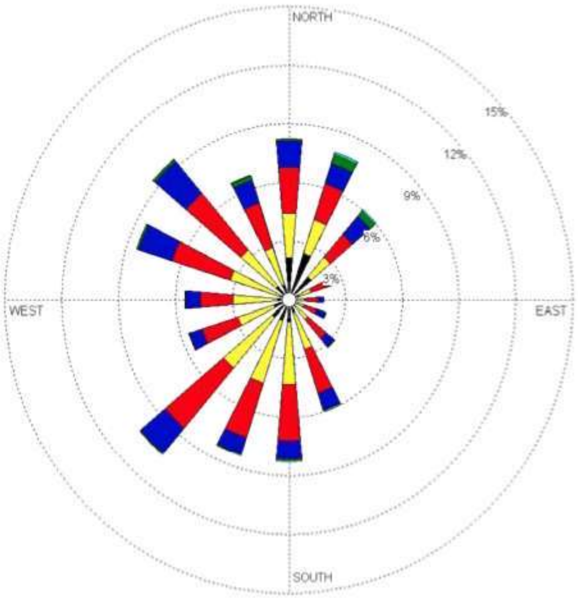
New Bedford Harbor Superfund Site
New Bedford, Massachusetts

02/24/10 dmf
Fig05 MeteorDataComp.cdr

Figure 5

Wind Speed - Direction (blowing from)

2006 Data



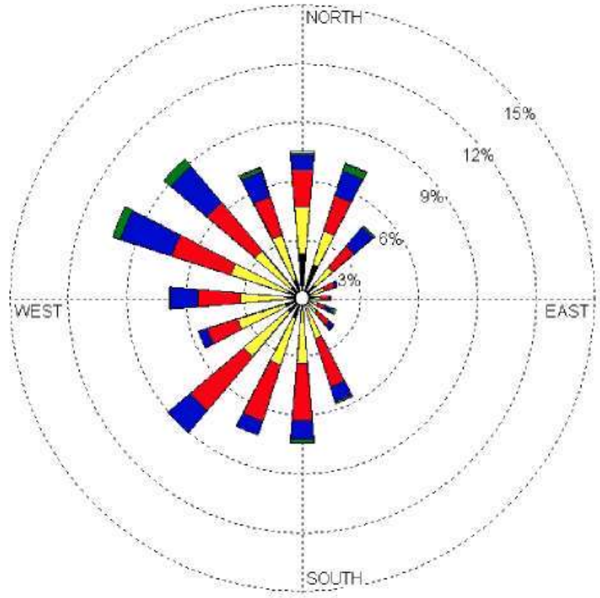
Data File Info

Total No. of Hours:	8761
Average Wind Speed:	7.32 Knots
Calm Hours:	0
Calm Winds Frequency:	0.00%
Data Availability:	100.00%
Incomplete/Missing Hours:	0
Total Hours Used:	8761

WIND SPEED (Knots)
- >= 22
- 17 - 21
- 11 - 17
- 7 - 11
- 4 - 7
- 1 - 4

Calms: 0.00%

2007 Data



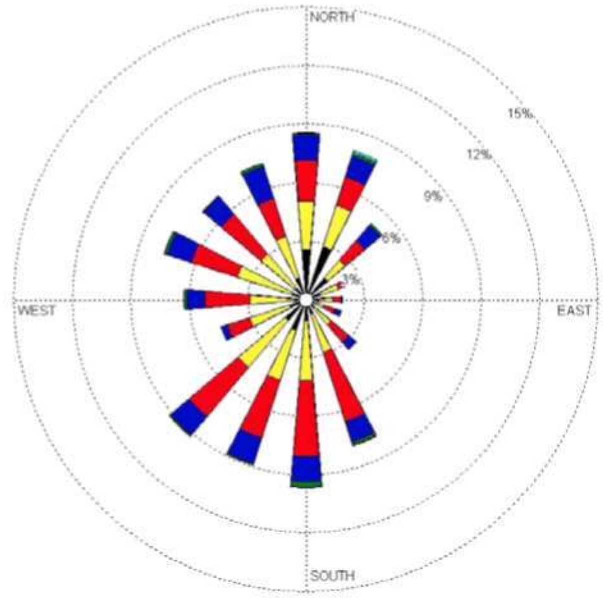
Data File Info

Total No. of Hours:	8761
Average Wind Speed:	7.44 Knots
Calm Hours:	10
Calm Winds Frequency:	0.11%
Data Availability:	99.36%
Incomplete/Missing Hours:	56
Total Hours Used:	8705

WIND SPEED (Knots)
- >= 22
- 17 - 21
- 11 - 17
- 7 - 11
- 4 - 7
- 1 - 4

Calms: 0.00%

2008 Data



Data File Info

Total No. of Hours:	8785
Average Wind Speed:	7.00 Knots
Calm Hours:	1
Calm Winds Frequency:	0.01%
Data Availability:	82.62%
Incomplete/Missing Hours:	1527
Total Hours Used:	7258

WIND SPEED (Knots)
- >= 22
- 17 - 21
- 11 - 17
- 7 - 11
- 4 - 7
- 1 - 4

Calms: 0.01%

Note:
North arrow indicates true north.

N

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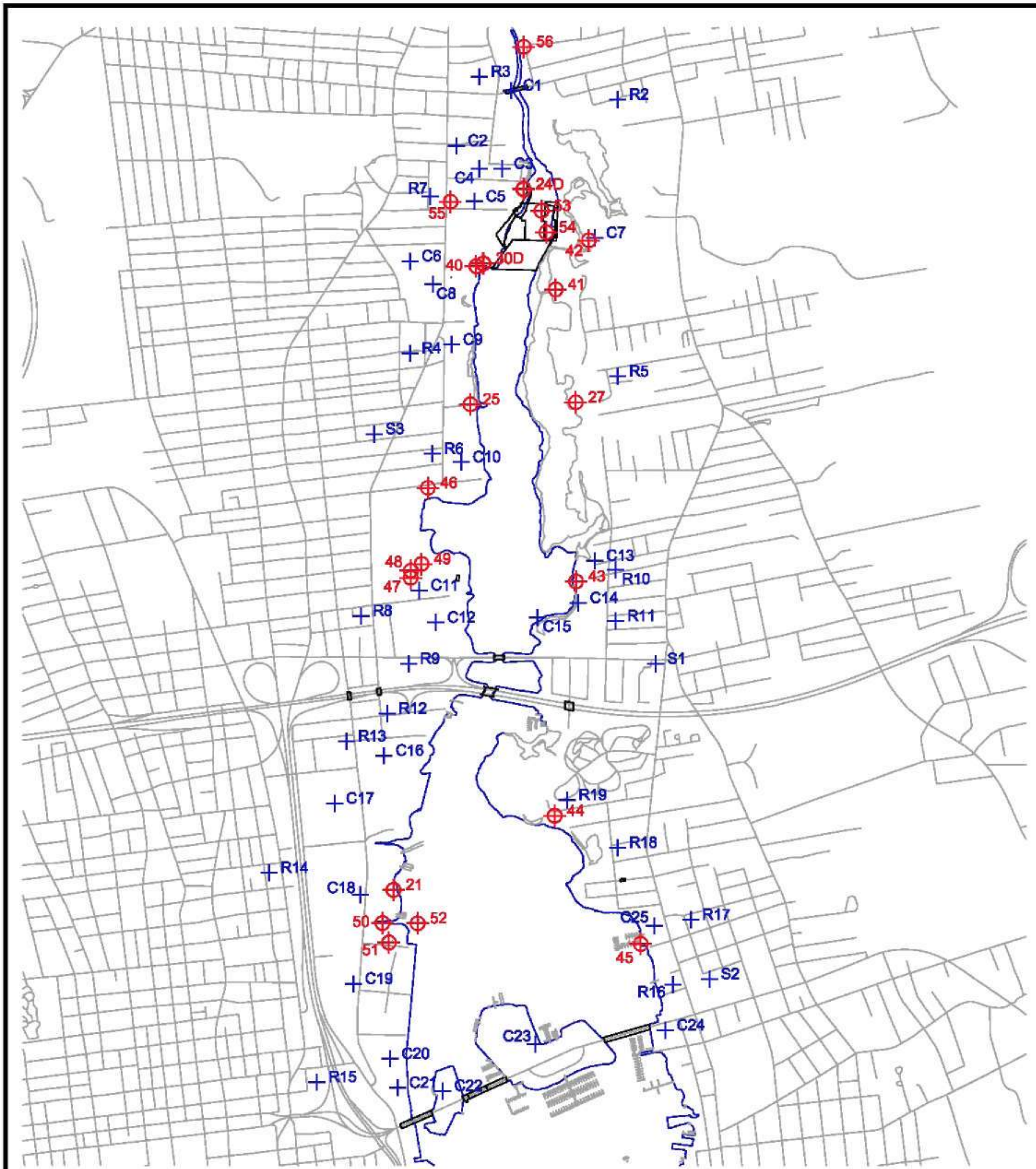
Wind Rose Diagrams for NBH On-Site Location

New Bedford Harbor Superfund Site
New Bedford, Massachusetts

02/24/10 dmf
Fig06 2006-08 Windrose Comp.cdr

Figure 6



Legend

Air Monitoring Station

Discrete Receptors

0 600

Scale in Meters

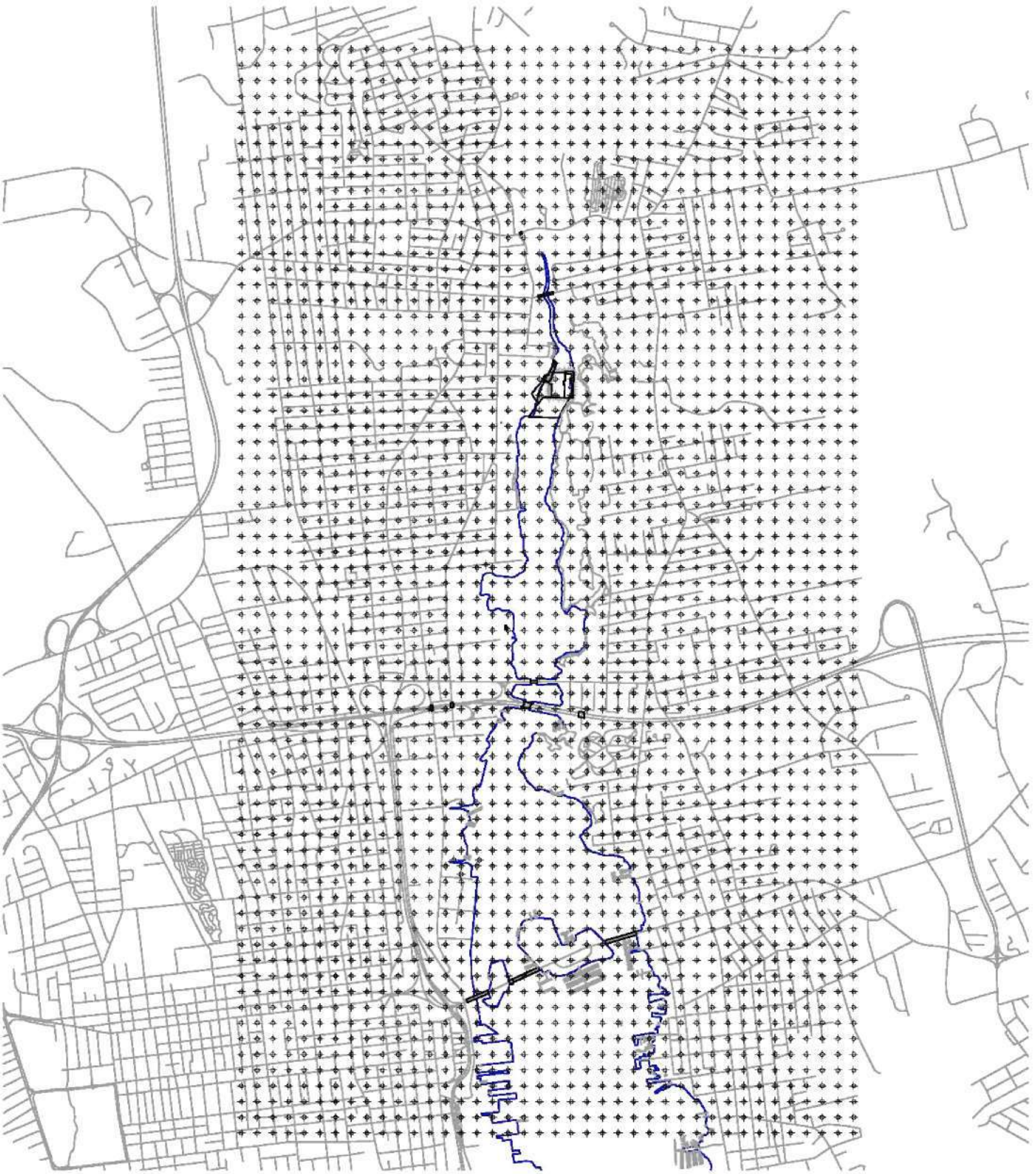
JACOBS

Discrete Receptors for Air Dispersion Modeling

New Bedford Harbor Superfund Site
New Bedford, Massachusetts

02/24/10 DF
Fig07 Discrete Receptors.dwg

Figure 7



Legend

◆ Model Grid Receptors

0 900

Scale in Meters

JACOBS

Receptor Grid System for Air Dispersion Modeling

New Bedford Harbor Superfund Site
New Bedford, Massachusetts

02/24/10 DF
Fig08 Grid.dwg

Figure 8

Legend

Water Line

Concentration in ng/m³

2 4 8 16 32 64 128 256 381

ng/m³ = nanograms per cubic meter

0 600

Scale in Meters

JACOBS

Model-Predicted Total Annual Average PCB Concentrations for 1st Year of 2-Year Dredging and CAD Activities Including Background Sources

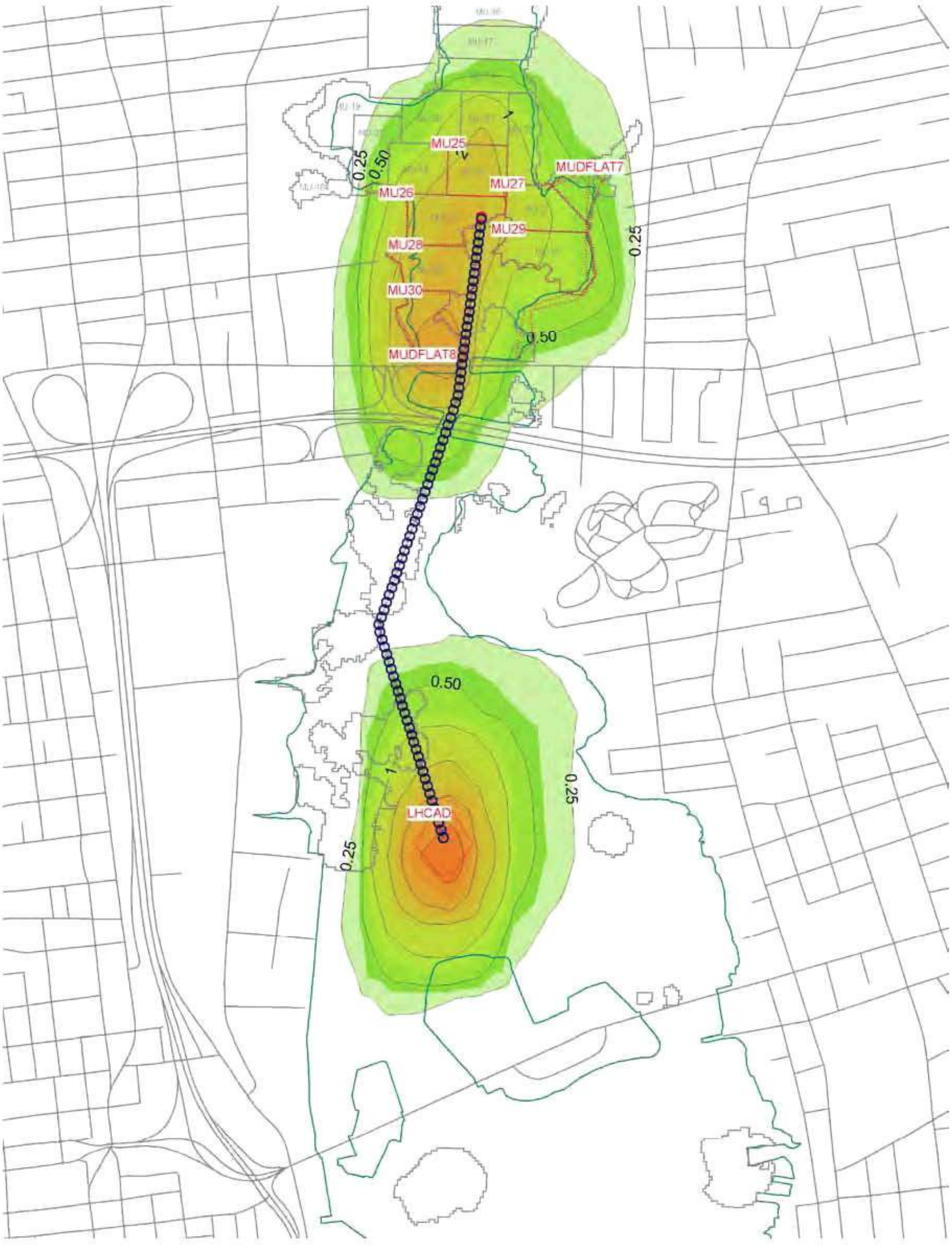
New Bedford Harbor Superfund Site

New Bedford, Massachusetts

05/17/10 DF

Fig09 2-yr_yr-1_all.dwg

Figure 9



Legend

Water Line

MU36A Source Area

Barge Transport Route

Concentration in ng/m³

0.25 0.5 1 2 4 8 16 25

ng/m³ = nanograms per cubic meter

0 400

Scale in Meters

JACOBS

Model-Predicted Annual Average PCB Concentrations Contributed from the 1st Year of 2-Year Dredging and CAD Activities - Background Sources NOT Included

New Bedford Harbor Superfund Site
New Bedford, Massachusetts

05/17/10 DF
Fig10 2-yr_yr-1.dwg

Figure 10

Legend

Water Line

Concentration in ng/m³

2 4 8 16 32 64 128 256 381

ng/m³ = nanograms per cubic meter

0 600

Scale in Meters

JACOBS

Model-Predicted Total Annual Average PCB Concentrations for 2nd Year of 2-Year Dredging and CAD Activities Including Background Sources

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

05/17/10 DF

Fig11 2-yr_yr-2_all.dwg

Figure 11

Legend

Water Line

MU36A Source Area

Barge Transport Route

Concentration in ng/m³

0.25 0.5 1 2 4 8 16 25

ng/m³ = nanograms per cubic meter

0 400

Scale in Meters

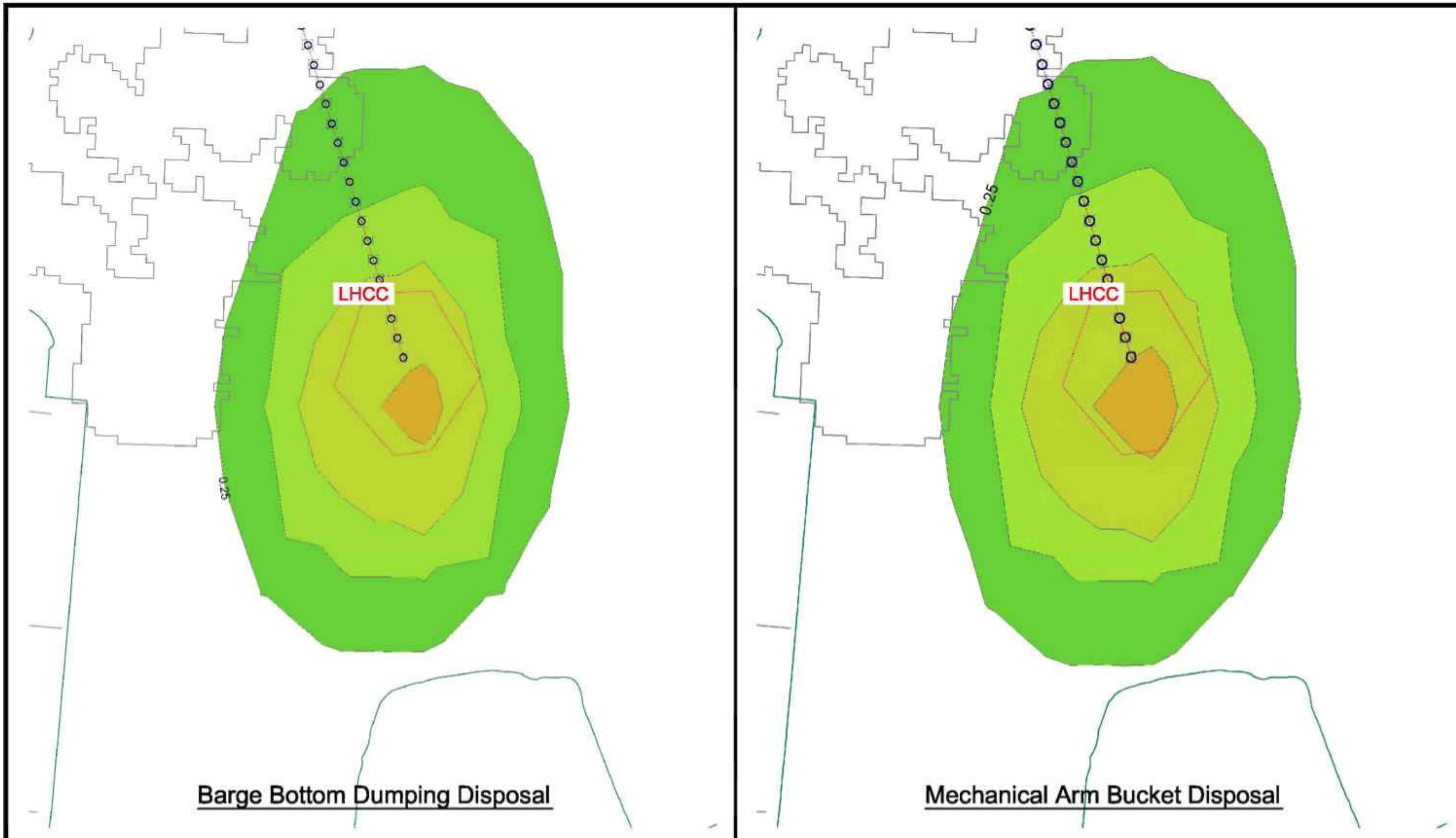
JACOBS

Model-Predicted Annual Average PCB Concentrations Contributed from the 2nd Year of 2-Year Dredging and CAD Activities - Background Sources NOT Included

New Bedford Harbor Superfund Site
New Bedford, Massachusetts

05/17/10 DF
Fig12 2-yr_yr-2.dwg

Figure 12



Legend

Barge Transport Route

Source Area

Management Unit

Concentration in ng/m³

0 0.25 0.5 1 2 4 8 10

ng/m³ = nanograms per cubic meter

0 140

Scale in Meters

JACOBS

Model-Predicted Annual Average PCB Concentrations at the LHCC Area for the Two Disposal Options for the 1st Year

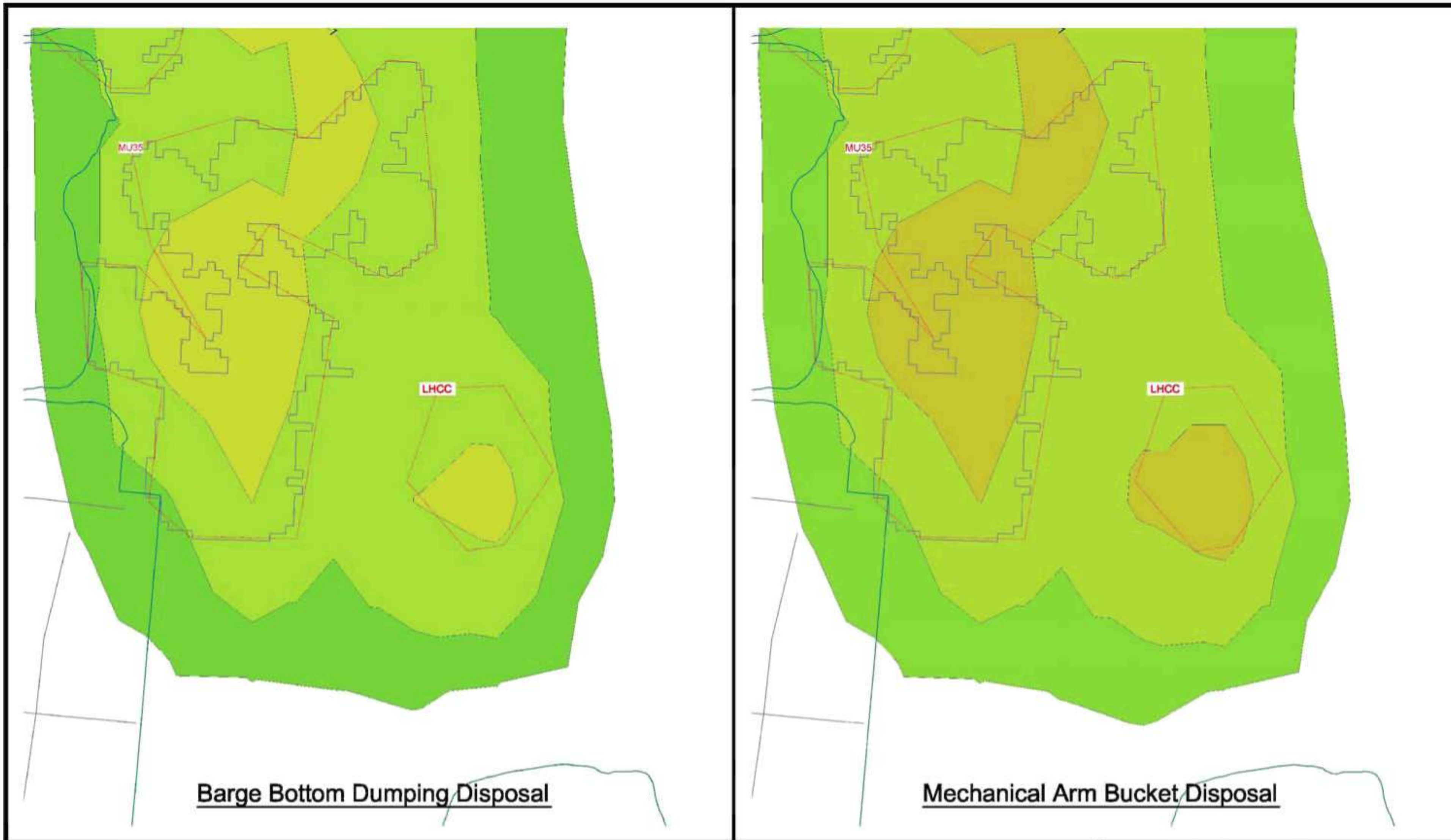
New Bedford Harbor Superfund Site

New Bedford, Massachusetts

06/09/10 DF

Fig13 LHCC Opt-1.dwg

Figure 13



Legend

Source Area

Management Unit

Concentration in ng/m³

0 0.25 0.5 1 2 4 8 10

ng/m³ = nanograms per cubic meter

0 140

Scale in Meters

JACOBS

Model-Predicted Annual Average PCB Concentrations at the LHCC Area for the Two Disposal Options for the 2nd Year

New Bedford Harbor Superfund Site

New Bedford, Massachusetts

06/09/10 DF

Fig14 LHCC Opt-2.dwg

Figure 14

TABLES

Table 1
Remediation Scenarios for Proposed Dredging and CAD Activities

	MU Information		Dredging Scenarios						
MU	Total Volume (cy)	PCB Concentration (ppm)	Remediation Timeline	Planing Dredging Volumes (cy)	Composite PCB Source Concentration (ppm)	Dredging Volume (cy)	Dredging Days	Dredge Method	Disposal
MU-1 *	29925	0	Year 1	0	1235	113783	204	Hydraulic	Off-site
MU-2 *	29842	0		0					
MU-3	21642	1691		14428					
MU-102	44299	1172		35439					
MU-103	11185	368		11185					
MU-4 *	14994	0		0					
MU-5	8973	1940		4487					
MU-6	21791	347		21791					
MU-7	26453	2050		26453					
MU-8	9146	2050	Year 2	9146	436	107513	206		
MU-9	15527	271		10351					
MU-10	34859	424		17430					
MU-11 *	17962	0		0					
MU-12	15700	199		15700					
MU-13	16297	147		16297					
MU-14	18954	322		18954					
MU-15	19635	322		19635					
MU-16	22462	212	Year 3	22462	180	111340	124		
MU-17	18948	244		18948					
MU-18	17376	238		17376					
MU-19	15624	182		5208					
MU-104	11462	91		11462					
MU-105	8912	62		8912					
MU-20	14505	166		4835					
MU-21	16953	213		5651					
MU-22	10001	133		3334					
MU-23	18983	91		6328					
MU-24	20475	136		6825					
MU-25	16495	186	Year 4	16495	187	93961	180	Mechanical	CAD cell
MU-26	15877	167		15877					
MU-27	8993	28		8993					
MU-28	15107	68		15107					
MU-29	15062	60		15062					
MU-30	22427	432		22427					
MU-31	16591	606	Year 5	16591	113	187628	156		
MU-32	3815	30		3815					
MU-33	41025	99		41025					
MU-34	20463	61		20463					
MU-35	52094	55		52094					
MU-36	11136	64		11136					
MU-37	42504	51		42504					

Notes:
* -- the MUs have been dredged during 2004-2009.
cy = cubic yards
MU = management unit
PCB = polychlorinated biphenyl
ppm = parts per million

Table 2
PCB Emission Sources at NBH During Dredging and CAD Activities

Category	Location (Process)	Source Type	Emission Duration	Emission Source Group	PCB Emission Rate
Background	Mudflat	Area	Intermittent and Long-Term	Background	Previous modeling
	Hot Spot (Aerovox)	Point	Continuous and Long-Term	Background	Previous modeling
Dredging Operation	Distrurbed Water Surface	Area	Short-Term	Remediation	Based on PCB concentration in sediment
	Exposed Bucket	Area/Point	Short-Term	Remediation	Based on PCB concentration in sediment
	Surface of Barge (uncovered)	Area/Point	Short-Term	Remediation	Based on PCB concentration in sediment
Emissions during barge transport	Open to Area	Line	Very Short-Term	Remediation	Based on PCB concentration in sediment
Emissions during filling of the CAD	Distrurbed Water Surface	Area	Short-Term	Remediation	Based on PCB concentration in sediment
	Exposed Bucket	Area/point	Short-Term	Remediation	Based on PCB concentration in sediment
	Surface of Barge (uncovered)	Area/point	Short-Term	Remediation	Based on PCB concentration in sediment
	CAD Surface Emission	Area	Long-Term	Remediation	Based on PCB concentration in water/sediment

Notes:
CAD = confined aquatic disposal
PCB = polychlorinated biphenyl

Table 3
Process and Emission Rates for Air Dispersion Modeling

Sources	Processes	Theoretical Emission Flux Rate (g/m^2-s)	Calculated Location Specific Emission Flux Rate (g/m^2-s)	Emission Duration	Note
Background Source					
Mud Flat in Harbor		8.84E-08	8.84E-08	Two 2-hour periods per day	Monitoring/model calibrated
Aerovox Parking Area		4.42E-08	4.42E-08	Continuous	Monitoring/model calibrated
Dredged Area					
MUs	Distrurbed water surface	2.56E-07 *	Based on PCB concentration in sediment	12 hours/per location	180 and 156 days for Dredge Season 1 and 2
	Exposed dredging bucket	5.31E-08 *	Based on PCB concentration in sediment	1 hour/per location	
	Surface of barge (uncovered)	1.49E-07 *	Based on PCB concentration in sediment	2 hours/per location	
Transportation					
	Surface of barge (uncovered)	1.49E-07 *	Based on PCB concentration in sediment	0.78 hours/per location along line for years 1 and 2	Assumed a 1,000 cy barge for Upper and Lower Harbor
Disposal					
	Exposed dredging bucket	5.31E-08 *	Based on PCB concentration in sediment	1 hour/per location years 1 and 2	180 and 156 days for Dredge Seasons 1 and 2
	Surface of barge (uncovered)	1.49E-07 *	Based on PCB concentration in sediment	2 hours/per location years 1 and 2	
	Distrurbed water surface	2.56E-07 *	Based on PCB concentration in sediment	16 and 12 hours/per location years 1 and 2	
	Pond water surface	7.35E-09 #	Based on PCB concentration in sediment	Continuous emission before capping	270 and 365 days for dredge seasons 1 and 2

Notes:
*- based on sediment with PCB concentration of 432 ppm.
# - based on sediment with PCB concentration of 1032 ppm.
cy = cubic yards
g/m^2-s = grams per square meters-second
MU = management unit
PCB = polychlorinated biphenyl

Table 4
Emission Rates Applied for Air Dispersion Modeling

MU	PCB Concentration in MU (ppm)	Composite PCB Concentration (ppm)	Site-Specific Emission Flux Rate (g/m^2-s) for Disturbed Surface Water	Site-Specific Emission Flux Rate (g/m^2-s) for Dredge Bucket	Site-Specific Emission Flux Rate (g/m^2-s) for Barge	Site-Specific Emission Flux Rate (g/m^2-s) for Ponded Water/Sediment	Total Emission Rate Applied in Model for Annual Avearge for the Dredging Seasons or the Year (After Emission Factor Consideration)
MU-25	186	187	1.10E-07	2.29E-08	6.42E-08	NA	3.41E-10
MU-26	167		9.90E-08	2.05E-08	5.76E-08	NA	3.06E-10
MU-27	28		1.66E-08	3.44E-09	9.66E-09	NA	5.14E-11
MU-28	68		4.03E-08	8.36E-09	2.35E-08	NA	1.25E-10
MU-29	60		3.56E-08	7.38E-09	2.07E-08	NA	1.10E-10
MU-30	432		2.56E-07	5.31E-08	1.49E-07	NA	7.92E-10
MU-31	606	113	3.59E-07	7.45E-08	2.09E-07	NA	1.28E-09
MU-32	30		1.78E-08	3.69E-09	1.03E-08	NA	6.35E-11
MU-33	99		5.87E-08	1.22E-08	3.41E-08	NA	2.10E-10
MU-34	61		3.61E-08	7.50E-09	2.10E-08	NA	1.29E-10
MU-35	55		3.26E-08	6.76E-09	1.90E-08	NA	1.16E-10
MU-36	64		3.79E-08	7.87E-09	2.21E-08	NA	1.35E-10
MU-37	51		3.02E-08	6.27E-09	1.76E-08	NA	1.08E-10
	Year						
Disposal Transport	1	187	NA	NA	6.46E-08	NA	1.17E-11
	2	113	NA	NA	3.90E-08	NA	2.61E-12
CAD Disposal (Bottom Dump) *	1	187	1.11E-07	NA	NA	1.33E-09	1.75E-09
	2	113	6.70E-08	NA	NA	8.06E-10	1.02E-09
CAD Disposal (Bucket Disposal) *	1	187	1.11E-07	2.30E-08	6.46E-08	1.33E-09	1.78E-09
	2	113	6.70E-08	1.39E-08	3.90E-08	8.06E-10	1.05E-09

Notes:
* -- The CAD cell is assumed to be a continuous emission source after its operation and before the final cap placement.
CAD = confined aquatic disposal
g/m^2-s = grams per square meters-second
MU = management unit
NA = not applicable
ppm = part per million
PCB = polychlorinated biphenyl

Table 5
Model Predicted Daily Average PCB Concentrations for 2-Year Dredging and CAD Activities

ID	Group	Easting UTM83 (m)	Northing UTM83 (m)	Note	Average Annual Concentrations (ng/m^3) from All Sources		Average Annual Concentrations (ng/m^3) from Dredging/Disposal Activities Only	
					Year-1	Year-2	Year-1	Year-2
R1	Residential	340777	4616194	in FW 2001 modeling	0.409	0.138	0.028	0.023
R2	Residential	340877	4615794	in FW 2001 modeling	0.601	0.314	0.031	0.025
R3	Residential	340277	4615894	in FW 2001 modeling	0.650	0.265	0.033	0.024
R4	Residential	339977	4614694	in FW 2001 modeling	0.812	0.141	0.050	0.041
R5	Residential	340877	4614594	in FW 2001 modeling	1.008	0.139	0.096	0.055
R6	Residential	340074	4614258	in FW 2001 modeling	1.363	0.138	0.092	0.064
R7	Residential	340065	4615374	in FW 2001 modeling	0.694	0.153	0.033	0.027
R8	Residential	339765	4613555	in FW 2001 modeling	0.899	0.098	0.081	0.062
R9	Residential	339970	4613347	in FW 2001 modeling	2.130	0.168	0.199	0.132
R10	Residential	340869	4613754	in FW 2001 modeling	4.765	0.186	0.146	0.161
R11	Residential	340869	4613532	in FW 2001 modeling	3.305	0.161	0.144	0.138
R12	Residential	339877	4613131	in FW 2001 modeling	1.512	0.157	0.148	0.127
R13	Residential	339701	4613011	in FW 2001 modeling	1.135	0.107	0.087	0.081
R14	Residential	339365	4612440	in FW 2001 modeling	0.336	0.060	0.033	0.042
R15	Residential	339573	4611532	in FW 2001 modeling	0.281	0.091	0.061	0.076
R16	Residential	341116	4611956	in FW 2001 modeling	0.386	0.113	0.068	0.103
R17	Residential	341194	4612236	in FW 2001 modeling	0.390	0.097	0.062	0.087
R18	Residential	340877	4612549	in FW 2001 modeling	0.622	0.171	0.126	0.157
R19	Residential	340658	4612756	in FW 2001 modeling	1.114	0.224	0.180	0.207
S1	School	341042	4613347	in FW 2001 modeling	1.415	0.124	0.104	0.106
S2	School	341275	4611979	in FW 2001 modeling	0.346	0.083	0.052	0.075
C1	Commercial	340416	4615834	in FW 2001 modeling	0.713	0.368	0.037	0.025
C2	Commercial	340177	4615594	in FW 2001 modeling	0.769	0.215	0.035	0.025
C3	Commercial	340377	4615494	in FW 2001 modeling	1.740	1.288	0.044	0.030
C4	Commercial	340277	4615494	in FW 2001 modeling	0.952	0.397	0.042	0.028
C5	Commercial	340255	4615352	in FW 2001 modeling	1.123	0.463	0.045	0.030
C6	Commercial	339977	4615094	in FW 2001 modeling	0.726	0.230	0.035	0.030
C7	Commercial	340777	4615194	in FW 2001 modeling	0.954	0.488	0.049	0.036
C8	Commercial	340077	4614994	in FW 2001 modeling	0.771	0.188	0.043	0.033
C9	Commercial	340156	4614732	in FW 2001 modeling	0.981	0.196	0.064	0.041
C10	Commercial	340198	4614222	in FW 2001 modeling	1.611	0.158	0.151	0.072

Table 5
Model Predicted Daily Average PCB Concentrations for 2-Year Dredging and CAD Activities

ID	Group	Easting UTM83 (m)	Northing UTM83 (m)	Note	Average Annual Concentrations (ng/m^3) from All Sources		Average Annual Concentrations (ng/m^3) from Dredging/Disposal Activities Only	
					Year-1	Year-2	Year-1	Year-2
C11	Commercial	340016	4613666	in FW 2001 modeling	1.897	0.135	0.162	0.089
C12	Commercial	340088	4613526	in FW 2001 modeling	3.916	0.164	0.286	0.119
C13	Commercial	340777	4613794	in FW 2001 modeling	9.421	0.251	0.233	0.222
C14	Commercial	340707	4613611	in FW 2001 modeling	32.754	0.332	0.614	0.303
C15	Commercial	340528	4613549	in FW 2001 modeling	15.332	1.516	0.506	1.488
C16	Commercial	339864	4612949	in FW 2001 modeling	1.028	0.165	0.115	0.137
C17	Commercial	339649	4612741	in FW 2001 modeling	0.582	0.098	0.061	0.075
C18	Commercial	339762	4612344	in FW 2001 modeling	0.500	0.131	0.063	0.110
C19	Commercial	339731	4611959	in FW 2001 modeling	0.381	0.128	0.067	0.110
C20	Commercial	339890	4611633	in FW 2001 modeling	0.535	0.159	0.101	0.138
C21	Commercial	339923	4611507	in FW 2001 modeling	0.488	0.148	0.093	0.128
C22	Commercial	340119	4611494	in FW 2001 modeling	0.473	0.176	0.127	0.159
C23	Commercial	340520	4611696	in FW 2001 modeling	0.460	0.178	0.124	0.167
C24	Commercial	341083	4611757	in FW 2001 modeling	0.397	0.124	0.081	0.115
C25	Commercial	341035	4612209	in FW 2001 modeling	0.461	0.129	0.083	0.118
CDF-C-n	CDF-C	340169	4613834	in FW 2001 modeling	83.617	0.169	0.348	0.108
CDF-C-w	CDF-C	340170	4613651	in FW 2001 modeling	11.748	0.190	0.836	0.134
CDF-C-s	CDF-C	340246	4613449	in FW 2001 modeling	47.895	0.298	9.235	0.251
CDF-C-e	CDF-C	340273	4613694	in FW 2001 modeling	18.593	0.250	4.241	0.193
CDF-D-n	CDF-D	339987	4612588	in FW 2001 modeling	0.888	1.549	0.125	1.521
CDF-D-w	CDF-D	339877	4612385	in FW 2001 modeling	0.596	0.236	0.085	0.212
CDF-D-e	CDF-D	340092	4612386	in FW 2001 modeling	0.909	1.692	0.194	1.665
CDF-D-s	CDF-D	339983	4612130	in FW 2001 modeling	0.752	0.463	0.137	0.439
HS-w	HS	339992	4613762	in FW 2001 modeling	1.257	0.127	0.114	0.080
HS-n	HS	340047	4613820	in FW 2001 modeling	1.702	0.132	0.147	0.081
HS-s	HS	340047	4613711	in FW 2001 modeling	2.346	0.139	0.174	0.091
HS-e	HS	340104	4613767	in FW 2001 modeling	6.246	0.149	0.247	0.096
S3	School	339820	4614343	Caldwell School	0.459	0.104	0.053	0.043
21	Old Monitoring	339904	4612365	New Bedford Welding	0.622	0.292	0.090	0.268
24D	Old Monitoring	340469	4615404	Aerovox NE Corner duplicate	381.468	381.064	0.050	0.032
30D	Old Monitoring	340295	4615083	Fiber Leather duplicate	1.382	0.568	0.056	0.036

Table 5
Model Predicted Daily Average PCB Concentrations for 2-Year Dredging and CAD Activities

ID	Group	Easting UTM83 (m)	Northing UTM83 (m)	Note	Average Annual Concentrations (ng/m^3) from All Sources		Average Annual Concentrations (ng/m^3) from Dredging/Disposal Activities Only	
					Year-1	Year-2	Year-1	Year-2
27	Old Monitoring	340695	4614480	Franxis St (Porter)	1.474	0.129	0.122	0.064
30	Old Monitoring	340293	4615082	Fiber Leather	1.379	0.563	0.056	0.036
40	Old Monitoring	340263	4615071	Wood St (Titleist)	1.296	0.469	0.055	0.035
43	Old Monitoring	340696	4613704	Bus Terminal Lot	26.538	0.347	0.617	0.316
44	Old Monitoring	340604	4612687	Taber St (Pumping Station)	1.164	0.252	0.208	0.235
45	Old Monitoring	340927	4608484	Cozy Cover Marina	0.081	0.015	0.008	0.010
41	Old Monitoring	340608	4614971	NSTAR substation	0.854	0.280	0.062	0.042
24	Monitoring	340469	4615407	Aerovox NE corner	347.695	347.291	0.050	0.032
25	Monitoring	340238	4614472	Cliftex, Manomet Street	1.318	0.174	0.106	0.054
42	Monitoring	340752	4615183	NSTAR North	0.945	0.460	0.050	0.037
46	Monitoring	340054	4614110	Coffin Ave	1.852	0.133	0.110	0.070
47	Monitoring	339979	4613720	Area C Downwind	1.526	0.127	0.118	0.082
48	Monitoring	339980	4613750	Area C Crosswind	1.277	0.126	0.111	0.080
49	Monitoring	340026	4613780	Area C Upwind	1.638	0.132	0.134	0.083
50	Monitoring	339856	4612222	Area D Downwind	0.517	0.206	0.079	0.184
51	Monitoring	339885	4612137	Area D Crosswind	0.542	0.239	0.099	0.217
52	Monitoring	340009	4612221	Area D Upwind	0.783	1.352	0.123	1.327
55	Monitoring	340152	4615351	Aerovox West (R7 receptor)	0.875	0.236	0.039	0.028
56	Monitoring	340470	4616023	Acushnet Park	0.551	0.246	0.034	0.023

Notes:
CDF = Central Disposal Facility
FW = Foster Wheeler
HS = high school
m = meter
ng/m^3 = nanograms per cubic meter
PCB = polychlorinated biphenyl
UTM = Universal Transverse Mercator coordinate system

APPENDIX A

Modeled Scenarios

Table A-1
Modeled Scenarios

Model Run #		42	52
Run Objective			
		Annual Average	Annual Average
Emission Source Applied			
Mud Flats	Flux Rate (g/m^2-s)	8.84E-08	
	Emission Factor	0.5 (4 hour/day) for whole year	
Aerovox On-Land Hot Spot	Flux Rate (g/m^2-s)	4.42E-08	4.42E-08
	Emission Factor	1.0 (all time)	1.0 (all time)
Dredging Units			
MU-25	Flux Rate (g/m^2-s)	3.41E-10	
	Emission Factor	1.0 (April - October)	
MU-26	Flux Rate (g/m^2-s)	3.06E-10	
	Emission Factor	1.0 (April - October)	
MU-27	Flux Rate (g/m^2-s)	5.14E-11	
	Emission Factor	1.0 (April - October)	
MU-28	Flux Rate (g/m^2-s)	1.25E-10	
	Emission Factor	1.0 (April - October)	
MU-29	Flux Rate (g/m^2-s)	1.10E-10	
	Emission Factor	1.0 (April - October)	
MU-30	Flux Rate (g/m^2-s)	7.92E-10	
	Emission Factor	1.0 (April - October)	
MU-31	Flux Rate (g/m^2-s)		1.28E-09
	Emission Factor		1.0 (May - October)
MU-32	Flux Rate (g/m^2-s)		6.35E-11
	Emission Factor		1.0 (May - October)
MU-33	Flux Rate (g/m^2-s)		2.10E-10
	Emission Factor		1.0 (May - October)
MU-34	Flux Rate (g/m^2-s)		1.29E-10
	Emission Factor		1.0 (May - October)
MU-35	Flux Rate (g/m^2-s)		1.16E-10
	Emission Factor		1.0 (May - October)
MU-36	Flux Rate (g/m^2-s)		1.35E-10
	Emission Factor		1.0 (May - October)
MU-37	Flux Rate (g/m^2-s)		1.08E-10
	Emission Factor		1.0 (May - October)
Barge Transport	Flux Rate (g/m^2-s)	1.17E-11	2.61E-12
	Emission Factor	1.0 (April - October)	1.0 (May - October)
CAD Disposal	Flux Rate (g/m^2-s)	4.11E-10	2.15E-10
	Emission Factor	1.0 (April - October)	1.0 (May - October)
Meteorological Data Used			
	2008 NBH Site-specific Data	All Year	All Year
Receptors			
	Discrete	Yes	Yes
	Grid	Yes	Yes

Notes:
g/m^2-s = grams per square meter-second

APPENDIX B

Modeling Input and Output Files

read-me-1st.txt

```
The CD contains all the air dispersion modeling files of the final runs listed in

Appendix A of the report titled

"FINAL EVALUATION OF THE IMPACT OF DREDGING AND CAD CELL DISPOSAL ON AIR QUALITY,
NEW BEDFORD HARBOR SUPERFUND SITE, NEW BEDFORD, MA"

by Jacobs Engineering (2010).

ISCST3 Input files (*.inp) were produced by:

** ISC-AERMOD View Ver. 5.0
** Lakes Environmental Software Inc.


For all simulation,


*****************************************
** ISCST3 Meteorology Pathway
*****************************************
   INPUTFIL 2008.MET

was used.

Outfile files (*.out) for the final runs are also included.
```

REPOSITORY TARGET SHEET

US EPA New England
Superfund Document Management System /
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Native Files Target Sheet

SDMS Document ID #: ____506004__________

Site Name: _New Bedford___________________

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File Type(s) Attached (examples: Excel file or .jpg):

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Document Type this Target Sheet Represents:

[ ]	Map	[ ]	Photograph	[ ]	Graph/Chart
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To view the attached files, open the "Attachment Panel" by clicking on the paper clip - - at the bottom left of this window.

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Telephone (617) 918 1440

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SDMS DocID 000218178

EPA WORK ASSIGNMENT NUMBER: 04-1L43

EPA CONTRACT NUMBER: 68-01-7250

EBASCO SERVICES INCORPORATED

DRAFT FINAL BASELINE PUBLIC HEALTH RISK ASSESSMENT; NEW BEDFORD HARBOR FEASIBILITY STUDY

AUGUST 1989

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NOTICE

The information in this document has been funded by the United States Environmental Protection Agency (EPA) under REM III Contract No. 68-01-7250 to Ebasco Services, Inc. (Ebasco). This document has been formally released by Ebasco to the EPA. This document does not represent, however, the EPA's position or policy, and has not been formally released by the EPA.

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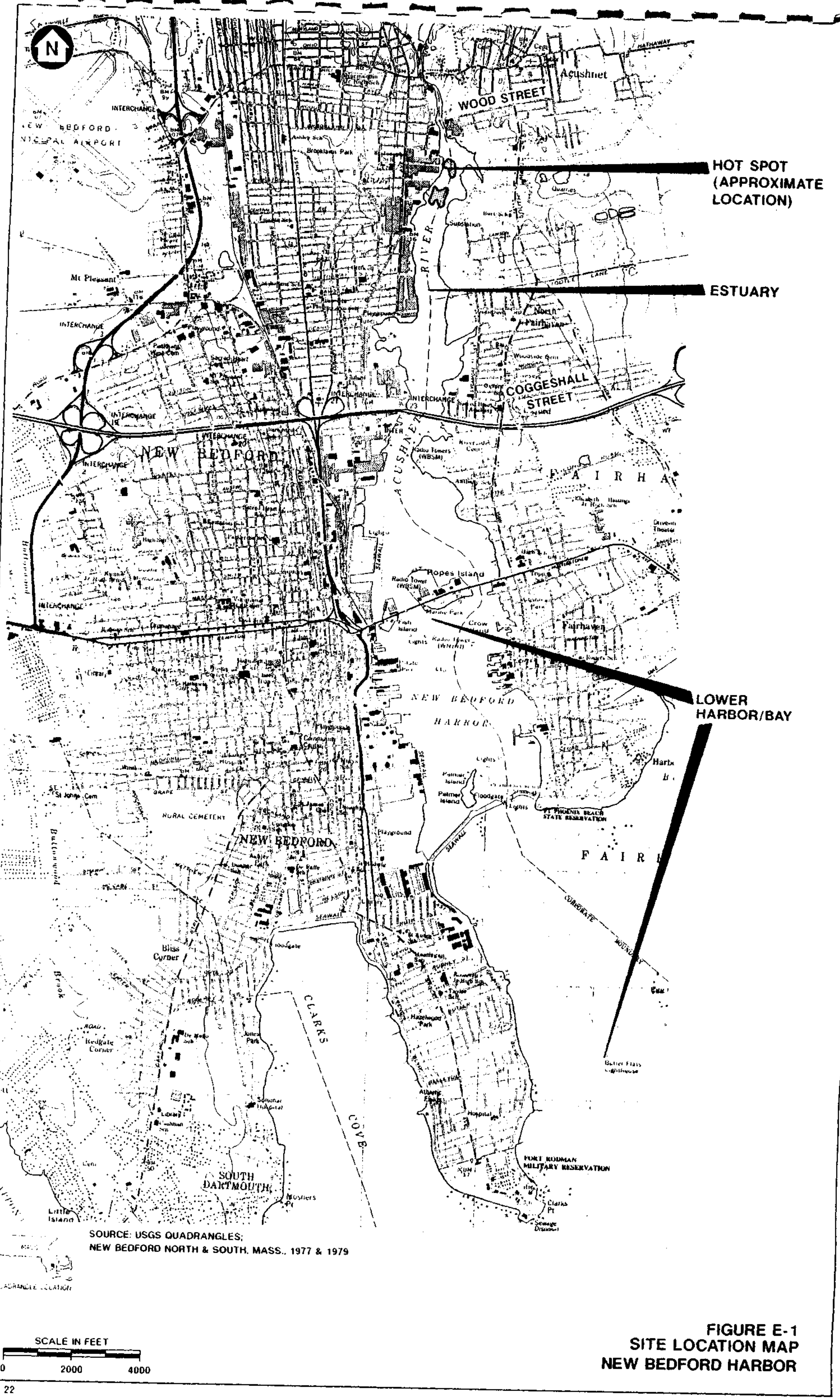
EXECUTIVE SUMMARY

New Bedford Harbor is an urban tidal estuary located between the City of New Bedford on the west and the Towns of Fairhaven and Acushnet on the east, at the head of Buzzards Bay, Massachusetts (Figure E-1). Between 1974 and July 1982, several environmental studies were conducted to assess the magnitude and extent of polychlorinated biphenyl (PCB) and heavy metal contamination in New Bedford Harbor. The studies revealed that sediments north of Hurricane Barrier contain elevated PCB and heavy metals levels. PCB concentrations range from a few parts per million (ppm) to over 100,000 ppm, and concentrations of metals range from a few ppm to over 5,000 ppm. PCB concentrations in surface water in excess of the Ambient Water Quality Criterion for PCBs were observed. Concentration of PCBs in locally caught fish were also detected in excess of the Food and Drug Administration PCB tolerance level of 2 ppm (previously 5 ppm). Data from these and more recent studies have been combined to form the central New Bedford Harbor Data Base.

The purpose of this risk assessment was to estimate potential risks to public health under baseline (i.e., current) conditions from exposure to PCBs and metals detected in the sediment, surface water biota and air within the New Bedford Harbor site. The baseline assessment is the first of a series of three risk assessments to provide the basis for evaluating the need for and the extent of remediation; it is based on existing conditions in the harbor and does not consider potential natural decreases in contaminant concentration due to transport and degradation through time.

Recent sampling data indicates that no appreciable changes in PCB concentrations have occurred over the past decade. Sustained elevated levels of PCBs (i.e., greater than 2 ppm) in lobster and several other species have been documented in fishing closure Area 3 (Kolek and Ceurvels, 1981; Massachusetts Divison of Marine Fisheries, unpublished data; Pruell et al., 1988), and elevated levels of PCBs (i.e., greater than 4,000 ppm) in sediment have been reported (USACE, 1988). While it is probable that natural processes such as biodegradation and photolysis will result in a decrease in PCB concentrations in sediment and biota, these changes are not expected to be significant over the next 10 years. The evaluation in this risk assessment indicates that an order-of-magnitude or more change in PCB concentrations would be necessary to reduce exposure concentrations to levels consistent with EPA and state public health guidance. Reduction of that magnitude is not expected to occur without remedial actions. *



SOURCE: USGS QUADRANGLES;
NEW BEDFORD NORTH & SOUTH, MASS., 1977 & 1979

FIGURE E-1
SITE LOCATION MAP
NEW BEDFORD HARBOR

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To evaluate the effectiveness of various remedial alternatives, additional risk assessments will be conducted based on the results of the sediment contaminant transport and food-chain models. These risk assessments will allow an evaluation of the relative effectiveness of the various remedial alternatives against the baseline conditions.

The methodology and results of this baseline assessment is summarized in the following subsections.

PUBLIC HEALTH RISK SUMMARY

The purpose of the public health risk assessment was to accomplish the following:

- identify human receptors potentially at risk from contaminant exposure
- determine significant exposure routes
- characterize the intrinsic toxicity of PCBs, cadmium, copper, and lead
- estimate the potential carcinogenic and noncarcinogenic risks to public health from contaminant exposure.

Primary sources of information used in this report were the New Bedford Harbor Data Base, the Greater New Bedford Health Effects Study (GNBHES), various site investigation reports, and data from the pilot study recently conducted by the Army Corps of Engineers. The public health risk assessment consists of four sections. The first section, the Introduction, reviews the site history. The second section, the Exposure Assessment, identifies potential human receptors and describes mechanisms by which these receptors may be exposed to contaminants within the New Bedford Harbor area. The third section, the Toxicity Assessment, provides a description of the toxic properties of PCBs, cadmium, copper, and lead. The final section, the Risk Characterization, quantifies carcinogenic and noncarcinogenic risks to public health.

SUMMARY OF THE EXPOSURE ASSESSMENT

An analysis of demographic and land use information, and activity and behavior patterns, indicated that contaminant exposure in the New Bedford Harbor area could occur through dermal contact with sediments and water, ingestion of water and biota, and/or inhalation of airborne contaminants. A quantitative screening analysis of the exposure pathways was performed to identify the principle pathways of exposure, which consist of the following:

- ingestion of aquatic biota
- direct contact with sediments
- ingestion of sediments
- inhalation of airborne contaminants

These exposure pathways accounted for over 99 percent of the potential exposures within the New Bedford Harbor area, and were the focus of the quantitative risk evaluation. Exposure to contaminants from direct contact with and/or ingestion of surface water was also evaluated. However, these exposure routes were not considered to present a public health risk. PCBs and metal concentrations in surface water were not at levels considered harmful to public health.

Exposure scenarios were developed to estimate the potential exposure dose contaminant and for each exposure pathway. These scenarios were based on a various exposure conditions, primarily focusing on areas where exposure was considered likely to occur.

The New Bedford Harbor site was divided into three areas (i.e., Areas I, II, and III) for purposes of assessing exposure to sediments. This division separates areas of high sediment contamination from areas of low sediment contamination. Area-specific contaminant concentrations provide a realistic estimate of the exposure point concentration. The areas were defined as follows:

- Area I - the area between the Wood Street and Coggeshall Street bridges
- Area II - the area between the Coggeshall Street Bridge and the Hurricane Barrier
- Area III - the area south of the Hurricane Barrier.

These areas are depicted in Figure E-2.

Exposure through the ingestion of biota was assessed separately for the following four areas:

- Area 1 - the area between the Wood Street Bridge and the Hurricane Barrier

consistent w/ fishing [illegible]

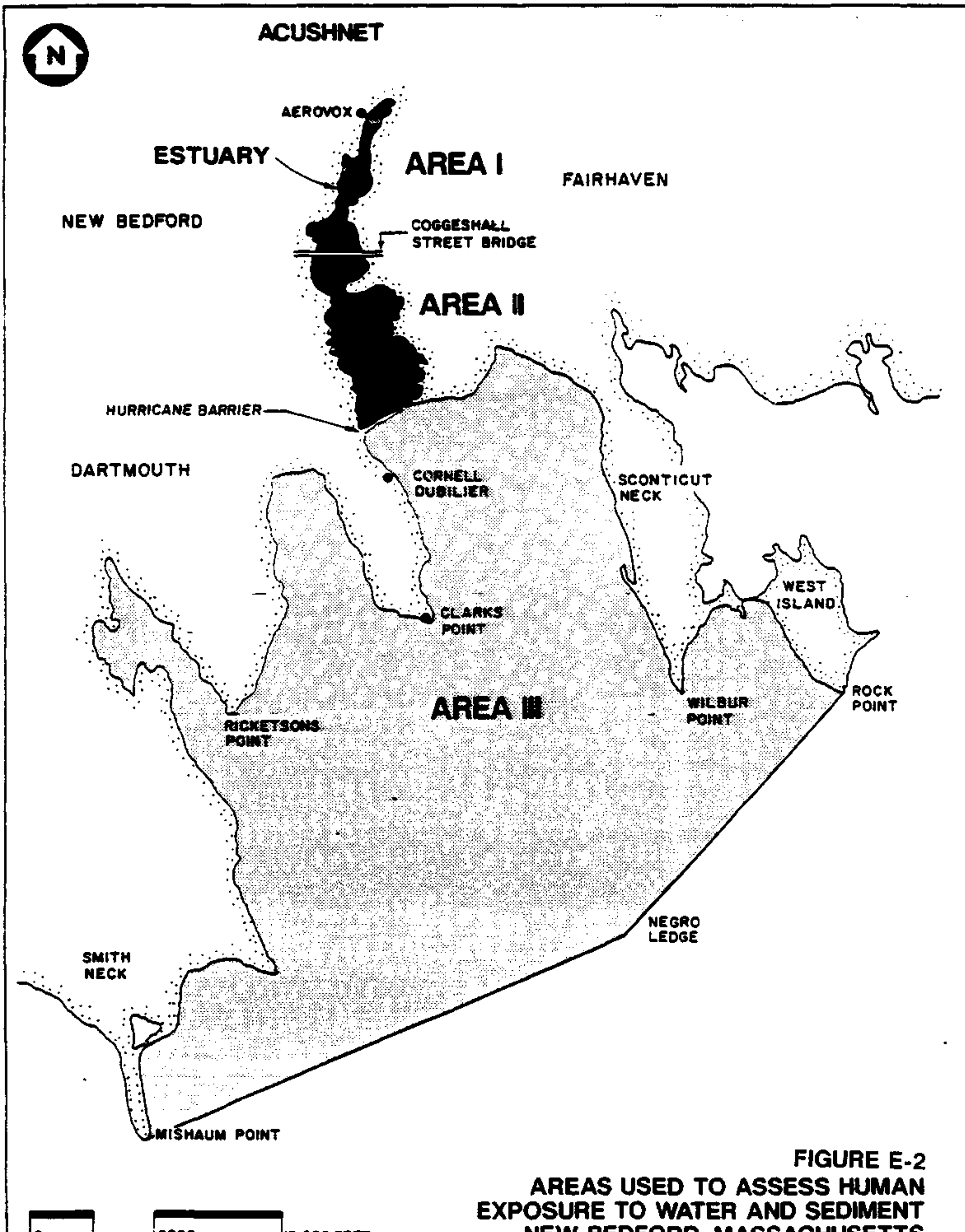

FIGURE E-2
AREAS USED TO ASSESS HUMAN EXPOSURE TO WATER AND SEDIMENT NEW BEDFORD, MASSACHUSETTS

4959-08

- Area 2 - the area between the Hurricane Barrier and Wilbur and Ricketsons Points

- Area 3 - the area between Wilbur, Ricketsons, and Rock points, and Negro Ledge and Mishaum Point

- Area 4 - beyond Area 3 extending into Buzzards Bay

These areas are depicted in Figure E-3.

SUMMARY OF THE TOXICITY ASSESSMENT

This section provides appropriate toxicological information necessary to evaluate the potential public health risks from exposure to PCBs, cadmium, copper, and lead.

Toxicological evaluations, developed for each contaminant, describe the nature and severity of potential adverse effects associated with exposure to each compound. Information contained in these evaluations includes physiochemical data, pharmacokinetic and toxicity information, and descriptions of noncarcinogenic effects associated with acute, chronic, and lifetime exposures.

In addition, information about the potency of PCBs, cadmium, copper, and lead was presented as part of the dose-response assessment. The assessment included pertinent standards, criteria, advisories, and guidelines developed for protecting public health. These standards and criteria were used to evaluate potential noncarcinogenic and carcinogenic risks associated with contaminant exposure.

SUMMARY OF PUBLIC HEALTH RISKS

Estimates of carcinogenic and noncarcinogenic risks associated with PCB and metals exposure were developed for direct contact and ingestion of sediments, ingestion of biota, and inhalation of airborne contaminants.

Noncarcinogenic risk estimates were generated by comparing the exposure dose for each contaminant to the most applicable health-based standard or criteria value. Values used in this risk assessment represent contaminant concentrations that do not present a public health risk. The ratio of the estimated body dose levels to standard or criteria values is used to evaluate risk. In this risk assessment, the ratio is referred to as the risk ratio.

The risk ratio was evaluated against a value of 1. Generally, the Environmental Protection Agency (EPA) states that if the risk ratio is less than 1, the predicted body dose level is

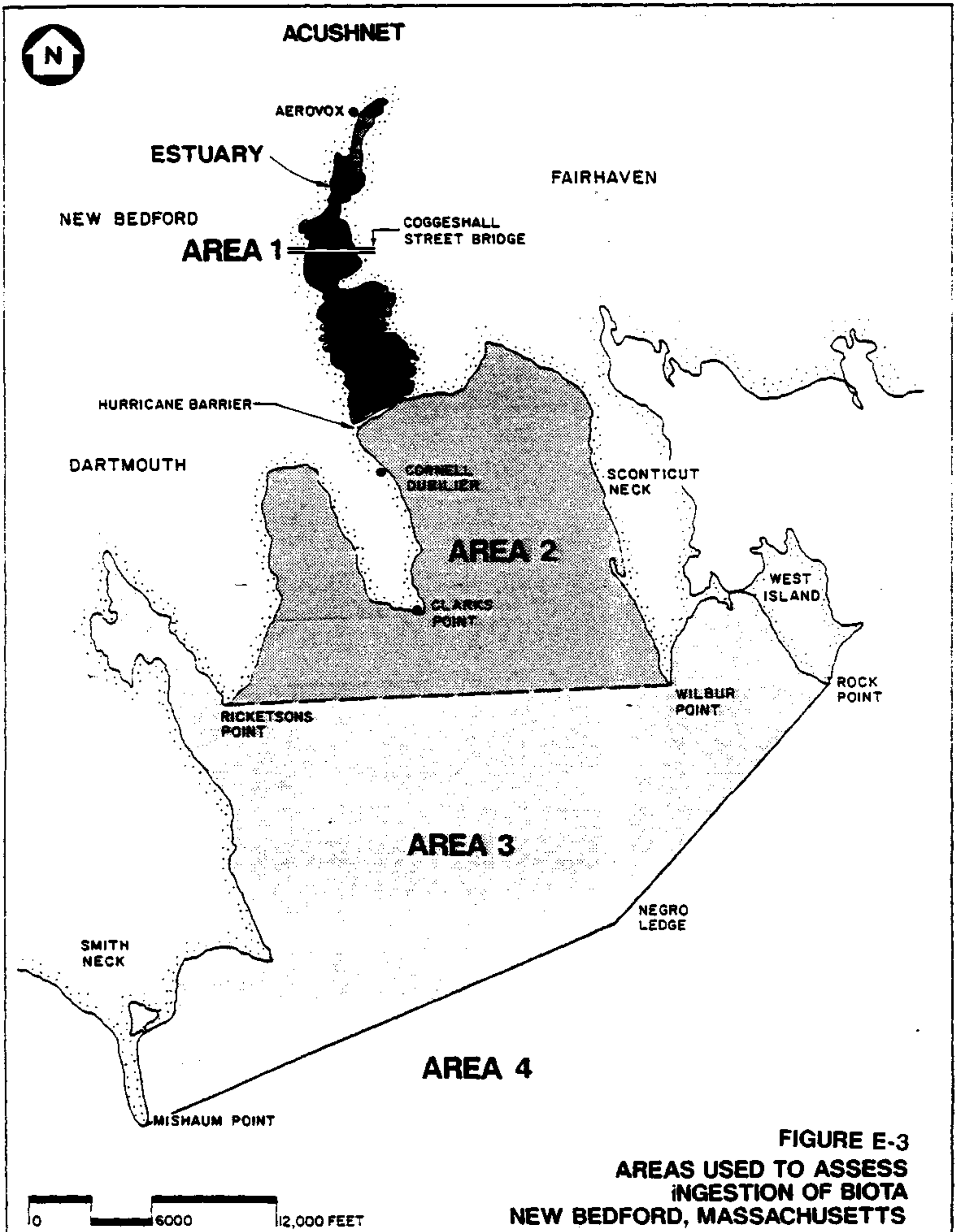

FIGURE E-3
AREAS USED TO ASSESS INGESTION OF BIOTA NEW BEDFORD, MASSACHUSETTS

4959-08

anticipated to be without lifetime risk to public health. The sum of these risk ratios, referred to as the Hazard Index (HI), represents the potential risk associated with concurrent exposure to multiple contaminants. As with the risk ratio, the HI is evaluated against a value of 1.

Carcinogenic risk estimates were calculated by multiplying the potency factor of the contaminant by the estimated body dose concentration. The product of the two values is an estimate of the incremental lifetime cancer risk, which is defined as the excess probability that an individual will develop cancer over a lifetime.

EPA guidance states that the target total carcinogenic risk for an individual resulting from exposure at a Superfund site may range from 10^{-4} to 10^{-7}. Therefore, response objectives and remedial alternatives are developed to reduce the total carcinogenic risks to levels within or below this range. Carcinogenic risk estimates developed in this report were evaluated using this target range.

In addition to the EPA target range, carcinogenic risk estimates were also evaluated against a total site cancer risk level of 10^{-5}. This risk level is stated in the portion of the Massachusetts Contingency Plan (MCP) relevant to risk assessment. The MCP requires that a permanent solution be implemented at all disposal sites that effectively eliminates significant or otherwise unacceptable risk to health, safety, public welfare, or the environment. As stated in the MCP, the total site cancer risk must be compared to a cancer risk of 10^{-5}.

The following subsections summarize risk estimates generated for each exposure route.

Direct Contact with Sediment

Noncarcinogenic and carcinogenic risks associated with direct contact exposure to PCB-, cadmium-, copper-, and lead-contaminated sediment were evaluated separately for Areas I, II, and III, and focused on locations within these areas where exposure was likely to occur. Contaminant concentrations detected in shoreline sediments were used when available.

Noncarcinogenic risk estimates for exposure to sediment in Area I exceeded 1 under the majority of scenarios evaluated, and ranged from 0.7 to 200. PCB exposure accounted for most of the risk. Individual risk ratios for cadmium, copper, and lead were all below 1. Noncarcinogenic risk ratios associated with PCB exposure in Area I indicate a potential public health risk.

Exposure to sediments from Areas II and III were associated with noncarcinogenic risk ratios ranging from less than 1 to 3. The only risk ratios to exceed 1 were based on conservative exposure assumptions, which were not considered representative of likely exposure conditions for these areas (including long-term repetitive exposure to the maximum detected contaminant concentration). Based on this evaluation, the noncarcinogenic risk for direct contact exposure in Areas II and III was not considered to pose a risk to public health.

Carcinogenic risks associated with direct contact exposure to sediments was greatest for Area I. Risk estimates based on exposure by a child, an older child, and an adult, ranged from $1x10^{-6}$ to $1x10^{-2}$, with most scenarios associated with risks in excess of the EPA target risk range of 10^{-4} to 10^{-7}. Based on this evaluation, methods to reduce these risks will be addressed in the Feasibility Study (FS).

Carcinogenic risks estimated for Area II assuming probable exposure conditions ranged from $2x10^{-7}$ to $8x10^{-6}$. The only risk estimates exceeding the target range were those associated with PCB exposure under conservative exposure conditions. Because these conditions assume repetitive, long-term exposure to the maximum PCB concentration, the associated risks were considered overly conservative. As stated, exposure under more realistic conditions were associated with risks in the lower end of the target range.

In Area III, carcinogenic risks ranged from $1x10^{-8}$ to $2x10^{-6}$ under probable exposure conditions, and from $2x10^{-7}$ to $1x10^{-4}$ under conservative exposure conditions. No risk estimates exceeded the EPA target risk range.

Ingestion of Sediment

Exposure through ingestion of sediment was considered an age-related activity and most significant for children less than six years old. Both noncarcinogenic and carcinogenic risks associated with this route of exposure were evaluated.

Noncarcinogenic risk associated with exposure to cadmium- and copper-contaminated sediments in Areas I, II, and III were below 1 for all scenarios evaluated. Risk ratios based on exposure to PCBs and lead-contaminated sediments exceeded 1 under certain scenarios. For Area I, risk ratios for PCBs and lead ranged from 11 to 175 and 26 to 33, respectively. The magnitude and extent to which the values exceed 1 indicates that ingestion of Area I sediment presents a potential health risk to children.

Risk ratios based on ingestion of PCB-contaminated sediment in Areas II and III ranged from below 1 to 17. However, the risk ratios based on exposure at recreational locations and under probable exposure conditions within these areas were all below 1. Because these scenarios were considered to represent actual exposure conditions, ingestion of sediments from Areas II and III was not considered to present a noncarcinogenic health risk.

Incremental carcinogenic risks associated with exposure through the ingestion of sediment were greatest for Area I and ranged from $6x10^{-6}$ to $1x10^{-2}$. These risk estimates were based on exposure to sediments in areas where access by children is considered possible. These risks fell within and exceeded the EPA target range of 10^{-4} to 10^{-7}. As such, methods to reduce these risks will be addressed in the FS.

Risk estimates based on exposure in Area II ranged from $9x10^{-7}$ to $2x10^{-4}$, with most risk values falling between 10^{-5} and 10^{-6}. Risk estimates based on probable exposure conditions ranged from $9x10^{-7}$ to $2x10^{-5}$. The risks based on exposure in Area III fall within the lower end of the target range and are between $2x10^{-7}$ to $3x10^{-6}$.

Risks associated with exposure through direct contact and ingestion of contaminated shoreline sediment are greatest for Area I. Both the carcinogenic and noncarcinogenic risk estimates based on PCB exposure in this area exceeded the EPA-established criteria levels. Noncarcinogenic risks based on exposure to metals in this area were below levels considered to represent a public health risk. Methods to reduce carcinogenic risks from PCB exposure will be evaluated in the FS.

Risk estimates based on exposure to sediment from other New Bedford Harbor areas were less than those developed for Area I. Noncarcinogenic risks based on exposure to PCBs and metals were below levels considered to represent a public health concern. Carcinogenic risks associated with probable exposure condition through direct contact with and ingestion of sediments from Areas II and III ranged from less than 10^{-7} to $8x10^{-5}$. Most risks were between 10^{-6} and 10^{-5}. Young children were considered at greater risk from contaminant exposure than older children or adults.

Risk estimates based on acute exposure to sediments, representing intermittent or once-in-a-lifetime exposure were below EPA criteria levels . Therefore, these exposures were not considered to present a public health risk.

<u>Ingestion of Aquatic Biota</u>

Exposure to PCBs and metals through ingestion of biota was evaluated for potential noncarcinogenic and carcinogenic risks.

Three species were considered in this evaluation: winter flounder, clams, and lobster (both with and without tomalley). Separate scenarios were developed for each species and assumed that 100 percent of the seafood diet was comprised of said species. A standard 8-ounce fish meal (i.e., 227 grams) was assumed for older children and adults, and a 4-ounce fish meal (i.e., 115 grams) was assumed for younger children.

Risk ratios based on exposure to cadmium and copper by older children and adults ranged from below 1 to 7.9. Ratios in excess of 1 were based on daily ingestion frequencies and whole-body tissue concentrations. These conservative assumptions may overestimate the actual risks, suggesting that exposure to cadmium and copper may not present a public health concern.

However, exposure to cadmium and copper by children resulted in risk ratios ranging from below 1 to 15.8. Because young children are more sensitive to contaminant exposure than older children and adults, this exposure route was considered to present a greater risk to a child's health.

Risk ratios based on exposure to lead and PCBs via ingestion of biota for all age classes exceeded 1 for most scenarios evaluated. No particular area or species appeared to consistently present a greater risk from exposure to these compounds. Based on this evaluation, exposure to lead and PCBs through the ingestion of biota presents a public health risk.

Incremental carcinogenic risks associated with the ingestion of biota fall within or exceed the EPA target range. Many scenarios evaluated had associated risks in excess of 10^{-3}. The risk estimates range from $1x10^{-5}$ to $9x10^{-3}$ for Area 1; from $4x10^{-6}$ to $1x10^{-2}$ for Area 2; from $6x10^{-6}$ to $8x10^{-3}$ for Area 3 and from $1x10^{-6}$ to $2x10^{-3}$ for Area 4. The highest risks were associated with ingestion of lobster including the tomalley.

Methods to reduce the noncarcinogenic risks from exposure to cadmium, copper, lead, and PCBs, and carcinogenic risks from exposure to PCBs will be assessed in the FS.

Inhalation of Airborne Contaminants

Limited air data were available to assess risks associated with inhalation exposure to PCBs. Data available for risk evaluation were collected from sampling stations distant from receptor locations that were chosen to provide a measure of the maximum PCB concentrations in the air above the mud-flats in Area I. Using these concentrations to assess potential risk was considered overly conservative.

Lifetime exposure to the assumed background concentration of 10 nanograms per cubic meter for the New Bedford Harbor area was assessed and associated with incremental carcinogenic risks in the 10^{-6} range. These risk estimates were based on conservative exposure conditions suggesting that actual risks from this route of exposure are less than 10^{-6}.

SUMMARY OF TOTAL SITE RISKS

The total site risk associated with multimedia and multitoxic exposure was generated by summing the individual risk estimates developed for the ingestion and direct contact with sediments, ingestion of biota and inhalation of air. This scenario represents the risks associated with concurrent or sequential exposure to contaminants through multiple exposure pathways. Total site risk estimates were evaluated against the MCP criteria of $1x10^{-5}$ incremental carcinogenic risk level and of 0.2 noncarcinogenic HI.

The total site risks evaluated in this report were based on chronic exposure via ingestion of, direct contact with, and inhalation of PCBs, cadmium, copper, and lead under probable exposure conditions. The carcinogenic and noncarcinogenic risk estimates for each age class and areas assessed exceed 10^{-5} and 0.2 respectively. Based on this evaluation, methods to reduce the overall site risk will be addressed in the FS.

THE GREATER NEW BEDFORD HEALTH EFFECTS STUDY

In the fall of 1987, the Massachusetts Department of Public Health released the findings of the GNBHES, a three-year study to determine the prevalence of elevated serum PCB levels in a random sample of Greater New Bedford area residents and to test the relationship between serum PCB levels and various health effects. GNBHES was a collaborative effort of the MDPH, the Massachusetts Health Research Institute, and the U.S. Centers for Disease Control.

GNBHES provided retrospective exposure and demographic information for the greater New Bedford area, which was incorporated into this exposure assessment. Because GNBHES focused on seafood consumption and occupational exposure, no information for either inhalation or direct contact exposure to PCBs was presented. Additionally, GNBHES provided exposure and limited demographic information only for persons between 18 and 64 years of age.

The purpose of this risk assessment was to predict how people are or may be exposed to PCBs under various exposure conditions. Exposure scenarios were developed to describe the possible exposures received by a hypothetical individual.

GNBHES does not contradict this risk assessment. Measures recommended in the GNBHES can be viewed as ways to reduce many of the risks identified in this risk assessment.

1.0 INTRODUCTION

This report presents the baseline public health risk assessment for the New Bedford Harbor Superfund site. This work is a component of the New Bedford Harbor REM III Superfund Feasibility Study (FS) and was conducted under contract to Ebasco Services, Inc. (Ebasco) under U.S. Environmental Protection Agency (EPA) Contract Number 68-01-7250.

1.1 SITE DESCRIPTION AND HISTORY

New Bedford Harbor is an urban tidal estuary on the western shore of Buzzards Bay, Massachusetts, situated between the City of New Bedford on the west and the Towns of Fairhaven and Acushnet on the east. The area contains approximately six square miles of open water, tidal creeks, salt marshes, and wetlands, and provides habitats for a wide variety of aquatic organisms that use this area for spawning, foraging, and overwintering.

The Acushnet River runs through three communities: Fairhaven, New Bedford, and Acushnet, Massachusetts. The coastal town of Dartmouth, Massachusetts, is located south of and adjacent to New Bedford and borders Clark Cove and Buzzards Bay. These four towns comprise the Greater New Bedford Harbor area. The estimated population of this area is 145,600 (based on the 1987 town census for Acushnet, Fairhaven, and Dartmouth and the 1986 census for the City of New Bedford).

Between 1974 and 1982, a number of environmental studies were conducted to assess the magnitude and extent of PCB (polychlorinated biphenyl) contamination in New Bedford Harbor. Results of these studies revealed that sediment north of the Hurricane Barrier contained elevated levels of PCBs and heavy metals. Additional investigations revealed that PCBs had been discharged into the surface waters of New Bedford Harbor, causing elevated PCB concentrations in sediment, water, fish, and shellfish.

To reduce the potential for human exposure to PCBs, the Massachusetts Department of Public Health closed much of the New Bedford Harbor area to fishing. Three closure areas were established on September 25, 1979. Area 1 (New Bedford Harbor) is closed to the taking of all finfish, shellfish, and lobsters. Area 2 (Hurricane Barrier to a line extending from Ricketson Point to Wilbur Point) is closed to the taking of lobster and bottomfeeding fish (eel, scup, flounder, and tautog). Area 3 (from Area 2 out to a line from Mishaum Point, Negro Ledge, and Rock Point) is closed to the taking of lobster.

In July 1982, the U.S. Environmental Protection Agency (EPA) placed New Bedford Harbor on the Interim National Priority List (NPL). The final NPL was promulgated in September 1984. The site, as listed, includes the Upper Estuary of the Acushnet River, New Bedford Harbor, and portions of Buzzards Bay. Following the NPL listing, EPA Region I initiated a comprehensive assessment of the PCB problem in the New Bedford area. This assessment included an area-wide ambient air monitoring program, a sediment profile for the Acushnet River and harbor, and a biota sampling program in the estuary and harbor.

As a result of these studies, a better understanding of the extent of PCB contamination has been gained. The entire harbor north of the Hurricane Barrier, an area of 985 acres, is underlain by sediment containing elevated levels of PCBs and heavy metals. PCB concentrations in this area range from a few parts per million (ppm) to over 100,000 ppm. Portions of western Buzzards Bay sediment are also contaminated, with PCB concentrations occasionally exceeding 50 ppm, primarily near locations of combined sewer outfalls. The water column in New Bedford has been measured to contain PCBs in excess of EPA's Ambient Water Quality Criterion (AWQC). Concentrations of PCBs in edible portions of locally caught fish have been measured in excess of the Food and Drug Administration (FDA) 2 ppm tolerance level for PCBs.

In 1984, EPA conducted an initial Feasibility Study (FS) of the highly contaminated mudflats and sediment in the upper estuary of the Acushnet River. Five clean-up options were presented in that report. EPA received extensive comments on these options from other federal, state, and local officials, potentially responsible parties, and the public. Many of the comments expressed concern regarding the proposed dredging techniques and potential impacts of dredging on the harbor, and potential leachate from the proposed unlined disposal sites.

In responding to these comments, EPA elected to conduct additional studies before choosing a clean-up alternative for the Upper Estuary. Concurrent with these studies, EPA is conducting additional surveys to better define the extent of PCB contamination throughout the overall Harbor and Bay. Through these efforts, clean-up options for this site are being developed.

PCBs are the primary contaminant of concern in the Hot Spot area and estuary. However, the Acushnet River Estuary is not a pristine estuarine environment, and has historically been polluted with industrial and sanitary waste discharges. Due to these other discharges, there are elevated levels of polycyclic aromatic hydrocarbons (PAHs) and heavy metals (i.e., copper, chromium, lead, and cadmium) in the estuary sediment. The presence of and potential risks from metal contamination are presented in the baseline risk assessment; risks from exposure to PAHs in the Hot Spot area have been previously evaluated (E.C. Jordan/Ebasco, 1987).

PAH compounds were found to be collocated with PCBs; however, the range of PAH concentrations in sediment was significantly less than the range of PCB concentrations. Total PAH concentrations range from below detection limit to 930 ppm, with an average PAH sediment concentrtion of approximately 70 ppm. (The highest PAH concentration of 930 ppm was detected in the Hot Spot area of the upper estuary.) No discrete areas of elevated levels of PAH compounds were observed, suggesting that PAH contamination results from non-point sources such as urban runoff. PAH concentrations detected in New Bedford Harbor sediment are similar to PAH concentrations detected in other urban and industrialized areas (EPA, 1982).

The relative toxicity of PAH compounds with respect to PCBs indicates that the majority of risk from exposure to sediment can be attributed to PCBs. Since PAH compounds can be effectively treated by the technologies identified in the Hot Spot FS to treat PCB contamination, methods taken to reduce PCB contamination will effectively reduce PAH contamination (E.C. Jordan/Ebasco, 1989). However unlike PCBs, the discharge of PAH compounds is expected to continue after remediation into the upper estuary from non-point sources. Therefore, remedial actions may not permanently reduce levels of these contaminants.

1.2 OBJECTIVES OF THIS REPORT

EPA Region I is responsible for the cleanup of the New Bedford Harbor site under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Act Reauthorization Amendments (SARA) of 1985. Pursuant to this charter, Region I has direct responsibility for conducting the appropriate studies for this site to support the need for and extent of remediation. In accordance with the National Contingency Plan (NCP), these studies form the basis of the Remedial Investigation/Feasibility Study (RI/FS) for the site.

This risk assessment presents and quantifies risks to public health due to PCB, cadmium, copper, and lead exposure in the New Bedford Harbor area under baseline (existing) conditions. The baseline assessment is the first of a series of risk assessments that will provide the basis for evaluating the need for and extent of remediation. It is based on existing conditions in the harbor only and does not consider potential natural decrease in contaminant concentration in the harbor due to transport and degradation through time.

While it is probable that natural processes will result in a decrease in contaminant concentrations, these processes are not expected to show significant changes over the next decade. Recent sampling data indicates no appreciable change in PCB concentrations have occured over the past 10 years. Sustained elevated levels of PCBs (i.e., greater than 2 ppm) in lobster and other species have been documented (Kolek and Ceurvels, 1981; Massachusetts Division of Marine Fisheries, unpublished data; Pruell et al., 1988), and elevated levels of PCBs in sediment (i.e., greater than 4,000 ppm) have been recorded (USACE, 1988). Reduction of PCB concentrations to levels consistent with EPA and state public health guidance are not expected to occur without remedial actions.

Additional risk assessments will be conducted to determine the effectiveness of various remedial alternatives. Results of the sediment contaminant transport and food-chain models will be used to provide future potential exposure point concentrations under various conditions. Risk assessments conducted using these modeled results will allow an evaluation of the relative effectiveness of the various remedial alternatives against the baseline conditions.

1.3 REPORT STRUCTURE

This report consists of three sections. The first section is the Exposure Assessment, which identifies potential human receptors and describes the mechanism by which these receptors may be exposed to contaminants within the New Bedford Harbor area. The second section, Toxicity Assessment, provides a description of the toxic properties of PCBs, cadmium, copper, and lead. In addition, the existing standards and criteria for these compounds are presented and discussed. The final section, Risk Characterization, combines information presented in the first two sections to describe and quantify the potential risks to public health.

1.4 PROGRAM DATA BASE

Data on the distribution of PCBs in sediment and overlying waters of New Bedford Harbor and the Acushnet River Estuary were provided by Battelle Pacific Northwest Laboratories (PNL). For consistency with other aspects of the RI/FS process in New Bedford, the public health risk assessment was based primarily on a data set developed as the initial conditions for the physical/chemical transport model. The initial conditions were established by PNL using information on PCBs in the harbor obtained from three sources, each of which will be described briefly below: data collected by Battelle Ocean Sciences (BOS) (Duxbury, MA) specifically for the calibration and validation of the model, a data base compiled by GCA Corporation (now Alliance Technologies Corporation) from a variety of historical sources, and a detailed survey of PCBs in the harbor developed by NUS. These three data sets were subsequently combined into the central New Bedford Harbor Data Base by BOS (Administrative Record).

1.4.1 BOS Calibration/Validation Data

From 1985 through 1986 BOS conducted four samplings of water, sediment, and biota in the Acushnet River Estuary, New Bedford Harbor, and adjacent areas of Buzzards Bay to provide data for calibration and validation of the physical/chemical transport model and food-chain model. Twenty-five stations were established and sampled on each of three surveys; the remaining survey was limited to eight stations and was conducted immediately following a storm event. Although the samples obtained during these surveys were collected and analyzed under rigorous quality control procedures, the data were intended for use primarily for model calibration/validation; their usefulness for determining patterns of PCB distribution in the harbor is limited by the relatively sparse spatial distribution.

1.4.2 Alliance Data Base

This previously compiled data base summarizing a number of diverse field investigations in the harbor represented an important source of data and was used extensively to set initial conditions for the model. The data base was originally constructed for EPA by Metcalf & Eddy, Inc. (1983) and was transferred to Alliance in 1986. Alliance began to expand the data base and converted it to run under dBase III, a personal computer data base management software package. This work was never completed, and the data base was subsequently provided to Jordan for their internal use, and to BOS for quality assurance checks and subsequent incorporation into the central New Bedford Harbor data base. The data base used to establish initial conditions for the model was provided to PNL by Jordan.

Several technical difficulties were encountered by PNL in using the Alliance data base in the dBASE III form. The most significant of these was that contaminant data were not indexed fully and consistently or, in some other cases, correctly. Data from the Alliance data base were eventually extracted from ASCII versions of the data base files using a combination of custom-written FORTRAN programs and hand editing at PNL.

1.4.3 NUS Data Base

The NUS data base was provided to PNL in digital form by BOS. The data base was apparently complete and contained data for PCBs expressed as the concentrations of various Aroclors for samples obtained on a regular grid. The GZA data proved to be valuable because they provided concentration data for the entire study area.

Sediment Data. PCBs detected in sediment from New Bedford Harbor vary both in level and composition. The Aerovox facility and the Cornell Dubilier facility used blends of PCBs (marketed under the trade name "Aroclor") in the manufacture of electronic capacitors from the late 1940s to the late 1970s. *Aroclor 1242* was used in substantial quantities in New Bedford until 1971 when Aroclor 1016 was introduced, replacing Aroclor 1242. Aroclors 1254 and 1252 were used in lesser quantities.

The data sets used to establish the initial condition for the modeling included PCB data in a variety of different forms. In some data sets, PCBs were reported as Aroclor 1242, Aroclor 1254, Aroclor 1242/1016, and non-specific PCB. Some samples included data on level-of-chlorination homologs. The desired final measure, total PCB, was obtained for each sample by summing the concentrations of all quantified Aroclors.

When quantitation in the Alliance data base had been performed on a wet-weight basis, a conversion to dry weight was performed using the group-average water content of 55 percent. Data obtained via this conversion were identified as "CDW" in the final data files. Only data with equivalent units of parts per million dry weight (ppm dw), milligrams per kilogram dry weight (mg/kg dw), or the same units in converted dry weight were used.

PCB concentrations in the NUS data base were reported as Aroclor 1242, Aroclor 1248, or Aroclor 1254 in units of micrograms per kilogram (ug/kg), and assumed to be dry weight. Typically, only one or two Aroclor concentrations were summed and converted to units of micrograms per gram (ug/g), equivalent to ppm dw. Some replicate samples occurred in the NUS data base; in these cases, the arithmetic average of the two reported concentrations was used.

The BOS data base reported PCB concentrations by level-of-chlorination homolog in units of ug/g dw. These concentrations were summed to produce an estimate of total PCB concentration.

Values below specified detection limits occurred in all data bases and were used in determining initial conditions; values reported as zero were not used. Data reported below detection limits were assigned a value equal to approximately 0.1 times the specified detection limit of the analytical procedure and were placed in a separate file. When detection limits were not reported, concentrations of zero were assigned values of approximately 0.1 times the lowest reported value. These arbitrary assignments were necessary because the data were later log-transformed and values of zero would have been unacceptable.

The selected and converted sediment PCB concentration data were combined into four files with common formats. Each record in the files contained information on the data source, location, total PCB concentration, units, and the number of samples summed to produce the total concentration. Original units were included in these files, but the units of ppm, ug/g, and mg/kg are numerically equivalent. The below-detection-limit values discussed in the preceding section were segregated to facilitate changes to the assigned values, if necessary.

Standard univariate statistics were calculated for the raw and log-transformed data. The log-transformed data produced near-normal distributions around the mean value for each data set.

Computerized contour plots of the PCB surface sediment concentrations were prepared at PNL using data contained in the New Bedford Harbor data base. These plots were used to estimate PCB exposure point concentrations at various locations within the study area. These concentrations are, therefore, based on both actual data and computerized interpolation of these data.

The metal concentrations used in this report were accessed directly from the New Bedford Harbor data base. These data were collected as part of the Battelle sampling programs and reported in wet weight concentrations. No conversion to equivalent dry weight concentrations were made. The mean metal value represents the mean concentration of only the detected (i.e., greater than the detection limit) samples. Using appropriate longitude and lattitude coordinates, area-specific metals data were obtained and used as exposure point concentrations.

Water Data. PCB concentrations in the water column for the risk assessment were also based on the values used for the physical/chemical transport model. Unlike sediment concentrations, however, the use of initial conditions, *per se*, is not appropriate because preliminary model runs indicated that concentrations in the water column are determined largely by the assigned sediment concentrations following a brief "spin up" period of approximately 90 days simulation. Accordingly, PNL did not determine initial conditions for the water column in a manner similar to that previously described for sediment, but assigned initial conditions that were generally consistent with the field data and then allowed the model to produce its own "starting conditions" based on the assigned sediment concentrations. These starting conditions in the water column were averaged vertically and provided to Jordan along with initial sediment conditions. As with the metals sediment data, metals water data were accessed directly from the Alliance data base.

1.4.4 Other Sources of Data

Additional information used in this risk assessment includes various site investigation reports, the Greater New Bedford Health Effects Study (GNBHES) (MDPH, 1986), the Pilot Study conducted by the U.S. Army Corps of Engineers, and the Damage Assessment Report prepared for National Oceanic and Atmospheric Administration (NOAA) (NOAA, 1986).

2.0 EXPOSURE ASSESSMENT

The purpose of this public health exposure assessment is to identify potential receptors (i.e., individuals or populations) and describe the mechanisms by which persons may be exposed to contaminants at the New Bedford Harbor site. This assessment is based on land-use and demographic information for this area and assumptions regarding the frequency and duration of activities likely to result in contaminant exposure. The demographic, land-use, and exposure information used to complete this section includes the GNBHES (MDPH, 1987), the federal census (U.S. Department of Commerce, 1980), the "Land-use and Point Source Inventory, New Bedford, Massachusetts" (EPA, 1982a), The Damage Assessment Report (NOAA, 1986), and the "New Bedford Harbor Site Visit; Summary Report" (GCA, 1986b).

Although it is not possible to identify specific individuals or determine the exact number of adults and/or children who may be exposed to contaminants in New Bedford Harbor, it is possible through interview, land-use and demographic information to estimate how and to what level of contamination individuals may be exposed. The following section describes possible contaminant exposure in qualitative terms which reflect behavioral patterns and physical and chemical conditions at the site.

2.1 DEMOGRAPHICS

PCB and heavy metal contamination in the Acushnet River is documented from the Wood Street Bridge throughout the harbor and into Buzzards Bay. The primary areas of concern for public health at this site include the Upper Estuary (from the Coggeshall Street Bridge to the Wood Street Bridge) where elevated levels of PCBs (i.e., greater than 4,000 ppm were documented in the sediment, and along the shoreline where access to the river is unrestricted.

The Acushnet River runs through three communities: Fairhaven, New Bedford, and Acushnet, Massachusetts (Figure 2-1). The coastal town of Dartmouth, Massachusetts, is located south of and adjacent to New Bedford, bordering Clarks Cove and Buzzards Bay. These four towns compose the Greater New Bedford Area, and are the focus of this exposure assessment. The inhabitants of these communities were considered most likely to be at potential risk to contaminant exposure due to their proximity to the river and harbor area. The total population of these four communities is 145,605 (Town Census for Acushnet, Fairhaven, and Dartmouth; 1986 Census for the City of New Bedford).

Although any individual within the defined population may potentially be exposed, four groups within the general population were considered more sensitive to environmental contaminant exposure:

TABLE 2-1

POPULATION DISTRIBUTION BY AGE GROUP AND SEX FOR THE
GREATER NEW BEDFORD AREA
NEW BEDFORD, MASSACHUSETTS

Age	New Bedford	Acushnet	Dartmouth	Fairhaven	Total
Males					
0-5*	4,268	264	657	466	5,655
6-16*	8,007	873	2,256	1,412	12,548
17-44	17,452	1,708	4,832	2,985	26,977
45-64	10,257	1,014	2,644	1,793	15,708
>65*	5,889	401	1,237	937	8,464
Females					
0-5*	3,941	288	573	429	5,231
6-16*	7,959	780	2,087	1,303	12,129
17-44*	18,782	1,722	5,495	2,942	28,941
45-64	12,181	1,075	2,911	1,966	18,133
>65*	10,007	579	1,781	1,526	13,893
Total					
0-5	8,209	552	1,230	895	10,886
6-16	15,966	1,653	4,343	2,715	24,677
17-44	36,239	3,340	8,929	5,927	55,918
45-64	22,438	2,089	5,555	3,759	33,841
>65*	15,896	980	3,018	2,463	22,357

Source: U.S. Department of Commerce, 1980

Note:

* Indicates subpopulations considered to be more sensitive to contaminant exposure (see text).

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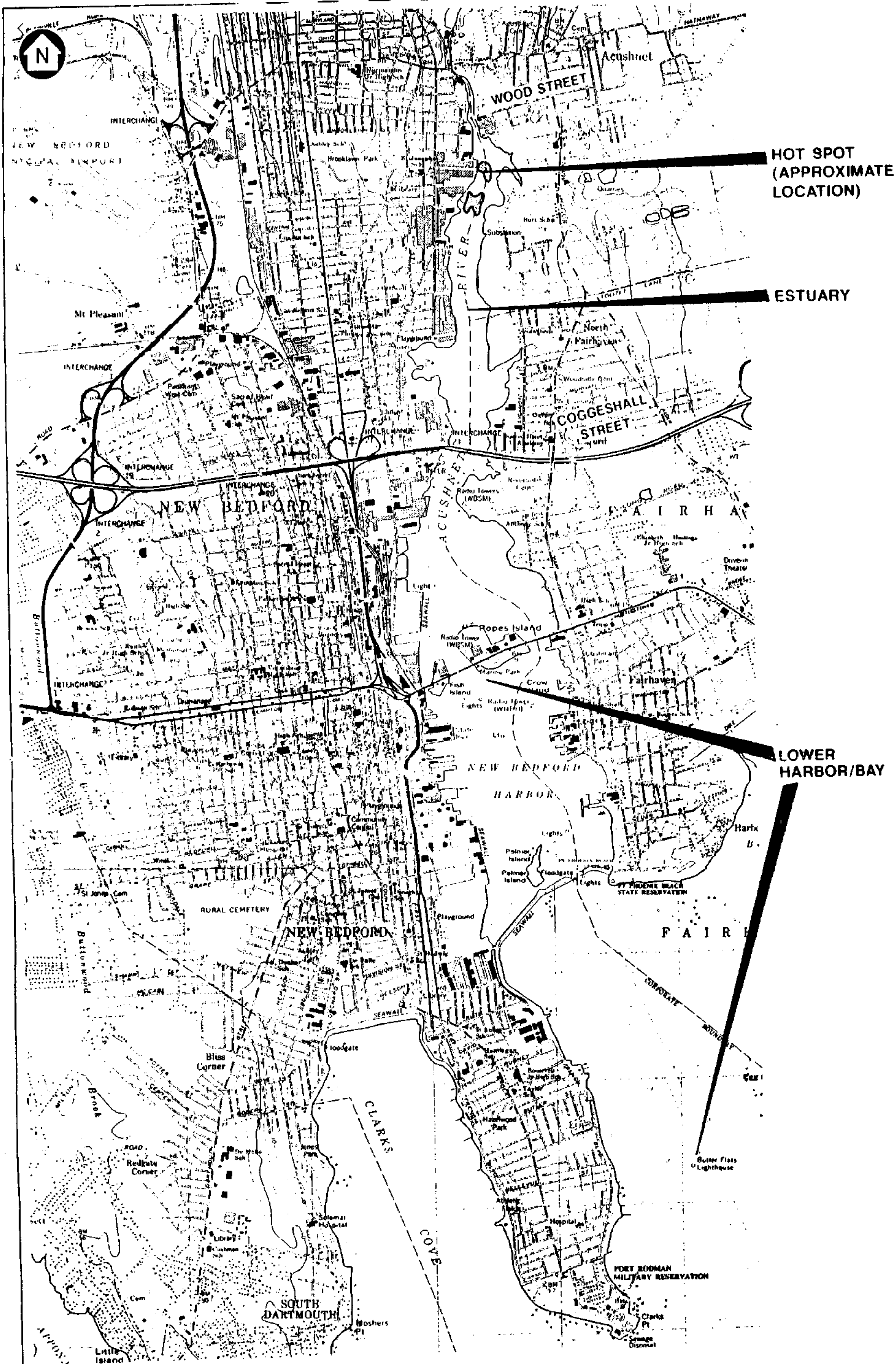


SOURCE: USGS QUADRANGLES;
NEW BEDFORD NORTH & SOUTH, MASS., 1977 & 1979

FIGURE 2-1
SITE LOCATION MAP
NEW BEDFORD HARBOR

- Infants and Young Children. Infants and children engage in more activities that could result in contaminant exposure. This subpopulation may be more sensitive to contaminant exposure because of their small body sizes, developing immune systems, and rapid development. These factors effectively reduce their ability to compensate for chemical insult.

- Developing Fetus. The fetus is often considered to be sensitive to chemical exposure because of rapid development, especially during the first trimester. Many environmental contaminants are capable of crossing the placental barrier and potentially interfering with fetal development. Because of its small body size, body weight, and rapid growth, the fetus is particularly sensitive to chemical insult.

- The Elderly. The elderly are considered a sensitive subpopulation because of potentially compromised immune systems and the frequent presence of disease and organ pathology. These conditions may reduce the functional ability to compensate for chemical injury through regeneration or repair of cells, or metabolic detoxification of chemicals.

- Chronically Ill. In addition to the groups discussed previously, there are also individuals in the mainstream population who may be hypersensitive to contaminant exposure because of their immunologic status, presence of disease or specific organ pathology, or medication status.

The 1980 Federal Census provides estimates of the number of infants/children (zero to 5 years), women of childbearing ages (14 to 44 years), and the elderly (older than 65 years) having permanent residence in the Greater New Bedford Area. These subpopulations are indicated by an asterisk in Table 2-1. Assuming that the age distribution within this population has not significantly changed since 1980, these high risk populations account for approximately 50 percent of the total population. Specifically, 7 percent of the people are less than 5 years old, 28 percent are women between 14 and 44 years, and 15 percent are over 65 years.

The group considered at highest risk of direct exposure to sediment within the New Bedford Harbor site area is children between the ages of 6 and 16, since individuals within this age group are most likely to wander and play in areas that may be contaminated, and are least likely to be aware of the potential dangers associated with contaminant exposure. Children younger than 5 years are at risk from contaminant exposure due to small

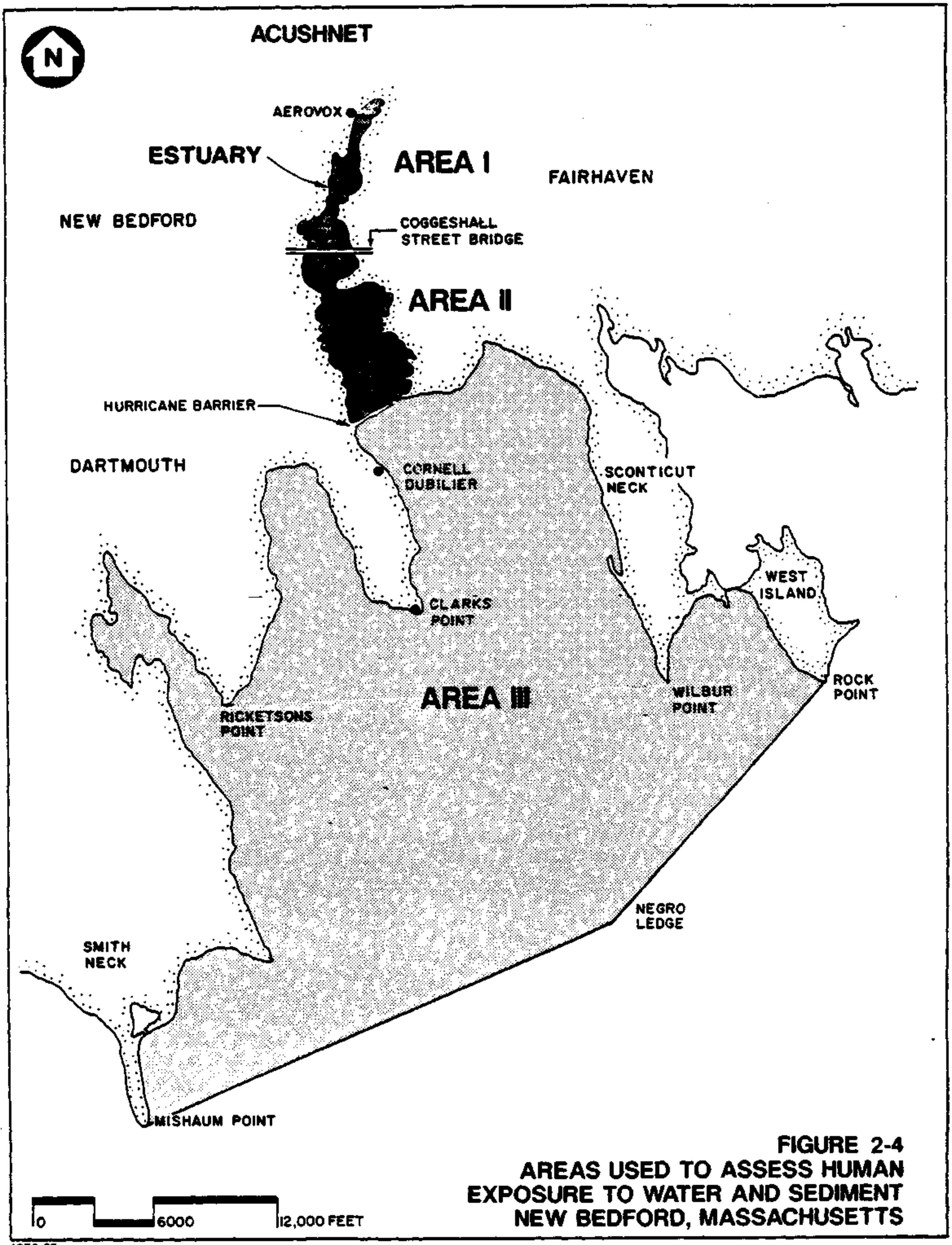


FIGURE 2-4
AREAS USED TO ASSESS HUMAN EXPOSURE TO WATER AND SEDIMENT NEW BEDFORD, MASSACHUSETTS

4959-08

body sizes, developing immune systems, and rapid growth and development. However, exposure to contaminants by this age class is expected to be limited, given that children under age 5 are generally supervised and have limited mobility. Therefore, they are unlikely to be playing in areas of high contamination.

Adults (including those older than 65 years) are also expected to have more limited exposure than older children. This age class is considered to be more aware of potential dangers associated with contaminant exposure and is likely to voluntarily restrict access to contaminated areas. However, it is considered likely that persons within this age class may fish or shellfish in contaminated areas.

According to the 1980 census, approximately 90 percent of New Bedford residents reported living in Bristol County during the previous five years, and approximately 60 percent of the population have not changed their residences. This indicates that chronic and/or lifetime contaminant exposure is possible for a large segment of the population.

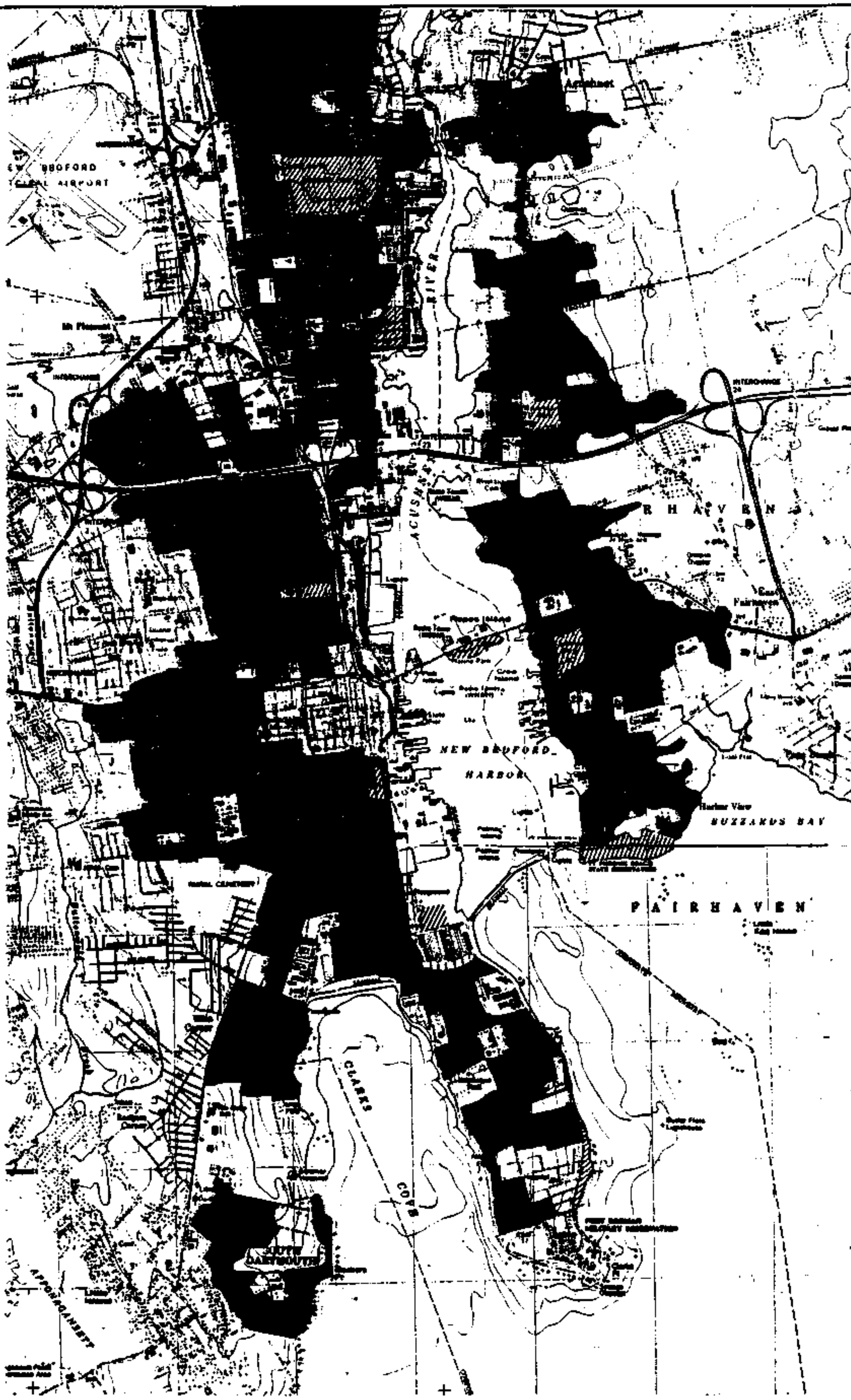
The Greater New Bedford Area experiences a seasonal fluctuation in population. Although this increase cannot be quantified, tourists and summer residents result in a temporary increase in population. Because of recreational activities associated with this area, summer residents and/or tourists have the potential for exposure to contaminants in the New Bedford Harbor Site Area while swimming, fishing, and shellfishing. However, given the temporary residence of this subpopulation, exposure is likely to be sporadic or short-term in duration.

Approximately 50 percent of the New Bedford population is of single Portuguese ancestry and 20 percent is from multiple ancestry (i.e., English, French, German, Irish, Italian, and Polish). Reportedly, 55 percent of the residents speak English, 35 percent Portugese, and 5 percent Spanish (U.S. Department of Commerce, 1980). Where possible, the REM III team has considered cultural differences that may affect exposure to contaminated media.

2.2 LAND-USE WITHIN THE NEW BEDFORD HARBOR SITE AREA

Land-use classifications for the Acushnet River/New Bedford Harbor Site Area include urban (residential and industrial), wetlands, beaches, and barren land; with the majority being classified as urban residential (Figure 2-2) (EPA, 1982a). The land-use information, combined with demographic data, can assist in determining how and where people may become exposed to contaminants.

Figure 2-2 identifies the residential and recreational areas located within an approximate 1-mile radius of the Acushnet



SOURCE: USEPA ([illegible])

LEGEND

RESIDENTIAL AREAS

RECREATIONAL AREAS

FIGURE 2-2
RESIDENTIAL AND RECREATIONAL LAND-USES AROUND THE ACUSHNET RIVER NEW BEDFORD, MASSACHUSETTS

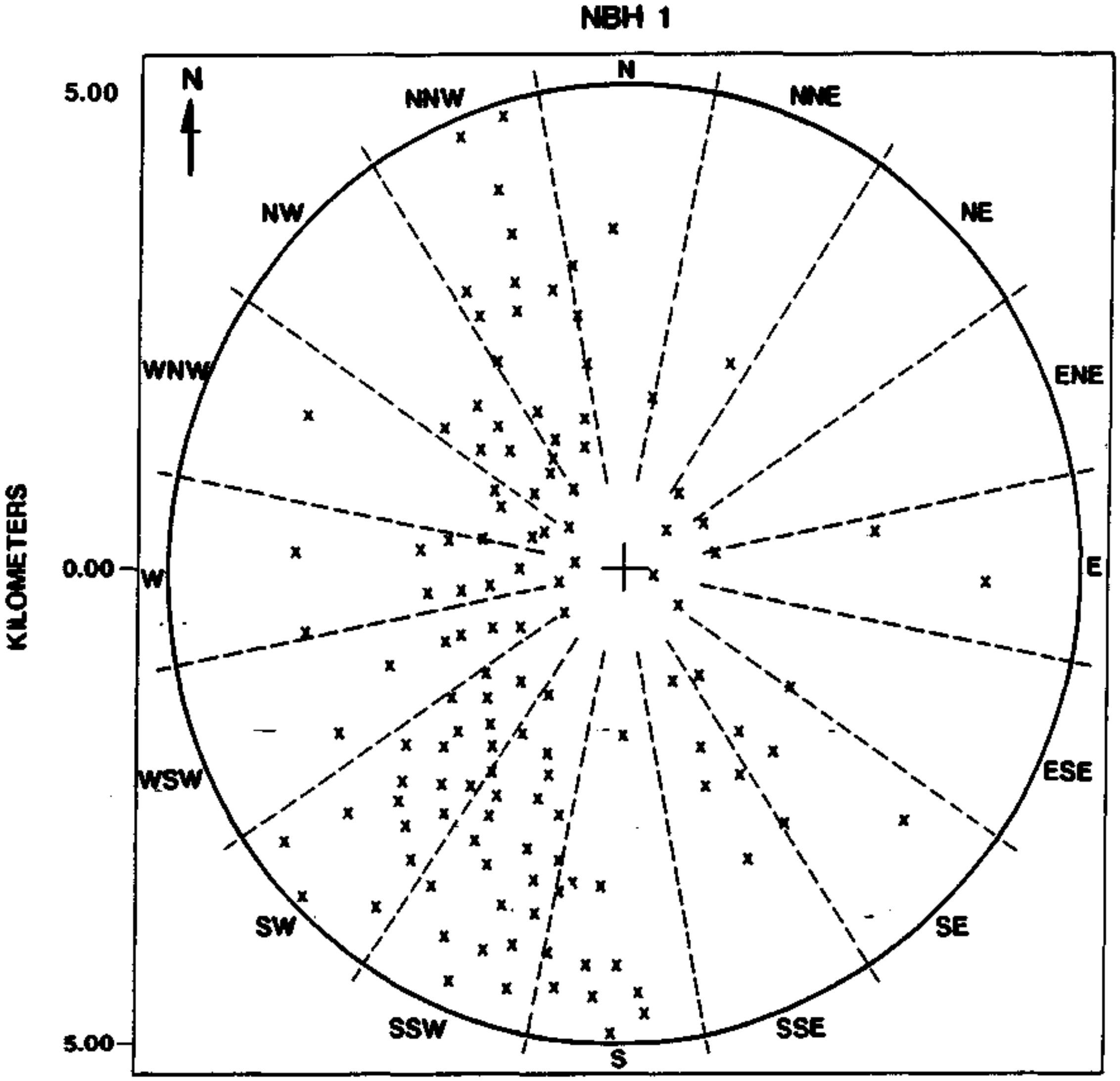
River. Most of the land within this area is used for residential purposes, with a much smaller portion set aside for recreational uses. The land directly adjacent to Acushnet River, on the New Bedford side, is primarily industrial. However, the amount of industrial land-use decreases southward from the harbor toward Buzzards Bay, where public beaches constitute most of the southern shoreline. The land-use on the Fairhaven side of the river is primarily residential. The population residing within a 3-mile radius of the Upper Estuary is estimated at 90,000 (Figure 2-3) (EPA, 1982b).

Recreational and land-use information obtained from NOAA (1986) and the GNBHES (MDPH, 1987) include data on beach use and recreational fishing in the Greater New Bedford area. Surveys conducted by NOAA show that 71 percent of the respondents reported visiting saltwater beaches in the Greater New Bedford area in 1985. Beaches located adjacent to the Acushnet River include the Fort Phoenix State Beach (Fairhaven, Massachusetts) and Fort Rodman/East Beach (New Bedford, Massachusetts). Twenty-three and 18 percent of respondents reported visiting these two locations, respectively (NOAA, 1986).

The NOAA study also reported that 19 percent of respondents fished in the New Bedford area in 1985. Eighty persons indicated having fished in the area north of Ricketson Point or Wilbur Point 14 times on average in 1985. The GNBHES reported that 12.9 percent of the Greater New Bedford population obtain fish by catching it themselves (MDPH, 1987). However, when looking at sources of seafood caught and consumed from contaminated areas, most people (61.5 percent) report they do not consume this seafood. The GNBHES concluded that the majority of the general public was not directly or knowingly catching and consuming fish from contaminated areas (MDPH, 1987). However, the GNBHES identified a small percentage of the population who did report catching and consuming locally caught fish (MDPH, 1986).

In addition to these data, qualitative information describing the Acushnet River and potential activities that may occur at various locations along the shoreline were made by GCA during a site visit to New Bedford Harbor (GCA, 1986b). These observations were limited to one season (late summer) and therefore cannot be considered representative of year-round conditions. However, these observations in conjunction with the GNBHES and NOAA reports, indicate that individuals access the river for various purposes. The major observations are summarized as follows:

Upper Estuary: Acushnet River Between Coggeshall and Wood Street Bridges



SOURCE: GRAPHICAL EXPOSURE MODELING SYSTEM (GEMS)

SECTOR	POPULATION
N	3090
NNE	1236
NE	1101
ENE	379
E	2947
ESE	1948
SE	2839
SSE	3790
S	11064
SSW	17767
SW	16680
WSW	7505
W	8245
WNW	4444
NW	7511
NNW	12906

Σ 103,452

X = RELATIVE POPULATION DENSITIES

+ = HOT SPOT LOCATION

FIGURE 2-3
POPULATION DISTRIBUTION
AROUND THE UPPER ESTUARY, ACUSHNET RIVER
NEW BEDFORD, MASSACHUSETTS

4959-08

- The New Bedford Harbor side of this section of the river is primarily industrial, while the Fairhaven side is much less commercially developed.

- Access to the river is unrestricted; however, warning signs are posted.

- Swimming is unlikely, although wading in the mudflat areas is possible.

- The Acushnet River is very "dirty" with brown and pungent water, oil stains, and trash.

- An approximate 10-foot width of bottom sediment is exposed at low tide.

- Children were observed in a playground located within 300 feet of the river bank (Cove Area).

Upper Harbor: Coggeshall Street to Fairhaven (Hutchinson Street) Bridge

- The Fairhaven side of this section of the river is less commercially developed than the New Bedford Harbor side.

- Access to the river is unrestricted, and no warning signs were observed.

- Wading and swimming in this section of the river are considered possible.

- The river shows visual signs of pollution (e.g., trash and oil stains).

- A pungent odor from the water was noted and the bottom sediment was exposed at low tide.

Lower Harbor: Fairhaven (Hutchinson Street) Bridge to Hurricane Barrier

- The Fairhaven side of this section of the river is primarily residential. The New Bedford Harbor side is less commercially developed than areas to the north.

- Access to the river is unrestricted along the Fairhaven side. Access along the New Bedford Harbor side is restricted by the presence of fenced private property (i.e., warehouses).

- Wading and swimming in this section of the river seem likely. Persons were observed fishing around the

Hurricane Barrier. Palmer Island can be accessed by foot at low tide.

Entrance to Buzzards Bay: Hurricane Barrier to Fort Rodman

- Fort Phoenix and Fort Rodman State Reservations are located in this section of the river.

- Children and adults were observed fishing, wading, and swimming in this area.

- Both sides of the river are primarily residential with some commercial development around the Hurricane Barrier.

- Fishing, wading, and swimming are likely activities in this area.

- Beaches run along the river bank for most of this area.

Access to the estuary and harbor is unrestricted in most areas, including locations of high contamination. Although warning signs are posted in the Upper Estuary, fishing, wading, and/or playing in this area was observed. However, activities along the shoreline were observed more frequently in the southern portion of Acushnet River near Buzzards Bay. This, in addition to the physical conditions of the Upper Estuary, suggests that exposure to sediment and water will be more common in the southern portion of the Lower Harbor/Bay Area. However, since access to the Upper Estuary is unrestricted, exposure to high levels of contaminated sediment is possible.

Summary. A culturally diverse population resides within the Greater New Bedford Area. A large percentage of residents report living in this area for at least five years. A seasonal influx of summer residents and tourists suggests that short-term or acute exposures to contaminated media may be occurring, in addition to possible chronic exposure experienced by permanent residents.

Activities observed or reported to occur include swimming, wading, fishing, and shellfishing (GCA, 1986b; NOAA, 1986c; MDPH, 1987). The areas of the Acushnet River where recreational activities are considered likely to occur include Palmer Island, Marsh Island, Popes Island, and Fort Rodman and Fort Phoenix State Beaches. These areas are either easily accessible or support organized recreational uses. However, because access to most portions of the Acushnet River is unrestricted, inadvertent contaminant exposure is considered possible for all areas of the river.

2.3 EXTENT OF CONTAMINATION

An extensive data base, containing contaminant concentrations for all media throughout the Acushnet River and Buzzards Bay, was developed and used in this risk assessment to provide exposure concentrations for various receptor locations within the New Bedford Harbor site area (New Bedford Harbor Data Base, 1987). The majority of sample analyses in this data base were obtained between 1981 and 1986 and, therefore, were considered to provide an accurate description of the current extent and level of PCB and metal contamination. This data base was also used to establish initial conditions for the physical/chemical transport model.

The Acushnet River/New Bedford Harbor Site Area was subdivided into three areas to assess sediment and water exposure in this risk assessment:

- Area I: the area between the Wood Street and Coggeshall Street bridges
- Area II: the area between the Hurricane Barrier and Coggeshall Street Bridge
- Area III: the area south of the Hurricane Barrier.

This subdivision, illustrated in Figure 2-4, separates areas of high contamination (i.e., hot spots) from areas of relatively low contamination (south of the Hurricane Barrier), thereby providing a more accurate estimate of exposure concentrations.

Another subdivision of the Acushnet River/New Bedford Harbor Site Area was used to assess exposure through the consumption of aquatic biota. The Acushnet River/Buzzards Bay Area was divided into four areas for purposes of modeling future contaminant concentrations in aquatic biota. Since these estimated concentrations will be used to evaluate future potential risks in this area, this subdivision was used to assess exposure via the ingestion of aquatic biota. These areas are shown in Figure 2-5.

In summary, exposure to sediment and water was assessed for the three areas, referred to by Roman numerals (i.e., I, II, and III), shown in Figure 2-4. Exposure through the ingestion of aquatic biota was assessed for the four areas established by HydroQual, referred to by Arabic numerals (i.e., 1, 2, 3, and 4), and shown in Figure 2-5.

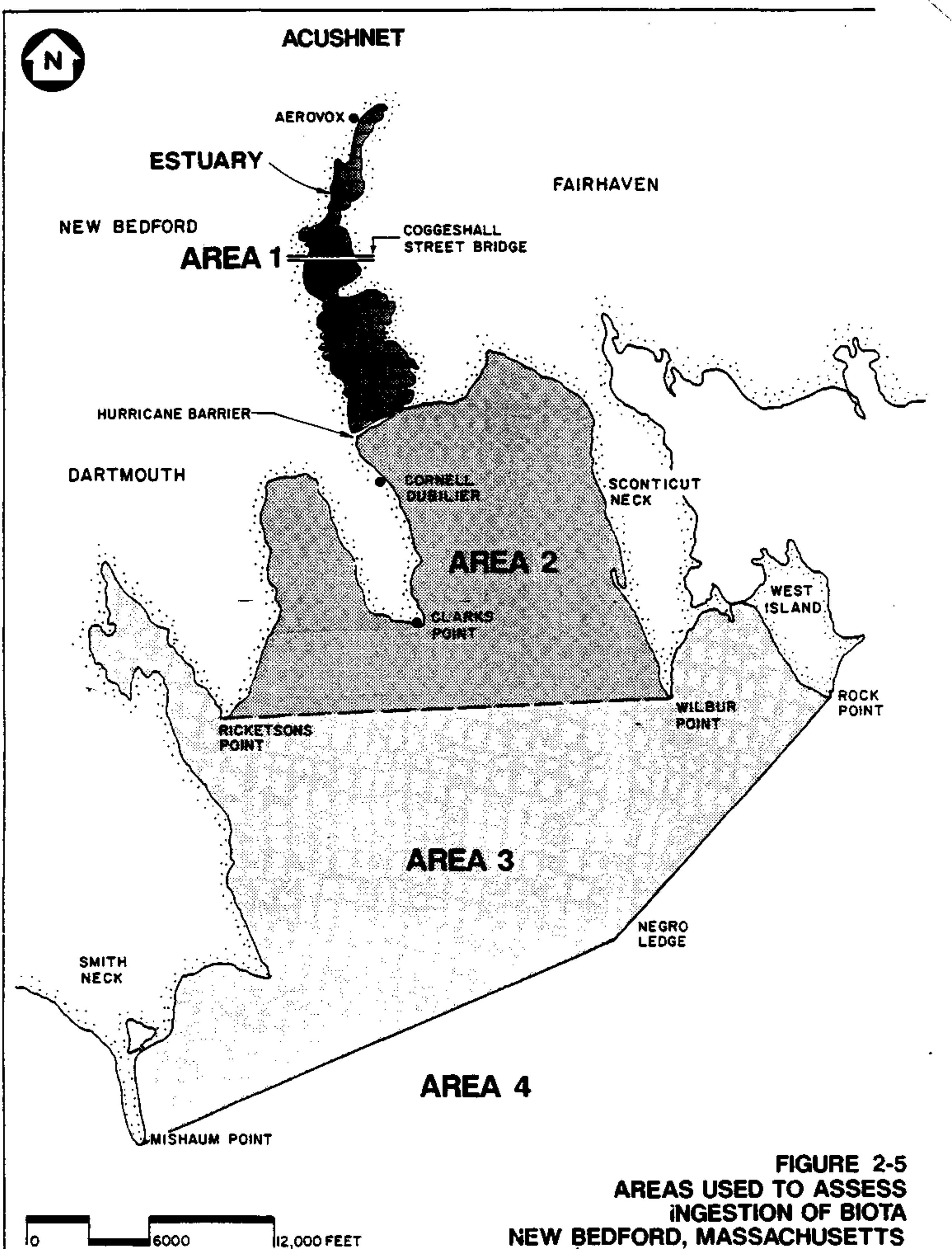


FIGURE 2-5
AREAS USED TO ASSESS
INGESTION OF BIOTA
NEW BEDFORD, MASSACHUSETTS

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2.4 PRINCIPAL EXPOSURE PATHWAYS

Demographic and land-use information indicates a large residential population in the immediate area surrounding the Acushnet River and that people access this site for occupational and recreational purposes. Analytical data for New Bedford Harbor document the presence of elevated levels of PCBs and metals in the sediment, water, biota, and air. Therefore, exposure to contaminants detected in these media is possible through several different pathways, including dermal contact with sediments and water, ingestion of sediment, water, and biota, and/or inhalation of airborne contaminants. To determine the exposure pathways that contribute most significantly to the total contaminant exposures at New Bedford Harbor, a screening evaluation was performed.

The route-specific exposure level (defined as the amount of contaminant taken into the body per unit weight per unit time [mg/kg/day]) attributed to each exposure pathway was determined. These levels were estimated based on extremely conservative exposure assumptions. The route-specific exposure level for each contaminant was estimated assuming the exposure point concentration was the maximum detected concentration of each contaminant. It was also assumed that repetitive exposure, over 70-years duration, occurred at this maximum concentration. The estimated exposure level was then compared to the most appropriate health-based criterion. Exposure pathways were excluded from further consideration only if they contributed a negligible amount to the total exposure dose and if the associated risk was minimal (see Section 4.0). This approach was considered appropriate since the screening evaluation was based on extremely conservative exposure assumptions, with lower exposure levels expected under more realistic exposure conditions.

Exposure to PCBs was evaluated for all routes of exposure. When or if the exposure levels for PCBs were considered insignificant, exposure to cadmium, copper, and lead was then evaluated. This approach prevented the elimination of any route of exposure considered a primary pathway for only one or two contaminants.

Estimated lifetime body doses for the exposure scenarios evaluated in the screening process are in Table 2-2. (The exposure assumptions and body dose calculations appear in Appendix A, Tables A-1 through A-6.)

Based on the screening results, direct contact with sediment, ingestion of aquatic biota and sediment, and inhalation of airborne contaminants were all considered to significantly contribute to the total PCB exposure at the New Bedford Harbor

TABLE 2-2

ESTIMATED LIFETIME BODY DOSES FOR SCREENING SCENARIOS
EXPOSURE TO PCBs
NEW BEDFORD, MASSACHUSETTS

Pathway of Exposure	Exposed Population	Average Daily Dose for PCBs (mg/kg-day)	Percent Contribution to Total Dose[a]	Principal Pathway
Ingestion of Aquatic Biota	Older Child (6-16)	$9.5x10^{-4}$	1.4	Yes
Direct Contact with Sediments	Older Child (6-16)	$5.7x10^{-2}$	84	Yes
Direct Contact with Surface Water	Older Child (6-16)	$5.3x10^{-7}$	$7.8x10^{-4}$	No
Ingestion of Surface Water	Older Child (6-16)	$3.4x10^{-6}$	$5.0x10^{-3}$	No
Inhalation of Airborne Contaminants[b]	Child (0-5)	$1.7x10^{-5}$	0.025	Yes
Ingestion of Sediments	Child (0-5)	$1.0x10^{-2}$	14.7	Yes
Total Dose		$6.8x10^{-2}$	100	

[a] The percent contribution was calculated by: $\frac{\text{Average Daily Dose}}{\text{Total Dose}}$ *x 100. It provides* a relative measure of exposure.

[b] The maximum concentration was assumed to represent the contaminant in the vapor phase.

NOTE:

The average daily dose was estimated based on conservative exposure assumptions, including repetitive exposure to the maximum detected contaminant concentration. The age-class chosen for each pathway of exposure was that considered most likely to be at risk from exposure due either to low body weight or higher frequency of exposure. For example, exposure to children ages 0 to 6 was evaluated because it is possible that this age class could be exposed 24 hours/day. The low body weight of children puts them at greater potential risk to PCB exposure than older children and adults exposed 24 hours/day with a higher body weight. These screening scenarios represent the upper bound, conservative estimate of potential risk.

The Average Daily Dose values in this table were used to screen exposure pathways and not forthe risk assessment presented in Chapter 4.0.

site. These four exposure pathways result in more than 99 percent of the total exposure and, therefore, were assumed to account for the majority of risk at the site. The screening results also show that direct contact with and/or the incidental ingestion of surface water does not result in a significant contaminant exposure. These exposure routes account for 0.001 percent of the PCB exposure.

Exposure dose levels for metals were estimated for direct contact with and incidental ingestion of surface water because these routes of exposure were considered insignificant for PCB exposure. The exposure dose levels for metals estimated under the same conservative assumptions were also insignificant. Because these scenarios were based on conservative exposure assumptions, lower exposure levels would be expected under more realistic exposure conditions. Therefore, exposure to contaminants through incidental ingestion of and direct contact with surface water was not evaluated further in this risk assessment. *In summary, PCB and metals exposures for* direct contact with and ingestion of sediment, ingestion of biota, and inhalation of airborne contaminants were carried through the analysis for quantitative evaluation.

2.5 QUANTITATIVE EXPOSURE ASSESSMENT

In this section, the equations used to calculate the route-specific exposure level for the principal exposure pathways are described. In addition, the exposure parameters used in these equations are identified and discussed. Values for these exposure parameters were chosen by the REM III team based on site-specific factors and realistic exposure considerations. For example, sediment deposition factors were chosen to reflect sediment characteristics, and site-specific weather conditions were considered in developing exposure frequencies. In addition, location-specific exposure concentrations were used that allowed exposure to be evaluated separately for areas of high contamination and areas of low contamination. This provided a realistic range of exposure parameters which reflected the exposure conditions in this area. Exposure parameters were obtained from the scientific literature and appear in the tables in Appendix C.

To provide a range of exposure doses, two exposure scenarios were considered in each analysis: one based on "average" or probable or moderate exposure conditions, and the other based on "conservative" exposure conditions. Together, these scenarios provide a range of potential exposure levels, within which the actual exposure for a particular individual would likely fall. Figure 2-6 is an overview of the exposure scenarios evaluated in this section.

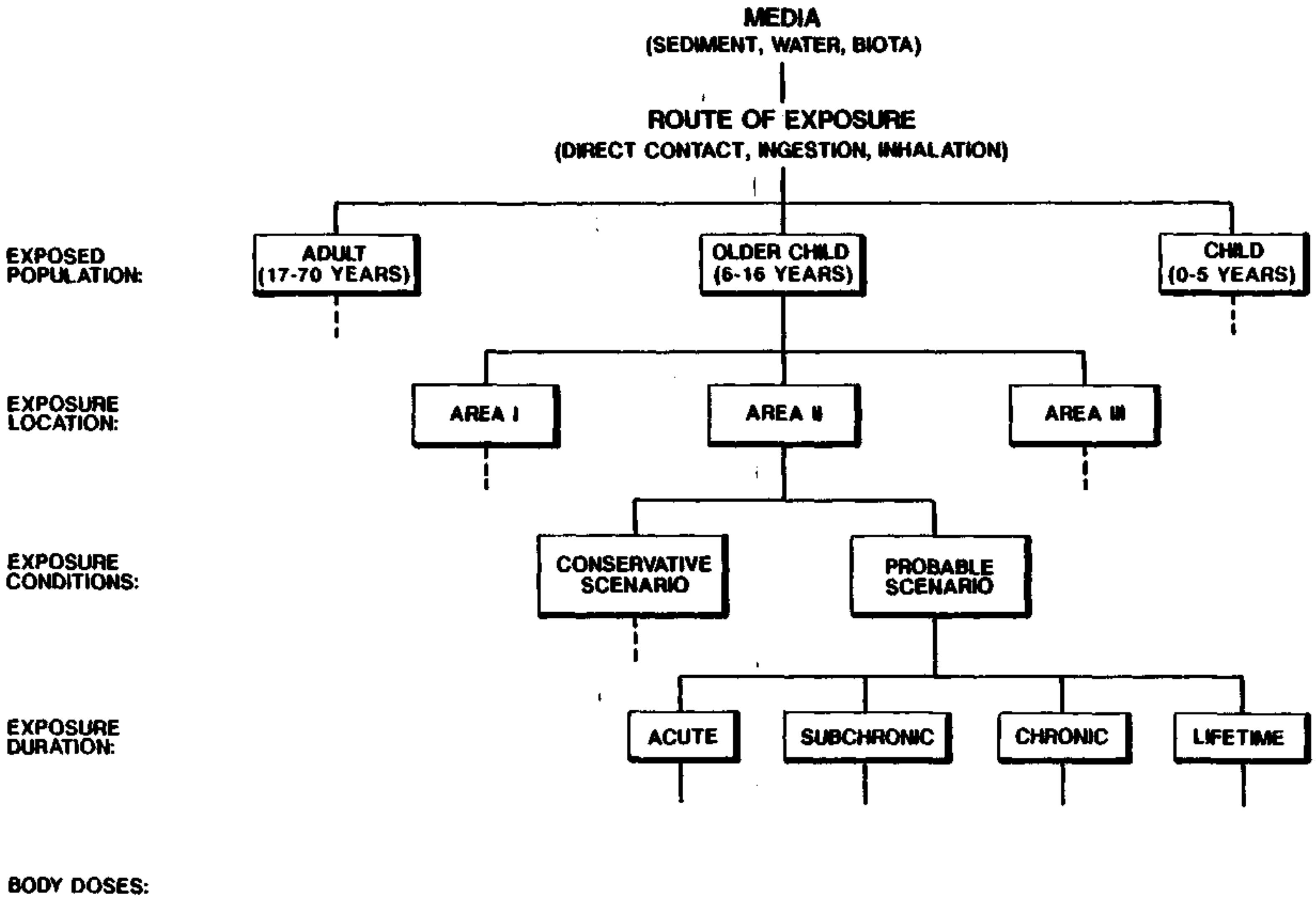

FIGURE 2-6
FLOW CHART OF
EXPOSURE SCENARIOS EVALUATED
NEW BEDFORD, MASSACHUSETTS

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The exposure scenarios evaluated in this report provide a range of possible exposure doses for a "hypothetical individual," rather than for a specific population. These scenarios do not predict the number of people who may be exposed to contaminants in the Greater New Bedford Area, but rather provide an estimate of the magnitude of exposure that could be incurred by an individual receptor under specified exposure conditions.

Exposure to each medium is discussed generally in subsequent subsections, followed by a quantitative exposure analysis for each scenario under review. The equations used to estimate systemic contaminant doses from the various exposure routes are in Table 2-3. The exposure parameters identified in these equations are summarized in Table 2-4, as well as in the text.

2.5.1 Sediment

For sediment, possible exposure pathways include two exposure scenarios: (1) direct contact exposure to sediment, and (2) ingestion of sediment.

Ingestion of sediment is considered limited to children younger than 6 years, while direct contact with sediment is possible for all age groups. Because different exposure parameters govern these two exposure pathways, separate evaluations were performed.

2.5.1.1 Direct Contact Exposure to Sediment

Land-use around the study area and results from NOAA (1986), indicate that the local population uses the beaches along the Acushnet River for recreational purposes. Therefore, persons of all ages may be exposed to contaminated sediment as a result of swimming, wading, and/or fishing in the Acushnet River. The most likely locations for these activities to occur are south of the Coggeshall Street Bridge (Areas II and III). However, because access to the river is not restricted, exposure to sediment in Area I is possible, and therefore, was evaluated in this section.

Direct contact exposure to sediment was assessed separately for Areas I, II, and III. Because of the wide range of PCB contaminant concentrations in Area I (ND to 6,393 ppm), separate exposure scenarios were developed for the Cove Area, and the Upper and Lower Estuary (Figure 2-7). For Areas II and III, exposure was evaluated at specific locations that support recreational activities; these included Popes Island, Palmer Island, and Marsh Island for Area II; and The Fort Rodman and Fort Phoenix state beaches for Area III.

The contaminant concentrations detected or estimated through computer interpolation in the shoreline sediment were used to

TABLE 2-3

EQUATIONS USED TO ESTIMATE SYSTEMIC CONTAMINANT DOSES
NEW BEDFORD, MASSACHUSETTS

Exposure Via Direct Contact:

$$DEX_{DC} = \frac{C_A \times SA \times DF \times TKF \times F \times CF}{BW}$$

Exposure Via Ingestion:

$$DEX_{ING} = \frac{C_A \times Q \times TKF \times F \times CF}{BW}$$

Exposure Via Inhalation:

$$DEX_{INH} = \frac{C_A \times IR \times TKF \times F}{BW}$$

For carcinogens, the average daily exposure over a lifetime is calculated by multiplying DEX by the duration of exposure (D = years) divided by 70-year lifetime.

where:

DEX = Average Daily Exposure Over Period of Exposure (mg/kg-day)

C_A = Contaminant Concentration Detected in Area A (mg/kg, mg/L or mg/m^3)

SA = Exposed Surface Area (cm^2)

DF = Sediment Deposition Factor (mg/cm^2-event)

Q = Quantity of Sediment Ingested (mg/exposure)

IR = Inhalation Rate (m^3/day)

BW = Body Weight (kg)

TKF = Toxicokinetic Factor (unitless)

F = Frequency of Exposure (events/exposure period (days))

D = Duration of Exposure (years)

CF = Correction Factor (1 kg/10^6 mg)

TABLE 2-4

AGE-SPECIFIC EXPOSURE PARAMETERS USED TO ESTIMATE AVERAGE DAILY EXPOSURE DOSES
NEW BEDFORD, MASSACHUSETTS

	Age Category		
	0-5	6-16	17-65
Body Weight[1]	10 kg	40 kg	70 kg
Surface Area Total[1]	6,880 cm^2	11,900 cm^2	18,000 cm^2
Legs and Feet[1]	2,280 cm^2	4,400 cm^2	3,060 cm^2 (lower legs only)
Forearms, Arms, Hands, Lower Legs and Feet[1]	2,525 cm^2	4,415 cm^2	4,990 cm^2
Sediment Deposition[2] Factors	1.5 mg/cm^2	1.5 mg/cm^2	1.5 mg/cm^2
Sediment Ingestion Rates[3]	0.5 grams	N/A	N/A
Inhalation Rates[4]	5 m^3/day	20 m^3/day	20 m^3/day
Biota Ingestion Rates	115 grams/per meal	227 grams/per meal	227 grams/per meal
Toxicokinetic Factor[5]			
Dermal-PCBs	0.07	0.07	0.07
-Metals	0.01-0.001	0.01-0.001	0.01-0.001
Inhalation-PCBs	1.0	1.0	1.0
-Metals	1.0	1.0	1.0
Gastrointestinal-PCBs	1.0	1.0	1.0
-Metals	1.0	1.0	1.0

Notes:

[1] USEPA, 1985
[2] USEPA, 1984
[3] LaGoy, 1987
[4] USEPA, 1986
[5] See Appendix B
N/A = Not Applicable

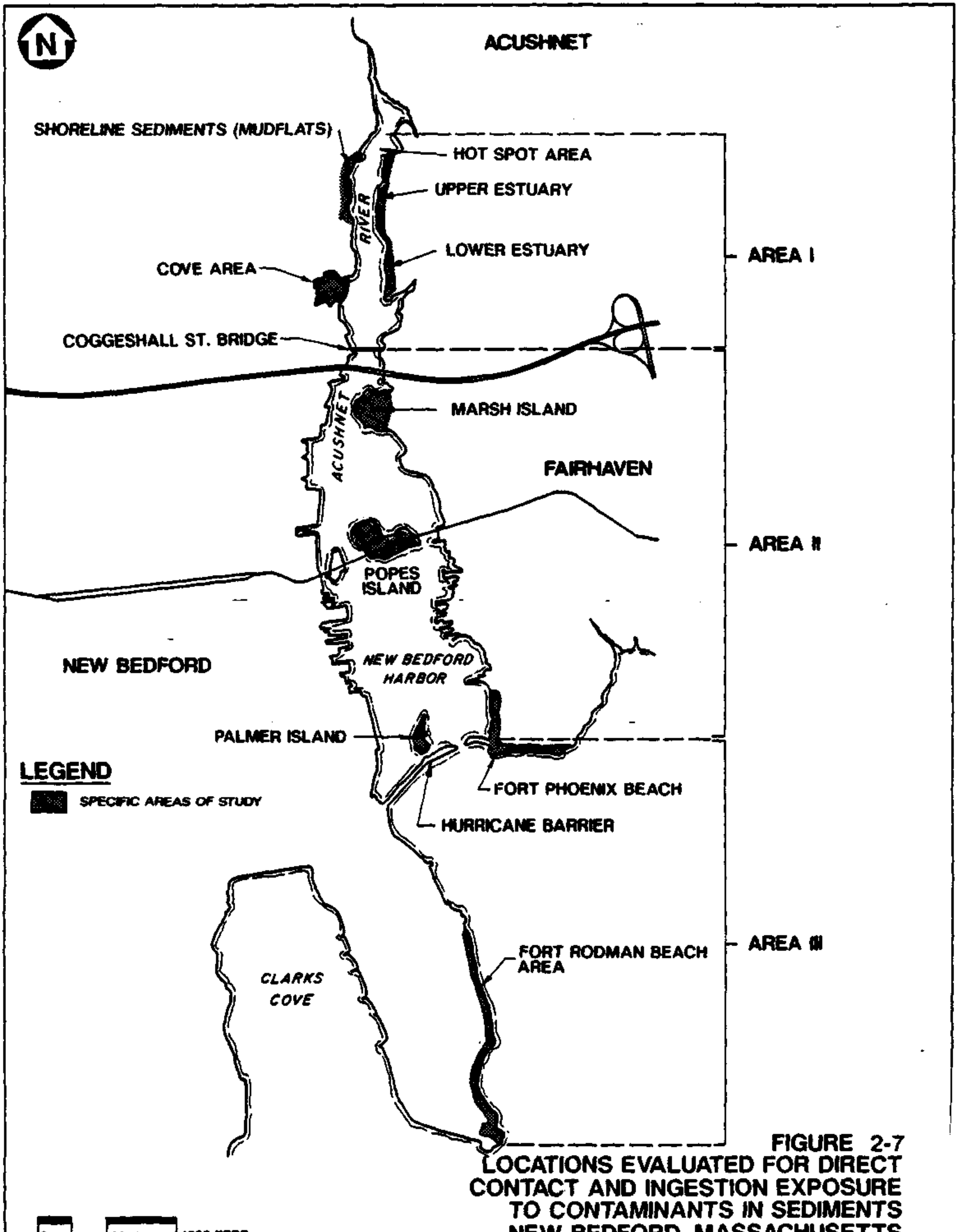

FIGURE 2-7
LOCATIONS EVALUATED FOR DIRECT CONTACT AND INGESTION EXPOSURE TO CONTAMINANTS IN SEDIMENTS
NEW BEDFORD, MASSACHUSETTS

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evaluate direct contact exposure when available. (These data are contained in the New Bedford Harbor Data Base and the Administrative Record.) Midchannel sediment concentrations were not included because exposure to this sediment is considered unlikely. In general, midchannel sediment was more contaminated than shoreline sediment. The geometric mean and the maximum PCB concentrations were used to evaluate exposure under probable and conservative exposure conditions, respectively. The arithmetic mean and maximum metal concentrations were used to evaluate exposure under probable and conservative exposure conditions, respectively. (Data were not available to determine the geometric mean concentrations for metals.) Table 2-5 presents the mean and maximum sediment concentrations used to assess direct contact and ingestion exposures.

It was assumed that young children would only be exposed to sediment while playing or swimming at the beach. The frequency of exposure (e.g., the number of trips to the beach per year) was estimated to range between 20 and 100 times per year, which corresponds to one and five days per week during the warmer months.

Although children in this age class are not expected to have access to nonbeach areas of the New Bedford Harbor site, a subsection of Area I (i.e., Cove Area) is located next to a playground and represents a specific area where children may access the shoreline. Because inadvertent exposure is possible, exposure scenarios were developed for this area. The frequency of exposure in this location was considered less than in the beach area, and was estimated to range from 1 to 20 exposures per year.

An older child or adult was assumed to have access to all areas (i.e., Areas I, II, and III) of the New Bedford Harbor site and contact with sediment as a result of swimming, wading, or shellfishing activities. The frequency of contact was estimated to be between 20 and 100 times per year. This range represents exposures occurring one and five days per week during the warmer summer months. Body weights of 10, 40, and 70 kilograms were assumed for children, older children, and adults, respectively (EPA, 1985a).

Exposure was also evaluated assuming acute (single event), subchronic (1- to 5-year), chronic (10-year), and lifetime exposure durations. Lifetime exposure was assessed by summing the exposure dose received during each age period (i.e., zero to 5, 6 to 16, and 17 to 70). These exposure durations were chosen to reflect likely exposure periods for the Greater New Bedford Area population.

TABLE 2-5

PCB and METALS SEDIMENT CONCENTRATIONS (ppm) USED
TO ASSESS DIRECT CONTACT AND INGESTION EXPOSURES
NEW BEDFORD, MASSACHUSETTS

	PCBs		Cadmium		Copper		Lead	
	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum
Area I								
Shoreline Concentrations								
Entire Area	378	6,393	19.2	69	591	3,180	384	1,680
Upper Estuary	378	6,393	18.8	69	588	1,900	445	1,680
Lower Estuary	149	399	20	63	598	3,180	278	1,330
Cove Area	286	399	19.8	48	915	3,180	393	1,330
Area II								
Shoreline Concentrations								
Entire Area	21	125	7.6	14	570	2,790	160	559
Palmer Island	3	11	ND	ND	310	310	139	139
Popes Island	11	34	ND	ND	492	771	156	272
Marsh Island	8	22	ND	ND	300	463	191	323
Area III								
Shoreline Concentrations								
Entire Area	4	29	ND	ND	94	154	55	106
Fort Rodman Beach Area	2	7	NA	NA	NA	NA	NA	NA
Fort Phoenix Beach Area	0.59	0.75	NA	NA	NA	NA	NA	NA

Notes:

Mean concentration for PCBs represents the geometric mean value. The mean concentration for metals represents the arithmetic mean value of the concentrations detected in each area.
Maximum concentration represents the maximum value detected in each area.
NA = Not Available; shoreline sediment data for metals was unavailable.
ND = Not Detected.

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The amount of sediment contacted per exposure event was estimated based on the exposed surface area and the deposition of sediment onto the skin. For wading and swimming activities, the exposed surface area was considered to be the lower legs; for shellfishing activities, both the lower legs and forearms were considered. Surface areas for these body parts were obtained from EPA and are in Table 2-4 (EPA, 1985a). The sediment deposition factor was estimated to be 1.5 mg/cm^2, which represents the upper end of the soil deposition range used by EPA to assess contact with soil (EPA, 1984a). This value was considered appropriate for assessing sediment exposure, given that sediment tends to adhere more to exposed skin than soil. The sediment deposition factor multiplied by the surface area equals the amount of contaminated sediment contacted per exposure event.

The toxicokinetic factor (TKF) is the final parameter necessary to assess direct contact exposure. This factor adjusts for the differences in absorption between the dermally absorbed dose received from exposure to sediment at the site, and the administered dose of the laboratory test from which the cancer potency factor or reference dose was derived. This adjustment allows quantitative dose-response data from animal studies to be applied to human exposure doses. Jordan derived two TKFs for dermal exposure to PCBs. A TKF of 0.5 (50 percent) was used to estimate exposure to highly contaminated sediment (i.e., PCB concentrations greater than 1 percent); 0.07 (7 percent) was used to assess exposure to moderately contaminated sediment (i.e., PCB concentrations less than 1 percent). The TKF and the basis for its development are discussed in Appendix B. The parameters used to assess direct contact exposure appear in Table 2-6; body dose calculations are in Appendix C.

2.5.1.2 Ingestion of Sediment

Exposure to contaminants can also result from the inadvertent or incidental ingestion of sediment deposited on the hands, food items, or objects placed in the mouth. This route of exposure is expected to be most significant for children less than 6 years old. Young children in this age group engage in substantial hand to mouth activities that can result in incidental soil ingestion. Therefore, this route of exposure is expected to be most significant at locations where children play. For the New Bedford Harbor Site Area, these include the public beaches in Area III and recreational areas located in Area II. Because recreational areas in Area I abut the shoreline (Cove Area), exposure via the ingestion of sediment at these locations is considered possible. The high concentration detected in this sediment suggests that even minimal exposure may be significant. Therefore, exposure scenarios were developed to assess incidental ingestion of contaminated sediment from Area I and the recreational and beach areas in Areas II and III (see Figure 2-7).

TABLE 2-6

EXPOSURE PARAMETERS USED TO ASSESS DIRECT CONTACT EXPOSURE
TO SEDIMENTS (SUBCHRONIC, CHRONIC, AND LIFETIME EXPOSURES)
NEW BEDFORD, MASSACHUSETTS

Exposure Parameter	Child	Older Child	Adult
Average Weight over Period of Exposure	10 kg	40 kg	70 kg
Frequency of Exposure			
Area I			
Probable	1 exp/year	20 exp/year	20 exp/year
Conservative	20 exp/year	100 exp/year	100 exp/year
Area II and III			
Probable	20 exp/year	20 exp/year	20 exp/year
Conservative	100 exp/year	100 exp/year	100 exp/year
Amount of Sediment Contacted			
Probable	Legs and Feet*	Legs and Feet*	Lower Legs and Feet*
Conservative	Forearms, Arms, Hands, Lower Legs and Feet*	Forearms, Arms, Hands, Lower Legs and Feet*	Forearms, Arms, Hands, Lower Legs and Feet*
Dermal Toxicokinetic Factor			
Concentrations <10,000 ppm	7%	7%	7%
Concentrations >10,000 ppm	50%	50%	50%
Duration of Exposure	1 year 5 years	1 year 10 years	1 year 10 years Lifetime

Note:

*See Table 2-4

A review of the literature indicates that between 100 to 500 mg of sediment per exposure is a reasonable estimate for sediment ingestion by children less than 5 years old (LaGoy, 1987). Recent EPA guidance suggests an ingestion rate of 200 mg/day be applied to exposures concerning children between the ages of 2-6 years (EPA, 1989). In this risk assessment, a value of 500 mg/exposure was assumed as the amount of sediment ingested. This is the upper end of the range of estimated values and will provide a conservative estimate of exposure. The frequency of exposure is assumed to be 1 to 20 days for Area I, and 20 to 100 days per year for Areas II and III. (These are the same frequencies used to assess direct contact exposure.)

The mean and maximum sediment concentrations detected in each area are used in the probable and conservative scenarios, respectively (see Table 2-5). The exposure assumptions used to assess this route of exposure are in Table 2-7; body dose calculations are in Appendix C.

2.5.2 Biota

Exposure to contaminants through ingestion of aquatic biota is considered a primary route of exposure for this area. Aquatic biota are known to bioaccumulate and bioconcentrate PCBs. Therefore, organisms living in contaminated areas may be a direct source of PCB exposure if consumed or contribute to PCB contamination of higher trophic level organism within the food chain. Studies conducted in New Bedford Harbor show elevated levels of PCBs in edible tissue of lobsters, clams, and winter flounder. In general, seafood consumption has been noted as a primary source of PCB exposure in the areas of the U.S. where PCB-contaminated sediment has been observed (ATSDR, 1987).

The FDA identified a number of species likely to have PCB residue if taken from contaminated areas (ATSDR, 1987). These species are listed in Table 2-8, along with the fraction of people participating in the GNBHES who reported consuming these locally caught species (MDPH, 1987). Based on this summary, ingestion of winter flounder, lobster, and softshell clam was considered in this exposure assessment. (Recent analytical data [post-1984] was not available to assess exposure to eel, striped bass, or mackerel.) In addition, exposure to metals via consumption of biota was assessed.

Ingestion of biota was assessed separately for each age class: children, older children, and adults. Body weights of 10, 40, and 70 kilograms were assumed for children, older children, and adults, respectively (EPA, 1985a).

A standard 8-ounce (i.e., 227 grams) portion of fish per meal for older children and adults, and 4 ounces (i.e., 115 grams)

TABLE 2-7

EXPOSURE ASSUMPTIONS USED TO ASSESS INGESTION OF SEDIMENTS
NEW BEDFORD, MASSACHUSETTS

Exposure Parameter	Value
Average Weight Over Period of Exposure	10 kg
Duration of Exposure	5 years
Exposure Locations	Cove Area and upper and lower estuary in Area I; Recreational and Beach Areas in II and III
Frequency of Exposure	
Area I:	
Most Probable	1 exp/year
Conservative	20 exp/year
Areas II and III:	
Most Probable	20 exp/year
Conservative	100 exp/year
Amount Ingested	0.5 grams/exposure
Gastrointestinal Toxicokinetic Factor	1.0
Contaminant Concentrations	See Table 2-5

TABLE 2-8

SEAFOOD CONSUMPTION BY SPECIES
NEW BEDFORD, MASSACHUSETTS

Fish/Shellfish	Percent Consuming Various Species: Prevalence[1] n=840 Local Fish	Enrichment[2] n=110 Local Fish
Clams, quahogs	23.3	70.9
Mussels	2.0	19.1
Eel	1.9	24.5
Bluefish/Striped Bass/Mackerel	13.4	70.0
Scup, tautog, fluke flounder, cod, or sea trout	17.1	59.1
Lobster	13.0	62.7

Notes:

* Self-reported consumption.

Source: The Greater New Bedford PCB Health Effects Study (1984-1987) (MDPH, 1987).

n = number of respondents

[1] Prevalence = The cross-sectional randomly sampled group of residents of Greater New Bedford participating in this study.

[2] Enrichment = The recruited group of residents considered to be at greater risk of exposure participating in this study.

per meal for younger children, was assumed. These values were decided after a review of the literature failed to provide a site-specific value applicable to recreational consumption of fish and shellfish.

Examination of the different sources of data shows that a variety of definitions have been used for "fish consumption." Some studies examine only commercially-caught fish and others do not distinguish between consumption of marine versus freshwater fish, or between finfish and shellfish. Finally, some do not differentiate between consumption of fresh fish versus processed (frozen, canned,smoked, etc.) fish. Thus, it is difficult to draw meaningful comparisons among the various fish consumption values derived from studies or sources (Environ, 1985).

Values cited in the literature range from 6.5 g fish/day used by EPA in its Ambient Water Quality Criteria to 18.7 g fish/day cited by Cordel et al. (1978). (These values correspond to 10.5 and 30 8-ounce fish meals per year, respectively.) The Environ (1985) report discusses the limitations of these values and recommends using 14 g fish/day (22.5 8-ounce fish meals per year) as a reasonable average daily fish consumption by freshwater recreational fishermen. Since there was no widely accepted value for recreational fish and shellfish consumption, the REM team chose to use 8 ounces (i.e., 227 grams) as a standard value for each fish meal, and vary the number of fish meals consumed per year to provide a range of exposure frequencies. The uncertainty associated with the 227- or 115-gram value is well within the ranges of uncertainty for other exposure parameters, indicating that the use of other values would not affect the overall uncertainty of the risk estimated for this route of exposure.

Exposure frequencies of one fish meal per day, per week, and per month were evaluated in this risk assessment because this range reflects reasonable exposure frequencies for both tourists (short-term exposure) and residents (chronic and lifetime exposure). Information on local seafood consumption was reported in GNBHES (MDPH, 1987). The majority of persons eating locally caught lobster reported a frequency of consumption of "less than once/month, at least once/year." However, some people reported consumption frequencies of "two or more times/week." (These data are presented in Table 2-9.) The range of consumption frequencies used in this report were based on likely consumption values of the local population. Acute exposure via ingestion of biota was evaluated to reflect the exposure frequency of less than one fish meal per month, and chronic exposure via ingestion of biota was evaluated to reflect exposure frequencies of greater than one fish meal per month.

Edible-tissue PCB concentrations were used when available, or estimated from the data using an edible tissue:whole body ratio

TABLE 2-9

LOCAL SEAFOOD CONSUMPTION FOR
NEW BEDFORD, MASSACHUSETTS

	Number of Persons Reporting			
PCB Blood Serum Level Range[1]:	0.5 - 2.68 n = 212	2.69 - 3.93 n = 209	3.94 - 6.84 n = 210	6.85 - 60.92 n = 209
FREQUENCY OF EATING LOCAL LOBSTER				
Two or more times/week	2	2	3	1
At least once/week	1	4	7	1
Less than once/week, at least once/month	6	7	13	7
Less than once/month, at least once/year	12	21	11	9
Less than once/year	--	1	--	1

[1] PCB concentrations reported in ppb

Source: MDPH, 1987; Tables 15 and 16

developed by Battelle Ocean Sciences (BOS, 1987). (The edible portion excludes inedible bones, scales, and viscera.) Edible tissue:whole body ratios for metals were not available for any of the species. Therefore, whole-body concentrations were used to assess exposure to metals.

The edible tissue:whole body ratio developed by BOS for the lobster did not include the tomalley (i.e., hepatopancreas) as part of the edible tissue. Since the tomalley is part of the lobster's digestive system and tends to accumulate PCBs, excluding this as part of the ratio underestimates the actual exposure concentration for those persons who consume lobster tomalley.

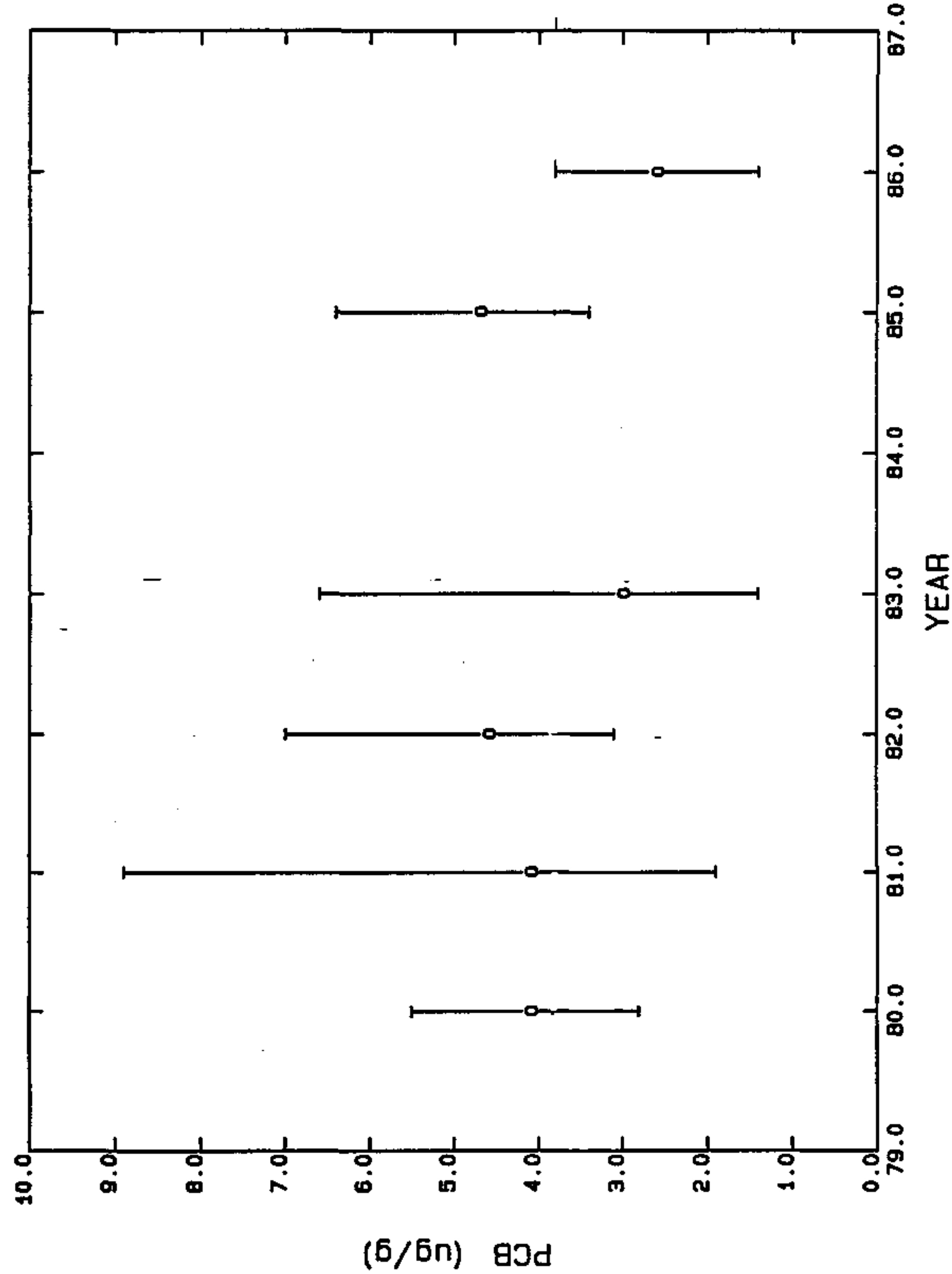
Inclusion of the tomalley is required by the FDA for calculation of compliance with its tolerance limit of 2 ppm. Analyses which include the tomalley have been prepared from 1981 through 1987 for Area III lobsters and show PCB levels in excess of 2 ppm, with no evidence of decline (see Figure 2-8). Analyses performed by EPA in 1987 included separate analyses of the tomalley and the muscle tissue, and provide data to calculate a ratio of these weights. Using this study, it can be shown that some lobsters analyzed by Battelle (Duxbury) would have exceeded the FDA limit had the tomalley been included.

PCB concentrations in the edible portion of the lobster, defined by FDA to include the tomalley, were calculated using data reported by Pruell et al. (1988). The mean weight of the edible tissue and tomalley from lobsters collected in Area 3 were 156 g and 14.4 g, respectively (Pruell, et al., 1988) (see Appendix E). The mean total weight of edible tissue was 170.4 g. Using these values and the PCB concentration detected by BOS (1987), edible tissue (including tomalley) concentrations were derived. The following equations were used:

- PCB concentration in edible tissue x weight of edible tissue = ug PCBs
- PCB concentration in tomalley x weight of tomalley = ug PCBs
- $\frac{\text{Equation (1) + (2) (ug)}}{\text{Total weight of edible tissue (g)}}$ = PCB concentration

An example calculation using the BOS data is presented in Table 2-10. Using the weights reported by Pruell et al., (1988), the PCB concentration in edible tissue for Areas 1 through 4 are: 7.6 ppm, 2.3 ppm, 1.4 ppm, and 0.4 ppm, respectively. Carcinogenic risk calculations have been performed using these data and show that higher levels of risk are associated with consumption of the tomalley. (see Section 4.2.2.2)

These are correct G2



Source: Dept. of Marine
Fisheries; Spring
Sampling

FIGURE 2-8
PCB CONCENTRATIONS (INCLUDING TOMALLEY) FROM LOBSTERS IN AREA 3: 1979-1987

TABLE 2-10

CALCULATION OF EDIBLE TISSUE PCB CONCENTRATIONS FOR LOBSTERS (INCLUDING TOMALLEY)
NEW BEDFORD, MASSACHUSETTS

Mean weight of hepatopancreas[1]: 14.4 grams
Mean weight of edible muscle[1]: 156 grams

Total weight of edible tissue: 170.4 grams

Median PCB concentration in edible muscle from lobsters in Area 3[2]: 0.231 μg/g

Median PCB concentration in hepatopancreas from lobsters in Area 3[2]: 14.414 μ/g

PCB concentration in edible tissue:

Edible Muscle Concentration

0.231 μg/g PCB x 156g = 36.1 μg PCB

Hepatopancreas

14.414 μg/g PCB x 14.4g = 207 μg PCB

Total Edible Tissue Concentration

$$\frac{36.1\ \mu g\ PCB + 207\ \mu g\ PCB}{170.4\ g\ tissue} = 1.43\ ppm\ PCB$$

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[1] Pruell et al., 1988

[2] BOS, 1987

Exposure to contaminants from the consumption of biota was assessed for each of the four areas identified Figure 2-5. Tables 2-11 and 2-12 present the mean and maximum PCB and metal concentrations used to assess exposure via ingestion of lobster, clams, and winter flounder. Other exposure parameters used in this assessment are presented in Table 2-13. Body dose calculations for these exposure scenarios are in Appendix C.

2.5.3 Air

The inhalation of airborne contaminants represents another potentially important route of exposure for the New Bedford Harbor area. However, limited air monitoring was performed in New Bedford and, as such, the data available for this risk assessment are viewed as representing a "snapshot" of contaminant levels in this area (NUS, 1986). Since the sampling locations used to obtain these data were designed to study possible tidal influence on airborne concentrations of PCBs and metals they may not be appropriate to characterize the extent of and potential exposure to airborne contamination at receptor locations.

Monitoring locations were selected to characterize the concentrations at high and low tide around the mudflat near the Aerovox Plant. Therefore, any extrapolation of the magnitude of air contamination at this area to other areas within the Greater New Bedford area may not be appropriate. However, to provide some indication of the potential exposure to airborne contaminants, these data were used (NUS, 1986).

Cadmium and lead were the only metals of concern monitored in the NUS study. Cadmium was not found in any of the samples analyzed, and the concentrations of lead were too low to make a precise determination of the ambient lead concentrations. Therefore, inhalation of airborne contaminants was assessed only for PCB exposure. Because no distinction between particulate and vapor phase PCBs can be made from the available monitoring data, it is assumed that all measured concentrations represent PCBs in the vapor-phase. This is a conservative assumption that may potentially overestimate the actual exposure; however, it is appropriate in the absence of specific data which could differentiate between PCBs in the particulate versus vapor phase.

Jordan evaluated inhalation exposure for each age class using the maximum, mean, and "background" PCB concentrations detected in the 1985 study. (The background PCB air concentration for New Bedford is estimated to be 10 ng/m^3 [NUS, 1986].) Inhalation rates of 5 m^3/day were assumed for a young child and 20 m^3/day for an older child and adult (EPA, 1985a).

TABLE 2-11

CONCENTRATIONS OF TOTAL PCBs (ppm) IN EDIBLE TISSUE OF
BIOTA COLLECTED FROM NEW BEDFORD HARBOR
NEW BEDFORD, MASSACHUSETTS

SPECIES	AREA 1[1]	AREA 2[1]	AREA 3[1]	AREA 4[1]
American Lobster[2]				
Mean	NC	~~0.568~~ 0.458 G2	~~0.213~~ 0.251	0.064
Maximum	NC	1.234	0.351	0.176
Winter Flounder[3]				
Mean	1.039	0.371	0.278	0.101
Maximum	2.629	1.048	0.825	0.340
Clam				
Mean	0.689	0.231	0.156	0.039
Maximum	2.121	1.181	0.478	0.137

Notes:

1 = Areas refers to the division of the Harbor and Bay established by HydroQual.
2 = Lobster concentrations DO NOT include tomalley.
3 = The edible tissue concentration was estimated using a whole body: edible tissue ratio of 0.13 (BOS, 1987).
NA = Not Applicable (shellfish and crustaceans have naturally high levels of copper in their bodies).
NC = Not Collected; lobsters were not collected from Area I.
Mean = Arithmetic mean value of all samples collected.
Maximum = Maximum value detected in each Area.

(s/b a ratio of 0.18 (Batelle, 1990) Hydroqual modeling

TABLE 2-12

CONCENTRATIONS OF METALS (ppm) IN BIOTA
COLLECTED FROM NEW BEDFORD HARBOR AREA
NEW BEDFORD, MASSACHUSETTS

SPECIES	AREA 1[1]			AREA 2[1]			Area 3[1]			Area 4[1]		
	Cd	Cu	Pb	Cd	Cu	Pb	Cd	Cu	Pb	Cd	Cu	Pb
Lobster												
Mean	NC	NC	NC	0.38	NA	0.99	0.33	NA	0.38	0.26	NA	0.23
Max	NC	NC	NC	0.7	NA	3.3	0.54	NA	1.12	0.59	NA	0.84
Clam												
Mean	0.17	NA	1.01	0.26	NA	0.76	0.29	NA	1.28	0.32	NA	0.97
Max	0.36	NA	1.9	0.33	NA	0.98	0.38	NA	3.46	0.49	NA	1.72
Flounder												
Mean	0.01	3.1	0.89	0.01	3.7	0.83	0.005	9.7	0.63	0.01	9.6	1.2
Max	0.014	11.1	3.35	0.02	19.8	4.52	0.012	51.6	2.72	0.09	43.9	6.84

Notes:

1 = Areas refers to the division of the Harbor and Bay established by HydroQual.
NA = Not Applicable (shellfish and crustaceans have naturally high levels of copper in their bodies).
NC = Not Collected; lobsters were not collected from Area I.
Mean = Arithmetic mean value of all samples collected.
Maximum = Maximum value detected in each Area.

TABLE 2-13

EXPOSURE PARAMETERS USED TO ASSESS INGESTION OF BIOTA
NEW BEDFORD, MASSACHUSETTS

Exposure Parameter	Child	Older Child	Adult
Average Weight over Period of Exposure	10 kg	40 kg	70 kg
Frequency of Exposure (fish meals)	1 per day 1 per week 1 per month	1 per day 1 per week 1 per month	1 per day 1 per week 1 per month
Amount Ingested	115 grams/ fish meal	227 grams/ fish meal	227 grams/ fish meal
Gastrointestinal Toxicokinetic Factor	1.0	1.0	1.0
Species Consumed	Lobster Winter Flounder Clam	Lobster Winter Flounder Clam	Lobster Winter Flounder Clam
Contaminant Concentrations		See Tables 2-9 and 2-10	See Tables 2-9 and 2-10

Daily exposure durations of 8 and 24 hours per day were assumed for the probable and conservative exposure scenarios, respectively. The pulmonary TKF was assumed to be 1.0.

Table 2-14 presents the parameters used to assess inhalation exposure to PCBs; the body dose calculations are in Appendix C.

2.5.4 Other Exposure Considerations

Other exposure pathways that may be important but which could not be quantitatively evaluated in this risk assessment include neonatal and occupational exposure to PCBs and metals.

PCBs were used in several manufacturing processes in the Greater New Bedford Area over an extended period. Because PCBs are no longer manufactured or used in the U.S., occupational exposures to PCBs in this area are expected to be limited to exposure during the repair of PCB-containing transformers and capacitors, or accidents involving electrical equipment containing PCBs. In an occupational setting, PCB exposure may occur through absorption by the skin or respiratory or alimentary tracts. Because PCBs are highly lipophilic and relatively stable, they tend to rapidly bioaccumulate and distribute into the adipose tissue of humans. These compounds are slowly eliminated from the body and tend to bioaccumulate over time. Therefore, historical and/or current limited occupational exposure to PCBs may result in an increased body burden of these compounds above the general population. Although it is not possible to quantitatively determine the extent of previous exposure from these sources, environmental exposures to PCBs discussed in this section represent an additional contribution of PCBs to existing body dose levels of occupationally exposed individuals.

In-utero and neonatal exposure to PCBs are significant. Neonates, fetuses, and embryos are unable to effectively detoxify and eliminate PCBs from the body (EPA, 1986b). Laboratory studies have demonstrated that PCBs can cross the placental barrier and accumulate in the fetus (ATSDR, 1987). In addition, PCBs are known to be excreted in the breast milk of lactating (i.e., nursing) women. Therefore, frequent and/or high exposure to PCBs may occur through lactation, in which the highly lipophilic PCBs are readily transferred from maternal milk to the neonate. A qualitative discussion of the potential health effects of neonatal and occupational exposures is presented in Appendix D.

2.6 THE GREATER NEW BEDFORD HEALTH EFFECTS STUDY

In the fall of 1987, MDPH released the findings of the GNBHES, a three-year study designed to (1) determine the prevalence of elevated serum PCB levels in a random sample of Greater New

TABLE 2-14

EXPOSURE PARAMETERS USED TO ASSESS INHALATION OF AIRBORNE CONTAMINANTS
NEW BEDFORD, MASSACHUSETTS

Exposure Parameter	Child	Older Child	Adult
Average Weight over Period of Exposure	10 kg	40 kg	70 kg
Duration of Exposure			
Probable	8 hrs/day	8 hrs/day	8 hrs/day
Conservative	24 hrs/day	24 hrs/day	24 hrs/day
Frequency of Exposure	Daily	Daily	Daily
Inhalation Rate	5 m^3/day	20 m^3/day	20 m^3/day
Pulmonary Toxicokinetic Factor	1.0	1.0	1.0
Contaminant Concentration			
Background (NUS, 1985)	10 ng/m^3	10 ng/m^3	10 ng/m^3
Most Probable (NUS, 1985)	84 ng/m^3	84 ng/m^3	84 ng/m^3
Realistic Worst (NUS, 1985)	471 ng/m^3	471 ng/m^3	471 ng/m^3

Bedford Area residents, and (2) test the relationship between serum PCB levels and various health effects. The GNBHES was a collaborative effort of the MDPH, the Massachusetts Health Research Institute (MHRI), and the U.S. Center for Disease Control (CDC).

The GNBHES was conducted in two phases. The purpose of Phase I was to determine the prevalence of elevated serum PCB levels in the Greater New Bedford Area population and whether there was a relationship between serum PCB levels and blood pressure measurements. Phase I required a random selection of 1,784 New Bedford, Acushnet, Dartmouth, and Fairhaven residents between 18 and 64 years of age.

In Phase II, if 150 individuals could be found whose serum PCB level exceeded 30 parts per billion (ppb), the level identified as the 99th percentile of the general U.S. population, the health of those individuals would be compared with a control group.

Of the 1,482 residents considered eligible for inclusion in the study, 840 individuals chose to participate (the "Prevalence Study"). The serum PCB levels for this group were measured. Eleven of the 840 (i.e., 1.3 percent) were identified with PCB levels (greater than or equal to 30 ppb). Blood pressure did not appear correlated with serum PCB levels.

Subsequently, additional participants were recruited. These individuals were not randomly selected and were considered at high risk from exposure to PCBs as a result of ingestion of moderate to high amounts of seafood from contaminated areas (the "Enrichment Group"). Seven of the 110 participants (6.4 percent) in the Enrichment Group had serum PCB levels greater than or equal to 30 ppb (MDPH, 1987). Because the number of individuals with greater than 30 ppb was too small for statistical analysis, Phase II was not conducted.

The geometric mean of PCB serum levels in non-exposed, non-fisheating populations in the U.S. has been found to range between 4.2 and 6.4 ppb. The Prevalence Study subjects had a geometric mean of 5.8 ppb, while the mean of the Enrichment Group was almost three times as high (i.e., 13.34 ppb).

The GNBHES provided retrospective exposure and demographic information for the Greater New Bedford Area, some of which was incorporated into this exposure assessment. Because the GNBHES focused on seafood consumption and occupational exposure, information for either inhalation or direct contact exposure to PCBs was not presented. In addition, the GNBHES provided exposure and demographic information only for persons between 18 and 64 years of age.

The GNBHES provided an assessment of the exposure of the general population several years after issuance of the fishing ban. This assessment focuses on estimating the potential exposures received by hypothetical individuals from all exposure pathways, assuming different levels of consumption and direct contact.

The exposure scenarios developed in this report are not intended to predict the actual number of individuals exposed to PCBs. These scenarios are intended to reflect the possible exposures received by hypothetical individuals in order to assess risks posed by the site. The scenarios are reasonable possibilities and are consistent with information collected in the GNBHES and in studies performed by NOAA of commercial and recreational fishing and recreational beach use.

Results of this risk assessment are being used to determine the need for and evaluation of remedial actions rather than to determine or predict actual health effects. Although the risk assessment and the GNBHES serve separate purposes, they can be viewed jointly to gain a better understanding of actual and potential effects of PCB exposure in this area. Recommendations stated in the GNBHES include the following:

- The current ban on fishing in and around the New Bedford Harbor site should remain in effect until PCB concentrations in aquatic life decline to acceptable standards.

- Residents should refrain from obtaining and consuming recreationally caught seafood from the closure areas.

- Small-scale follow-up studies, including surveillance of high risk individuals, should be designed and conducted by MDPH for health research purposes.

3.0 TOXICITY ASSESSMENT

This section provides appropriate toxicological information necessary to evaluate the potential carcinogenic and noncarcinogenic risks to human health from exposure to PCBs, cadmium, copper, and lead.

A toxicological summary was compiled for each of the four contaminants and are in Appendix D. These evaluations describe the nature and severity of the potential adverse effects associated with exposure to each compound. Information contained in the summaries for each compound includes: physiochemical data, pharmacokinetic and toxicity information, and descriptions of the noncarcinogenic and carcinogenic effects associated with acute, chronic, and lifetime exposures. The information presented in these assessments summarize available research for descriptive purposes. They are not intended to be exclusive reviews of the toxicity of the contaminants of concern. Comprehensive discussions of the most recent research considered by EPA and ATSDR are also presented in EPA (1988a) and ATSDR (1987).

In addition, information on the potency of the four contaminants is presented as part of the dose-response assessment. Included in this assessment are the pertinent standards, criteria, advisories, and guidelines developed for protecting public health. How these values were derived and applied to the risk evaluation of the contaminants for the New Bedford Harbor site is described in the following subsection.

Because some of the standards and guidelines described in this section will be designated as chemical-specific applicable or relevant and appropriate requirements (ARARs) or non-promulgated standards, criteria, and guidance to be considered (TBCs) in the FS, a brief discussion of these values is also presented. These ARARs, and TBCs, however, are not necessarily used to assess the health risks. For example, Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act are ARARs, but because the MCLs are not based strictly on health considerations, they are not relevant to the dose-response evaluation (see Section 3.2.2). It should be noted that the FS includes a section identifying and summarizing all ARARs and TBCs associated with New Bedford Harbor.

3.1 TOXICOLOGICAL SUMMARY

Toxicological summaries compiled for PCBs, cadmium, copper, and lead are in Appendix D. These evaluations emphasize the potential health effects associated with the principal routes of exposure at the New Bedford Harbor site. Therefore, the toxicological evaluations for PCBs, cadmium, copper, and lead focus on (when possible) the oral, dermal, and inhalation routes of exposure. Each evaluation includes background information, an overview of the health effects observed in animals and humans, and a discussion of the toxicokinetics and interactive effects of each contaminant.

3.2 DOSE-RESPONSE EVALUATION

This subsection contains the quantitative indices of toxicity that were used to estimate risks associated with PCBs, cadmium, copper, and lead exposure at the New Bedford Harbor site. These contaminants were identified as the contaminants of concern. Various regulatory agencies have developed standards, guidelines, and criteria to protect public health from the adverse effects of chemical exposure. The NCP identifies these health-based standards/guidelines/criteria and categorizes them, along with other technology-based values, as either "potential ARARs" or "TBCs." Those health-based values relevant to the assessment of potential risk at the New Bedford Harbor site were identified for the four chemicals of concern (Table 3-1).

To compare the estimated body doses developed in Subsection 2.5 to an applicable standard or guideline, it was often necessary to convert the criterion to the same units as the body dose units (i.e., mg/kg-day). To adjust mg/l into mg/kg-day for an adult, the following conversion was used:

$$\frac{mg}{l} \times \frac{2l}{day} \times \frac{1}{70\ kg} = \text{Equivalent Daily Dose (mg/kg-day)}$$

(Two liters of water ingested per day and an average adult body weight of 70 kg are the standard exposure assumptions used by EPA.)

This conversion was used specifically for Health Advisory (HA) criteria and the Maximum Contaminant Level Goals (MCLGs) (see Subsection 3.2.2).

3.2.1 Carcinogens

If toxicological evidence suggests that a chemical may be a potential carcinogen, mathematical models are used to calculate the estimated excess cancer risk associated with exposure to the chemical. Unit cancer risks or carcinogenic potency factors were developed by the EPA Carcinogen Assessment Group (CAG) for approximately 58 chemicals. CAG calculated the unit risks using a linearized multistage model for low-dose extrapolation.

This model leads to a plausible upper limit (upper 95-percent confidence limit) of carcinogenic risk. The risk value obtained

TABLE 3-1. DOSE RESPONSE TABLE FOR THE CONTAMINANTS OF CONCERN AT NEW BEDFORD HARBOR NEW BEDFORD, MASSACHUSETTS.

COMPOUND	CARCINOGENIC GROUP	RfD (a) (mg/kg/day) (oral)	CANCER POTENCY FACTOR (b) (mg/kg/day)-1	MCL (c) (mg/l)	MCLG (d) (mg/l)	HEALTH ADVISORY (e) (mg/l) 1-DAY (10 kg) (child)	10-DAY (10 kg) (child)	LONGER TERM (10 kg) (child)	LONGER TERM (70 kg) (adult)	LIFETIME (70 kg) (adult)
PCBs	B2	NA	7.7 (oral)	0.0005 proposed	0	NA	NA	0.001	0.0035	NA
COPPER	D	NA	NA	1.3 proposed	1.3 proposed	NA	NA	NA	NA	NA
LEAD	C	NA	NA	0.005 proposed	0 proposed	NA (under review)	NA (under review)	NA (under review)	NA (under review)	NA (under review)
CADMIUM	B1	0.0005	6.1 (inhalation)	0.01 final	0.005 proposed	0.04	0.04	0.005	0.02	0.0003

TABLE 3-1 (con't). DOSE RESONSE TABLE FOR THE CONTAMINANTS OF CONCERN AT NEW BEDFORD HARBOR.

COMPOUND	10-DAY HEALTH ADVISORY (mg/kg) (f)	HEAs (g)		FDA ACTION LIMIT (edible portion fish and shellfish) (h)	AWQC (mg/l) (i)			OSHA STANDARD (mg/m3) (j)	NIOSH RECOMMENDED LEVEL (k) (ug/m3)
		AIS mg/kg-day (oral)	AIC mg/kg-day (oral)		Water + Fish Ingestion	Fish Ingestion Only	Drinking Water Ingestion Only		
PCBs	0.01	NA	NA	2	7.9E-8	NA	> 12.6E-6	1.0 (TWA) (1242) 0.5 (TWA) (1254)	1.0 (TWA)
COPPER	NA	0.037	0.037	NA	1 (based on taste)	NA	1 (based on taste)	1 (TWA)	NA
LEAD	NA	NA	0.0014	NA	0.05	NA	NA	0.05 (TWA)	<100 (TWA)
CADMIUM	NA	NA	0.013	NA	NA	NA	NA	0.2 (TWA) 0.6 (C)	Lowest Feasible Limit

TABLE 3-1 (con't). DOSE RESPONSE TABLE FOR THE CONTAMINANTS OF CONCERN AT NEW BEDFORD HARBOR.

COMPOUND	ACGIH TLV (l) (mg/m3)	MASS. AAL (m) (ug/m3)	NAAQS (n) (ug/m3)	MASS. MCL (p) (mg/l)
PCBs	1 (TWA) (1242) 0.5 (TWA) (1254)	0.003 (under review)	NA	NA
COPPER	1 (Dust and Mist)	NA	NA	NA
LEAD	0.15	0.68 (under review)	1.5 (o) (90-day)	0.05
CADMIUM	0.05 (Dust and Salts)	0.0003 (under review)	NA	0.01

TABLE 3-1 (con't). DOSE RESPONSE TABLE FOR CONTAMINANTS OF CONCERN AT NEW BEDFORD HARBOR.

FOOTNOTES

NA = Not Available

(a) RfD = Reference dose, an estimate (with an uncertainty of one order of magnitude or more) of a lifetime dose which is likely to be without significant risk to human populations.

(b) Cancer Potency Factor = A value, established by the USEPA Carcinogen Assessment Group, which is used to calculate the incremental cancer risk that a carcinogen could potentially pose. PCB value obtained from the USEPA DWQC Document, 1988a.

(c) MCL = Maximum Contaminant Level, drinking water regulations that are promulgated under the Safe Drinking Water Act. Proposed MCLs for copper and lead were listed in the Federal Register 8/18/88. The MCL for PCBs is listed in the Federal Register 5/22/89 p.22062.

(d) MCLG = Maximum Contaminant Level Goal, non-enforceable health goals that are instituted under the Safe Drinking Water Act.

(e) Health Advisory = Drinking water guidance issued by the USEPA Office of Drinking Water (USEPA, 1987). PCB values from USEPA DWQC Document, 1988a. Values for lead are currently under review and should not be used per USEPA. Lifetime cadmium value from ODW Health Advisory, 1987.

(f) PCB value developed by USEPA Exposure Assessment Group. (USEPA, 1986).

(g) HEAs = Health Effects Assessments; expressed as AIC (acceptable intakes chronic) and AIS (acceptable intake subchronic); Prepared by USEPA Environmental Criteria and Assessment Office. These values are listed in the Superfund Public Health Manual (USEPA, 1986)

(h) The edible portion of fish excludes the head, scales, viscera and inedible bones

(i) AWQC = Ambient Water Quality Criteria, guidance for the protection of human health set by the USEPA Office of Water, Standard and Criteria Division. Values based on carcinogenesis are listed for 10-6 risk. PCB values from the AWQC Document, 1980; Lead and cadmium values from IRIS.

(j) OSHA Standard = Workplace air regulations promulgated under the Occupational Safety and Health Act. Standards listed are either TWA (Time Weighted Averages) or C (Ceiling values). Values from NIOSH Pocket Guide to Chemical Hazards, 1985.

(k) NIOSH is the National Instituste for Ocupational Safety and Health. The Recommended Level is a Time Weighted Average(TWA) for 10 hrs/day; 40 hrs/wk expsoure. Values from NIOSH Pocket Guide to Chemical Hazards, 1985.

(l) ACGIH = American Conference of Government Industrial Hygienists. Values listed are Time Weighted Averages (TWA).

(m) MASS AAL = Massachusetts Acceptable Ambient Level for contaminants in air. Corresponds to a 10-5 risk level

(n) NAAQS = National Ambient Air Quality Standard, air regulations promulgated under the Clean Air Act.

(o) 3-month arithmetic mean

(p) Mass MCL = Massachusetts Maximum Contaminant Level for contaminants in water. Values from Mass. DEQE.

represents increased carcinogenic risk over a person's lifetime from exposure to a particular chemical. The cancer potency factors are expressed in units of $(mg/kg\text{-}day)^{-1}$.

EPA developed a classification system for the overall weight of evidence for carcinogenicity of chemicals based on human and animal studies, as well as other supporting data. The classification system is divided into five categories: Group A, Carcinogenic in Humans; Group B, Probably Carcinogenic to Humans (B1 and B2 for higher and lower degrees of evidence, respectively); Group C, Possibly Carcinogenic to Humans; Group D, Not Classifiable as to Human Carcinogenicity; and Group E, No Evidence of Carcinogenicity for Humans.

For the contaminants of concern at the New Bedford Harbor site, EPA classified PCBs and cadmium as Group B2 and B1 carcinogens, respectively; lead as a Group C carcinogen; and copper as a Group D carcinogen. However, for lead, the test doses that induce cancer in animals were greater than the lethal dose for humans. Therefore, exposure to lead is not assessed for carcinogenic effects. In addition, there are not sufficient data to consider cadmium to be carcinogenic to humans by the oral route. Therefore, the potential carcinogenic risks for cadmium are assessed only for inhalation exposure. Potency factors were derived by CAG for PCBs and cadmium (see Table 3-1).

The potency factor for PCBs was recently revised from 4.34 $(mg/kg\text{-}day)^{-1}$ to 7.7 $(mg/kg\text{-}day)^{-1}$ (EPA, 1988a). In the past, EPA based risk estimates on a study in which chronic exposure to Aroclor 1260 was shown to cause hepatocellular carcinomas in female Sherman rats (Kimbrough et al., 1975). The revised potency factor (7.7 $(mg/kg\text{-}day)^{-1}$) is based on a study in which chronic dietary administration of Aroclor 1260 was shown to cause hepatocellular carcinomas in male and female Sprague-Dawley rats (Norback and Weltman, 1985). This recent study is preferred because the Sprague-Dawley rat has a low incidence of spontaneous hepatocellular neoplasms and because the study spanned the natural life of the animal. Although the potency estimate is computed based on exposure to Aroclor 1260, it is intended to represent other PCB mixtures as well (EPA, 1988a).

A more recent review of the congener-specific toxicity of PCBs was performed by EPA as part of a risk assessment for Quincy Bay, Massachusetts (EPA, 1988b). In this report, a cancer potency factor specific to Aroclor 1254 was used to evaluate the potential risk from fish consumption. This value was derived based on the 1978 National Cancer Institute (NCI) study of Aroclor 1254 and estimated to be 2.6 $(mg/kg\text{-}day)^{-1}$ (EPA, 1988). The application of this cancer potency factor toward assessing risk at this site was warranted based on the congener mix detected in Quincy Bay seafood. Analyses of these data showed the congener make-up to more closely resemble Aroclor 1254 than Aroclor 1260.

EPA conducted new congener-specific PCB analyses on lobster and flounder collected from New Bedford Harbor to determine the most appropriate cancer potency factor to apply to this risk assessment (EPA, 1988c). These data were statistically analyzed and the conclusions were summarized as follows: "The PCB mixture of the seafood from New Bedford Harbor cannot be classified as any commercial mixture, although the pattern of PCBs in the seafood appears to lie roughly between Aroclors 1254 and 1260. That the non-ortho-substituted congeners are not depleted but are actually enriched in New Bedford Harbor seafood lends some support for taking a conservative approach to assessing risks from seafood ingestion" (see Appendix E). Based on this review, the revised cancer potency factor of 7.7 $(mg/kg\text{-}day)^{-1}$ was used to evaluate risks from PCB exposure.

3.2.2 Noncarcinogenic

Evaluation of the potential noncarcinogenic effects of a compound is performed by comparing the exposure dose to the most applicable health-based standard or criteria. Because multiple criteria were developed for many compounds, the following list describes the hierarchy followed in this risk assessment. Noncarcinogenic risk for each contaminant was estimated by making the appropriate comparison of the body dose level to the first standard or criteria on this list available for the route-specific exposure. Separate lists exist for the oral/dermal and inhalation routes of exposures. When possible, chronic exposures were evaluated against criteria based on chronic exposure (e.g., derived from a chronic toxicity test) and likewise for acute and lifetime exposures.

The risk evaluation process often requires comparisons between exposure doses received via direct contact with or ingestion of contaminants and criteria developed for drinking water exposure (i.e., MCLs or HAs). This is appropriate and standard procedure for conducting risk assessments (SPHEM, 1986), since these criteria values were developed to provide a level of protection against contaminant exposure. As discussed in Section 2, the use of the TKF corrects for differences between contaminant uptake from the various routes of exposure (see Appendix B). Often it is necessary to convert the criteria values expressed in mg/l to units of mg/kg-day. This is accomplished by incorporating the standard exposure assumptions for drinking water ingestion (see Section 3.2).

It is also possible to estimate the noncarcinogenic effects associated with carcinogenic compounds, because some compounds elicit both carcinogenic and noncarcinogenic effects. However, the noncarcinogenic risk estimates do not account for the potential carcinogenic effects.

To assess the potential toxicity from exposure to Noncarcinogenic from the oral and/or dermal route of exposure, the following standards or criteria were used. Preference was given to the first standard or guideline presented.

EPA Reference Dose. Route-specific Reference Doses (RfDs) are the preferred criteria to evaluate noncarcinogenic effects. These values are based on the assumption that threshold levels exist for the toxic effects elicited by each compound. The RfD is considered to be the level unlikely to cause adverse health effects in humans exposed for a lifetime. These values are expressed in mg/kg body weight/day for a 70-kg person. The degree of uncertainty associated with these values may span one or more orders of magnitude or more.

RfDs are calculated by dividing a NOAEL (no observed adverse effect level) or LOAEL (lowest observed adverse effect level) by an uncertainty factor. The toxic endpoint chosen for calculating RfDs is the most sensitive effect seen in a test animal. RfDs for carcinogenic compounds can also be derived. These values are designed to protect against the noncarcinogenic effects of carcinogens, but should not be considered to provide protection from their carcinogenic effects. RfDs are developed by the EPA Environmental Criteria and Assessment Office (ECAO) in Cincinnati, Ohio. These values are available through the Integrated Risk Information System (IRIS).

An RfD exists only for cadmium; this value was used to evaluate chronic exposure to this contaminant. No RfDs exist for the other contaminants of concern at New Bedford Harbor. Therefore, the health-based criteria and standards that follow were used to assess the potential noncarcinogenic health risks from exposure to these contaminants at this site.

EPA Health Advisories. The EPA Office of Drinking Water (ODW) developed Health Advisories (HAs) for contaminants in drinking water. These HAs are set at levels that are not expected to cause adverse health effects and are expressed in units of mg/l. HA values are developed from data describing noncarcinogenic endpoints of toxicity; therefore, they are not considered protective of the potential carcinogenic effects of carcinogenic compounds.

HA values are derived for 1-day, 10-day, longer-term, and lifetime exposures when applicable information is available.

HAs are based on a 10-kg child drinking 1 liter of water per day, or a 70-kg adult drinking 2 liters per day. Lifetime HA values are developed for adults only.

Because HAs are developed for various exposure durations (1-day, longer-term, and lifetime), these criteria were used (when available) to assess potential risks associated with a specific exposure duration. HAs, developed by the ODW, exist for PCBs and cadmium (see Table 3-1). The HAs developed for lead are currently under review by the ODW and are therefore not listed in Table 3-1. In addition to the HAs developed by the ODW, the EPA Exposure Assessment Group (EAG) developed a 10-day HA for PCBs. This value was used to assess acute exposures to PCBs because it is considered protective against the noncarcinogenic effects of PCBs for an exposure period of 10 days or less. The 10-day HA values were used in this risk assessment to assess acute exposures, and the longer-term HAs were used to assess chronic exposure to PCBs and cadmium. (The longer-term HA and RfD for cadmium are the same value.) These values, expressed as mg/l, were converted to the same units as the exposure dose (mg/kg-day) using the standard exposure assumptions discussed in Section 3.2.

EPA Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Level (MCLs). Pursuant to Section 1412 of the Safe Drinking Water Act, EPA promulgated drinking water standards for certain organic and inorganic substances. These standards establish Maximum Concentration Limits (MCLs) that specify the maximum permissible level of a contaminant in water used as a public water supply. MCLs are enforceable standards and are based in part on economic considerations such as the availability and cost of treatment techniques. Generally, an MCL for a compound represents the maximum allowable lifetime exposure to the compound, assuming a 70 kg adult ingests 2 liters of water per day.

In the process of developing MCLs, EPA also develops MCLGs. MCLGs are nonenforceable health-based goals and are therefore always equal to or less than the MCLs. MCLGs are based on toxicological information and are set at a level at which no adverse health effects are anticipated. For contaminants where no safe threshold is known to exist (i.e., carcinogens), the MCLG is set at zero.

MCLs and/or MCLGs exist for all the contaminants of concern at the New Bedford Harbor site (see Table 3-1). Only the MCL for cadmium is a final value. The MCLs for PCBs, lead, and copper are proposed values (5/22/89 for PCBs and 8/18/88 for lead and copper). MCLGs for copper, lead, and cadmium have also been established. These values are set at levels at which no known or anticipated effects are expected; therefore, the MCLGs can be used to evaluate potential risk. The proposed MCLG for lead was lowered on August 18, 1988 from 0.005 mg/l to zero. However, because the earlier MCLG value (0.005 mg/l and now the proposed MCL for lead) was the only criteria available to assess noncarcinogenic risks from exposure to lead, it was used in this risk assessment. As such, the noncarcinogenic risks for lead may underestimate the potential risks. The MCLG for PCBs is set at zero because it has been classified by the EPA as a Group B2 carcinogen (54 FR 22064). Since no RfDs or HAs exist for lead and copper, the MCLGs were used to assess the noncarcinogenic risks associated with exposure to these contaminants. These MCLGs, expressed as mg/l, were converted to the same units as the exposure dose (mg/kg-day) using the standard exposure assumptions discussed in Section 3.2.

Health Effects Assessment. Health Effects Assessments, prepared by EPA's ECAO, provide route-specific acceptable exposure levels for contaminants. Two categories are estimated for each systemic toxicant (i.e., toxicants for which cancer is not the endpoint of concern) when sufficient data exist. The Acceptable Intake Subchronic (AIS) is an estimate of an exposure level at which no adverse effects are expected when exposure occurs during a limited time period (subchronic exposure). Animal data used to estimate AIS levels generally include studies with exposure durations of 30 to 90 days. The Acceptable Intake Chronic (AIC), the second category, is an estimate of an exposure level at which no adverse effects are expected when exposure occurs for a significant portion of the lifespan (chronic exposure). Neither AISs nor AICs are derived for compounds for which there is sufficient evidence of carcinogenicity.

For the contaminants at the New Bedford Harbor site, AISs and/or AICs exist for cadmium, copper, and lead. No AIC or AIS exists for PCBs. The AIC for copper (0.037 mg/kg-day) is the same value as the converted MCLG for copper and was used to assess chronic exposure. No other AIC or AIS values were used in this risk assessment.

[redacted] Federal Ambient Water Quality Criteria (AWQC), developed under Section 304(a)(1) of the Clean Water Act, are health-based estimates of the ambient surface water concentration that will not result in adverse health effects.

For most compounds, AWQC are available for two different exposure pathways. One criterion is based on lifetime ingestion of both drinking water and aquatic organisms; the other is based on lifetime ingestion of aquatic organisms alone. These criteria assume a 70-kg adult consumes 2 liters of water and/or 6.5 grams of aquatic organisms daily for 70 years.

For carcinogens, the AWQC are water concentrations, corresponding to incremental carcinogenic risks of 10^{-7}, 10^{-6}, and 10^{-5}. AWQC exist for PCBs, cadmium, and lead (See Table 3-1). An AWQC exists for copper but is based on the organoleptic threshold and is therefore not considered a health-based criterion.

MCL not AWQC

Food and Drug Administration Tolerance Level. The FDA is authorized to establish tolerance levels for unavoidable food contaminants which are set to protect public health, as well as to consider other factors such as economic and technical feasibility. The current tolerance for residues of PCBs in fish and shellfish (edible portion) is 2 ppm. The edible portion of fish excludes head, scales, viscera, and inedible bones. FDA tolerance levels do not exist for cadmium, copper, or lead.

Because the FDA tolerance levels are intended to be national standards, they are developed based on the assumptions that not all of an exposed person's diet is from the contaminated food source, and not all of the contaminated food source contains concentrations at the tolerance level. The FDA tolerance levels do not allow the conclusion that lower levels pose no risk, particularly in the New Bedford context, because New Bedford residents that consume seafood caught within the fish and shellfish closure areas may receive a large portion of their total diet from a contaminated source.

Massachusetts Maximum Contaminant Level. The Massachusetts Department of Environmental Quality Engineering (DEQE) Office of Research and Standards adopted the MCLS promulgated by EPA (310 CMR 22.00). As previously described, EPA MCLs are enforceable standards, based in part on economic considerations, which specify the maximum permissible level of a contaminant in water used as a public water supply. Massachusetts MCLS (MMCLs) exist for lead and cadmium (see Table 3-1).

Inhalation Exposure. To assess risk from inhalation exposure, the following criteria and standards may be used.

EPA National Ambient Air Quality Standards. Primary National Ambient Air Quality Standards (NAAQS) were developed by EPA based on air quality criteria for individual pollutants. Primary NAAQS are designed to protect public health, while secondary NAAQS are designed to protect the public welfare (e.g., visibility, property, wildlife, and vegetation). The Clean Air Act, under which NAAQS are promulgated, does not require EPA to consider the costs (economics) of achieving or the technological feasibility of implementing the standards. Standards can be promulgated as annual maximums, annual geometric means, annual arithmetic means, or for other periods that vary from 1 hour to one year.

Primary NAAQS must allow for an adequate margin of safety to account for unidentified hazards and effects. The law requires EPA to set its ambient air standards to protect particularly sensitive populations (e.g., asthmatics). In developing primary NAAQS, EPA must specify the nature and severity of the health effects of each contaminant, characterize the sensitive population involved, determine probable adverse health effect levels in sensitive persons, and estimate the level that provides an adequate margin of safety to protect public health.

For the four contaminants of concern, NAAQS exist only for lead (see Table 3-1).

Massachusetts Acceptable Ambient Level. The DEQE Air Toxics Program established draft Acceptable Ambient Levels (AALs) for certain compounds. AALs are ambient air limits for specific chemicals based on the health effects data. AALs are considered protective against the most sensitive effect elicited by a chemical. For carcinogens, the AAL is set to correspond to an excess lifetime carcinogenic risk of 10^{-5}. AALs were developed for PCBs, lead, and cadmium (see Table 3-1).

Occupational Safety and Health Administration Standard. The Occupational Safety and Health Administration (OSHA) develops standards for workplace exposures to hazardous substances (CFR 29 Section 1910, 1000 Subpart Z). OSHA standards are expressed as 8-hour time-weighted averages (TWA) and are legally enforceable for occupational exposures. Table 3-1 lists OSHA standards for the four contaminants of concern.

National Institute of Occupational Safety and Health Recommended Standard. The National Institute of Occupational Safety and Health (NIOSH) develops recommended standards for workplace exposure to hazardous chemicals, which are then recommended to OSHA. NIOSH recommends standards based on exposures up to 10 hours/day for a 40-hour week. NIOSH-recommended standards exist for PCBs, lead, and chromium (see Table 3-1).

Threshold Limit Values. Threshold limit values (TLVs) are developed by the American Conference of Governmental Industrial Hygienists (ACGIH) and are used in evaluating occupational exposure to a chemical. A TLV is a TWA concentration for a contaminant considered to be without adverse effects, assuming an 8-hour workday and a 40-hour workweek. TLVs refer to airborne concentrations of chemicals, and are typically expressed in units of ppm or mg/m^3. As shown in Table 3-1, TLVs exist for all the contaminants of concern.

3.3 ARARs

Chemical-specific ARARs and TBCs were also identified for the contaminants of concern. ARARs and TBCs can be used to determine the extent of site cleanup by providing either actual clean-up levels or the basis for calculating medium-specific target concentrations, which can then be used to assess the effectiveness of remedial alternatives. In addition, ARARs can be used to assess the attainment or non-attainment of institutional requirements.

Although the FS will include a section detailing all ARARs pertinent to the New Bedford Harbor remediation efforts, a brief description of ARARs is included herein because chemical-specific ARARs and TBCs are identified for the contaminants of concern. As required by the National Contingency Plan (NCP) and CERCLA as amended by SARA, ARARs are required to be identified and evaluated throughout the CERCLA RI/FS process. ARARs are promulgated and enforceable federal and state requirements that evaluate the appropriate extent of site cleanup, scope and formulate remedial action alternatives, and govern the implementation and operation of a selected action.

Applicable requirements specifically address a hazardous substance, location, or remedial action. Relevant and appropriate requirements address circumstances sufficiently similar to those at a CERCLA site, thus making the requirement relevant. If it is deemed appropriate to use the requirement given the circumstances, the requirement is considered an ARAR. Applicable requirements and relevant and appropriate requirements are given the same weight.

ARARs are identified and considered so that CERCLA responses are consistent with the state and federal environmental laws. ARARs are divided into three categories: chemical-specific (e.g., SDWA, MCLs), location-specific (e.g., wetlands regulations, Endangered Species Act), and action-specific (e.g., hazardous waste rules governing incineration). Federal and state nonregulatory guidance, standards, and criteria such as AWQC, MCLGs, and RfDs are not considered ARARs; however, they may be considered during a CERCLA response when ARARs do not exist. These nonpromulgated standards, guidelines, and criteria are categorized as TBCs.

3.4 SUMMARY

Selected criteria presented previously were used to develop quantitative indices of the potential risks associated with exposure at the New Bedford Harbor site. The revised cancer potency factor of 7.7 $(mg/kg\text{-}day^{-1})$ was used to provide estimates of the incremental carcinogenic risks associated with exposure to PCBs, which was the only contaminant evaluated for carcinogenic risks. (As discussed in Section 2.5.3, it was not necessary to evaluate the carcinogenic risks associated with the inhalation of cadmium.) Because an RfD exists only for cadmium, other criteria were used to evaluate the noncarcinogenic risks associated with exposure to PCBs, copper, and lead. The converted 10-day and longer-term HAs or the MCLG values were used when appropriate.

4.0 PUBLIC HEALTH RISK CHARACTERIZATION

This section characterizes potential risks associated with exposure to contaminants at the New Bedford Harbor site. The estimated body dose levels of PCBs and selected metals, calculated in Section 2.5, are evaluated in this section using the appropriate health-based standards and criteria identified and discussed in Section 3.1.

Estimates of carcinogenic and noncarcinogenic risks associated with acute, subchronic, chronic, and lifetime exposure durations to PCBs and metals are included in this section, as are individual risk estimates for each contaminant and the overall risks resulting from each route of exposure. The contaminants, exposure routes, and specific locations within the New Bedford Harbor area that present a significant risk are identified and summarized. These results are used in the FS to establish response objectives, indicate impacts associated with the no-action alternative, and evaluate the effectiveness of the proposed remedial alternatives.

4.1 METHODOLOGY

The methodology used to generate the various risk estimates is discussed in the following subsections. Table 4-1 presents the equations used to derive these quantitative risk estimates.

4.1.1 Estimating Noncarcinogenic Risk

Noncarcinogenic effects associated with contaminant exposure include a variety of effects on various tissues and organ systems. These effects are considered to have a threshold value below which toxicant exposure results in no adverse effects. The specific noncarcinogenic effects for PCBs, cadmium, copper, and lead are discussed in Appendix D.

Noncarcinogenic risk estimates for the New Bedford Harbor site were generated by comparing the exposure dose for each contaminant to the most applicable health-based standard or criteria value. The values used in this risk assessment, listed in Table 3-1, represent the best estimate of the maximum contaminant level that will not result in adverse effects. The ratio of the estimated body dose levels to these standard or criteria values is used to evaluate risk. This ratio is referred to in this risk assessment as the risk ratio.

Generally, EPA states that if the risk ratio is less than 1, the predicted body dose level is anticipated to be without lifetime risk to human health. For example, a value of 0.25 implies that a person is receiving an estimated average daily dose equal to 25 percent of the acceptable intake of that contaminant. If the ratio exceeds 1, the estimated average daily dose levels exceed a level considered safe; therefore, the exposure could

TABLE 4-1

EQUATIONS USED TO ESTIMATE RISK
NEW BEDFORD, MASSACHUSETTS

Noncarcinogenic Risk Estimates:

Risk Ratio: $\frac{E}{RL}$

where E = Exposure Level generally in (mg/kg-day).
RL = Reference Level expressed in same units as E.

Carcinogenic Risk Estimates:

Incremental Carcinogenic Risk = CDI x CPF

where CDI = Chronic Daily Intake (mg/kg-day)
CPF = Carcinogenic Potency Factor $(mg/kg\text{-}day)^{-1}$

Multitoxic Risk Estimates:

Noncarcinogenic: $HI = E_1/RL_1 + E_2/RL_2 + E_3/RL_3 \ldots E_i/RL_i$

where E_i = Exposure Level for i^{th} toxicant
RL_i = Reference Level for i^{th} toxicant
HI_i = Hazard Index

Carcinogenic: $\Sigma\ (CDI_i \times CPF_i)$

where CDI_i = Chronic Daily Intake for i^{th} toxicant
CPF_i = Carcinogenic Potency Factor for i^{th} toxicant

3.88.80
0054.0.0

potentially result in adverse health effects. The noncarcinogenic risk estimates developed in this subsection are evaluated against a risk ratio of 1.

The risk ratio best reflects the potential noncarcinogenic risk when comparisons are made to standards or criteria that are based on the same exposure assumptions as the exposure dose. For example, acute exposure doses should be compared to 1- or 10-day health-based criteria and chronic exposure doses to longer-term criteria. However, for many contaminants in this risk assessment, the only criteria available to evaluate noncarcinogenic risks were those based on lifetime exposure. RfDs and MCLGs are criteria that define an acceptable daily exposure of a contaminant, assuming a 70-year exposure duration. Therefore, comparing an average daily dose derived for a chronic (10-year) or acute exposure to the RfD or MCLG may overestimate the actual risk. In such instances, the significance of the risk ratio value requires further evaluation. For this report, the toxicity endpoints and the magnitude of the uncertainty associated with the criteria development were considered in evaluating these potential risks.

4.1.2 Estimating Carcinogenic Risk

Carcinogenic risk estimates for known or probable human carcinogens were calculated by multiplying the potency factor of the chemical (expressed as $(mg/kg\text{-}day)^{-1}$) by the estimated body dose (expressed as (mg/kg-day)). The product of these two values is an estimate of the incremental lifetime cancer risk, which is defined as the excess probability that an individual will develop cancer over a lifetime.

In this risk evaluation, PCBs are the only contaminants assessed for carcinogenic risks. Of the other contaminants, copper and lead are not classified as known or probable human carcinogens, and cadmium is considered carcinogenic only by the inhalation route of exposure. Because cadmium was not detected in any air samples, a risk evaluation for this route of exposure was not necessary.

The incremental carcinogenic risk estimates appear in scientific notation in this report. For example, a $2x10^{-6}$ incremental risk level implies that an individual's probability of manifesting cancer from the exposure assessed is two in one million.

The method used to estimate carcinogenic risks is based on EPA's linearized, multistage model of carcinogenic dose-response. This model assumes that no threshold value exists below which exposure to a carcinogen can be considered safe or risk-free. Therefore, any positive dose is assumed to result in a finite increment to an individual's lifetime risk of developing cancer.

EPA guidance states that the target total carcinogenic risk for an individual resulting from exposure at a Superfund site may range from 10^{-4} to 10^{-7} (EPA, 1986a and 1988). Response objectives and remedial alternatives should be developed to reduce total carcinogenic risks to levels within or below this range. The carcinogenic risk estimates developed in this subsection are evaluated using this target range.

4.1.3 Estimating Multitoxic Risk

Because most instances of environmental contamination involve concurrent exposure to a variety of compounds, it is necessary to assess the potential adverse effects that exposure to contaminant mixtures may have on public health. EPA proposed guidelines for assessing the effects of exposure to chemical mixtures (51FR:34014, 1986). These guidelines, based on the assumption of dose additivity, recommend estimating a Hazard Index (HI) for a mixture by summing the individual risk ratios for each chemical in the mixture. This approach assumes that multiple subthreshold exposures may result in adverse effects even if no single chemical exceeds its reference level. As with single contaminant exposure, concern over the potential risk increases as the HI approaches unity.

Because of the assumption of dose additivity, the use of the HI is appropriate only if chemicals in the mixture are expected to exert similar toxic effects by the same mechanism. Therefore, the chemicals of concern in this risk assessment were grouped and assessed together based on their critical effect. HI values for multitoxic exposure were calculated for PCB and metal exposure, because these compounds have been shown to exert similar toxic effects (i.e., renal, hepatic, and reproductive) in test animals and humans.

For carcinogens, the multitoxic value is derived by summing the incremental carcinogenic risks associated with each compound in the mixture. Because only one carcinogenic compound (i.e., PCBs) was evaluated in this risk assessment, multitoxic carcinogenic risk estimates were not developed.

As mentioned in Section 1.0, PAH compounds have also been detected in sediment from the New Bedford Harbor area. These compounds tend to be co-located with PCBs, but generally are present at lower concentrations (E.C. Jordan/Ebasco, 1986). Total PAH concentrations ranged from below detection limit to 930 ppm. The carcinogenic risks associated with exposure to PAH compounds were not evaluated in this risk assessment. As such, the risk cited for direct contact with and/or incidental ingestion of sediment may be underestimated. However, because the treatment technologies proposed for remediating PCB contamination would adequately reduce PAH concentrations, no residual risks from exposure to these compounds are anticipated

(E.C. Jordan/Ebasco, 1989). PCBs are the carcinogenic contaminants of concern and were the focus of this risk assessment.

4.1.4 Uncertainties in Estimating Risk

It should be emphasized that the risk estimates in this subsection are based on numerous assumptions, each having uncertainty associated with it. Several types of uncertainties should be considered in any risk evaluation:

- uncertainties associated with estimating the frequency, duration, and magnitude of exposure
- uncertainties associated with assigning exposure parameters to a heterogeneous population (e.g., body weight and ventilation rate)
- uncertainties in estimating carcinogenic potency factors and/or noncarcinogenic measures of toxicity (e.g., RfDs and MCLGs)

The uncertainties associated with estimating exposure result from the variance in sampling and analytical techniques, estimating the extent of contamination, and quantifying parameters that are not directly observed (e.g., frequency and duration of exposure). Because some of these parameters are functions of the behavior patterns and personal habits of the exposed populations, no one value can be assumed representative of all possible exposure conditions. To account for some of this variation, exposure scenarios were developed based on a range of exposure frequencies and durations. For some exposure scenarios, the range of exposure parameters spans two orders of magnitude. It was assumed that the actual exposure encountered by any individual receiving exposure will fall within this range.

There is also uncertainty associated with assigning quantitative values to exposure parameters such as body weight, ventilation rate, surface areas, and absorption or TKFs. The parameters used in this exposure assessment were based on actual or extrapolated values from surveys reported in the literature and professional judgment; therefore, they may not be representative of specific individuals in the New Bedford Harbor site area. However, the parameters are considered representative of the populations described in the exposure scenarios. The uncertainties associated with assigning values to these parameters are estimated to be less than one order of magnitude.

The use of toxicity parameters (e.g., RfDs and MCLGs) and cancer potency factors introduces additional uncertainties into the risk assessment process. These parameters are generally based on animal studies, many of which are performed at high doses relative to the site-specific exposures actually experienced at Superfund sites. These data require interpretation and/or extrapolation in the low dose area of the dose-response curve. Uncertainty factors are often incorporated to account for species-to-species and/or route-to-route extrapolations. The uncertainties associated with the use of toxicity parameters may be as high as three orders of magnitude.

To account for some of the uncertainties described in the previous paragraphs, the approach taken in this risk assessment was to estimate risk based on both most probable and upper-bound exposure conditions. This approach provided risk estimates that were considered appropriately conservative and unlikely to underestimate the actual risk.

4.1.5 Evaluating Risk

As stated previously, EPA established criteria for evaluating both noncarcinogenic and carcinogenic risk estimates at Superfund sites. For noncarcinogenic risks, a risk ratio less than 1 represents an exposure dose considered to be without lifetime risk to public health. For carcinogenic risks, EPA uses a target risk range of 10^{-4} to 10^{-7} to evaluate the need for and effectiveness of various remedial actions. The risk estimates developed in the following subsections are evaluated against these criteria.

In addition, the Commonwealth of Massachusetts enacted legislation parallel to CERCLA authorizing state response to releases of oil or hazardous materials and the assignment of liability, and providing for cost recovery for assessment, remedial response, and damage to natural resources. This legislation is contained in Chapter 21E of the Massachusetts General Laws (MGL.C.21E 1983, amended 1986). Regulations in the form of a state contingency plan were promulgated in October 1988. The portion of the Massachusetts Contingency Plan (MCP) relevant to this risk assessment requires that a permanent solution, which effectively eliminates significant or otherwise unacceptable risks to health, safety, public welfare or the environment, be implemented at all disposal sites. As stated in the MCP, the total site cancer risk will be compared to a cancer risk limit of 1 in 100,000 ($1x10^{-5}$). The total site noncarcinogenic risk will be compared to a risk limit represented by an HI equal to 0.2. The risk estimates generated in this report are also evaluated against the MCP criteria (see Section 4.3).

4.2 QUANTITATIVE RISK EVALUATION

Numerous risk estimates were derived as part of the risk evaluation for the New Bedford Harbor site. Each risk calculation is in Appendix C and is presented in summary tables throughout this subsection. A strict comparison of these risk estimates to appropriate standards and criteria values or the target range risk levels shows that many of these values exceed levels of risk considered to be of potential concern, under current EPA and state guidance. As such, these risks indicate that remedial actions may be warranted at this site.

Noncarcinogenic and carcinogenic risks were evaluated separately and are presented in the following subsections. The noncarcinogenic evaluation, discussed first, describes risks associated with acute and chronic exposure to PCBs, cadmium, copper, and lead. The carcinogenic evaluation follows and describes the risks from chronic and lifetime exposure to PCBs.

4.2.1 Noncarcinogenic Risk Evaluation

Noncarcinogenic risk ratios were developed for exposure to cadmium, copper, lead, and PCBs under both acute and chronic exposure conditions for the following routes of exposure:

- ingestion of sediment
- direct contact with sediment
- ingestion of aquatic biota

In addition to deriving the individual risk ratio values, Jordan generated multitoxic HI values for concurrent exposure to the three metals and PCBs. These compounds exhibit similar toxic endpoints (see Appendix D); therefore, it was appropriate to sum the individual risk ratios to derive a multitoxic HI value.

4.2.1.1 Sediment

Two routes of exposure (i.e., direct contact with and ingestion of contaminated sediment) were evaluated in this risk assessment. Exposure dose levels of PCBs, cadmium, copper, and lead were estimated separately for both routes of exposure and compared to the most applicable standard or criteria value. The noncarcinogenic risk evaluation for these routes of exposure are discussed separately in the following paragraphs.

Direct Contact with Sediment. The land use and activity patterns for the New Bedford Harbor area suggest that persons of all ages may be exposed to contaminated sediment as a result of swimming, wading, and/or fishing in the Acushnet River. As stated previously, the most likely locations for these activities to occur are south of the Coggeshall Street Bridge in

Areas II and III. Exposure to contaminated sediment in these areas was estimated to occur between 20 and 100 times per year. Because access to the shoreline Area I is not restricted, exposure to sediment in this area was considered possible and also evaluated. For adults and older children, who may access the mudflats in Area I to clam or fish, exposure to sediment was estimated to occur between 20 and 100 times per year. Since there are no recreational areas located within Area I and children (0-5) have limited mobility, exposure to sediment in Area I was estimated to occur between 1 and 20 times per year.

Risk ratio and multitoxic HIs were evaluated for both acute and chronic exposure durations. These values are listed in Table 4-2.

<u>Chronic</u>. Risk ratios for chronic exposure to PCB- and cadmium-contaminated sediment were derived by comparing the estimated exposure dose of each contaminant to the respective longer-term HAs. The HAs, expressed in mg/l, were converted to mg/kg-day by factoring in the standard exposure assumptions of 1 liter of water ingested per day for a 10-kg child or 2 liters of water ingested per day for a 70-kg adult. The converted longer-term HAs are $1x10^{-4}$ mg/kg-day and $5x10^{-4}$ mg/kd-day for PCBs and cadmium, respectively. (Note the converted longer-term HA for cadmium is the same value as the RfD for cadmium.)

Risk ratios for lead and copper exposure were derived by comparing the exposure dose of each contaminant to the respective MCL or MCLG. The MCL and MCLG values were converted to units of mg/kg-day by factoring in the standard exposure assumptions of 2 liters of water ingested per day for a 70-kg adult. The converted MCL for lead is $1.4x10^{-4}$ and MCLG for copper is $3.7x10^{-2}$. (Note the converted MCLG for copper is the same value as the AIC for copper.)

Location-specific exposure concentrations were used when available. However, the metals data could not be segregated by specific locations within an area; therefore, area-wide contaminant concentrations were used to evaluate exposure to metals. As such, the assumed exposure-point concentrations may overestimate actual exposure conditions, because they include data collected from the more-contaminated midchannel sediment.

Risk ratios for chronic exposure by children (0-5) years to sediment in Area I under most-probable conditions were not evaluated since it was assumed that exposure in this area occurs only once per year. The potential risks for this route of exposure is evaluated under acute exposure to sediment. Chronic exposure to contaminated sediment in Area I is evaluated assuming conservative exposure conditions only. Exposure to

TABLE 4-2. NONCARCINOGENIC RISK FROM DIRECT CONTACT WITH SEDIMENTS; CHILDREN OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Location	PCB Risk Ratio (a)	Cadmium Risk Ratio (b)	Copper Risk Ratio (c)	Lead Risk Ratio (d)	Multi-Toxic HI (e)
CHRONIC EXPOSURE:					
AREA I					
Area wide					
Child					
Prob.	NA	NA	NA	NA	NA
Cons.	93	0.003	0.002	0.2	93
Older Child					
Prob.	2.4	0.0003	0.00014	0.025	2
Cons.	200	0.0060	0.0038	0.5	201
Adult					
Prob.	1.0	0.0001	0.00006	0.010	1
Cons.	130	0.0040	0.0025	0.35	130
Upper Estuary					
Child					
Prob.	NA	NA	NA	NA	NA
Cons.	93	0.003	0.001	0.3	93
Older Child					
Prob.	2.4	0.0003	0.00014	0.028	2
Cons.	200	0.0062	0.0023	0.5	201
Adult					
Prob.	1.0	0.0001	0.00006	0.011	1
Cons.	130	0.0040	0.0015	0.35	130
Lower Estuary					
Child					
Prob.	NA	NA	NA	NA	NA
Cons.	6	0.003	0.002	0.2	6
Older Child					
Prob.	0.9	0.0004	0.00015	0.018	1
Cons.	13	0.0057	0.0038	0.43	13
Adult					
Prob.	0.4	0.0001	0.00006	0.007	0.4
Cons.	8	0.0036	0.0025	0.27	8
Cove Area					
Child					
Prob.	NA	NA	NA	NA	NA
Cons.	6	0.002	0.002	0.2	6
Older Child					
Prob.	1.8	0.0004	0.00022	0.025	2
Cons.	13	0.0043	0.0039	0.43	13

TABLE 4-2. NONCARCINOGENIC RISK FROM DIRECT CONTACT WITH SEDIMENTS; CHILDREN OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Location			PCB Risk Ratio (a)	Cadmium Risk Ratio (b)	Copper Risk Ratio (c)	Lead Risk Ratio (d)	Multi-Toxic HI (e)
Cove Area	Adult						
		Prob.	0.7	0.0001	0.00009	0.010	0.7
		Cons.	8	0.0028	0.0025	0.28	8
AREA II							
Area wide							
	Child						
		Prob.	0.27	0.0003	0.0003	0.021	0.3
		Cons.	9	0.0029	0.008	0.410	9
	Older Child						
		Prob.	0.13	0.0001	0.00013	0.010	0.1
		Cons.	4	0.0012	0.003	0.2	4
	Adult						
		Prob.	0.05	0.00005	0.00005	0.004	0.06
		Cons.	2.60	0.0008	0.002	0.100	3
Popes Island							
	Child						
		Prob.	0.14	ND	0.00024	0.02	0.2
		Cons.	2.50	ND	0.002	0.2	3
	Older Child						
		Prob.	0.069	ND	0.00012	0.01	0.08
		Cons.	1.10	ND	0.0009	0.087	1
	Adult						
		Prob.	0.027	ND	0.000047	0.004	0.03
		Cons.	0.69	ND	0.0006	0.057	0.7
Palmer Island							
	Child						
		Prob.	0.039	ND	0.00015	0.018	0.06
		Cons.	0.80	ND	0.0009	0.100	0.9
	Older Child						
		Prob.	0.019	ND	0.000075	0.0089	0.03
		Cons.	0.35	ND	0.0004	0.044	0.4
	Adult						
		Prob.	0.0075	ND	0.00003	0.0035	0.01
		Cons.	0.23	ND	0.0002	0.029	0.3
Marsh Island							
	Child						
		Prob.	0.1	ND	0.00015	0.025	0.13
		Cons.	1.60	ND	0.0008	0.240	1.8

TABLE 4-2. NONCARCINOGENIC RISK FROM DIRECT CONTACT WITH SEDIMENTS; CHILDREN OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Location	PCB Risk Ratio (a)	Cadmium Risk Ratio (b)	Copper Risk Ratio (c)	Lead Risk Ratio (d)	Multi-Toxic HI (e)
Older Child					
Prob.	0.05	ND	0.00007	0.012	0.06
Cons.	0.70	ND	0.0004	0.100	0.8
Adult					
Prob.	0.02	ND	0.000029	0.0049	0.02
Cons.	0.45	ND	0.0002	0.067	0.5
AREA III					
Area wide					
Child					
Prob.	0.05	ND	0.00005	0.007	0.06
Cons.	2.10	ND	0.0004	0.078	2.2
Older Child					
Prob.	0.02	ND	0.00002	0.004	0.027
Cons.	0.93	ND	0.0002	0.034	1.0
Adult					
Prob.	0.01	ND	0.000009	0.00140	0.011
Cons.	0.59	ND	0.0001	0.022	0.6
Fort Rodman					
Child					
Prob.	0.03	ND	ND	ND	0.03
Cons.	0.50	ND	ND	ND	0.5
Older Child					
Prob.	0.01	ND	ND	ND	0.012
Cons.	0.22	ND	ND	ND	0.2
Adult					
Prob.	0.005	ND	ND	ND	0.005
Cons.	0.14	ND	ND	ND	0.1
Fort Phoenix					
Child					
Prob.	0.008	ND	ND	ND	0.01
Cons.	0.05	ND	ND	ND	0.1
Older Child					
Prob.	0.004	ND	ND	ND	0.004
Cons.	0.02	ND	ND	ND	0.0
Adult					
Prob.	0.001	ND	ND	ND	0.001
Cons.	0.02	ND	ND	ND	0.0

TABLE 4-2. NONCARCINOGENIC RISK FROM DIRECT CONTACT WITH SEDIMENTS; CHILDREN OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Location	PCB Risk Ratio (a)	Cadmium Risk Ratio (b)	Copper Risk Ratio (c)	Lead Risk Ratio (d)	Multi-Toxic HI (e)
ACUTE EXPOSURE					
AREA I					
Cove Area					
Child					
Prob.	0.68	0.0020	NA	NA	0.7
Cons.	1.10	0.0042	NA	NA	1.1
Older Child					
Prob.	0.33	0.0007	NA	NA	0.3
Cons.	0.46	0.0018	NA	NA	0.5
Adult					
Prob.	0.13	0.0003	NA	NA	0.1
Cons.	0.29	0.0012	NA	NA	0.3
Maximum Concentration					
Child					
Prob.	15.00	0.0038	NA	NA	15.0
Cons.	17.00	0.0042	NA	NA	17.0
Older Child					
Prob.	7.30	0.0018	NA	NA	7.3
Cons.	7.30	0.0018	NA	NA	7.3
Adult					
Prob.	2.90	0.0007	NA	NA	2.9
Cons.	4.70	0.0012	NA	NA	4.7

(a) = The modified longer-term HA was used to assess chronic exposure and the modified 10-day HA was used to assess acute exposure.
(b) = The modified longer-term HA was used to assess chronic exposure and the modified 10-day HA was used to assess acute exposure.
(c) = The AIC was used to assess chronic exposure; no appropriate standard or guideline exists to assess acute exposure.
(d) = The modified proposed MCL was used to assess chronic exposure; no appropriate standard or guideline exists to assess acute exposure.
(e) = The Multitoxic Hazard Index (HI) is the sum of the risk ratios for PCBs, cadmium, copper and lead.
NA = Not Applicable
ND = Not Detected

sediment in Area I by older children and adults was evaluated for both most-probable and conservative scenarios.

Metals. The risk ratios based on exposure to cadmium-, copper-, and lead-contaminated sediment were below 1 for all areas and for all exposure conditions. These included risk ratios based on exposure to the maximum contaminant concentration detected in sediment. Because these values fall below 1, direct contact exposure to these contaminants is not considered to present a human health risk.

PCBS. The risks associated with direct contact exposure to PCB-contaminated sediment were greatest for the Upper Estuary in Area I. Risk ratio values for older children and adults under probable exposure conditions ranged from less than 1 to 2.4, and under conservative exposure conditions ranged from 8 to 200. Chronic exposure to sediment by younger children was assessed under conservative exposure assumptions only. The risk ratios for these scenarios ranged from 6 to 93. The magnitude to which these values exceed 1 indicates that exposure to PCB-contaminated sediment in this area presents a public health risk. All age classes appear to be at risk from direct contact exposure to PCBs. Methods to reduce these risks will be addressed in the FS.

Risk ratios based on exposure to PCB-contaminated shoreline sediment from Area II ranged from below 1 to 9. Risks associated with exposure to sediment from specific locations within Area II were lower than those estimated based on area-wide PCB concentrations. Risk ratios based on exposure to PCB concentrations detected in shoreline sediment from the Palmer Island area were all below 1, while risk ratios for Marsh Island ranged from 0.05 to 1.6, and risk ratios for the Popes Island area ranged from 0.03 to 3 (see Table 4-2).

The two risk ratios which exceeded 1 (1.6 and 3) were based on exposure by a young child to the maximum PCB concentration detected in these specific areas. Since it is unlikely that repetitive, long-term exposure to this concentration will occur, the potential risk to young children is considered to be less than the risks indicated by the ratios. Exposure to sediment in Area II is not considered to present a public health risk.

The risk ratios based on exposure to shoreline sediment at Fort Rodman and Fort Phoenix beaches in Area III were below 1 for all scenarios evaluated. The only risk ratio to exceed 1 was based on exposure to the maximum PCB concentration detected in shoreline sediment from all of Area III, and was estimated at 2. Since it is unlikely that repetitive long-term exposure will occur at this concentration, this scenario is considered to be overly conservative. The risks associated with exposure under more realistic conditions are all less than 1. Direct contact exposure to PCB-contaminated sediment in Area III is not considered to present a public health risk.

Multitoxic. The multitoxic HI values based on concurrent exposure to the three metals was less than 1 for all exposure conditions except one, in which the HI was 1.1. However, this exposure scenario was based on conservative assumptions and is not considered representative of actual exposure conditions. Therefore, concurrent exposure to cadmium, copper, and lead is not considered to present a risk to human health.

The multitoxic HI based on concurrent exposure to all four contaminants slightly exceeded 1 in Area I (most-probable case) and exceeded 1 only under conservative exposure conditions for other areas within the New Bedford Harbor area. The major contribution to the HI value was the individual risk associated with exposure to PCBs.

Because exposure to all four contaminants at the maximum concentration is unlikely, these exposure scenarios are considered to be overly conservative. Actual exposure conditions are more likely to be represented by the conditions assumed under the probable exposure scenarios. The multitoxic HI values associated with these scenarios were below 1. Exposure through direct contact with metal-contaminated sediment is therefore not considered to present a risk to public health.

Acute. An acute exposure scenario was evaluated to determine if intermittent or once-in-a-lifetime contact with contaminated sediment posed a risk to public health. To provide an estimate of potential risk, body dose levels were calculated using the mean and maximum contaminant levels detected in shoreline sediment from Area I. This area was the most widely contaminated and had the highest shoreline PCB concentrations. The body dose levels estimated under this scenario were compared to appropriate short-term criterion. For PCBs and cadmium, the converted 10-day HAs were used to evaluate risk; however, there were no appropriate short-term criteria available to assess lead or copper exposure. The risk ratios are listed in Table 4-2.

The risk ratios associated with acute exposure to cadmium-contaminated sediment were below 1 for all scenarios. The risk ratios associated with acute exposure to PCB-contaminated sediment ranged from 0.2 to 17. The ratios that exceeded 1 were all based on exposure to the maximum PCB concentration detected in this area (6,393 ppm). A distribution of the PCB concentration in sediment from this area estimates the 90th percentile to be 1,800 ppm and the 75th percentile to be 390 ppm PCB (Battelle Sediment Data Base, 1988), suggesting that it is unlikely for exposure to occur at the maximum PCB concentration. Risk ratios based on acute exposure via direct contact exposure to 1,800 or 390 ppm PCB were below 1 for all subpopulations. Since shoreline PCB concentrations in Areas II and III are less than 390 ppm, acute exposure to sediment in all three areas is not considered to present a public health risk.

Ingestion of Sediment. Ingestion of sediment is considered an age-related activity and most significant for children less than six years old. Exposure through ingestion of sediment was, therefore, assessed for the zero to 5-year age class only, and focused on areas where exposure by this age group was likely. Risk ratios for PCBs and metals were generated for exposure to sediment in the Upper and Lower Estuary and the Cove Area of Area I, and the recreational and beach areas within Areas II and III (see Figure 2-7). Location-specific concentrations of these contaminants were used when available. Given the nature of the metals data, cadmium, copper, and lead concentrations could not be estimated for specific recreational areas. Since the exposure concentrations used to derive the risk ratios for metals are based on area-wide concentrations, they may be greater than the location-specific exposure concentrations.

The areas chosen in these exposure scenarios represent locations where young children may have access to shoreline sediment. Children were expected to frequent the recreational and beach areas more often than areas in Area I. Therefore, differentfrequencies of ingestion were assumed for Area I than Areas II and III. Risk ratio values for exposure via ingestion of sediment are in Table 4-3.

Chronic. Risk ratios based on exposure to cadmium- and copper-contaminated sediment were below 1 for all scenarios. Risk ratios based on exposure to PCB- and lead-contaminated sediment exceeded 1 under certain scenarios. For Area I, risk ratios were derived assuming only conservative exposure assumptions, since the probable exposure scenarios assumed only 1 exposure per year which represents an acute versus chronic exposure. Assuming chronic exposure, both PCB and lead risk ratios exceeded 1 for all areas within Area I and ranged from 11 to 175 and 26 to 33, respectively. The multitoxic HI for these scenarios ranged from 37 to 209. Although these risk ratios were based on conservative exposure assumptions, the magnitude to which they exceed 1 indicates that ingestion of sediment from Area I presents a potential health risk.

The risk ratios for ingestion of lead-contaminated sediment from Area II ranged from 2.7 (Palmer Island) to 55 (area-wide). The highest risk ratios were based on conservative exposure conditions. Because the maximum lead concentrations used to derive these ratios were detected in midchannel sediment, they may overestimate the potential exposure and subsequent risk from

TABLE 4-3. NONCARCINOGENIC RISK FROM CHRONIC INGESTION OF SEDIMENTS; CHILDREN
NEW BEDFORD, MASSACHUSETTS.

Location	PCB Risk Ratio (a)	Cadmium Risk Ratio (b)	Copper Risk Ratio (c)	Lead Risk Ratio (d)	Multi-Toxic HI (e)
AREA I					
Area wide					
Child					
Prob.	NA	NA	NA	NA	NA
Cons.	175	0.380	0.23	33	209
Upper Estuary					
Child					
Prob.	NA	NA	NA	NA	NA
Cons.	175	0.380	0.140	33.0	209
Lower Estuary					
Child					
Prob.	NA	NA	NA	NA	NA
Cons.	11	0.340	0.230	26.0	38
Cove Area					
Child					
Prob.	NA	NA	NA	NA	NA
Cons.	11	0.260	0.230	26.0	37
AREA II					
Area wide					
Child					
Prob.	0.57	0.0410	0.0420	3.1	3.8
Cons.	17	0.3800	1.000	55	73
Popes Island					
Child					
Prob.	0.3	ND	0.04	3	3.3
Cons.	4.70	ND	0.280	27.0	32
Palmer Island					
Child					
Prob.	0.08	ND	0.02	2.7	2.8
Cons.	1.50	ND	0.1100	14	15.6

TABLE 4-3. NONCARCINOGENIC RISK FROM CHRONIC INGESTION OF SEDIMENTS; CHILDREN
NEW BEDFORD, MASSACHUSETTS.

Location	PCB Risk Ratio (a)	Cadmium Risk Ratio (b)	Copper Risk Ratio (c)	Lead Risk Ratio (d)	Multi-Toxic HI (e)
Marsh Island					
Child					
Prob.	0.22	ND	0.02	3.7	3.9
Cons.	3.00	ND	0.1100	32	35
AREA III					
Area Wide					
Child					
Prob.	0.11	ND	0.00700	1.100	1.2
Cons.	4.00	ND	0.0600	10.000	14
Fort Rodman					
Child					
Prob.	0.06	ND	ND	ND	0.06
Cons.	0.90	ND	ND	ND	0.9
Fort Phoenix					
Child					
Prob.	0.020	ND	ND	ND	0.02
Cons.	0.10	ND	ND	ND	0.1

(a) = The modified longer-term HA was used to assess chronic exposure.
(b) = The modified longer-term HA was used to assess chronic exposure.
(c) = The modified MCLG (AIC) was used to assess chronic exposure.
(d) = The modified proposed MCL was used to assess chronic exposure.
(e) = The Multitoxic Hazard Index (HI) is the sum of the risk ratios for PCBs, cadmium, copper and lead.
ND = Not Detected

this route of exposure. Midchannel sediment, in general, was more contaminated than shoreline sediment.

The risk ratios developed for ingestion of lead-contaminated sediment in specific areas, under probable exposure conditions, were considered more representative of the potential risks from this route of exposure. These values slightly exceed 1 and ranged from 2.7 to 3.7, suggesting that chronic exposure to lead through ingestion of sediment is not significant for Area II. Lead was not detected in sediment from the Fort Rodman and Fort Phoenix beach areas in Area III.

The risk ratios based on ingestion of PCB-contaminated sediment in Areas II and III ranged from below 1 to 17. However, the risk ratios based on probable exposure conditions and location-specific PCB concentrations were all below 1. Since these scenarios are considered to be most representative of actual exposure conditions, ingestion of sediment from Areas II and III is not considered to present a noncarcinogenic public health risk.

Acute. Acute exposure to contaminants from ingestion of sediment was evaluated to determine if intermittent or once-in-a-lifetime exposure to sediment in New Bedford Harbor presented a risk to children, older children, and adults. The acute scenario was based on exposure to the maximum contaminant level detected in shoreline sediment. Risk ratios could only be derived for PCBs and cadmium because no appropriate standards or criteria exist to evaluate acute exposure to copper or lead. The body dose levels for PCBs and cadmium were compared to converted 10-day HAs. These risk ratios appear in Table 4-4.

The risk ratios based on ingestion of cadmium-contaminated sediment were below 1 for all subpopulations and areas. The risk ratios based on ingestion of PCB-contaminated sediment exceeded 1 only in Area I and ranged from 0.28 to 2 based on exposure to the mean PCB concentration and 4.6 to 32 for the maximum PCB concentration. Children are considered to be at greater risk than older children and adults. Risk ratios for this age class exceeded 1 under both most probable and conservative scenarios.

Summary. The noncarcinogenic risks associated with direct contact and ingestion exposures to sediment were evaluated by comparing the estimated exposure dose to the most appropriate standard or criterion. The risk ratios developed based on these evaluations indicate a potential risk to public health from chronic exposure via ingestion and/or direct contact with sediment in Area I. Children may be at risk from acute exposure via ingestion of sediment in Area I. PCBs are the major contaminant of concern in this area, and methods to reduce these

TABLE 4-4. NONCARCINOGENIC RISK FROM ACUTE EXPOSURE TO CONTAMINANTS VIA INGESTION OF SEDIMENTS; CHILDREN; OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Location	PCB Risk Ratio (a)	Cadmium Risk Ratio (b)	Copper Risk Ratio (c)	Lead Risk Ratio (d)	Multi-Toxic HI (e)
AREA I (Maximum Concentration)					
Child	32	0.8	NA	NA	33
Older Child	8	0.2	NA	NA	8
Adult	4.6	0.11	NA	NA	5
AREA I (Mean Concentration)					
Child	2	0.23	NA	NA	2
Older Child	0.47	0.056	NA	NA	0.5
Adult	0.28	0.03	NA	NA	0.3
AREA II (Maximum Concentration)					
Child	0.6	0.16	NA	NA	0.76
Older Child	0.16	0.04	NA	NA	0.20
Adult	0.086	0.023	NA	NA	0.11
AREA III (Maximum Concentration)					
Child	0.14	ND	ND	ND	0.1
Older Child	0.03	ND	ND	ND	0.03
Adult	0.021	ND	ND	ND	0.02

(a) = The modified 10-day HA was used to assess acute exposure.
(b) = The modified 10-day HA was used to assess acute exposure.
(c) = No appropriate criterion was available to assess acute exposure.
(d) = No appropriate criterion was available to assess acute exposure.
(e) = The Multitoxic Hazard Index (HI) is the sum of the risk ratios.
ND = Not Detected
NA = Not Applicable

risks will be evaluated in the FS. Chronic and acute exposure to PCB-, cadmium-, copper-, or lead-contaminated sediment in other locations of the New Bedford Harbor site area were not considered to present a significant noncarcinogenic risk to public health.

4.2.1.2 Biota

Risk ratios were generated for acute and chronic exposures to PCBs, cadmium, copper, and lead through ingestion of aquatic biota and are listed on Table 4-5. Because copper occurs at naturally high levels in shellfish and crustaceans (due to their copper-based blood), it is not possible to determine the copper concentration in these organisms resulting from contaminant exposure. Because copper data for lobsters and clams were not suitable for describing contaminant exposure, exposure to copper was only assessed for the ingestion of winter flounder. As discussed in Section 2.5, exposure to aquatic biota was assessed for the same four areas (Areas 1 through 4) established by HydroQual for their food-chain model.

Exposure through the ingestion of aquatic biota by younger children, older children, and adults was evaluated for both weekly and daily exposure frequencies, assuming an ingestion amount of 4 ounces (i.e., 115 grams) for younger children and 8 ounces (i.e., 227 grams) of fish per meal for older children and adults. Separate exposure scenarios were developed for each of the three species. Therefore, each scenario assumes that 100 percent of the seafood diet is comprised of the species evaluated.

Chronic. Chronic exposure to PCBs and metals via ingestion of biota was based on daily and weekly consumption frequencies and evaluated against criteria based on toxicity studies of chronic but less than lifetime exposure duration, when available. The most appropriate criterion for assessing chronic exposure to PCBs and cadmium is the converted longer-term HA. No appropriate criteria are available to evaluate chronic exposure to lead or copper; therefore, these contaminants were evaluated using the converted MCL and MCLG, respectively. Because the MCL and MCLGs are developed to be protective for lifetime exposure, using them to assess chronic exposure (i.e., 10-year) may overestimate potential risks.

Metals. Chronic exposure to cadmium and copper by older children and adults was not considered to present a public health risk. Risk ratios based on both weekly and daily ingestion frequencies for these subpopulations ranged from less than 1 to 7.9. Ratios in excess of 1 were based on daily ingestion frequencies and whole body tissue concentrations. These factors may result in conservative estimates of risk. The

TABLE 4-5. NONCARCINOGENIC RISK FROM INGESTION OF BIOTA; CHILDREN; OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

		Younger Child					Older Child					Adult				
		Risk Ratios				Multi Toxic	Risk Ratios				Multi Toxic	Risk Ratios				Multi Toxic
Species	Area	Cadmium	Copper	Lead	PCBs	HI (a)	Cadmium	Copper	Lead	PCBs	HI (a)	Cadmium	Copper	Lead	PCBs	HI (a)
Daily Ingestion																
Lobster	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Clam	1	4.0	NA	80	78	162	1.9	NA	40.0	39.0	80.9	1.1	NA	23.0	22	46
Flounder	1	0.2	0.9	70	118	189	0.088	0.5	35.0	59.0	94.6	0.050	0.3	20.0	34	54
Lobster	2	8.4	NA	79	64	151	4.2	NA	39.0	32.0	75.2	2.4	NA	22.0	18	42
Clam	2	5.3	NA	60	26	91	2.6	NA	30.0	13.0	45.6	1.6	NA	17.0	7.5	26.1
Flounder	2	0.2	1.1	65	42	108	0.099	0.6	32.0	21.0	53.7	0.056	0.3	19.0	12.0	31.4
Lobster	3	7.3	NA	30	24	61	3.6	NA	15.0	12.0	30.6	2.1	NA	9.0	6.9	18.0
Clam	3	6.5	NA	101	18	125	3.3	NA	51.0	8.8	63.1	1.9	NA	29.0	5.1	36.0
Flounder	3	0.1	3.0	50	32	85	0.055	1.5	25.0	16.0	42.5	0.030	0.9	14.0	9.0	23.9
Lobster	4	5.7	NA	18.0	7.2	31	2.9	NA	9.0	3.6	15.5	1.6	NA	5.0	2.0	8.6
Clam	4	7.1	NA	77	4.4	88	3.5	NA	38.0	2.2	43.7	2.0	NA	22.0	3.2	27.2
Flounder	4	2.2	2.9	95	11	112	1.1	1.5	48.0	5.7	56.3	0.6	0.8	27.0	3.2	31.7

TABLE 4-5. NONCARCINOGENIC RISK FROM INGESTION OF BIOTA; CHILDREN; OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

		Younger Child					Older Child					Adult				
		Risk Ratios				Multi Toxic	Risk Ratios				Multi Toxic	Risk Ratios				Multi Toxic
Species	Area	Cadmium	Copper	Lead	PCBs	HI (a)	Cadmium	Copper	Lead	PCBs	HI (a)	Cadmium	Copper	Lead	PCBs	HI (a)
PROBABLE SCENARIO																
Weekly Ingestion																
Lobster	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Clam	1	0.5	NA	11.0	11.1	23	0.3	NA	5.7	5.6	11.5	0.2	NA	3.3	3.2	6.7
Flounder	1	0.03	0.1	11.0	16.8	28	0.01	0.1	5.0	8.4	13.5	0.008	0.0	2.9	4.8	7.7
Lobster	2	1.2	NA	11.0	9.2	21	0.6	NA	5.6	4.6	10.8	0.3	NA	3.2	2.6	6.1
Clam	2	0.8	NA	8.7	3.7	13.2	0.4	NA	4.3	1.9	6.6	0.2	NA	2.5	1.1	3.8
Flounder	2	0.03	0.2	9.4	6.0	15.6	0.014	0.1	4.7	3.0	7.8	0.001	0.0	2.7	1.7	4.4
Lobster	3	1.0	NA	4.3	3.4	8.7	0.5	NA	2.1	1.7	4.3	0.3	NA	1.2	1.0	2.5
Clam	3	0.9	NA	14.0	2.6	17.5	0.5	NA	7.2	1.3	9.0	0.3	NA	4.1	0.7	5.1
Flounder	3	0.02	0.4	7.1	4.4	11.9	0.008	0.2	3.6	2.2	6.0	0.0005	0.1	2.0	1.3	3.4
Lobster	4	0.8	NA	2.6	1.0	4.4	0.4	NA	1.3	0.5	2.2	0.2	NA	0.7	0.3	1.3
Clam	4	1.0	NA	11.0	0.6	12.6	0.5	NA	5.5	0.3	6.3	0.3	NA	3.1	0.2	3.6
Flounder	4	0.3	0.4	13.0	1.6	15.4	0.16	0.2	6.8	0.8	8.0	0.090	0.1	3.9	0.5	4.6

TABLE 4-5. NONCARCINOGENIC RISK FROM INGESTION OF BIOTA; CHILDREN; OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

		Younger Child					Older Child					Adult				
		Risk Ratios				Multi Toxic	Risk Ratios				Multi Toxic	Risk Ratios				Multi Toxic
Species	Area	Cadmium	Copper	Lead	PCBs	HI (a)	Cadmium	Copper	Lead	PCBs	HI (a)	Cadmium	Copper	Lead	PCBs	HI (a)
CONSERVATIVE SCENARIO																
Weekly Ingestion																
Lobster	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Clam	1	1.1	NA	21.0	34	56	0.6	NA	11.0	17.0	28.6	0.3	NA	6.0	9.8	16.1
Flounder	1	0.04	0.5	38.0	42	81	0.020	0.2	19.0	21.0	40.3	0.010	0.1	11.0	12.0	23.2
Lobster	2	2.2	NA	37.0	20	59	1.1	NA	19.0	9.9	30.0	0.6	NA	11.0	5.7	17.3
Clam	2	1.0	NA	11.0	19	31	0.5	NA	5.0	9.6	15.1	0.3	NA	3.0	5.5	8.8
Flounder	2	0.06	0.9	51.0	17	69	0.030	0.4	26.0	8.5	35.0	0.020	0.3	15.0	4.8	20.1
Lobster	3	1.7	NA	13.0	5.6	20	0.9	NA	6.0	2.8	9.7	0.5	NA	4.0	1.6	6.1
Clam	3	1.2	NA	39.0	7.8	48	0.6	NA	20.0	3.9	24.5	0.3	NA	11.0	2.2	13.5
Flounder	3	0.04	2.2	31.0	13	47	0.020	1.1	15.0	6.7	22.8	0.1	0.6	9.0	3.8	13.5
Lobster	4	1.9	NA	9.0	2.8	13.7	0.9	NA	5.0	1.4	7.3	0.5	NA	3.0	0.8	4.3
Clam	4	1.6	NA	19.0	2.2	22.8	0.8	NA	10.0	1.1	11.9	0.4	NA	6.0	0.6	7.1
Flounder	4	0.3	1.9	77	5.4	85	0.1	1.0	39.0	2.7	42.8	0.080	0.6	22.0	1.6	24.2

TABLE 4-5. NONCARCINOGENIC RISK FROM INGESTION OF BIOTA; CHILDREN; OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

		Younger Child					Older Child					Adult				
		Risk Ratios				Multi Toxic	Risk Ratios				Multi Toxic	Risk Ratios				Multi Toxic
Species	Area	Cadmium	Copper	Lead	PCBs	HI (a)	Cadmium	Copper	Lead	PCBs	HI (a)	Cadmium	Copper	Lead	PCBs	HI (a)
Daily Ingestion																
Lobster	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Clam	1	7.9	NA	150	240	398	4.0	NA	75	120	199	2.3	NA	43	69	114
Flounder	1	0.3	3.4	270	298	572	0.2	1.7	130	149	281	0.088	1.0	76	85	162
Lobster	2	15.5	NA	260	140	415	7.7	NA	131	70	209	4.4	NA	75	40	119
Clam	2	7.3	NA	78	134	219	3.6	NA	39	67	110	2.1	NA	22.0	38	62
Flounder	2	0.4	6.1	360	118	485	0.2	3.0	180	59	242	0.1	1.7	102	34	138
Lobster	3	11.9	NA	89	40	141	6.0	NA	45	20	71	3.4	NA	25.0	11	39
Clam	3	8.4	NA	275	54	337	4.2	NA	137	27	168	2.4	NA	78	15	95
Flounder	3	0.3	15.8	216	92	324	0.1	7.9	108	46	162	0.080	4.5	62	27	94
Lobster	4	13.0	NA	67	20	100	6.5	NA	33.0	10	50	3.7	NA	19.0	5.7	28
Clam	4	10.9	NA	137	15	163	5.5	NA	68	7.7	81	3.1	NA	39	4.4	47
Flounder	4	2.0	13.4	540	38	593	1.0	6.7	270	19	297	0.6	3.8	155	11	170

(a) The Multi HI is the sum of the risk ratios for cadmium, copper, lead and PCBs.
A Longer-term Health Advisory was used to estimate the risk ratio for cadmium and PCB exposure.
The MCLG and proposed MCL were used to estimate the risk ratio for copper and lead respectively.
NA = Not Applicable

risk ratios for cadmium and copper generated under weekly exposure conditions are considered more reflective of actual exposure conditions, and these values were less than 1.

Chronic exposure to cadmium and copper through the ingestion of fish by children (zero to 5 years) resulted in risk ratios ranging from below 1 to 16. Of the 70 scenarios evaluated for children, 35 had corresponding risk ratios greater than 1. Although many of these scenarios were based on conservative assumptions (i.e., daily ingestion and whole-body contaminant concentrations), the frequency and magnitude to which these values exceed 1 suggest a potential health risk. In addition, young children are more sensitive to contaminant exposure than adults. Therefore, exposure to cadmium and copper through ingestion of biota may pose a risk to a child's health.

The risk ratio based on exposure to lead through the ingestion of biota by all age classes exceed 1 under both sets of exposure conditions and for all areas. These risk ratios were based on both weekly and daily ingestion frequencies and were as high as 540 (see Table 4-5). The frequency and magnitude by which the risk ratio values exceeded 1 indicate a potential risk to human health from lead exposure.

No one area or species appeared to consistently present a greater risk for exposure to lead. The mean lead concentration detected in winter flounder, clams, and lobsters from all four areas ranged from 0.23 to 1.28 ppm, and the maximum concentrations ranged from 0.84 to 6.84 ppm. The relatively low variance in concentrations indicates that chronic ingestion of any species from any area presents a potential risk to public health.

<u>PCBs</u>. The noncarcinogenic risks associated with PCB exposure were estimated by comparing the intake contaminant level to the longer-term HA established for PCBs. The risk ratio based on all sets of exposure conditions ranged from below 1 to 298. Elevated risk ratios were observed even under probable exposure conditions, suggesting that exposure to PCBs via ingestion of biota presents a potential health risk for all age classes.

As with lead, no one species or area appeared to consistently present a greater risk for PCB exposure. The mean PCB concentration in all three species (edible portion) ranged from 0.064 to 1.039 ppm, and the maximum PCB concentration ranged from 0.137 to 2.629 ppm. The low variance in concentrations indicates that ingestion of any species from any area presents a potential noncarcinogenic risk to public health.

These risk estimates only address the potential noncarcinogenic effects associated with PCB exposure and do not reflect the potential carcinogenic risks. The carcinogenic risks associated with PCB exposure are evaluated in the next subsection.

Multitoxic. The combined HI values generated by summing individual risk ratios for the four contaminants exceed 1 for most exposure conditions evaluated (see Table 4-5). Concurrent exposure to these contaminants may therefore result in exposure levels in excess of those recommended in health-based criteria. The majority of the risk described by the multitoxic HI value is derived from the contribution of lead and PCB exposure. As indicated, the ingestion of biota may result in exposure to lead and PCBs above recommended levels. Because cadmium and copper exhibit similar toxic effects, the concurrent exposure to these contaminants may increase this risk.

Acute. Acute exposure via ingestion of biota was evaluated to reflect the potential risks associated with consumption frequencies of less than one fish meal per month. As discussed in Section 2.5.2 and presented in Table 2-9, the majority of residents in the Greater New Bedford area consume seafood less than once per month but greater than once per year. Because of the infrequent exposure, a larger portion of fish per meal was assumed. The exposure scenario was based on a single meal consisting of 400 grams of fish containing the maximum contaminant level detected in each species. The 10-day HAs for PCBs and cadmium were used to derive risk ratios (Table 4-6). Currently, no appropriate standard or criteria values are available to assess acute exposures to lead or copper.

Risk ratios based on cadmium exposure are equal to or less than 1 for all species and for all areas, indicating that acute exposures do not exceed the acceptable daily intake for this contaminant. These risk ratio values represent the upper-bound risk estimates because they were based on the maximum cadmium concentration detected in each species. Therefore, lower risks would be associated with more probable exposure conditions (i.e., lower contaminant concentrations).

The risk ratios based on acute exposure to PCBs slightly exceeded 1. However, the probability of ingesting fish contaminated with the maximum concentration of PCBs is low, suggesting that these risk ratios are overly conservative. Lower risk ratio values based on the ingestion of 400 grams of fish contaminated at the mean PCB concentration were below 1. These values are considered more reflective of potential risks from acute exposure via ingestion of biota. Therefore, noncarcinogenic risks associated with acute exposure via ingestion of aquatic biota are not considered to present a public health risk.

TABLE 4-6. NONCARCINOGENIC RISK FROM INGESTION OF BIOTA; ACUTE EXPOSURE NEW BEDFORD, MASSACHUSETTS.

Species/ Contaminant	Maximum Concentration (PPM)	Acute Criteria (mg/kg)	Risk Ratios Child	Risk Ratios Older Child	Risk Ratios Adult
Lobster					
PCBs	1.23	0.01	4.92	1.23	0.70
Cd	0.7	0.004	7	1.75	1
Cu	N/A				
Pb	16				
Flounder					
PCBs	2.63	0.01	10.52	2.63	1.50
Cd	0.1	0.004	1	0.25	0.14
Cu	51.64				
Pb	6.89				
Clam					
PCBs	2.12	0.01	8.48	2.12	1.21
Cd	0.5	0.004	5	1.25	0.71
Cu	N/A				
Pb	6.34				

N/A = Data Not Available due to the naturally high level of copper in blood of these organisms.
No appropriate criteria or standards are available to assess acute exposure to copper or lead.
The converted 10-day HA values were used to assess acute exposure to PCBs and cadmiumn.

4.2.1.3 Air

The noncarcinogenic risks associated with inhalation of airborne contaminants were not developed because of the limited amount of available data (see Section 2.5). Carcinogenic risk estimates associated with this route of exposure were developed to provide a conservative estimate of the potential risks (see Subsection 4.2.2.3).

4.2.2 Carcinogenic Risk Evaluation

A major focus of this risk assessment was on the carcinogenic risks associated with exposure to PCB-contaminated sediment (ingestion and direct contact), biota, and air. As discussed in Section 3.0, exposure to copper, lead, and cadmium was not evaluated for potential carcinogenic risks.

Incremental carcinogenic risk estimates were developed based on subchronic, chronic, and lifetime exposures to PCBs and are presented in summary tables throughout this subsection. Chronic exposures to PCBs were considered most representative of probable exposure durations for the population within the New Bedford Harbor site area, given that a relatively large percentage of the population reported living in this area for more than five years (see Section 2.1). Therefore, risk estimates based on chronic exposure were the focus of the carcinogenic risk evaluation. The lifetime and subchronic risk estimates were used as upper and lower bounds of potential risks and to strengthen conclusions regarding risks associated with a particular route of exposure. The lifetime risks were estimated by summing the incremental risks associated with exposure during 0-5 years, 6-16 years and 17-70 years.

The carcinogenic risk estimates are based on environmental conditions as they exist in 1986 and assume that contaminant concentrations remain constant over the period of time evaluated. Therefore, the lifetime incremental carcinogenic risk estimates assume that PCB concentrations in sediment and biota remain constant over 70 years. This assumption may overestimate the actual exposure dose and subsequent risk.

Carcinogenic risk estimates developed for each route of exposure were evaluated with reference to the Superfund target range of 10^{-4} to 10^{-7}. Additional criteria used to evaluate the significance of these risk estimates included the contaminant distribution for both the general areas (Areas I, II, and III) and the specific exposure locations within each area; the ease of access to and the physical conditions at exposure locations; and the assumed exposure parameters, including frequency and duration of exposure. The discussion of carcinogenic risks for the New Bedford Harbor site is presented by medium for the significant routes of exposure in the following subsections.

4.2.2.1 Sediment

Two routes of exposure (i.e., direct contact with and ingestion of contaminated sediment) were evaluated in the exposure assessment. The risks associated with these routes of exposure are presented in the following paragraphs.

Direct Contact with Sediment. Risks from direct contact exposure to PCB-contaminated sediment were assessed separately for area-wide mean contaminant concentrations in Areas I, II, and III, and for location-specific mean and maximum concentrations within these areas (see Figure 2-7). Wading, shellfishing, and fishing were activities considered most likely to result in contaminant exposure. Because these activities occur in shoreline areas, the exposure concentrations used to assess direct contact exposure were based on contaminant levels detected in the shoreline sediment. Concentrations of PCBs detected in midchannel sediment were not included as part of this evaluation. The incremental carcinogenic risks associated with these exposure scenarios are in Table 4-7 and summarized by area in the following paragraphs.

Area I. Exposure to sediment in Area I was considered likely for all age classes based on the ease of access to the shoreline, the large mudflat areas suitable for clamming, and the high population density around this area. Because of the large range of contaminant concentrations detected in shoreline sediment from this area (ND to 6,393 ppm), separate evaluations were made for the upper and lower halves of the estuary and the Cove Area.

The incremental carcinogenic risks associated with direct contact exposure were greatest for children and older children. The risk estimates for these age classes range from within to greater than the target range for all subdivisions of Area I even under probable exposure conditions. The risk estimates for adults also exceeded the 10^{-4} risk level. Under conservative exposure assumptions, these risks were as high as $2x10^{-2}$ for chronic exposures by children and older children. The relatively high risk estimates generated for all three areas, in addition to the ease of access and likely land-use indicates a potential risk to public health. Methods to reduce these risks will be addressed in the FS.

Area II. The risk associated with direct contact exposure to sediment from Area II focused on locations where recreational activities were likely to occur. A majority of the shoreline in Area II is not readily accessible since the private property abutting the shoreline is fenced off. In addition, much of the land use in this area is classified as industrial. However, three locations within Area II are accessible and support

TABLE 4-7. CARCINOGENIC RISK ESTIMATES FOR DIRECT CONTACT WITH SEDIMENTS; CHILDREN; OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Location of Exposure	PCB Concentration (ppm)	CHILD Incremental Risks		OLDER CHILD Incremental Risks		ADULT Incremental Risks		Life time (70 yrs)
		Sub-Chronic (1 year)	Sub-Chronic (5 years)	Sub-Chronic (1 year)	Chronic (10 year)	Sub-Chronic (1 year)	Chronic (10 year)	
AREA I								
Upper Est.								
Prob.	378	2.7E-06	1.4E-05	2.6E-05	2.6E-04	1.0E-05	1.0E-04	8.2E-04
Cons.	6393	1.0E-03	5.1E-03	2.2E-03	2.2E-02	1.4E-03	1.4E-02	1.0E-01
Lower Est.								
Prob.	149	1.1E-06	5.4E-06	1.0E-05	1.0E-04	4.1E-06	4.1E-05	3.3E-04
Cons.	399	6.4E-05	3.2E-04	1.4E-04	1.4E-03	9.0E-05	9.0E-04	6.7E-03
Cove Area								
Prob.	286	2.1E-06	1.0E-05	2.0E-05	2.0E-04	7.9E-06	7.9E-05	6.4E-04
Cons.	399	6.4E-05	3.2E-04	1.4E-04	1.4E-03	9.0E-05	9.0E-04	6.7E-03
AREA II								
Entire Area								
Prob.	21	3.0E-06	1.5E-05	1.5E-06	1.5E-05	5.6E-07	5.6E-06	6.1E-05
Cons.	125	9.9E-05	4.9E-04	4.3E-05	4.3E-04	2.8E-05	2.8E-04	2.5E-03
Palmer Is.								
Prob.	3	4.4E-07	2.2E-06	2.2E-07	2.2E-06	8.4E-08	8.4E-07	9.0E-06
Cons.	11	9.1E-06	4.5E-05	4.0E-06	4.0E-05	2.6E-06	2.6E-05	2.3E-04
Popes Is.								
Prob.	11	1.6E-06	8.0E-06	7.6E-07	7.6E-06	3.0E-07	3.0E-06	3.2E-05
Cons.	34	2.7E-05	1.4E-04	1.2E-05	1.2E-04	7.7E-06	7.7E-05	6.8E-04
Marsh Island								
Prob.	8	1.2E-06	5.6E-06	5.5E-07	5.5E-06	2.2E-07	2.2E-06	2.3E-05
Cons.	22	1.7E-05	8.7E-05	7.8E-06	7.8E-05	4.9E-06	4.9E-05	4.3E-04
AREA III								
Entire Area								
Prob.	3.7	5.3E-07	2.7E-06	2.6E-07	2.6E-06	1.0E-07	1.0E-06	1.1E-05
Cons.	29	2.3E-05	1.2E-04	1.0E-05	1.0E-04	6.6E-06	6.6E-05	5.8E-04
Ft. Phoenix								
Prob.	0.6	8.5E-08	4.2E-07	4.1E-08	4.1E-07	1.6E-08	1.6E-07	3.3E-05
Cons.	0.75	6.0E-07	3.0E-06	2.6E-07	2.6E-06	1.7E-07	1.7E-06	9.4E-05
Ft. Rodman								
Prob.	2.1	3.1E-07	1.5E-06	1.5E-07	1.5E-06	5.9E-07	5.9E-06	3.9E-06
Cons.	7.1	5.7E-06	2.8E-05	2.5E-06	2.5E-05	1.6E-06	1.6E-05	6.3E-05

The cancer potency factor for PCBs is 7.7 (mg/kg-day)-1
Prob. = Probable exposure conditions.
Cons. = Conservative exposure conditions.
Lifetime = Incremental carcinogenic risks for a 70 year exposure.

recreational land uses. These are: Popes Island, Marsh Island, and Palmer Island.

The PCB concentration in shoreline sediment was lowest for the Palmer Island area (3 ppm mean; 11 ppm maximum) than for Marsh Island (8 ppm mean; 22 ppm maximum) or Popes Island (11 ppm mean; 34 ppm maximum). The incremental carcinogenic risks associated with contaminant exposure around Palmer were greatest for children and older children. Risk estimates based on realistic exposure conditions for these age classes ranged from $2x10^{-7}$ to $2x10^{-6}$. Under more conservative exposure conditions, the risk estimates increased and ranged from $4x10^{-6}$ to $4x10^{-5}$. Lower risks were associated with contaminant exposure by adults.

The concentration distribution of PCBs in sediment from Palmer Island show that 93 percent of the concentrations fall below 5 ppm (Figure 4-1), indicating that the actual exposure in this area is reflected by the assumptions used in the probable exposure scenario (mean concentration 3 ppm; 93 percentile is 5 ppm). Since these risk estimates fall at or below the lower end of the target range, exposure in this area is not considered to present a significant health risk.

The risk estimates generated for exposure to sediment around Marsh Island were greatest for children and older children, and ranged from $5x10^{-7}$ to $5x10^{-6}$ under probable exposure conditions and $8x10^{-6}$ to $8x10^{-5}$ under conservative exposure conditions. Risk estimates for adults were lower than those for children. All risk estimates, however, fall within the target range of 10^{-4} to 10^{-7}.

The concentration distribution of PCBs in sediment from the Marsh Island area indicates that 77 percent of the PCB concentrations are less than 8 ppm and similar to the concentration used to assess risk under probable exposure conditions (Figure 4-2). As stated, risk estimates based on exposure by all age classes to 8 ppm PCBs and probable exposure parameters range from $2x10^{-7}$ to $6x10^{-6}$ (Table 4-7). These risk estimates fall within the lower end of the target range and are considered reflective of the likely exposure conditions in this area.

The concentrations of PCBs in sediment from Pope's Island are higher than those detected at either Marsh Island or Palmer Island (Figure 4-3). The risks associated with exposure to this sediment are within or slightly above the target range with two scenarios exceeding a 10^{-4} risk ($1.2x10^{-4}$ and $1.3x10^{-4}$). As with exposure around Palmer and Marsh Island, the incremental carcinogenic risks were greatest for children and older children. These risks ranged from $8x10^{-7}$ to $8x10^{-6}$ under

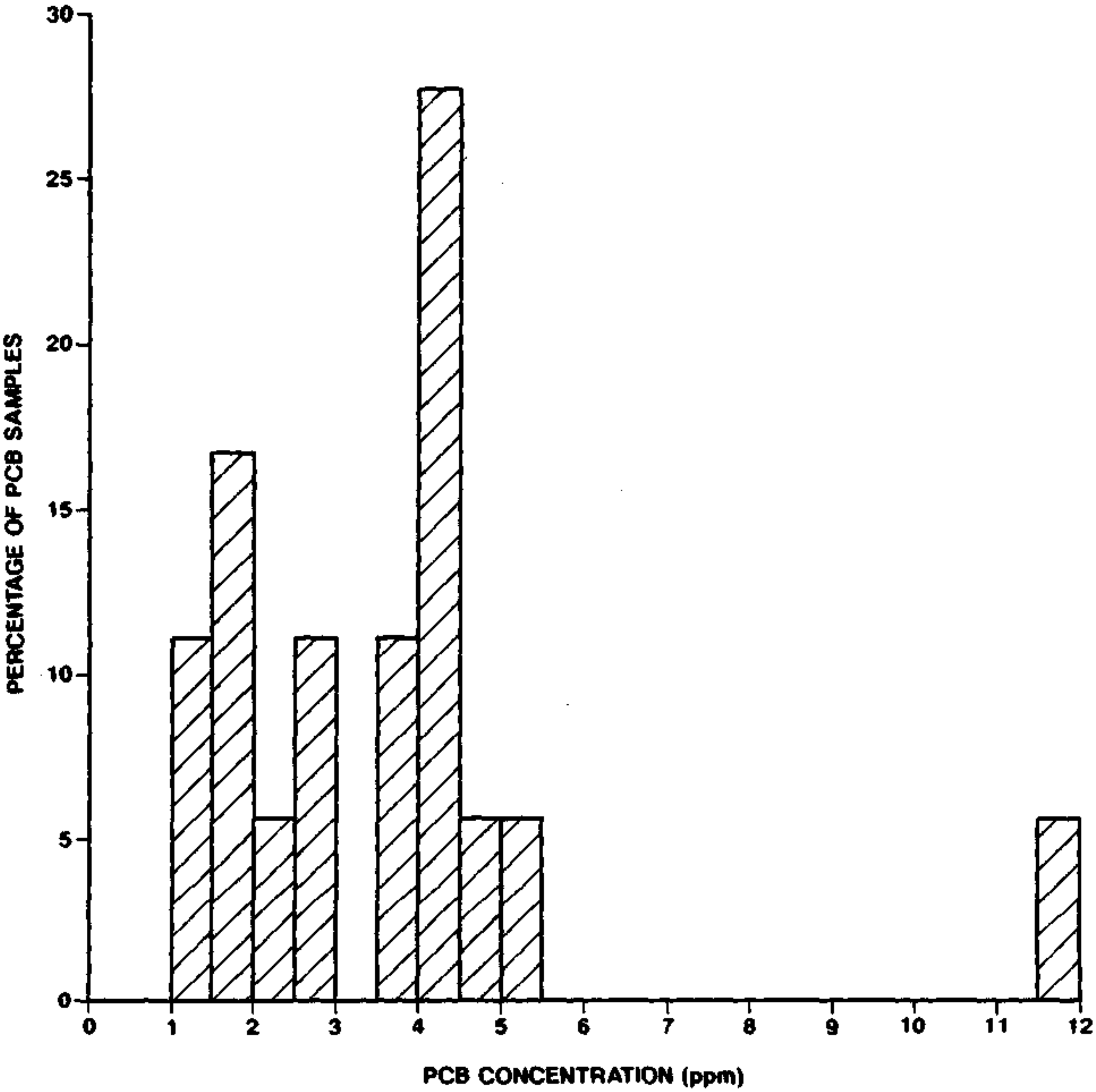

FIGURE 4-1
PCB DISTRIBUTION IN SEDIMENT
IN THE PALMER ISLAND AREA (AREA II)
NEW BEDFORD, MASSACHUSETTS

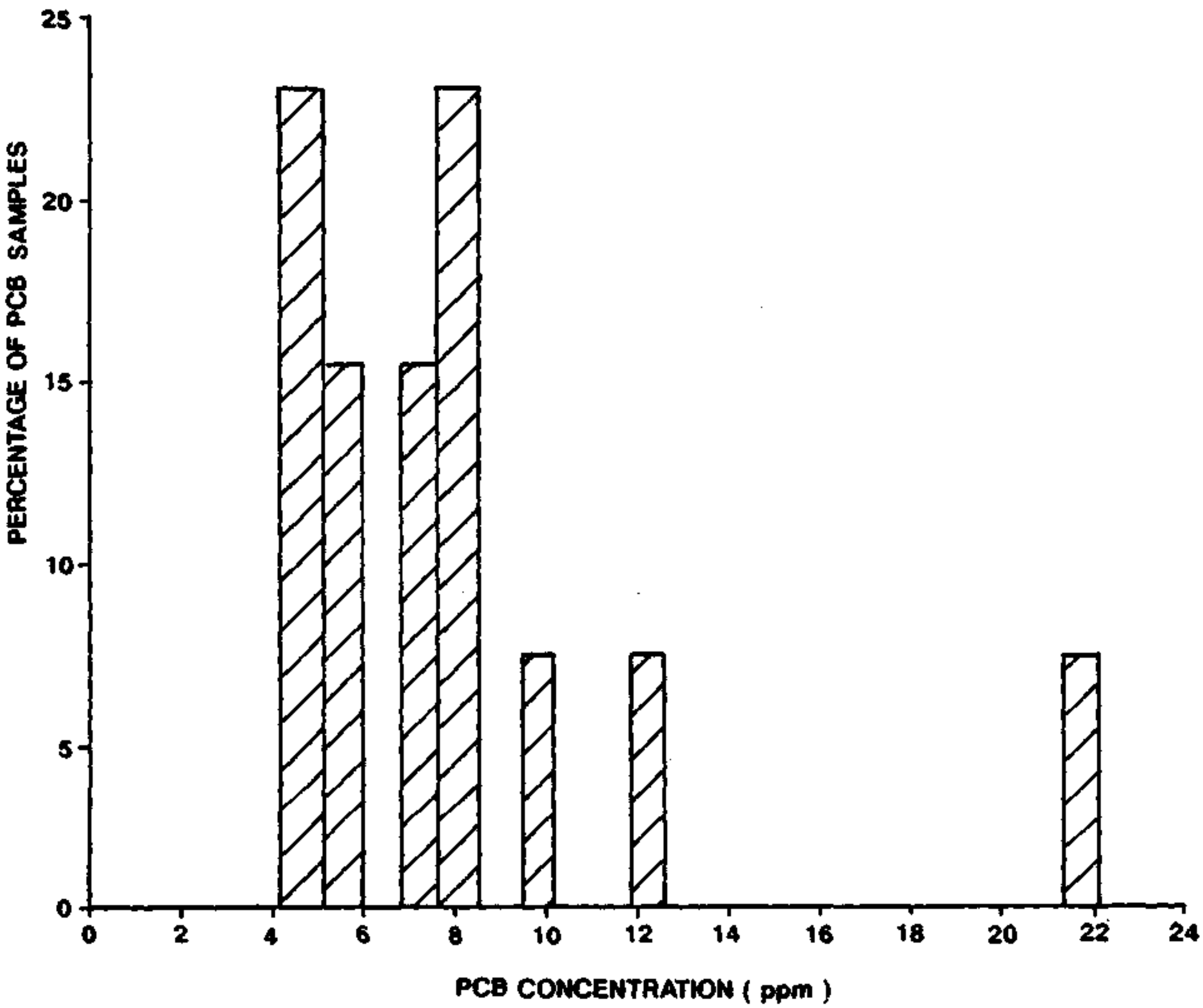

FIGURE 4-2
PCB DISTRIBUTION IN SEDIMENT
IN THE MARSH ISLAND AREA (AREA II)
NEW BEDFORD, MASSACHUSETTS

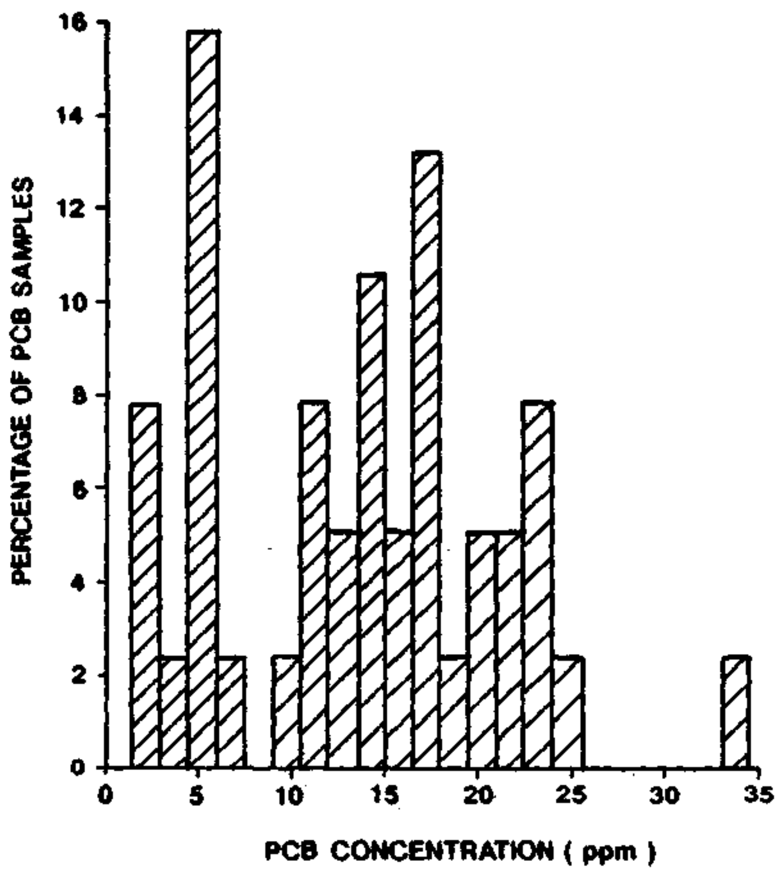

FIGURE 4-3
PCB DISTRIBUTION IN SEDIMENT
IN THE POPES ISLAND AREA (AREA II)
NEW BEDFORD, MASSACHUSETTS

probable exposure conditions and $1x10^{-5}$ to $1x10^{-4}$ under conservative exposure conditions. Because the 50th percentile of PCB concentrations from this area is greater than the mean concentration used to evaluate risk under probable exposure conditions, the risks estimated under conservative exposure conditions are considered to reflect likely exposure conditions in this area. Because these risk estimates span the target range with two scenarios exceeding a 10^{-4} risk, methods to reduce these risks will be addressed in the FS.

Area III. Direct contact exposure to sediment in Area III was assessed separately for the Fort Rodman (2.1 ppm mean; 7.1 ppm maximum) and Fort Phoenix (0.6 ppm mean; 0.8 ppm maximum) state park areas. The incremental risks estimated for all age classes for these locations range from $2x10^{-8}$ to $3x10^{-5}$. Under the probable exposure conditions, risks ranged from $2x10^{-8}$ to $2x10^{-6}$.

The concentration distribution of PCBs in sediment from the beach areas indicates that exposure is likely to occur at concentrations similar to those assumed under the probable exposure conditions. Seventy-five percent of samples had PCB concentrations less than 5 ppm from the Fort Rodman area, and less than 0.65 ppm for Fort Phoenix area (Figures 4-4 and 4-5). Risks associated with exposure to sediment from these areas are reflected by those calculated under probable exposure conditions. The low frequency of detection of highly contaminated sediment, combined with carcinogenic risks that are less than $2x10^{-6}$ suggests minimal public health risks from exposure to this sediment.

Ingestion of Sediment. Ingestion of sediment is considered an age-related exposure pathway that is most significant for ages 2 through 5. For the New Bedford Harbor site area, exposure through the ingestion of contaminated sediment is considered likely for the Cove Area of Area I and the beaches (Fort Rodman and Fort Phoenix) located in Area III (see Figure 2-7). These locations represent areas where children may play. Access to shoreline sediment in other locations in Areas I and II is considered unlikely given that industrial land use accounts for the majority of shoreline, and that children ages 2 through 5 are generally not unsupervised or sufficiently mobile to gain access to such areas. However, because access to these other areas is not restricted, exposure is possible. Therefore, the carcinogenic risks associated with exposure to sediment in all locations were evaluated. The incremental carcinogenic risks to young children are listed in Table 4-8 and summarized by area in the following paragraphs.

Area I. The incremental carcinogenic risks associated with the ingestion of sediment were greatest for exposure to sediment in

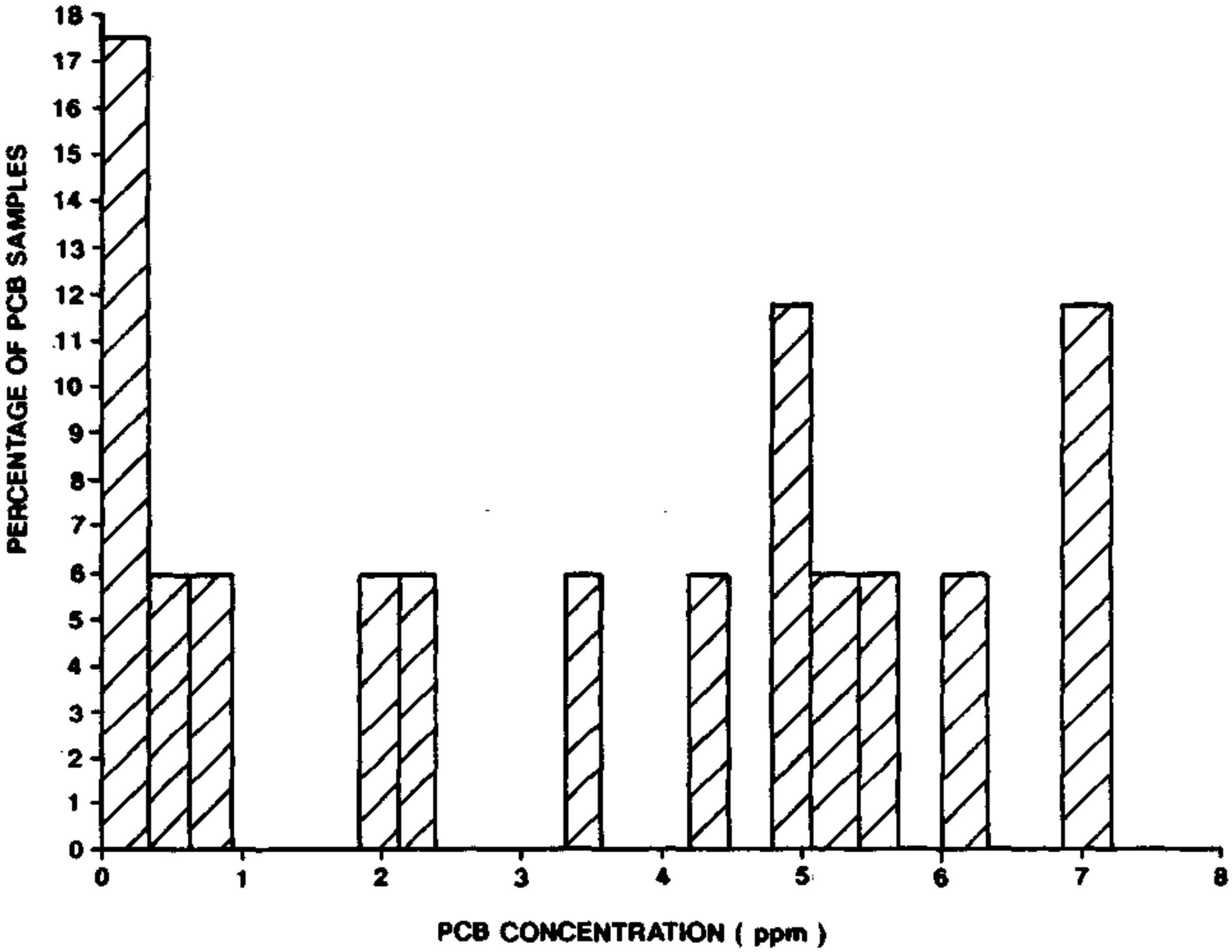

FIGURE 4-4
PCB DISTRIBUTION IN SEDIMENT IN THE FORT RODMAN BEACH AREA (AREA III)
NEW BEDFORD, MASSACHUSETTS

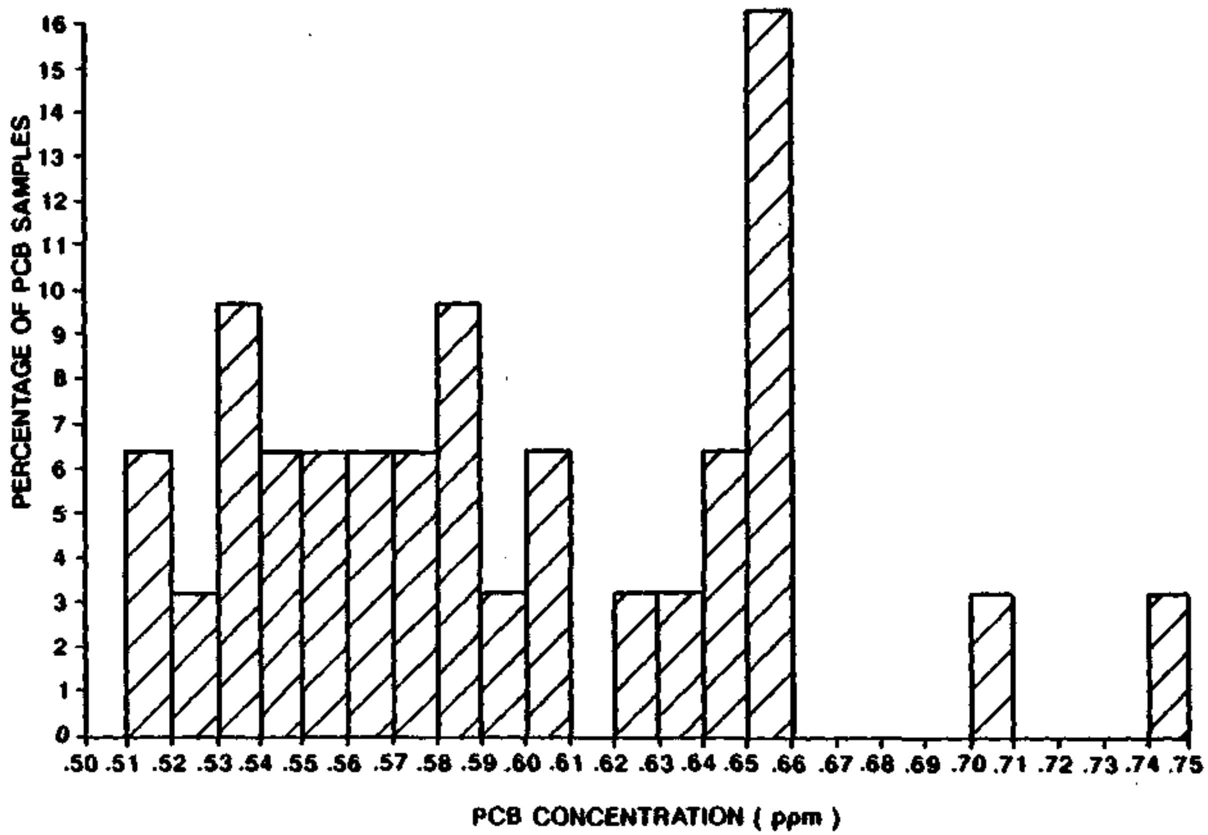

FIGURE 4-5
PCB DISTRIBUTION IN SEDIMENT IN THE FORT
PHOENIX BEACH AREA (AREA III)
NEW BEDFORD, MASSACHUSETTS

TABLE 4-8. CARCINOGENIC RISK ESTIMATES FROM THE INGESTION OF SEDIMENTS; CHILDREN; NEW BEDFORD, MASSACHUSETTS.

Location of Exposure	PCB Concentration (ppm)	CHILD Incremental Risks Sub-Chronic (1 year)	Sub-Chronic (5 years)	OLDER CHILD Sub-Chronic (1 year)	Chronic (10 year)	ADULT Sub-Chronic (1 year)	Chronic (10 year)	Life time (70 yrs)
AREA I								
Upper Estuary								
Prob.	378	5.60E-06	2.80E-05	NA	NA	NA	NA	2.80E-05
Cons.	6393	1.90E-03	9.60E-03	NA	NA	NA	NA	9.60E-03
Lower Estuary								
Prob.	149	2.20E-06	1.10E-05	NA	NA	NA	NA	1.10E-05
Cons.	399	1.20E-04	6.00E-04	NA	NA	NA	NA	6.00E-04
Cove Area								
Prob.	286	4.30E-06	2.10E-05	NA	NA	NA	NA	2.10E-05
Cons.	399	1.20E-04	6.00E-04	NA	NA	NA	NA	6.00E-04
AREA II								
Popes Island								
Prob.	11	3.20E-06	1.60E-05	NA	NA	NA	NA	1.60E-05
Cons.	34	5.10E-05	2.50E-04	NA	NA	NA	NA	2.50E-04
Palmer Island								
Prob.	3	9.00E-07	4.50E-06	NA	NA	NA	NA	4.50E-06
Cons.	11	1.70E-05	8.30E-05	NA	NA	NA	NA	8.30E-05
Marsh Island								
Prob.	8	2.40E-06	1.20E-05	NA	NA	NA	NA	1.20E-05
Cons.	22	3.30E-05	1.60E-04	NA	NA	NA	NA	1.60E-04
AREA III								
Ft.Rodman								
Prob.	2.1	6.30E-07	3.10E-06	NA	NA	NA	NA	3.10E-06
Cons.	7.1	1.00E-05	5.30E-05	NA	NA	NA	NA	5.30E-05
Ft. Phoenix								
Prob.	0.6	1.80E-07	9.00E-07	NA	NA	NA	NA	9.00E-07
Cons.	0.7	1.00E-06	5.20E-06	NA	NA	NA	NA	5.20E-06

The cancer potency factor for PCBs is 7.7 (mg/kg-day)-1
Prob. = Probable exposure conditions.
Cons. = Conservative exposure conditions.
Lifetime = Incremental carcinogenic risks for a 70 year exposure.

the Upper Estuary Area of Area I. The risks estimated based on exposure in this area were within or exceeded the target range of 10^{-4} to 10^{-7} ($6x10^{-6}$ to $1x10^{-2}$). The PCB exposure-point concentrations were 378 and 6,393 ppm. However, since young children are not expected to have access to these areas the risks estimated may not reflect actual exposure conditions.

The risk estimates for exposure to sediment from the Cove Area are considered more representative of potential exposure conditions because this area is located near a playground. The risk estimates based on ingestion of sediment from the Cove Area fall within or exceed the target range ($4x10^{-6}$ to $6x10^{-4}$). The assumed exposure concentrations in this area were 286 and 399 ppm of PCBs. The PCB distribution in shoreline sediment from the Cove Area shows that over 80 percent of this sediment have concentrations between 250 and 400 ppm (Figure 4-6), indicating that exposure to sediment in this area is likely to occur at concentrations similar to those used to assess risk. Because these risk estimates are based on realistic exposure conditions, they are considered to represent a public health risk; methods to reduce these risks will be developed in the FS.

Area II. The risk estimates based on ingestion of sediment from Area II ranged from $9x10^{-7}$ to $2x10^{-4}$, with the majority of risk values falling between 10^{-5} and 10^{-6}. Risks associated with exposure to sediment were lower at the Palmer Island area ($9x10^{-7}$ to $8x10^{-5}$) than Marsh Island ($2x10^{-6}$ to $2.x10^{-4}$) or Popes Island ($3x10^{-6}$ x $2x10^{-4}$). The higher risk estimates are associated with exposure under conservative conditions.

The highest risk estimates for this route of exposure are associated with chronic exposure to sediment from the Pope Island and Marsh Island area. Because these values exceed the target range, they may present a public health risk. As such, methods to reduce these risks will be evaluated in the FS.

Area III. The risk estimates generated based on ingestion exposure to sediment in the southern portion of New Bedford Harbor are lower than those estimated for Areas I or II. Specific locations within Area III, where exposure was considered likely to occur, included the beaches at Fort Rodman and Fort Phoenix state parks. The concentrations used to assess exposure at these areas ranged from 0.6 to 7.1 ppm PCBs. The risk estimates generated for these areas are below or within the lower end of the target range (the highest risk estimate was $5x10^{-5}$).

The concentration distribution in sediment from these areas suggests that exposure is more likely to occur at concentrations similar to those evaluated under the probable exposure scenario

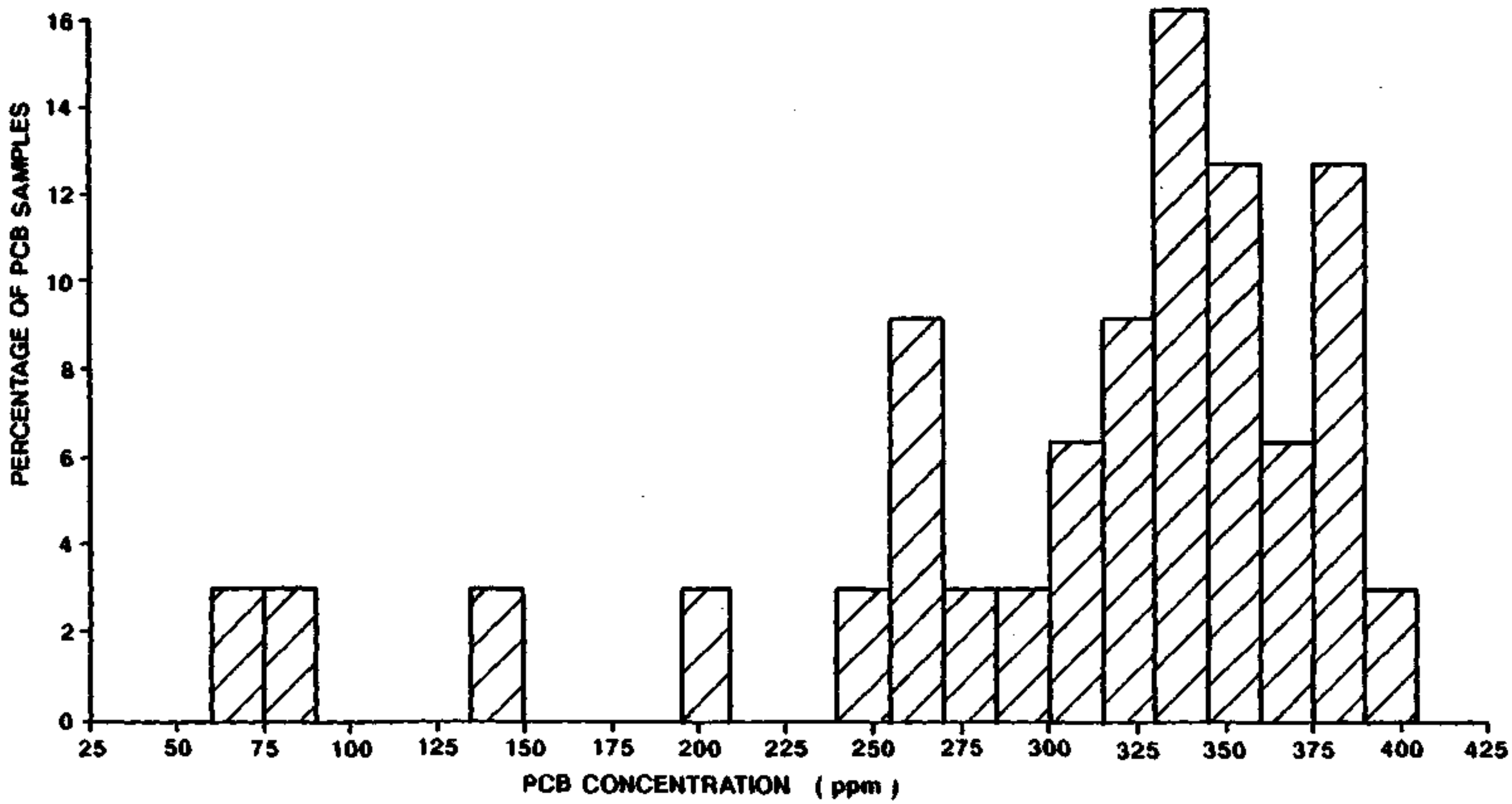

FIGURE 4-6
PCB DISTRIBUTION IN SEDIMENT IN THE COVE AREA
(AREA I)
NEW BEDFORD, MASSACHUSETTS

(3 to 5 ppm) (see Figures 4-4 and 4-5). Therefore, the risk estimates generated under probable exposure conditions are considered to best reflect the potential risks associated with this route of exposure. These values fall within the lower end of the target range and are between $2x10^{-7}$ and $3x10^{-6}$.

Summary. Risk from direct contact and ingestion of contaminated shoreline sediment is greatest for Area I. Exposure to sediment in all three subdivisions of this area (i.e., Upper Estuary, Lower Estuary, and Cove Area) resulted in risks for all age classes exceeding the target range of 10^{-4}. Risks were high even under probable exposure conditions (i.e., mean concentrations and probable exposure parameters). Exposure through direct contact to and ingestion of sediment around the Popes Island area was within or above the target range. Young children were considered to be at greater risk from contaminant exposure in this area than older children or adults. Ingestion of sediment from the Marsh Island area was associated within or above the target range. Methods to reduce risks associated with these exposure scenarios will be addressed in the FS. Exposure to sediment from other locations in Areas II and III was not considered to present a public health risk.

4.2.2.2 Biota

Exposure to PCBs through the ingestion of biota was assessed separately for lobster, winter flounder, and clams. These species were considered representative of biota most commonly consumed in the New Bedford Harbor site area. Exposure frequencies of one fish meal per day, per week, and per month were assessed. As discussed in Section 2.5.2 and presented in Table 2-9, the majority of the population in this area consumes fish less than once per month but greter than once per year. Each scenario assumes that the particular species evaluated comprises total seafood consumption. Incremental carcinogenic risk estimates for this route of exposure are in Table 4-9.

Risk estimates were derived for subchronic, chronic, and lifetime exposure durations, to the mean and maximum PCB concentrations detected in these species. As discussed in Section 2.5.2, the edible-tissue PCB concentration was used when available. PCB concentrations in the winter flounder, lobster (without tomalley), and clams ranged from 0.039 to 2.7 ppm, with only two concentrations greater than 2 ppm (see Table 2-9). Lobster concentration in edible tissue including tomalley ranged from 0.4 to 2.3 ppm (Pruell, 1988). Risks from ingestion of biota were evaluated separately for each area.

Area 1. Risk estimates based on exposure to biota obtained from Area 1 exceed the 10^{-4} risk level for the majority of exposure conditions evaluated. The best indicator of potential risks

TABLE 4-9. CARCINOGENIC RISK ESTIMATES FOR THE INGESTION OF BIOTA; CHILDREN; OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Area of Exposure	PCB Concentration (ppm)	CHILD Incremental Risks Sub-Chronic (1 year)	CHILD Incremental Risks Chronic (5 year)	OLDER CHILD Incremental Risks Sub-Chronic (1 year)	OLDER CHILD Incremental Risks Chronic (10 year)	ADULT Incremental Risks Sub-Chronic (1 year)	ADULT Incremental Risks Chronic (10 year)	Life time (70 yrs)
AREA 1								
Lobster								
Prob. daily	0.52	NA	NA	NA	NA	NA	NA	NA
weekly		NA	NA	NA	NA	NA	NA	NA
monthly		NA	NA	NA	NA	NA	NA	NA
Cons. daily	0.52	NA	NA	NA	NA	NA	NA	NA
weekly		NA	NA	NA	NA	NA	NA	NA
monthly		NA	NA	NA	NA	NA	NA	NA
Clam								
Prob. daily	0.689	8.6E-04	4.3E-03	4.3E-04	4.3E-03	2.4E-04	2.4E-03	2.2E-02
weekly		1.2E-04	6.1E-04	6.1E-05	6.1E-04	3.5E-05	3.5E-04	3.1E-03
monthly		2.8E-05	1.4E-04	1.4E-05	1.4E-04	8.1E-06	8.1E-05	7.3E-04
Cons. daily	2.121	2.6E-03	1.3E-02	1.3E-03	1.3E-02	7.6E-03	7.6E-02	4.4E-01
weekly		3.8E-04	1.9E-03	1.9E-04	1.9E-03	1.1E-04	1.1E-03	9.9E-03
monthly		8.6E-05	4.3E-04	4.3E-05	4.3E-04	2.5E-05	2.5E-04	2.2E-03
Flounder								
Prob. daily	1.039	1.3E-03	6.5E-03	6.5E-04	6.5E-03	3.7E-04	3.7E-03	3.3E-02
weekly		1.8E-04	9.2E-04	9.2E-05	9.2E-04	5.3E-05	5.3E-04	4.8E-03
monthly		4.2E-05	2.1E-04	2.1E-05	2.1E-04	1.2E-05	1.2E-04	1.1E-03
Cons. daily	2.629	3.2E-03	1.6E-02	1.6E-03	1.6E-02	9.3E-04	9.3E-03	8.3E-02
weekly		4.6E-04	2.3E-03	2.3E-04	2.3E-03	1.3E-04	1.3E-03	1.2E-02
monthly		1.0E-04	5.2E-04	5.2E-05	5.4E-04	3.1E-05	3.1E-04	2.8E-03
AREA 2								
Lobster (w/o tomalley)								
Prob. daily	0.57	7.0E-04	3.5E-03	3.5E-04	3.5E-03	2.0E-04	2.0E-03	1.8E-02
weekly		1.0E-04	5.0E-04	5.0E-05	5.0E-04	2.9E-05	2.9E-04	2.6E-03
monthly		2.4E-05	1.2E-04	1.2E-05	1.2E-04	6.7E-06	6.7E-05	6.1E-04
Cons. daily	1.234	1.5E-03	7.7E-03	7.7E-04	7.7E-03	4.4E-04	4.4E-03	4.0E-02
weekly		2.2E-04	1.1E-03	1.1E-04	1.1E-03	6.3E-05	6.3E-04	5.7E-03
monthly		5.0E-05	2.5E-04	2.5E-05	2.5E-04	1.5E-05	1.5E-04	1.3E-03
Lobster (tomalley)								
daily	2.3	2.8E-03	1.4E-02	1.4E-03	1.4E-02	8.1E-04	8.1E-03	7.3E-02
weekly		4.0E-04	2.0E-03	2.0E-04	2.0E-03	1.2E-04	1.2E-03	1.0E-02
monthly		9.7E-05	4.8E-04	4.8E-05	4.8E-04	2.7E-05	2.7E-04	2.5E-03

TABLE 4-9. CARCINOGENIC RISK ESTIMATES FOR THE INGESTION OF BIOTA; CHILDREN; OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Area of Exposure	PCB Concentration (ppm)	CHILD Incremental Risks Sub-Chronic (1 year)	CHILD Incremental Risks Chronic (5 year)	OLDER CHILD Incremental Risks Sub-Chronic (1 year)	OLDER CHILD Incremental Risks Chronic (10 year)	ADULT Incremental Risks Sub-Chronic (1 year)	ADULT Incremental Risks Chronic (10 year)	Life time (70 yrs)
Clam								
Prob. daily	0.231	2.8E-04	1.4E-03	1.4E-04	1.4E-03	8.2E-05	8.2E-04	7.3E-03
weekly		4.0E-05	2.0E-04	2.0E-05	2.0E-04	1.2E-05	1.2E-04	1.1E-03
monthly		9.4E-06	4.7E-05	4.7E-06	4.7E-05	2.7E-06	2.7E-05	2.4E-04
Cons. daily	1.181	1.5E-03	7.4E-03	7.4E-04	7.4E-03	4.2E-04	4.2E-03	3.8E-02
weekly		2.0E-04	1.0E-03	1.0E-04	1.0E-03	6.0E-05	6.0E-04	5.3E-03
monthly		4.8E-05	2.4E-04	2.4E-05	2.4E-04	1.4E-05	1.4E-04	1.3E-03
Flounder								
Prob. daily	0.371	4.6E-04	2.3E-03	2.3E-04	2.3E-03	1.3E-04	1.3E-03	1.2E-02
weekly		6.6E-05	3.3E-04	3.3E-05	3.3E-04	1.9E-05	1.9E-04	1.7E-03
monthly		1.5E-05	7.6E-05	7.6E-06	7.6E-05	4.3E-06	4.3E-05	3.9E-04
Cons. daily	1.048	1.3E-03	6.5E-03	6.5E-04	6.5E-03	3.7E-04	3.7E-03	3.3E-02
weekly		1.9E-04	9.3E-04	9.3E-05	9.3E-04	5.3E-05	5.3E-04	4.8E-03
monthly		4.4E-05	2.2E-04	2.2E-05	2.2E-04	1.2E-05	1.2E-04	1.1E-03
AREA 3								
Lobster (w/o tomalley)								
Prob. daily	0.213	2.6E-04	1.3E-03	1.3E-04	1.3E-03	7.6E-05	7.6E-04	6.8E-03
weekly		3.8E-05	1.9E-04	1.9E-05	1.9E-04	1.1E-05	1.1E-04	9.8E-04
monthly		8.8E-06	4.4E-05	4.4E-06	4.4E-05	2.5E-06	2.5E-05	2.3E-04
Cons. daily	0.351	4.4E-04	2.2E-03	2.2E-04	2.2E-03	1.2E-04	1.2E-03	1.1E-02
weekly		6.2E-05	3.1E-04	3.1E-05	3.1E-04	1.8E-05	1.8E-04	1.6E-03
monthly		1.4E-05	7.2E-05	7.2E-06	7.2E-05	4.1E-06	4.1E-05	3.7E-04
Lobster (tomalley)								
daily	1.4	1.7E-03	8.5E-03	8.5E-04	8.5E-03	5.0E-04	5.0E-03	4.5E-02
weekly		2.3E-04	1.2E-03	1.2E-04	1.2E-03	7.2E-05	7.2E-04	6.3E-03
monthly		5.8E-06	2.9E-05	2.9E-06	2.9E-05	1.6E-05	1.6E-04	9.6E-04
Clam								
Prob. daily	0.156	1.9E-04	9.7E-04	9.7E-05	9.7E-04	5.6E-05	5.6E-04	5.0E-03
weekly		2.8E-05	1.4E-04	1.4E-05	1.4E-04	7.9E-06	7.9E-05	7.1E-04
monthly		6.4E-06	3.2E-05	3.2E-06	3.2E-05	1.8E-06	1.8E-05	1.6E-04
Cons. daily	0.478	6.0E-04	3.0E-03	3.0E-04	3.0E-03	1.7E-04	1.7E-03	1.5E-02
weekly		8.4E-05	4.2E-04	4.2E-05	4.2E-04	2.4E-05	2.4E-04	2.2E-03
monthly		2.0E-05	9.8E-05	9.8E-06	9.8E-05	5.6E-06	5.6E-05	5.0E-04

TABLE 4-9. CARCINOGENIC RISK ESTIMATES FOR THE INGESTION OF BIOTA; CHILDREN; OLDER CHILDREN AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Area of Exposure	PCB Concen-tration (ppm)	CHILD Incremental Risks Sub-Chronic (1 year)	CHILD Incremental Risks Chronic (5 year)	OLDER CHILD Incremental Risks Sub-Chronic (1 year)	OLDER CHILD Incremental Risks Chronic (10 year)	ADULT Incremental Risks Sub-Chronic (1 year)	ADULT Incremental Risks Chronic (10 year)	[redacted] (70 yrs)
Flounder								
Prob. daily	0.278	3.4E-04	1.7E-03	1.7E-04	1.7E-03	9.9E-05	9.9E-04	8.8E-03
weekly		5.0E-05	2.5E-04	2.5E-05	2.5E-04	1.4E-05	1.4E-04	1.3E-03
monthly		1.1E-05	5.7E-05	5.7E-06	5.7E-05	3.3E-06	3.3E-05	3.0E-04
Cons. daily	0.825	1.0E-03	5.1E-03	5.1E-04	5.1E-03	2.9E-04	2.9E-03	2.6E-02
weekly		1.5E-04	7.3E-04	7.3E-05	7.3E-04	4.2E-05	4.2E-04	3.8E-03
monthly		3.4E-05	1.7E-04	1.7E-05	1.7E-04	9.7E-05	9.7E-04	5.7E-03
[redacted]								
Lobster (w/o tomalley)								
Prob. daily	0.069	8.0E-05	4.0E-04	4.0E-05	4.0E-04	2.3E-05	2.3E-04	2.1E-03
weekly		1.1E-05	5.7E-05	5.7E-06	5.7E-05	3.2E-06	3.2E-05	2.9E-04
monthly		2.6E-06	1.3E-05	1.3E-06	1.3E-05	7.5E-07	7.5E-06	6.7E-05
Cons. daily	0.176	2.2E-04	1.1E-03	1.1E-04	1.1E-03	6.3E-05	6.3E-04	5.7E-03
weekly		3.2E-05	1.6E-04	1.6E-05	1.6E-04	8.9E-06	8.9E-05	8.1E-04
monthly		7.2E-06	3.6E-05	3.6E-06	3.6E-05	2.1E-06	2.1E-05	1.9E-04
Lobster (tomalley)								
daily	0.4	4.6E-04	2.3E-03	2.3E-04	2.3E-03	1.3E-04	1.3E-03	1.2E-02
weekly		6.6E-05	3.3E-04	3.3E-05	3.3E-04	1.9E-05	1.9E-04	1.7E-03
monthly		1.5E-05	7.5E-05	7.5E-06	7.5E-05	4.3E-06	4.3E-05	3.9E-04
Clam								
Prob. daily	0.039	5.0E-05	2.5E-04	2.5E-05	2.5E-04	1.4E-05	1.4E-04	1.3E-03
weekly		7.0E-06	3.5E-05	3.5E-06	3.5E-05	2.0E-06	2.0E-05	1.8E-04
monthly		1.6E-06	8.1E-06	8.1E-07	8.1E-06	4.7E-07	4.7E-06	4.2E-05
Cons. daily	0.137	1.7E-04	8.5E-04	8.5E-05	8.5E-04	4.9E-05	4.9E-04	4.4E-03
weekly		2.4E-05	1.2E-04	1.2E-05	1.2E-04	6.9E-06	6.9E-05	6.2E-04
monthly		5.6E-06	2.8E-05	2.8E-06	2.8E-05	1.6E-06	1.6E-05	1.4E-04
Flounder								
Prob. daily	0.101	1.3E-04	6.3E-04	6.3E-05	6.3E-04	3.6E-05	3.6E-04	3.2E-03
weekly		1.8E-05	9.0E-05	9.0E-06	9.0E-05	5.1E-06	5.1E-05	4.6E-04
monthly		4.2E-06	2.1E-05	2.1E-06	2.1E-05	1.2E-06	1.2E-05	1.1E-04
Cons. daily	0.339	4.2E-04	2.1E-03	2.1E-04	2.1E-03	1.2E-04	1.2E-03	1.1E-02
weekly		6.0E-05	3.0E-04	3.0E-05	3.0E-04	1.7E-05	1.7E-04	1.5E-03
monthly		1.4E-05	7.0E-05	7.0E-06	7.0E-05	4.0E-06	4.0E-05	3.6E-04

The cancer potency factor for PCBs is 7.7 (mg/kg-day)-1
Prob. = Probable exposure conditions.
Cons. = Conservative exposure conditions.
Lifetime = Incremental carcinogenic risk for 70 year exposure.
NA = Data not available.

from exposure to biota from this area is the clam because this organism is sessile and lives its entire life within the contaminated sediment from this area. (Winter flounder is a migratory species and spends a portion of its life cycle outside the contaminated area; lobster is not expected to inhabit this area because of the physical and chemical conditions of the Upper Estuary.) Risk estimates based on ingestion of clams fall within or exceed the target range of 10^{-4} to 10^{-7}. These estimates range from $8x10^{-6}$ to $2x10^{-2}$. Risk estimates for ingestion of winter flounder range from $1x10^{-5}$ to $2x10^{-2}$. Because of the frequency and magnitude to which these values exceed the target range, methods to reduce risks associated with ingestion of biota will be addressed in the FS.

Area 2. Incremental carcinogenic risk estimates based on consumption of biota obtained for Area 2 were within or exceeded the target range of 10^{-4} to 10^{-7}. Chronic exposure through the daily or weekly ingestion of any species (i.e., clam, lobster, or winter flounder) containing the mean PCB concentration resulted in risk estimates that exceed $3x10^{-5}$. Ingestion of lobster (including the tomalley) presented the highest risks. These risks ranged from $3x10^{-5}$ to $2x10^{-2}$. Methods to reduce risks from ingestion of biota from this area will be considered in the FS.

Area 3. Exposure through the consumption of biota obtained from Area 3 results in incremental risks in excess of 10^{-4} for most scenarios. Risks in excess of $6x10^{-5}$ are noted even when assuming probable exposure conditions. Methods to reduce these risks will be addressed in the FS. As in Area 2, ingestion of lobsters (including the tomalley) presented the greatest risk.

Area 4. Biota concentrations detected in Area 4 were lower than other areas (0.039 to 0.4 ppm). However, risk estimates based on exposure to PCB concentrations observed in biota from this area still fall within or above the target range ($2x10^{-6}$ to $2x10^{-3}$). Methods to reduce these risks will be addressed in the FS. The highest risks were associated with ingestion of lobster (including the tomalley).

Summary. Risks from ingestion of contaminated biota, when assessed for all species and areas, fall within or exceed the target range for most scenarios, even when assuming probable exposure conditions (see Table 4-9). The highest risks were associated with the ingestion of lobster including the tomalley. Risks associated with ingestion of lobster excluding tomalley were consistently lower, indicating that persons who consume tomalley are potentially at greater risk from PCB exposure than persons who do not consume tomalley. In addition, high incremental carcinogenic risks are estimated for lifetime exposure to PCBs from this route of exposure. Many of the lifetime exposure scenarios exceed the $1x10^{-3}$ risk level.

Methods to reduce the risks from contaminant exposure via ingestion of biota will be addressed in the FS.

4.2.2.3 Air

Limited data were available to assess risks associated with inhalation exposure to PCBs. Risk estimates associated with the probable and conservative scenarios for subchronic and chronic exposures ranged from $1x10^{-7}$ to $3x10^{-4}$ and are in Table 4-10. The data available for risk characterization were taken from areas distant from receptor locations and were considered indicative only of maximum concentrations from certain point source areas (i.e., the Hot Spot Area). Therefore, it was difficult to interpret the potential risk to public health from this route of exposure.

An interpretation of the assumed background PCB concentrations of 10 ng/m^3 was also made in this risk assessment (NUS, 1986). Assessing exposure to PCBs at this concentration results in risk estimates at the lower end of the target range (10^{-6} to 10^{-7}). The conservative nature of the exposure assumptions (i.e., continual exposure, complete absorption, and PCBs exclusively in the vapor phase) in this analysis suggests that actual risks from a background exposure of 10 ng/m^3 may be even lower. The lifetime risk associated with a 70-year exposure duration to the estimated 10 ng/m^3 background level is $8x10^{-6}$.

4.2.3 Risk Summary

The noncarcinogenic and carcinogenic risks associated with exposure to PCBs, cadmium, copper, and lead are summarized by route of exposure in the following subsections.

4.2.3.1 Direct Contact with Sediment

Noncarcinogenic and carcinogenic risks associated with direct contact exposure to PCB-, cadmium-, copper-, and lead-contaminated sediment were evaluated separately for Areas I, II, and III, and focused on locations within these areas where exposure was likely to occur. Contaminant concentrations detected in shoreline sediments were used when available.

Noncarcinogenic risk estimates for exposure to sediment in Area I exceeded 1 under the majority of scenarios evaluated and ranged from 0.7 to 200. Exposure to PCBs accounted for the majority of the risk. Individual risk ratios for cadmium, copper, and lead were all below 1. The noncarcinogenic risk ratios associated with PCB exposure in Area I indicate a potential public health risk. Young children were considered to be at greatest risk.

Exposure to sediment from Areas II and III was associated with noncarcinogenic risk ratios ranging from less than 1 to 3. The

TABLE 4-10. CARCINOGENIC RISK ESTIMATES FOR INHALATION OF AIR; CHILDREN, OLDER CHILDREN, AND ADULTS; NEW BEDFORD, MASSACHUSETTS.

Location of Exposure	PCB Concentration (ng/m3)	CHILD Sub-Chronic (1 year)	CHILD Sub-Chronic (5 years)	OLDER CHILD Sub-Chronic (1 year)	OLDER CHILD Chronic (10 year)	ADULT Sub-Chronic (1 year)	ADULT Chronic (10 year)	Life time (70 yrs)
ALL AREAS								
Background	10	1.80E-07	9.20E-07	1.80E-07	1.80E-06	1.00E-07	1.00E-06	8.00E-06
Prob.	85	1.60E-06	7.80E-06	1.60E-06	1.60E-06	8.80E-07	8.80E-06	6.00E-05
Cons.	471	2.60E-05	1.30E-04	2.60E-05	2.60E-04	1.50E-05	1.50E-04	1.00E-03

The cancer potency factor for PCBs is 7.7 (mg/kg-day)-1
Prob. = Probable exposure conditions.
Cons. = Conservative exposure conditions.
Lifetime = Incremental carcinogenic risks from 70 year exposure.

only risk ratios to exceed 1 were based on conservative exposure assumptions which were not considered representative of likely exposure conditions for these areas. These include long-term repetitive exposure to the maximum detected contaminant concentration. The risk ratios based on more realistic exposure conditions were less than 1. Based on this evaluation, the noncarcinogenic risk for direct contact exposure in Areas II and III was not considered to pose a risk to public health.

The carcinogenic risks associated with direct contact exposure to sediment was greatest for Area I. The risk estimates based on exposure by a child, older child and adult, ranged from $1x10^{-6}$ to $2x10^{-2}$, with the majority of scenarios associated with risks in excess of EPA's target risk range of 10^{-4} to 10^{-7}. Based on this evaluation, methods to reduce these risks will be addressed in the FS.

The carcinogenic risks estimated for Area II assuming probable exposure conditions ranged from $2x10^{-7}$ to $5x10^{-6}$. The only risk estimates exceeding the target range were those associated with exposure to PCBs under conservative exposure conditions. Since these conditions assume repetitive, long-term exposure to the maximum PCB concentration, the associated risks were considered to be overly conservative. As stated, exposure under more realistic conditions were associated with risks in the lower end of the target range.

In Area III, the carcinogenic risks ranged from $1x10^{-8}$ to $2x10^{-6}$ under probable exposure conditions, and from $2x10^{-7}$ to $1x10^{-4}$ under conservative exposure conditions. No risk estimates exceeded EPA's target risk range.

4.2.3.2 Ingestion of Sediment

Exposure through ingestion of sediment was considered to be an age-related activity and most significant for children less than six years. Both noncarcinogenic and carcinogenic risks associated with this route of exposure were evaluated.

Noncarcinogenic risk associated with exposure to cadmium- and copper-contaminated sediment in all three areas was below 1 for all scenarios evaluated. Risk ratios based on exposure to PCB- and lead-contaminated sediment exceeded 1 under certain scenarios. For Area I, risk ratios for PCBs and lead ranged from 11 to 175 and 26 to 33, respectively. The magnitude and extent to which these values exceed 1 indicates that ingestion of sediment from Area I presents a potential health risk to children.

Risk ratios based on ingestion of PCB-contaminated sediment in Area II and III ranged from below 1 to 17. However, risk ratios based on exposure at recreational locations and under probable exposure conditions within these areas were all below 1. Since these scenarios were considered representative of actual exposure conditions, ingestion of sediment from Areas II and III was not considered to present a noncarcinogenic health risk.

The incremental carcinogenic risks associated with exposure through ingestion of sediment were greatest for Area I and ranged from $6x10^{-6}$ to $1x10^{-2}$. These risk estimates were based on exposure to sediment in areas where access by children is considered possible. These risk fall within and exceeded the EPA's target range of 10^{-4} to 10^{-7}. As such, methods to reduce these risks will be addressed in the FS.

The risk estimates based on exposure in Area II ranged from $9x10^{-7}$ to $2x10^{-4}$, with the majority of risk values falling between 10^{-5} and 10^{-6}. Risk estimates based on probable exposure conditions ranged from $9x10^{-7}$ to $2x10^{-5}$. The risks based on exposure in Area III fall within the lower end of the target range and are between $2x10^{-7}$ to $3x10^{-6}$.

Summary of Sediment Exposure. The risks associated with exposure via direct contact with and ingestion of contaminated shoreline sediment are greatest for Area I. Both the carcinogenic and noncarcinogenic risk estimates based on exposure to PCBs in this area exceeded the criteria levels established by EPA. Noncarcinogenic risks based on exposure to metals in this area were below levels considered to represent a public health risk. Methods to reduce these carcinogenic risks from PCB exposure will be evaluated in the FS.

Risk estimates based on exposure to sediment from other areas in the New Bedford Harbor were less than those developed for Area I. Noncarcinogenic risks based on exposure to PCBs and metals were below levels considered to represent a public health concern. Carcinogenic risks associated with probable exposure conditions via direct contact with and ingestion of sediment from Areas II and III ranged from less than 10^{-7} to $8x10^{-5}$. The majority of risks were between 10^{-6} to 10^{-5}. Young children were considered to be at a greater risk from contaminant exposure than either older children or adults.

Risk estimates based on acute exposure to sediment, representing intermittent or once-in-a-lifetime exposure, were not considered to present a public health risk.

4.2.3.3 Ingestion of Aquatic Biota

Exposure to PCBs and metals via ingestion of biota was evaluated for potential noncarcinogenic and carcinogenic risks. Three species were considered in this evaluation: winter flounder, clam, and lobster. Separate scenarios were developed for each species and assumed that 100 percent of the seafood diet was comprised of these species. A standard 8-ounce (i.e., 227 grams) fish meal was assumed for older children and adults and 4-ounce (i.e., 115 grams) fish meal was assumed for younger children.

Risk ratios based on exposure to cadmium and copper by older children and adults ranged from below 1 to 7.9. Ratios in excess of 1 were based on daily ingestion frequencies and whole body tissue concentrations. These conservative assumptions may overestimate the actual risks, suggesting that exposure to cadmium and copper may not present a public health concern. However, exposure to cadmium and copper by children resulted in risk ratios ranging from below 1 to 16. Since young children are more susceptible to contaminant exposure than older children and adults, this route of exposure was considered to present a greater risk to a child's health.

Risk ratios based on exposure to lead and PCBs via ingestion of biota for all age classes exceeded 1 for the majority of scenarios evaluated. No one area or species appeared to consistently present a greater risk from exposure to these compounds. Based on this evaluation, exposure to lead and PCBs through ingestion of biota presents a public health risk.

Incremental carcinogenic risks associated with ingestion of biota fall within or exceed EPA's target range. Many of the scenarios evaluated had associated lifetime risks in excess of 10^{-3}. The risk estimates based on chronic exposure range from $1x10^{-5}$ to $9x10^{-3}$ for Area 1; from $4x10^{-6}$ to $1x10^{-2}$ for Area 2; from $6x10^{-6}$ to $9x10^{-3}$ for Area 3; and from $1x10^{-6}$ to $2x10^{-3}$ for Area 4. Ingestion of lobster, including tomalley, presents the greatest risk from exposure to PCBs.

Methods to reduce the noncarcinogenic risks from exposure to cadmium, copper, lead, and PCBs and carcinogenic risks from exposure to PCBs will be assessed in the FS.

4.2.3.4 Inhalation of Airborne Contaminants

Limited air data were available to assess risks associated with inhalation exposure to PCBs. The data available for risk evaluation were collected from sampling stations distant from receptor location. These areas were chosen to provide a measure of the maximum PCB concentrations in the air above the mudflats in Area I. Using these concentrations to assess potential risk was considered to be overly conservative.

Lifetime exposure to the assumed "background" concentration of 10 ng/m^3 for the New Bedford area was assessed and associated with incremental carcinogenic risks in the 10^{-6} range. These risk estimates were based on conservative exposure conditions, suggesting that actual risks from this route of exposure are less than 10^{-6}.

4.3 OVERALL SITE RISKS

The risk evaluation performed in Section 4.2 focused on the carcinogenic and noncarcinogenic risks from a single exposure pathway. Based on this evaluation, exposure to contaminants through ingestion of and direct contact with sediment in Area I and ingestion of biota from all areas may result in potential risks to human health. PCBs were identified as the major contaminant of concern. Noncarcinogenic risks in excess of EPA's criterion were also attributed to lead exposure through the ingestion of biota (all age classes). In addition, young children (zero to 5 years) were considered to be at a higher risk from cadmium and copper exposure through the ingestion of biota than older children and adults.

The total site risk associated with multimedia and multitoxic exposure was generated by summing the individual risk estimates developed for the ingestion of and direct contact with sediment, ingestion of biota, and inhalation of air. This scenario represents the risks associated with concurrent or sequential exposure to contaminants through multiple exposure pathways. These risk estimates are listed in Table 4-11. Total site risk estimates were evaluated against the MCP criteria of $1x10^{-5}$ incremental carcinogenic risk level and 0.2 noncarcinogenic HI.

The total site risks evaluated in this report were based on chronic exposure via ingestion of, direct contact with, and inhalation of PCBs, cadmium, copper, and lead under probable exposure conditions. The carcinogenic and noncarcinogenic risk estimates for each age class and area assessed exceed 10^{-5} and 0.2, respectively. Based on this evaluation, methods to reduce the overall site risk will be addressed in the FS.

Table 4-11. SUMMARY TABLE OF TOTAL SITE CARCINOGENIC AND NONCARCINOGENIC RISKS - PROBABLE EXPOSURE SCENARIO; NEW BEDFORD, MASSACHUSETTS.

AREA 1 (1)

		Cancer Risk	Hazard Index
YOUNG CHILD			
Ingestion of biota		7.65E-04 (2)	17.00 (3)
Ingestion of sediments (4/5)		1.50E-05	3.40
Direct Contact/Sediments (5)		7.50E-06	0.17
	Total	7.88E-04	20.57
OLDER CHILD			
Ingestion of biota		7.65E-04	8.50
Ingestion of sediments		NE	NE
Direct Contact/Sediments		9.50E-05	0.06
	Total	8.60E-04	8.56
ADULT			
Ingestion of biota		4.40E-04	4.90
Ingestion of sediments		NE	NE
Direct Contact/Sediments		3.75E-05	0.02
	Total	4.78E-04	4.92
LIFETIME			
Ingestion of biota		3.18E-03	
Ingestion of sediments		4.02E-05	
Direct Contact/Sediments		4.29E-04	
	Total	3.65E-03	

AREA 2

		Cancer Risk	Hazard In
YOUNG CHILD			
Ingestion of biota		3.43E-04 (2)	9.43
Ingestion of sediments (4/6)		2.00E-06	1.20
Direct Contact/Sediments (6)		2.65E-06	0.02
	Total	3.48E-04	10.65
OLDER CHILD			
Ingestion of biota		3.43E-04	4.77
Ingestion of sediments		NE	NE
Direct Contact/Sediments		2.60E-06	0.01
	Total	3.46E-04	4.77
ADULT			
Ingestion of biota		2.00E-04	2.67
Ingestion of sediments		NE	NE
Direct Contact/Sediments		1.00E-06	0.01
	Total	2.01E-04	2.68
LIFETIME			
Ingestion of biota		1.45E-03	
Ingestion of sediments		2.00E-06	
Direct Contact/Sediments		1.08E-05	
	Total	1.46E-03	

Table 4-11. SUMMARY TABLE OF TOTAL SITE CARCINOGENIC AND NONCARCINOGENIC RISKS - PROBABLE EXPOSURE SCENARIO; NEW BEDFORD, MASSACHUSETTS.

AREA 3

		Cancer Risk	Hazard Index
YOUNG CHILD			
	Ingestion of biota (2)	1.93E-04	6.40
	Ingestion of sediments	NA	NA
	Direct Contact/Sediments	NA	NA
	Total	1.93E-04	6.40
OLDER CHILD			
	Ingestion of biota	1.93E-04	3.23
	Ingestion of sediments	NE	NE
	Direct Contact/Sediments	NA	NA
	Total	1.93E-04	3.23
ADULT			
	Ingestion of biota	1.10E-04	1.83
	Ingestion of sediments	NE	NE
	Direct Contact/Sediments	NA	NA
	Total	1.10E-04	1.83
LIFETIME			
	Ingestion of biota	4.91E-04	
	Ingestion of sediments	NA	
	Direct Contact/Sediments	NA	
	Total	4.91E-04	

AREA 4

		Cancer Risk	Hazard Index
YOUNG CHILD			
	Ingestion of biota (2)	6.07E-05	4.23
	Ingestion of sediments	NA	NA
	Direct Contact/Sediments	NA	NA
	Total	6.07E-05	4.23
OLDER CHILD			
	Ingestion of biota	6.07E-05	2.13
	Ingestion of sediments	NE	NE
	Direct Contact/Sediments	NA	NA
	Total	6.07E-05	2.13
ADULT			
	Ingestion of biota	3.43E-05	1.23
	Ingestion of sediments	NE	NE
	Direct Contact/Sediments	NA	NA
	Total	3.43E-05	1.23
LIFETIME			
	Ingestion of biota	2.50E-04	
	Ingestion of sediments	NA	
	Direct Contact/Sediments	NA	
	Total	2.50E-04	

1. These Areas correspond geographically to the subdivision of the New Bedford Harbor depicted in Figure 2-5.
2. Cancer risks for ingestion of biota reflect the mean values for the three species evaluated under the weekly ingestion, chronic exposure, probable scenario.
3. Hazard indices for ingestion of biota reflect the mean values for the three species evaluated.
4. Ingestion of sediments was only evaluated for young children.
5. Hazard indices and carcinogenic risk for direct contact with and ingestion of sediments in Area 1 represent the mean values estimated for chronic exposure to sediments from Areas I and II in Tables 4-2, 4-3, 4-7 and 4-8.
6. Hazard indices and carcinogenic risk for direct contact with and ingestion of sediments in Area 1 represent the mean values estimated for chronic exposure to sediments from Areas III in Tables 4-2, 4-3, 4-7 and 4-8.

NE - not evaluated.
NA - data not available.

Area I corresponds geographically to Areas I and II as depicted in Figure 2-4.
Area 2 corresponds geographically to Area III as depicted in Figure 2-4.
Exposure to sediments in Areas 3 and 4 were not evaluated in this risk assessment.

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APPENDIX A

EXPOSURE ASSUMPTIONS AND BODY DOSE CALCULATIONS FOR THE SCREENING SCENANRIOS

TABLE A-1

EXPOSURE ASSUMPTIONS FOR INGESTION OF BIOTA: SCREENING SCENARIO

Exposure Parameter	Value
Average Weight Over Period of Exposure	40 kg
Duration of Exposure	10 years
Frequency of Exposure	52 exp/year
Amount Ingested	227 grams
Gastrointestinal Toxicokinetic Factor	1.0

Contaminant Concentration	Average Daily Exposure Dose
8.2 ug/g (reported by Battelle)	9.5×10^{-4} (mg/kg-day)

3.88.80
0017.0.0

TABLE A-2

EXPOSURE ASSUMPTIONS FOR DIRECT CONTACT WITH SEDIMENTS: SCREENING SCENARIO

Exposure Parameter	Value
Average Weight Over Period of Exposure	40 kg
Duration of Exposure	10 years
Frequency of Exposure	100 exp/year
Amount of Sediment Contacted*	6.6 grams/exp
Dermal Toxicokinetic Factor	0.5

Contaminant Concentration	Average Daily Exposure Dose
17,404 mg/kg (reported by Battelle)	5.7×10^{-2} (mg/kg-day)

* Surface Area (4,415 cm^2) x Deposition Factor (1.5 mg/cm^2) = 6.6 grams/exposure.

3.88.80
0018.0.0

TABLE A-3

EXPOSURE ASSUMPTIONS FOR DIRECT CONTACT WITH SURFACE WATER: SCREENING SCENARIO

Exposure Parameter	Value
Average Weight Over Period of Exposure	40 kg
Duration of Exposure	10 years
Frequency of Exposure	100 exp/year
Hours Exposed	2.6 hrs/exp
Exposed Surface Area	11,900 cm^2
Flux Rate of Contaminant Across Skin	0.5 $mg/cm^2/hr$

Contaminant Concentration	Average Daily Exposure Dose
Weight Fraction of Penetrant in H_2O $\frac{0.035\ mg}{1000\ gm\ H_2O}$ = PCBs	$5.3x10^{-7}$ (mg/kg-day)
$\frac{0.00029\ mg}{1000\ mg\ H_2O}$ = Cadmium	$4.3x10^{-4}$ (mg/kg-day)
$\frac{0.004\ mg}{1000\ mg\ H_2O}$ = Lead	$6.0x10^{-8}$ (mg/kg-day)
$\frac{0.0094\ mg}{1000\ mg\ H_2O}$ = Copper	$1.4x10^{-7}$ (mg/kg-day)

TABLE A-4

EXPOSURE ASSUMPTIONS FOR INCIDENTAL INGESTION OF SURFACE WATER: SCREENING SCENARIO

Exposure Parameter	Value
Average Weight Over Period of Exposure	40 kg
Duration of Exposure	10 years
Frequency of Exposure	100 exp/year
Amount Ingested	100 mls/exp
Gastrointestinal Toxicokinetic Factor	1.0

Contaminant Concentration	Average Daily Exposure Dose
35 μg/ℓ (reported by Battelle)-PCB	$3.4x10^{-6}$ (mg/kg-day)
0.29 μg/ℓ Cadmium	$2.8x10^{-11}$ (mg/kg-day)
4 μg/ℓ Lead	$3.9x10^{-7}$ (mg/kg-day)
9.9 μg/ℓ Copper	$9.1x10^{-7}$ (mg/kg-day)

3.88.80
0020.0.0

TABLE A-5

EXPOSURE ASSUMPTIONS FOR INHALATION OF AIRBORNE CONTAMINANTS: SCREENING SCENARIO

Exposure Parameter	Value
Average Weight Over Period of Exposure	10 kg
Duration of Exposure	5 years
Frequency of Exposure	24 hours/day
Amount Inhaled	5 m^3/day
Respiratory Toxicokinetic Factor	1.0

Contaminant Concentration	Average Daily Exposure Dose
471 ng/m^3 (reported by NUS)	1.7×10^{-5} (mg/kg-day)

3.88.80
0021.0.0

TABLE A-6

EXPOSURE ASSUMPTIONS FOR INGESTION OF SEDIMENTS: SCREENING SCENARIO

Exposure Parameter	Value
Average Weight Over Period of Exposure	10 kg
Duration of Exposure	3 years
Frequency of Exposure	100 exp/year
Amount Ingested	0.5 grams/exp
Gastrointestinal Toxicokinetic Factor	1.0

Contaminant Concentration	Average Daily Exposure Dose
17,404 mg/kg (reported by Battelle)	1.0×10^{-2} (mg/kg-day)

3.88.80
0022.0.0

APPENDIX B

DERIVATION OF THE TOXICOKINETIC FACTORS FOR PCBs

APPENDIX B
PCB TOXICOKINETIC FACTORS FOR USE IN NEW BEDFORD HARBOR RISK ASSESSMENT

Because the dose/response information employed in risk assessments is derived from toxicological studies that are based on administered doses, it is important in a quantitative risk assessment to estimate an administered dose, not an absorbed dose. In comparing two administered doses, it may be necessary to make adjustments if the efficiency of absorption is known or expected to differ because of physiological effects and/or matrix or vehicle effects. The toxicokinetic factor (TKF) is used for this purpose. The TFK is defined as the ratio of the estimated dermal absorption factor for contaminated soil or sediment to the absorption factor for the laboratory toxicology study from which the cancer potency factor or reference dose was derived. Most commonly, this will be a study where the test compound was administered orally. For PCBs, the cancer potency factor was derived from a long-term feeding study with laboratory animals.

PCB TKFs have been developed for two types of contaminated sediment: heavily contaminated sediments in which the concentration of total PCBs exceeds 1 percent; and less contaminated sediments. The two approaches are required because PCBs not adsorbed to matrix matter are present in samples that are contaminated in the percent range. In lesser contaminated sediments, PCBs are adsorbed to matrix components. It is appropriate to consider the effects of matrix components in reducing the bioavailability of PCBs only when the ratio of sediment to PCBs is large, such as when PCBs are present at ppm levels.

To estimate the two TKFs for dermal exposure to contaminated sediments, the following three factors have been derived:

(1) The gastrointestinal absorption factor for the study from which the EPA cancer potency factor was derived (Norback and Weltman, 1985) is estimated at <u>80%</u>.

(2) The dermal absorption factor for pure PCBs is estimated at <u>41%</u>.

(3) The dermal absorption factor for PCBs in sediments contaminated with PCBs at levels below 1% is estimated at <u>5.4%</u>.

The supporting documentation for these estimates appears in the accompanying appendices.

The TKFs for use in risk assessment are derived below:

(A) TKF for highly contaminated sediments ([PCBs]>1%):

$$\text{TKF} = \frac{\text{Absorption, dermal, pure compound}}{\text{Absorption, oral, diet}} = \frac{41\%}{80\%} = 50\% \ (0.50)$$

(B) TKF for moderately contaminated sediments ([PCBs]<1%):

$$\text{TKF} = \frac{\text{Absorption, dermal sediment}}{\text{Absorption, oral, diet}} = \frac{5.4\%}{80\%} = 7\% \ (0.07)$$

For risk assessment, the administered doses from contaminated sediment should appear in the equations for estimated body dose levels, and they should be multiplied by the appropriate TKF before computation of carcinogenic risk. The relevant exposure level of PCB-contaminated sediment is estimated by multiplying surface area (cm^2) by the deposition factor (mg/cm^2). Because of the nature of the experiments from which the above absorption factors were derived, the estimated deposition factor should not exceed 15 mg/cm^2. Optimal accuracy will be achieved for moderately contaminated sediments (<1% PCBs), with deposition factors of 1.5-15 mg/cm^2, because this range of deposited sediment per unit area is similar to the amount of pure PCB administered to experimental animals per unit area. For highly contaminated sediments (>1% PCBs), optimal accuracy will be achieved with deposition factors of 1.5 mg/cm^2 or less. This is because a smaller fraction of the sediment-adsorbed PCBs in contact with the skin is available for absorption compared to pure PCBs.

Supporting Documentation for PCB Toxicokinetic Factor

Gastrointestinal Absorption Factor for Norback and Weltman (1985) Study

This study, from which the current EPA carcinogenic potency factor is derived, is a chronic feed study using Sprague-Dawley rats. PCBs (Arochlor 1260) were administered in the diet. Arochlor 1260 was mixed in corn oil and then added to Purina Rat Chow. No information on the efficiency of gastrointestinal absorption was available from the study. To estimate the efficiency of gastrointestinal absorption, the toxicological literature was searched for appropriate studies on PCBs. Six studies were identified that contained relevant absorption information:

(1) Allen, et. al. (1975) gave single oral doses of 2,5,2',5'-tetrachlorobiphenyl (18 mg/kg bw) to four adult rhesus monkeys by gastric intubation. PCBs were given in 2.5 mL of corn oil on an empty stomach. Unmetabolized PCBs were analyzed in the feces by GC. Minimum gastrointestinal absorption was found to be 88%. PCBs found in the feces over specified post-dosing times were presumed to be unabsorbed material. Because PCB metabolites are known to be eliminated in the bile, the possibility exists that some of the PCBs present in the feces were absorbed and then eliminated. As such, only minimum absorption efficiencies can be determined from this and similar studies.

(2) Allen, et. al. (1974) gave single oral doses of PCBs (Arochlor 1248) (1.5 or 3.0 g/kg bw) to two adult rhesus monkeys by gastric intubation. The vehicle was not specified but is presumed to be corn oil. Dosing was done on an empty stomach. Unmetabolized PCBs were analyzed for in feces by GC. Recovery was reported to be high. Minimum gastrointestinal absorption was reported to be 94%.

(3) Norback, et. al. (1978) gave single oral doses of 2,4,5,2',4',5'-hexachlorobiphenyl (mg/kg bw) to two adult rhesus monkeys by nasogastric intubation. Corn oil was the vehicle. No information was available concerning the animals' stomach contents at the time of dosing. Total radioactivity was measured in the feces and the bile (bile duct cannulated). Minimum absorption was 13% in one animal and 41% in the other (average = 27%).

Because these investigators were measuring both parent and metabolized species in the feces (total radioactivity), the degree of absorption may be underestimated if metabolites were present in the feces during the first week. In addition, according to the limited experimental details available in this abstract, bile was returned from the cannulated bile duct to the duodenum. If so, not all of the radioactivity in the feces may be due to unabsorbed material. Thus, the reported absorption figures are minimum values.

(4) Albro and Fishbein (1972) gave single oral doses of 20 different PCB congeners (5-100 mg/kg bw) and the unabsorbed marker compound, squalene, to CD rats. The mixture was given by stomach tube to feed animals who were allowed food and water ad libitum. No vehicle was specified. Although this was not a diet study, per se, it is possible that dietary components were present in the stomach at the same time as were the test compounds. Minimum absorption was reported to be 90% for all congeners.

(5) Tanabe, et. al. (1981) gave repeated oral doses of Kanechlors (300, 400, 500, 600) (c.30 mg/kg bw/day x 5 days) to Wistar rats. The dose was given in corn oil.

Commercial diet was given ad libitum. No information on the animals' stomach contents was reported. Parent compounds were analyzed in the feces by GC/MS. Minimal gastrointestinal absorption was reported to be 85% for total PCBs. Cl_5 to Cl_7 congeners had 75-90% absorption.

(6) Berlin, et. al. (1974) gave a single oral dose of 2,4,5,2',4',5'-pentachlorobiphenyl (7 mg/kg bw) to three CBA mice. The PCBs were given as an aqueous emulsion. No information on the animals' stomach contents was given. Minimal gastrointestinal absorption was reported to be 93%.

These studies, which involve both rodents and primates and various PCB mixtures and purified congeners, all show that PCBs are very effectively absorbed from the gastrointestinal tract. It is possible that absorption of PCBs that are thoroughly mixed in the diet is lower than absorption from these studies in which PCBs are dissolved in corn oil and given by gastric intubation. In the chronic feeding study of Norback and Weltman (1985), however, PCBs were added to the diet as a corn oil solution. Jordan has determined that the above studies do yield reasonable estimates of the degree of absorption expected in the Norback and Weltman study. This six absorption factors were averaged to yield the estimate of <u>80%</u>.

Dermal Absorption of Pure PCBs

Several studies have investigated the efficiency of dermal absorption of pure PCBs or PCBs given in aqueous solution.

(A) Shah, et. al. (1981) place 2,4,5,2',4',5',-hexachlorobiphenyl on the shaved backs of Dulpin ICR mice for various times. The PCB was administered in 100 mL of acetone, which was quickly evaporated. Total radioactivity was determined in specific tissues, organs, excretory products, and the carcass. Radioactivity at the application site was analyzed to determine the quantity of unabsorbed chemical. 45% of the administered dose was systemically absorbed in 30 minutes (n=3), and <u>55%</u> was absorbed in 1 hour (n=3). After evaporation, the quantity of PCB on the skin surface was a film 0.0005 mm thick (assuming that the density is 1 g/cm^3).

(B) Wester, et. al. (1983) placed 42% PCB (4.1 and 19.3 ug/cm^2) on the shaved abdomens of four rhesus monkeys for 24 hours. The PCB was administered in 50 uL of hexane/benzene (1:1) that evaporated quickly. The efficiency of dermal absorption was determined by comparing the total urinary excretion of radioactivity following topical administration to the following parenteral administration. 15-34% of the administered dose was systemically absorbed. The average absorption for the four animals was 21.5 ± 8.5%. After evaporation, the dose of PCB corresponded to a thin film of 4-19 x 10^{-5} mm thickness (assuming that the density is 1 g/cm^3).

Guinea pigs were dosed with 42% PCB (4.6 ug/cm^2) or 54% PCB (5.2 ug/cm^2) on the skin on the back of the ear for 24 hours. Dermal absorption was 33.2 ± 6.3% (n=3) for 42% PCB and 55.6 ± 2.6% (n=3) for 54% PCB. These values indicate the dermal absorption that was observed after 24 hours. No earlier time points were determined. Shah, et. al. (1981), however, found that dermal absorption of PCBs in mice was not linear over time. Instead, it plateaued after only a short periodof time (approximately 1 hour). Thus, the absorption observed by Wester, et. al. (1983) over 24 hours was probably virtually complete after 1-2 hours.

(C) Wester, et al. (1987) found that 96% of the 54% PCB in dilute aqueous solution (1.6 ug/mL) bound to powdered human skin (stratum corneum). In this experiment, 1.5 mL of aqueous solution was mixed with 1.5 mg of powdered skin. The fraction of chemical bound was determined by measuring the amount of radioactivity on the skin and in the supernatant. In another <u>in vitro</u> experiment, 12% of the PCBs in the same aqueous solution were bound to and absorbed through a section of fresh human skin from surgical reduction. The administered dose corresponds to a thin film of aqueous solution 1.6 mm in depth above the skin surface.

For purposes of estimating the dermal absorption of pure PCBs from the available data based on several experiments, the results of Wester, et. al.'s <u>in vitro</u> powdered skin experiment was excluded. The absorption may have been abnormally high due to the very high surface area of the skin. The four results for mice, guinea pigs, rhesus monkeys, and humans from the three studies were averaged to yield a value of 41.3 ± 16.8% absorption for pure PCBs.

<u>Dermal Absorption of PCBs for Contaminated Sediments</u>

There are no experiments in which the dermal absorption for PCB contaminated soils or sediments is measured. In one study, however, the absorption of structurally similar TCDD was compared for a TCDD solution in methanol and for TCDD-contaminated soil. Poiger and Schlatter (1980) dosed hairless rats (Naked ex Back-Cross and Holzman strain) with radiolabelled TCDD. The percent of the administered dose in the liver after 24 hours was compared for two situations:

(1) 26 mg TCDD in 50 uL of methanol per 3 cm^2 of skin; and

(2) 350 or 1,300 mg TCDD in a soil/water paste of 75 mg per 3-4 cm^2 of skin (50 mg dry soil/3-4 cm^2)

The percent dose in the liver after administration of the soil paste was the same for the two dose levels. Jordan averaged the values and compared them to the percent dose in the liver following administration of pure PCB from a methanol solution:

$$\frac{\text{dermal absorption, soil}}{\text{dermal absorption, solvent}} = \frac{1.95}{14.8} = 13\%\ (0.13)$$

It is assumed that PCBs are absored to soil and retarded in their dermal absorption to the same degree as is TCDD. Thus, the dermal absorption factor for PCBs in contaminated sediments is derived by multiplying the dermal absorption factor for pure PCBs by the expected ratio for the dermal absorption from sediments to the dermal absorption of pure PCBs.

The dermal absorption factor for PCBs in contaminated sediment = 0.13 x 1.413 = 0.054 (5.4%). This value agrees well with the dermal absorption factor used by EPA for PCB contaminated soil in contact with human skin (5%) (EPA, 1986).

APPENDIX B

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EBASCO SERVICES INCORPORATED

DRAFT FINAL

BASELINE ECOLOGICAL RISK ASSESSMENT NEW BEDFORD HARBOR SITE FEASIBILITY STUDY

APRIL 1990

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NOTICE

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ECOLOGICAL RISK ASSESSMENT

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EXECUTIVE SUMMARY

New Bedford Harbor is a tidal estuary on the western shore of Buzzards Bay, Massachusetts. Studies of the harbor conducted in the mid-1970s indicated widespread polychlorinated biphenyl (PCB) and heavy metals contamination. Large areas of the harbor were subsequently closed to fishing to reduce the potential for human exposure to PCBs. The New Bedford Harbor site was added to the U.S. Environmental Protection Agency (EPA) Interim National Priorities List in July 1982; shortly thereafter, EPA initiated a more comprehensive assessment of the extent of the PCB contamination problem. These and other studies have confirmed extensive PCB contamination of water, sediments, and biota in the harbor, with sediment concentrations reported in excess of 100,000 parts per million (ppm) in the area of maximum contamination. Concentrations in biota in many areas exceed the U.S. Food and Drug Administration tolerance level of 2 ppm.

Under authority of the Comprehensive Environmental Response, Compensation, and Liability Act (or Superfund), EPA is responsible for conducting a Remedial Investigation and Feasibility Study (RI/FS) to support the need for and extent of remediation in New Bedford Harbor. This baseline ecological risk assessment, as part of the RI/FS process, presents and quantifies risks to aquatic organisms due to exposure to PCBs and heavy metals in New Bedford Harbor. Based on current conditions in the harbor, it will serve as a benchmark against which the effectiveness of various remedial options may be evaluated.

The ecological risk assessment is based on data collected by several investigations, but draws most heavily on information generated by Battelle (Battelle Pacific Northwest Laboratories, Richland, Washington; and Battelle Ocean Sciences, Duxbury, Massachusetts) in conjunction with the development of a numerical hydrodynamic/sediment-transport model of the harbor. Risk to aquatic biota was evaluated using a joint probability analysis in which two probability distributions, one representing contaminant levels in various zones of the harbor and the second representing the sensitivity of biota to contaminants, were combined to present a comprehensive probabilistic evaluation of risk. The joint probability analysis was supplemented by comparison of PCB levels in the harbor to EPA water quality criteria, evaluation of site-specific toxicity tests, and examination of data on the structure of faunal communities in the harbor.

Results of these various approaches to evaluating risk, both together and independently, support the conclusion that aquatic organisms are at significant risk due to exposure to

PCBs in New Bedford Harbor. Some risk due to exposure to metals was also identified; however, it was negligible compared to the risk due to PCBs.

Concentrations of dissolved PCBs in the area of maximum contamination (i.e., the Hot Spot) and in all areas of the Inner Harbor (i.e., inside the Hurricane Barrier) were sufficiently elevated to result in a significant likelihood of chronic effects to indigenous biota. PCB concentrations in sediment and sediment pore water in many areas of the harbor were found to be highly toxic to at least some members of all major taxonomic groups of organisms. In the Upper Estuary, the probability of these sediments being toxic to marine fish, the most sensitive taxonomic group investigated, approached certainty. These conclusions were found to be consistent with the reported results of laboratory experiments conducted using New Bedford Harbor sediments and with available data on faunal community structure. EPA ambient water quality criteria and interim sediment quality criteria were exceeded in many areas of the Inner Harbor.

Potential community or ecosystem level impacts due to PCBs in New Bedford Harbor cannot be evaluated fully by assessing impacts to individual species or taxonomic groups. However, the state of development of ecological risk assessment methodology does not allow quantification of impacts or risk at these higher levels. Nonetheless, the results of numerous site-specific and laboratory studies, including this risk assessment, indicate that New Bedford Harbor is an ecosystem under stress and there is a high probability that PCBs are a significant contributing factor to the integrity of the harbor as an integrated functioning ecosystem.

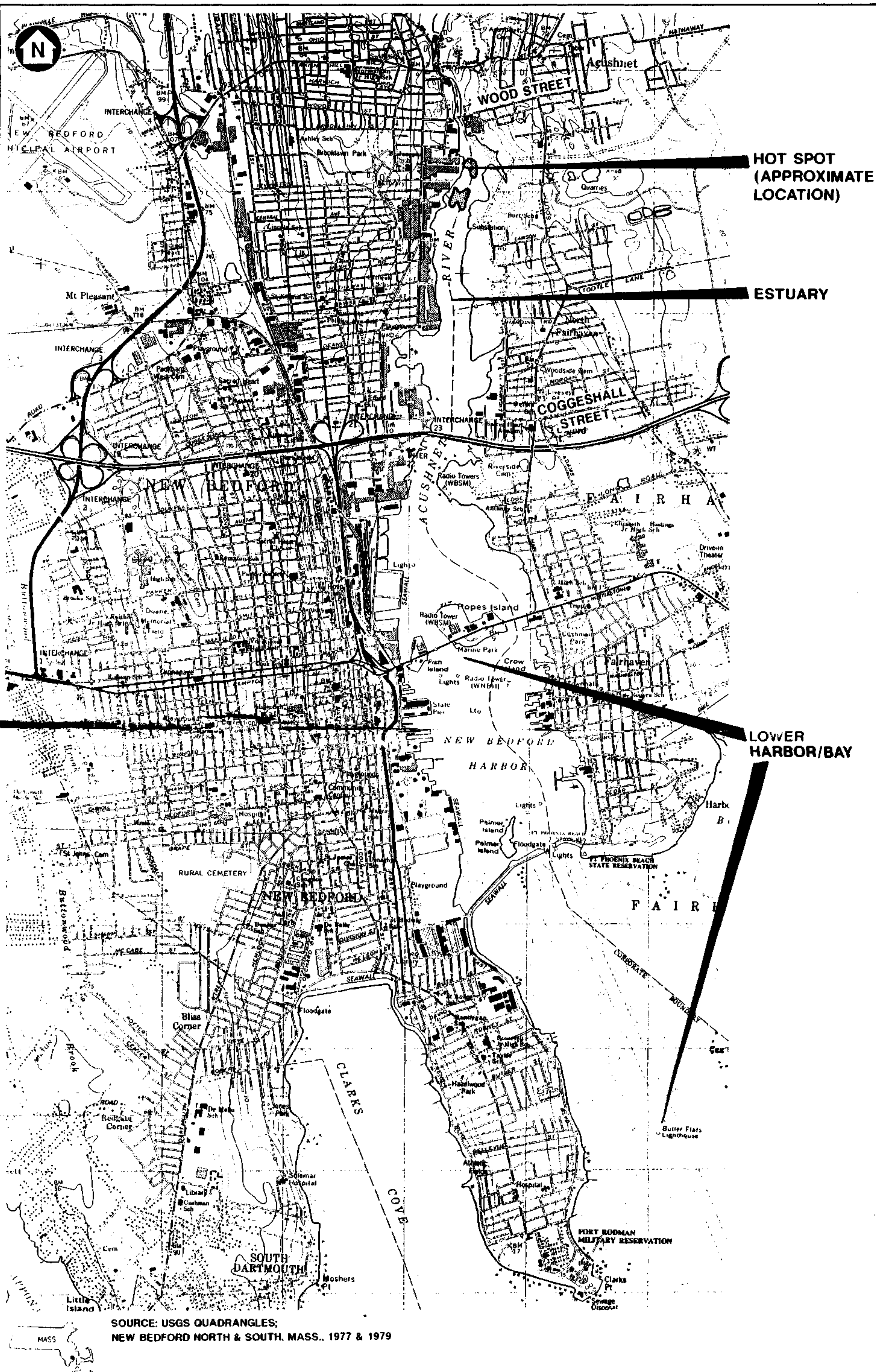
1.0 INTRODUCTION

1.1 NEW BEDFORD HARBOR ECOSYSTEM

New Bedford Harbor is a tidal estuary on the western shore of Buzzards Bay, Massachusetts, situated between the City of New Bedford on the west and the towns of Fairhaven and Acushnet on the east. The area contains approximately six square miles of open water, tidal creeks, salt marshes, and wetlands. The major freshwater inflow to this area is the Acushnet River, a small stream with mean annual flow of approximately 1 cubic meter per second. As a result, the system does not fit the traditional definition of an estuary; salinities throughout the harbor are high and the strong horizontal and vertical salinity gradients that control patterns of faunal distribution in estuaries are absent. Nonetheless, the system does provide habitats for a wide variety of aquatic organisms that use this area for spawning, foraging, and overwintering.

The topographical characteristics of New Bedford Harbor have been adequately described in several other reports generated as a result of studies undertaken to provide information for the Remedial Investigation/Feasibility Study (RI/FS) process and will not be repeated herein. However, several features of the area have importance for understanding the ecological risk assessment. The estuary and harbor may be conveniently divided into subareas by bridges and other manmade structures that also represent logical divisions between zones of ecological similarity. Therefore, the Coggeshall Street Bridge represents not only a convenient boundary for the area defined in these studies as the Upper Estuary, but also separates an area of shallow water with predominantly organic silts and clays with silty sands poorly sorted muddy to the north from deeper water with silty sands to the south (Figure 1-1). At the State Route 6 Bridge (Popes Island), depths generally increase, with water depths in most of the area south of the bridge maintained by dredging. This area of New Bedford Harbor is also the most heavily impacted by industrialization, with considerable shoreline development and ship traffic related to the fishing industry.

The Lower Harbor ends at the Hurricane Barrier, which separates the comparatively low-energy silty sediment of the harbor from the high-energy sands typical of littoral areas in Buzzards Bay. The Hurricane Barrier represents a significant feature of importance for the current regime in the harbor, and the jet effect created by the narrow opening dominates patterns of mixing.



SOURCE: USGS QUADRANGLES;
NEW BEDFORD NORTH & SOUTH, MASS., 1977 & 1979

FIGURE 1-1
SITE LOCATION MAP
NEW BEDFORD, MASSACHUSETTS

1.2 SITE HISTORY

Between 1974 and 1982, a number of environmental studies were conducted to assess the magnitude and distribution of polychlorinated biphenyl (PCB) and, to a lesser extent, heavy metals contamination in New Bedford Harbor. Results of these studies revealed that sediment north of the Hurricane Barrier contain elevated levels of PCBs and heavy metals. Additional investigations revealed that PCBs had been discharged into the surface waters of New Bedford Harbor, causing significantly elevated PCB concentrations in sediment, water, fish, and shellfish.

To reduce the potential for human exposure to PCBs, the Massachusetts Department of Public Health closed much of the New Bedford Harbor area to fishing. Three closure areas were established on September 25, 1979 (Figure 1-2). Area 1 (New Bedford Harbor) is closed to the taking of all finfish, shellfish, and lobster. Area 2 (Hurricane Barrier to a line extending from Ricketson Point to Wilbur Point) is closed to the taking of lobster and bottom-feeding fish (eel, scup, flounder, and tautog). Area 3 (from Area 2 out to a line from Mishaum Point, Negro Ledge, and Rock Point) is closed to the taking of lobster.

In July 1982, the U.S. Environmental Protection Agency (EPA) placed New Bedford Harbor on the Interim National Priorities List (NPL). The final NPL was promulgated in September 1984. The site, as listed, includes the Upper Estuary of Acushnet River, New Bedford Harbor, and portions of Buzzards Bay. Following the NPL listing, EPA Region I initiated a comprehensive assessment of the PCB problem in the New Bedford Harbor area, including an areawide ambient air monitoring program, sediment sampling in the Acushnet River and New Bedford Harbor, and biota sampling in the estuary and harbor.

As a result of these studies, the extent of PCB contamination is better understood. The entire harbor north of the Hurricane Barrier, an area of 985 acres, is underlain by sediment containing elevated levels of PCBs and heavy metals. PCB concentrations in this area range from a few parts per million (ppm) to more than 100,000 ppm. Portions of western Buzzards Bay sediment are also contaminated, with PCB concentrations occasionally exceeding 50 ppm. The water column in New Bedford Harbor has been measured to contain PCBs in excess of the EPA 30-parts-per-trillion ambient water quality criterion

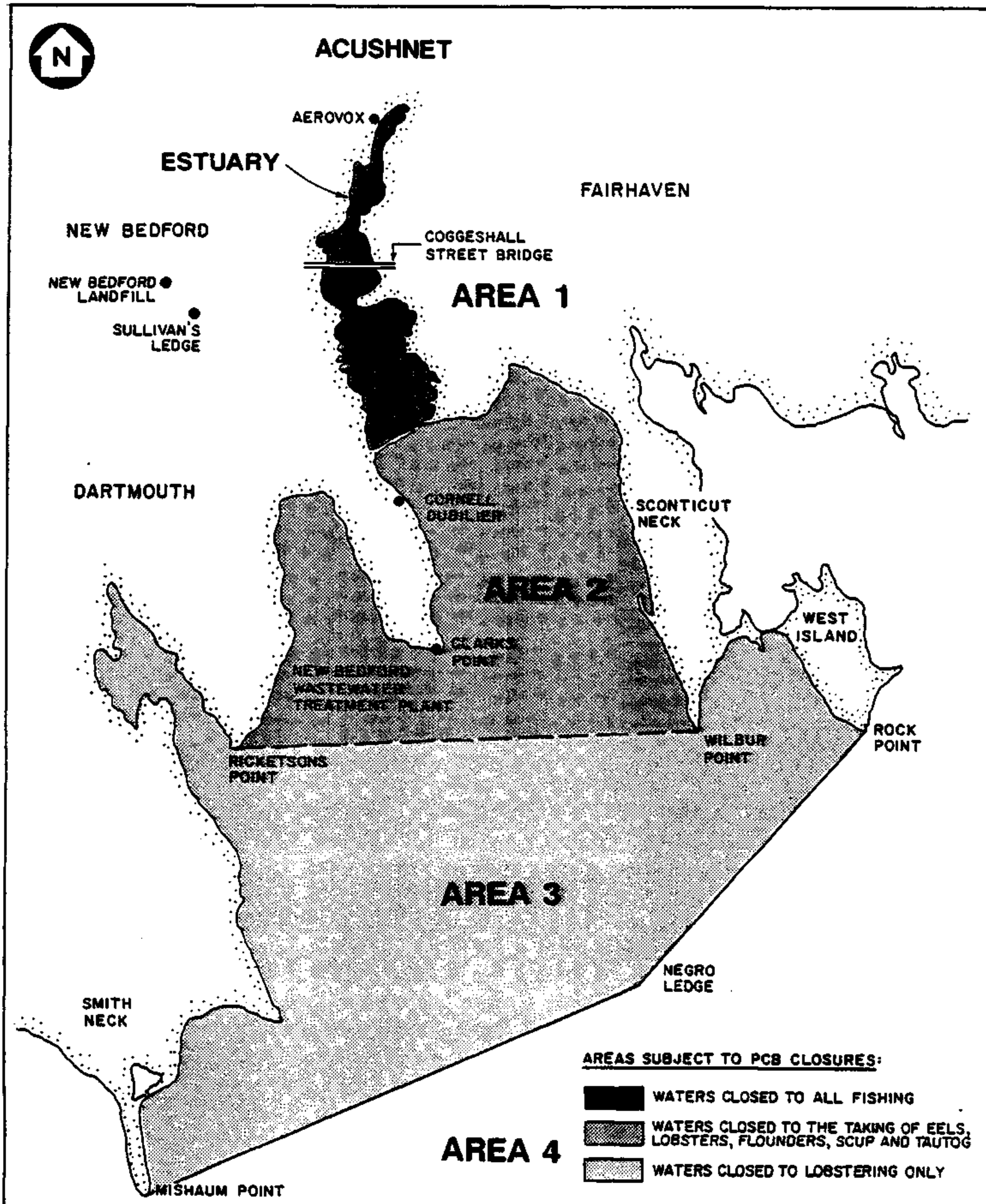


FIGURE 1-2
FISHERY CLOSURE AREAS
NEW BEDFORD, MASSACHUSETTS

NOT TO SCALE

(AWQC). Concentrations of PCBs in edible portions of locally caught fish have been measured in excess of the U.S. Food and Drug Administration (FDA) 2-ppm tolerance level for PCBs.

In 1984, EPA conducted an initial FS of the highly contaminated mudflats and sediment in the Upper Estuary of Acushnet River (NUS, 1984a and 1984b). Five clean-up options were presented in that report. EPA received extensive comments on these options from other federal, state, and local officials, potentially responsible parties, and the public. Many of the comments expressed concern regarding the proposed dredging techniques and potential impacts of dredging on the harbor, and potential leachate from the proposed unlined disposal sites.

In responding to these comments, EPA elected to conduct additional studies before choosing a clean-up alternative for the Upper Estuary. Concurrent with these studies, EPA conducted additional surveys to better define the extent of PCB contamination throughout the overall harbor and bay. Through these efforts, clean-up options for the site are being developed.

1.3 OBJECTIVES AND LIMITATIONS OF THIS REPORT

EPA Region I is responsible for the cleanup of the New Bedford Harbor site under authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986. Pursuant to this charter, EPA has direct responsibility for conducting the appropriate studies for this site to support the need for and extent of remediation. In accordance with the National Contingency Plan, these studies form the basis of the RI/FS for the site.

This ecological risk assessment presents and quantifies risks to aquatic organisms due to exposure to PCBs and selected heavy metals (i.e., copper, cadium, and lead) in the New Bedford Harbor area under baseline (i.e., existing) conditions. The baseline assessment is the first of a series of risk evaluations that will provide the basis for evaluating the need for and extent of remediation. It is based on existing conditions in New Bedford Harbor only; the potential natural decrease in contaminant mass and concentration in the harbor due to transport and degradation through time is not considered. Subsequent evaluations will examine the relative effectiveness of various remedial alternatives against current conditions using results of the numerical simulation model for PCBs.

EPA defines ecological risk resulting from toxic contaminants to include both direct risks to the growth, reproduction, or survival of the ecological receptor species, as well as the resource value of any species being reduced as a result of contaminant body burdens. Although both aspects of risk will be considered to some extent in this document, the former (direct) risk is the major concern of the assessment.

Ecological risks in New Bedford Harbor were determined by a mathematical evaluation and combination of two factors: (1) the degree of exposure to contaminants at the site, and (2) the ecotoxicity of PCBs and the three metals to aquatic organisms. Ecological risk was then quantified as the probability of impact to specific taxonomic groups representing the major ecotypes present in the harbor. Future evaluation of remedial alternatives via this method will require only repeating the exposure section of the assessment to reflect the new exposure conditions as determined by the numerical modeling results, and then using the previously derived (and unchanged) ecotoxicity calculations to determine new risk probabilities.

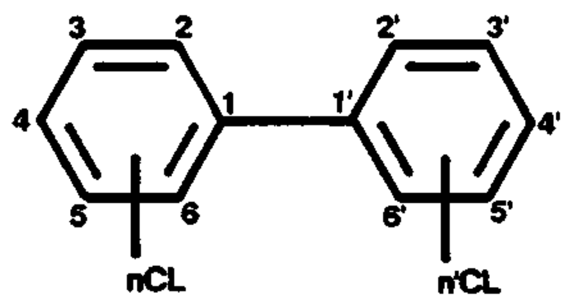
Following this strategy, this report consists of three sections. The first section is the exposure assessment, in which a representative subset of the organisms residing in the New Bedford Harbor area is identified, the routes of exposure are defined, and the degree of exposure is quantified. The second section, the ecotoxicity assessment, describes the acute and chronic toxic effects associated with PCB and metals exposure for each identified group. In addition, existing standards and criteria for PCBs and metals are discussed. The final section, the risk evaluation, combines the information presented in the two preceding sections to describe and quantify potential adverse effects on the New Bedford Harbor ecosystem resulting from the presence of these contaminants.

Both PCBs and metals are discussed in this report; however, PCBs were the primary focus of this study. Therefore, only the tables and figures for PCBs are included with the text. The tables and figures associated with the metals discussion are presented in Appendices A, B, and C.

The development of methodologies for determination of ecological risk is a relatively new and rapidly advancing field; the consensus among professionals concerning the most applicable methods at a particular site is limited. In addition, there are particular difficulties in determining risk due to PCBs in New Bedford Harbor because of the peculiar characteristics of PCBs as an environmental contaminant. PCBs are often treated as a single chemical or a small group of chemicals with similar properties; however, they actually consist of a group of 209 distinctly different chemical congeners. PCBs are relatively inert and, therefore, persistent compounds, with low vapor pressures, low water solubility, and high octanol/water partition coefficients. Although perhaps only half the potential congeners have actually been found to occur in the environment, they nonetheless consist of a diverse group of chemical species with widely varying physical, chemical, and biochemical properties.

In the manufacturing process, PCBs were formed by the addition of chlorine to the biphenyl molecule, and the number and types of PCB congeners formed in this process were not precisely determinable (Figure 1-3). Because PCBs were desirable primarily for their physical properties, which are largely related to the amount of chlorine substitution on the two rings, it was not necessary to know or control the exact congener mix; rather, only the percent of substituted chlorine in the final PCB mixture.

Most PCBs used in the U.S. were marketed as a mix of congeners under the name of Aroclor, a trade name of the Monsanto Company. Different Aroclors were designated by a four-digit code number (e.g., 1242 and 1254), with the last two digits signifying the amount of chlorine substitution as a weight percentage of the total mixture (e.g., Aroclor 1242 is 42 percent chlorine by weight). The sole exception to this numbering scheme is Aroclor 1016, which is approximately 41 percent chlorine. Aroclors 1016, 1242, and 1254 were most commonly used by the electrical component manufacturers in New Bedford. Because the desired properties of the Aroclors were determined by the overall amount of chlorination rather than the specific mix of congeners, it is probable that the actual congeners in a particular Aroclor varied among manufacturing batches. Reference Aroclors were subsequently established for analytical purposes; however, the relation of the reference Aroclors to the actual production batches is not clear.



(WHERE n AND n' MAY VARY FROM 0 TO 5)

FIGURE 1-3
CHEMICAL STRUCTURE OF A PCB MOLECULE
NEW BEDFORD, MASSACHUSETTS

After PCBs in the form of Aroclors are introduced into the environment, they begin to "weather," thereby changing and further complicating the problem of determining the actual mixture of components present. Lighter (i.e., less chlorinated) congeners are generally more volatile and soluble; therefore, they are (1) transported farther from the source before deposition, (2) less easily deposited into sediment, and (3) more easily mobilized and transported out of the original zone of deposition. More saturated congeners would demonstrate generally opposite behavior. In addition, differential rates of biochemical degradation, uptake, and depuration by biota, not easily related to level-of-chlorination but also determined by the actual pattern of chlorine substitution, would further serve to make the actual congener mix at any location different from the mixture originally released.

Although work is still ongoing to develop better analytical methods, it is possible to analyze environmental samples for many of the actual PCB congeners present; however, few congener-specific data are available because of the considerably greater analytical cost of the procedure. Most early studies reported PCBs as a "total" concentration or as the concentration of one or more Aroclors. Due to these problems, both methods produce less than completely satisfactory results. For the field sampling program conducted by Battelle Ocean Sciences (BOS) to produce calibration/validation data for the physical/chemical model (the source of much of the data used in this risk assessment), the analyses were reported in terms of "level-of-chlorination" homologs. This type of analysis provides valuable additional information, and because physical behavior determining fate and transport of PCBs is relatively similar for each homolog group, quantification (and subsequent numerical modeling) by homologs was deemed a reasonable cost-effective analytical goal for the modeling program. It was later decided to model only total PCBs, and the modeling program data were subsequently converted into total PCBs for risk assessment purposes by summing all homolog groups. Because the modeling and any remedial activities will be determined solely on the basis of total PCBs and, because of the lack of homolog-specific toxicity data, the risk assessment was conducted using total PCBs only.

The unique properties of PCBs and the problems with analysis described previously present considerable difficulties for determination of ecological (or public health) risk. Without analysis for specific congeners, it is not possible in most cases to know the actual congener

mix at a particular site, even if the exact congener composition of the PCBs introduced to the site were known, which is essentially never the case. Even if the mix of congeners were determined, the analysis would be valid only for the specific sample, and in an area such as New Bedford Harbor, the changing concentrations and mixture of congeners would present a complicated mosaic of spatial and temporal change. Therefore, the first step in conducting a risk assessment (i.e., determining the concentration of the contaminant(s) of interest at the specified site) is not possible for PCBs at the same level of detail as for other environmental contaminants.
Most analytical difficulties and uncertainties associated with determining PCB concentrations in the environment apply equally to any toxicological studies conducted with PCBs. A synthesis of the results of these studies is the second fundamental step in risk assessment and, because work to date has been conducted with contaminant concentrations reported as total PCBs or as one or more Aroclors, it is difficult to combine and use all data sources equally. Accordingly, various assumptions and simplifications were necessary at several points in the risk assessment so that the limited available data on PCB toxicity would not be unnecessarily reduced.

Recent work indicated substantial variability among congeners with regard to toxicity to aquatic organisms (Dill et al., 1982). Some toxicological properties are believed related to the configuration the two phenyl rings assume relative to each other which is, in turn, controlled by the position of the chlorines on the molecule. Fully ortho-substituted congeners do not assume a co-planar structure and are believed, in general, to be the least toxic. Conversely, non-ortho-substituted congeners are free to assume a co-planar configuration and are believed to be more toxic in general.

Site-specific water and sediment toxicity testing is perhaps the best solution to this problem; however, limited work has been conducted on New Bedford Harbor water and sediment. Although the availability of more data would have been valuable in that it would enable evaluation of the toxicity of the actual weathered PCB mixtures in New Bedford Harbor, it cannot prove that any effects measured are in fact due to the PCBs present rather than another contaminant. Therefore, both laboratory data on the toxicity of "pure" Aroclors and the limited data on actual toxicity of New Bedford Harbor environmental media must be used in combination to provide the "weight of evidence" for ecological risk.

The combination of these factors necessarily limits to some degree confidence in the accuracy of the risk probabilities for PCBs generated in this assessment, in the same way that confidence is decreased in using a statistical test to calculate probabilities when all assumptions for the test are not strictly satisfied. In some cases, it was possible to quantify the degree of uncertainty of some of the parameters and develop a quantitative estimate of overall uncertainty. For other issues, such as the question of congener-specific toxicity, it is not possible to approach the issue in a quantitative sense. However, because most toxicity studies have used congener mixtures, it is probable that a wide variety of toxicities is represented in both the test mixtures and the mixture occurring in New Bedford Harbor. The use of the risk probabilities in a relative sense (i.e., to compare the efficacy of different remedial alternatives against a no-action alternative) would have considerably greater validity, even if the absolute risk probabilities were questionable. It is this latter use that is important for the risk assessment.

Determination of risk due to heavy metals was not affected by the problems described previously for PCBs; however, other concerns became apparent during the analysis. Chief among these was the considerably smaller data set available for the three metals (particularly cadmium) and the probability that sampling for metals was concentrated in areas of suspected high concentrations, thereby biasing the data set. In addition, analysis of metals was deleted from the Battelle physical/chemical model and it was therefore not possible to work from the initial conditions established for each model cell, as was done for PCBs. This latter procedure would have largely corrected for the sampling bias. It was decided finally to use the available metals data exactly as provided thereby providing, to the extent that the data are biased toward higher concentrations, a more conservative estimate of risk.

1.4 PROGRAM DATA BASE

At most CERCLA sites, the ecological risk assessment would be based on findings of the RI report. However, because of the many studies conducted as part of the New Bedford Harbor project, numerous reports have been produced which obviate the need for a separate RI document. Therefore, this risk assessment is based primarily on the sampling data contained in the New Bedford Harbor data base, aspects of modeling efforts by HydroQual, Inc. (Hydroqual) and Battelle Pacific Northwest Laboratories (PNL), various site investigation reports, the Greater New Bedford Health Effects Study, and the U.S. Army Corps of Engineers (USACE) Pilot Dredging Study and Wetlands Assessment. An extensive data base generated between 1981 and 1986 provides an accurate description of the current extent and level of contamination within most of the New Bedford Harbor area.

1.4.1 <u>PCB Concentrations in Sediments</u>

Data on distribution of PCBs in sediment and overlying waters of New Bedford Harbor and the Acushnet River Estuary were provided by PNL and BOS. For consistency with other aspects of the RI/FS process at the New Bedford Harbor site, the ecological risk assessment for PCBs was based primarily on a data set developed as the initial conditions for the physical/chemical transport model. Initial conditions were established by PNL using information on PCBs in the harbor obtained from three sources: (1) data collected by BOS (Duxbury, Massachusetts) specifically for the calibration and validation of the model; (2) a data base compiled by GCA Corporation (now Alliance Technologies Corporation [Alliance]) from various historical sources; and (3) a detailed survey of PCBs in the harbor conducted by NUS Corporation (NUS). These three data sets were subsequently combined into the central New Bedford Harbor data base by BOS. An additional intensive sampling of the Hot Spot provided the data used to establish concentrations in Hot Spot sediment.

1.4.1.1 BOS Calibration/Validation Data

From 1985 through 1986, BOS conducted four samplings of water, sediment, and biota in the Acushnet River Estuary, New Bedford Harbor, and adjacent areas of Buzzards Bay to provide data for calibration and validation of the physical/chemical transport model and food-chain model. Twenty-five stations were established and sampled on each of three surveys; the remaining survey was limited to eight stations and was conducted immediately following a storm event. Although the samples obtained during these surveys were collected and analyzed under rigorous quality control procedures, the data were intended for use primarily for model calibration/validation. The usefulness for determining patterns of contaminant distribution in New Bedford Harbor is limited by the relatively sparse spatial distribution.

1.4.1.2 Alliance Data Base

This previously compiled data base summarizing several of diverse field investigations in New Bedford Harbor represents an important source of data and was used extensively to set initial conditions for the model. The data base was originally constructed for EPA by Metcalf & Eddy, Inc., in 1983 and was transferred to Alliance in 1986. Alliance began to expand the data base and converted it to run under dBASE III, a personal computer data base management software package. This work was never completed, and the data base was subsequently provided to BOS for quality assurance checks and subsequent incorporation into the central New Bedford Harbor data base. The Alliance data base was provided to PNL by E.C. Jordan Co. (Jordan) as part of the data base PNL used to establish initial conditions for the physical/chemical transport model.

1.4.1.3 NUS Data Base

The NUS data base was provided to PNL in digital form by BOS. The data base was apparently complete and contained data for PCBs expressed as the concentrations of various Aroclors for samples obtained on a regular grid. The NUS data proved to be valuable because concentration data for the entire study area was provided. Data in the Alliance data base, for example, were concentrated at the Hot Spot and around various wastewater or combined sewer overflow discharges.

Details of the data selection, conversions, and manipulations conducted by PNL to establish the initial sediment PCB concentrations for the physical/chemical model will be discussed in the final modeling report currently in preparation (Battelle, 1990). In the remainder of this section, aspects of this process that are important for understanding this risk assessment are reviewed.

1.4.1.4 Selection of Data

Sediment PCB data from the BOS and NUS data sets were complete and easily interpretable, and were used as received. The Alliance data base contained a wide variety of contaminant measurements and included samples of air, water, wastewater, sediment, and biota from the general vicinity of New Bedford Harbor. In addition to data on PCBs and metals, the data base included data on water quality parameters and other organic and inorganic contaminants, most of which were irrelevant for establishing initial PCB concentrations for the modeling. PCB data were retrieved from the Alliance data base via a series of FORTRAN programs written by PNL.

1.4.1.5 Sample Depths

The BOS data base contained various combinations of samples taken at a number of different horizons in the sediment, gross (bulk) samples, and samples of different size fractions (i.e., sand, silt, and clay). Only gross (bulk) sediment samples from the upper stratum (5 centimeters) were retained for subsequent evaluation. The NUS data included samples taken from the upper stratum (6 inches), depths of 12 to 18 inches, and at specified greater depths. Only samples from the upper 6-inch stratum were retained.

Reflecting its multiple data sources, the Alliance data base included a wide variety of sampling horizons. The data records were divided into two categories: (1) surface samples obtained with a grab sampling device or collected as subsamples from the upper 8 inches of a sediment core; and (2) deep samples, for which any part of the subsample was taken from 8 inches or deeper below the sediment water interface. Only the surface samples were used in subsequent data analysis.

1.4.1.6 Data Conversions

The data sets used by PNL to establish the initial conditions for the modeling included PCB data in various forms. The most variation was encountered in the Alliance data base, in which PCBs were reported most commonly as Aroclors 1242, 1254, and 1242/1016, and non-specific PCBs. Some samples included data on level-of-chlorination homologs. The desired final measure, total PCBs, was obtained for each sample by summing the concentrations of all quantified Aroclors. Any samples reported on a wet-weight basis were converted to dry weight using an average water content of 55 percent.

PCB concentrations in the NUS data base were reported as Aroclor 1242, Aroclor 1248, or Aroclor 1254 in units of micrograms per kilogram, and assumed to be dry weight. Typically, only one or two Aroclor concentrations were reported for each sample. All reported Aroclor concentrations were summed and converted to units of micrograms per gram (ug/g), equivalent to ppm dry weight.

The BOS data base reported PCB concentrations by level-of-chlorination homolog in units of ug/g dry weight. These concentrations were summed to produce an estimate of total PCB concentration.

Values below specified detection limits occurred in all three data bases and were used in determining the initial conditions; values reported as zero were not used. Data reported below detection limits were assigned a value equal to approximately 0.1 times the specified detection limit of the analytical procedure and were placed in a separate file. When detection limits were not reported, concentrations of zero were assigned values of approximately 0.1 times the lowest reported value. These somewhat arbitrary assignments were necessary because the data were later log-transformed and values of zero would have been unacceptable.

1.4.1.7 Data Processing and Analysis

Standard univariate statistics were calculated by PNL for the raw and log-transformed data. The log-transformed data produced near-normal distributions around the mean value for each data set.

Contour plots of the surface sediment PCB concentrations were prepared at PNL and delivered to Jordan in November 1987. Initial PCB concentrations were calculated by PNL on a 100-by-100-foot grid and subsequently transferred to the larger i,j physical/chemical model grid by calculating an arithmetic average of all 100-foot grid data within each model grid element. The initial values for the i,j model grid, provided to Jordan by PNL in April 1989, were used for all subsequent analyses conducted for the ecological risk assessment, with one modification at the Hot Spot. Following the final assignment of initial conditions for the model, USACE funded an additional intensive survey of PCB concentrations in the Hot Spot. Three model grid cell concentrations were changed from initial condition assignments to reflect the updated information.

1.4.2 <u>PCB Water Concentrations</u>

PCB concentrations in the water column for the risk assessment were also based on values used for the physical/chemical transport model. However, unlike sediment concentrations, the use of initial conditions is not appropriate because preliminary model runs indicated that concentrations in the water column are determined largely by the assigned sediment concentrations following a brief "spin-up" period of approximately 90 days simulation. Accordingly, PNL did not determine initial conditions for the water column in a manner similar to that previously described for sediment; rather, it assigned initial conditions generally consistent with the field data and then allowed the model to produce its own "starting conditions" based on the assigned sediment concentrations. These starting conditions in the water column were averaged vertically for each cell in the i,j grid and provided to Jordan with the initial sediment conditions.

1.4.3 Metals Concentrations

Because metals were not included in the Battelle physical/chemical modeling effort, it was not possible to use model initial conditions for the calculation of exposure estimates at the New Bedford Harbor site. Metals data were obtained from the program data base maintained by BOS. All data for the three metals in water and sediment were requested and received via magnetic disk. Data characterized as "rejected" in the data validation were removed from the data set and not used in the risk assessment. The data set contained numerous "non-detects," which were entered into the analysis as half the lowest reported concentration for the particular metal. All remaining data were used as received.

1.5 OVERVIEW OF METHOD FOR THE ECOLOGICAL RISK ASSESSMENT

A joint probability model was used in the risk assessment to quantitatively evaluate potential impacts to New Bedford Harbor biota for each contaminant. The basic components of the model are two probability distributions, one representing the expected distribution of contaminant levels in the environment, and the second representing the probability distribution of some benchmark concentration for a particular group of potential receptors over a range of contaminant levels. The joint probability model is used to determine the likelihood that a typical species (which displays a particular biological effect at the benchmark concentration) will encounter an environmental concentration sufficient to elicit the particular effect.

In Subsection 2.1.2, development of the expected distribution of environmental levels is discussed. These distributions are termed expected environmental concentration (EEC) probability curves. The development of the probability density function that relates contaminant concentration to a biological benchmark is discussed in Subsection 3.2. Finally, the joint probability model is used to determine quantitative risk estimates in Section 4.0.

2.0 EXPOSURE ASSESSMENT

The environmental exposure assessment was performed to identify representative organisms within New Bedford Harbor that may be exposed to PCBs and metals. The assessment included identification of ecological receptors and exposure routes, with the goal of selecting a subset of species to represent the wide variety of potential aquatic receptors at the site. These species were used to identify the principal routes of exposure and describe contaminant exposure within the New Bedford Harbor area.

For the purposes of accumulating results at various (simulated) points in time, the Battelle transport model divides the estuary and harbor into the following five zones, based in part on natural and manmade structures and on the initial contaminant concentrations detected in the sediment (Figure 2-1):

- Zone 1: the area between the Wood Street Bridge and the southern boundary of the Hot Spot
- Zone 2: from the southern boundary of the Hot Spot to the Coggeshall Street Bridge
- Zone 3: the area between the Coggeshall Street Bridge and Popes Island (State Route 6 Bridge)
- Zone 4: the area between Popes Island (State Route 6 Bridge) and the Hurricane Barrier
- Zone 5: from the Hurricane Barrier out to the limit of the modeling grid, roughly delineated by the line from Ricketsons Point to Wilbur Point

Different systems of dividing New Bedford Harbor into zones have been used at various times for specific purposes. The zone definition used in this report for the purpose of the ecological risk assessment is identical to the zonation being used for the physical/chemical transport modeling. The risk assessment is based primarily on both the input to and output from the model, and use of the same zones simplified inclusion of the data from modeling runs. Therefore, slightly different divisions of the harbor were used for the HydroQual food-chain model, the public health risk assessment, and the draft ecological risk assessment.

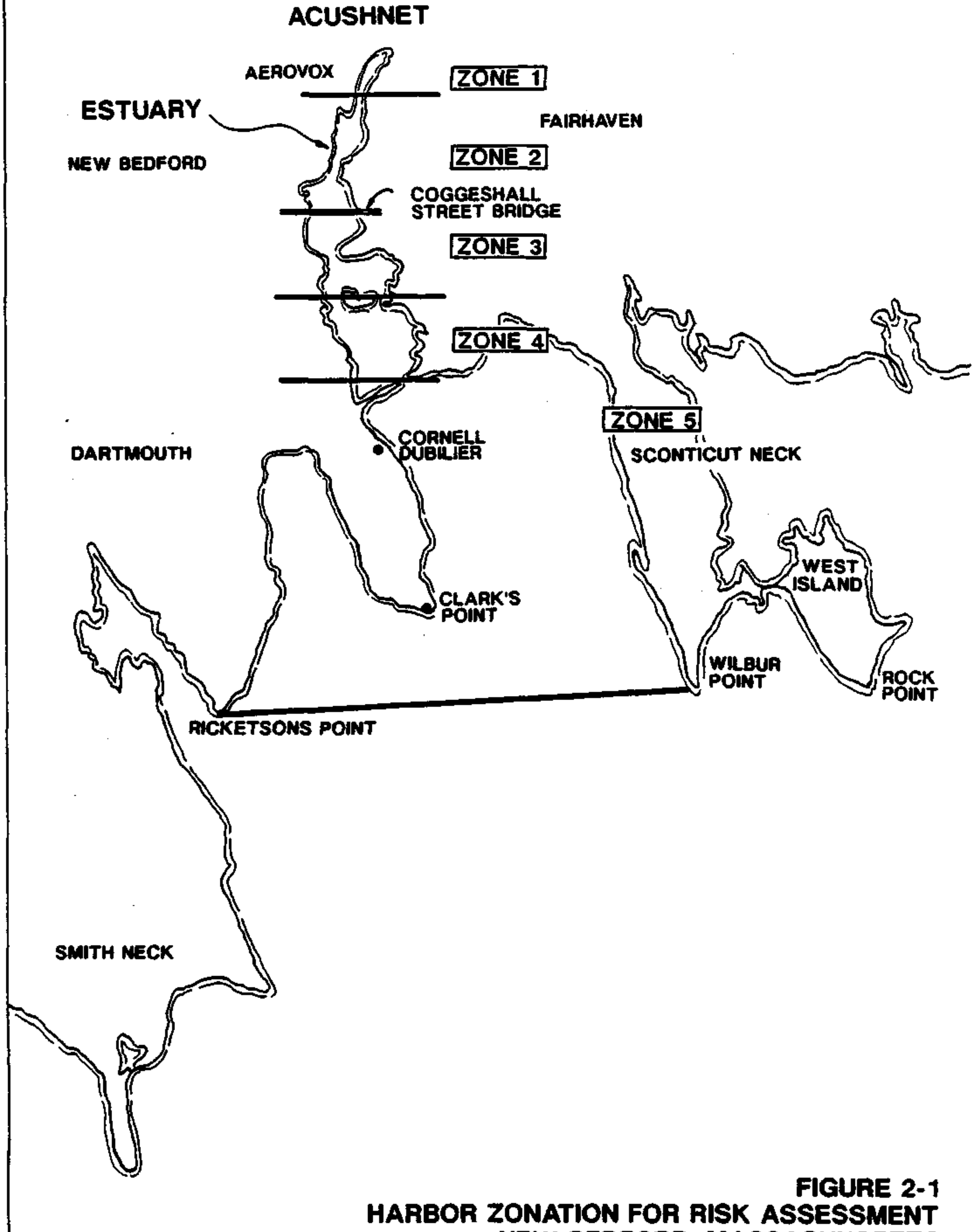


FIGURE 2-1
HARBOR ZONATION FOR RISK ASSESSMENT
NEW BEDFORD, MASSACHUSETTS

Although all these divisions correspond in some areas to the various fishery closure zones, none is exactly the same.

2.1 RECEPTOR IDENTIFICATION

2.1.1 Exposed Species Analysis

Many organisms in New Bedford Harbor are potentially at risk as a result of exposure to PCBs and heavy metals. The four primary routes of exposure include (1) direct contact with the water in the water column, (2) direct contact with or ingestion of sediment, (3) direct contact with sediment pore water, and (4) ingestion of contaminated food. The route of exposure can also be defined by the method of obtaining food (e.g., herbivore, carnivore, suspension feeder, deposit feeder, and scavenger). To describe how aquatic organisms may be exposed to contaminants at the New Bedford Harbor site, a representative subset of the species known to inhabit this area was identified. The basis of the selection was defined by the possible routes of exposure for the organisms in question.

To evaluate the level of effects due to exposure and for risk characterization, the organisms in New Bedford Harbor were separated into ecotypes, which also correspond to taxonomic groups. Five groups of organisms, corresponding to the major aquatic organisms present in the harbor and also representative of the range of exposure routes, were developed: marine fish, crustaceans, mollusks, polychaetes, and algae. The rationale for these groupings and typical representative species for each in New Bedford Harbor are presented in Section 3.0. Lack of toxicological data for marine polychaetes precluded separate analysis of potential contaminant effects on this group. However, these organisms are considered relatively insensitive to organic contamination in sediment and are widely used for bioaccumulation studies for this reason. In the determination of risk in Section 4.0, it is assumed that a typical polycheate would be no more sensitive than a typical mollusk, and the benchmark distribution for mollusks will be used conservatively to assess risk to polychaetes as well.

Although most organisms can be exposed to environmental contaminants via all media, for purposes of assessing exposure in this risk assessment, the various habitat locations (i.e., benthic or pelagic), lifestages (i.e., egg, larvae, and adult), and feeding method (e.g., filter feeder, deposit feeder, or carnivore) of typical members of each group were used to define the primary routes of exposure for the group. Based on habitat, direct contact with dissolved or particulate contaminants in the water column was considered the primary route of exposure for pelagic fish, bivalves, and plankton. An important secondary route of exposure for most species is consumption of biota that have bioaccumulated contaminants. For benthic infaunal invertebrates, it was determined that direct contact with and ingestion of contaminated sediment and food organisms were the primary routes of exposure. Direct contact with the water column was determined to be a secondary route of exposure, although it can also be the primary exposure route for planktonic lifestages of infaunal adults.

2.1.2 Species of Concern

Species of concern inhabiting the New Bedford Harbor area were identified based on the biological surveys conducted by IEP, Inc., for USACE (USACE, 1988b); Sanford Ecological Services for USACE (USACE, 1986); Camp, Dresser and McKee (Camp, Dresser and McKee, 1979); and historical data reported in Bigelow and Schroeder (Bigelow and Schroeder, 1953).

A subset of receptor species was selected from these data based on the following criteria: distribution within the study area, trophic level (i.e., producer, primary, secondary, or tertiary consumer); commercial and/or recreational use; and availability of biological and ecological information.

Criteria such as habitat location, trophic level, and reproductive potential are important factors that may influence the ways in which each species may be exposed to contaminants in the New Bedford Harbor area and the potential effects of contaminant exposure. The commercial and/or recreational value of a resource species is a key factor for species selection because the loss and limitation of use of such species may have economic significance.

Twenty-eight species of various trophic levels and habitat types representing the five taxonomic groups of aquatic organisms discussed previously (i.e., finfish, crustaceans, mollusks, annelids, and plankton) were selected as typical aquatic receptors for the New Bedford Harbor site. Distribution of these species within the Acushnet River/Buzzards Bay area is shown in Table 2-1.

TABLE 2-1
DISTRIBUTION OF THE 28 SELECTED SPECIES OF CONCERN IN NEW BEDFORD HARBOR

NEW BEDFORD HARBOR

ALL ZONES	ZONE 1 (AREA 1)	ZONE 2 (AREA 1)	ZONE 3 (AREA 1)	ZONE 4 (AREA 1)	ZONE 5 (AREA 2)
Fish					
Herring Flounder Silverside Mummichog	American Eel	American Eel	Scup Tautog American Eel	Scup Tautog Mackeral	Scup Tautog Mackeral
Crustaceans					
	Isopod	Blue Crab Fiddler Crab Green Crab Amphipod	Blue Crab Green Crab Lobster Fiddler Crab Amphipod Grass Shrimp	Green Crab Lobster Grass Shrimp	Lobster Amphipod
Mollusks					
Quahog Ribbed Mussel	Mud Nasa Soft-shell Clam	Mud Nasa Soft-shell Clam Blue Mussel Quahog	Blue Mussel Slipper Shell Bay Scallop Soft-shell Clam Eastern Oyster Quahog	Blue Mussel Slipper Shell Eastern Oyster Quahog	Quahog
Plankton					
Diatoms		Copepod	Copepod	Copepod	Copepod
Annelids					
Clam Worm Mud Worm Thread Worm					

NOTE:

Zones correspond to Figure 2-1; areas correspond to Figure 1-2.

2.2 EXPOSURE LEVELS FOR RECEPTORS

2.2.1 Introduction

The amount of contaminant exposure experienced by an aquatic organism is a function of the type(s) of contaminated media to which the organism is exposed, contaminant concentrations in the media, and the mechanisms by which contaminants are taken up from each medium. Each factor was considered and, to the extent possible, quantified, in determining exposure levels for the five organism groups used for the risk assessment.

PCB contamination in New Bedford Harbor has been documented in all environmental media (i.e., water, sediment, and biota) throughout the harbor; however, it varies considerably in concentration, generally decreasing with distance from the Hot Spot in the Upper Estuary. Metals contamination is similarly ubiquitous; however, the area of highest metals concentrations is found in Zone 3 between the Coggeshall Street and Popes Island bridges. Organisms residing in New Bedford Harbor for all or part of their lives may be exposed to these contaminants as a result of direct contact with and/or ingestion of contaminated food, water, and sediment. Migration from the harbor of prey species with elevated PCB and metals tissue burdens expands the potential area of exposure for predators. Uptake of contaminants from water, sediment, or food into the tissues of organisms ultimately occurs by either passive diffusion, active transport, or facilitated transport across the membranes of the gills, gastrointestinal lining, mouth lining, and body wall (Swartz and Lee, 1980).

Terms such as bioconcentration and bioaccumulation relate to the source and specific outcomes of exposure to contaminants. Bioconcentration refers to the net uptake of dissolved chemicals into an organism from water. Another directly related term, bioconcentration factor (BCF), is the ratio of concentration found in the tissue of an organism to the concentration in the water to which the organism was exposed (Schimmel and Garnas, 1985). The term bioaccumulation refers to the net uptake of a contaminant by an organism from all sources, including ingestion of and/or contact with water, food, and sediment (Menzer and Nelson, 1986). Biomagnification is generally used to refer to the concentration of a contaminant between trophic levels in a food chain.

2.2.2 Methods

PCB concentrations in the water column (i.e., dissolved concentration), pore water, and sediment developed as initial conditions for the modeling program were the primary sources of exposure data for the ecological risk assessment. The source and development of the initial condition concentrations are discussed in Subsection 1.4. For the Upper Estuary Hot Spot, the initial conditions data were supplemented with concentrations obtained from the USACE data set for this area (USACE, 1988c).

The modeling program PCB data were provided as total bed sediment concentrations and vertically averaged water column concentrations for each element in the i,j grid used for the physical/chemical model. Each data point was weighted equally for subsequent analysis; however, there is some variation in the size and, therefore, the amount of the harbor represented by each model grid element. Hot Spot concentrations, assumed to represent the range of concentrations present in the Hot Spot, were also weighted equally.

All data were log-transformed and assigned to one of six groups representing the Hot Spot and each of the five zones of the harbor discussed previously (see Figure 2-1). Simple descriptive statistics (mean and variance) were calculated for each zone and used to generate an EEC probability function for each zone. EECs are cumulative frequency distributions that quantify the likelihood that the actual environmental concentration at any location in a zone will be equal to or less than a particular value.

Because the joint probability model used to estimate risks in Section 4.0 presumes that the EEC and the effects distributions are normally distributed, the log-transformed PCB concentration data for each harbor zone were examined for deviations from normality using the Kolmogorov-Smirnov test (i.e., a=0.05). In most cases, results indicated that the transformed concentration data are not normally distributed. No other transformations were attempted to rectify this problem, because the toxicological data used in development of effects curves are log-normally distributed, and the same scales must be used for both the EEC and effects distributions to determine a joint probability risk estimate. Also, examination of the moment statistics for EEC distributions indicated that the major reason distributions are not normally distributed is due to leptokurtosis rather than skewness. In contrast with skewed distributions, the distributions are symmetrical around the mean value, and deviations from normality are less problematical.

Data reduction and analysis for metals was conducted following procedures essentially similar to those described previously for PCBs, the primary difference being that raw data from the program data base maintained by BOS were used in place of initial conditions for the physical/chemical model.

2.2.3 Exposure to Water Column Contamination

2.2.3.1 Species and Mechanisms

Organisms exposed to contaminants primarily via the water column include pelagic or planktonic species that live suspended or swimming in the water column, and demersal finfish that may have some contact with the bottom but receive most exposure from the water. Representative pelagic and demersal fish found in the New Bedford Harbor area include winter flounder (Pseudopleuronectes americanus), bluefish (Pomatomus saltatrix), blueback herring (Alosa aestivalis), and Atlantic silverside (Menidia menidia).

Phytoplankton and zooplankton are also exposed nearly exclusively via contaminants in the water column. Although effects on holozooplankton and phytoplankton are usually not of direct concern, their importance for higher trophic levels can be significant. Representative plankton in New Bedford Harbor include the copepods (Acartia tonsa) and two diatoms (Rhizosolenia alata and Skeletonema costatum). The opossum shrimp (Neomysis americana) is generally considered epibenthic rather than planktonic; however, for the purposes of the risk assessment, its behavior is sufficiently similar to planktonic organisms that it can be considered part of the planktonic group.

Bivalve mollusks, although seemingly species that would be exposed via sediment, are primarily exposed to waterborne contaminants due to the filtering of large amounts of water to extract food. In addition, bivalve mollusks have planktonic larval stages that are also exposed to contaminants in the water column. Representative bivalves in New Bedford Harbor include the Atlantic ribbed mussel (Geukensia demissa), the blue mussel (Mytilus edulis), the Atlantic bay scallop (Aequipecten irradians), and the Eastern oyster (Crassostrea virginica).

For all these organisms, the epithelial tissue of the gills is usually the primary site of contaminant uptake because of its structure and function. Uptake of contaminants from water can also occur across the linings of the mouth and gastrointestinal tract, the sensory organs, and even the viscera if they are perfused with water, as in some mollusks. Waterborne contaminants can also become adsorbed onto exposed surfaces such as the skin, where they may disrupt the function of some tissues but do not generally contribute to systemic toxicity.

2.2.3.2 PCB Exposure Concentrations in Water

Exposure levels in the water column are for the disssolved concentrations of PCBs. The dissolved component in the water column, as opposed to total concentrations, was used because most data about toxicological effects of PCBs on organisms are based on dissolved concentrations. Therefore, assessing the impact of dissolved concentrations of the contaminant more directly relates to the toxicological data. The concentration is the average for the entire water column. The mean, standard deviation, and variance for each zone are listed in Table 2-2. Cumulative probability plots for the water column exposure levels, presented in Figure 2-2, are based on a random sample of 100 data points from distributions with the calculated parameters (see Table 2-2). As shown in Table 2-2, the mean water column PCB levels decrease with increasing distance from the Hot Spot in Zone 1. Despite the large difference in the number of grid elements for the various zones, the variances associated with the different zones are similar. Mean values for Zone 1 and the Hot Spot are 2.55 and 3.10 micrograms per liter (ug/L), respectively, decreasing to 0.02 ug/L in Zone 5.

Because of the similarity in the variances associated with the environmental concentration data, the shape of the resulting EEC curves are similar, differing mainly in location along the PCB concentration axis (see Figure 2-2).

2.2.3.3 Metals Exposure Concentrations in Water

The exposure levels in the water column for all metals are for the dissolved concentrations of the metals. As in the case of PCBs, the dissolved component was used rather than the total concentration because most of the data about toxicological effects of metals are based on dissolved concentrations. The geometric mean, standard deviation, and variance for each zone are in Appendix A; that is, Table A-1 for copper, Table A-2 for cadmium, and Table A-3 for lead. The cumulative EEC probability plots for all zones for copper, cadmium, and lead are presented in Figures A-1, A-2, and A-3, respectively.

There is little indication of any relationship between the concentrations of copper and cadmium, and distance from

TABLE 2-2
EXPECTED EXPOSURE CONCENTRATIONS FOR PCBS (1)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

HARBOR ZONE	MEAN (ug/l)	TRANSFORMED VALUES (2)		
		MEAN	STANDARD DEVIATION	VARIANCE
Hot Spot, Water Column	3.097	0.491	0.128	0.016
1. Water Column	2.559	0.408	0.139	0.019
2. Water Column	1.074	0.031	0.272	0.074
3. Water Column	0.157	-0.804	0.250	0.063
4. Water Column	0.065	-1.185	0.099	0.010
5. Water Column	0.023	-1.639	0.255	0.065
Hot Spot, Pore Water	73.114	1.864	0.642	0.767
1. Pore Water	38.282	1.583	0.302	0.091
2. Pore Water	4.406	0.644	0.954	0.910
3. Pore Water	0.277	-0.558	0.393	0.154
4. Pore Water	0.075	-1.125	0.708	0.502
5. Pore Water	1.000	-1.320	0.551	0.303

NOTES:

1. All data developed using initial conditions for Battelle numerical model. Expected pore water concentrations derived from initial sediment concentrations times model mass-transfer coefficient.

2. Log (base 10) transformed values, with standard deviations and variances.

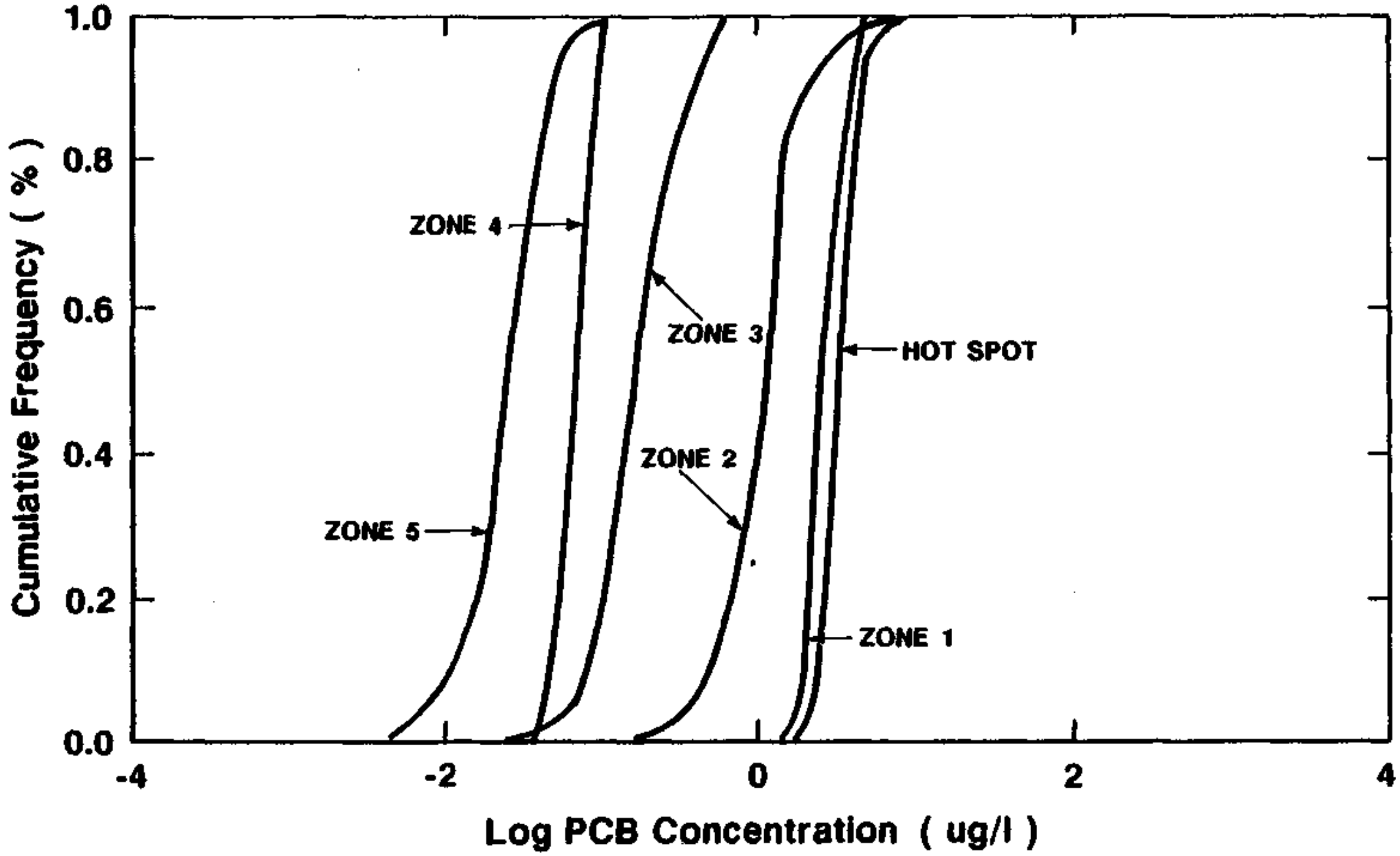


FIGURE 2-2
EECs BY ZONE FOR PCBs, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

the Upper Estuary, as was found with PCBs. However, there is a noticeable decrease in lead concentrations with increasing distance from Zone 1; within zones, lead concentrations were more variable than copper and cadmium concentrations.

2.2.4 Exposure to Sediment Contamination

2.2.4.1 Species and Mechanisms

Direct contact with and ingestion of contaminated sediment and its associated pore water are the primary routes of exposure for benthic infauna that live in close association with or are buried in the sediment. Exposure of epifaunal benthic organisms is more difficult to quantify because they are exposed to both sediment and the overlying water; for these species, exposure primarily to sediment can be used as a conservative worst case. Typical benthic invertebrates in New Bedford Harbor include the American lobster (*Homarus americanus*), amphipod (*Ampelisca vadorum*), tubificid worm (*Tubificoides* sp.), slipper shell (*Crepidula fornicata*), and mud snail (*Ilyanassa obsoleta*).

In the environment, sediment usually provides the most concentrated pool of contaminants, as evidenced at the New Bedford Harbor site (Larsson, 1985). For most of the contaminated sediment in the harbor, PCBs and metals are continually being released into the interstitial or pore water, from which uptake by benthic organisms occurs. Resuspension of sediment also increases total contaminant concentrations in the water column, but these particulate-bound contaminants are not directly available for uptake as are the dissolved-phase contaminants.

Sediment-bound contaminants are also taken up directly from the sediment by aquatic organisms (O'Donnel et al., 1985). Deposit-feeding organisms that feed by ingesting sediment also ingest any contaminants bound to the sediment. Contaminants strongly bound to sediment are less likely to desorb from sediment particles, and are absorbed in the gut less than the more weakly bound contaminants. Uptake may also occur as a result of equilibrium partitioning of contaminants between the body surfaces of the organism and surface coatings of the sediment (Swartz and Lee, 1980).

Although these various modes of uptake have all been documented, a quantitative assessment of risk incorporating all the mechanisms is not possible because of the lack of sufficient relevant toxicological data. Therefore, risk for benthic organisms was defined as risk due to exposure to contaminants dissolved in pore water. By assessing risk in this form, it is possible to draw on the body of toxicological data that has largely been developed using dissolved contaminants.

2.2.4.2 PCB Exposure Concentrations in Sediment Pore Water

PCB concentrations in pore water were calculated from the initial conditions sediment concentration data for the physical/chemical model via partition coefficients (K_d). Because of the properties of PCBs discussed in Subsection 1.3, partitioning is a complex phenomenon that varies over several orders of magnitude according to specific PCB congeners. Because the PCBs present in New Bedford Harbor represent a mixture of congeners, no single K_d can fully describe the partitioning that is occurring.

Values for site-specific apparent K_d in New Bedford Harbor are available from experiments conducted by BOS as part of the modeling program, and from the literature (Brownawell and Farrington, 1986). The K_ds ultimately selected were numerically equivalent to the mass transfer K_ds used in the physical/chemical model to approximate diffusion of dissolved PCBs from bed sediment, and are generally comparable to K_ds determined empirically by BOS, and consistent with the range of values reported in other studies (Brownawell and Farrington, 1986; and Pavlou and Dexter, 1979).

For areas above the Coggeshall Street Bridge (i.e., Zones 1 and 2), the K_d used was $5x10^5$; below the Coggeshall Street Bridge (i.e., Zones 3, 4, and 5), the K_d used was $2x10^5$. The K_ds were applied to the original data and the results log-transformed. Descriptive statistics were calculated as described for water concentrations, and the results are summarized in Table 2-2. As with the water column data, estimated pore-water PCB concentrations are highest in the Hot Spot, decreasing with distance from this area. Mean values for Zone 1 and the Hot Spot are 38.28 and 73.11 ug/L, respectively, decreasing to 0.05 ug/L in Zone 5. As was the case with data for water column PCB levels, variances associated with estimated pore water levels for the different zones are comparable, resulting in similarly shaped EEC curves (Figure 2-3).

2.2.4.3 Metals Exposure Concentrations in Sediment Pore Water

Exposure levels for metals in the pore water were calculated from the sediment concentrations via K_ds.

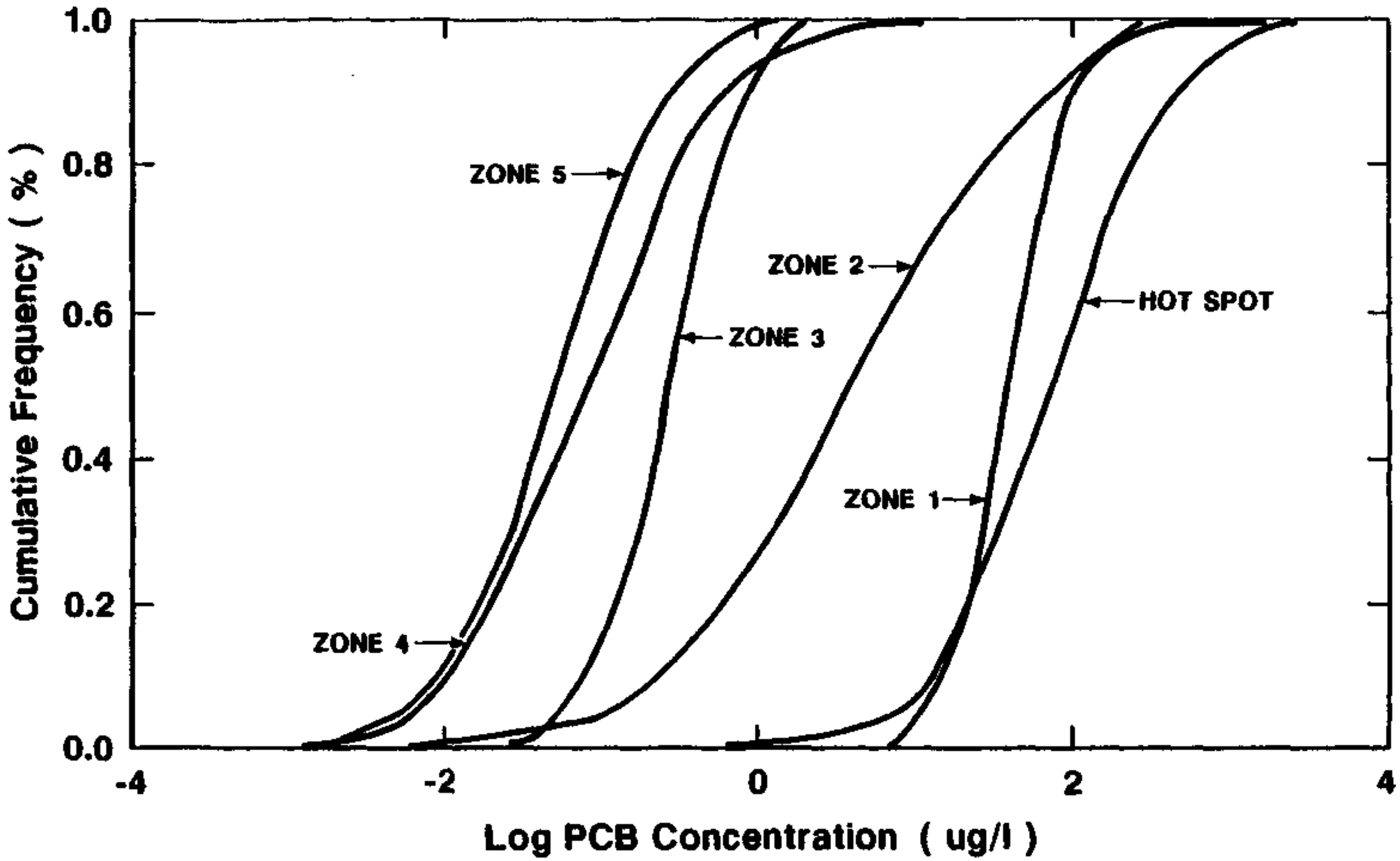


FIGURE 2-3
EECs BY ZONE FOR PCBs, PORE WATER
NEW BEDFORD, MASSACHUSETTS

The K_ds used were based on field measurements made throughout the New Bedford Harbor site, provided by Damian Shea from BOS (unpublished masters thesis). The K_ds used were $8x10^5$ for copper, $4x10^4$ for cadmium, and $2x10^5$ for lead.

The mean, standard deviation, and variance for each zone are presented in Table A-1 for copper, Table A-2 for cadmium, and Table A-3 for lead. The cumulative EEC probability plots for all zones for copper, cadmium, and lead are presented in Figures A-4, A-5, and A-6, respectively.

Calculated pore water concentrations of copper and cadmium were the lowest in Zone 5 and the highest in Zones 1 and 3 (Figures A-4 and A-5). Lead concentrations in the pore water were the lowest in Zone 4 and the highest in Zones 1 and 3. For all metals, the highest variance was associated with Zone 2. As with the water column concentrations, a decrease in concentrations with increasing distance from the PCB Hot Spot is not as well defined as for PCB concentrations, although a weak trend can be observed.

2.2.5 <u>Exposure to Contaminated Food</u>

Allotrophic organisms in New Bedford Harbor are exposed to PCBs and metals via ingestion of contaminated food. Lipophilic organic compounds (e.g., PCBs) transfer efficiently across the gut membranes because of the relatively long contact time between food and membranes. The consumption of contaminated food is of concern if dietary intake directly results in toxicity, and/or if the chemical is subject to food-chain transfer resulting in tissue burdens that may potentially be toxic.

A food-chain model is being developed for the New Bedford Harbor site by HydroQual. The transfer and fate of PCBs and metals are being assessed with the model for two different food chains, culminating in American lobster (<u>Homarus americanus</u>) and winter flounder (<u>Pseudopleuronectes americanus</u>), respectively (Figures 2-4 and 2-5).

The HydroQual model consists of a series of differential equations that numerically simulate the various processes that determine the residue value, or amount of a contaminant that remains in the tissues of the organism over time. Processes simulated in the model include surface sorption, transfer across the gills, ingestion of

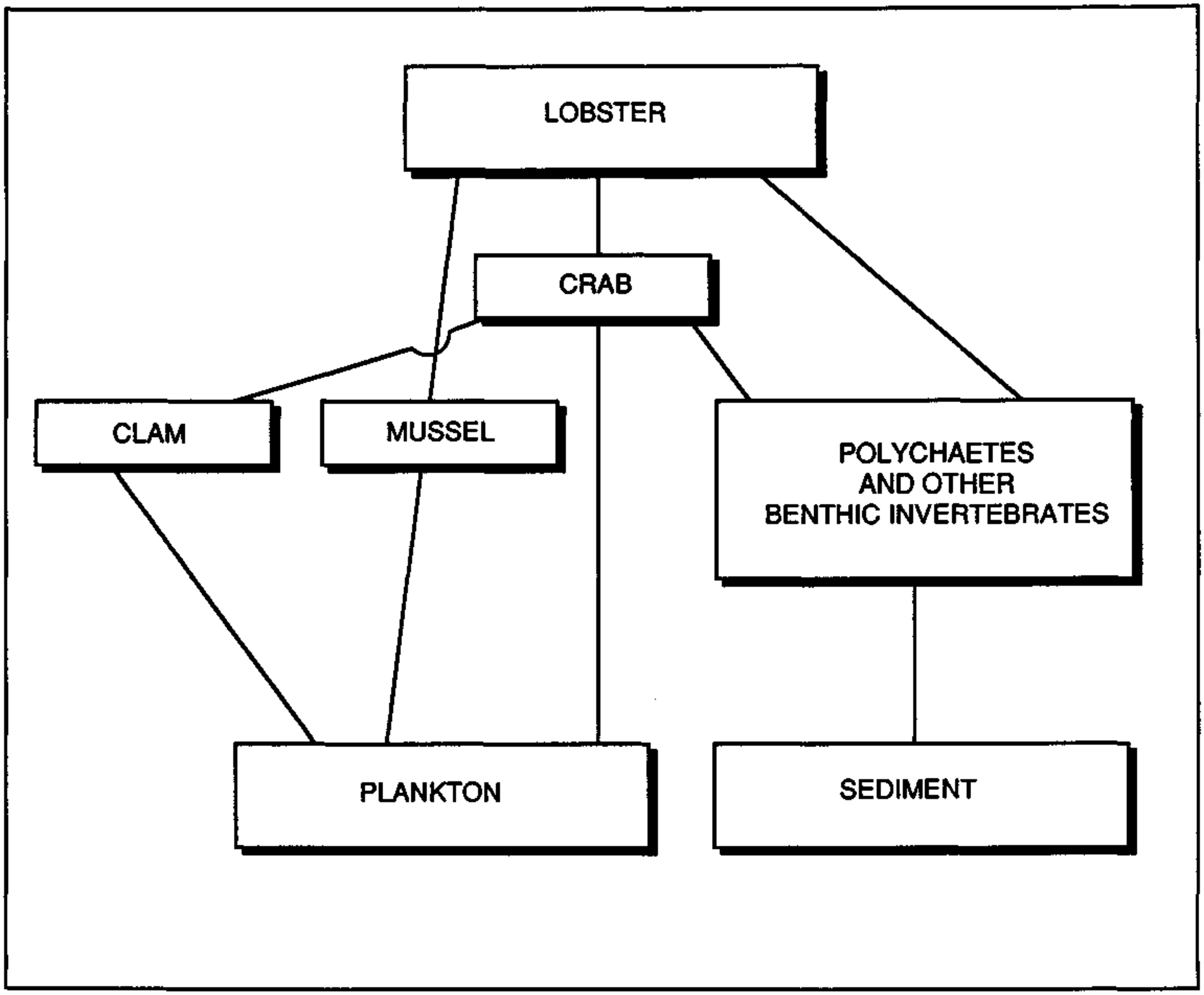


FIGURE 2- 4
LOBSTER FOOD CHAIN
NEW BEDFORD, MASSACHUSETTS

4959-50

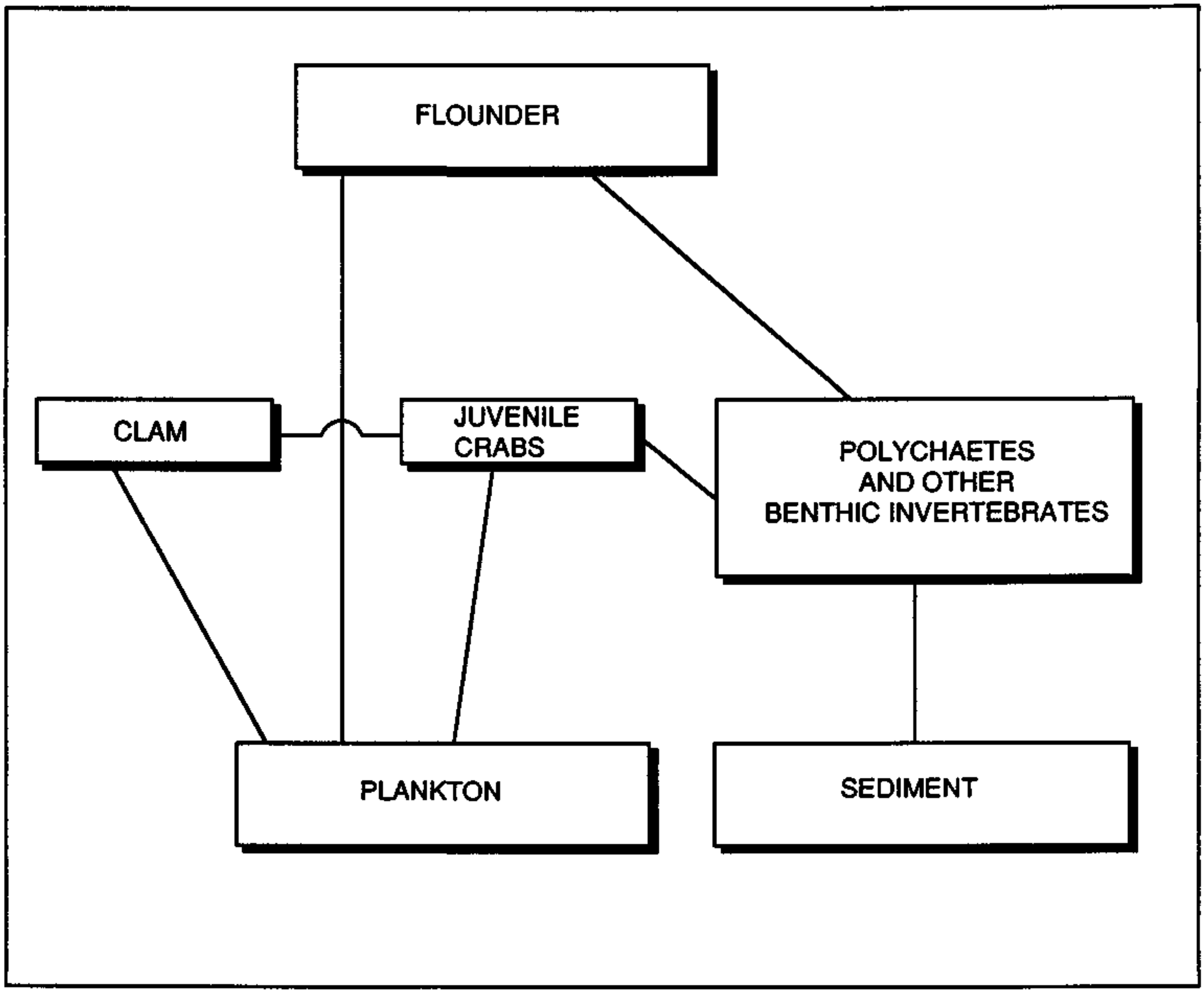


FIGURE 2- 5
FLOUNDER FOOD CHAIN
NEW BEDFORD, MASSACHUSETTS

4959-50

contaminated food, desorption, metabolism, excretion, and growth. These processes are regulated by the physical/chemical characteristics of PCBs and by the physiological processes of the biota.

The food-chain model is designed to predict residue concentrations in species consumed by humans; therefore, it is a component of the public health risk assessment, as well as the ecological risk assessment. Because there are relatively few data available on the effect of residue values on aquatic biota, it is not possible to use the model results directly in the ecological risk assessment. The model does not include provisions for modifying any of the physiological processes as the organisms become stressed due to increasing body burdens of contaminants. However, it is necessary to consider toxic effects due to residue values as part of the risk assessment (see Section 4.0).

Also of importance for the risk assessment is the observation, based on calibration and validation of the food-chain model, that consumption of PCB-contaminated food may account for the majority (up to 95 percent) of PCB residue concentrations in aquatic species in New Bedford Harbor, although other investigators consider this figure unreasonably high for all but top predators (Hansen, 1990). Therefore, although there are insufficient data to evaluate this pathway quantitatively, it must be considered in some way if the risk assessment is to reflect actual effects on aquatic biota in New Bedford Harbor. This aspect of ecological risk is discussed in Section 4.0.

The mean levels (and ranges) of PCB tissue concentration found in organisms in the New Bedford Harbor area are summarized in Table 2-3, which is based on levels found in samples collected during the Battelle cruises of 1984, 1985, and 1986. These data indicate that PCB tissue residue concentrations are correlated with the levels of PCBs found in the New Bedford Harbor sediment and water column. For the six species comprising varied trophic levels and habitat preferences, highest tissue burdens were found in organisms collected from the inner harbor; levels decreased in successive areas in the outer harbor. The highest tissue levels were observed in polychaete worms, which are in direct and continuous contact with highly contaminated sediment. Winter flounder (*Pseudopleuronectes americanus*) also had relatively high whole-body tissue levels, perhaps reflecting its position in the marine food web and its habit of lying partially covered by bottom sediments.

TABLE 2-3
WHOLE-BODY CONCENTRATIONS OF TOTAL PCBS (PPM) IN ORGANISMS
COLLECTED FROM NEW BEDFORD HARBOR

NEW BEDFORD HARBOR

	LOCATION[1]			
SPECIES	AREA 1	AREA 2	AREA 3	AREA 4
American Lobster				
Minimum	---	0.195	0.042	0.017
Mean	1.131[2]	0.568	0.213	0.064
Maximum	---	1.235	0.351	0.176
Winter Flounder				
Minimum	3.138	0.926	0.515	0.123
Mean	7.992	2.853	2.138	0.777
Maximum	20.230	8.067	6.349	2.616
Mussel				
Minimum	1.467	1.461	0.254	0.008
Mean	2.262	3.874	0.266	0.023
Maximum	2.962	6.204	0.278	0.039
Quahog				
Minimum	0.200	0.010	0.026	0.200
Mean	5.300	1.777	1.200	0.300
Maximum	2.121	1.182	0.478	0.137
Green Crab				
Minimum	0.071	0.067	0.624	0.020
Mean	0.398	0.184	0.976	0.048
Maximum	0.725	0.301	1.329	0.077
Polychaetes				
Minimum	---	---	0.096	0.182
Mean	12.972[2]	1.654[2]	0.392	0.486
Maximum	---	---	0.689	0.790

NOTES:

[1] Locations correspond to Fishing Closure Areas (see Figure 1-2).
[2] Only one value available.

SOURCE: New Bedford Harbor Data Base

Table 2-4 summarizes the ranges of whole-body metals concentrations detected in organisms in the New Bedford Harbor area. The tissue residue levels of metals did not show general trends in contaminant concentrations between areas or between species. Overall, cadmium was detected at concentrations lower than either copper or lead. Copper concentrations were highest in crustaceans (i.e., crabs and lobsters), which probably reflects their copper-based heme system.

TABLE 2-4
RANGE [1] OF TOTAL WHOLE-BODY METALS IN NEW BEDFORD HARBOR BIOTA

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

ORGANISM	CADMIUM (ppm)	n [3]	COPPER (ppm)	n [3]	LEAD (ppm)	n [3]
Lobster	0.002NC	2	0.11-24.9	2	0.223-1.29	2
	0.002-0.703	16	20.778-46.814	16	0.106-3.034	16
	0.001-0.538	14	17.997-50.945	14	0.021-1.124	14
	0.002-0.588	21	15.788-62.663	21	0.029-0.842	21
Winter Flounder	0.004-0.014	23	0.692-11.147	23	0.215-3.336	22
	0.002-0.019	27	0.618-19.847	27	0.154-4.523	27
	0.002-0.012	17	0.691-51.642	17	0.099-2.728	17
	0.003-0.099	22	0.480-43.9	22	0.089-6.84	22
Mussel	0.242-0.326	9	1.948-2.49	9	0.293-1.41	9
	0.229-0.271	9	1.895-2.779	9	0.237-1.17	9
	0.326-0.397	6	0.726-0.841	6	0.367-0.647	6
	0.145-0.209	6	0.727-1.081	6	0.134-0.308	6
Quahog	0.087-0.356	18	3.727-8.302	18	0.58-1.901	18
	0.209-0.329	18	1.47-4.055	18	0.488-0.981	18
	0.12-0.381	18	1.302-2.713	18	0.208-3.463	18
	0.119-0.495	10	1.225-2.239	10	0.098-1.720	10
Green Crab	0.075-0.105	5	53.418-262.475	5	4.292-29.768	5
	0.027-0.095	4	12.1-52.897	4	1.45-6.908	4
	0.081[2]	1	201[2]	1	30.6[2]	1
	0.057	3	180.231[2]	3	13.824	3
Polychaetes	NA		NA		NA	
	NA		NA		NA	
	0.065-0.188	6	2.36-6.37	6	0.467-3.979	6
	0.111[2]	3	7.708[2]	3	1.076[2]	3

NOTES:

1 Each value represents the mean of several organisms within one size class
2 Only one value available
3 Total number of organisms sampled in each area
4 Areas correspond to Fisheries Closure Areas
NA = Not Available

3.0 ECOTOXICITY ASSESSMENT

The ecotoxicity assessment is a two-step process consisting of a compilation and evaluation of available toxicological information, and a synthesis of the information to provide a quantitative assessment of concentration/response data. Available toxicological information, some of which is presented herein, strongly supports the conclusion that PCBs in the marine environment represent a potential threat to biota, and provides additional information necessary to determine the nature and severity of actual or potential adverse effects associated with exposure. Although additional toxicological studies would be useful, the data available are sufficient to allow a quantitative estimation of the risk from contaminant exposure for four of the five groups discussed in Section 2.0. For the remaining group, the polychaete worms, the lack of available data precludes development of good quantitative concentration/response relationships. The concentration/response relationships developed herein will be combined with the exposure concentrations from Section 2.0 to provide the quantitative estimate of risk.

3.1 ECOTOXICITY PROFILES

3.1.1 PCBs

PCBs belong to a class of chemically stable, multi-use industrial chemicals that have been widely distributed in the New Bedford Harbor ecosystem. Electrical component manufacturers in New Bedford used PCBs in transformers and capacitors as dielectric insulating fluids resistant to fire. Discharge of PCBs into the harbor has resulted in contamination of the sediment, water, and biota in the area. Aspects of the structure, fate, and transport of PCBs with importance for determination of ecological risk are discussed in Subsection 1.3.

Adsorption to organic material in sediment is probably the major fate in the marine and estuarine environments of at least the more heavily chlorinated PCBs. Once bound, PCBs may persist for years, with slow desorption providing continuous exposure to the surrounding environment. Because PCBs are persistent in the environment and are lipophilic compounds, they are bioaccumulated (EPA, 1980b). The potential for bioaccumulation of an Aroclor mixture, as with other aspects of the biochemical behavior of PCBs, is related to the percentage of chlorine, with the BCF value generally increasing with higher chlorine content (Callahan et al., 1979). PCBs may be degraded by microorganisms (mainly the mono-, di-, and tri-chlorinated congeners) and by photolysis by ultraviolet light (mainly PCBs with five or more chlorines). Biodegradation rates and mechanisms appear to be specific to individual isomers and it is impossible to generalize about the overall rate for complex mixtures, except that many Aroclors persist for years or decades in the environment. Photolysis is extremely slow, but it may be a significant degradation pathway (EPA, 1980b).

EPA derived an AWQC for the protection of marine organisms for PCBs of 0.03 ug/L (parts per billion [ppb]). This value is based on laboratory-derived BCFs and was established to ensure that PCB burden in edible fish tissue (i.e., the final residue value [FRV]) would not exceed the former FDA tolerance level of 5.0 milligrams per kilogram (mg/kg) and not necessarily to protect ecological receptor organisms (EPA, 1980c). A recalculation of the criteria based on the new tolerance level value of 2.0 mg/kg would establish the new criterion at 0.012 ug/L (ppb); however, this change has not yet been made.

FDA tolerance levels are set to be protective of public health, but are based in part on economical and technical considerations. However, data from acute and chronic toxicity tests using Aroclors indicate that neither acute nor chronic toxicity should occur at the AWQC of 0.03 ug/L.

Marine AWQC, based on final toxicity values, are established to be protective of 95 percent of saltwater species. For PCBs, the AWQC document does not derive final acute or chronic values because determination of acute toxicity concentrations is problematic for PCBs (acute values are often in excess of maximum solubilities); minimum data criteria are not satisfied; and differing toxicities are demonstrated by the various PCB Aroclors and congeners (EPA, 1980b). Therefore, the saltwater AWQC for PCBs is based on the FRV, and is intended to protect the use of marine species as seafood rather than the species themselves, although it is considered sufficiently protective of the organisms as well. As such, these criteria serve as a tool to make general comparisons between the observed water column concentrations in New Bedford Harbor and toxicity information. However, site-specific ecotoxicity data provide a more definitive measure of the potential adverse effects of PCBs to marine organisms in New Bedford Harbor.

Tables B-1, B-2, and B-3 in Appendix B summarize available PCB ecotoxicity data, including acute and chronic toxicity data, as well as bioconcentration data for saltwater species discussed in the toxicological evaluation. Although PCBs have been shown to be acutely toxic to aquatic organisms, the actual exposure concentrations are unknown because the reported concentrations for the acute toxicity tests exceeded solubilities for some portion of PCB isomers, and the complex physical behavior of PCB mixtures makes cross-study comparisons difficult.

Based on the summarized acute and chronic toxicity data on PCBs, marine fish as a group are sensitive to the effects of PCB exposure. Chronic effects observed for marine fish include reduced hatching of embryos, reduced survivorship of fry, lethargy, fin rot, and decreased feeding, as well as mortality. Crustaceans are also quite sensitive, with acute effects being observed at exposures as low as 1 ug/L. The observed effects after chronic exposure for crustaceans include molt inhibition, dispersion of melanin in shells, altered metabolic state, and avoidance (Table B-2). Mortality has also been observed for crustaceans after chronic exposure.

Mollusks as a group are generally not as sensitive to PCB exposure as marine fish and crustaceans; however, reduced growth was observed at an exposure of 5 ug/L. Reduced growth rates are also observed in alga exposed to PCBs. Reduced cell division, reduced carbon dioxide uptake, and even no growth have been observed in alga after chronic exposure to PCBs. When populations of more than one algae species are exposed to PCBs, changes in species ratios and decreased diversity in the communities are observed. Overall PCB toxic effects are varied and at low concentrations. Toxic effects have been reported at concentrations of PCBs higher than the solubilities of the compounds.

BCFs for marine organisms are relatively high, ranging from 800 to greater than 670,000 (EPA, 1980b). Field and Dexter summarized available data for bioaccumulation from PCB-contaminated sediment with ratios ranging to 20 (Field and Dexter, 1988). These high factors would be predictable based on the lipophilic nature of PCBs. BCFs vary depending on several factors, including the level of total organic carbon (TOC) in the sediment and the length of exposure. BCFs vary among species and for different congeners. In general, the factors will be higher for species with greater amounts of fatty tissue. For congeners, the highest factors appear to occur among the congeners with five and six chlorine atoms; the lowest among those with eight and nine atoms (Lake et al., 1989).

3.1.2 Copper

Copper is a necessary nutrient for plants and animals; however, it is toxic at higher concentrations (EPA, 1985a). The copper ion is highly reactive and complexes with many inorganic and organic constituents of natural waters (EPA, 1985a). Hydrous iron and manganese oxides can effectively remove almost all free copper from the water column (Lee, 1975); and sediment/clay complexes, carbonates, and organic acids are all similarly effective under particular conditions. Most organic and inorganic copper complexes and precipitates appear to be much less toxic than free cupric ion.

Relatively few marine toxicological data are available for copper. However, mollusks and phytoplankton appear to be most sensitive to copper. Tables B-4 and B-5 in Appendix B summarize the toxicity data available for marine organisms. Copper has been shown to be acutely toxic to embryos of the blue mussel (Mytilus edulis) at 5.8 ug/L (Martin et al., 1977), and several diatom and marine alga species are sensitive to copper in the 1-to-10-ppb range. In fact, copper has been historically used as an aquatic herbicide and as a molluscicide to control schistosomiasis. Mean lethal concentration (LC_{50}) values for tests on winter flounder embryos (Pseudopleuronectes americanus) and the American lobster (Homarus americanus) were 130 and 69 ug/L, respectively (EPA, 1985a).

The only chronic data available for marine organisms are for Mysidopsis bahia; EPA established a chronic value of 54 ug/L based on lifecycle tests with this species. Various phytoplankton, polychaete worms, and mollusks have been shown to bioaccumulate copper with BCF values ranging from less than 100 to over 20,000. The marine chronic AWQC was established by EPA at 2.9 ug/L (ppb).

3.1.3 Cadmium

Although cadmium is insoluble in water, its chloride and sulphate salts readily solubilize. Humic acids and, to a lesser extent, hydrous iron and manganese oxides, appear to be primarily responsible for determining the extent of adsorption to sediment, while increased acidity and oxygenation tends to amplify desorption rates and subsequent bioavailability (Eisler, 1985; and Forstner, 1983). In addition, increasing salinity appears to mitigate the toxicological impact of this contaminant (EPA, 1985b). Tables B-6 and B-7 in Appendix B summarize the available saltwater ecotoxicity data for cadmium.

In general, freshwater species are considerably more sensitive to cadmium poisoning than marine species (Eisler, 1985). Among marine organisms, invertebrates are most sensitive to cadmium toxicity, with acute test results ranging from 41 to 135,000 ug/L for Mysidopsis bahia and an oligochaete worm, Monophylephorus cuticalcatus, respectively (EPA, 1985b).

Sublethal effects, including growth retardation, physiological disruptions, and alteration of oxygen consumption and respiratory rates, have been observed in marine organisms exposed to ambient cadmium concentrations on the order of 0.5 to 10 ug/L (Eisler, 1985).

Marine organisms can readily bioconcentrate cadmium, and BCF values over 2,000 have been recorded in some polychaete worms and mollusks (EPA, 1985b). However, reported BCFs for the lobster (Homarus americanus) and a marine fish, Fundulus heteroclitus, were 21 and 15, respectively (Eisler, 1985). EPA derived a chronic AWQC of 9.3 ug/L for the protection of marine organisms for cadmium.

3.1.4 Lead

Lead is most soluble under aqueous conditions characterized by low pH, low organic content, low particulate matter, and low concentrations of the salts of calcium, cadmium, iron, manganese, and zinc (Eisler, 1988). Most lead entering aquatic environments is quickly precipitated to bed sediments, and is released only under specific conditions (Demayo et al., 1982).

Relatively few toxicological data for marine species are available, with chronic-level effects observed in some organisms, particulary phytoplankton, in the 1-to-10-ug/L range. The plaice, Pleoronectes platessa, was acutely sensitive to tetramethyl lead at 50 ug/L (Eisler, 1988); a lifelong maximum acceptable toxicant concentration (MATC) between 17 and 37 ug/L was calculated for Mysidopsis bahia.

BCFs for lead in marine organisms ranged from 17.5 to 2,570 for the quahog (Mercenaria mercenaria) and the blue mussel (Mytilus edulis), respectively (EPA, 1980b). However, there is no evidence to indicate that lead is transferred through aquatic food chains (Eisler, 1988).

Tables B-8 and B-9 in Appendix B summarize available ecotoxicological data specific to the effects of lead exposure to marine organisms. Based on these data, EPA derived a chronic AWQC of 5.6 ug/L for the protection of marine organisms for lead.

3.2 EFFECTS EVALUATION

3.2.1 Methods

PCB and metals effects curves were constructed for the four taxonomic groups (i.e., marine fish, crustaceans, mollusks, and alga) for which ecotoxicity data were available. Data on benchmark effects were summarized, and the mean and variance of these data were used in the joint probability analysis to estimate risk, and to generate cumulative frequency probability curves. The curves provide an evaluation of probability of effect at various contaminant concentrations.

The standard acute benchmark for evaluating the acute response of an aquatic organism to the environmental concentration of a toxic contaminant is the 96-hour median LC_{50} (EPA, 1982; and ASTM, 1984). However, for purposes of risk assessment, the acute benchmark is not appropriate because the organisms are assumed to be exposed for periods longer than 96 hours. A more appropriate benchmark is the MATC, which is the threshold for significant effects on growth, reproduction, or survival (EPA, 1982; and ASTM, 1984). The benchmark is based on the most sensitive response of the organism to the contaminant in question.

Few MATC data are available for marine organisms, and the research that has been performed is limited with respect to both contaminant type and test organisms used. There are insufficient MATC data for PCBs to generate distributions for any of the taxonomic groups of interest. For this risk assessment, MATCs for the four taxonomic groups were developed using a method described by Suter and Rosen (Suter et al., 1986; and Suter and Rosen, 1986). This method uses an errors-in-variables regression model to predict a toxicological endpoint (in this case, the MATC) based on an extrapolation from existing endpoints for similar organisms. The regression equations used were established based on several large aquatic toxicological data bases (Suter and Rosen, 1986). For example, the model allows extrapolation from the LC_{50} of one species to the LC_{50} of another; similar extrapolations can be performed between LC_{50}s and MATCs. Therefore, a regression equation can be developed that has a coefficient (slope) and constant (intercept) that characterizes a between-taxon LC_{50} relationship or a within-taxon relationship between LC_{50}s and MATCs.

The errors-in-variables approach considers the following characteristics of toxicity data that a linear least-squared model would not address: (1) the observed values of both the independent (X) and dependent (Y) variables have inherent variability and are subject to measurement error; (2) the independent variable is not a controlled variable; and (3) the values assumed by (X) and (Y) are open-ended and non-normally distributed (Ricker, 1973). This method allows for quantification of uncertainty from interspecific differences in sensitivity, and the variability of the relationship between acute and chronic effects of contaminants. The uncertainty is quantified in the variances that result from the extrapolation. This variance is then applied in the joint probability analysis, which uses the estimated toxicological benchmark value and its variance, along with an EEC and its variance to estimate risk of chronic effects to a particular group of organisms. The final risk estimate is interpreted as the probability of an adverse effect being realized in a typical member of the group in question, given the variability in contaminant levels.

This model and its application are discussed in more detail in Section 4.0. MATCs for four groups of organisms (i.e., marine fish, crustaceans, mollusks, and alga) representative of the range of organisms found in New Bedford Harbor were developed using this approach. The taxonomic groupings were necessary to facilitate the application of the errors-in-variables methodology, because extrapolations are within or between taxonomic levels. A comparable analysis by strict trophic and/or habitat classification by this method would not have been possible because multiple taxa groups would be a part of such an analysis. However, these groups generally also define a primary means of exposure (e.g., via water or sediment) and, therefore, allow consistency with respect to applying exposure concentrations to provide a risk estimate.

For marine fish, crustaceans, and mollusks, MATCs were developed using the errors-in-variables methodology. For the algae, a chronic effect concentration was developed based on the existing toxicological data. The data used for the overall MATC development for alga and mollusks came from the AWQC and Eisler documents (EPA, 1980a, 1980b, and 1980c; and Eisler, 1986). These data sets were also used as the source of the LC_{50} for the sheepshead minnow and the MATC for *Daphnia magna* used in extrapolations for marine fish and crustacean MATCs.

All data used for the regressions were log-transformed. Test results reported as greater than or less than a particular value were not used. When replicate data were available for a chemical-species pair, the geometric mean for the species was used. Use of the geometric rather than the arithmetic mean for replicate tests is consistent with EPA methods for AWQC development (EPA, 1982).

3.2.2 Application and Results

3.2.2.1 Marine Fish

Development of the MATCs for marine fish was based on previously reported relationships. Suter and Rosen performed extrapolations between the LC_{50}s for sheepshead minnow (*Cyprinodon variegatus*) and LC_{50}s for marine species, as well as derivation of the errors-in-variables relationship between marine fish LC_{50} and marine fish MATCs (Suter and Rosen, 1986). The slope, intercept, and variance from these extrapolations used in the MATC development and risk assessment for marine fish in New Bedford Harbor are presented in Table 3-1.

The overall marine fish MATC for PCBs was created by a double extrapolation: first from the sheepshead minnow chronic LC_{50} for PCBs (0.93 ug/L) to a typical marine fish LC_{50} for PCBs

TABLE 3-1
PCB MATC ESTIMATES FOR ORGANISMS AT NEW BEDFORD HARBOR

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

TAXON	SLOPE	INTERCEPT	MATC	TOTAL VARIANCE
Marine Fish	0.97	0.03		
	0.98	-0.6	-0.601	1.021
Crustaceans	0.95	0.0	0.668	0.956
Mollusks	1.577	-0.456		
	0.98	-0.6	1.358	3.024
Algae			0.987	4.907

NOTES:

1. The basic regression equation that defines the extrapolation is Y = Intercept + (X * Slope), where X is the acute toxicological estimate and Y the extrapolated MATC value.

2. No extrapolation was done for algae; rather, chronic data were used to estimate the benchmark value for the taxon.

3. In cases where two sets of slope and intercept values are listed, the first set is for a LC50-to-LC50 extrapolation, and the second for the final LC50-to-MATC extrapolation.

4. All units expressed as Log (base 10) ug/L.

(0.99 ug/L), then to a marine fish MATC of 0.25 ug/L. The chronic LC_{50} value used as the starting point for these extrapolations was an early life stage test using Aroclor 1254. Similar testing with Aroclor 1016 produced similar responses only at concentrations above 10 ug/L. Other Aroclors are expected to fall generally within this range, and the lower value for Aroclor 1254 provides a conservative estimate of the toxicity of the actual mix of PCB congeners in New Bedford Harbor. The effect curve, which is a cumulative probability plot based on the MATC value and its variance, is shown in Figure 3-1.

Approximately 95 percent of the calculated MATC values for marine fish falls within a range of four orders of magnitude; chronic values in the literature, most of which are based on one of three species, span approximately half this range. This difference is largely a result of the procedure that uses the actual data as a sample from the universe of MATCs and generates a probability plot for all marine species in the taxon of interest. The actual range for species residing in New Bedford Harbor may well be smaller; however, there is no way of developing such a site- specific MATC with the available data.

The metal MATC values for marine fish were extrapolated using a relationship between the MATCs of the mysid, Mysidopsis bahia and the MATCs of fish developed by Suter and Rosen (Suter and Rosen, 1986). The extrapolations were from the mysid MATCs of 54, 5.5, and 25 ug/L for copper, cadmium, and lead, respectively. The MATCs derived for marine fish were 329, 32, and 150 ug/L for copper, cadmium, and lead, respectively.

The MATC effects curves are shown in Figures B-1, B-2, and B-3 in Appendix B. The slope, intercept, and variance from these extrapolations used in the MATC development and risk assessment for metals and marine fish in New Bedford Harbor are presented in Tables B-10, B-11, and B-12.

3.2.2.2 Crustaceans

The PCB MATC for crustaceans was obtained from the association between the MATC for the cladoceran (Daphnia magna) and MATCs for marine crustaceans developed by Suter and Rosen (Suter and Rosen, 1986). The slope, intercept, and variance developed in this errors-in-variables model are presented in Table 3-1. One extrapolation from the cladoceran MATC (5.14 ug/L) was required to derive the typical marine crustacean MATC of 4.66 ug/L. The MATC probability curve for crustaceans is shown in Figure 3-1.

A single extrapolation was required to develop the metal MATCs for crustaceans. These MATC values were extrapolated using a relationship between the MATCs of the mysid, Mysidopsis bahia, and the MATCs of crustaceans developed by Suter and Rosen (Suter

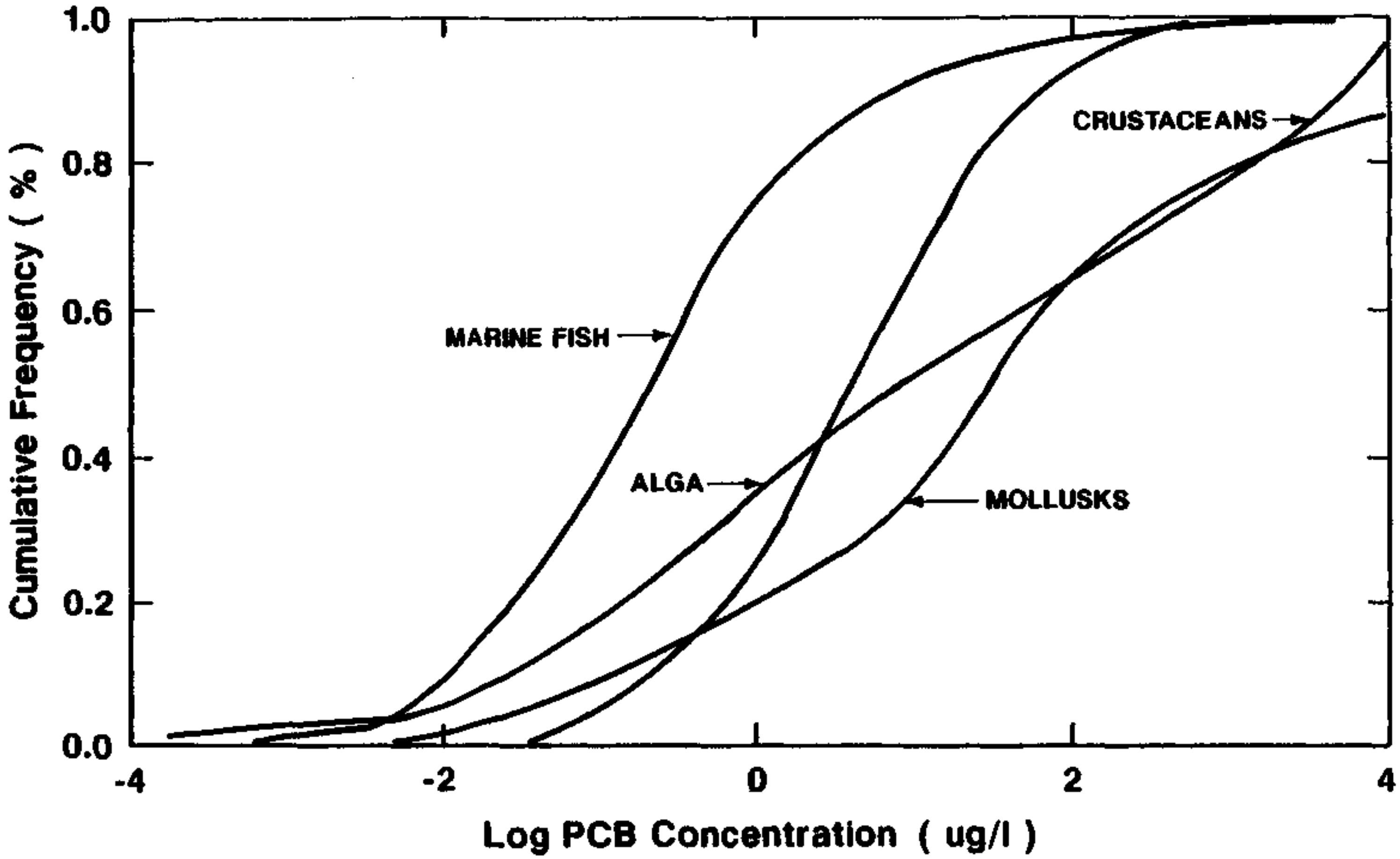


FIGURE 3-1
MATC CURVES FOR PCBs
NEW BEDFORD, MASSACHUSETTS

and Rosen, 1986). The extrapolations were from the mysid MATC values of 54, 5.5, and 25 ug/L for copper, cadmium, and lead, respectively. The extrapolated MATCs developed for crustaceans were 65.5, 10.5, and 35.3 ug/L for copper, cadmium, and lead, respectively. The slope, intercept, and variance from these models are shown in Tables B-10, B-11, and B-12 in Appendix B. The MATC curves for copper, cadmium, and lead are shown in Figures B-1, B-2, and B-3, respectively.

3.2.2.3 Mollusks

To develop the PCB MATC for mollusks, two extrapolations were needed. First, a relationship between the LC_{50}s for the mysid, <u>Mysidopsis bahia</u>, and LC_{50}s of mollusks was developed. The relationship between these species was used because the greatest number of matches between chemical-species pairs was available and, although there is no close taxonomic relationship, the mysid is a standard test species. Because there are no MATC data available for mollusks, an estimate of the MATC was performed by using the relationship between marine fish LC_{50}s and MATCs, on the assumption that the ratios between acute and chronic effects for marine fish and mollusks are similar. The slopes, intercepts, and variances used in this MATC development are shown in Table 3-1.

The mollusk LC_{50} of 99.61 ug/L was obtained by forward extrapolation from the mysid LC_{50} (36.0 ug/L). The estimated mollusk LC_{50} was then used to estimate the typical mollusk MATC (22.82 ug/L) based on the LC_{50}/MATC relationship for marine fish. The effects curve is shown in Figure 3-1. There is a large variance associated with this MATC due to the double extrapolation. Large variances were observed by Suter and Rosen for similar extrapolations between higher level taxonomic groups (Suter et al., 1986; and Suter and Rosen, 1986). Because the variance for the extrapolation from LC_{50} to MATC for marine fish is small, its use in this application may result in an underestimation of the variance associated with the MATC for mollusks.

As in the case of PCBs, limited data are available on metal MATCs for mollusks. To develop MATCs for mollusks, the same marine fish LC_{50}-to-MATC relationship was used as for PCBs, assuming that the ratios between acute and chronic effects for marine fish and mollusks are similar. The LC_{50}s used in this extrapolation were developed from values reported in the AWQC and Eisler documents (EPA, 1980a, 1980b, and 1980c; and Eisler 1985 and 1986). These data are compiled in Tables B-4 through B-9 in Appendix B. For each metal, the mollusk LC_{50} value used in the extrapolation is a geometric mean of the values reported for all mollusks.

The metal MATCs for mollusks were derived from the mollusk LC_{50} values of 72.4, 2,666, and 1,244 ug/L for copper, cadmium, and lead, respectively. The single forward extrapolation for each metal estimated the mollusk MATCs to be 16.7, 571, and 271 ug/L for copper, cadmium, and lead, respectively. The effects curves for the MATCs are presented in Figures B-1, B-2, and B-3 in Appendix B. The slope, intercept, and variance from these extrapolations are presented in Tables B-10, B-11, and B-12.

3.2.2.4 Polychaetes

There were sufficient acute toxicological data for the three metals to develop MATC estimates for polychaetes, using the crustacean LC_{50} and MATC extrapolation developed by Suter and Rosen (Suter and Rosen, 1986). In this case, it was assumed that the ratios between acute and chronic effects for crustaceans and polychaetes are similar. The LC_{50}s used in this extrapolation were developed from values reported in the AWQC and Eisler documents (EPA, 1980a, 1980b, and 1980c; and Eisler 1985 and 1986). Tables B-4 through B-9 in Appendix B summarize of the toxicological data used to develop MATC estimates for polychaetes. The polychaete LC_{50} for each metal is a geometric mean of the values reported for all polychaetes and oligochaetes.

The metal MATCs for polychaetes were derived from the polychaete LC_{50} values of 199, 9,682, and 10,691 ug/L for copper, cadmium, and lead, respectively. A single forward extrapolation for each metal was necessary to estimate the polychaete MATCs as 30.2, 1,276, and 1,409 ug/L for copper, cadmium, and lead, respectively. MATC curves for copper, cadmium, and lead are shown in Figures B-1, B-2, and B-3, respectively. The slope, intercept, and variance from these individual extrapolations are presented in Tables B-10, B-11, and B-12.

3.2.2.5 Algae

For the algal species at the New Bedford Harbor site, a benchmark concentration was developed using the geometric mean of the results from chronic tests as presented in the AWQC and Eisler documents (EPA, 1980; and Eisler, 1986). Although this value is not an MATC by definition, it is a reasonable best estimate of chronic toxicological effects of PCBs on algal species based on the limited data available. The benchmark concentration of 9.71 ug/L has a high amount of variance (4.44); this is due to the large amount of variability in reported responses to PCBs. The effects curve is shown in Figure 3-1.

For the metals, a geometric mean was developed from chronic effects data presented in the AWQC and Eisler documents (EPA, 1980a and 1980c; and Eisler, 1985 and 1988). The benchmark values derived were 12, 99.3, and 234 ug/L for copper, cadmium, and lead, respectively. The effects curves for the MATCs are shown in Figures B-1, B-2, and B-3 in Appendix B. Summary statistics for these benchmark concentrations are in Tables B-10, B-11, and B-12.

3.2.3 Evaluation of MATCs

Because of the limited amount of data available about the effects of PCBs and metals on marine organisms, the estimates of MATC or chronic effect benchmarks as used in this risk assessment have some uncertainty, which was quantified to some extent by the variances from the errors-in-variables extrapolations. The relative effect of this source of uncertainty may be observed graphically by comparison of the slope of the probability function for the MATC of each group in Figure 3-1. This uncertainty is also evident in the effect of the variance on results of the analysis of extrapolation error model used for risk characterization in Section 4.0. In all cases, the variance in the estimates for metal MATC values was not as high as for PCBs, primarily due to the fact that only one extrapolation was necessary.

Another area of uncertainty for these MATC estimates results from the need to perform extrapolations from a single species to a taxonomic group consisting of many species, some of which may be only distantly related. If the single species used in the extrapolation happens to be particularly sensitive to contaminants, the final estimate of the group MATC may be overly conservative. This is probably the case for the extrapolation from the sheepshead minnow to marine fish in general. The PCB LC_{50} for the sheepshead minnow (0.93 ug/L), the species used to develop most of the available data, is quite low, driving the marine fish MATC to a lower value than may be the case. However, other marine fish tested also have low LC_{50}s for PCBs.

4.0 RISK CHARACTERIZATION

Risk to marine organisms in New Bedford Harbor was evaluated for exposure to waterborne and sediment-bound PCBs and metals, as well as for consumption of PCB-contaminated food. Risk estimates for each environmental medium were evaluated by taxonomic group for each harbor zone described in Section 1.0, and overall ecosystem risk was assessed qualitatively from the individual risk estimates.

A quantitative uncertainty (or joint probability) analysis was performed by combining results of the analyses of exposure and ecotoxicity presented in the two preceding sections to develop probabilistic estimates of risk in New Bedford Harbor. In addition, risk to organisms exposed to dissolved contaminants in the water and directly to PCB-contaminated sediment was evaluated by comparing analytical data on existing contaminant levels with appropriate water and sediment criteria, and by examining the results of site-specific bioassays. Risk due to ingestion of PCB-contaminated food was evaluated by comparing the tissue burden levels detected in New Bedford Harbor biota to effect levels associated with reproductive impairment and pathological effects in marine fish.

4.1 JOINT PROBABILITY ANALYSIS

4.1.1 PCB Water Column Contamination

The probability functions for chronic effects due to dissolved PCBs in the water column for each of the four taxonomic groups with sufficient toxicological data to perform the analysis are shown co-plotted with the EEC probability functions for the Hot Spot and Zones 1 through 5 in Figures 4-1 through 4-4. Results of the joint probability analysis for each group using these two sets of curves are presented in Table 4-1. For the algae (see Figure 4-1), potential impacts are projected for each zone, particularly areas north of the Coggeshall Street Bridge (Zones 1 and 2, and the Hot Spot), where there is a 30 percent or greater probability that the average dissolved PCB concentration encountered by a typical marine algal species would exceed the respective chronic benchmark. Another way of expressing this effect would be as an impact on the most sensitive 30 percent of the various algal species used for the toxicity studies upon which the chronic effects curve was based and, therefore, are representative of taxa that might occur in the area. For Zones 3 and 4, the average concentration encountered would potentially impact 20 percent or less of the algal species; however, essentially the entire harbor north of the Hurricane Barrier has a high probability of impacting more than 5 percent of the algal species (i.e., a benchmark used by EPA in determining water quality criteria). Because of the wide range of sensitivities

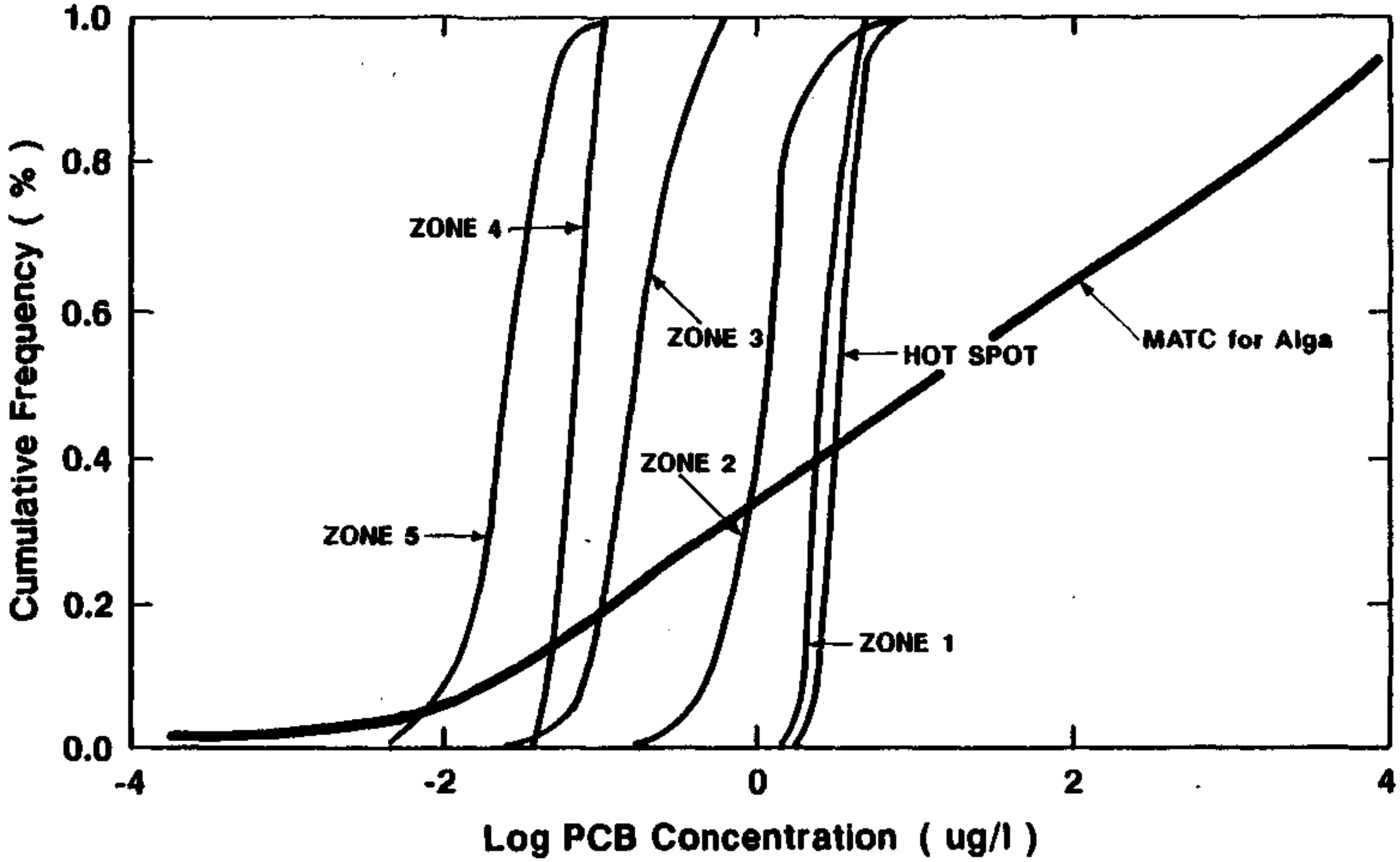


FIGURE 4-1
MATC FOR ALGA AND EECs FOR ALL ZONES, PCBs, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

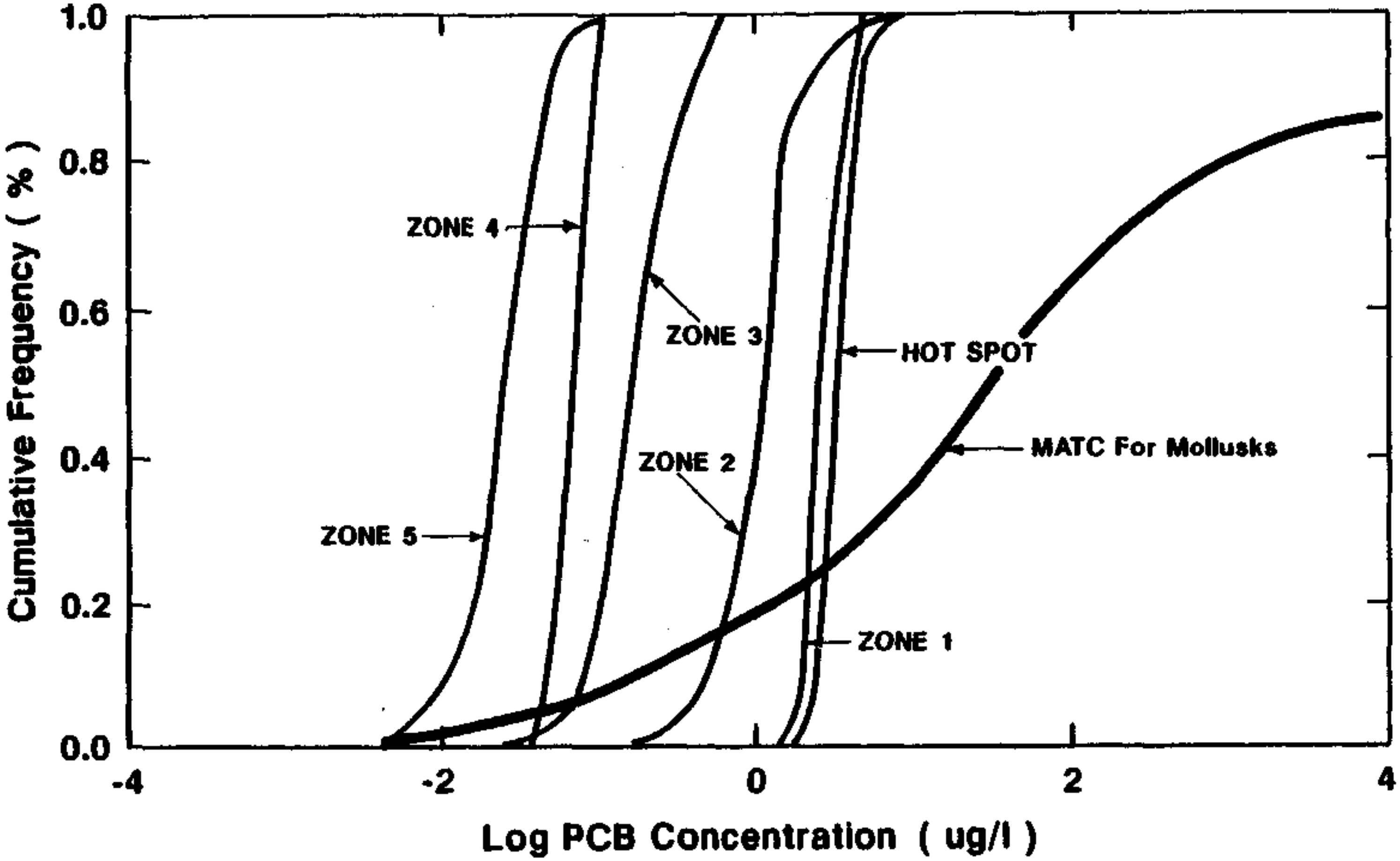


FIGURE 4-2
MATC FOR MOLLUSKS AND EECs FOR ALL ZONES, PCBs, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

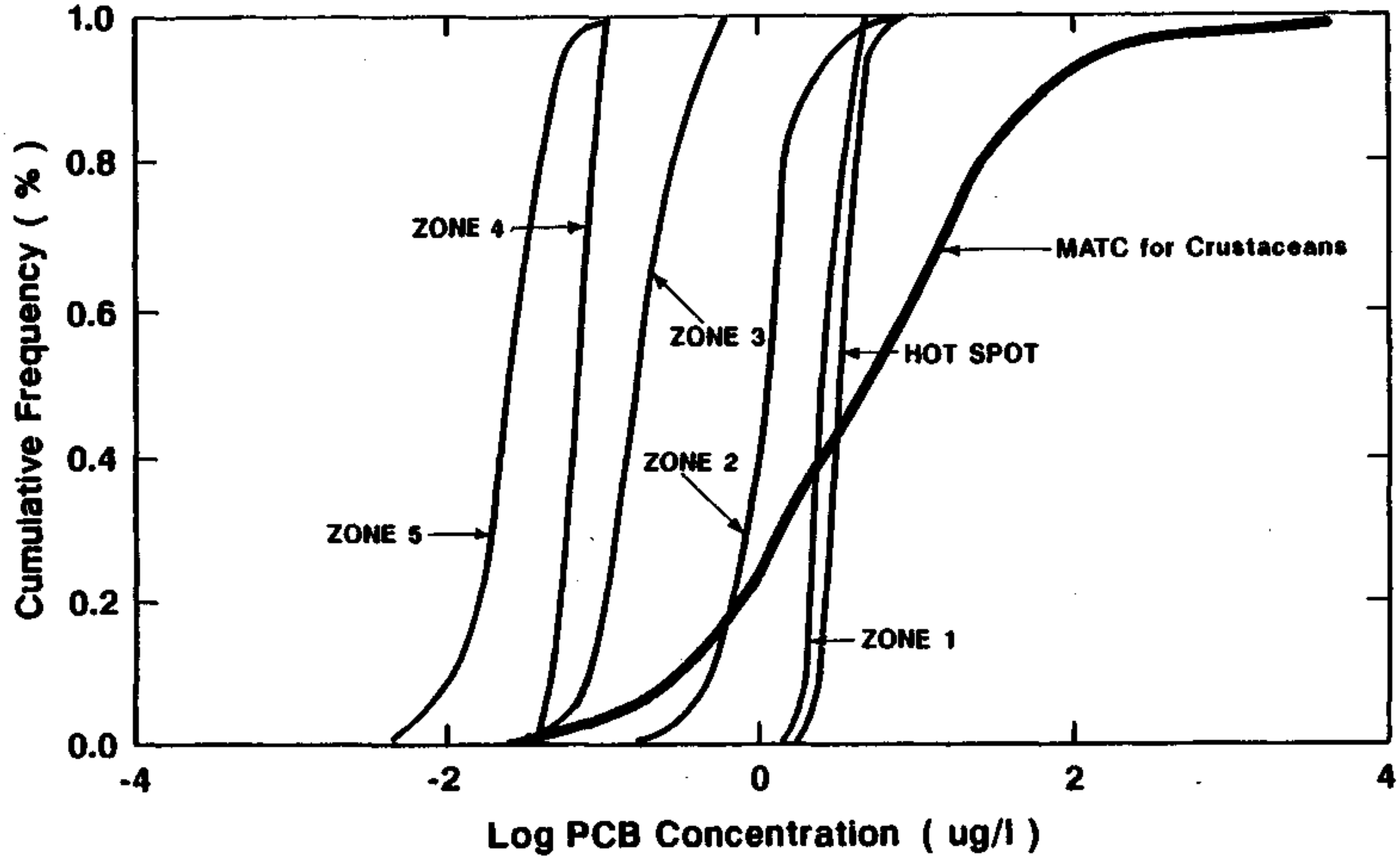


FIGURE 4-3
MATC FOR CRUSTACEANS AND EECs FOR ALL ZONES, PCBs, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

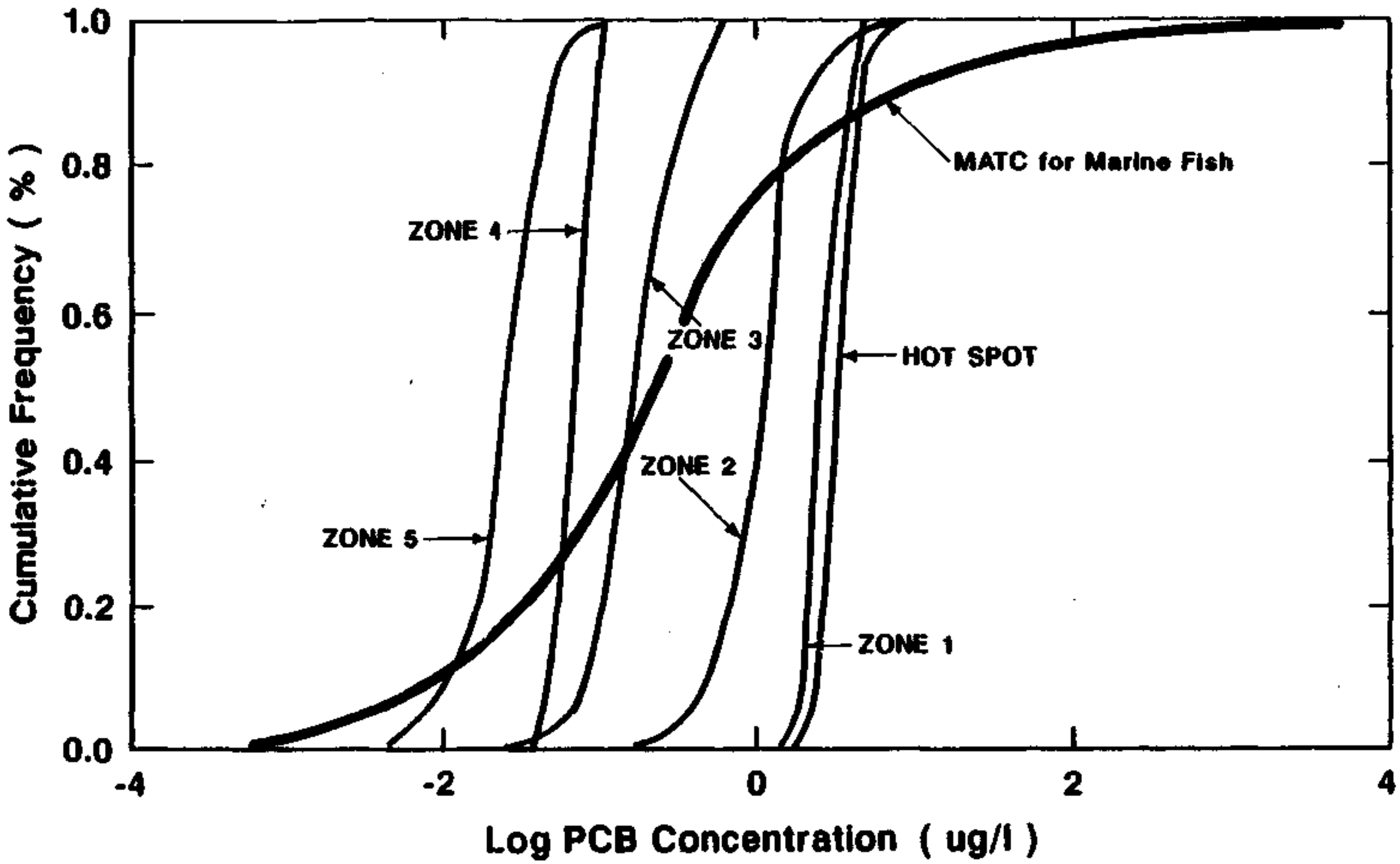


FIGURE 4-4
MATC FOR MARINE FISH AND EECs FOR ALL ZONES, PCBs, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

TABLE 4-1
CUMULATIVE PROBABILITY THAT THE EXPECTED EXPOSURE CONCENTRATION WILL EXCEED THE PCB MATC FOR THE PARTICULAR TAXON

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

HARBOR ZONE	MARINE FISH	CRUSTACEANS	MOLLUSKS	ALGAE
Hot Spot, Water Column	0.86	0.43	0.31	0.41
1. Water Column	0.84	0.40	0.29	0.40
2. Water Column	0.73	0.26	0.23	0.33
3. Water Column	0.42	0.07	0.11	0.21
4. Water Column	0.28	0.03	0.07	0.16
5. Water Column	0.16	0.01	0.04	0.12
Hot Spot, Pore Water	0.97	0.82	0.60	0.64
1. Pore Water	0.98	0.81	0.55	0.61
2. Pore Water	0.82	0.49	0.36	0.44
3. Pore Water	0.52	0.12	0.14	0.25
4. Pore Water	0.33	0.07	0.09	0.18
5. Pore Water	0.24	0.04	0.07	0.16

NOTES:

Probabilities calculated as the area under a normally distributed curve defined by a particular Z score, where Z = (Mean EEC - BM) / (Var EEC + Var BM)^2. Source: Suter et al., 1986.

EEC = Expected Environmental Concentration

BM = Benchmark, which in this application are the MATCs developed by extrapolation, in the case of Marine Fish, Crustaceans, and Mollusks. For Algae, the benchmark was based on available chronic toxicity data demonstrated by this taxonomic group (indicated by the slope of the chronic effects function), even the highest concentrations seen at the Hot Spot would not impact the least sensitive 50 percent of algal species.

Because of the similarity between the chronic effects probability curves, the effects for algal species generally are true for mollusks (see Figure 4-2). PCB concentrations above the Coggeshall Street Bridge would be expected to impact approximately 20 percent of the molluscan species; however, concentrations in the remainder of the harbor would not be expected to pose as great a threat to this group, and would likely impact less than 10 percent of the species.

The pattern of risk for crustaceans (see Figure 4-3) is markedly different from the preceding two groups because of the generally narrower range of sensitivities to PCB exposure, as indicated by the steeper slope of the MATC function. For the crustaceans, there is approximately a 40 percent likelihood that the typical PCB concentrations encountered in the Hot Spot and Zone 1 would be expected to exceed the MATC value of the typical crustacean. The slightly lower concentrations in Zone 2 would have a smaller yet still serious impact. Outside the Coggeshall Street Bridge, anticipated impacts on crustaceans are small, with concentrations projected to impact less than 5 percent of the species.

Because of their much greater sensitivity to dissolved PCBs, marine fish are the most heavily impacted group (see Figure 4-4). For this group, typical concentrations in the Upper Estuary are projected to impact more than 80 percent of the fish species, and even the tenth-percentile concentration would have nearly as large an effect. In Zones 3 and 4, the impact remains high, with concentrations projected to impact approximately 30 percent of the marine fish. This analysis indicates that marine fish are at high risk of impact due to chronic exposure to dissolved PCBs for the entire area inside the Hurricane Barrier.

The mean total PCB concentration in Zone 5 was below concentrations shown in laboratory studies to produce toxic effects. In addition, the exceedance probabilities for all taxonomic groups were in the 5- to 15-percent range, indicating that potential impacts of PCB contamination in this zone would be expected to be much less than the remainder of the study area, although still significant.

Figures 4-5 through 4-8 show the areal extent of the probability that chronic effects will be observed due to water column exposure to PCBs for the various taxonomic groups, based on the initial conditions concentration for each grid cell. The probability contours shown on these maps indicate general trends within each zone and should not be used to assess localized differences of chronic effects.

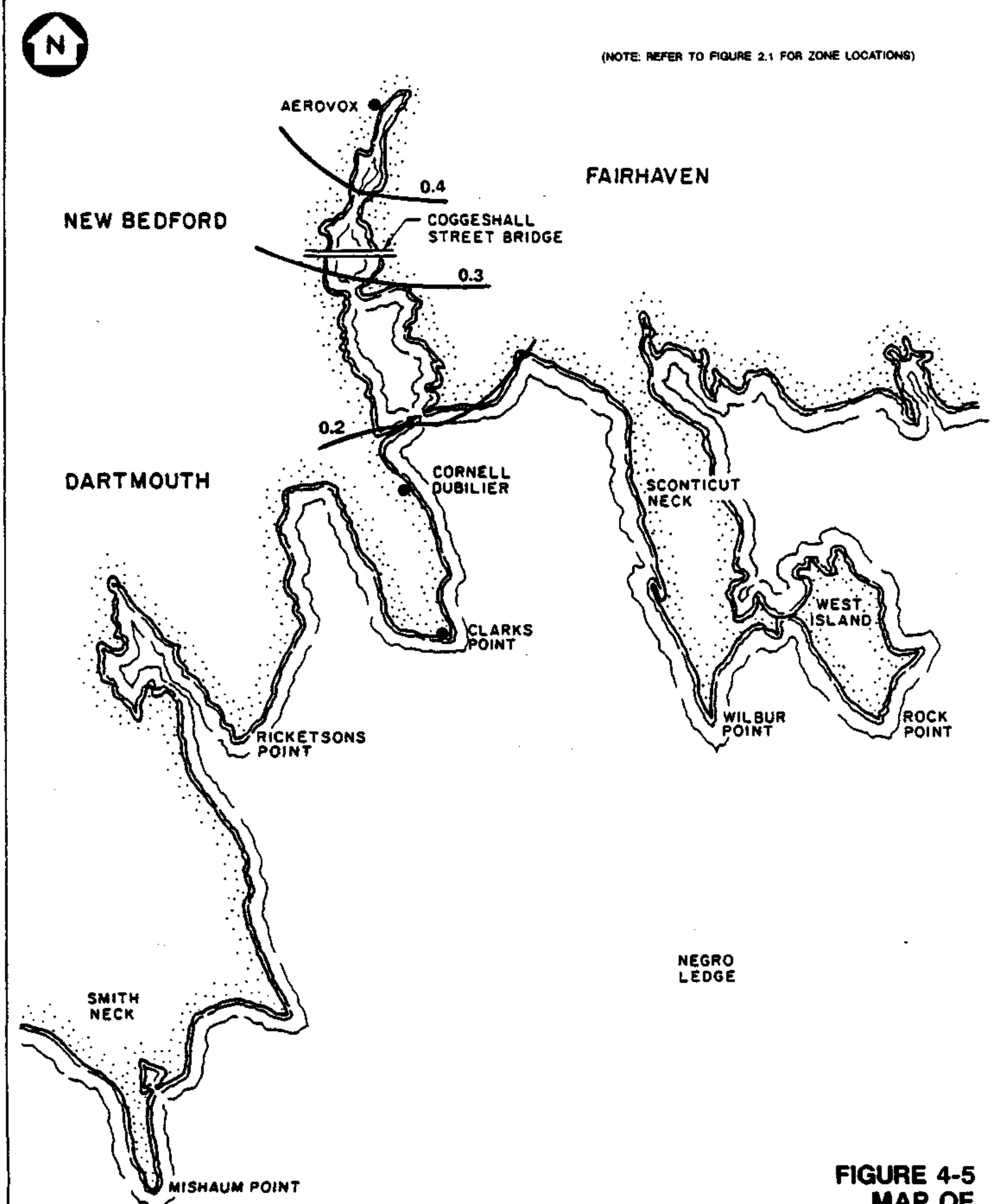


FIGURE 4-5
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
ALGA, PCBs, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

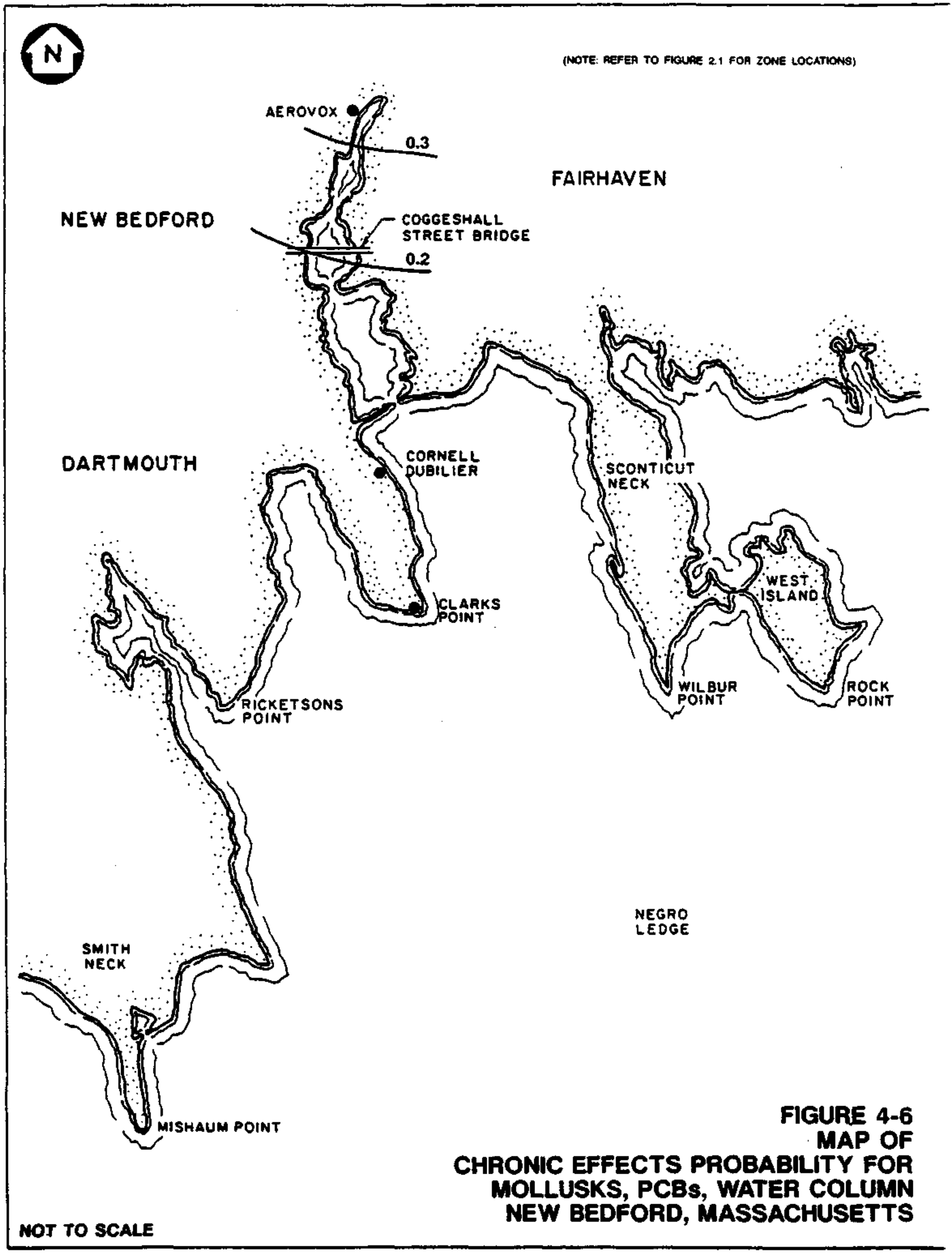


FIGURE 4-6
MAP OF
CHRONIC EFFECTS PROBABILITY FOR
MOLLUSKS, PCBs, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

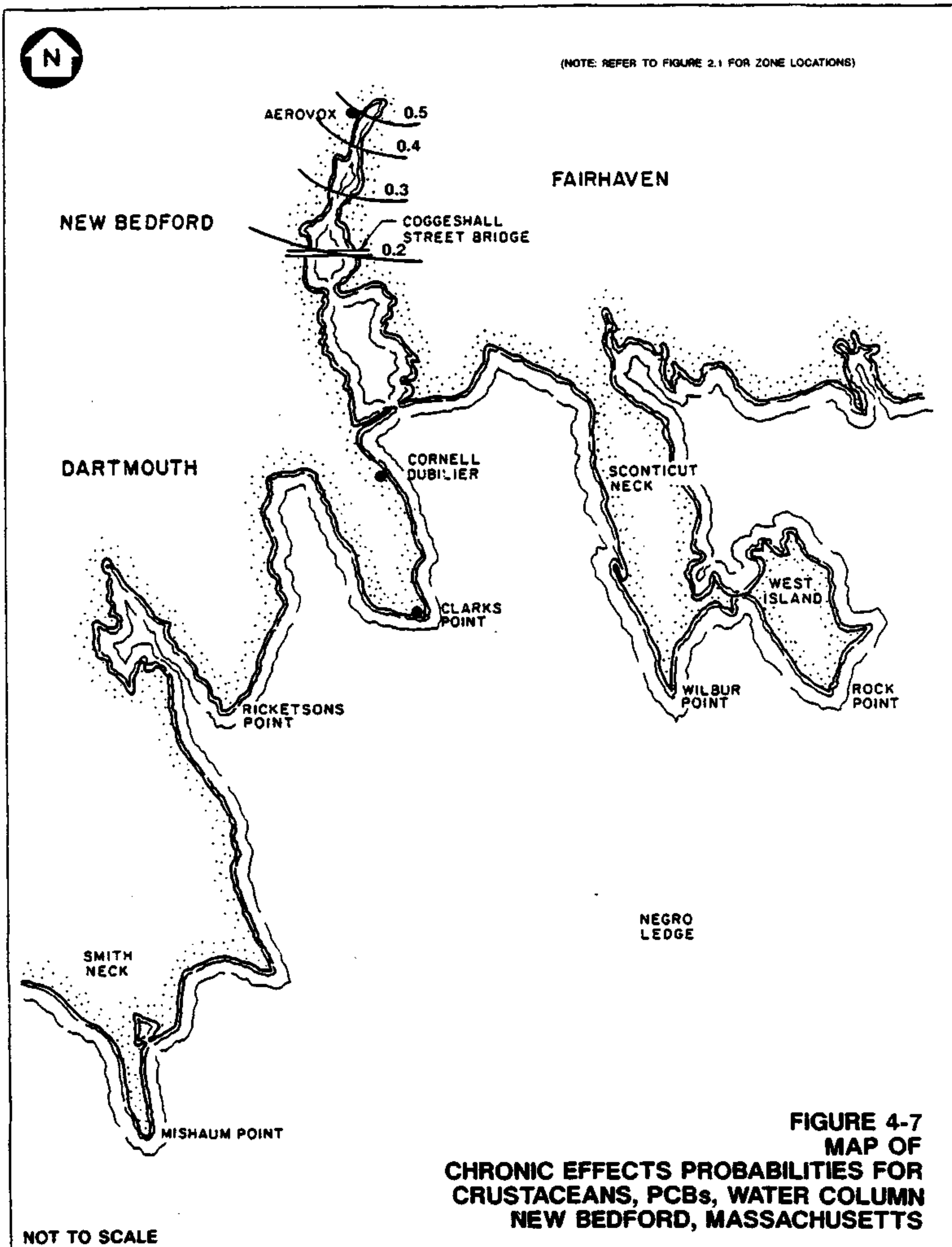


FIGURE 4-7
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR CRUSTACEANS, PCBs, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

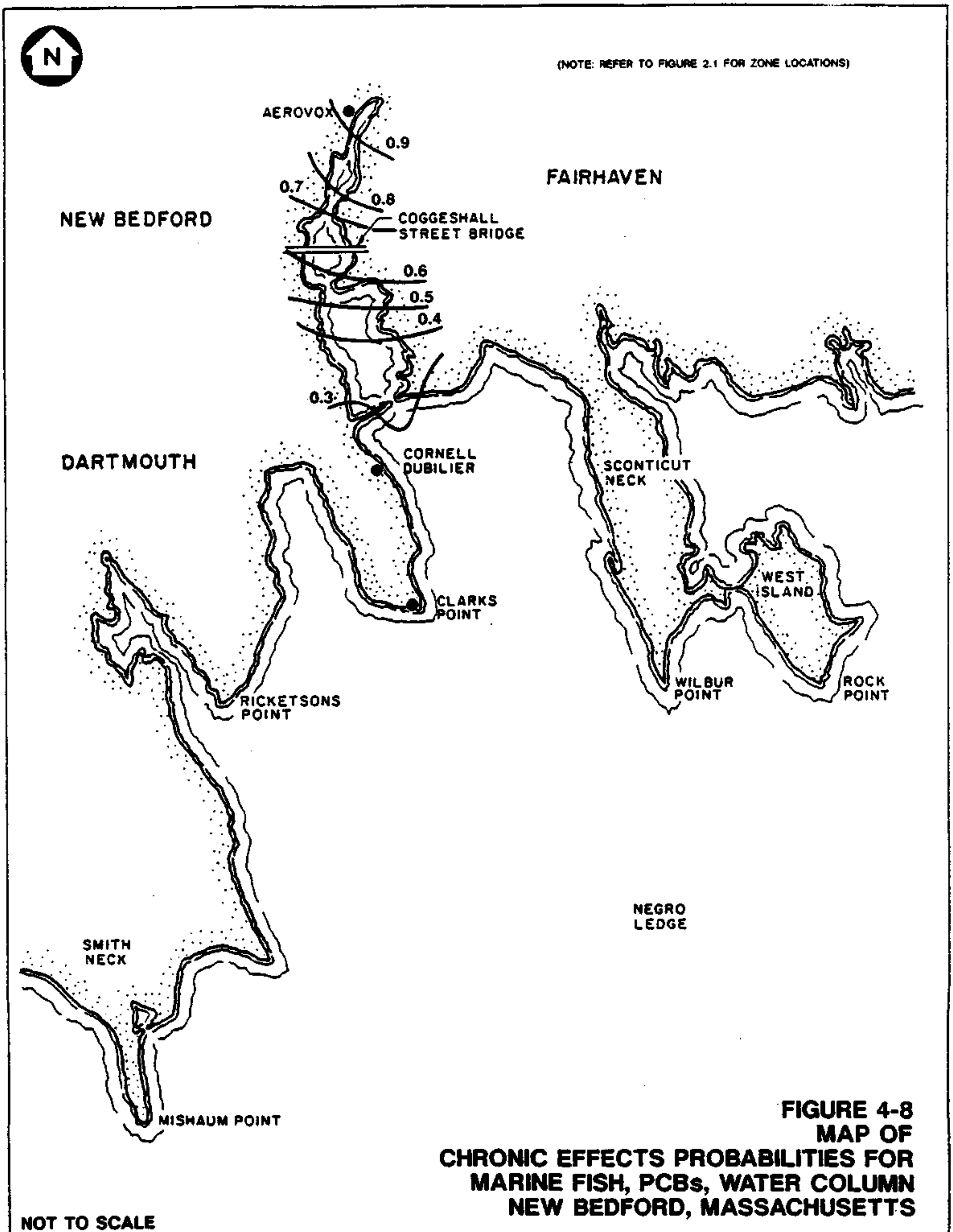


FIGURE 4-8
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MARINE FISH, PCBs, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

4.1.2 PCB Sediment Contamination

The risks previously discussed caused by water column contamination with dissolved PCBs occur ultimately as a result of contaminated bed sediment in the harbor and estuary, which provide a reservoir of PCBs that are desorbed and resuspended into the water column. Therefore, all risks in the system may be thought of as due to sediment contamination. However, throughout the risk assessment risks due to contaminated sediment are meant to include those risks that result from direct exposure to the sediment and its associated pore water, and not to overlying water contaminated from the sediment.

The exposure curves developed for the various harbor zones in this analysis represent the expected distribution of PCB contaminant levels in the pore water. Considerable effort has been devoted in the New Bedford Harbor project to the question of pore water concentrations as part of the modeling effort; however, no site-specific calculation of pore water PCB concentrations from sediment-bound concentrations has been developed. As discussed in Subsection 2.2.2.2, the mass transfer coefficients developed for calibration of the physical/chemical model were used as apparent K_ds to calculate pore water concentrations for this risk assessment. This approach results in pore water concentrations that are generally higher than the overlying water column concentrations.

In development of the food-chain model, pore water was assumed to be in equilibrium with the overlying water column; therefore, the water column concentrations were also used as pore water concentrations. It is probable that the actual concentrations experienced by benthic and demersal organisms will be between these two extremes; consequently, the developed exposure curves probably overestimate the actual exposure concentrations experienced by most species. As such, the risk probabilities should be considered conservative; however, in the absence of more specific data, a conservative approach is necessary.

MATC curves and EEC sediment (i.e., sediment pore water) curves are co-plotted for mollusks, crustaceans, and marine fish in Figures 4-9 through 4-11. Because they would not be expected to be exposed to sediment pore water, the evaluation was not conducted for algae. There is considerable variability in behavior and habitat preference among the species comprising all three taxonomic groups, and some species (e.g., pelagic fish, mussels, and copepods) would not be expected to have any direct contact with sediment pore water. However, insufficient data were available to construct separate MATC curves based on life history and, on the assumption that sensitivity to PCBs would not be expected to vary between benthic and pelagic members of a taxonomic group, the single MATC curve was used for each group. Consequently, chronic effects distributions for these three

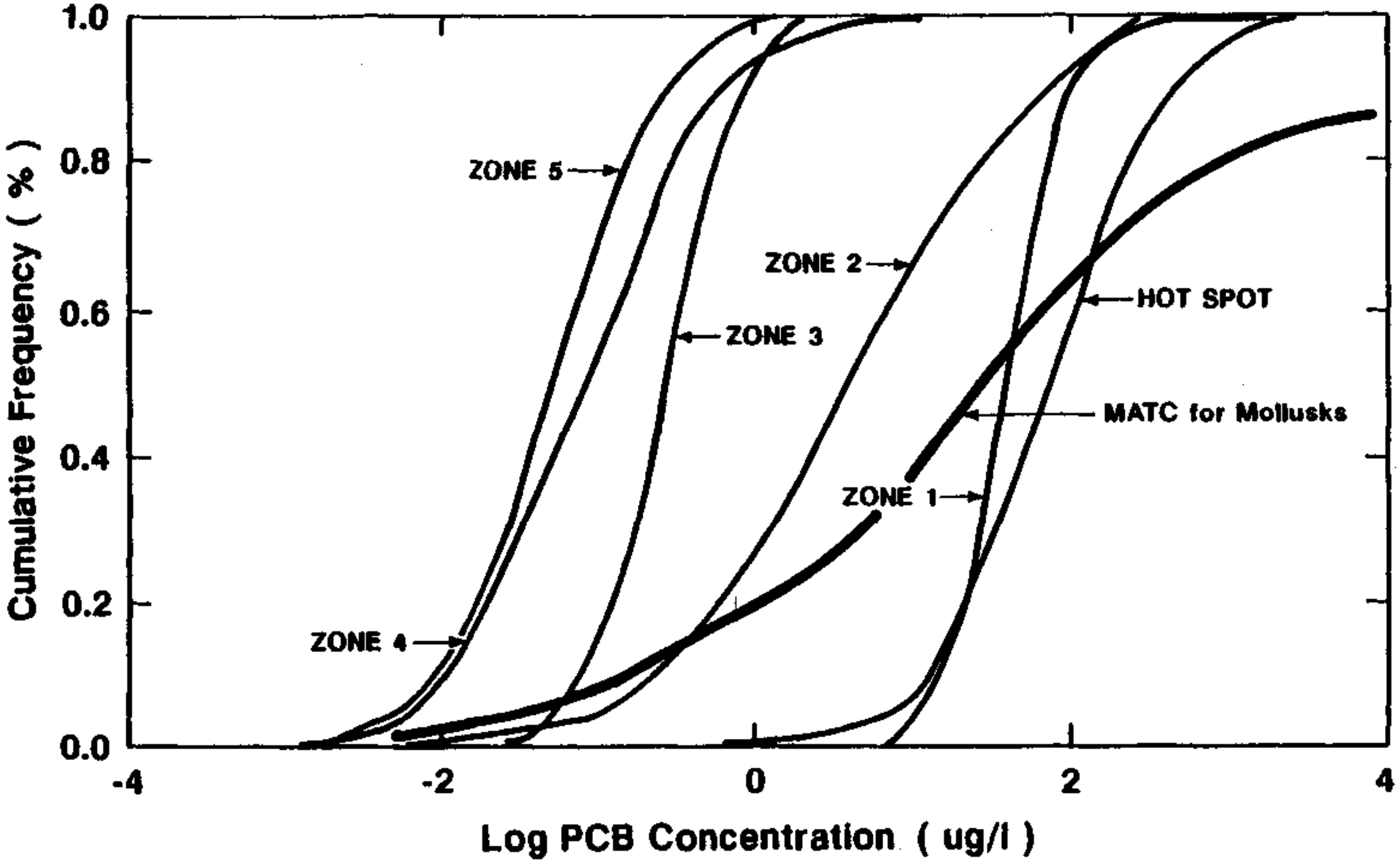


FIGURE 4-9
MATC FOR MOLLUSKS AND EECs FOR ALL ZONES, PCBs, PORE WATER
NEW BEDFORD, MASSACHUSETTS

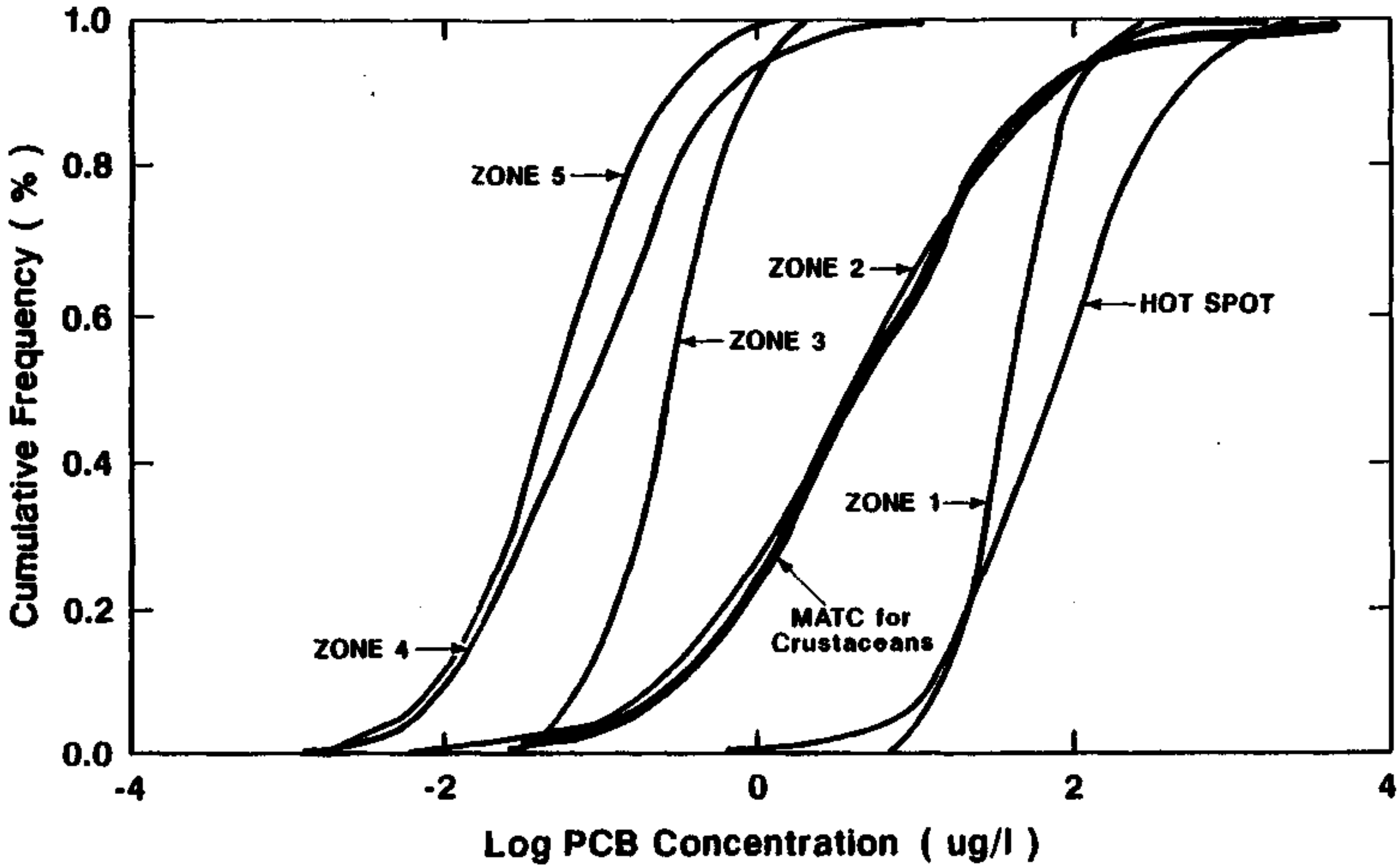


FIGURE 4-10
MATC FOR CRUSTACEANS AND EECs FOR ALL ZONES, PCBs, PORE WATER
NEW BEDFORD, MASSACHUSETTS

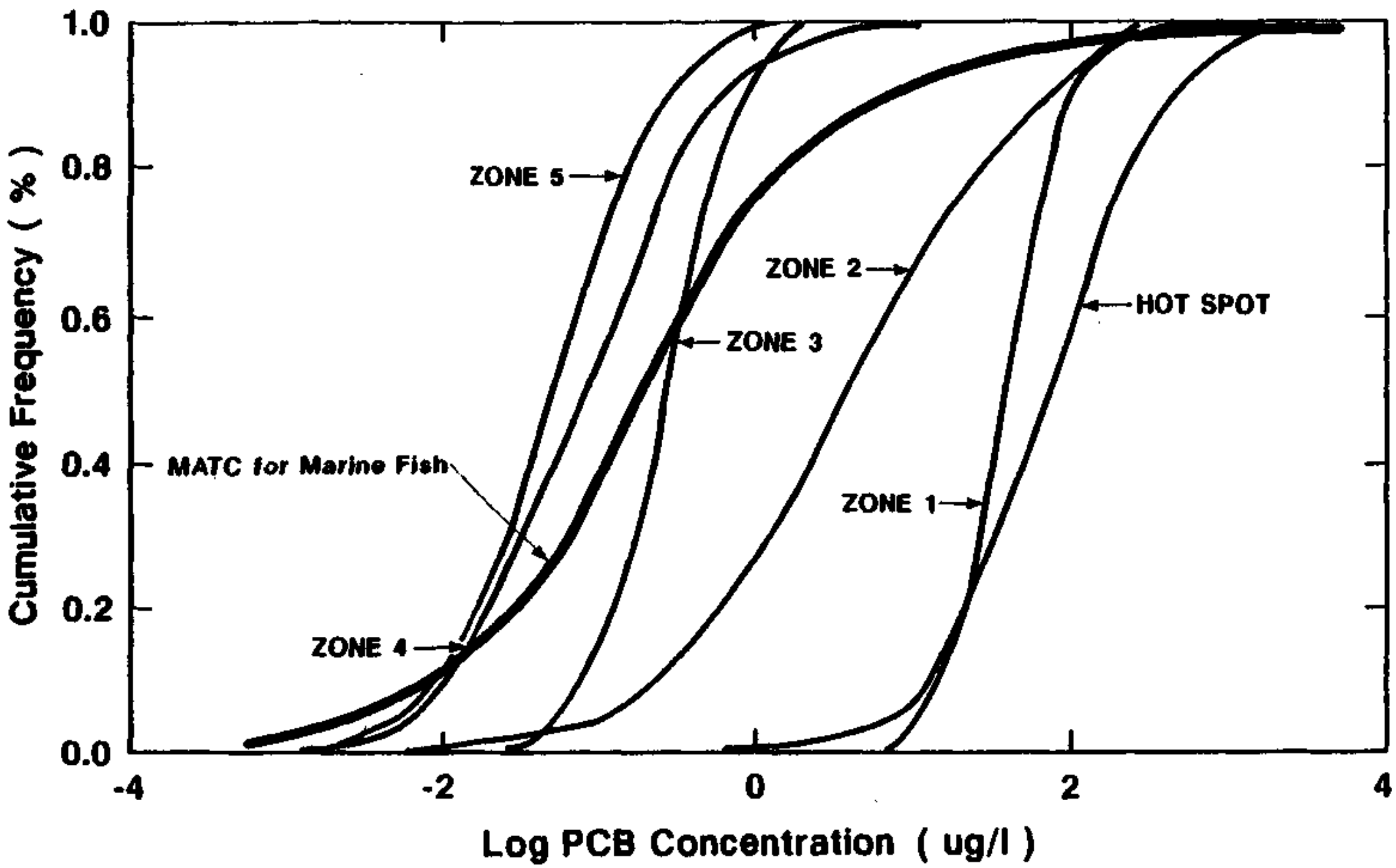


FIGURE 4-11
MATC FOR MARINE FISH AND EECs FOR ALL ZONES, PCBs, PORE WATER
NEW BEDFORD, MASSACHUSETTS

groups are the same as used in the joint probability analysis for the water column exposure.

These results are summarized in Table 4-1 as the percent probability of the median sediment concentration resulting in risk to each group. Exceedance probabilities in the Hot Spot and Zone 1 are 81 and 55 percent for crustaceans and mollusks, respectively, declining with increasing distance from the Upper Estuary. In Zone 4, the probability that a typical member of either group would experience contaminant levels likely to result in chronic effects is predicted to be less than 10 percent.

Based on available toxicological data, the probability that fish exposed to pore water PCB concentrations in Zone 1 and the Hot Spot, specifically, will experience chronic effects is close to a certainty. This likelihood is approximately 82 percent in Zone 2, declining to 24 percent in Zone 5. It is unlikely that any fish will be continually exposed to dissolved PCB concentrations similar to those found in the pore water; to the extent that this is not the case, the actual risks experienced would be considerably lower.

Figures 4-12 through 4-14 show the areal extent of the probability that chronic effects will be observed due to pore water exposure to PCBs for the various taxonomic groups, based on initial conditions for each grid cell.

4.1.3 Water Column Metals Contamination

The chronic effects probability functions for each of the five taxonomic groups are shown in Appendix C, co-plotted with the EEC probability functions for Zones 1 through 5 in Figures C-1 through C-5, Figures C-6 through C-10, and Figures C-11 through C-15, for copper, cadmium, and lead, respectively. Tables C-1 through C-3 present results of the joint probability analysis for each group.

Compared with results discussed previously for PCBs, there is less indication that aquatic organisms are at risk due to the metals contamination in New Bedford Harbor. This analysis would predict that crustaceans, as a group, are most likely to experience deleterious effects from copper, cadmium, and lead contamination. However, even in the most contaminated zones, impacts are predicted for less than 20 percent of these sensitive organisms. The other four taxonomic groups are at little discernable risk due to metals contamination in the water column, except for mollusks exposed to dissolved copper in Zones 1, 2, and 3 (see Figure C-3). In this case, this analysis would predict that levels of dissolved copper in the water column could have some impact on the most sensitive 10 to 15 percent of mollusk species in New Bedford Harbor. Although these potential

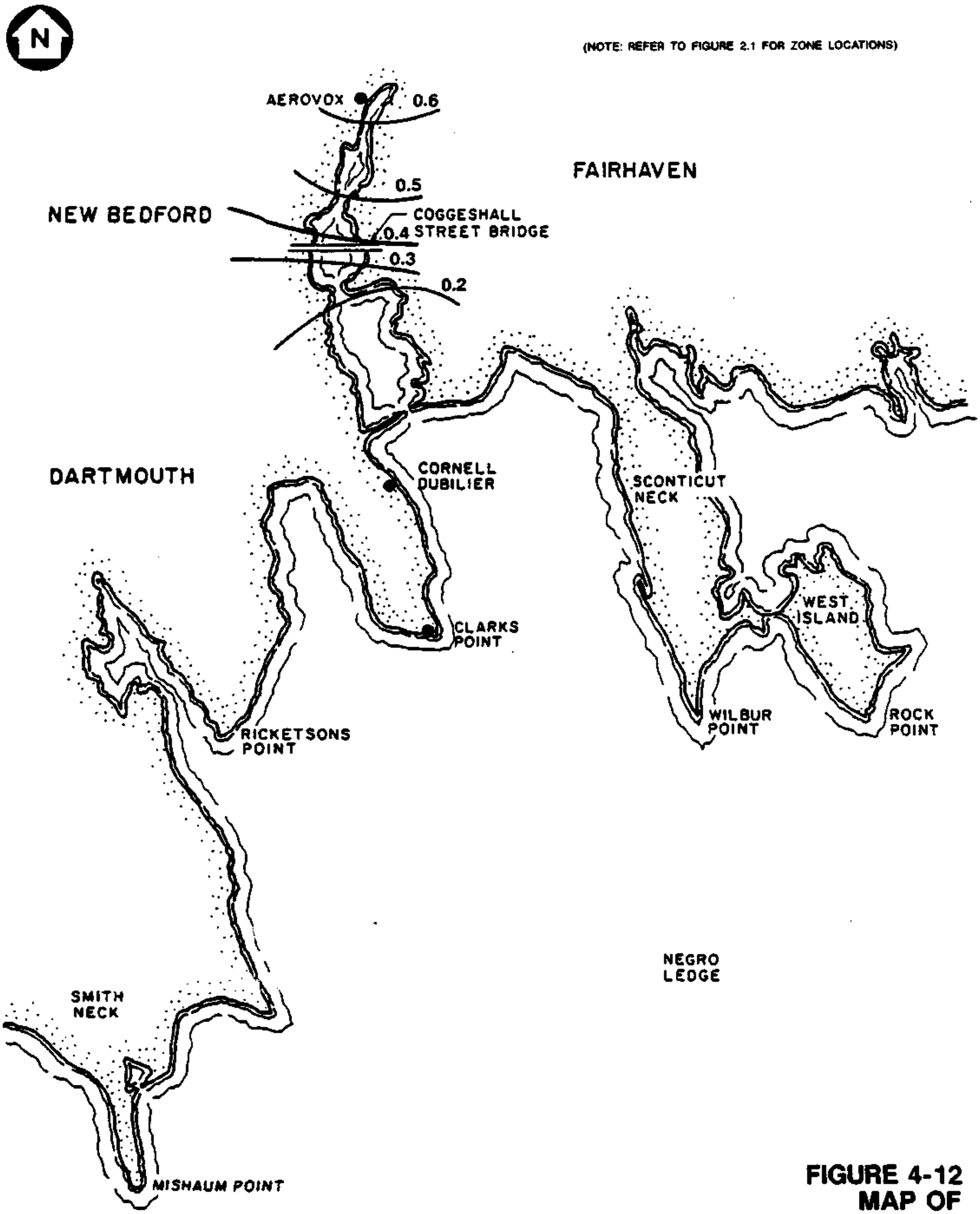


FIGURE 4-12
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MOLLUSKS, PCBs, PORE WATER
NEW BEDFORD, MASSACHUSETTS

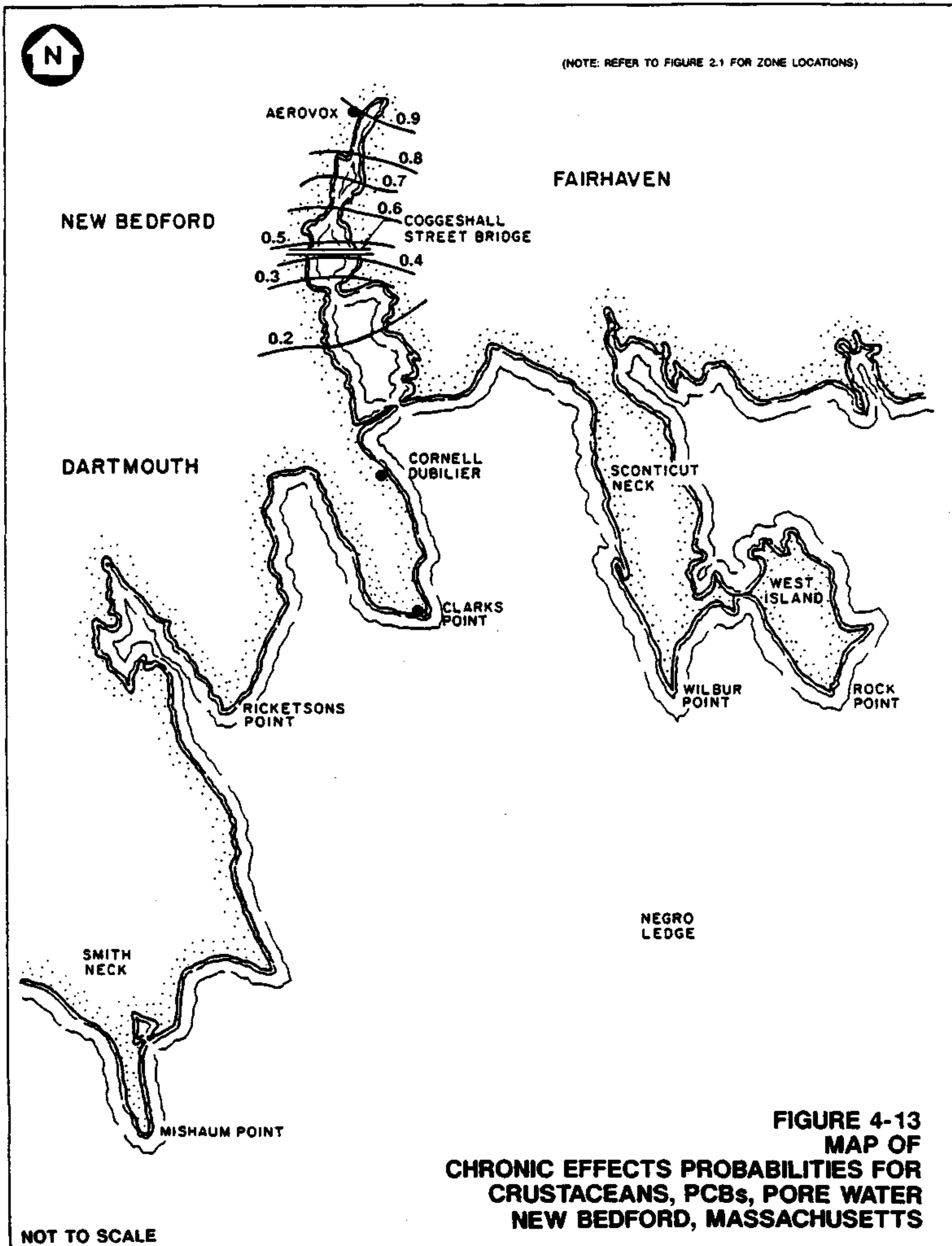


FIGURE 4-13
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR CRUSTACEANS, PCBs, PORE WATER
NEW BEDFORD, MASSACHUSETTS

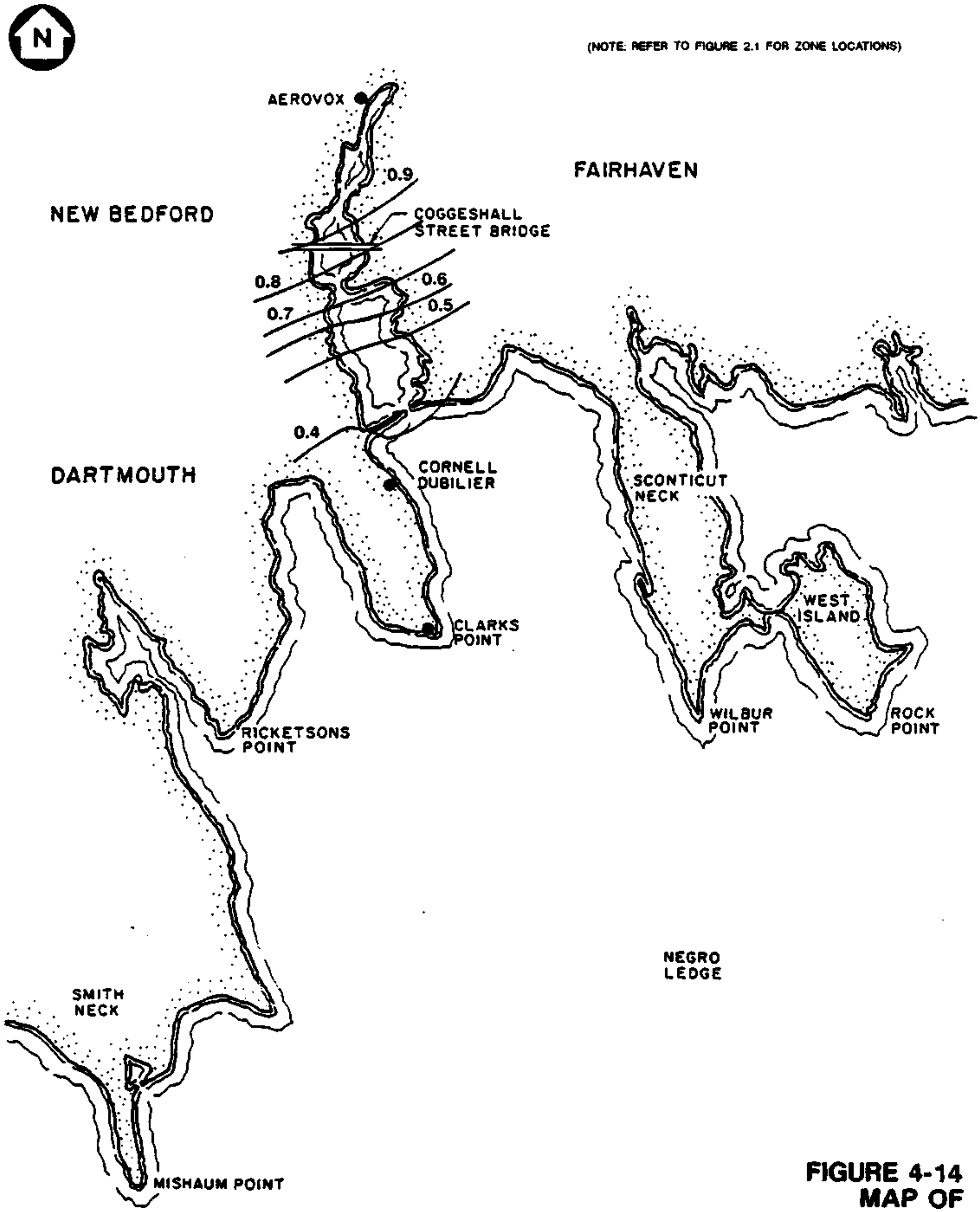


FIGURE 4-14
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MARINE FISH, PCBs, PORE WATER
NEW BEDFORD, MASSACHUSETTS

risks are significant, they are not of the same magnitude as those described previously for PCBs.

Figures C-16 through C-30 show the areal extent of the probability that chronic effects will be observed due to water column exposure to metals for the various taxonomic groups.

4.1.4 Sediment Metals Contamination

MATC curves and EEC pore water curves are co-plotted for all taxonomic groups except algae in Appendix C, Figures C-31 through C-34, Figures C-35 through C-38, and Figures C-39 through C-42 for copper, cadmium, and lead, respectively. As for PCBs, the same chronic effects distributions were used for comparison with sediment pore water concentrations as with water column concentrations.

These results are summarized in Tables C-1 through C-3 as the percent probability of the mean sediment concentration resulting in risk to each group for the three metals of concern. In general, the exceedance probabilities are similar to those determined for water column exposures to these metals. Crustaceans are predicted to be most likely impacted by sediment contamination, with risk estimates of a much lower magnitude to those calculated for PCB contamination in these same areas (i.e., Zones 1, 2, and 3).

The other three taxonomic groups are predicted to be minimally impacted by the levels of these three contaminants in sediment, with probabilities ranging from 5 percent to virtually zero probability of exceeding the respective chronic effects thresholds.

Figures C-43 through C-46, Figures C-47 through C-50, and Figures C-51 through C-54, present the areal extent of the probabilities that chronic effects will be observed due to pore water exposure to copper, cadmium, and lead (respectively) for the various taxonomic groups.

4.2 COMPARISON WITH AMBIENT WATER QUALITY CRITERIA

4.2.1 Water Column Concentrations

The chronic PCB AWQC for the protection of marine life and its uses is 0.03 ug/L. There is no 1-hour marine acute criterion for PCBs; however, the AWQC document indicates that acute effects to aquatic organisms from PCB exposure may be probable at concentrations greater than 10 ug/L (EPA, 1980b).

Because the intent of the baseline risk assessment is to provide a benchmark against which results of numerical modeling of remedial alternatives may be compared, the model start-up conditions were used for risk comparisons. The start-up conditions reflect both the initial sediment conditions, which are based on available data for the area, and the dynamics of the physical/chemical model. The vertically averaged start-up conditions in each zone were believed to accurately represent chronic exposure in the harbor.

The maximum concentrations observed were considered to be reflective of potential short-term exposures. Consequently, for each zone, maximum PCB concentration values were compared to the 10-ug/L benchmark, and mean concentration data to the chronic AWQC, to generate a measure of potential risks to aquatic organisms. Simple statistics summarizing the concentration data by zone are presented in Table C-1 in Appendix C. The acute benchmark concentration of 10 ug/L was not exceeded by the maximum concentration in the start-up conditions data in any zone at the New Bedford Harbor site. Based on this comparison, potential risks associated with short-term exposure to PCBs dissolved in the water column are expected to be slight.

However, the chronic AWQC is exceeded by the mean PCB concentration in all zones except Zone 5. Therefore, aquatic organisms are potentially at risk of experiencing effects due to chronic exposure to PCB contamination in all areas of New Bedford Harbor north of the Hurricane Barrier. Because the chronic AWQC of 0.03 ug/L for PCBs is not based solely on toxicity information (EPA, 1980b), it does not necessarily reflect a level protective of aquatic life, but rather of aquatic life and its uses, and may be considered a conservative standard against which to evaluate risk.

Although the chronic marine AWQC for copper (2.9 ug/L) was exceeded by the mean water column concentrations in both Zones 2 and 3 (see Table 2-3), the exceedence was slight. Ratios of the mean copper concentration to the chronic criterion were only 1.17 and 1.2 for Zones 2 and 3, respectively. Although some potential exists for adverse impacts due to dissolved copper in the water column in these areas, these ratios suggest that any effects would not be severe. The chronic criteria for cadmium and lead were not exceeded in any zone in New Bedford Harbor.

4.2.2 Sediment Concentrations

An interim Sediment Quality Criterion (SQC) is available for PCBs (Aroclor 1254); no SQC have been developed for metals. As is the case for the AWQC, the interim SQC developed by EPA (EPA, 1988) is residue-based; that is, it is intended to be a value that will not result in commercially harvested species having PCB body burdens exceeding the original FDA action level of 5 ppm. SQC are not currently considered to be ARARs for Superfund programs. The SQC was derived from the AWQC by applying a partitioning coefficient (K_{oc}) that varies with the amount of organic carbon in the sediment. The upper and lower 95 percent confidence intervals (CIs) for the SQC are based on the variance of K_{oc} and represent the range within which the actual sediment criterion value is expected to fall. The lower CI is assumed to represent the concentration which, with 97.5 percent certainty, will result in body burdens in resident commercial species remaining below 5 ppm.

The mean sediment concentrations in each zone were compared to the lower 95 percent CI; the maximum concentrations were compared to the SQC. TOC values for sediments in the area of interest vary from less than 1 percent to nearly 10 percent, but are generally higher in the Acushnet River Estuary where values near 5 percent are typical. For simplicity, a value of 1 percent TOC was assumed for all areas, providing a conservative estimate of sediment toxicity in the estuary. Assuming an average TOC of 1 percent, the carbon-normalized SQC is 0.418 ug/g (ppm), with a lower 95 percent CI of 0.083 ug/g. These results indicate that virtually all areas of the harbor, including most adjacent areas of the Outer Harbor and even some areas well out into Buzzards Bay, pose a risk to at least some aquatic organisms. Even assuming a TOC of 10 percent, which would reduce the amount of PCB available for uptake by biota by an order of magnitude, essentially all areas of the harbor would exceed the lower 95 percent CI of 0.829 ug/g.

4.3 SITE-SPECIFIC TOXICITY TESTS

Several toxicity tests have been performed with New Bedford Harbor sediment, and the results provide the most realistic indication of the degree of toxicity posed by contaminated sediment in the harbor. Although these studies provide the most direct indication of toxicity, it is difficult to separate effects due to PCBs from effects due to metals and other contaminants that may be present in the sediment. In addition, it is difficult to evaluate how closely the laboratory conditions simulated actual harbor conditions in the various tests. Despite these limitations, site-specific data permit an independent verification of the reasonableness and accuracy of the more theoretically based predictions discussed previously.

In a solid-phase bioassay, Hansen exposed the sheepshead minnow (Cyprinodon variegatus) and amphipod (Ampelisca abdita) to New Bedford Harbor sediment (Hansen, 1986). The toxicological endpoints examined were mortality, fish embryo survival, and hatched fish survival. Other sublethal effects theoretically included in the joint probability and AWQC evaluations may also have been occurring but were not evaluated. In addition, it is not possible to identify the specific contaminants responsible for these effects.

The reported results of Hansen's study were as follows (Hansen, 1986):

- o significant reduction in survival of adult sheepshead minnows exposed for 29 days to sediment (i.e., to water contaminated by contact with contaminated sediment) collected from Zones 1 and 2 (zero and 72 percent, respectively)

- o significant reduction in survival of progeny (i.e., embryos and/or hatched fish) of adult minnows exposed to sediment collected from Zones 1, 2, and 3

- o 10-day amphipod mortality correlated with the spatial gradient of contaminants in harbor sediment, with mortality rates of 100 and 92.2 percent in amphipods exposed to sediment from Zones 1 and 2, respectively, compared to 13.3 percent in the reference area

- o mortality rates of 11.1 to 73.3 percent in amphipods exposed for 10 days to sediment obtained from Zones 4 and 3, respectively

Results of these sediment toxicity tests indicate that New Bedford Harbor sediment is toxic to certain aquatic organisms. Based on these data, it appears that sediment obtained from within the inner harbor (north of the Popes Island/State Route 6 Bridge) poses a risk to resident aquatic invertebrates and to the survival and reproduction of resident fish. Measurable but less severe adverse effects were observed in fish and amphipods exposed to sediment obtained from Zone 4, which contained 10 ppm total PCBs (Hansen, 1986).

In general, the toxicity of New Bedford Harbor sediment to amphipods and fish decreases from the Upper Estuary toward the Hurricane Barrier. Toxic effects have been observed in sediment from Zone 4; however, these effects are not statistically significant when compared to a reference sediment collected from central Long Island Sound.

In 1988, the National Oceanic and Atmospheric Administration developed sediment target levels for PCBs that were considered protective of aquatic life. The recommended range, 0.1 to 1.0 ppm PCBs, is based on information showing that concentrations of PCBs in aquatic organisms residing in contaminated areas are equal to or exceed the PCB concentrations found in the sediment (Field and Dexter, 1988). This relationship is generally true for xenobiotic compounds (e.g., PCBs) that are persistent in the environment, readily bioaccumulated by aquatic organisms, and slowly biotransformed and excreted by fish (Lech and Peterson, 1983). In addition, toxicological effects were observed in fish with tissue concentrations of PCBs less than 0.1 ppm (see Subsection 4.4).

4.4 RISK DUE TO BIOACCUMULATION OF PCBS

Bioaccumulation of PCBs by exposed organisms results in high tissue burden levels of these compounds. There is evidence suggesting that PCBs are also biomagnified in the food chain (Shaw and Connell, 1982; Thomann, 1978; and Thomann and Connolly, 1984). The bioaccumulation of PCBs may result in elevated tissue levels that may be toxic to the organism directly, or indirectly as a result of modified behavior with consequent increased exposure to predators.

Food-chain transfer of PCBs is considered likely for organisms within the New Bedford Harbor area, because elevated PCB concentrations were detected in prey organisms. Mean PCB concentrations in polychaetes, clams, mussels, and crabs in the harbor are 12.9, 5.3, 2.6, and 0.4 ppm, respectively (see Figure 4-2). These organisms are all constituents of the diet of winter flounder, striped bass, and bluefish.

PCB tissue concentrations resulting from dietary exposure in upper level carnivores have been shown to produce the following effects in marine fish:

- Concentrations of 11 to 98 mg/kg caused liver abnormalities in the tomcod (Klauda et al., 1981).
- Concentrations greater than 24 mg/kg caused reproductive failure in the cyprinid minnow (Bengtsson, 1980).
- Concentrations greater than 7.0 mg/kg caused reduced survival of sheepshead minnow embryos (Hansen, 1973).
- Concentrations of 0.12 mg/kg caused inhibited reproduction in the Baltic flounder (Spies, 1985).
- Concentrations of 0.2 mg/kg reduced reproductive success in the starry flounder (Spies, 1985).
- Concentrations of 1.4 mg/kg caused reproductive impairment in the striped bass (Ray et al., 1984).
- Concentrations from 0.005 to 0.05 mg/kg caused histological changes in the Atlantic cod (Freeman et al., 1982).

PCB tissue levels in winter flounder from the New Bedford Harbor area were compared to available toxicity data for similar species. To allow comparisons between the New Bedford Harbor whole-body concentrations and organ-specific toxicity data, the whole-body PCB concentrations were adjusted using an edible:whole-body ratio derived by BOS for winter flounder collected to provide calibration data for the food-chain model (Battelle, 1987). Whole-body concentrations for winter flounder in the modeling program data base were multiplied by 0.13 to produce edible-tissue concentrations, which were then adjusted based on the results using striped bass to produce concentrations in the gonads (Ray et al., 1984). Ray found that fish tend to accumulate PCBs in the gonadal tissues, with the ratio of muscle to gonad PCB concentrations ranging from 1:1 to 10:1 (Ray et al., 1984). Estimates of the PCB concentration in the gonads of winter flounder are listed in Table 4-2.

Limited data are available on the effects of PCB concentrations in gonads of winter flounder. Toxicity data for two similar species (Baltic and starry flounder) were used to qualitatively assess the potential risks associated with PCB tissue burdens. These data indicate that concentrations as low as 0.12 and 0.2 ppm PCBs in the ovaries of these species can inhibit reproduction (Spies, 1985; and Von Westernhagen et al., 1981). The range of estimated PCB concentrations in the gonads of the winter flounder exceed 0.2 ppm PCBs in all areas except Area 4, where the mean estimated gonad concentration was 0.1 ppm.

Because of the assumptions used to derive these concentrations, conclusions concerning the potential risk to these organisms cannot be made. However, these data do indicate the potential for the accumulation of PCBs in reproductive organs of species inhabiting New Bedford Harbor to levels that have been shown to cause reproductive effects.

Reproductive effects in winter flounder exposed to surface water from New Bedford Harbor have been observed by Black (Black, et al., 1986). Gravid female flounder were collected from New Bedford Harbor (Zone 5), and the collected progeny were reared under uncontaminated conditions. Elevated PCB concentrations were observed in the eggs of winter flounder from the New Bedford Harbor area. Larvae hatched from these eggs were significantly smaller in length and lower in weight than the eggs and larvae from the reference area near Fox Island in lower Narragansett Bay. PCB tissue concentrations in the adult winter flounder were not reported; therefore, direct relationships between PCB body burdens and reproductive effects cannot be made. At larval metamorphosis, the differences between locations had disappeared. However, in a competitive and stressful natural environment, it is likely that even transient differences in size would result in significant differences in juvenile survivorship.

TABLE 4-2
CONVERSION OF WHOLE-BODY WINTER FLOUNDER PCB
TISSUE CONCENTRATIONS TO EXPECTED GONAD CONCENTRATIONS

NEW BEDFORD, MASSACHUSETTS

Winter Flounder	Whole-body PCB Concentration (mg/kg)	Edible-tissue PCB Concentration[1] (mg/kg)	Expected Range of PCB-gonad Concentration[2] (mg/kg)
Area 1 MAXIMUM	20.23	2.63	2.63 - 26.30
MEAN	7.99	1.039	1.039 - 10.39
Area 2 MAXIMUM	8.07	1.05	1.05 - 10.5
MEAN	2.85	0.371	0.371 - 3.71
Area 3 MAXIMUM	6.35	0.83	0.83 - 8.3
MEAN	2.14	0.278	0.278 - 2.78
Area 4 MAXIMUM	2.62	0.34	0.34 - 3.4
MEAN	0.78	0.101	0.101 - 1.01

NOTES:

[1] These values are based on an edible-muscle-to-whole-body ratio of 0.13.
[2] These values are based on muscle-to-gonad ratios ranging from 1:1 to 10:1.

Thurberg examined the effects of high PCB body residues in American lobster, Homarus americanus, on egg-hatching success, larval growth and survival, molting success, and the duration of the larval period (Thurberg, 1985). Despite the elevated levels of PCBs in the eggs and larvae of New Bedford Harbor lobsters, there were no discernable differences in any of the biological response variables.

Capuzzo investigated the effects of PCB uptake and accumulation on growth, energetics, and reproductive potential of the mollusk (Mytilis edulis) (Capuzzo, 1986). Mussels were placed in screened cages at various locations in Buzzards Bay and Nantucket Sound where in situ physiological measurements relating to energetic partitioning were taken. Mussels transplanted to the Hurricane Barrier (Zone 4) showed considerable uptake of PCBs initially, followed by a gradual stabilization, and experienced a lower growth potential, relative to the stations in Nantucket Sound and at Cleveland Ledge. This effect was due to a decrease in the amount of carbon ingested and assimilated, as well as to increased respiratory expenditures. These individuals also made the lowest reproductive effort (measured as the amount of energy allocated to reproduction relative to the total amount of energy assimilated to growth and respiration during the spawning period) of the three stations.

The studies cited previously have shown that:

- PCBs accumulate in certain aquatic organisms (Capuzzo, 1986).
- PCBs concentrate in the gonads of fish (Ray et al., 1984).
- PCB concentrations greater than 0.1 ppm in the gonads of flounder have been shown to cause reproductive effects (Spies, 1985 and Van Westernhagen et al., 1981).
- Eggs from winter flounder in the New Bedford Harbor area had elevated levels of PCBs (Black et al., 1986).
- Larvae hatched from eggs containing elevated PCB levels were smaller in length and lower in weight.
- Reproductive effects (measured as the amount of energy allotted to reproduction) were lower in the mussels exposed to surface water from the New Bedford Harbor area.

The body of toxicity data described indicate that biota at the New Bedford Harbor site are at potential risk due to the consequences of PCB accumulation; this is supported by the site-specific data generated by Black and Capuzzo (Black et al., 1986; and Capuzzo, 1986).

Because no toxicity data associated with PCB tissue burdens could be identified for other species (e.g., lobsters, clams, crabs, and polychaetes), a discussion of risk to these species is not possible. However, PCBs are lipophilic, are known to accumulate in fatty tissues, and have been detected in all biota in New Bedford Harbor. Although there is considerable variation in tolerance to PCBs across species, some species would be expected to be at least as sensitive to PCBs as the species for which data are available, and would therefore be expected to be impacted by the observed body burdens.

4.5 BENTHIC SURVEYS

Several infaunal surveys have been performed at the New Bedford Harbor site. Although many ecological factors in addition to chemical contamination can contribute to areal differences in the numbers and kinds of organisms, these results generally support the conclusions reached previously in this report.

An extensive benthic sampling program was conducted for USACE (USACE, 1988a). The 26 sampling locations spanned all areas of New Bedford Harbor discussed in this report. Significant correlations between the level of PCB contamination in the harbor and several measures of community, including the number of species, and diversity and evenness indices were found. Due to differences in the sampling methodology used during the program, there is some concern regarding comparability of the sampling data. However, overall trends relating benthic community descriptors to PCB levels appear to be consistent. The basic pattern observed was a domination in the Upper Estuary by the polychaete, Streblospio benedicti; another polychaete, Tharyx acutus, was dominant in the rest of the inner harbor. Outside the Hurricane Barrier, bivalves and gastropods became the most common organisms. Associated with these taxonomic differences were an increase in the species diversity of the infaunal community and a more equal representation of individual species from the Upper Estuary into the outer harbor.

A comparative study of this nature suffers from the gross differences in habitat between different locations. It is possible that physical factors (e.g., sediment characteristics and turbidity) are the primary determinants of the community patterns observed. However, these results do not contradict previous conclusions regarding risks associated with different zones. Many polychaetes are generally less sensitive to sediment contamination than other taxa, and their general domination of the most highly contaminated sediments in the harbor suggests the impact that PCBs and other chemicals may be having on this ecosystem (Rubinstein, 1989).

A wetland study compared chemical and biological data from six wetland areas in the harbor and from a relatively unpolluted reference area in Buzzards Bay (USACE, 1988b). The study found a depressed benthic community in the Zone 1 wetland. In addition, comparison of the biological data between a Zone 2 wetland and the reference area indicated significant differences in species diversity and evenness, particularly among polychaetes, amphipods, and mollusks. However, habitat differences complicate any attempt to relate differences in benthic community patterns to variation in the PCB contamination between these locations.

4.6 SUMMARY OF RISK CHARACTERIZATION

As part of the ecological risk assessment for the New Bedford Harbor site, a joint probability analysis was used to develop probabilistic risk estimates for the effects of PCBs and heavy metals (i.e., copper, cadmium, and lead) contamination on marine organisms. The expected distribution of a taxonomic group response to a contaminant was estimated by extrapolating the responses observed in individual organisms to larger groups. This methodology involved the summarization of the available toxicological data using errors-in-variables regression models and the quantification of uncertainty as the combining of variances through the various extrapolations.

Separate estimates were developed for the major taxonomic groups in New Bedford Harbor to provide more detailed information on how contamination is affecting specific components of the harbor ecosystem. This permits the risk assessment process to isolate the most sensitive groups of organisms, as well as quantifying the likelihood of impact for all groups. Presentation of the risk analysis in probabilistic terms will provide a more complete representation of the impacts of the various remedial alternatives on potentially affected organisms. In addition to this approach, PCB and metals concentrations in the harbor were compared to sediment and water criteria, and the results of various site-specific bioassays and benthic surveys were evaluated with respect to potential risk. Results of these different approaches are summarized in the following paragraphs; risks are discussed in view of these findings.

Aquatic organisms (particularly marine fish) are at risk due to exposure to waterborne PCBs in New Bedford Harbor. The mean PCB concentrations in the Hot Spot and Zones 1 through 4 exceed the chronic AWQC, and the joint probability analysis indicates that there is significant likelihood that chronic effects will be realized in at least some species inhabiting New Bedford Harbor. These risks are most severe in Zones 1 and 2 and the Hot Spot; however, potential risk is evident for all zones within the Hurricane Barrier.

The pore water PCB concentrations in the sediment are highly toxic to at least some members of all major taxonomic groups. In the Upper Estuary, the likelihood that chronic effects would be observed in a typical marine fish species exposed to PCBs in pore water is close to 100 percent; risk is substantial for mollusks and crustaceans as well. The risk probabilities for all groups decline toward the outer harbor; however, marine fish may still be substantially impacted in Zone 5. However, in Zone 4, the likelihood that chronic effects would be realized in typical crustaceans and mollusks is predicted to be less than 10 percent. The SQC, carbon-normalized to 1 percent TOC, is exceeded in Zones 1 and 2, and the lower 95 percent confidence level for the SQC is exceeded in all zones. Finally, results of various sediment bioassays support the conclusions based on laboratory-generated toxicological data and comparisons with interim SQC. Sediment from the inner harbor has been demonstrated to be toxic to both benthic invertebrates and fish; the degree of toxicity is correlated with PCB levels in test sediments.

Many marine organisms from New Bedford Harbor have been shown to be contaminated with elevated tissue levels of PCBs. PCB levels in gonadal tissue of winter flounder collected from Zones 1, 2, and 3 exceed levels shown to result in reproductive impairment and other effects in marine fish. Levels in organisms from lower trophic levels may either induce toxicological effects or impact predator species.

Risk due to exposure to PCBs is also largely dependent on location of the organisms in the harbor, and may be a function of migratory behavior or reproductive habits. Organisms such as American eels, which reside mostly in the Upper Estuary (i.e., Zones 1 and 2) in close contact with the sediment, are likely to be at greater risk of toxic effects from exposure to PCB contamination than organisms that only migrate periodically into this area (e.g., blueback herring) and remain in the water column. In addition, juvenile aquatic organisms using the Upper Estuary/Hot Spot area as a nursery ground may be at an elevated risk of contaminant exposure, given that this lifestage is generally more sensitive to chemical insult than the adult stage. Foraging behavior and prey preferences can also influence the degree of exposure encountered by a particular organism.

With regard to potential risks due to heavy metals, both the joint probability analysis and a comparison with AWQC indicate some possibility for impacts on marine biota in New Bedford Harbor. Based on comparisons with AWQC, concentrations of copper in the water column represent some potential for concern, with crustaceans determined to be the taxon most likely at risk. Results of this analysis suggest that, although metals may be having some impact on the harbor ecosystem, the effects attributable to these contaminants are overshadowed by the presence of PCBs at much more harmful levels.

Potential impacts due to the presence of PCBs or heavy metals in New Bedford Harbor cannot be adequately defined by assessing risk to a single species or taxonomic group or by exposure to a single medium. Chemical stresses placed on aquatic organisms are multilayered. An organism in New Bedford Harbor is simultaneously exposed to many contaminants in addition to those evaluated in this risk assessment. However, based on available data, it appears that the four contaminants chosen (i.e., PCBs, copper, cadmium, and lead) constitute the most significant risk to organisms in the harbor. It is impossible to quantify the effects of multiple exposures to a mixture of contaminants. Furthermore, member species in an ecological community interact and depend on other species to satisfy many essential biological needs. Because of the interdependence of ecological units that comprise an ecosystem, seemingly minor disturbances affecting components of the system can have significant ramifications on the stability and functioning of the overall system. In view of the inherent complexity involved in attempting to assess the impacts of chemical stress on overall ecosystem integrity, only a qualitative approach is typically feasible.

The effects of chemical stress on an ecosystem can potentially affect such interspecific ecological interactions as competition, predation, and disease resistance. These effects can alter a population's birth and death rates resulting in long-term changes in numerical abundance (Ricklefs, 1979). The elimination of commercial harvesting of finfish, shellfish, and lobsters since 1979 further complicates the evaluation of large-scale effects in New Bedford Harbor.

Numerous site-specific and laboratory studies indicate that New Bedford Harbor is an ecosystem under stress due to PCBs and other chemical contamination. This stress can be manifested in many ways that are perceived as having negative consequences from a human perspective. There are many potentially affected species for which changes in population dynamics or marketability are of interest, including various shellfish and fish harvested from New Bedford Harbor before the closure enactment. On another level, however, the health of the overall harbor is of concern, in that anthropogenic effects can alter the resource value of the harbor (i.e., recreational, food, and esthetics). The issue is whether the stability and functioning of the harbor ecosystem has been or will be impacted by the described contamination, stability being defined as the intrinsic ability of a system to withstand or recover from externally caused change (Ricklefs, 1979). Overall stability may be affected by various changes related to chemical contamination in the harbor, including population size, species diversity or evenness, and physiological or behavioral changes that impact interactions between species.

In conclusion, all approaches used to assess risk associated with PCB contamination in New Bedford Harbor indicate that levels in Zones 1, 2, and 3 have the potential to strongly impact individual biota in the harbor, as well as the overall integrity of the harbor as an integrated functioning unit. This impact may take the form of numerical changes at the population level, changes in community composition, and ultimately ecosystem stability. Ecosystem level disruptions are less strongly indicated in Zone 4 but still are probable.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AWQC	Ambient Water Quality Criteria
BCF	bioconcentration factor
BOS	Battelle Ocean Sciences
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CI	confidence interval
EEC	expected environmental concentration
EPA	U.S. Environmental Protection Agency
FDA	U.S. Food and Drug Administration
FRV	final residue value
FS	Feasibility Study
K_d	partition coefficient
K_{oc}	partitioning coefficient
MATC	maximum acceptable toxicant concentration
mg/kg	milligrams per kilogram
NPL	National Priorities List
NUS	NUS Corporation
PCB	polychlorinated biphenyl
PNL	Pacific Northwest Laboratories (Battelle)
ppb	parts per billion
ppm	parts per million
RI	Remedial Investigation
SQC	Sediment Quality Criterion
TOC	total organic carbon
ug/g	micrograms per gram
ug/L	micrograms per liter
USACE	U.S. Army Corps of Engineers

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APPENDIX A

EXPECTED EXPOSURE CONCENTRATIONS

FOR

COPPER, CADMIUM, AND LEAD

TABLE A-1
EXPECTED EXPOSURE CONCENTRATIONS FOR COPPER (1)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

HARBOR ZONE	MEAN (ug/l)	TRANSFORMED VALUES (2)		
		MEAN	ST. DEV.	VARIANCE
1, Water Column	2.218	0.346	0.067	0.004
2, Water Column	3.406	0.532	0.134	0.018
3, Water Column	3.486	0.542	0.131	0.017
4, Water Column	2.180	0.338	0.247	0.061
5, Water Column	0.710	-0.149	0.340	0.115
1, Pore Water	0.317	-0.499	0.836	0.698
2, Pore Water	0.112	-0.953	1.137	1.129
3, Pore Water	0.340	-0.468	0.818	0.670
4, Pore Water	0.191	-0.719	0.695	0.483
5, Pore Water	0.047	-1.327	0.687	0.472

Notes:

(1) Estimates derived from the program data base maintained by Battelle Ocean Sciences.

(2) Log (base 10) transformed values, with standard deviations and variances.

TABLE A-2
EXPECTED EXPOSURE CONCENTRATIONS FOR CADMIUM (1)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

HARBOR ZONE	MEAN (ug/l)	TRANSFORMED VALUES (2)		
		MEAN	ST. DEV.	VARIANCE
1, Water Column	2.460	-0.709	0.391	0.153
2, Water Column	2.404	-0.508	0.381	0.145
3, Water Column	1.560	-0.735	0.193	0.037
4, Water Column	2.198	-0.971	0.342	0.117
5, Water Column	2.477	-1.359	0.394	0.155
1, Pore Water	2.985	-0.694	0.475	0.226
2, Pore Water	8.810	-0.866	0.945	0.893
3, Pore Water	2.924	-0.907	0.466	0.217
4, Pore Water	3.597	-1.281	0.556	0.309
5, Pore Water	5.957	-1.963	0.775	0.601

Notes:

(1) Estimates derived from the program data base maintained by Battelle Ocean Sciences.

(2) Log (base 10) transformed values, with standard deviations and variances.

TABLE A-3
EXPECTED EXPOSURE CONCENTRATIONS FOR LEAD (1)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

HARBOR ZONE	MEAN (ug/l)	TRANSFORMED VALUES (2) MEAN	ST. DEV.	VARIANCE
1, Water Column	1.259	0.100	0.412	0.170
2, Water Column	1.183	0.073	0.088	0.008
3, Water Column	0.560	-0.251	0.482	0.233
4, Water Column	0.212	-0.673	0.520	0.270
5, Water Column	0.052	-1.280	0.957	0.916
1, Pore Water	1.005	0.002	0.785	0.617
2, Pore Water	0.287	-0.541	1.009	1.018
3, Pore Water	0.583	-0.235	0.677	0.458
4, Pore Water	0.103	-0.988	0.577	0.333
5, Pore Water	0.245	-0.611	0.675	0.456

Notes:

(1) Estimates derived from the program data base maintained by Battelle Ocean Sciences.

(2) Log (base 10) transformed values, with standard deviations and variances.

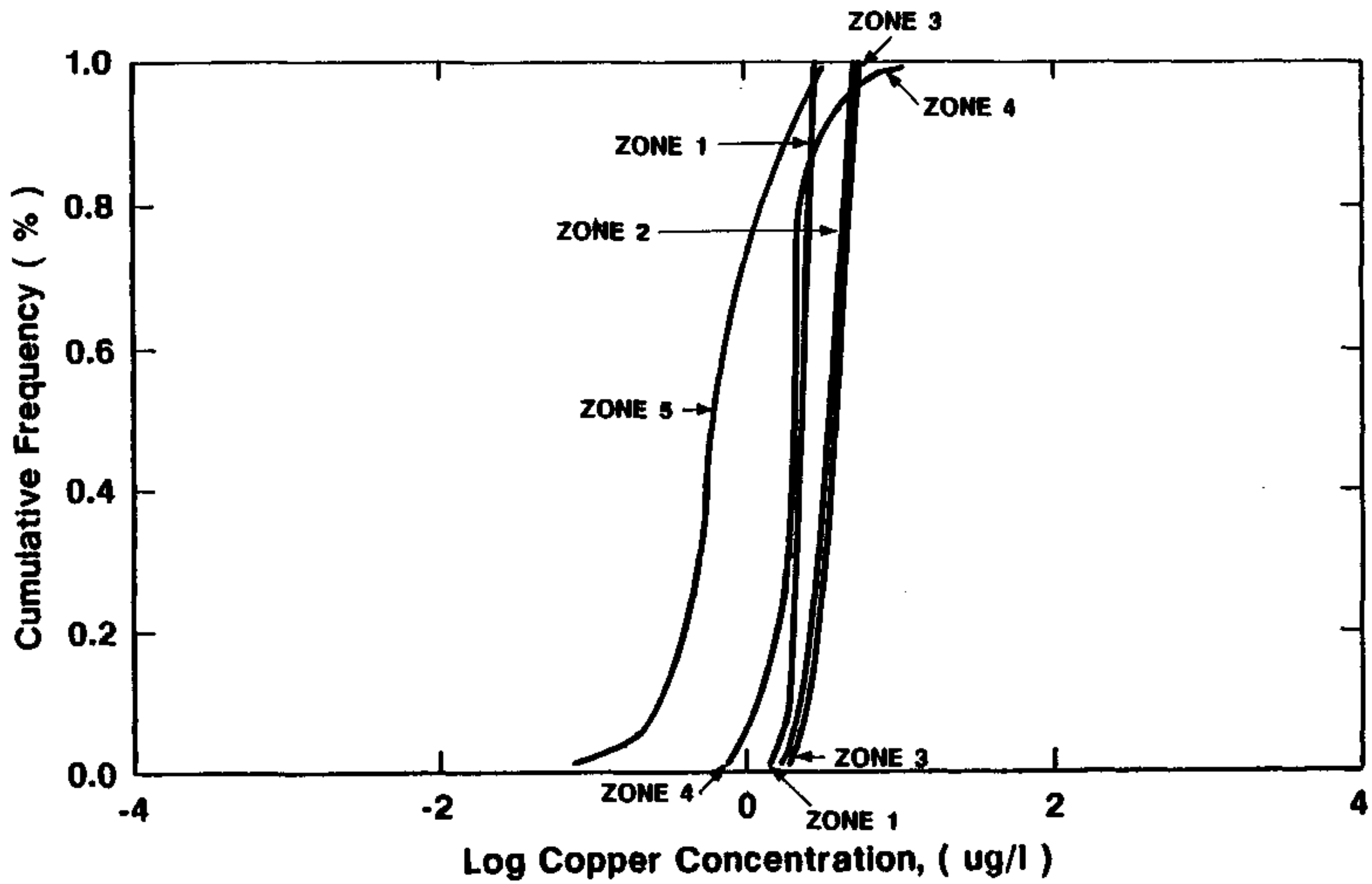


FIGURE A-1
EECs BY ZONE FOR COPPER, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

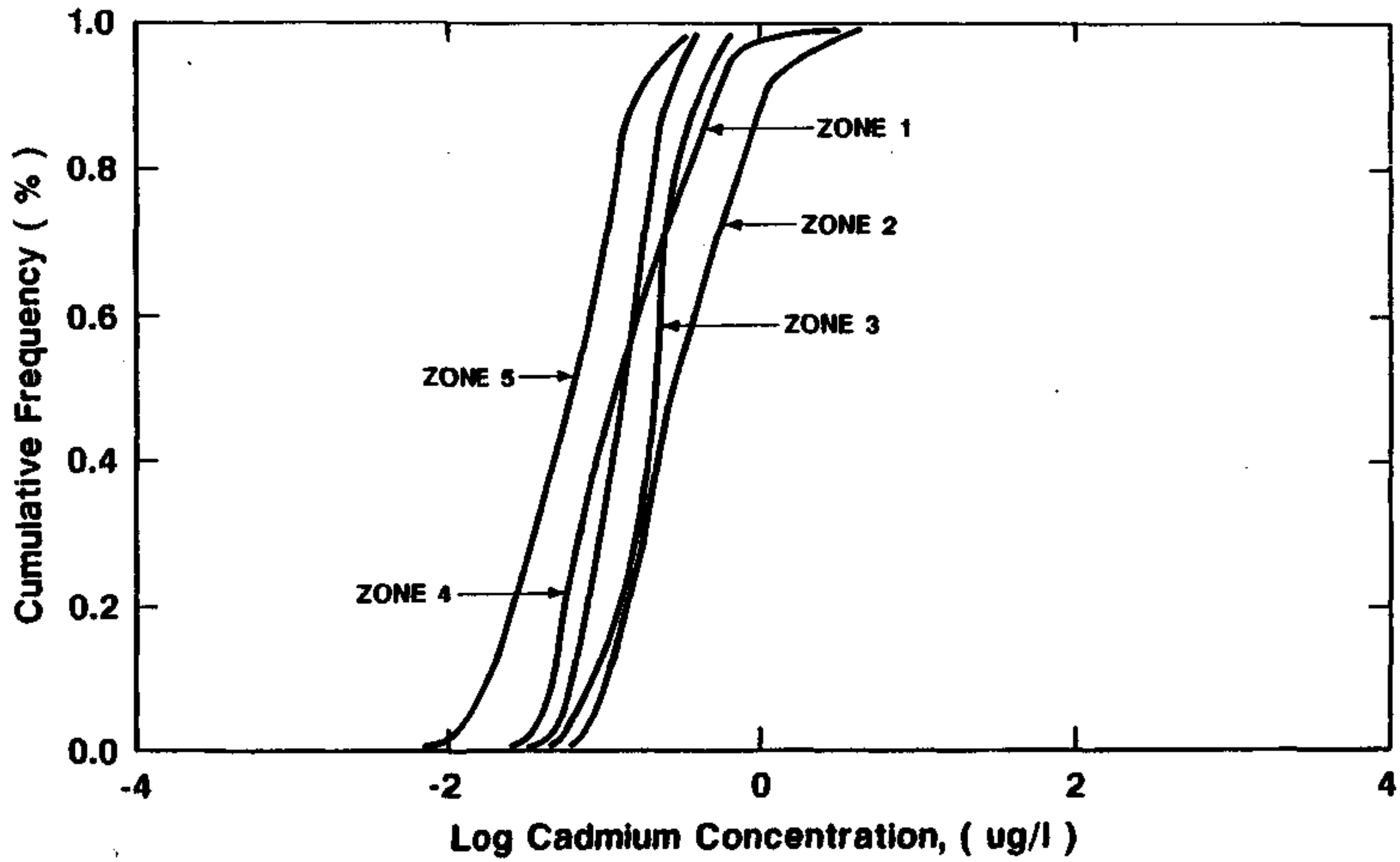


FIGURE A-2
EECs BY ZONE FOR CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

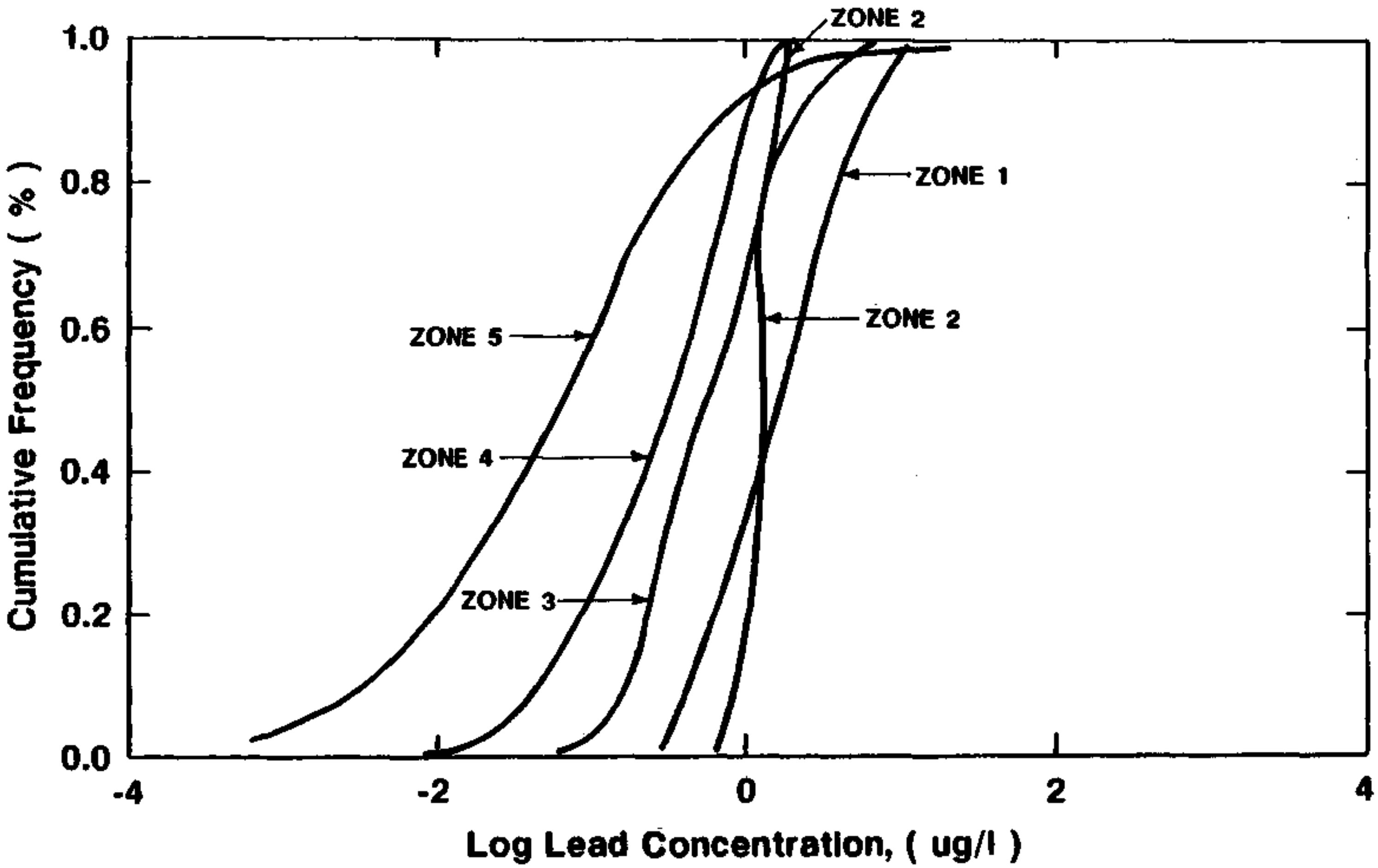


FIGURE A-3
EECs BY ZONE FOR LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

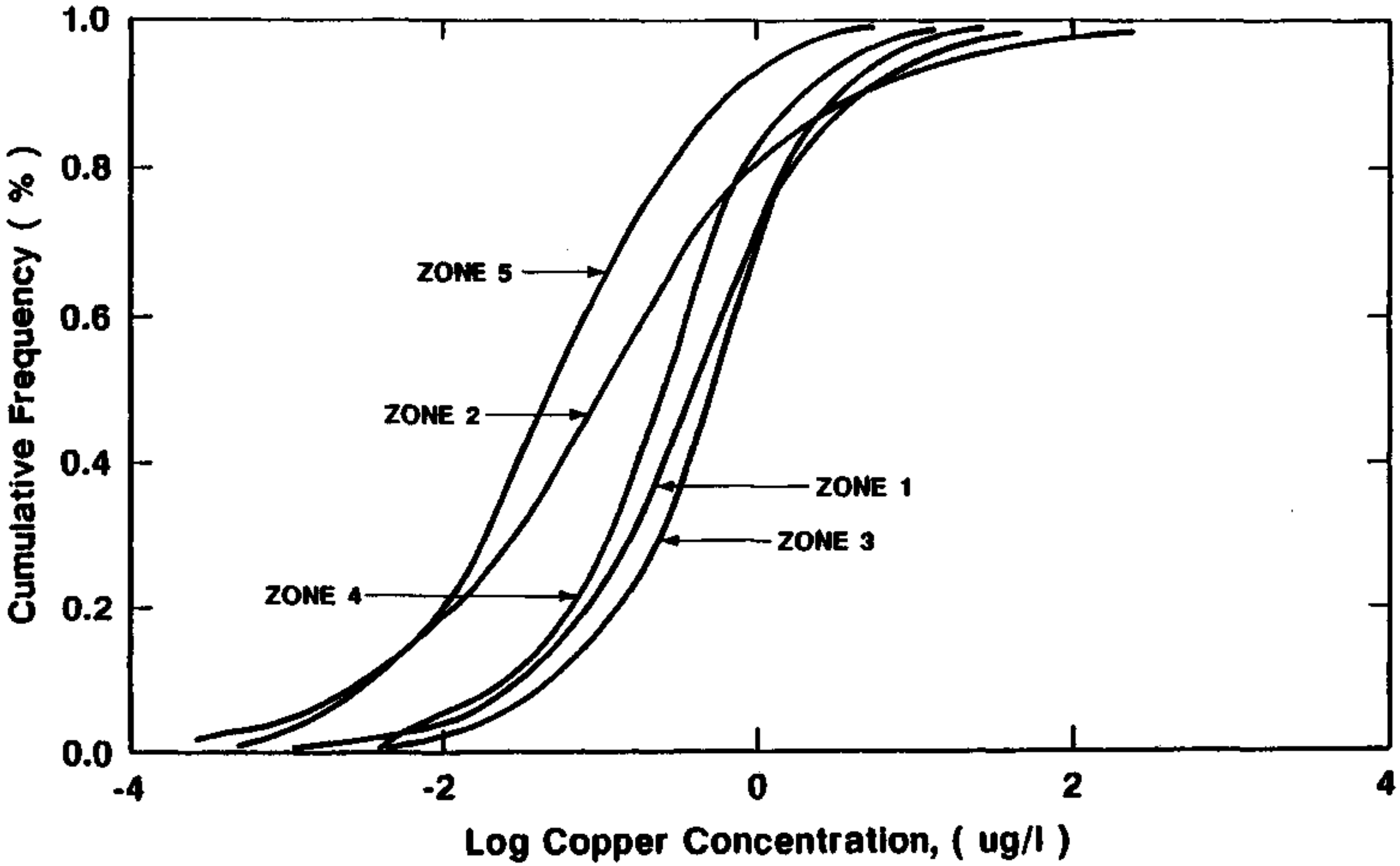


FIGURE A-4
EECs BY ZONE FOR COPPER, PORE WATER
NEW BEDFORD, MASSACHUSETTS

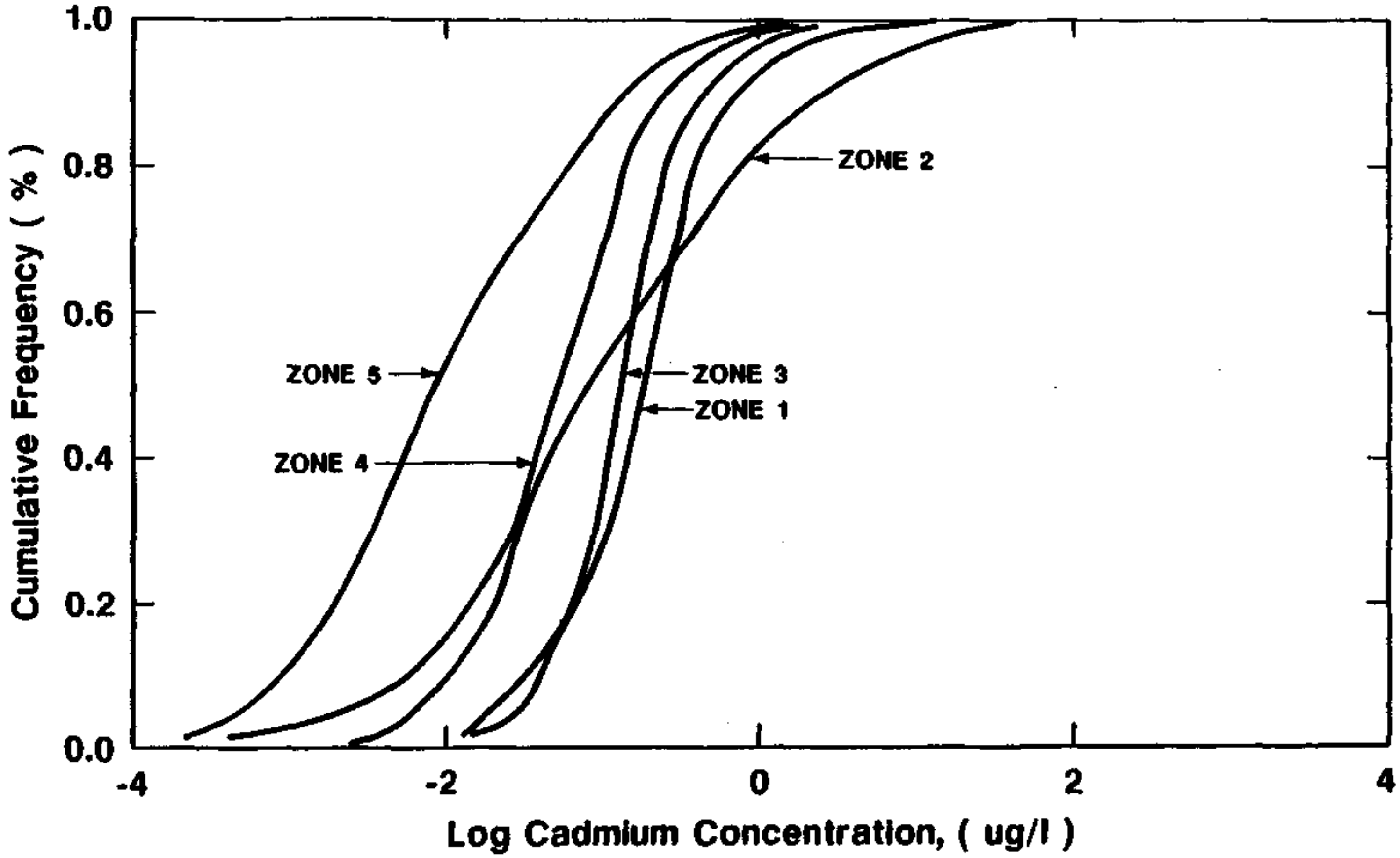


FIGURE A-5
EECs BY ZONE FOR CADMIUM, PORE WATER
NEW BEDFORD, MASSACHUSETTS

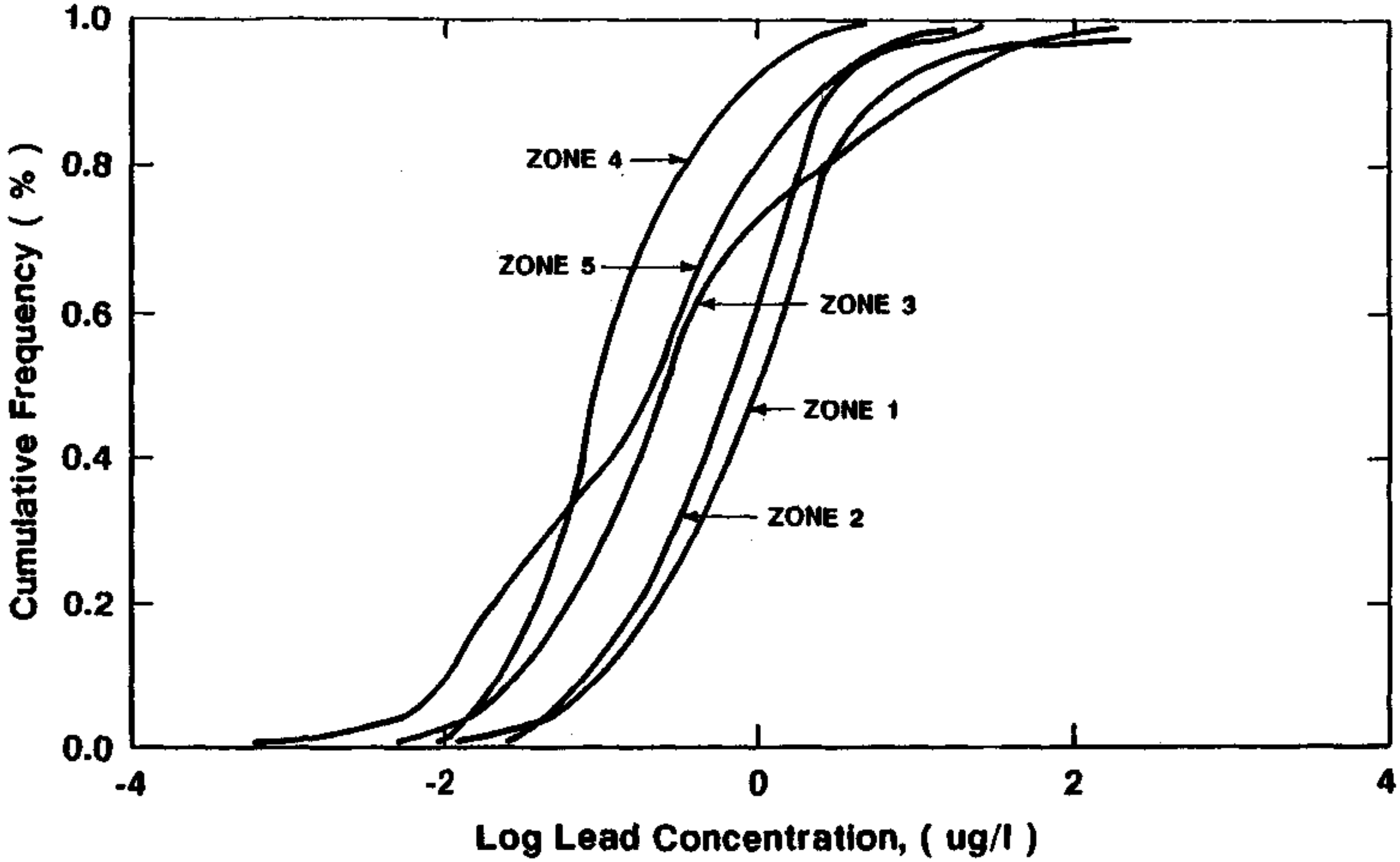


FIGURE A-6
EECs BY ZONE FOR LEAD, PORE WATER
NEW BEDFORD, MASSACHUSETTS

APPENDIX B

TOXICITY DATA

FOR

PCBs, COPPER, CADMIUM, AND LEAD

TABLE B-1
PCB ACUTE TOXICITY DATA FOR MARINE ORGANISMS

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

SPECIES	CHEMICAL	LC50 or EC50 (ug/l)	REFERENCE	HABITAT GROUP
Brown shrimp Penaeus aztecus	Aroclor 1016	10.5	Hansen et al., 1974a	Demersal
Grass shrimp Palaemonetes pugio	Aroclor 1016	12.5	Hansen et al., 1974a	Demersal
Grass shrimp Palaemonetes pugio	Aroclor 1254	6.1 to 7.8	Ernst, 1984	Demersal
Pink shrimp Penaeus duorarum	Aroclor 1248	32	Lowe, undated	Demersal
Pink shrimp Penaeus duorarum	Aroclor 1254	1	Nimmo & Bahner, 1976	Demersal
Pink shrimp Penaeus duorarum	Aroclor 1254	32	Lowe, undated	Demersal
Shrimp, Crangon septemspinosa	Aroclor 1242	13	McLeese & Metcalf, 1980	Demersal
Shrimp, Crangon septemspinosa	Aroclor 1254	12	McLeese & Metcalf, 1980	Demersal
Sheepshead minnow (embyros and fry) Cyprinodon variegatus	Aroclor 1254	0.93	Schimmel et al., 1974	Demersal
Sheepshead minnow (fry) Cyprinodon variegatus	Aroclor 1254	0.1 to 0.32	Ernst, 1984	Demersal
Eastern oyster Crassostrea virginica	Aroclor 1016	10.2	Hansen et al., 1974a	Benthic
Eastern oyster Crassostrea virginica	Aroclor 1248	17	Lowe, undated	Benthic
Eastern oyster Crassostrea virginica	Aroclor 1260	60	Lowe, undated	Benthic
Eastern oyster Crassostrea virginica	Aroclor 1254	14	Lowe, undated	Benthic
Pinfish Lagodon rhomboides	Aroclor 1254	0.5	Ernst, 1984	Demersal

TABLE B-1
PCB ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Spot Leiostomus xanthurus	Aroclor 1254	0.5	Ernst, 1984	Demersal
Cladoceran, Daphnia magna	Aroclor 1254	1.8	Nebeker & Puglisi, 1974	Nekton/Plankton
Cladoceran, Daphnia magna	Aroclor 1254	1.3	Nebeker & Puglisi, 1974	Nekton/Plankton
Cladoceran, Daphnia magna	Aroclor 1254	24	Maki & Johnson, 1975	Nekton/Plankton
Cladoceran, Daphnia magna	Aroclor 1248	2.6	Nebeker & Puglisi, 1974	Nekton/Plankton
Cladoceran, Daphnia magna	Aroclor 1221	180	Nebeker & Puglisi, 1974	Nekton/Plankton
Cladoceran, Daphnia magna	Aroclor 1232	72	Nebeker & Puglisi, 1974	Nekton/Plankton
Cladoceran, Daphnia magna	Aroclor 1242	67	Nebeker & Puglisi, 1974	Nekton/Plankton
Cladoceran, Daphnia magna	Aroclor 1260	36	Nebeker & Puglisi, 1974	Nekton/Plankton

Table taken from USEPA, 1980, and Eisler, 1985.

Toxicity data for the cladoceran, Daphnia magna, are included because these values were used during the extrapolation process.

TABLE B-2
OTHER DATA ON EFFECTS OF PCBs ON MARINE ORGANISMS

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

SPECIES	CHEMICAL	DURATION	EFFECT	RESULT (ug/l)	REFERENCE	HABITAT GROUP
Chlorophyceae Dunallella tertiolecta	Aroclor 1254	-	Increased cell division	100	Harding & Phillips, 1978	Nekton/Plankton
Chrysophyceae Monochrysis lutheri	Aroclor 1254	-	Reduced cell division	10	Harding & Phillips, 1978	Nekton/Plankton
Diatom Thalassiosira pseudonana	Aroclor 1254	-	Reduced cell division	1	Harding & Phillips, 1978	Nekton/Plankton
Diatom Skeletonema costatum	Aroclor 1254	-	Reduced growth	10	Mosser et al.,1972a	Nekton/Plankton
Diatom Rhizosolenia setiger	Aroclor 1254	48 hours	No growth in 48	0.1	Fisher & Wurster, 1973	Nekton/Plankton
Diatom Thalassiosira pseudonana	Aroclor 1254	-	Reduced growth	25 to 100	Mosser et al.,1972b	Nekton/Plankton
Diatom Nitzschia lonsissima	Aroclor 1254	-	No effect on cell	100	Harding & Phillips, 1978	Nekton/Plankton
Diatom Skeletoma costatum	Aroclor 1254	-	Reduced cell division	10	Harding & Phillips, 1978	Nekton/Plankton
Diatom Cylindortheca closterium	Aroclor 1254	-	Reduced growth	100	Kell et al., 1971	Nekton/Plankton
Diatom, Thalassiosira pseudonana and green alga	Aroclor 1254	-	Species ratio change	1	Mosser et al.,1972a	Nekton/Plankton
Haptophyceae Isochrysisgalbana	Aroclor 1254	-	Reduced cell division	1	Harding & Phillips, 1978	Nekton/Plankton
Natural phytoplankton community	Aroclor 1254	-	Decreased diversity,	100	Laird, 1973	Nekton/Plankton
Phytoplankton populations	Aroclor 1254	-	Toxicity in 24 hours	6.5	Moore & Hariss, 1972	Nekton/Plankton
Phytoplankton populations	Aroclor 1254	-	Toxicity in 24 hours	15	Moore & Hariss, 1972	
Diatoms Thalassiosira pseudonana and Skeletomema costatum	Aroclor 1254	-	Reduced growth and carbon	10	Fisher et al., 1973	Nekton/Plankton

TABLE B-2
OTHER DATA ON EFFECTS OF PCBs ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Diatom, Thalassiosira pseudonana and green alga Dunaliella tertiolecta	Aroclor 1254	-	Species ratio change	0.1	Fisher et al., 1974	Nekton/Plankton
Diatom Chaetoceros socialis	Aroclor 1254	-	Reduced cell divsion	10	Harding & Phillips, 1978	Nekton/Plankton
Eastern Oyster Crassostrea virginica	Aroclor 1254	24 weeks	Reduced growth	5	Lowe et al., 1972	Benthic
Amphipod, Gammarus oceanicus	Aroclor 1254	30 days	Mortality	>= 10	Wildish, 1970	Benthic
Grass shrimp, Palaemonetes pugio	Aroclor 1254	1 hour	Avoidance	10	Hansen et al., 1974b	Demersal
Grass shrimp, Palaemonetes pugio	Aroclor 1254	4 days	Water efflux affected and altered metabolic state	25 to 45	Roesijadi et al.,1976a,b	Demersal
Grass shrimp, Palaemonetes pugio	Aroclor 1254	96 hours	LC50	6.1 to 7.8	Ernst, 1984	Demersal
Pink shrimp, Penaeus deorarum	Aroclor 1248	48 hours	LC50	32	Lowe, undated	Demersal
Pink shrimp, Penaeus deorarum	Aroclor 1254	48 hours	LC50	32	Lowe, undated	Demersal
Pink shrimp, Penaeus deorarum	Arclor 1254	48 hours	51% Mortality	0.94	Nimmo et al., 1971	Demersal
Pink shrimp, Penaeus deorarum	Aroclor 1254	48 hours	LC50	1	Nimmo & Bahner, 1976	Demersal
Ciliate protozoans, Tetrahymena pyriformis	Aroclor 1248	96 hours	Reduced growth	1000	Cooley et al., 1973	Nekton/Plankton
Ciliate protozoans, Tetrahymena pyriformis	Aroclor 1254	96 hours	Reduced growth	1	Cooley et al., 1973	Nekton/Plankton
Ciliate protozoans, Tetrahymena pyriformis	Aroclor 1260	96 hours	Reduced growth	1000	Cooley et al., 1973	Nekton/Plankton
Fiddler crab, Uca pugilator	Aroclor 1254	38 days	Inhibited molting	8	Fingerman & Fingerman, 1977	Benthic
Fiddler crab, Uca pugilator	Aroclor 1242	4 days	Greater dispersion of melanin	2000	Fingerman & Fingerman, 1978	Benthic
Communities of organisms	Aroclor 1254	4 months	Affected composition	0.6	Hansen, 1974	

TABLE B-2
OTHER DATA ON EFFECTS OF PCBs ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Spot, Leiostomus xanthurus	Aroclor 1254	-	Liver pathogenesis	5	Nimmo et al., 1975	Demersal
Spot, Leiostomus xanthurus	Aroclor 1254	20 to 45 days	51 to 62% mortality	5	Hansen et al., 1971	Demersal
Spot, Leiostomus xanthurus	Aroclor 1254	96 hours	LC50	0.5	Ernst, 1984	Demersal
Pinfish, Lagodon rhomboides	Aroclor 1254	1 hour	Avoidance	10	Hansen et al., 1974b	Demersal
Pinfish, Lagodon rhomboides	Aroclor 1254	96 hours	LC50	0.5	Ernst, 1984	Demersal
Pinfish, Lagodon rhomboides	Aroclor 1254	14 to 35 days	41 to 66% mortality	5	Hansen et al., 1971	Demersal
Pinfish, Lagodon rhomboides	Aroclor 1016	42 days	50% mortality	21	Hansen et al., 1974a	Demersal
Sheepshead minnow (adult) Cyprinodon variegatus	Aroclor 1254	28 days	Lethaargy, reduced feeding, fin rot, mortality	10	Hansen et al., 1973	Demersal
Sheepshead minnow (juvenile) Cyprinodon variegatus	Aroclor 1254	21 days	Mortality	10	Schimmel et al., 1974	Demersal
Sheepshead minnow (embryos and fry) Cyprinodon variegatus	Aroclor 1254	21 days	LC50	0.93	Schimmel et al., 1974	Demersal
Sheepshead minnow (fry) Cyprinodon variegatus	Aroclor 1254	21 days	LC50	0.1 to 0.32	Ernst, 1984	Demersal
Sheepshead minnow Cyprinodon variegatus	Aroclor 1254	28 days	Significantly affected hatching of embryos or the survival of fry	0.14	Hansen et al., 1973	Demersal
Sheepshead minnow Cyprinodon variegatus	Aroclor 1016	-	Chronic value	3.4 to 15.0	Hansen et al., 1975	Demersal
Sheepshead minnow Cyprinodon variegatus	Aroclor 1254	-	Chronic value	0.06 to 0.16	Hansen et al., 1974	Demersal
Atlantic cod, Sadus morhua	Aroclor 1254	-	Impaired bone development and abnormalities in	0.4	Sangalang et al., 1981	Nekton/Plankton

Table taken from USEPA, 1980.

TABLE 8-3
BIOCONCENTRATION DATA FOR PCBs - MARINE ORGANISMS

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

SPECIES	TISSUE	LIPID %	CHEMICAL	BIOCONCENTRATION FACTOR	DURATION (days)	REFERENCE	HABITAT GROUP
Diatom, Cylindrotheca closterium	Whole organism	-	Aroclor 1242	1,000	14	Kell et al., 1971	Nekton/Plankton
Polychaete, Nereis diversicolor	Whole body	-	Pnenochlor DP-5	800	14	Fowler, et al., 1978	Benthic
Eastern oyster, Crassostrea virginica	Edible portion	-	Aroclor 1016	13,000	84	Parrish et al., 1974	Demersal
Eastern oyster, Crassostrea virginica	Edible portion	-	Aroclor 1254	101,000	245	Lowe et al., 1972	Demersal
Eastern oyster, Crassostrea virginica	Edible portion	-	Aroclor 1254	>100,000	Field data	Duke et al., 1979; Nimmo et al., 1975	Demersal
Grass shrimp, Palaemonetes pugio	Whole body	-	Aroclor 1254	27,000	16	Nimmo et al., 1974	Demersal
Blue crab, Callinectes sapidus	Whole body	-	Aroclor 1254	>230,000	Field data	Nimmo et al., 1975	Demersal
Spot, Leiostomus xanthurum	Whole body	1.1	Aroclor 1254	37,000	28	Hansen et al., 1971	Demersal
Sheepshead minnow (adult) Cyprinodon variegatus	Whole body	3.6	Aroclor 1016	25,000	28	Hansen et al., 1975	Nekton/Plankton
Sheepshead minnow (juvenile) Cyprinodon variegatus	Whole body	-	Aroclor 1016	43,100	28	Hansen et al., 1975	Nekton/Plankton
Sheepshead minnow (fry) Cyprinodon variegatus	Whole body	-	Aroclor 1016	14,400	28	Hansen et al., 1975	Nekton/Plankton
Sheepshead minnow (adult) Cyprinodon variegatus	Whole body	3.6	Aroclor 1254	30,000	28	Hansen et al., 1973	Nekton/Plankton
Pinfish, Lagodon rhomboides	Whole body	-	Aroclor 1016	17,000	21-28	Hansen et al., 1974a	Nekton/Plankton
Speckled trout, Cynoscion nebulosus	Whole body	-	Aroclor 1254	>670,000	Field data	Duke et al., 1970; Nimmo et al., 1975	Nekton/Plankton
Fishes	Whole body	-	Aroclor 1254	>133,000	Field data	Nimmo et al., 1975	
Invertebrates	Whole body	-	Aroclor 1254	>27,000	Field data	Nimmo et al., 1975	

Table taken from USEPA, 1980.

TABLE B-4
COPPER ACUTE TOXICITY DATA FOR MARINE ORGANISMS

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

SPECIES	METHOD	CHEMICAL	LC50 or EC50 (ug/l)	SPECIES MEAN ACUTE VALUE (ug/l)	REFERENCE	HABITAT GROUP
Polychaete worm, Phyllodoce maculata	S, U	Copper sulfate	120.00	120.00	McLusky & Phillips, 1975	Benthic
Polychaete worm, Neanthes arenaceodentata	FT, M	Copper nitrate	77.00	-	Pesch & Morgan, 1978	Benthic
Polychaete worm, Neanthes arenaceodentata	FT, M	Copper nitrate	200.00	-	Pesch & Morgan, 1978	Benthic
Polychaete worm, Neanthes arenaceodentata	FT, M	Copper nitrate	222.00	150.60	Pesch & Hoffman, 1982	Benthic
Polychaete worm, Nereis diversicolor	S, U	Copper sulfate	200.00	-	Jones et al., 1976	Benthic
Polychaete worm, Nereis diversicolor	S, U	Copper sulfate	445.00	-	Jones et al., 1976	Benthic
Polychaete worm, Nereis diversicolor	S, U	Copper sulfate	480.00	-	Jones et al., 1976	Benthic
Polychaete worm, Nereis diversicolor	S, U	Copper sulfate	410.00	363.80	Jones et al., 1976	Benthic
Blue mussel (embryo) Mytilus edulis	S, U	Copper sulfate	5.80	5.80	Martin et al., 1981	Benthic
Pacific oyster (embryo), Crassostrea gigas	S, U	Copper sulfate	5.30	-	Martin et al., 1981	Benthic
Pacific oyster (embryo), Crassostrea gigas	S, U	Copper sulfate	11.50	-	Cogilanese & Martin, 1981	Benthic
Pacific oyster (adult), Crassostrea gigas	FT, M	Copper sulfate	560.00	7.80	Okazaki, 1976	Benthic
Eastern oyster (embryo), Crassostrea virginica	S, U	Copper chloride	128.00	-	Calabrese et al., 1973	Benthic
Eastern oyster (embryo), Crassostrea virginica	S, U	Copper chloride	15.10	-	Macinnes & Calabrese, 1978	Benthic
Eastern oyster (embryo), Crassostrea virginica	S, U	Copper chloride	18.70	-	Macinnes & Calabrese, 1978	Benthic
Eastern oyster (embryo), Crassostrea virginica	S, U	Copper chloride	18.30	28.52	Macinnes & Calabrese, 1978	Benthic

TABLE B-4
COPPER ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Wedge clam, Rangia cuneata	S, U	-	8000.00	-	Olson & Harrel, 1973	Benthic
Wedge clam, Rangia cuneata	S, U	-	7400.00	7694.00	Olson & Harrel, 1973	Benthic
Soft-shelled clam, Mya arenaria	S, U	Copper chloride	39.00	39.00	Eisler, 1977	Benthic
Copepod, Pseudodiaptomus coronatus	S, U	Copper chloride	138.00	138.00	Gentile, 1982	Nekton/Plankton
Copepod, Eurytemora affinis	S, U	Copper chloride	526.00	526.00	Gentile, 1982	Nekton/Plankton
Copepod, Acartia clausi	S, U	Copper chloride	52.00	52.00	Gentile, 1982	Nekton/Plankton
Copepod, Acartia tonsa	S, U	Copper chloride	17.00	-	Sosnowski & Gentile, 1978	Nekton/Plankton
Copepod, Acartia tonsa	S, U	Copper chloride	55.00	-	Sosnowski & Gentile, 1978	Nekton/Plankton
Copepod, Acartia tonsa	S, U	Copper chloride	31.00	30.72	Sosnowski & Gentile, 1978	Nekton/Plankton
Mysid, Mysidopsis bahia	FT, M	Copper nitrate	181.00	181.00	Lussler et al., Manuscript	Demersal
Mysid, Mysidopsis bigelowi	FT, M	Copper nitrate	141.00	141.00	Gentile, 1982	Demersal
American lobster (larva), Homarus americanus	S, U	Copper sulfate	48.00	-	Johnson & Gentile, 1979	Demersal
American lobster (adult), Homarus americanus	S, U	Copper sulfate	100.00	69.28	McLeese, 1974	Demersal
Dungeness crab (larva), Cancer magister	S, U	Copper sulfate	49.00	49.00	Martin, et al., 1981	Demersal
Green crab (larva), Carcinus maenas	S, U	Copper nitrate	600.00	600.00	Conner, 1972	Demersal
Sheepshead minnow, Cyprinondon variegatus	S, U	Copper nitrate	280.00	280.00	Hansen, 1983	Demersal
Atlantic silverside (larva), Menidia menidia	FT, M	Copper nitrate	66.60	-	Cardin, 1982	Demersal

TABLE B-4
COPPER ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Atlantic silverside (larva), Menidia menidia	FT, M	Copper nitrate	216.50	-	Cardin, 1982	Demersal
Atlantic silverside (larva), Menidia menidia	FT, M	Copper nitrate	101.80	-	Cardin, 1982	Demersal
Atlantic silverside (larva), Menidia menidia	FT, M	Copper nitrate	97.60	-	Cardin, 1982	Demersal
Atlantic silverside (larva), Menidia menidia	FT, M	Copper nitrate	155.90	-	Cardin, 1982	Demersal
Atlantic silverside (larva), Menidia menidia	FT, M	Copper nitrate	197.60	-	Cardin, 1982	Demersal
Atlantic silverside (larva), Menidia menidia	FT, M	Copper nitrate	190.90	135.60	Cardin, 1982	Demersal
Tidewater silverside, Menidia peninsulae	S, U	Copper nitrate	140.00	140.00	Hansen, 1983	Demersal
Florida pompano Trachinotus carolinus	S, U	Copper sulfate	360.00	-	Birdsong & Avavit, 1971	Nekton/Plankton
Florida pompano Trachinotus carolinus	S, U	Copper sulfate	380.00	-	Birdsong & Avavit, 1971	Nekton/Plankton
Florida pompano Trachinotus carolinus	S, U	Copper sulfate	510.00	411.70	Birdsong & Avavit, 1971	Nekton/Plankton
Summer flounder (embryo), Paralichthys dentatus	FT, M	Copper nitrate	16.30	-	Cardin, 1982	Demersal
Summer flounder (embryo), Paralichthys dentatus	FT, M	Copper nitrate	11.90	-	Cardin, 1982	Demersal
Summer flounder (embryo), Paralichthys dentatus	FT, M	Copper chloride	111.80	13.93	Cardin, 1982	Demersal
Winter flounder (embryo), Pseudopleuronectes americanus	FT, M	Copper nitrate	77.50	-	Cardin, 1982	Demersal
Winter flounder (embryo), Pseudopleuronectes americanus	FT, M	Copper nitrate	167.30	-	Cardin, 1982	Demersal
Winter flounder (embryo), Pseudopleuronectes americanus	FT, M	Copper nitrate	52.70	-	Cardin, 1982	Demersal
Winter flounder (embryo), Pseudopleuronectes americanus	FT, M	Copper nitrate	158.00	-	Cardin, 1982	Demersal

TABLE B-4
COPPER ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Winter flounder (embryo), Pseudopleuronectes americanus	FT, M	Copper chloride	173.70	-	Cardin, 1982	Demersal
Winter flounder (embryo), Pseudopleuronectes americanus	FT, M	Copper nitrate	271.00	-	Cardin, 1982	Demersal
Winter flounder (embryo), Pseudopleuronectes americanus	FT, M	Copper chloride	132.80	-	Cardin, 1982	Demersal
Winter flounder (embryo), Pseudopleuronectes americanus	FT, M	Copper nitrate	148.20	-	Cardin, 1982	Demersal
Winter flounder (embryo), Pseudopleuronectes americanus	FT, M	Copper nitrate	98.20	128.90	Cardin, 1982	Demersal

Table taken from USEPA, 1985b.

S = static, R = renewal, FT = flow through, M = measured, U = unmeasured.

TABLE B-5
OTHER DATA ON EFFECTS OF COPPER ON MARINE ORGANISMS

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

SPECIES	CHEMICAL	DURATION	EFFECT	RESULT (ug/l)	REFERENCE	HABITAT GROUP
Alga, Amphidinium carteri	Copper	14 Days	EC50 Growth rate	<50	Erickson et al., 1970	Nekton/Plankton
Diatom, Skeletonema costatum	Copper	14 day EC50	Growth rate	5.00	Erickson et al., 1970	Nekton/Plankton
Diatom, Thalassiosira aestevallis	Copper	-	Reduced chlorophyll a	19.00	Hollibaugh et al., 1980	Nekton/Plankton
Diatom, Thalassiosira aestevallis	Copper	3 day EC50	Growth rate	5.00	Erickson, 1972	Nekton/Plankton
Diatom, Asterionella japonica	Copper	3 day EC50	Growth rate	12.70	Fisher & Jones, 1981	Nekton/Plankton
Alga, Olisthodiscus luteus	Copper	14 days	EC50 Growth rate	<50	Erickson et al., 1970	Nekton/Plankton
Alga, Nitschia closterium	Copper	4 days	EC50 Growth rate	33.00	Rosko & Rachlin, 1975	Nekton/Plankton
Alga, Scrippsiella faeroense	Copper	5 days	EC50 Growth rate	5.00	Saifullah, 1978	Nekton/Plankton
Alga, Prorocentrum micans	Copper	5 days	EC50 Growth rate	10.00	Saifullah, 1978	Nekton/Plankton
Alga, Gymnodinium splendons	Copper	5 days	EC50 Growth rate	20.00	Saifullah, 1978	Nekton/Plankton
Red alga, Champia parvula	Copper	-	Reduced tetrasporophyte growth	4.60	Steele & Thursby, 1983	Nekton/Plankton
Red alga, Champia parvula	Copper	-	Reduced tetrasporangia production	13.30	Steele & Thursby, 1983	Nekton/Plankton
Red alga, Champia parvula	Copper	-	Reduced female growth	4.70	Steele & Thursby, 1983	Nekton/Plankton
Red alga, Champia parvula	Copper	-	Stopped sexual reproduction	7.30	Steele & Thursby, 1983	Nekton/Plankton
Natural phytoplankton population	Copper	5 days	Reduced chlorophyll a	19.00	Hollibaugh et al., 1980	Nekton/Plankton
Natural phytoplankton population	Copper	4 days	Reduced biomass	6.40	Hollibaugh et al., 1980	Nekton/Plankton

TABLE B-5
OTHER DATA ON EFFECTS OF COPPER ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Hydroid, Campanularia flexuosa	Copper	11 days	Growth rate inhibition	10-13	Stebbing, 1976	Benthic
Hydroid, Campanularia flexuosa	Copper	-	Enzyme inhibition	1.43	Moore & Stebbing, 1976	Benthic
Hydromedusa, Phalalldium spp.	Copper	1 day	LC50	36.00	Reeve et al., 1976	Benthic
Ctenophore, Pleurobrachia pileus	Copper	1 day	LC50	33.00	Reeve et al., 1976	Nekton/Plankton
Ctenophore, Mnemiopsis mccrdayl	Copper	1 day	LC50	17-29	Reeve et al., 1976	Nekton/Plankton
Rotifer, Brachionus plicatilis	Copper	1 day	LC50	100.00	Reeve et al., 1976	Nekton/Plankton
Polychaete worm, Phyllodoce maculata	Copper	9 days	LC50	80.00	McLusky & Phillips, 1975	Benthic
Polychaete worm, Neanthes arenaceodentata	Copper	28 days	LC50	44.00	Pesch & Morgan, 1978	Benthic
Polychaete worm, Neanthes arenaceodentata	Copper	28 days	LC50	100.00	Pesch & Morgan, 1978	Benthic
Polychaete worm, Neanthes arenaceodentata	Copper	7 days	LC50	137.00	Pesch & Morgan, 1982	Benthic
Polychaete worm, Neanthes arenaceodentata	Copper	10 days	LC50	98.00	Pesch & Morgan, 1982	Benthic
Polychaete worm, Neanthes arenaceodentata	Copper	28 days	LC50	56.00	Pesch & Morgan, 1982	Benthic
Polychaete worm, Cirriformia spirabranchia	Copper	26 days	LC50	40.00	Milanovich et al., 1976	Benthic
Larval annelids, Mixed species	Copper	1 day	LC50	89.00	Reeve et al., 1976	Benthic
Channeled whelk, Busycon canaliculatum	Copper	77 days	LC50	470.00	Betzer & Yevich, 1975	Benthic
Mud snail, Nassarius obsoletus	Copper	3 days	Decrease in oxygen consumption	100.00	MacInnes & Thurberg, 1973	Demersal
Blue mussel, Mytilus edulis	Copper	7 days	LC50	200.00	Scott & Major, 1972	Benthic

TABLE B-5
OTHER DATA ON EFFECTS OF COPPER ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Bay scallop, Argopecton irradians	Copper	42 days	EC50 (growth)	5.80	Pesch et al., 1979	Benthic
Bay scallop, Argopecton irradians	Copper	119 days	100% mortality	5.00	Zaroogian & Johnson, 1983	Benthic
Eastern oyster, Crassostrea virginica	Copper	12 days	LC50	46.00	Calabrese et al., 1977	Benthic
Wedge clam, Rangia cuneata	Copper	4 days	LC50 (<1 g/kg salinity)	210.00	Olson & Harrel, 1973	Benthic
Clam, Macoma inquinata	Copper	30 days	LC50	15.70	Crecellus et al., 1982	Benthic
Clam, Maçoma inquinata	Copper	30 days	LC50	20.70	Crecellus et al., 1982	Benthic
Quahog clam (larva), Mercenaria mercenaria	Copper	8-10 days	LC50	30.00	Calabrese et al., 1977	Benthic
Quahog clam (larva), Mercenaria mercenaria	Copper	77 days	LC50	25.00	Shuster & Pringle, 1968	Benthic
Common Pacific littleneck, Protothaca staminea	Copper	17 days	LC50	39.00	Roesijadi, 1980	Benthic
Soft-shelled clam, Mya arenaria	Copper	7 days	LC50	35.00	Eisler, 1977	Benthic
Copepod, Undinula vulgaris	Copper	1 day	LC50	192.00	Reeve et al., 1976	Nekton/Plankton
Copepod, Euchaeta marina	Copper	1 day	LC50	188.00	Reeve et al., 1976	Nekton/Plankton
Copepod, Metridia pacifica	Copper	1 day	LC50	176.00	Reeve et al., 1976	Nekton/Plankton
Copepod, Labidocera scotti	Copper	1 day	LC50	132.00	Reeve et al., 1976	Nekton/Plankton
Copepod, Acartia clausi	Copper	2 days	LC50	34-82	Moraltou-Apostolopoulou, 1978	Nekton/Plankton
Copepod, Acartia tonsa	Copper	6 days	LC50	9-73	Sosnowski et al., 1979	Nekton/Plankton

Table taken from USEPA, 1985b.

TABLE B-6
CADMIUM ACUTE TOXICITY DATA FOR MARINE ORGANISMS

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

SPECIES	METHOD	CHEMICAL	LC50 or EC50 (ug/l)	SPECIES MEAN ACUTE VALUE (ug/l)	REFERENCE	HABITAT GROUP
Polychaete worm (adult), Neanthes arenaceodentata	S, U	Cadmium chloride	12000	-	Relsh, et al., 1976	Benthic
Polychaete worm (juvenile), Neanthes arenaceodentata	S, U	Cadmium chloride	12500	12250	Relsh, et al., 1976	Benthic
Sand Worm Nereis virens	S, U	Cadmium chloride	9300	-	Eisler & Hennekey, 1977	Benthic
Polychaete worm Nereis virens	S, U	Cadmium chloride	11000	10110	Eisler, 1971	Benthic
Polychaete worm (adult) Capitella capitella	S, U	Cadmium chloride	7500	-	Relsh, et al., 1976	Benthic
Polychaete worm (larvae) Capitella capitella	S, U	Cadmium chloride	200	200	Relsh, et al., 1976	Benthic
Oligochaete worm Limnodriloides verrucosus	R, U	Cadmium sulfate	10000	10000	Chapman, et al., 1982a	Benthic
Oligochaete worm Monophylephorus cuticalatus	R,U	Cadmium sulfate	135000	135000	Chapman, et al., 1982a	Benthic
Oligochaete worm Tubificoides gabriellae	R, U	Cadmium sulfate	24000	24000	Chapman, et al., 1982a	Benthic
Oyster drill Urosalpinx cinerea	S, U	Cadmium chloride	6600	6600	Eisler, 1971	Benthic
Mud snail Nassarius oboletus	S, U	Cadmium chloride	35000	-	Eisler & Hennekey, 1977	Benthic
Mud snail Nassarius oboletus	S, U	Cadmium chloride	10500	19170	Eisler, 1971	Benthic
Blue mussel Mytilus edulis	S, U	Cadmium chloride	25000	-	Eisler, 1971	Benthic
Blue mussel (embryo), Mytilus edulis	S, U	Cadmium chloride	1200	-	Martin, et al., 1981	Benthic
Blue mussel Mytilus edulis	S, M	Cadmium chloride	1620	-	Ahsanullah, 1976	Benthic
Blue mussel Mytilus edulis	S, M	Cadmium chloride	3600	-	Ahsanullah, 1976	Benthic

TABLE B-6
CADMIUM ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Blue mussel Mytilus edulis	FT, M	Cadmium chloride	4300	3934	Ahsanullah, 1976	Benthic
Bay Scallop (juvenile) Argopecten irradiens	FT, M	Cadmium chloride	1480	1480	Nelson, et al., 1976	Benthic
Pacific Oyster Crassostrea gigas	S, U	Cadmium chloride	611	-	Martin, et al., 1981	Benthic
Pacific Oyster Crassostrea gigas	S, U	Cadmium chloride	85	227.9	Watling, 1982	Benthic
Atlantic Oyster Crassostrea virginica	S, U	Cadmium chloride	3800	3800	Calabrese, et al., 1973	Benthic
Soft-shell clam Mya arenaria	S, U	Cadmium chloride	2500	-	Eisler & Hennekey, 1977	Benthic
Soft-shell clam Mya arenaria	S, U	Cadmium chloride	2200	-	Eisler, 1971	Benthic
Soft-shell clam, Mya arenaria	S, U	Cadmium chloride	850	1672	Eisler, 1977	Benthic
Copepod, Pseudolaptomus coronatus	S, U	Cadmium chloride	1708	1708	Gentile, 1982	Nekton/Plankton
Copepod, Eurytemora affinis	S, U	Cadmium chloride	1080	-	Gentile, 1982	Nekton/Plankton
Copepod (nauplius), Eurytemora affinis	S, U	Cadmium chloride	147.7	399.4	Sullivan et al., 1983	Nekton/Plankton
Copepod, Acartia clausi	S, U	Cadmium chloride	144	144	Gentile, 1982	Nekton/Plankton
Copepod, Acarti tonsa	S, U	Cadmium chloride	90	-	Sosnowski & Gentile, 1978	Nekton/Plankton
Copepod, Acarti tonsa	S, U	Cadmium chloride	122	-	Sosnowski & Gentile, 1978	Nekton/Plankton
Copepod, Acarti tonsa	S, U	Cadmium chloride	220	-	Sosnowski & Gentile, 1978	Nekton/Plankton
Copepod, Acarti tonsa	S, U	Cadmium chloride	337	168.9	Sosnowski & Gentile, 1978	Nekton/Plankton
Copepod, Nitocra spinipes	S, U	Cadmium chloride	1800	1800	Bengtsson, 1978	Nekton/Plankton

TABLE B-6
CADMIUM ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Mysid, Mysidopsis bahia	FT, M	Cadmium chloride	15.5	-	Nimmo, et at., 1977a	Demersal
Mysid, Mysidopsis bahia	FT, M	Cadmium chloride	110	41.29	Gentile, et al., 1982 Lussler, et al., Manuscript	Demersal
Mysid, Mysidopsis bigelowi	FT, M	Cadmium chloride	110	110	Gentile, et al., 1982	Demersal
Amphipod (adult), Ampeilsca abdita	S, M	Cadmium chloride	2900	2900	Scott, et al., Manuscript	Benthic
Amphipod (young), Marinogammarus obtusatus	S, M	Cadmium chloride	3500	-	Wright & Frain, 1981	Benthic
Amphipod (adult), Marinogammarus obtusatus	S, M	Cadmium chloride	13000	3500	Wright & Frain, 1981	Benthic
Pink Shrimp Penaeus duorarum	FT, M	Cadmium chloride	3500	3500	Nimmo, et at., 1977b	Demersal
Grass shrimp, Palaemonetes vulgaris	S, U	Cadmium chloride	420	-	Eisler, 1971	Demersal
Grass shrimp, Palaemonetes vulgaris	FT, M	Cadmium chloride	760	760	Nimmo, et at., 1977b	Demersal
Sand shrimp, Crangon septemspinosa	S, U	Cadmium chloride	320	320	Eisler, 1971	Benthic
American lobster (larvae), Homarus americanus	S, U	Cadmium chloride	78	78	Johnson & Gentile, 1979	Demersal
Hermit crab, Pagurus longicarpus	S, U	Cadmium chloride	320	-	Eisler, 1971	Benthic
Hermit crab, Pagurus longicarpus	S, U	Cadmium chloride	1300	645	Eisler & Hennekey, 1977	Benthic
Rock crab (zoea), Cancer irroratus	FT, M	Cadmium chloride	250	250	Johns & Miller, 1982	Demersal
Dungeness crab (zoea), Cancer magister	S, U	Cadmium chloride	247	247	Martin, et al., 1981	Demersal
Blue crab (juvenile), Callinectes sapidus	S, U	Cadmium chloride	11600	-	Frank & Robertson, 1979	Demersal
Blue crab (juvenile), Callinectes sapidus	S, U	Cadmium chloride	4700	7384	Frank & Robertson, 1979	Demersal

TABLE B-6
CADMIUM ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Green crab, Carcinus maenas	S, U	Cadmium chloride	4100	4100	Eisler, 1971	Demersal
Fiddler crab, Uca pugilator	S, U	Cadmium chloride	46600	-	O'Hara, 1973a	Benthic
Fiddler crab, Uca pugilator	S, U	Cadmium chloride	37000	-	O'Hara, 1973a	Benthic
Fiddler crab, Uca pugilator	S, U	Cadmium chloride	32300	-	O'Hara, 1973a	Benthic
Fiddler crab, Uca pugilator	S, U	Cadmium chloride	23300	-	O'Hara, 1973a	Benthic
Fiddler crab, Uca pugilator	S, U	Cadmium chloride	10400	-	O'Hara, 1973a	Benthic
Fiddler crab, Uca pugilator	S, U	Cadmium chloride	6800	21240	O'Hara, 1973a	Benthic
Starfish, Asterias forbesi	S, U	Cadmium chloride	7100	-	Eisler & Hennekey, 1977	Benthic
Starfish, Asterias forbesi	S, U	Cadmium chloride	820	2413	Eisler, 1971	Benthic
Sheepshead minnow, Cyperindon variegatus	S, U	Cadmium chloride	50000	50000	Eisler, 1971	Demersal
Mummichog (adult), Fundulus heteroclitus	S, U	Cadmium chloride	49000	-	Eisler, 1971	Demersal
Mummichog (adult), Fundulus heteroclitus	S, U	Cadmium chloride	22000	-	Eisler & Hennekey, 1977	Demersal
Mummichog (juvenile), Fundulus heteroclitus	S, U	Cadmium chloride	114000	-	Voyer, 1975	Demersal
Mummichog (juvenile), Fundulus heteroclitus	S, U	Cadmium chloride	92000	-	Voyer, 1975	Demersal
Mummichog (juvenile), Fundulus heteroclitus	S, U	Cadmium chloride	78000	-	Voyer, 1975	Demersal
Mummichog (juvenile), Fundulus heteroclitus	S, U	Cadmium chloride	73000	-	Voyer, 1975	Demersal
Mummichog (juvenile), Fundulus heteroclitus	S, U	Cadmium chloride	63000	-	Voyer, 1975	Demersal

TABLE B-6
CADMIUM ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Mummichog (juvenile), Fundulus heteroclitus	S, U	Cadmium chloride	31000	-	Voyer, 1975	Demersal
Mummichog (juvenile), Fundulus heteroclitus	S, U	Cadmium chloride	30000	-	Voyer, 1975	Demersal
Mummichog (juvenile), Fundulus heteroclitus	S, U	Cadmium chloride	29000	50570	Voyer, 1975	Demersal
Stripped killfish (adult), Fundelus majallis	S, U	Cadmium chloride	21000	21000	Eisler, 1971	Demersal
Atlantic silverside, Menidia menidia	S, U	Cadmium chloride	2032	-	Cardin, 1982	Demersal
Atlantic silverside, Menidia menidia	S, U	Cadmium chloride	28532	-	Cardin, 1982	Demersal
Atlantic silverside, Menidia menidia	S, U	Cadmium chloride	13652	-	Cardin, 1982	Demersal
Atlantic silverside (larvae), Menidia menidia	S, U	Cadmium chloride	1054	-	Cardin, 1982	Demersal
Atlantic silverside (larvae), Menidia menidia	S, U	Cadmium chloride	577	779.8	Cardin, 1982	Demersal
Winter flounder (larvae), Pseudopleuronectes americanus	S, U	Cadmium chloride	602	-	Cardin, 1982	Benthic
Winter flounder (larvae), Pseudopleuronectes americanus	S, U	Cadmium chloride	14297	14297	Cardin, 1982	Benthic

Table taken from USEPA, 1985a.

S = static, R = renewal, FT = flow-through, M = measured, U = unmeasured.

TABLE B-7
OTHER DATA ON EFFECTS OF CADMIUM ON MARINE ORGANISMS

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

SPECIES	CHEMICAL	DURATION	EFFECT	RESULT (ug/l)	REFERENCE	HABITAT GROUP
Natural phytoplankton population	Cadmium chloride	4 days	Reduced biomass	112	Hollibaugh et al., 1980	Nekton/Plankton
Diatom, Asterionella japonica	Cadmium chloride	3 days	72-hr EC50 growth rate	224.8	Fisher & Jones, 1981	Nekton/Plankton
Diatom, Ditylum brightweilli	Cadmium chloride	5 Days	EC50 Growth	60	Centerford & Centerford, 1980	Nekton/Plankton
Diatom, Thalaaaiosira pseudonana	Cadmium chloride	4 days	EC50 Growth rate	160	Gentile & Johnson, 1982	Nekton/Plankton
Diatom, Skeletoma costatum	Cadmium chloride	4 days	EC50 Growth rate	175	Gentile & Johnson, 1982	Nekton/Plankton
Red alga, Champia parvula	Cadmium chloride	-	Reduced tetrasporophyte growth	24.9	Steele & Thursby, 1983	Benthic
Red alga, Champia parvula	Cadmium chloride	-	Reduced tetrasporangia production	>189	Steele & Thursby, 1983	Benthic
Red alga, Champia parvula	Cadmium chloride	-	Reduced female growth	22.8	Steele & Thursby, 1983	Benthic
Red alga, Champia parvula	Cadmium chloride	-	Stopped sexual reproduction	22.8	Steele & Thursby, 1983	Benthic
Hydroid, Campanularia flexuosa	-	-	Enzyme inhibition	40-75	Moore & Stebbling, 1976	Benthic
Hydroid, Campanularia flexuosa	-	11 days	Growth Rate	110-280	Stebbling, 1976	Benthic
Polychaete worm, Neanthes arenaceodentata	Cadmium chloride	28 days	LC50	3000	Relsh et al., 1976	Benthic
Polychaete worm, Capitella capitata	Cadmium chloride	28 days	LC50	630	Relsh et al., 1976	Benthic
Polychaete worm, Capitella capitata	Cadmium chloride	28 days	LC50	700	Relsh et al., 1976	Benthic
Blue mussel Mytilus edulis	Cadmium EDTA	28 days	BCF=252	-	George & Coombs, 1977	Benthic
Blue mussel Mytilus edulis	Cadmium alginate	28 days	BCF=252	-	George & Coombs, 1977	Benthic

TABLE B-7
OTHER DATA ON EFFECTS OF CADMIUM ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Blue mussel Mytilus edulis	Cadmium humate	28 days	BCF=252	-	George & Coambs, 1977	Benthic
Blue mussel Mytilus edulis	Cadmium pectate	28 days	BCF=252	-	George & Coambs, 1977	Benthic
Blue mussel Mytilus edulis	Cadmium chloride	21 days	BCF=710	-	Janssen & Scholz, 1979	Benthic
Bay scallop, Argopecton irradians	Cadmium chloride	42 days	EC50 (growth reduction)	78	Pesch & Stewart, 1980	Benthic
Bay scallop, Argopecton irradians	Cadmium chloride	21 days	BCF=168		Eisler et al., 1972	Benthic
Eastern oyster, Crassostrea virginica	Cadmium iodide	40 days	BCF=677		Kerfoot & Jacobs, 1976	Benthic
Eastern oyster, Crassostrea virginica	Cadmium chloride	21 days	BCF=149		Eisler et al., 1972	Benthic
Eastern oyster, Crassostrea virginica	Cadmium chloride	2 days	Reduction in embryonic development	15	Zarooglan & Morrison, 1981	Benthic
Pacific oyster, Crassostrea gigas	Cadmium chloride	6 days	50% reduction in settlement	20-25	Watling, 1983b	Benthic
Pacific oyster, Crassostrea gigas	Cadmium chloride	14 days	Growth reduction	10	Watling, 1983b	Benthic
Pacific oyster, Crassostrea gigas	Cadmium chloride	23 days	LC50	50	Watling, 1983b	Benthic
Soft-shell clam, Mya arenaria	Cadmium chloride	7 days	LC50	150	Eisler, 1977	Benthic
Soft-shell clam, Mya arenaria	Cadmium chloride	7 days	LC50	700	Eisler & Hennekey, 1977	Benthic
Copepod (naupilus), Eurytemora affinis	Cadmium chloride	1 day	Reduction in swimming speed	130	Sulivan et al., 1983	Nekton/Plankton
Copepod, (naupilus), Eurytemora affinis	Cadmium chloride	2 days	Reduction in development rate	116	Sulivan et al., 1983	Nekton/Plankton
Copepod, Tisbe holothuriae	Cadmium chloride	2 days	LC50	970	Moraitou-Apostolopoulou & Verriopoulos, 1982	Nekton/Plankton
Mysid, Mysidopsis bahia	-	17 days	LC50 (15-23 g/kg salinity)	11	Nimmo et al., 1977a	Demersal

TABLE B-7
OTHER DATA ON EFFECTS OF CADMIUM ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Mysid, Mysidopsis bahia	Cadmium chloride	16 days	LC50 (30 g/kg salinity)	28	Gentile et al., 1982	Demersal
Mysid, Mysidopsis bahia	Cadmium chloride	8 days	LC50	60	Gentile et al., 1982	Demersal
Mysid, Mysidopsis bigelowi	Cadmium chloride	8 days	LC50	70	Gentile et al., 1982	Demersal
Mysid, Mysidopsis bigelowi	Cadmium chloride	28 days	LC50	18	Gentile et al., 1982	Demersal
Isopod, Idotea baltica	Cadmium sulfate	5 days	LC50 (3 g/kg salinity)	10000	Jones, 1975	Benthic
Isopod, Idotea baltica	Cadmium sulfate	3 days	LC50 (21 g/kg salintiy)	10000	Jones, 1975	Benthic
Isopod, Idotea baltica	Cadmium sulfate	1.5 days	LC50 (14 g/kg salintiy)	10000	Jones, 1975	Benthic
Pink shrimp, Penaeus duorarum	Cadmium chloride	30 days	LC50	720	Nimmo et al., 1977b	Demersal
Grass shrimp, Palaemonetes pugio	Cadmium chloride	42 days	LC50	300	Pesch & Stewart, 1980	Demersal
Grass shrimp, Palaemonetes pugio	Cadmium chloride	21 days	LC25 (5 g/kg salinity)	50	Vernberg et al., 1977	Demersal
Grass shrimp, Palaemonetes pugio	Cadmium chloride	21 days	LC10 (10 g/kg salinity)	50	Vernberg et al., 1977	Demersal
Grass shrimp, Palaemonetes pugio	Cadmium chloride	21 days	LC5 (20 g/kg salinity)	50	Vernberg et al., 1977	Demersal
Grass shrimp, Palaemonetes pugio	Cadmium chloride	6 days	LC75 (10 g/kg salintiy)	300	Middaugh & Floyd, 1978	Demersal
Grass shrimp, Palaemonetes pugio	Cadmium chloride	6 days	LC50 (15 g/kg salinity)	300	Middaugh & Floyd, 1978	Demersal
Grass shrimp, Palaemonetes pugio	Cadmium chloride	6 days	LC25 (30 g/kg salinity)	300	Middaugh & Floyd, 1978	Demersal
Grass shrimp, Palaemonetes pugio	Cadmium chloride	21 days	BCF=140	-	Vernberg et al., 1977	Demersal
Grass shrimp, Palaemonetes vulgaris	Cadmium chloride	29 days	LC50	120	Nimmo et al., 1977b	Demersal

TABLE B-7
OTHER DATA ON EFFECTS OF CADMIUM ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

American lobster, Homarus americanus	Cadmium chloride	21 days	BCF=25	-	Eisler et al., 1972	Benthic
American lobster, Homarus americanus	Cadmium chloride	30 days	Increase in ATPase activity	6	Tucker, 1979	Benthic
Hermit crab, Pagurus longicarpus	Cadmium chloride	7 days	25% mortality	270	Eisler & Hennekey, 1977	Benthic
Hermit crab, Pagurus longicarpus	Cadmium chloride	60 days	LC56	70	Pesch & Stewart, 1980	Benthic
Rock crab, Cancer irroratus	Cadmium chloride	4 days	Enzyme activity	1000	Gould et al., 1976	Demersal
Rock crab (larvae), Cancer irroratus	Cadmium chloride	28 days	Delayed development	50	Johns & Miller, 1982	Demersal
Blue crab, Callinectes sapidus	Cadmium chloride	7 days	LC50 (10 g/kg salinity)	50	Rosenberg & Costlow, 1976	Demersal
Blue crab, Callinectes sapidus	Cadmium nitrate	7 days	LC50 (30 g/kg salinity)	150	Rosenberg & Costlow, 1976	Demersal
Blue crab (juvenile), Callinectes sapidus	Cadmium nitrate	4 days	LC50 (1 g/kg salinity)	320	Frank & Robertson, 1979	Demersal
Mud crab (larva), Eurypanopeus depressus	Cadmium chloride	8 days	LC50	10	Mirkes, et al., 1978	Benthic
Mud crab (larva), Eurypanopeus depressus	Cadmium chloride	44 days	Delay in metamorphysis	10	Mirkes, et al., 1978	Benthic
Mud crab, Rhithropanopeus harrisii	Cadmium nitrate	11 days	LC80 (10 g/kg salinity)	50	Rosenberg & Costlow, 1976	Benthic
Mud crab, Rhithropanopeus harrisii	Cadmium nitrate	11 days	LC75 (20 g/kg salinity)	50	Rosenberg & Costlow, 1976	Benthic
Mud crab, Rhithropanopeus harrisii	Cadmium nitrate	11 days	LC40 (30 g/kg salinity)	50	Rosenberg & Costlow, 1976	Benthic
Fiddler crab, Uca puilator	-	10 days	LC50	2900	O'Hara, 1973a	Benthic
Fiddler crab, Uca puilator	Cadmium chloride	-	Effect on respiration	1	Vernburg, et al., 1974	Benthic
Starfish, Asterias forbesi	Cadmium chloride	7 days	25% mortality	270	Eisler & Hennekey, 1977	Benthic

TABLE B-7
OTHER DATA ON EFFECTS OF CADMIUM ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Herring (larvae), Clupea harengus	Cadmium chloride	-	100% embryonic survival	5000	Westernhagen et al., 1979	Nekton
Pacific Herring (embryo), Clupea harengus pallasi	Cadmium chloride	< 1 day	17% reduction in volume	10000	Alderdice et al., 1979a	Nekton
Pacific Herring (embryo), Clupea harengus pallasi	Cadmium chloride	4 days	Decrease in capsule strength	1000	Alderdice et al., 1979b	Nekton
Pacific Herring (embryo), Clupea harengus pallasi	Cadmium chloride	2 days	Reduced osmolality of perivitelline fluid	1000	Alderdice et al., 1979c	Nekton
Mummichog (adult), Fundulus heteroclitus	Cadmium chloride	2 days	LC50 (20 g/kg salinity)	60000	Middaugh & Dean, 1977	Demersal
Mummichog (adult), Fundulus heteroclitus	Cadmium chloride	2 days	LC50 (30 g/kg salinity)	43000	Middaugh & Dean, 1977	Demersal
Mummichog, Fundulus heteroclitus	Cadmium chloride	21 days	BCF=48	-	Eisler, et al., 1972	Demersal
Mummichog (larva), Fundulus heteroclitus	Cadmium chloride	2 days	LC50 (20 g/kg salinity)	32000	Middaugh & Dean, 1977	Demersal
Mummichog (larva), Fundulus heteroclitus	Cadmium chloride	2 days	LC50 (30 g/kg salinity)	7800	Middaugh & Dean, 1977	Demersal
Atlantic silverside, Menidia menidia	Cadmium chloride	2 days	LC50 (20 g/kg salinity)	13000	Middaugh & Dean, 1977	Demersal
Atlantic silverside, Menidia menidia	Cadmium chloride	2 days	LC50 (30 g/kg salinity)	12000	Middaugh & Dean, 1977	Demersal
Atlantic silverside, Menidia menidia	Cadmium chloride	19 days	LC50 (12 g/kg salinity)	160	Voyer et al., 1979	Demersal
Atlantic silverside, Menidia menidia	Cadmium chloride	19 days	LC50 (20 g/kg salinity)	540	Voyer et al., 1979	Demersal
Atlantic silverside, Menidia menidia	Cadmium chloride	19 days	LC50 (30 g/kg salinity)	970	Voyer et al., 1979	Demersal
Atlantic silverside (larvae), Menidia menidia	Cadmium chloride	2 days	LC50 (20 g/kg salinity)	2200	Middaugh & Dean, 1977	Demersal
Atlantic silverside (larvae), Menidia menidia	Cadmium chloride	2 days	LC50 (30 g/kg salinity)	1600	Middaugh & Dean, 1977	Demersal
Stripped bass (juvenile), Morone saxatilis	Cadmium chloride	90 days	Significant decrease in enzyme activity	5	Dawson et al., 1977	Nekton

TABLE B-7
OTHER DATA ON EFFECTS OF CADMIUM ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Stripped bass (juvenile), Morone saxatilis	Cadmium chloride	30 days	Significant decrease in oxygen consumption	0.5-5.0	Dawson et al., 1977	Nekton
Spot (larva), Leiostomus xanthurus	Cadmium chloride	9 days	Incipient LC50	200	Middaugh et al., 1975	Demersal
Cunner (adult), Tautogolabrus adspersus	Cadmium chloride	60 days	37.5% mortality	100	MacInnes et al., 1977	Demersal
Cunner (adult), Tautogolabrus adspersus	Cadmium chloride	30 days	Depresses gill tissue oxygen consumption	50	MacInnes et al., 1977	Demersal
Cunner (adult), Tautogolabrus adspersus	Cadmium chloride	4 days	Decreased enzyme activity	3000	Gould & Karolus, 1974	Demersal
Winter flounder, Pseudopleuronectes americanus	Cadmium chloride	8 days	50% viable hatch	300	Voyer et al., 1977	Benthic
Winter flounder, Pseudopleuronectes americanus	Cadmium chloride	60 days	Increased gill tissue oxygen respiration	5	Calabrese et al., 1975	Benthic
Winter flounder, Pseudopleuronectes americanus	Cadmium chloride	17 days	Reduction of viable hatch	586	Voyer et al., 1982	Benthic
Diatom, Skeletonema costatum	-	-	Decreased growth	10-25	Berland et al., 1977	Nekton/Plankton
Crab, Pontoporeia affinis	-	265 days	Reduced F1 life span	6.5	Sundelin, 1983	Demersal
Mysid shrimp, Mysidopsis spp.	-	23-27 days	Molt inhibition	10	Gentile et al., 1982	Demersal
Mysid shrimp, Mysidopsis spp.	-	23-27 days	No effect	5.1	Gentile et al., 1982	Demersal

Table taken from USEPA, 1985a, and Eisler, 1985.

TABLE B-8
LEAD ACUTE TOXICITY DATA FOR MARINE ORGANISMS

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

SPECIES	METHOD	CHEMICAL	LC50 or EC50 (ug/l)	SPECIES MEAN ACUTE VALUE (ug/l)	REFERENCE	HABITAT GROUP
Amphipod, Ampelisca abdita	R, U	Lead nitrate	547	547	Scott et al. Manuscript	Benthic
Atlantic silverside, Menidia menidia	S, U	Lead nitrate	10000	>10,000	Berry, 1981	Demersal
Copepod, Acarti clausi	S, U	Lead nitrate	668	668	Gentile, 1982	Nekton/Plankton
Dungeness crab, Cancer magister	-	Lead	575	575	Reish & Gerlinger, 1984	Demersal
Inland silverside, Menidia beryllina	FT, M	Lead nitrate	3140	>3,140	Cardin, 1981	Demersal
Mummichog, Fundulus heteroclitus	S, U	Lead nitrate	315	315	Dorfman, 1977	Demersal
Mysid, Mysidopsis bahia	FT, M	Lead nitrate	3130	3130	Lussier, et al. Manuscript	Demersal
Plaice, Pleuronectes platessa	-	Diethyl Pb	75000	-	Maddock and Taylor, 1980	Demersal
Sheepshead minnow, Cyperinodon variegatus	FT, M	Lead nitrate	3140	-	Cardin, 1981	Demersal
Shrimp, Crangon crangon	-	Trimethyl Pb	8800	-	Maddock and Taylor, 1980	Demersal
Alga, Phaeodactylum tricornutum	-	Trimethyl Pb	800	-	Maddock and Taylor, 1980	Nekton/Plankton
Alga, Phaeodactylum tricornutum	-	Pb+2	>5000	-	Maddock and Taylor, 1980	Nekton/Plankton
Alga, Phaeodactylum tricornutum	-	Triethyl Pb	100	-	Maddock and Taylor, 1980	Nekton/Plankton
Alga, Phaeodactylum tricornutum	-	Tetraethyl Pb	100	-	Maddock and Taylor, 1980	Nekton/Plankton
Alga, Phaeodactylum tricornutum	-	Tetramethyl Pb	1300	-	Maddock and Taylor, 1980	Nekton/Plankton

TABLE 8-8
LEAD ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Amphipod, Amplisca abdita	-	Lead	547	-	EPA, 1985	Benthic
Dungeness crab, Cancer magister	S, U	Lead nitrate	575	-	Martin et al., 1981	Demersal
Mummichog, Fundulus heteroclitus	-	Lead	315	-	EPA, 1985	Demersal
Plaice, Pleuronectes platessa	-	Tetraethyl Pb	230	-	Maddock and Taylor, 1980	Demersal
Plaice, Pleuronectes platessa	-	Tetramethyl Pb	50	-	Maddock and Taylor, 1980	Demersal
Plaice, Pleuronectes platessa	-	Triethyl Pb	1700	-	Maddock and Taylor, 1980	Demersal
Plaice, Pleuronectes platessa	-	PB+2	180000	-	Maddock and Taylor, 1980	Demersal
Plaice, Pleuronectes platessa	-	Dimethyl Pb	300000	-	Maddock and Taylor, 1980	Demersal
Plaice, Pleuronectes platessa	-	Trimethyl Pb	24600	-	Maddock and Taylor, 1980	Demersal
Shrimp, Crangon crangon	-	Tetramethyl Pb	110	-	Maddock and Taylor, 1980	Demersal
Shrimp, Crangon crangon	-	Tetraethyl Pb	20	-	Maddock and Taylor, 1980	Demersal
Shrimp, Crangon crangon	-	Triethyl Pb	5800	-	Maddock and Taylor, 1980	Demersal
Shrimp, Crangon crangon	-	Pb+2	375000	-	Maddock and Taylor, 1980	Demersal
Blue mussel, Mytilus edulis	-	Pb+2	>500000	-	Maddock and Taylor, 1980	Benthic
Blue mussel, Mytilus edulis	-	Tetraethyl Pb	100	-	Maddock and Taylor, 1980	Benthic
Blue mussel, Mytilus edulis	40 days	Lead chloride	30000	-	Talbot et al., 1976	Benthic
Blue mussel, Mytilus edulis	-	Tetramethyl Pb	270	-	Maddock and Taylor, 1980	Benthic

TABLE 8-8
LEAD ACUTE TOXICITY DATA FOR MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Blue mussel, Mytilus edulis	150 days	Lead nitrate	500	-	Schultz-Baldes, 1972	Benthic
Blue mussel, Mytilus edulis	-	Triethyl Pb	1100	-	Maddock and Taylor, 1980	Benthic
Blue mussel, Mytilus edulis	-	Trimethyl Pb	500	-	Maddock and Taylor, 1980	Benthic
Blue mussel, Mytilus edulis	S, U	Lead nitrate	476	-	Martin et al., 1981	Benthic
Blue mussel (larva), Mytilus edulis	-	Pb+2	476	-	EPA, 1985	Benthic
Eastern oyster, Crassostrea viginica	S, U	Lead nitrate	2450	-	Calabrese et al., 1973	Benthic
Pacific oyster, Crassostrea gigas	S, U	Lead nitrate	758	-	Martin et al., 1981	Benthic
Polychaete worm, Ophryotrocha diadema	4 days	Lead acetate	14100	-	Reish et al., 1976	Benthic
Polychaete worm, Ophryotrocha diadema	2 days	Lead acetate	100000	-	Parker, 1984	Benthic
Polychaete worm, Capitella capitata	4 days	Lead acetate	1200	-	Reish et al., 1976	Benthic
Quahog clam (larva), Mercenaria mercenaria	S, U	Lead nitrate	780	-	Calabrese & Nelson, 1974	Benthic
Sandworm, Neanthes arenaceodentata	-	Lead	7700	-	Reish & Gerlinger, 1984	Benthic
Sandworm, Neanthes arenaceodentata	-	Lead	10700	-	Reish & Gerlinger, 1984	Benthic
Soft-shell clam, Mya arenaria	S, U	Lead nitrate	27000	-	Eisler, 1977	Benthic
Soft-shell clam, Mya arenaria	7 days	Lead nitrate	8800	-	Eisler, 1977	Benthic

Table taken from USEPA, 1980, and Eisler, 1988.

S = static, R = renewal, FT = flow through, M = measured, U = unmeasured.

TABLE B-9
OTHER DATA ON EFFECTS OF LEAD ON MARINE ORGANISMS

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

SPECIES	CHEMICAL	DURATION	EFFECT	RESULT (ug/l)	REFERENCE	HABITAT GROUP
Alga, Dunaliella salina	Lead	-	65% growth reduction	900	Pace et al., 1977	Nekton/Plankton
Alga, Dundaliella tertiolecta	Tetramethyl lead	4 days	EC50	1650	Marchetti, 1978	Nekton/Plankton
Alga, Dundaliella tertiolecta	Tetraethyl lead	4 days	EC50	150	Marchetti, 1978	Nekton/Plankton
Alga, Chorella stigmatophora	Lead	21 days	50% growth inhibition	700	Christensen, et al., 1979	Nekton/Plankton
Alga, Champia parvula	Lead	-	Reduced tetrasporophyte growth	23.3	Steele & Thursby, 1983	Nekton/Plankton
Diatom, Phaeodactylum tricornutum	Lead	3 days	No growth inhibition	1000	Hannan & Patoulliet, 1972	Nekton/Plankton
Diatom, Asterionella japonica	Lead	-	EC50	207	Fisher & Jones, 1981	Nekton/Plankton
Diatom, Ditylum brightwelli	Lead	-	EC50	40	Centerford & Centerford, 1980	Nekton/Plankton
Diatom, Phaeodactylium tricornutum	Lead	1 day	Completely inhibited photosynthis	10000	Woolery & Lewin, 1976	Nekton/Plankton
Diatom, Skeletonema costatum	Lead	12 days	EC50 (growth rate)	3.7	Rivkin, 1979	Nekton/Plankton
Diatom, Phaeodactylum tricornutum	Lead	2-3 days	Reduced photosynthesis and respiration	100	Woolery & Lewin, 1976	Nekton/Plankton
Natural phytoplankton populations	Lead	4 days	Reduced biomass	21	Hollibaugh, et al., 1980	Nekton/Plankton
Natural phytoplankton populations	Lead	5 days	Reduced chlrophyll a	207	Hollibaugh, et al., 1980	Nekton/Plankton
Phytoplankton, Platymonas subcordiformes	Lead	3 days	Retarded population growth	2500	Hessler, 1974	Nekton/Plankton
Eastern oyster Crassostera virginica	Lead	1 yr	BCF = 326	-	Kopfler & Mayer, 1973	Benthic

TABLE B-9
OTHER DATA ON EFFECTS OF LEAD ON MARINE ORGANISMS
(continued)

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

Polychaete worm, Ophryotrocha diadema	Lead	21 days	Suppressed reproduction	1000	Relsh & Carr, 1978	Benthic
Polychaete worm, Ctenodrilus serratus	Lead	21 days	Suppressed reproduction	1000	Relsh & Carr, 1978	Benthic
American lobster Homarus americanus	Lead	30 days	Reduced enzyme activity	50	Gould & Greig, 1983	Benthic
Mud crab, Rhithropanopeus harrisii	Lead	-	Delayed larval development	50	Benijts-Claus & Benijts, 1975	Benthic
Mummichog (embyro), Fundulus heterociltus	Lead	-	Depressed axis formation	100	Weis & Weis, 1977	Planktonic
Mummichog (embyro), Fundulus heterociltus	Lead	-	Retarded hatching	10000	Weis & Weis, 1982	Planktonic

Table taken from USEPA, 1980.

TABLE B-10

COPPER MATC ESTIMATES FOR ORGANISMS AT NEW BEDFORD HARBOR

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

TAXON	SLOPE	INTERCEPT	MATC	TOTAL VARIANCE
Marine Fish	1.02	0.75	2.517	1.319
Crustacea	0.8	0.43	1.816	2.708
Mollusca	0.98	-0.6	1.223	0.420
Polychaeta	1.0	-0.88	1.480	0.210
Alga			1.081	0.069

Notes:

(1) The basic regression equation that defines the extrapolation is Y = Intercept + (X * Slope), where X is the acute toxicological estimate and Y the extrapolated MATC value.

(2) No extrapolation was done for the alga, rather chronic data were used to estimate the benchmark value for the taxon.

(3) All units expressed as Log (base 10) ug/l.

TABLE B-11
CADMIUM MATC ESTIMATES FOR ORGANISMS AT NEW BEDFORD HARBOR

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

TAXON	SLOPE	INTERCEPT	MATC	TOTAL VARIANCE
Marine Fish	1.02	0.75	1.505	0.698
Crustacea	0.8	0.43	1.022	1.824
Mollusca	0.98	-0.6	2.757	0.424
Polychaeta	1.0	-0.88	3.106	0.212
Alga			1.997	0.115

Notes:

(1) The basic regression equation that defines the extrapolation is Y = Intercept + (X * Slope), where X is the acute toxicological estimate and Y the extrapolated MATC value.

(2) No extrapolation was done for the alga, rather chronic data were used to estimate the benchmark value for the taxon.

(3) All units expressed as Log (base 10) ug/l.

TABLE B-12
LEAD MATC ESTIMATES FOR ORGANISMS AT NEW BEDFORD HARBOR

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

TAXON	SLOPE	INTERCEPT	MATC	TOTAL VARIANCE
Marine Fish	1.02	0.75	2.176	1.028
Crustacea	0.8	0.43	1.548	2.317
Mollusca	0.98	-0.6	2.433	0.421
Polychaeta	1.0	-0.88	3.149	0.210
Alga			2.370	0.909

Notes:

(1) The basic regression equation that defines the extrapolation is Y = Intercept + (X * Slope), where X is the acute toxicological estimate and Y the extrapolated MATC value.

(2) No extrapolation was done for the alga, rather chronic data were used to estimate the benchmark value for the taxon.

(3) All units expressed as Log (base 10) ug/l.

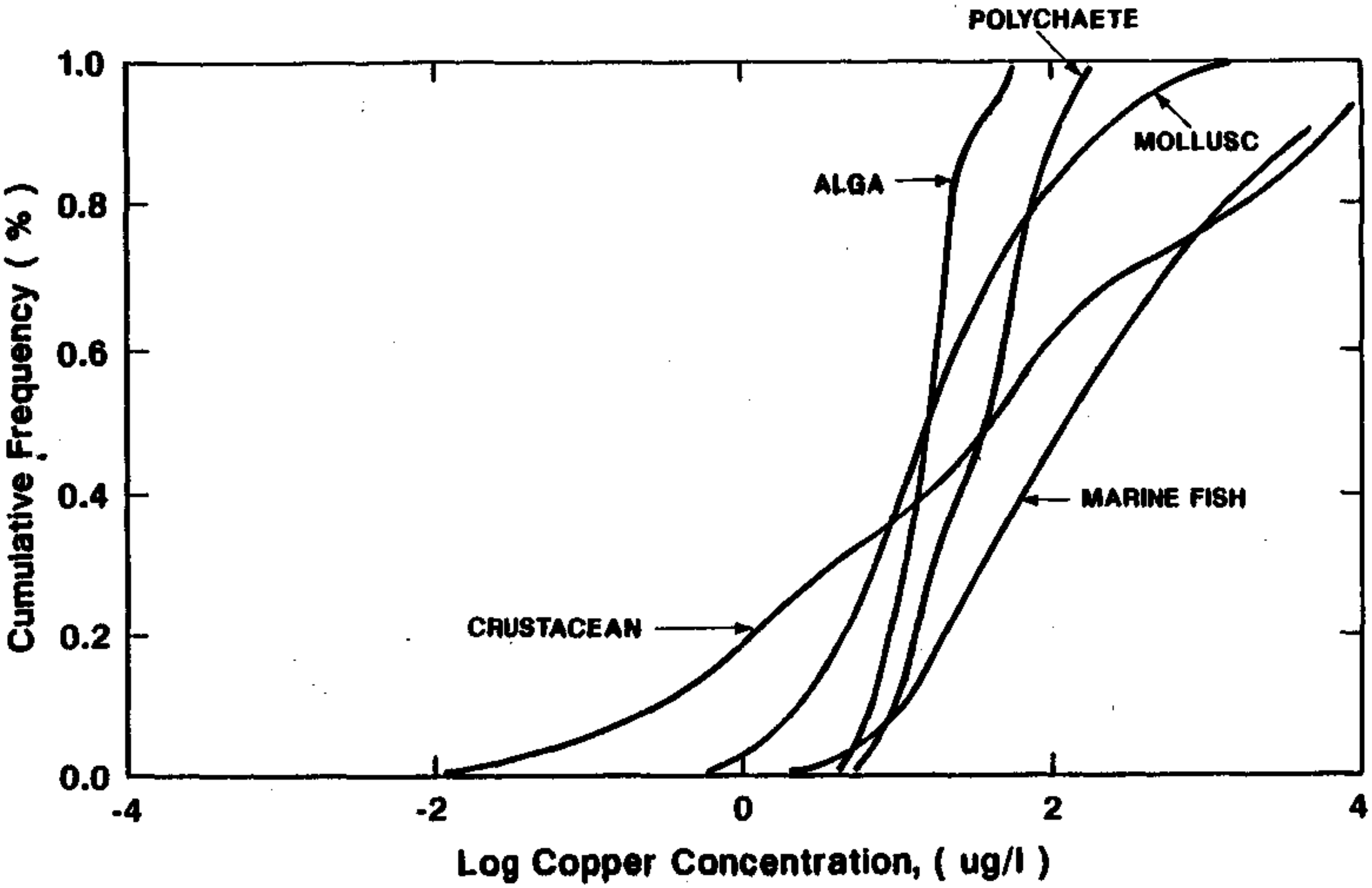


FIGURE B-1
MATC CURVES FOR COPPER
NEW BEDFORD, MASSACHUSETTS

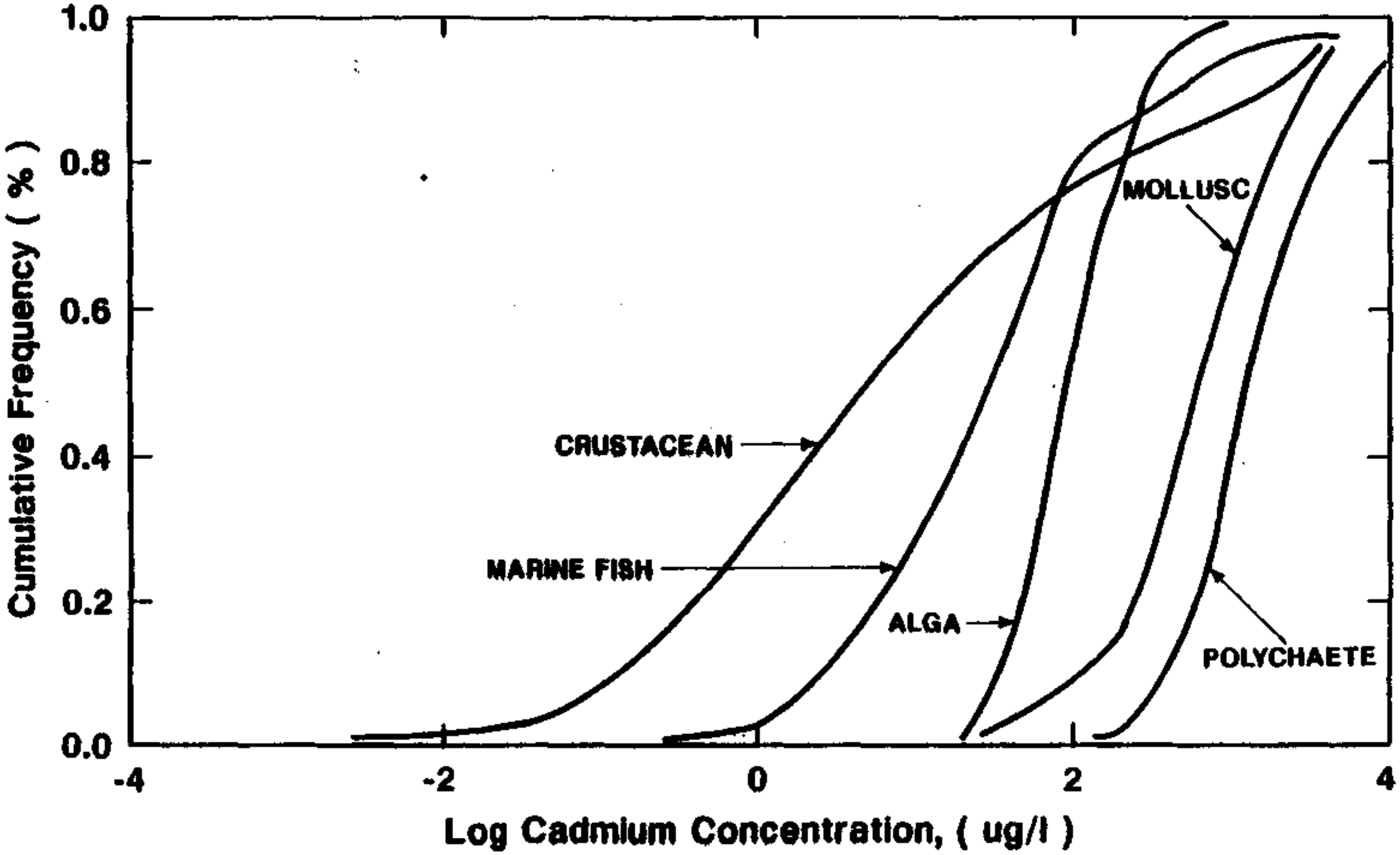


FIGURE B-2
MATC CURVES FOR CADMIUM
NEW BEDFORD, MASSACHUSETTS

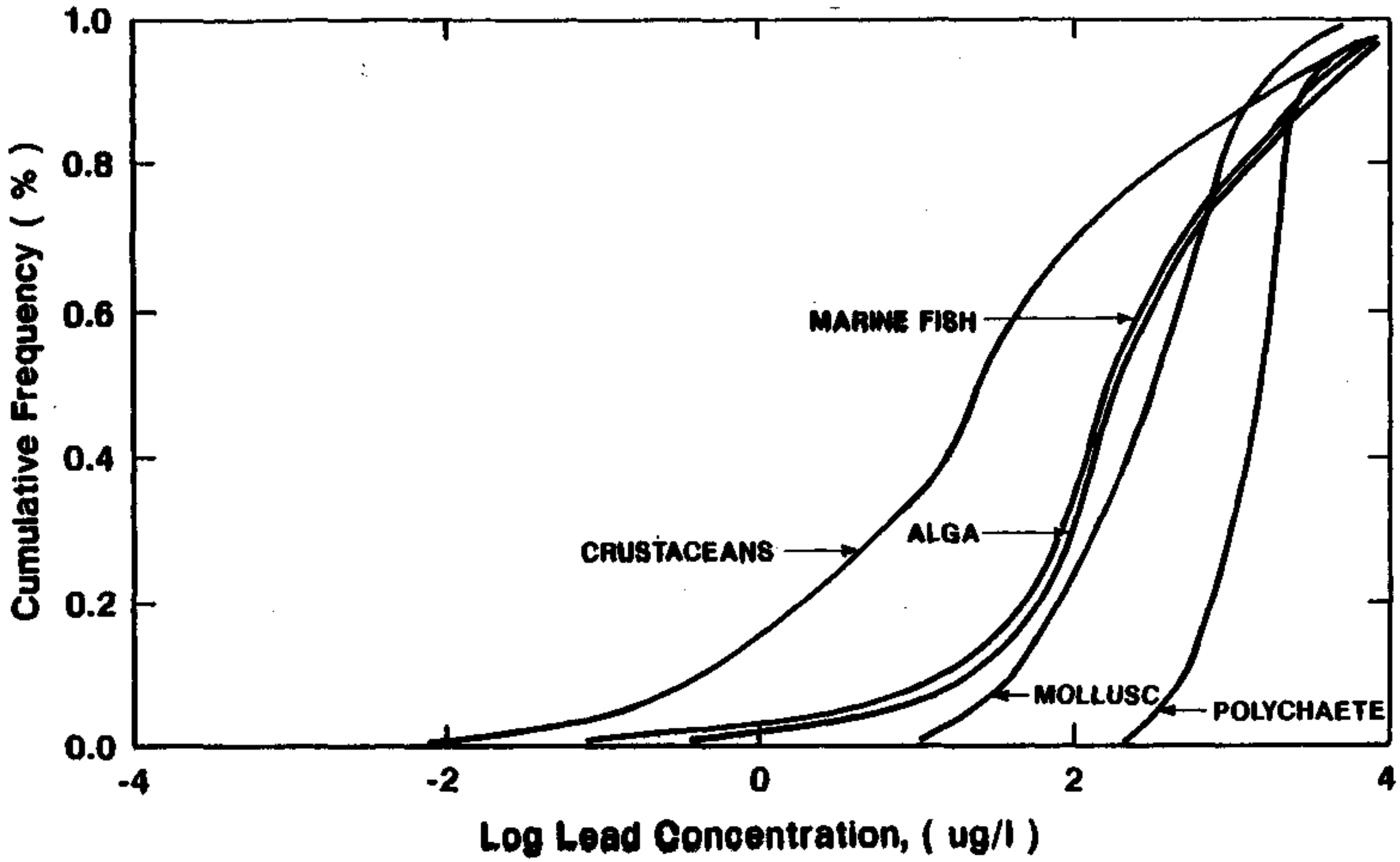


FIGURE B-3
MATC CURVES FOR LEAD
NEW BEDFORD, MASSACHUSETTS

APPENDIX C

MATCs, EECs, and CHRONIC EFFECTS PROBABILITIES

FOR

COPPER, CADMIUM, AND LEAD

TABLE C-1
CUMULATIVE PROBABILITY THAT THE EXPECTED EXPOSURE CONCENTRATION WILL EXCEED THE COPPER MATC FOR THE PARTICULAR TAXON.

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

HARBOR ZONE	MARINE FISH	CRUSTACEA	MOLLUSCA	POLYCHAETA	ALGA
1, Water Column	0.03	0.19	0.09	0.01	0.00
2, Water Column	0.04	0.22	0.15	0.02	0.03
3, Water Column	0.04	0.22	0.15	0.02	0.03
4, Water Column	0.03	0.19	0.10	0.01	0.02
5, Water Column	0.01	0.12	0.03	0.00	0.00
1, Pore Water	0.02	0.11	0.05	0.02	0.04
2, Pore Water	0.01	0.08	0.04	0.02	0.03
3, Pore Water	0.02	0.11	0.05	0.02	0.04
4, Pore Water	0.01	0.08	0.02	0.00	0.01
5, Pore Water	0.00	0.04	0.00	0.00	0.00

Notes:

Probabilities calculated as the area under a normally-distributed curve defined by a particular Z score, where Z = (Mean EEC - BM) / (Var EEC + Var BM)^2. Equation presented by Suter et al., 1986.

EEC = Expected Environmental Concentration

BM = Bench Mark, which in this application are the MATCs developed by extrapolation, in the case of Marine Fish, Crustaceans, Mollusks, and Polychaetes. For Alga, the bench mark was based on available chronic toxicity data.

TABLE C-2
CUMULATIVE PROBABILITY THAT THE EXPECTED EXPOSURE CONCENTRATION WILL EXCEED THE CADMIUM MATC FOR THE PARTICULAR TAXON.

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

HARBOR ZONE	MARINE FISH	CRUSTACEA	MOLLUSCA	POLYCHAETA	ALGA
1, Water Column	0.01	0.11	0.00	0.00	0.00
2, Water Column	0.01	0.14	0.00	0.00	0.00
3, Water Column	0.00	0.10	0.00	0.00	0.00
4, Water Column	0.00	0.08	0.00	0.00	0.00
5, Water Column	0.00	0.05	0.00	0.00	0.00
1, Pore Water	0.01	0.12	0.00	0.00	0.00
2, Pore Water	0.03	0.13	0.00	0.00	0.00
3, Pore Water	0.01	0.09	0.00	0.00	0.00
4, Pore Water	0.00	0.06	0.00	0.00	0.00
5, Pore Water	0.00	0.03	0.00	0.00	0.00

Notes:

Probabilities calculated as the area under a normally-distributed curve defined by a particular Z score, where Z = (Mean EEC - BM) / (Var EEC + Var BM)^2. Equation presented by Suter et al., 1986.

EEC = Expected Environmental Concentration

BM = Bench Mark, which in this application are the MATCs developed by extrapolation, in the case of Marine Fish, Crustaceans, Mollusks, and Polychaetes. For Alga, the bench mark was based on available chronic toxicity data.

TABLE C-3
CUMULATIVE PROBABILITY THAT THE EXPECTED EXPOSURE CONCENTRATION WILL EXCEED THE LEAD MATC FOR THE PARTICULAR TAXON.

NEW BEDFORD HARBOR
ECOLOGICAL RISK ASSESSMENT

HARBOR ZONE	MARINE FISH	CRUSTACEA	MOLLUSCA	POLYCHAETA	ALGA
1, Water Column	0.03	0.18	0.00	0.00	0.01
2, Water Column	0.02	0.17	0.00	0.00	0.01
3, Water Column	0.02	0.13	0.00	0.00	0.01
4, Water Column	0.01	0.08	0.00	0.00	0.00
5, Water Column	0.01	0.06	0.00	0.00	0.00
1, Pore Water	0.04	0.18	0.01	0.00	0.03
2, Pore Water	0.03	0.13	0.01	0.00	0.02
3, Pore Water	0.02	0.14	0.00	0.00	0.01
4, Pore Water	0.00	0.06	0.00	0.00	0.00
5, Pore Water	0.01	0.10	0.00	0.00	0.01

Notes:

Probabilities calculated as the area under a normally-distributed curve defined by a particular Z score, where Z = (Mean EEC - BM) / (Var EEC + Var BM)^2. Equation presented by Suter et al., 1986.

EEC = Expected Environmental Concentration

BM = Bench Mark, which in this application are the MATCs developed by extrapolation, in the case of Marine Fish, Crustaceans, Mollusks, and Polychaetes. For Alga, the bench mark was based on available chronic toxicity data.

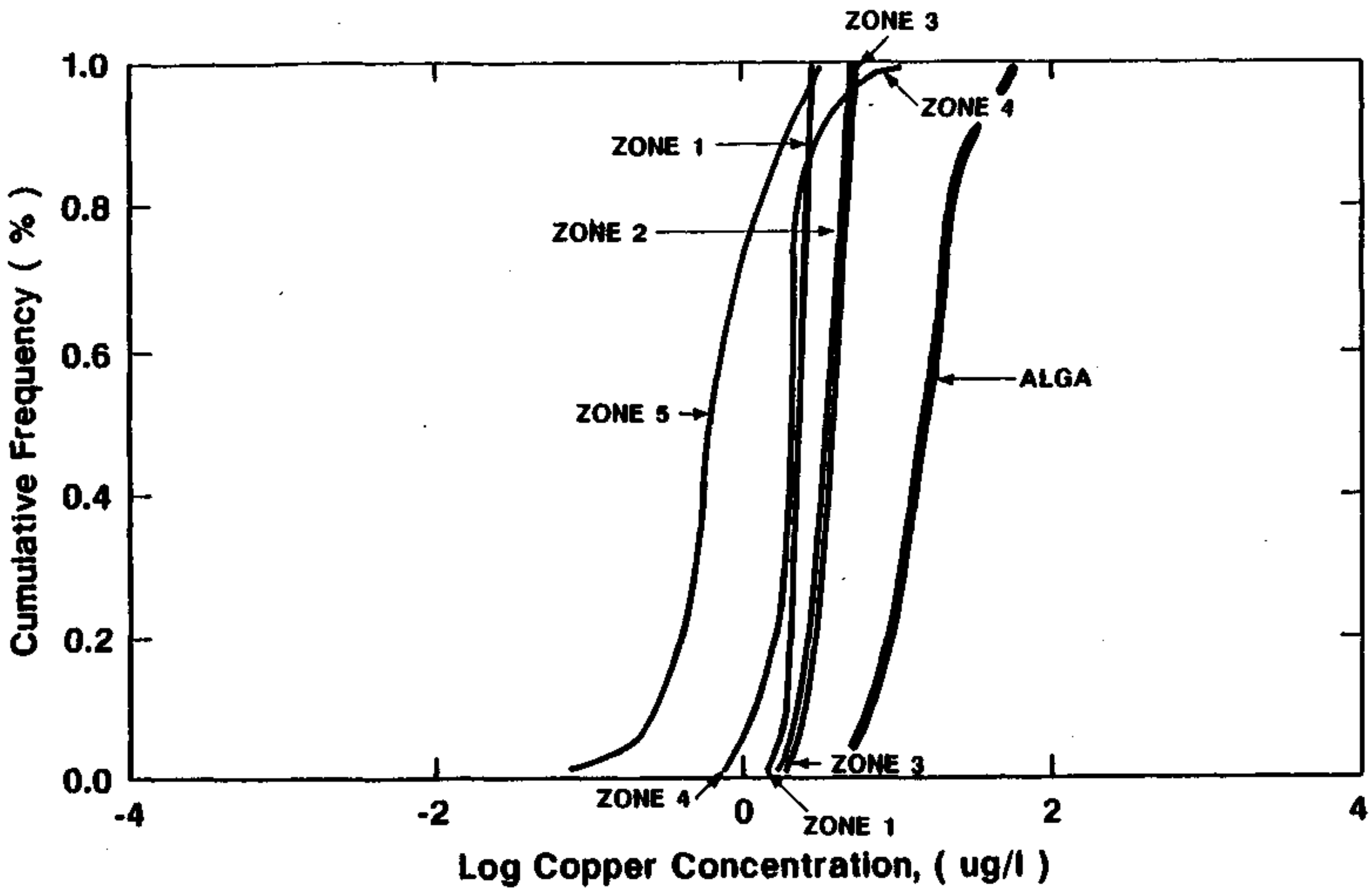


FIGURE C-1
MATC FOR ALGA AND
EECs FOR ALL ZONES, COPPER, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

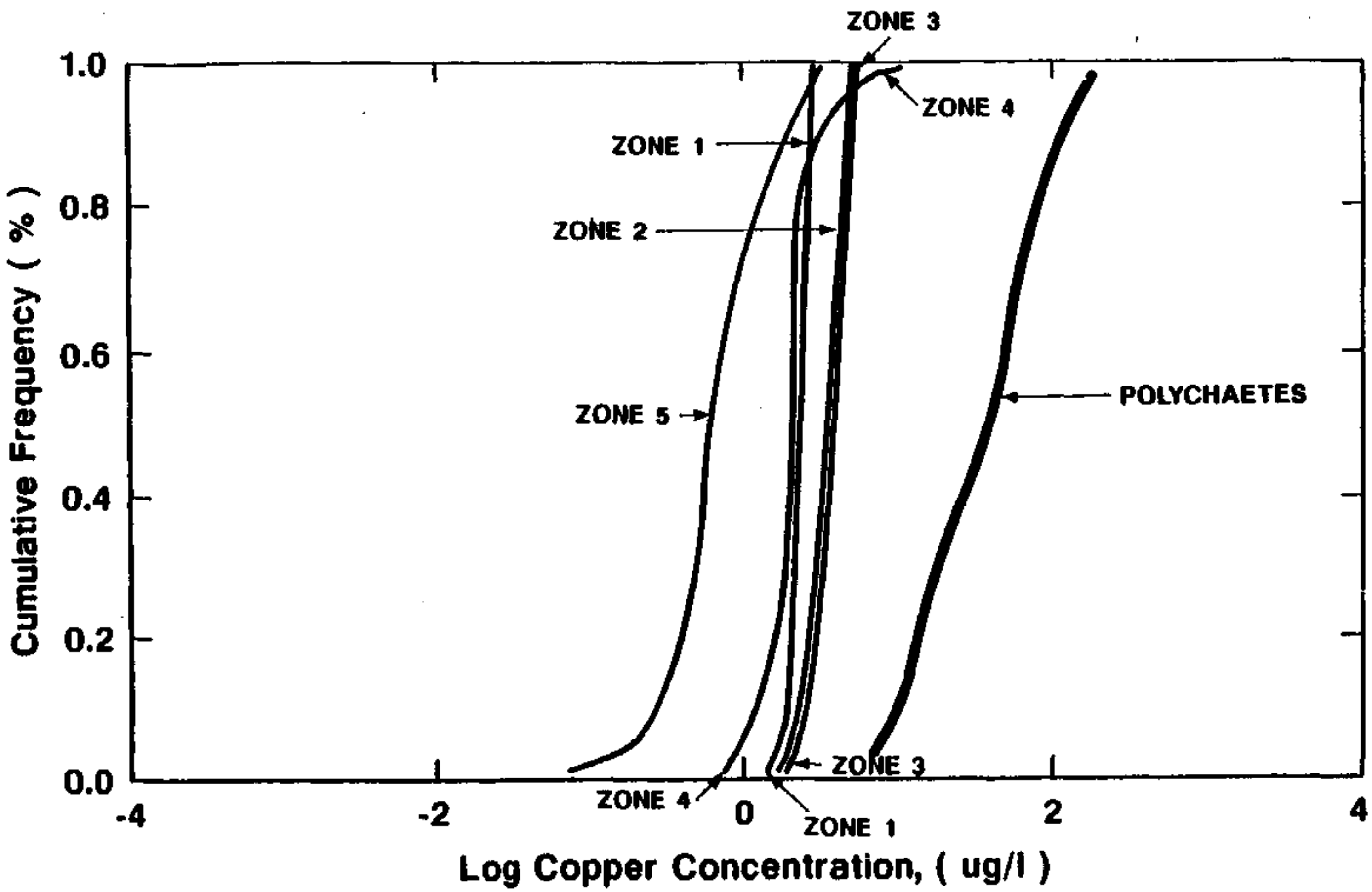


FIGURE C-2
MATC FOR POLYCHAETES AND
EECs FOR ALL ZONES, COPPER, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

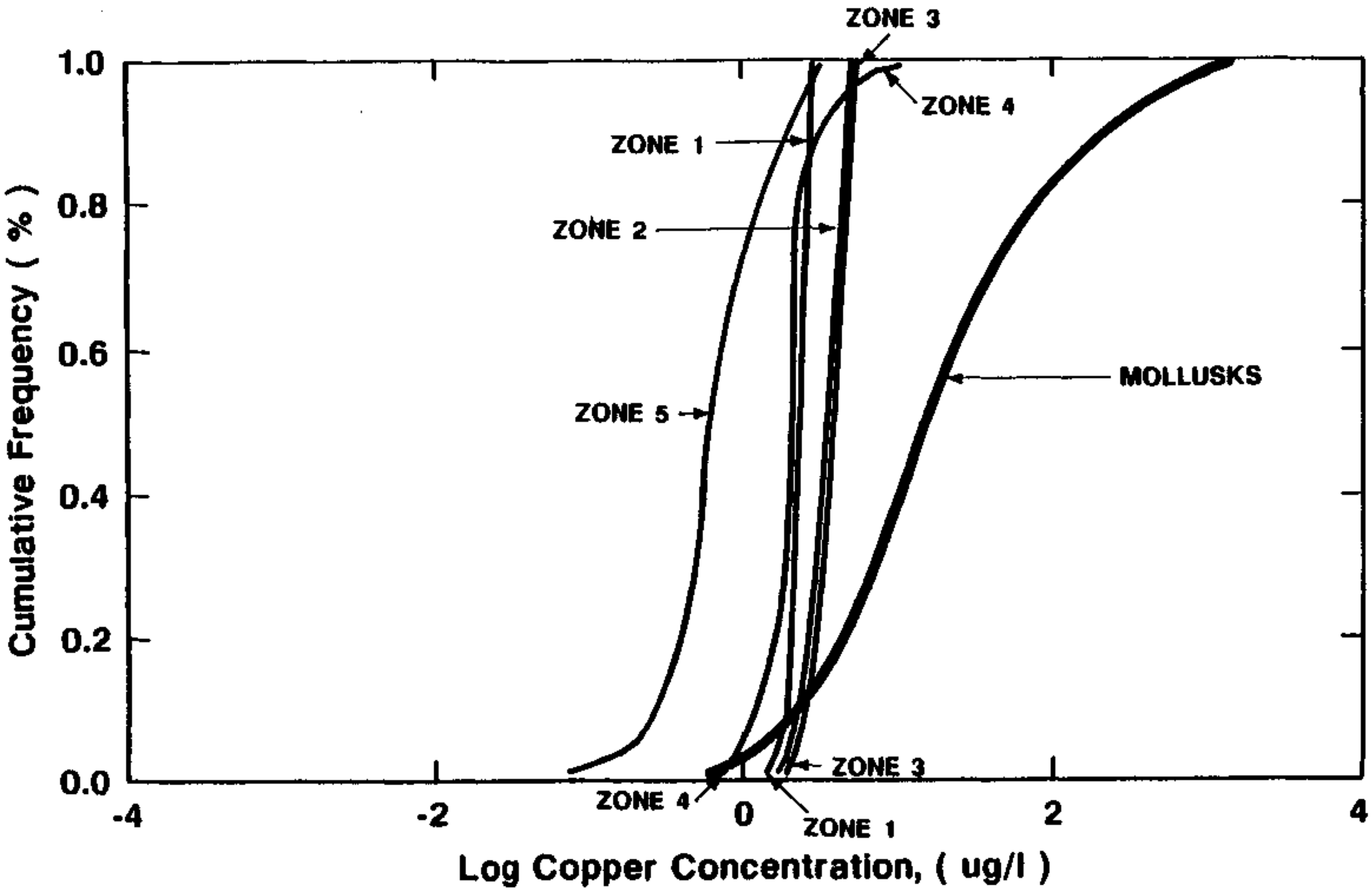


FIGURE C-3
MATC FOR MOLLUSKS AND
EECs FOR ALL ZONES, COPPER, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

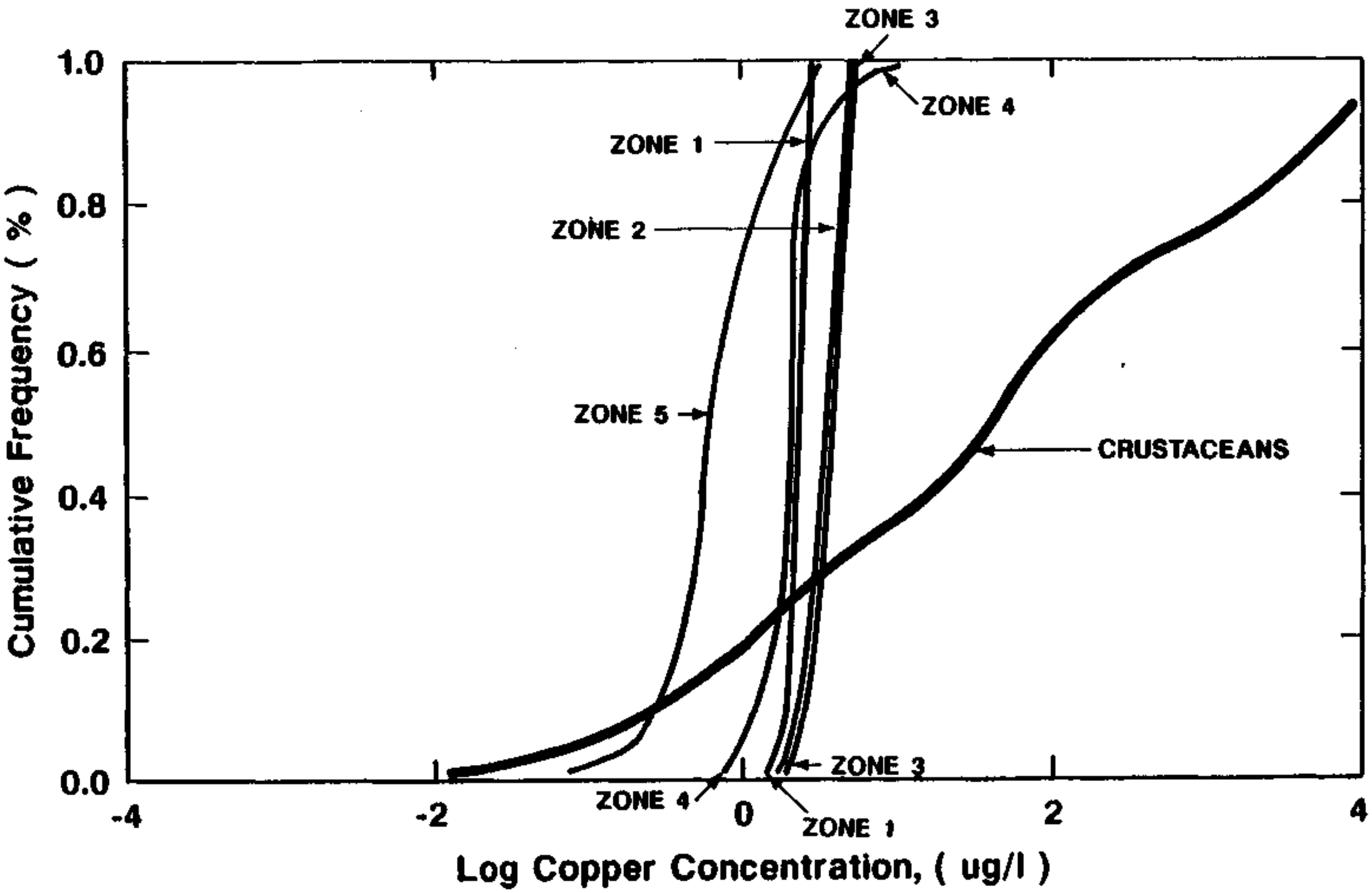


FIGURE C-4
MATC FOR CRUSTACEANS AND
EECs FOR ALL ZONES, COPPER, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

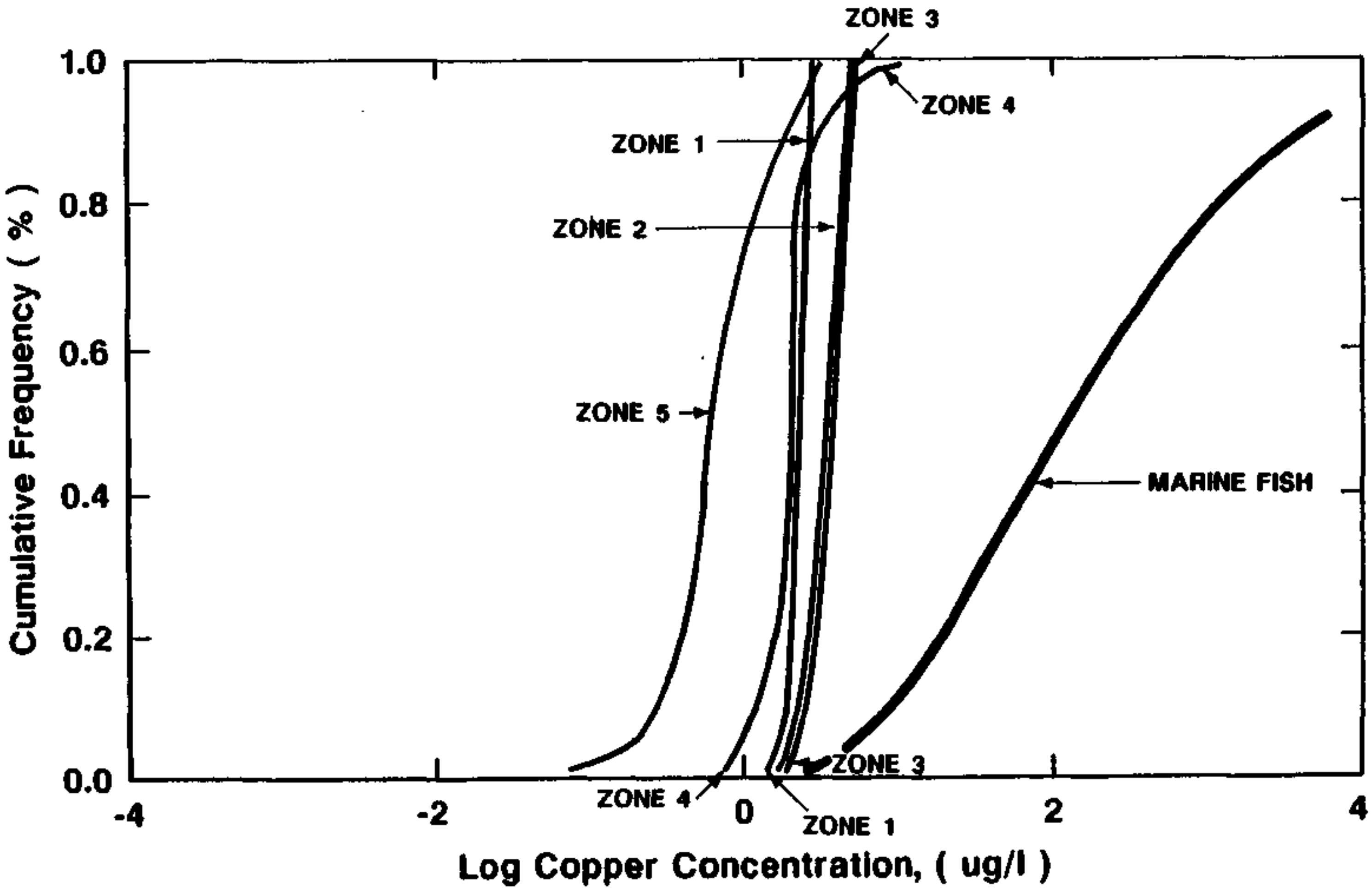


FIGURE C-5
MATC FOR MARINE FISH AND
EECs FOR ALL ZONES, COPPER, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

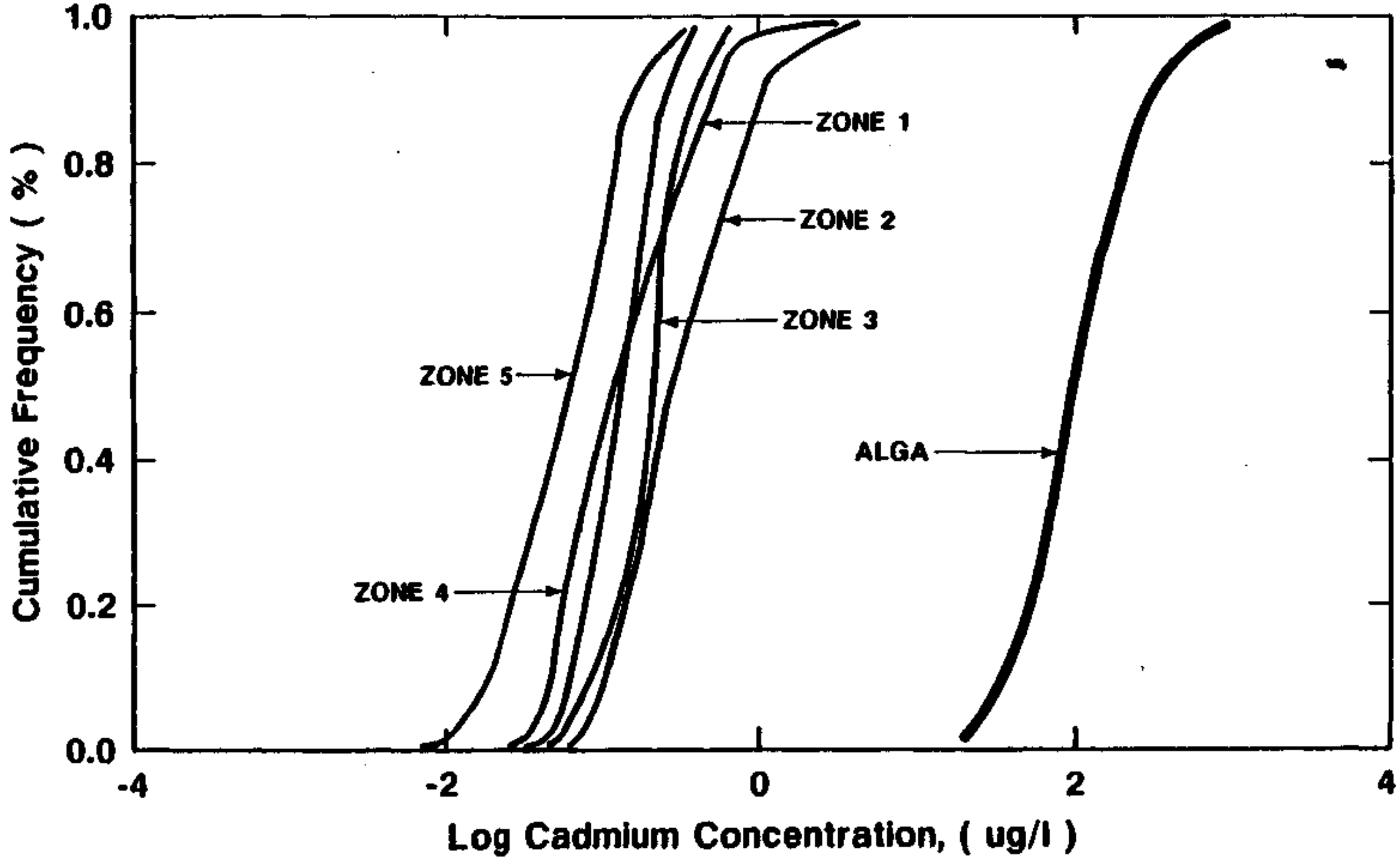


FIGURE C-6
MATC FOR ALGA AND
EECs FOR ALL ZONES, CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

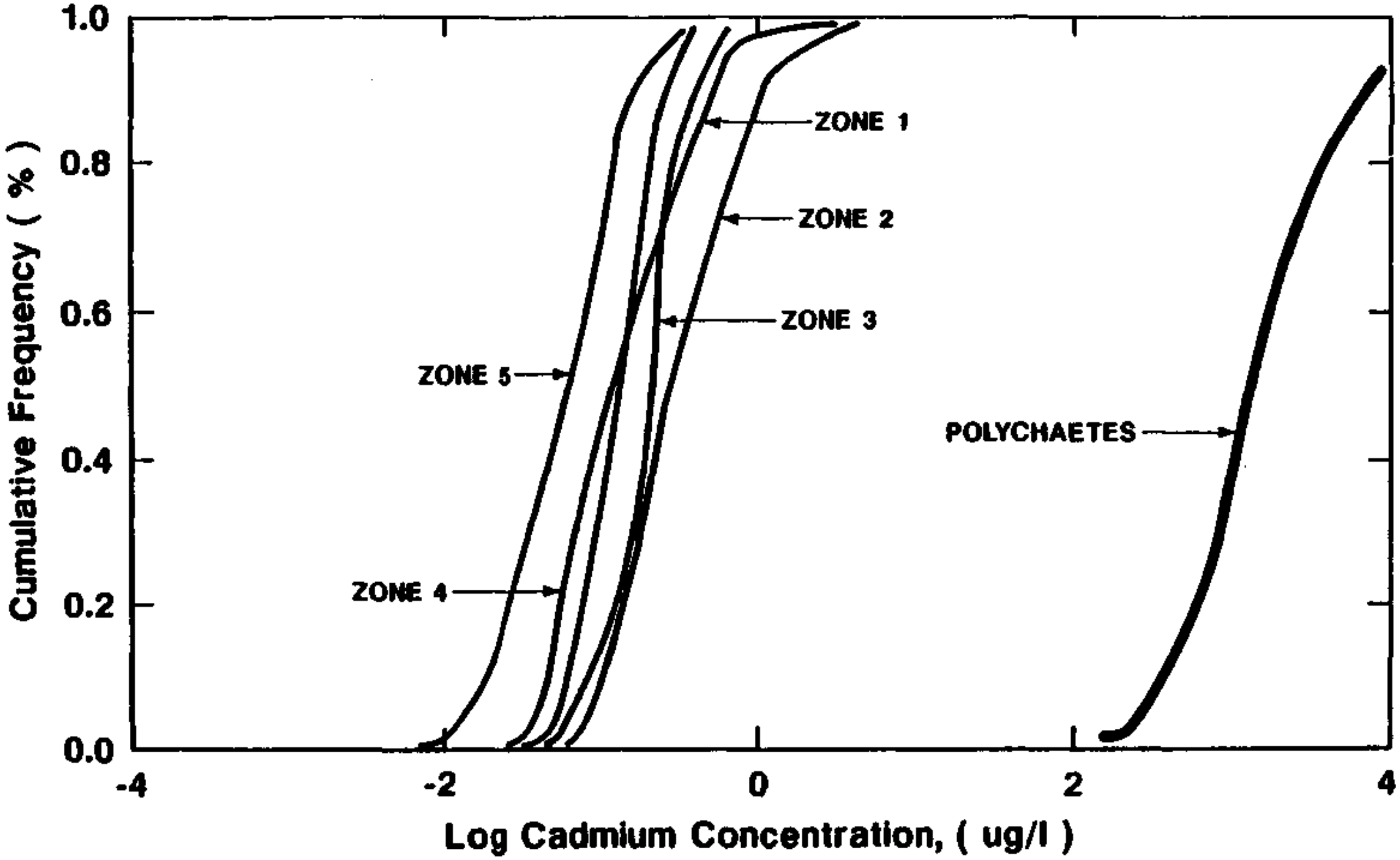


FIGURE C-7
MATC FOR POLYCHAETES AND
EECs FOR ALL ZONES, CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

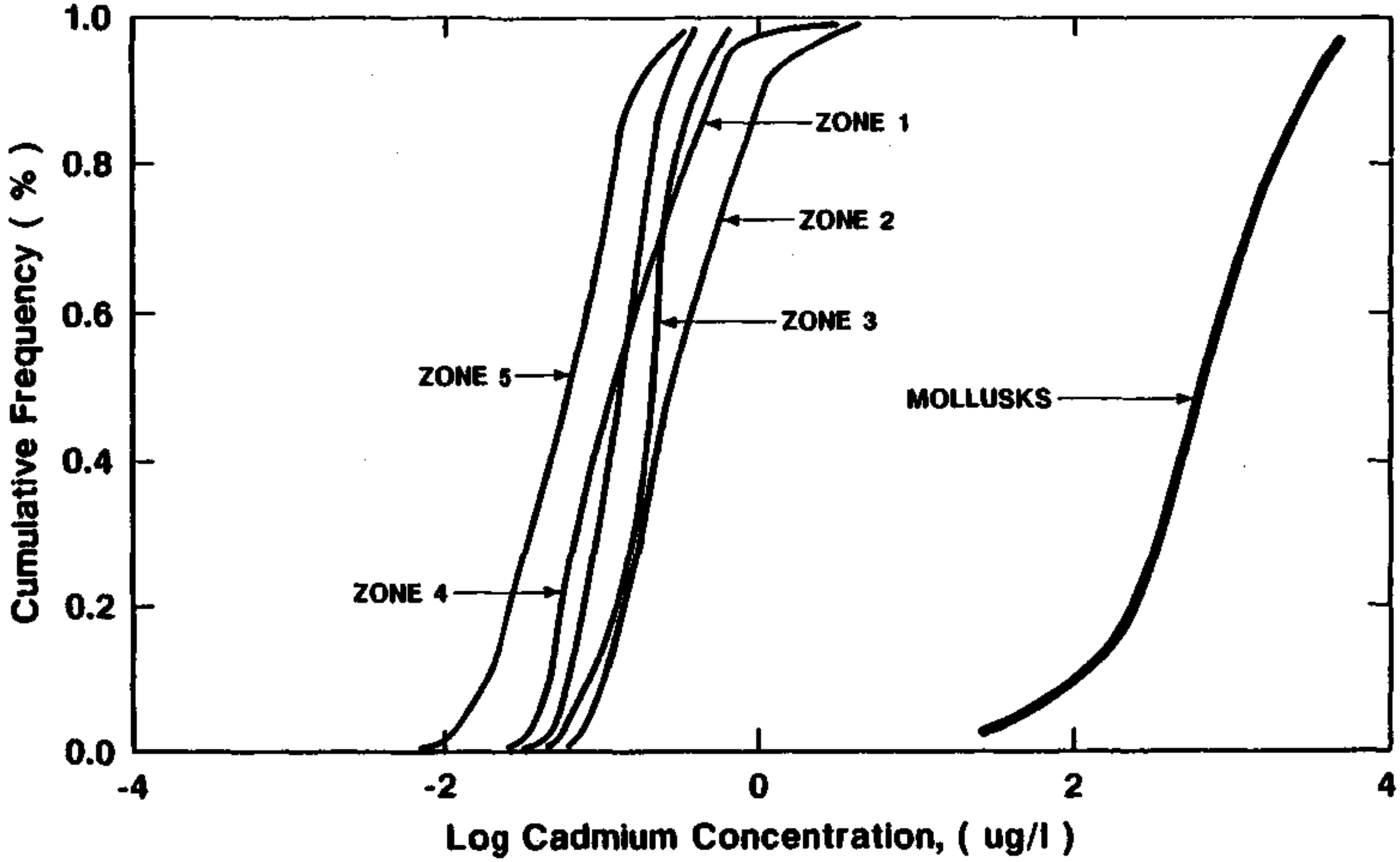


FIGURE C-8
MATC FOR MOLLUSKS AND
EECs FOR ALL ZONES, CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

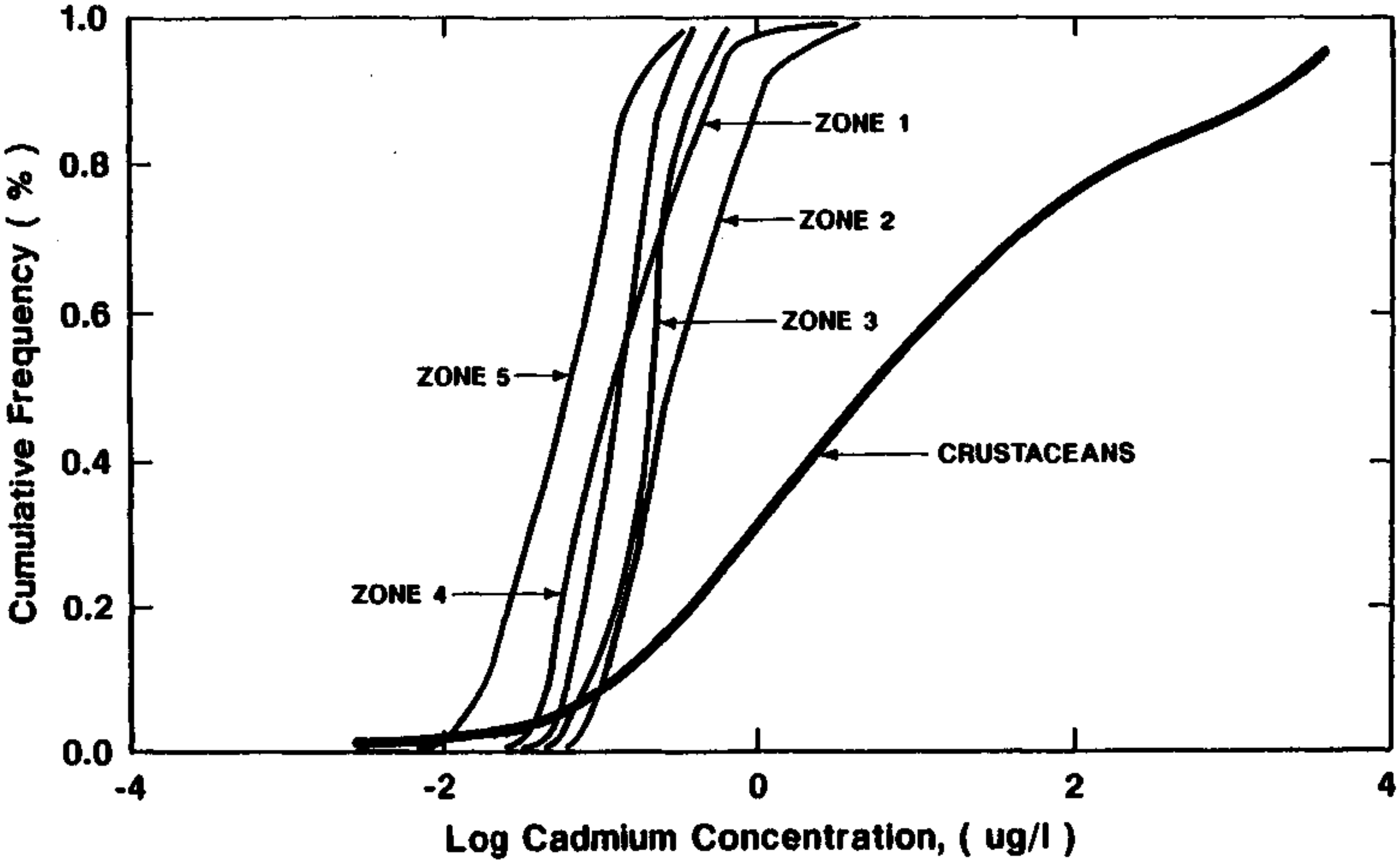


FIGURE C-9
MATC FOR CRUSTACEANS AND
EECs FOR ALL ZONES, CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

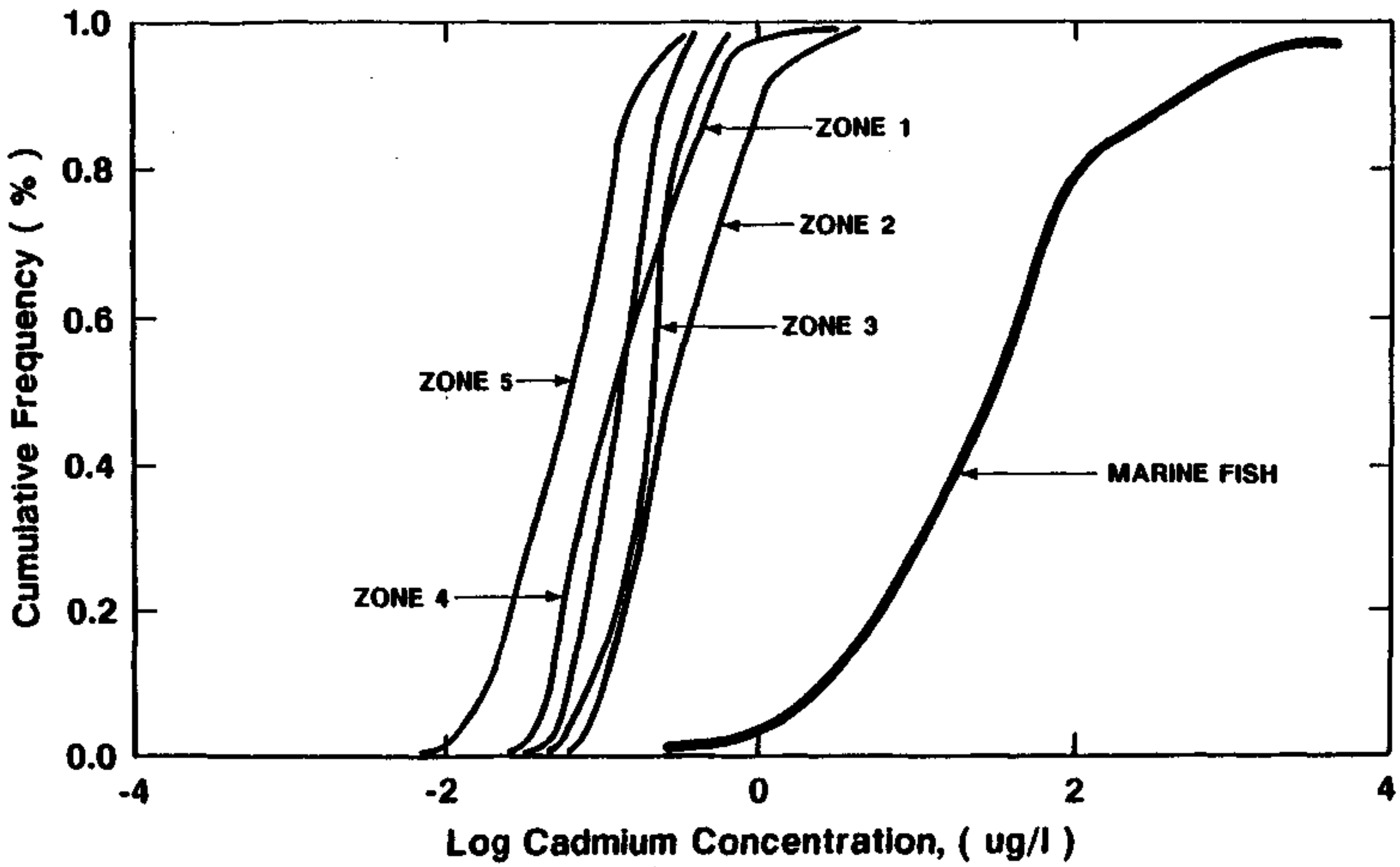


FIGURE C-10
MATC FOR MARINE FISH AND
EECs FOR ALL ZONES, CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

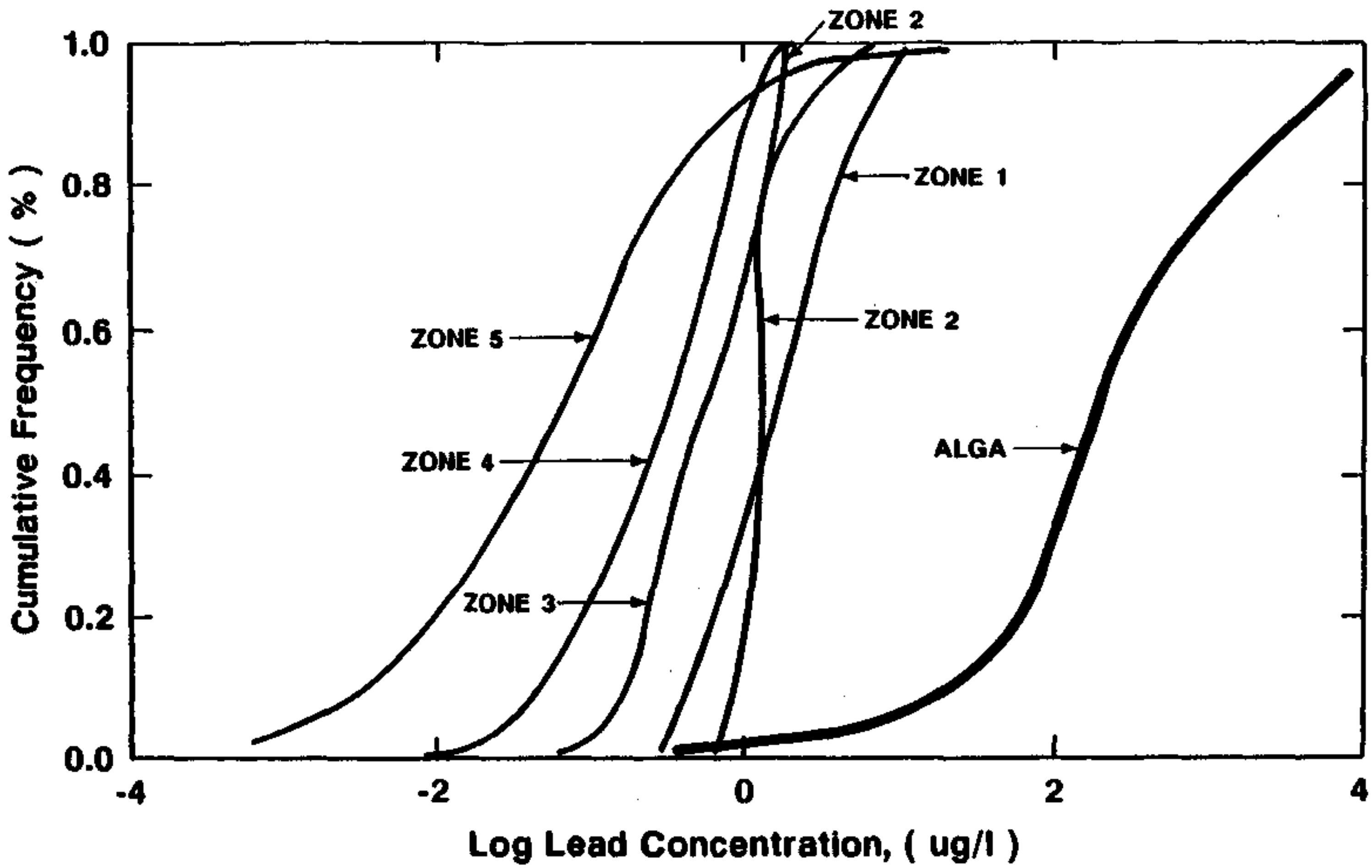


FIGURE C-11
MATC FOR ALGA AND
EECs FOR ALL ZONES, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

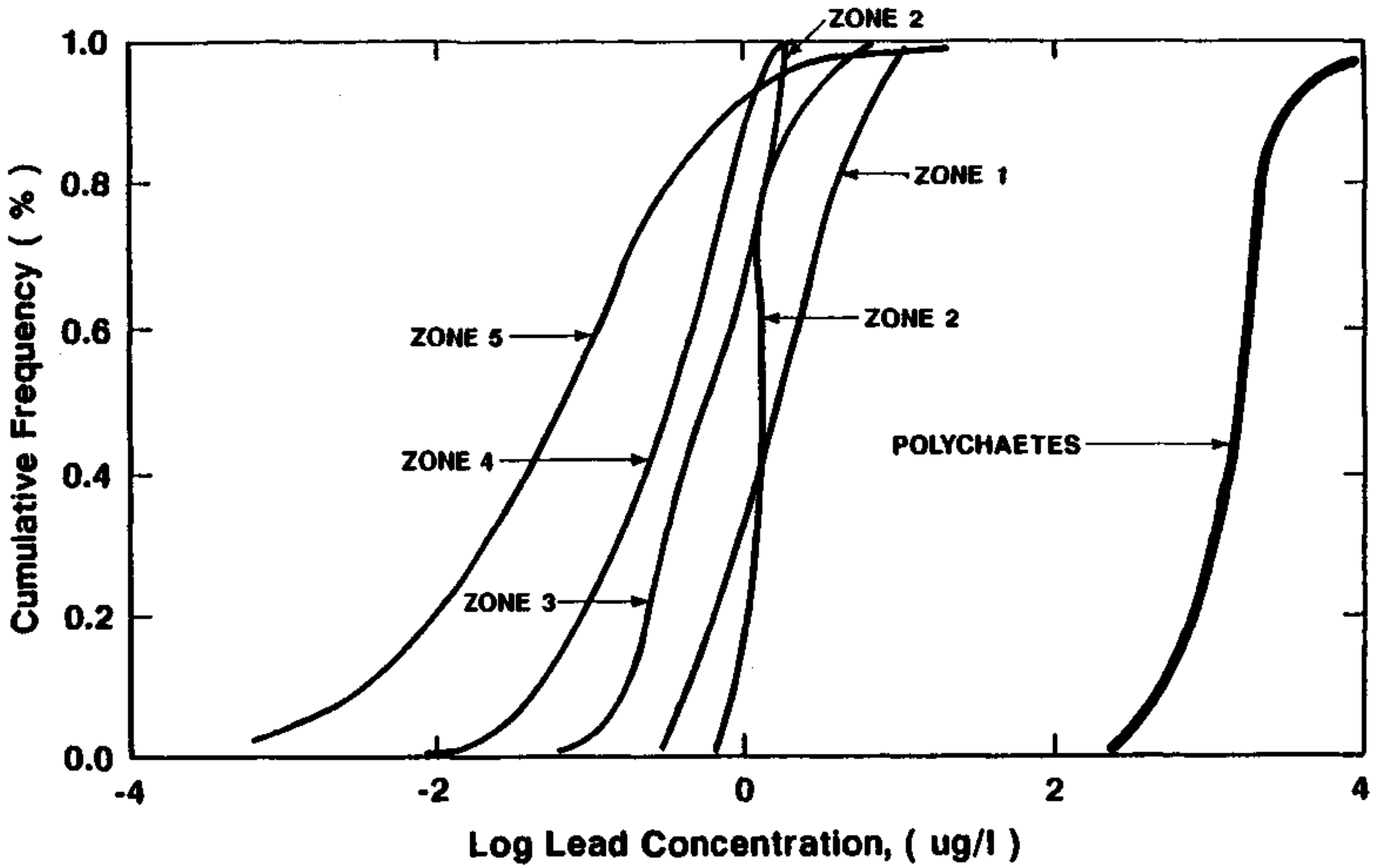


FIGURE C-12
MATC FOR POLYCHAETES AND
EECs FOR ALL ZONES, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

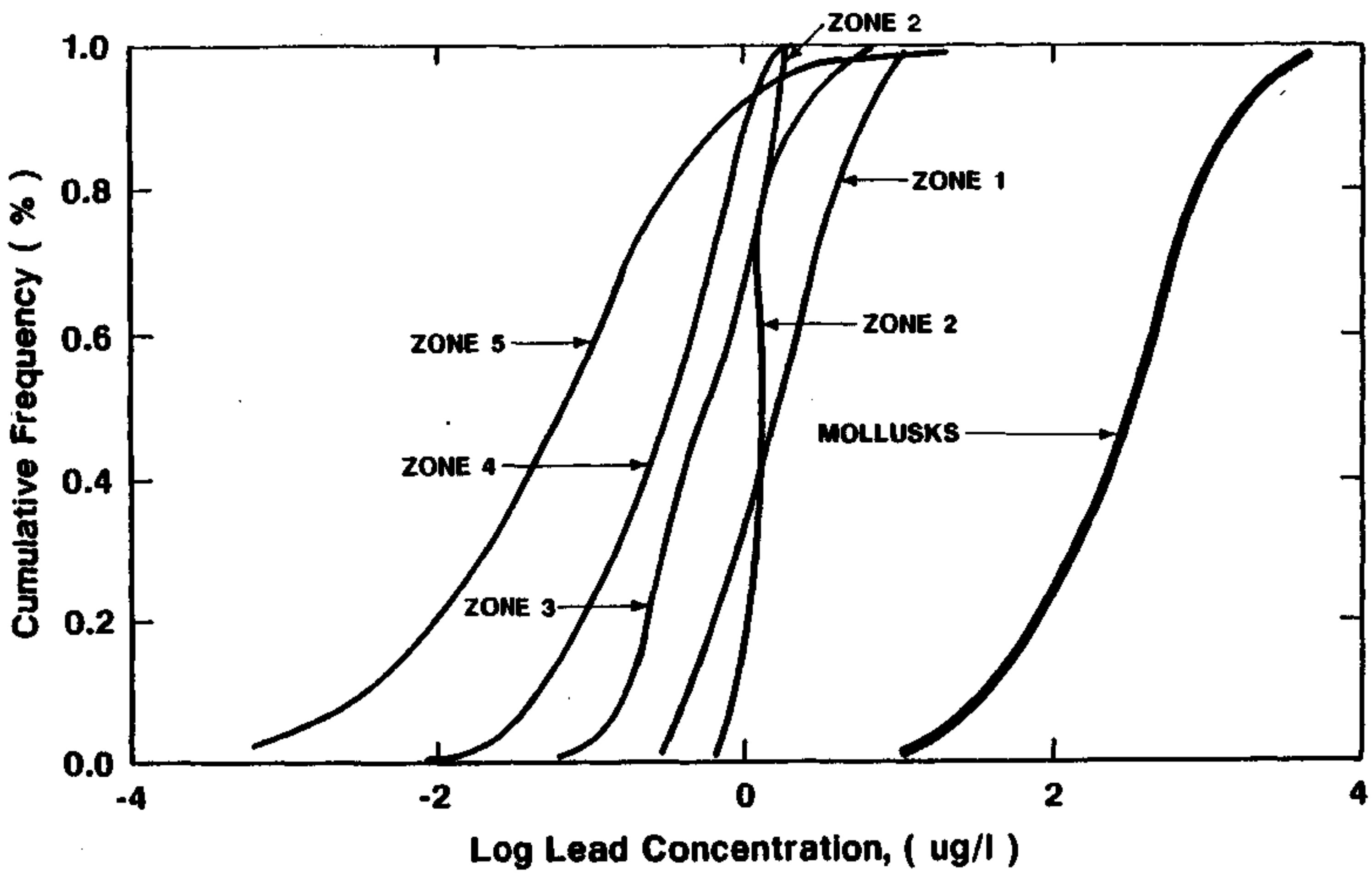


FIGURE C-13
MATC FOR MOLLUSKS AND
EECs FOR ALL ZONES, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

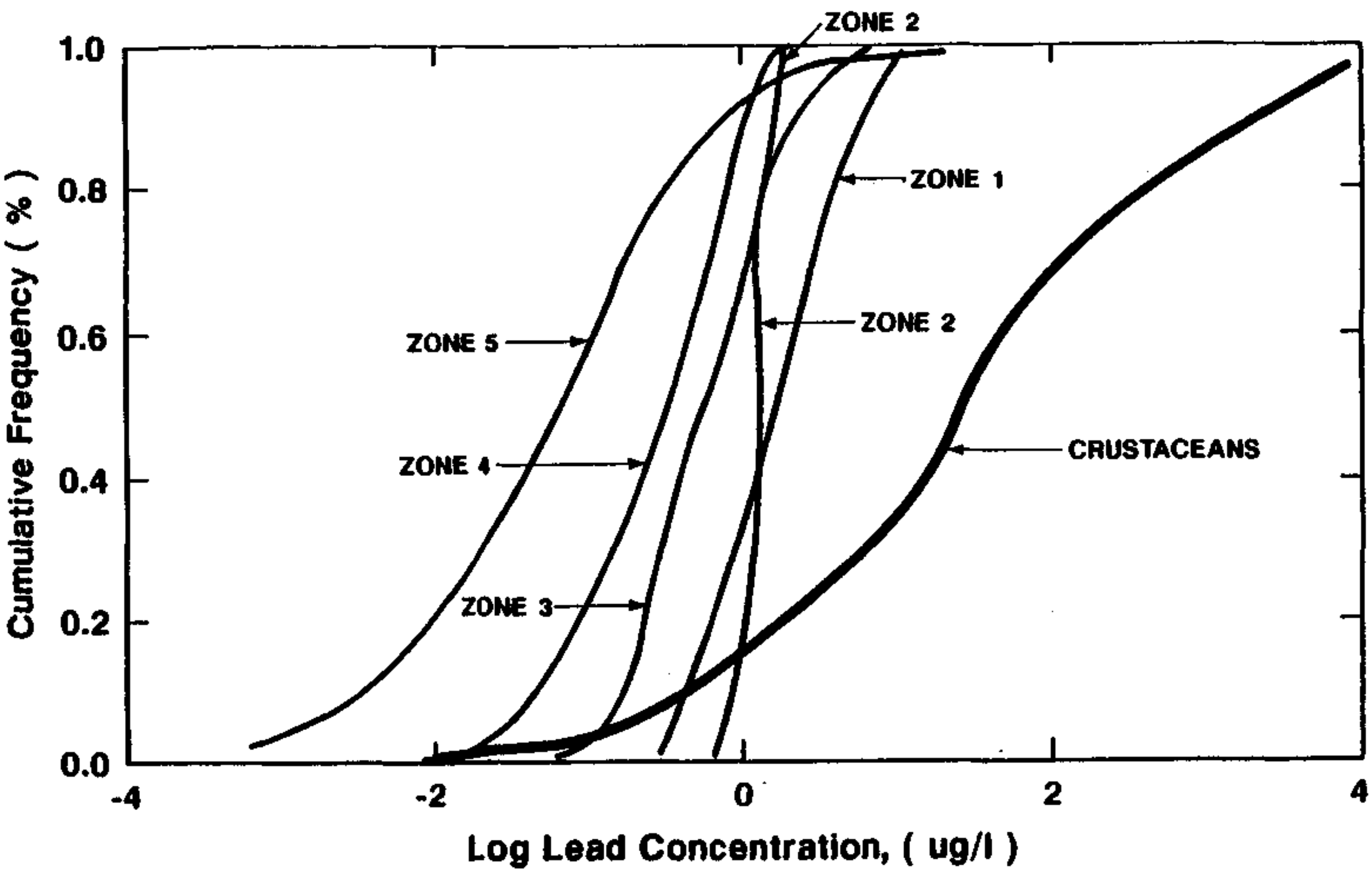


FIGURE C-14
MATC FOR CRUSTACEANS AND
ECCs FOR ALL ZONES, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

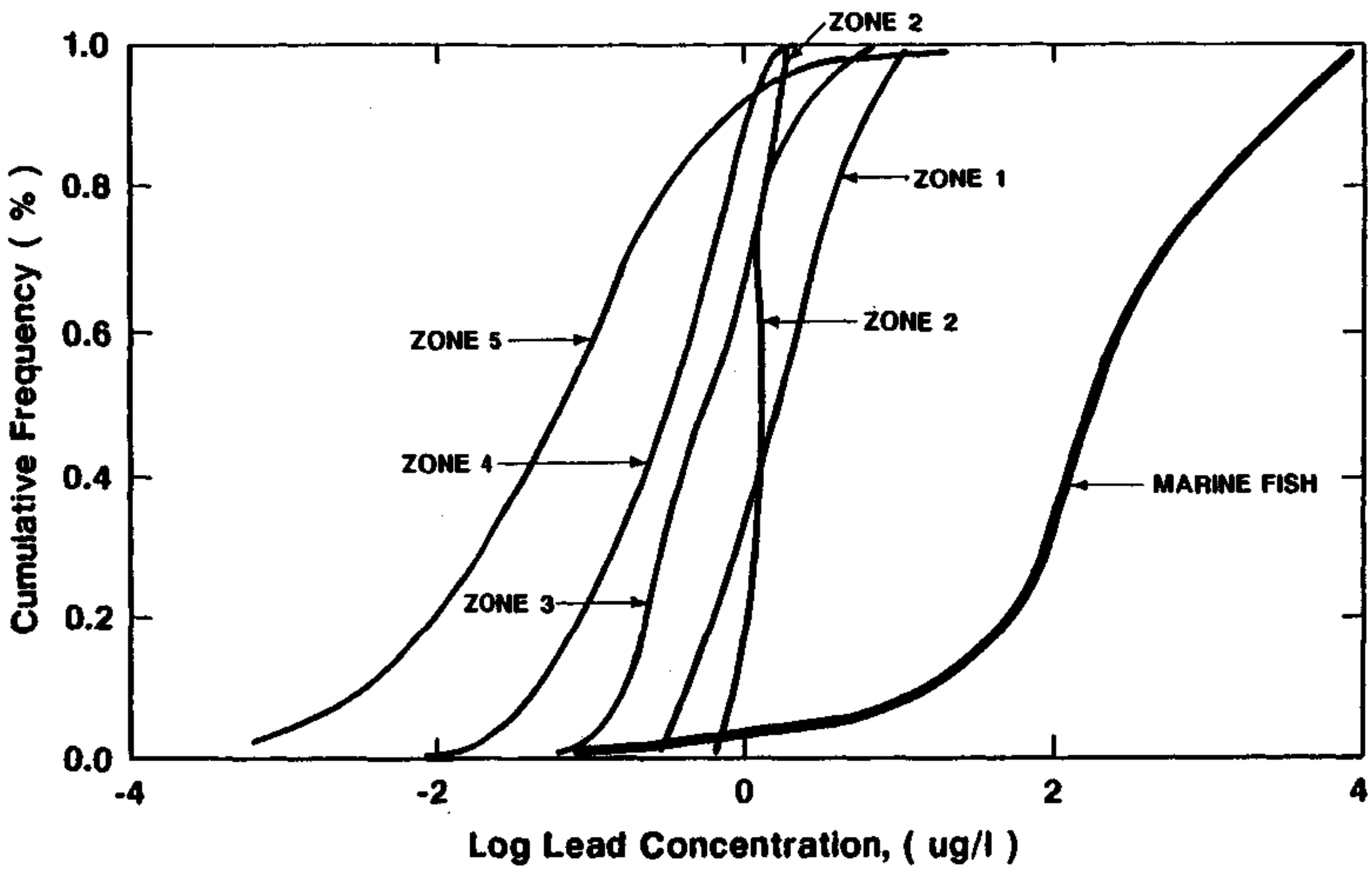


FIGURE C-15
MATC FOR MARINE FISH AND
EECs FOR ALL ZONES, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

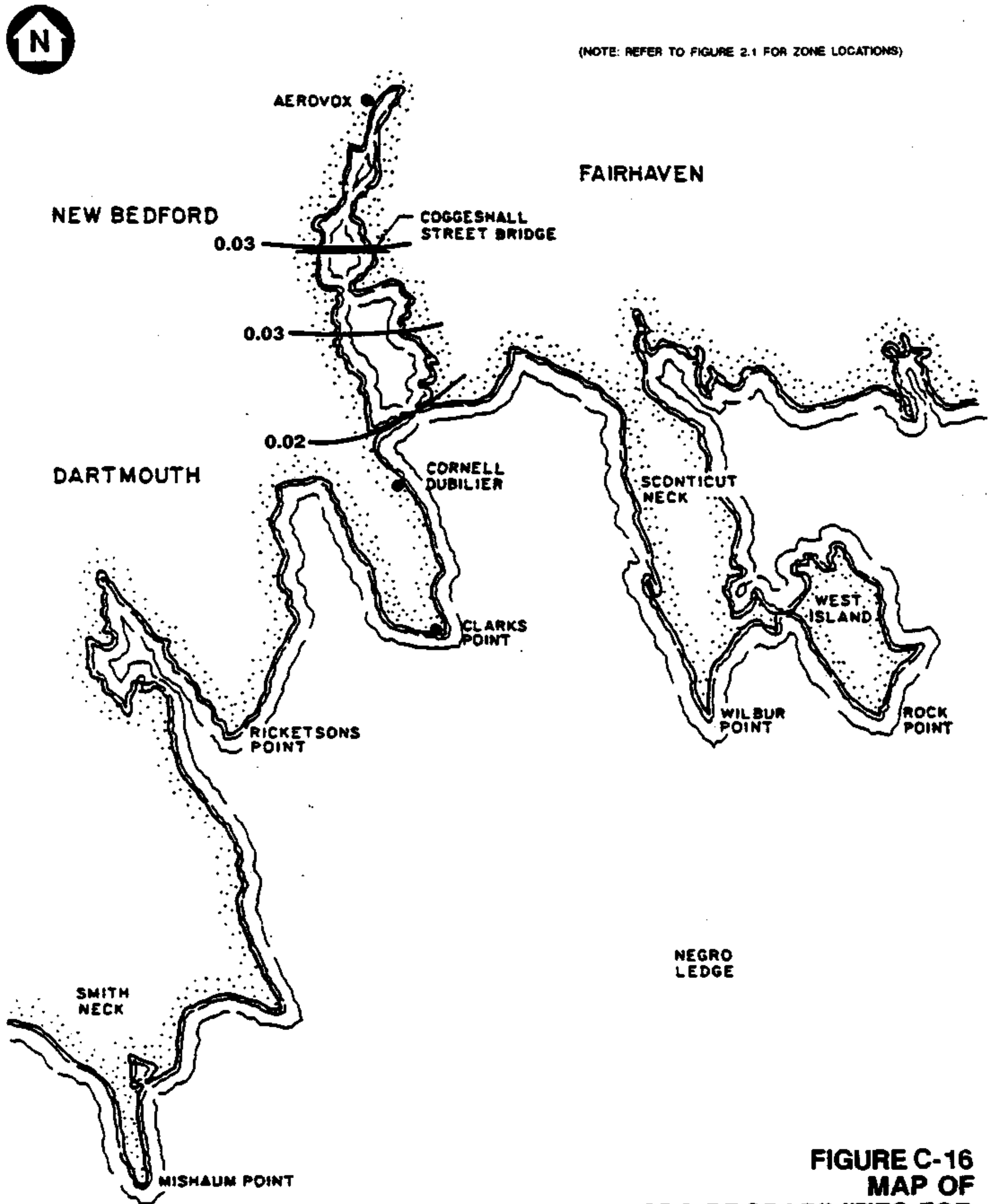


FIGURE C-16
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
ALGA, COPPER, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

NOT TO SCALE

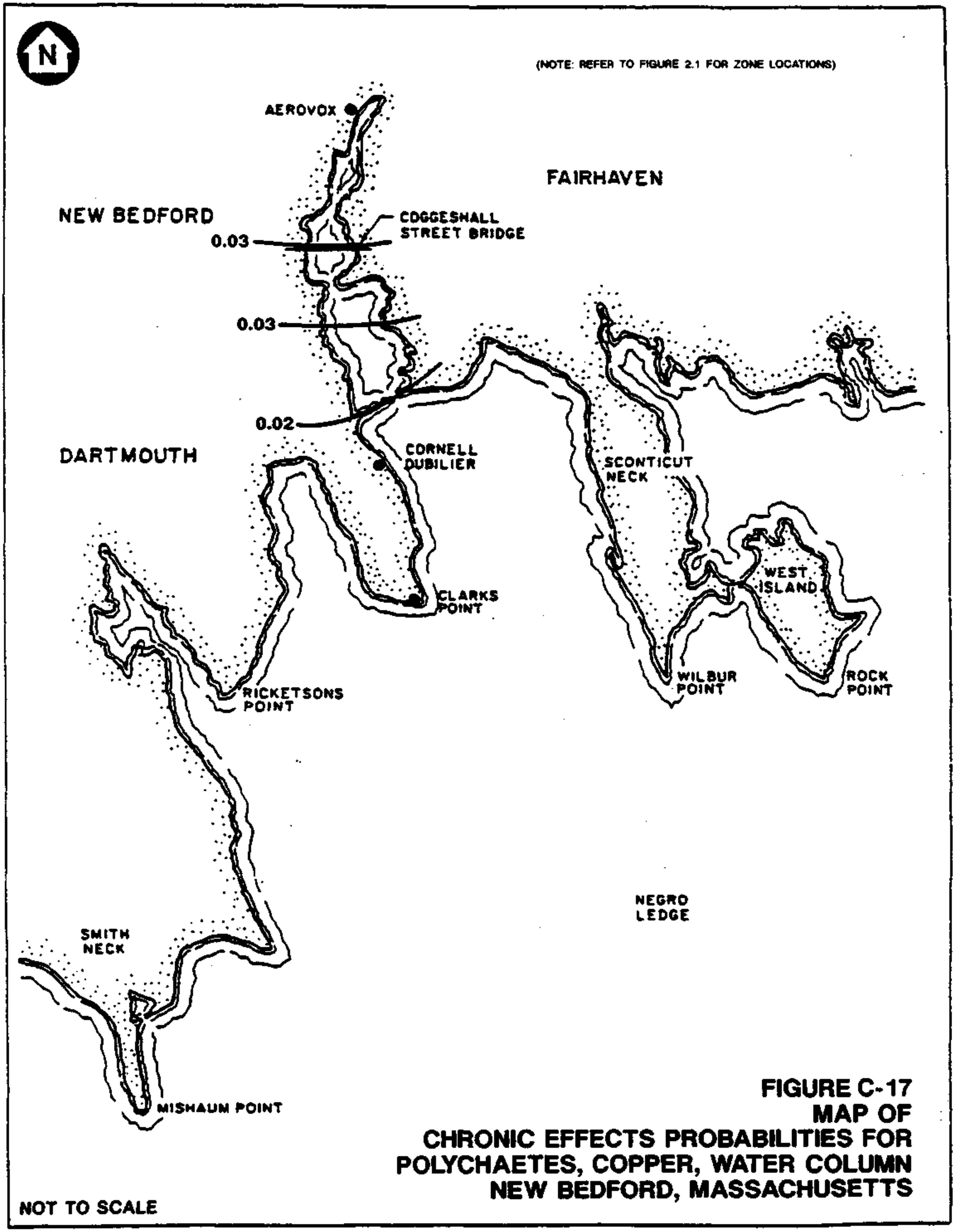
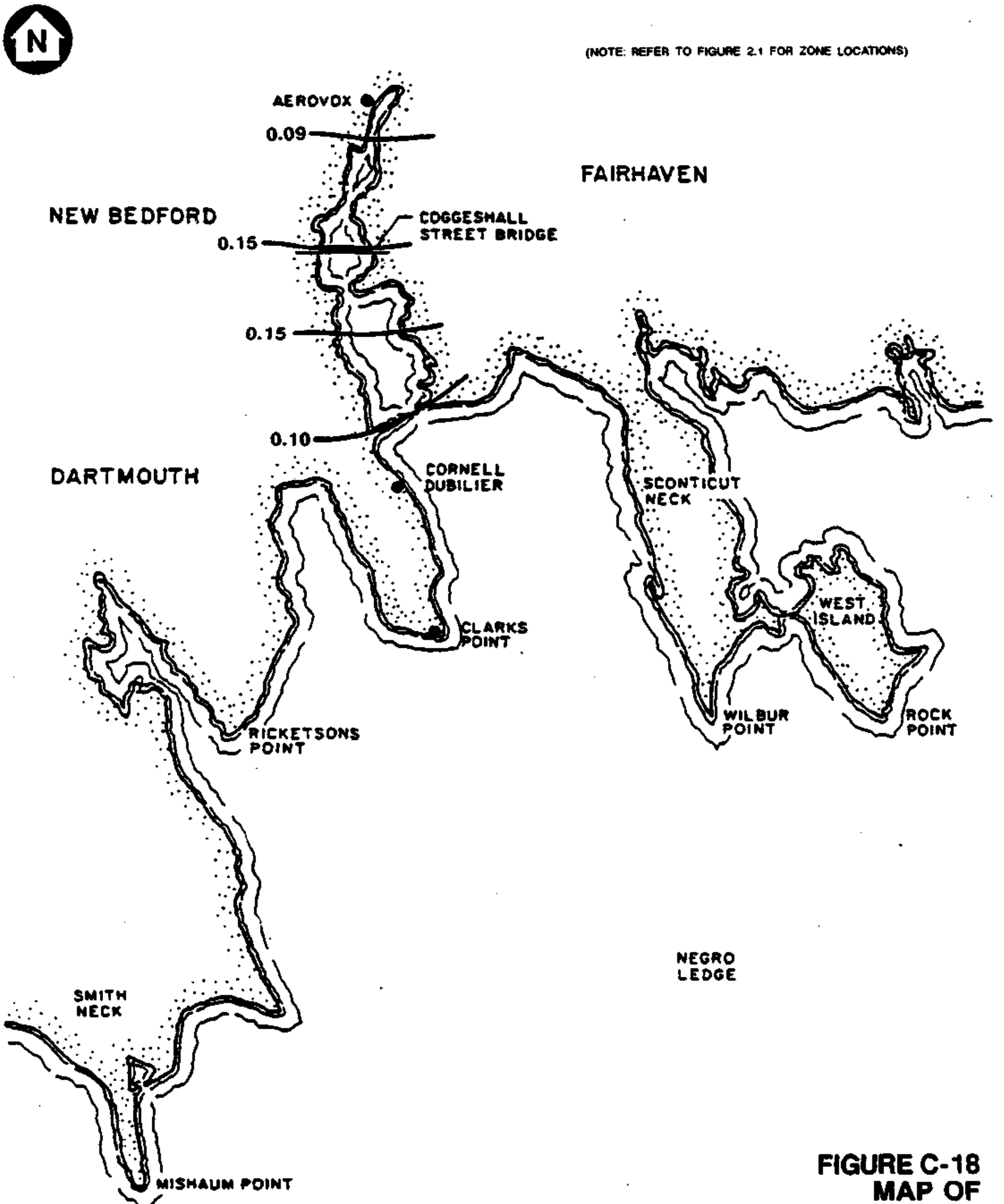


FIGURE C-17
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR POLYCHAETES, COPPER, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS



NOT TO SCALE

FIGURE C-18
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MOLLUSKS, COPPER, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

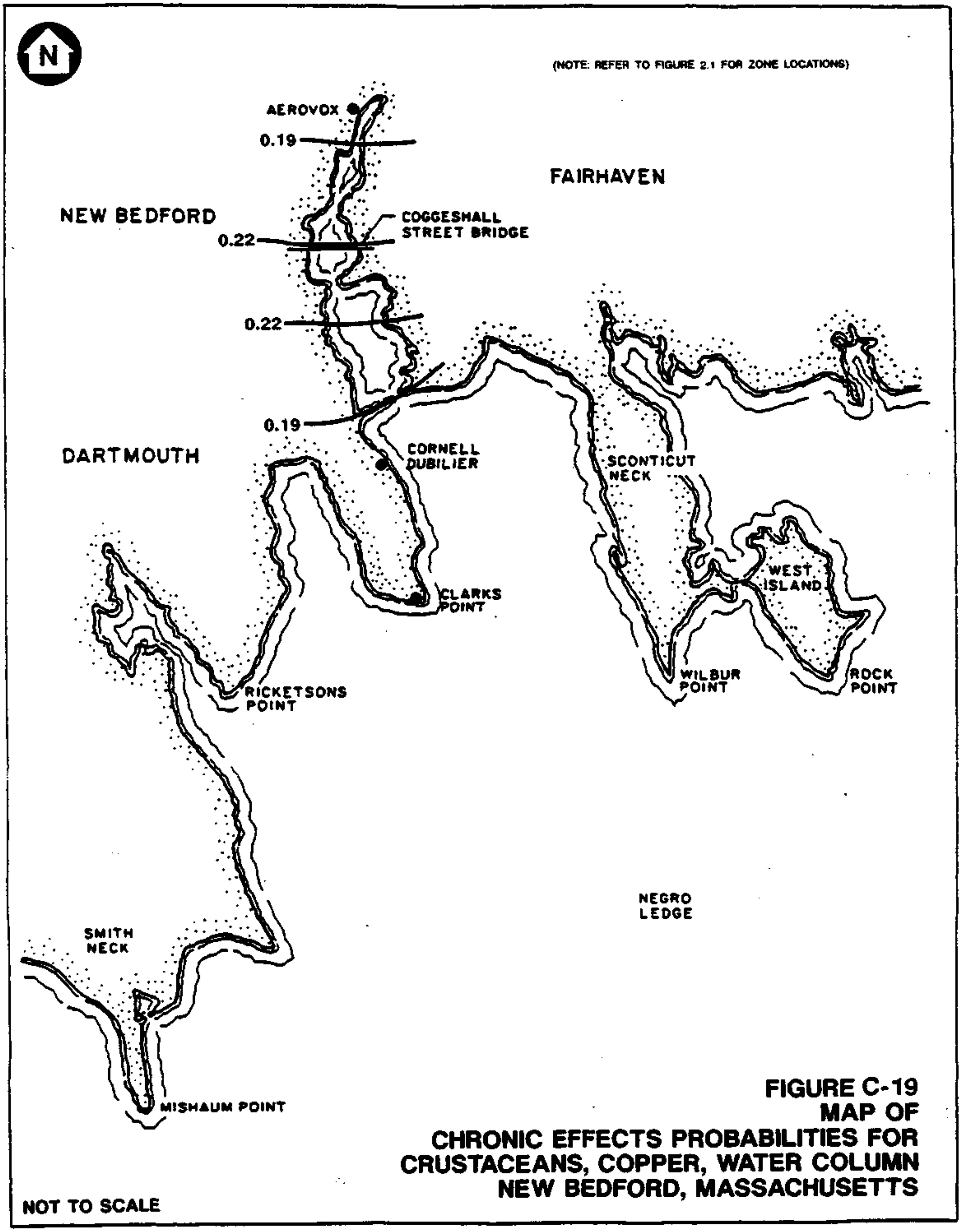


FIGURE C-19
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR CRUSTACEANS, COPPER, WATER COLUMN NEW BEDFORD, MASSACHUSETTS

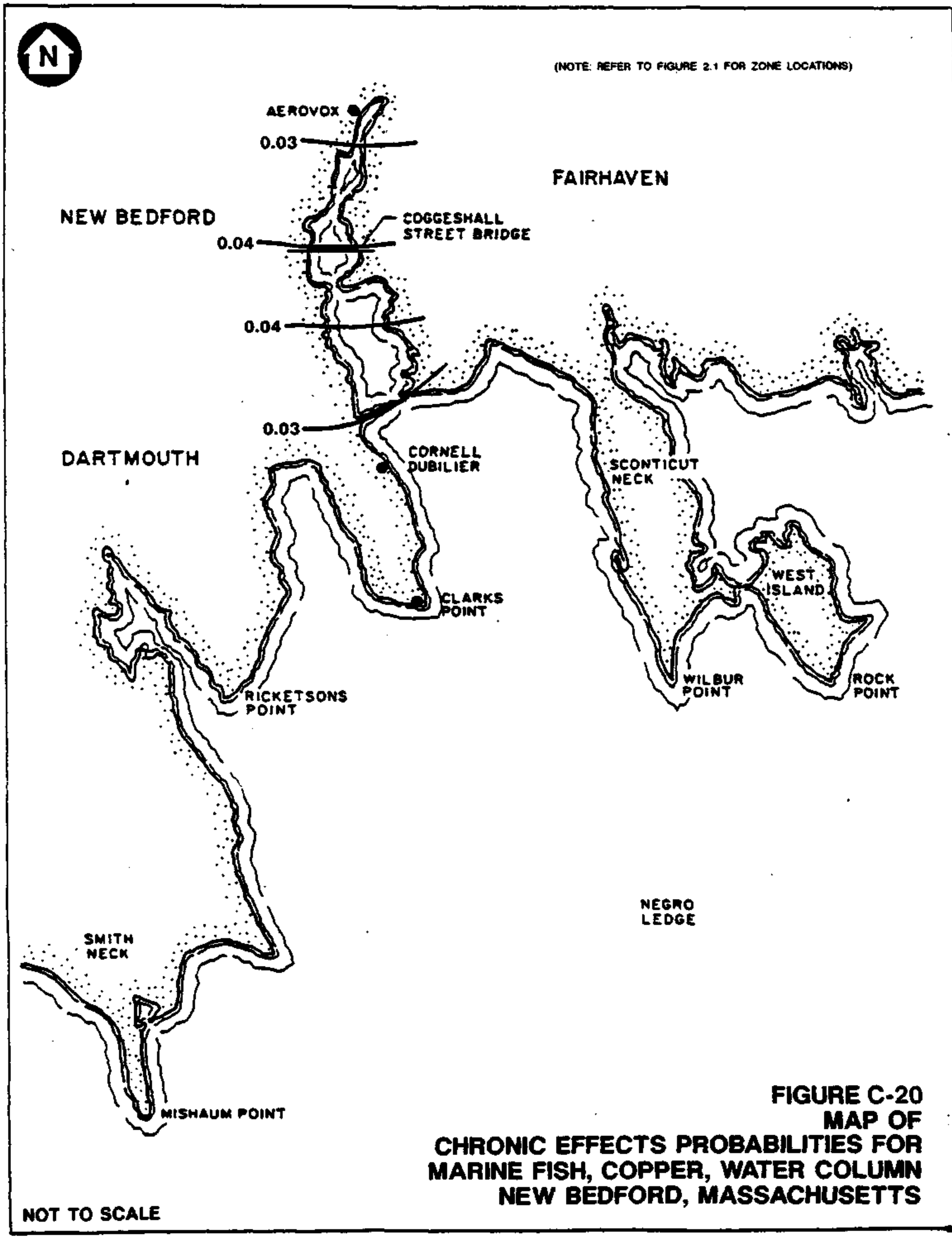


FIGURE C-20
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR MARINE FISH, COPPER, WATER COLUMN NEW BEDFORD, MASSACHUSETTS

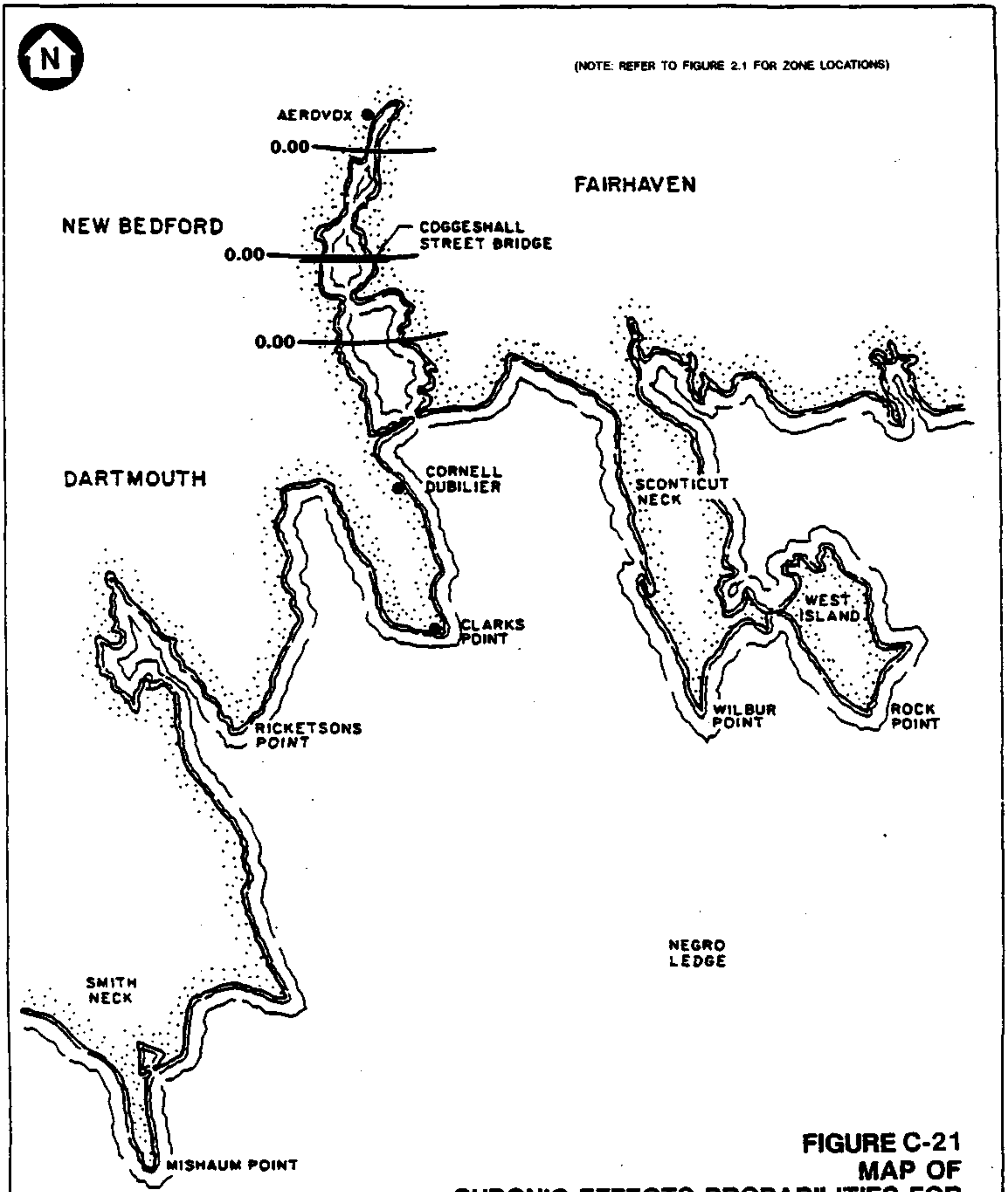


FIGURE C-21
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
ALGA, CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

NOT TO SCALE

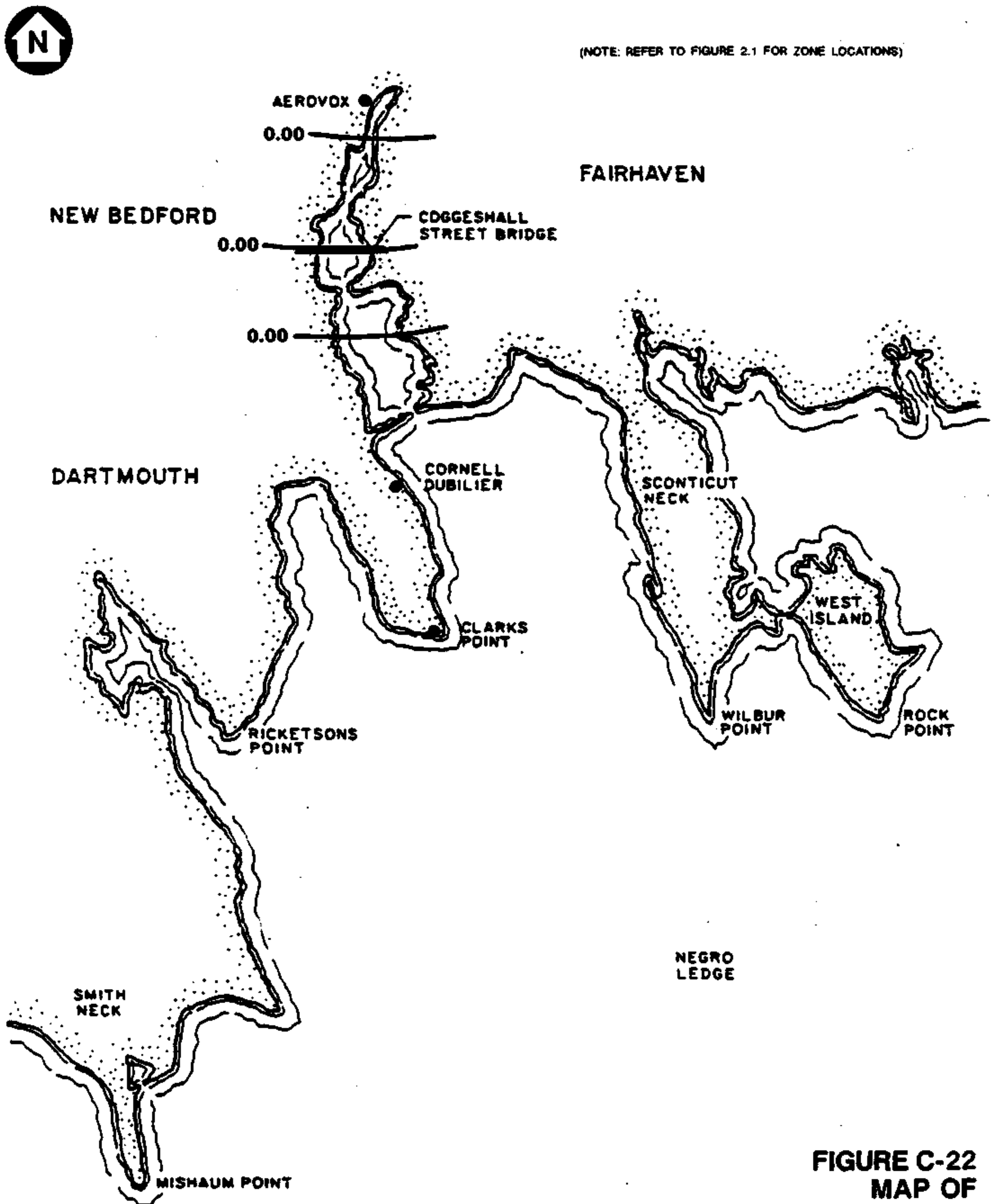


FIGURE C-22
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
POLYCHAETES, CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

NOT TO SCALE

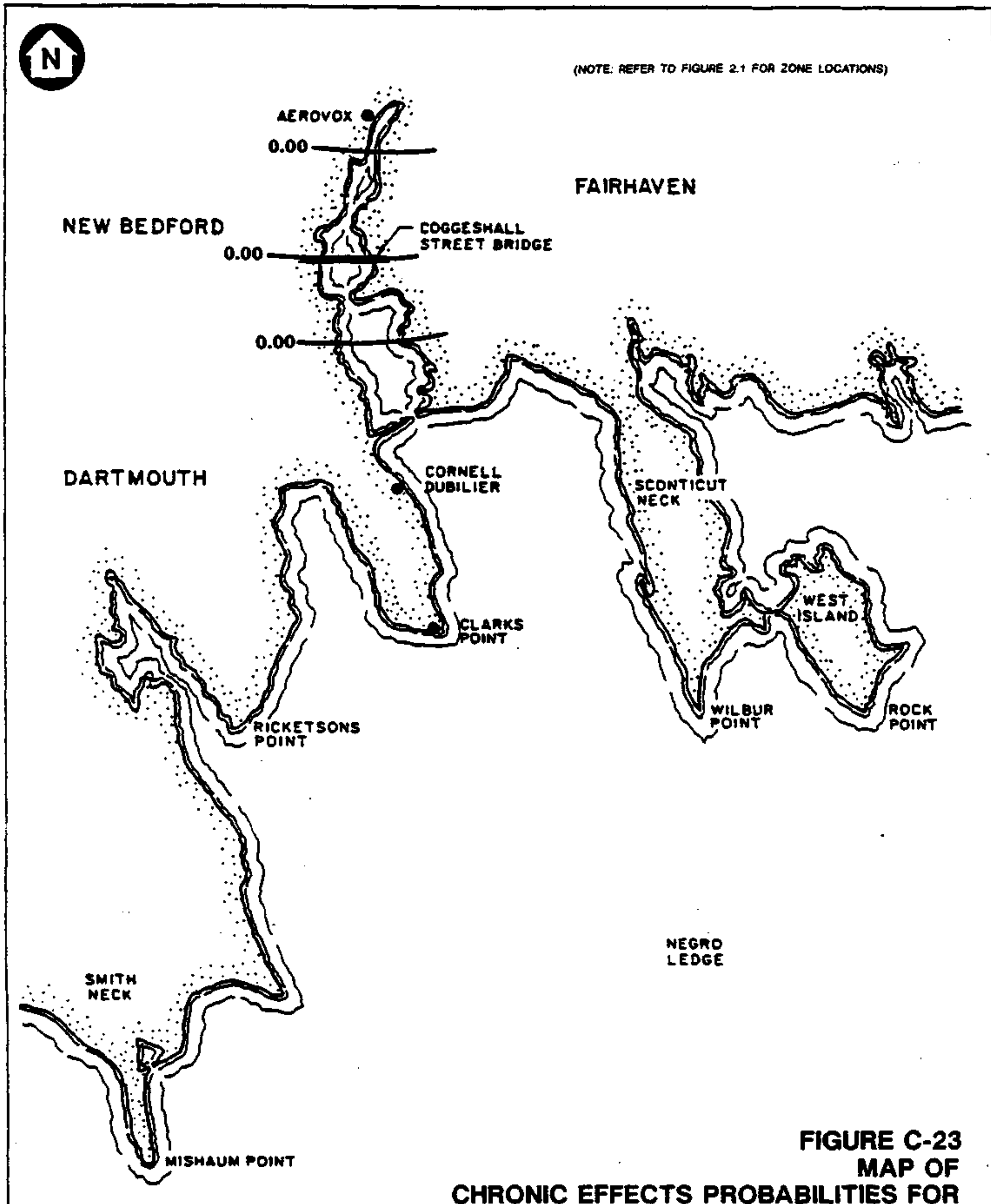


FIGURE C-23
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR MOLLUSKS, CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

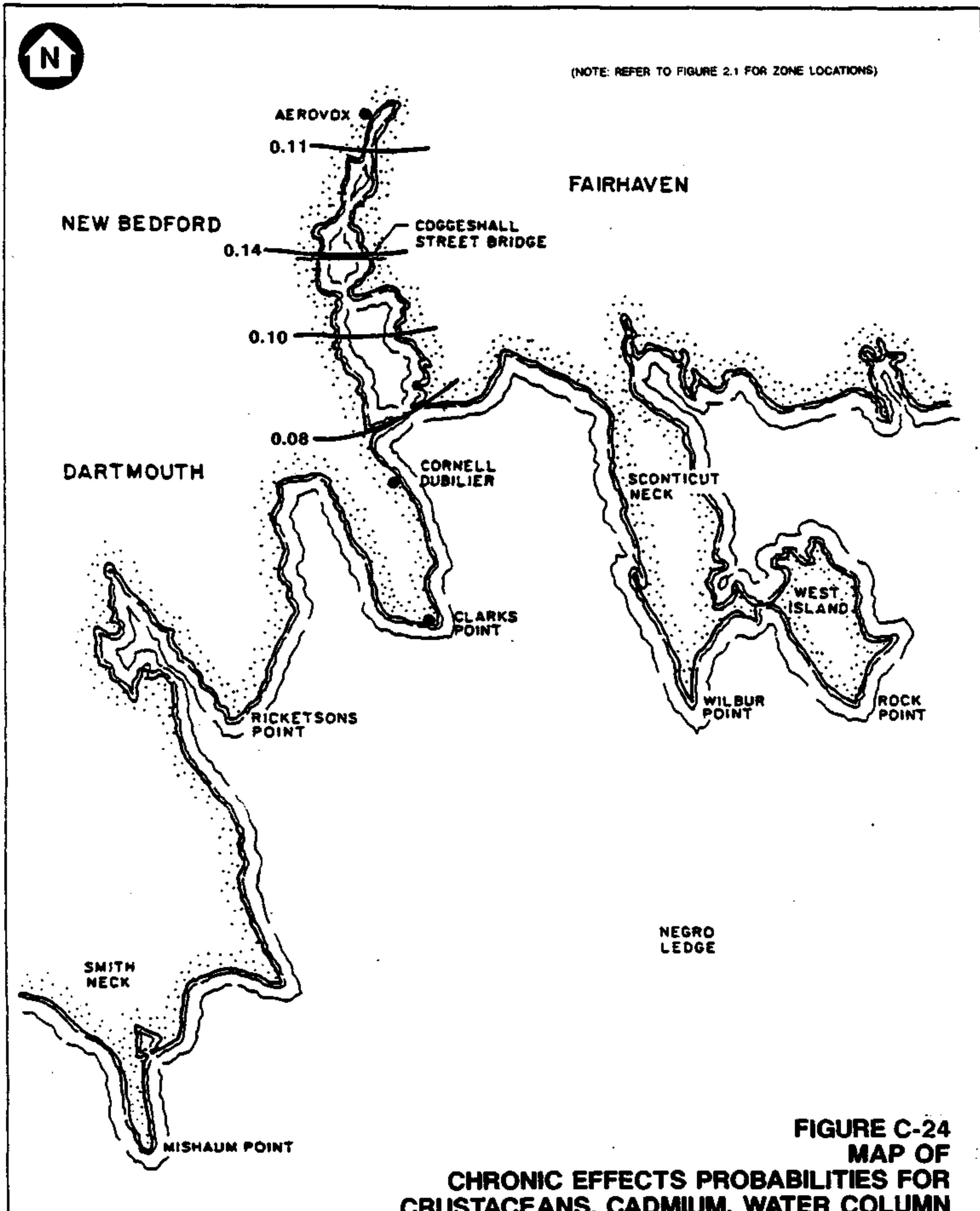


FIGURE C-24
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR CRUSTACEANS, CADMIUM, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

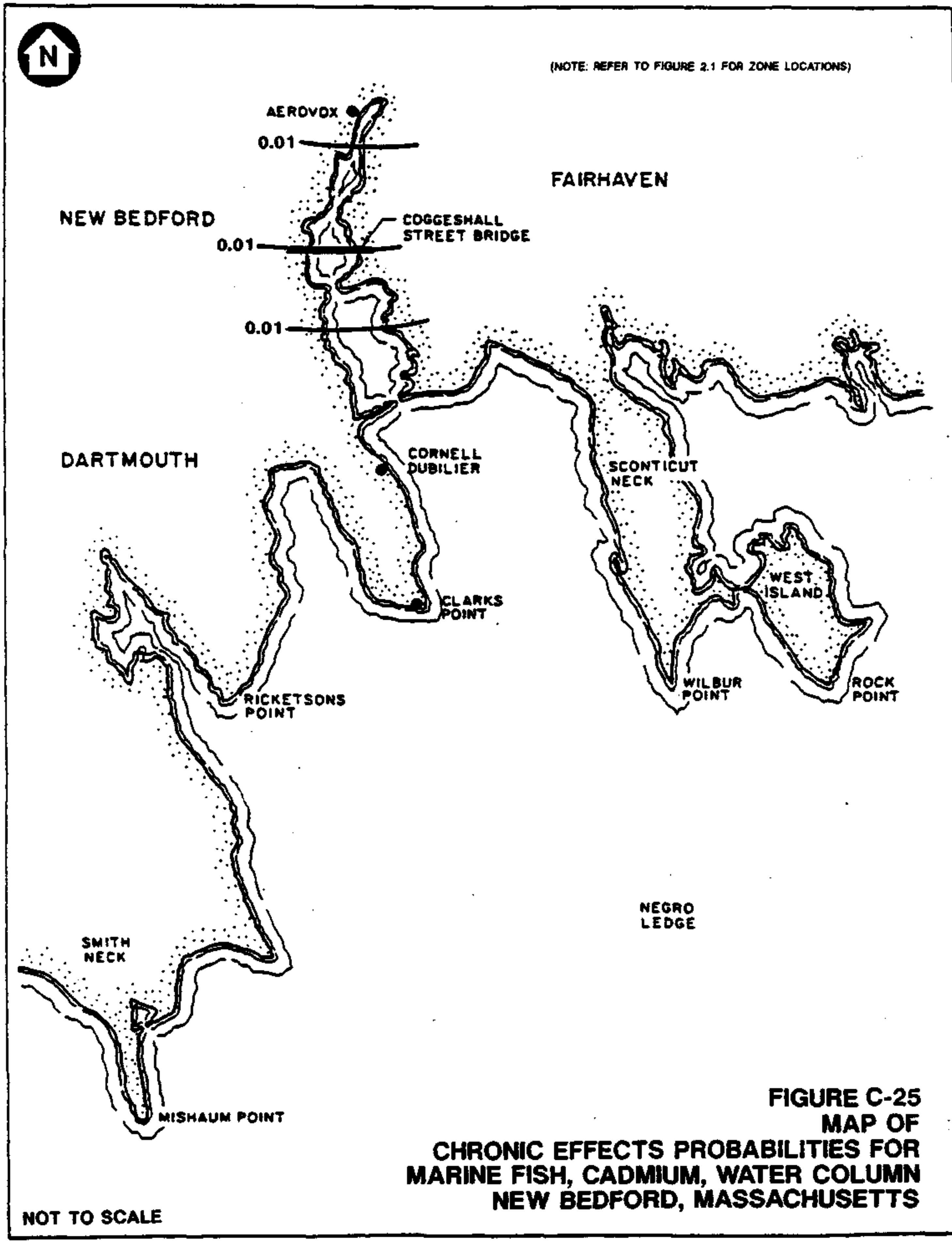


FIGURE C-25
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR MARINE FISH, CADMIUM, WATER COLUMN NEW BEDFORD, MASSACHUSETTS

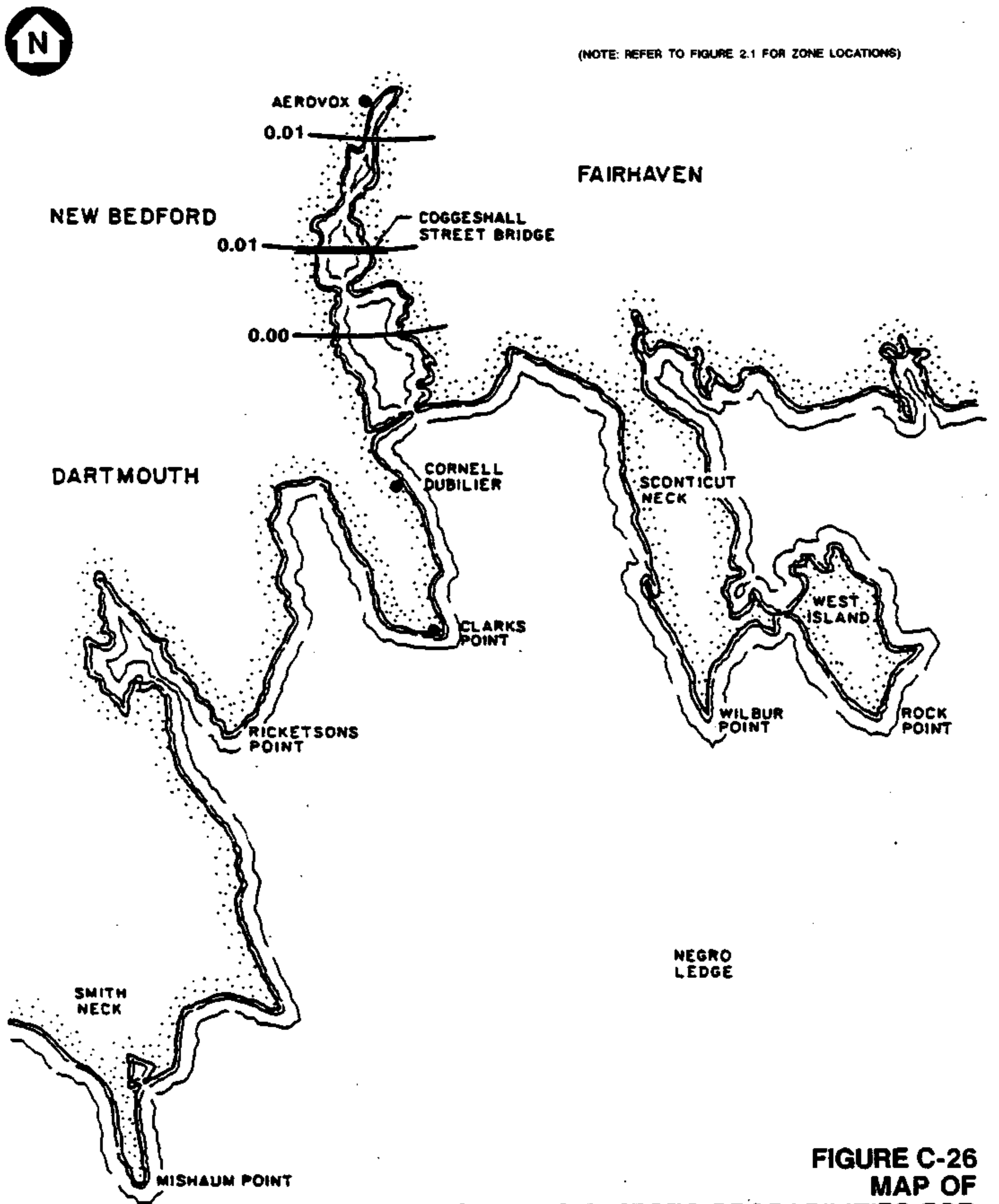


FIGURE C-26
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
ALGA, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

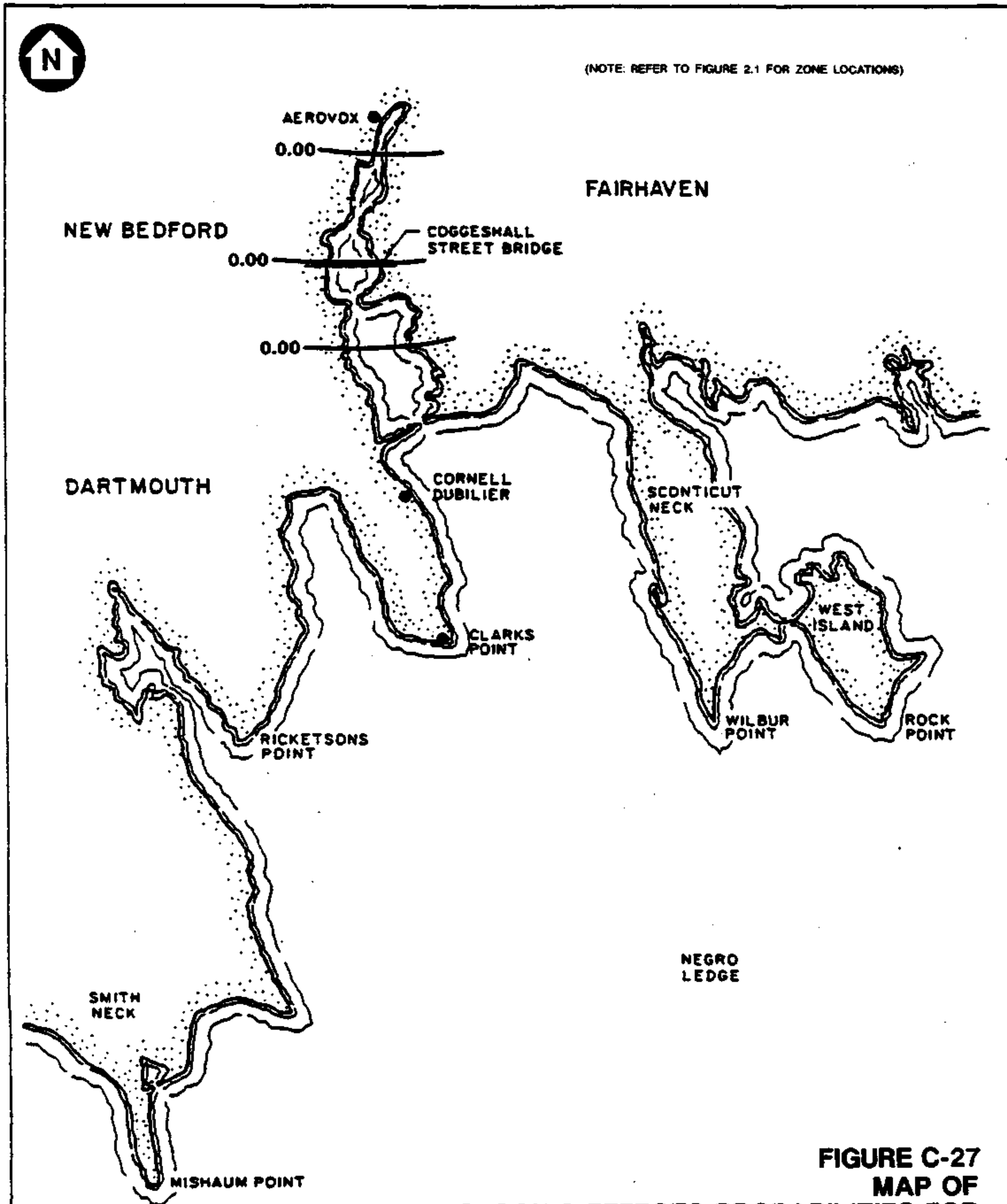


FIGURE C-27
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR POLYCHAETES, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

NOT TO SCALE

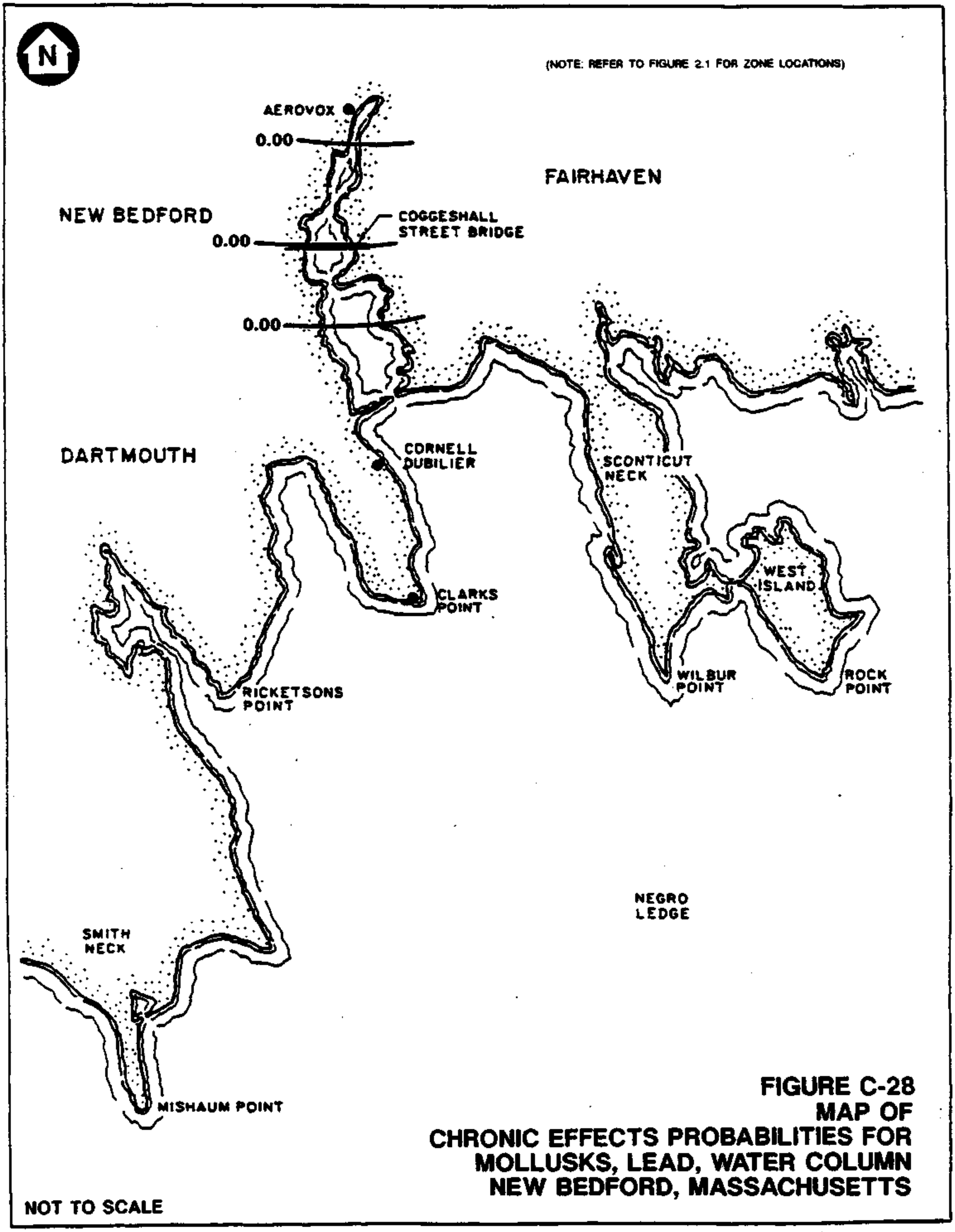


FIGURE C-28
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MOLLUSKS, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

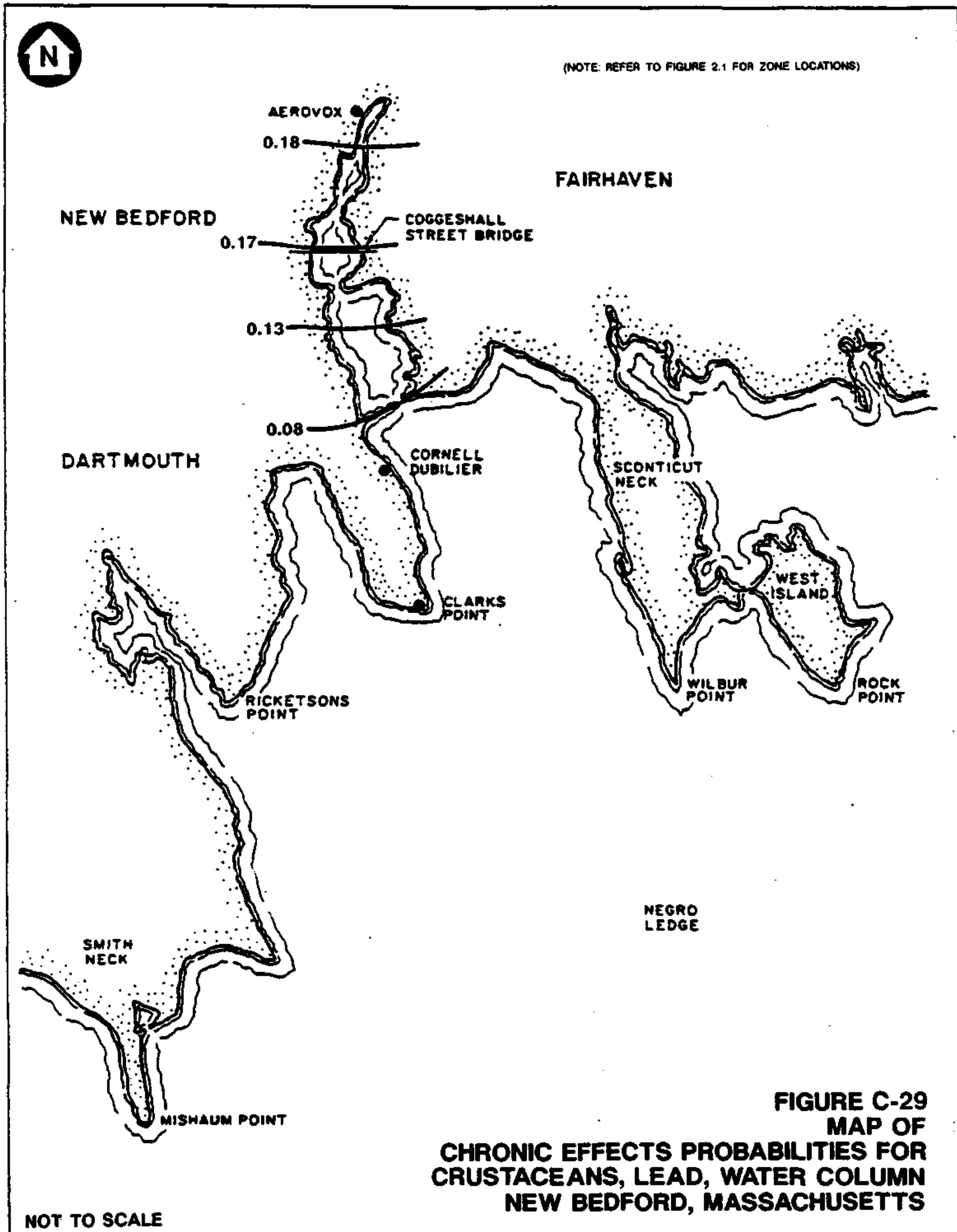


FIGURE C-29
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR CRUSTACEANS, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

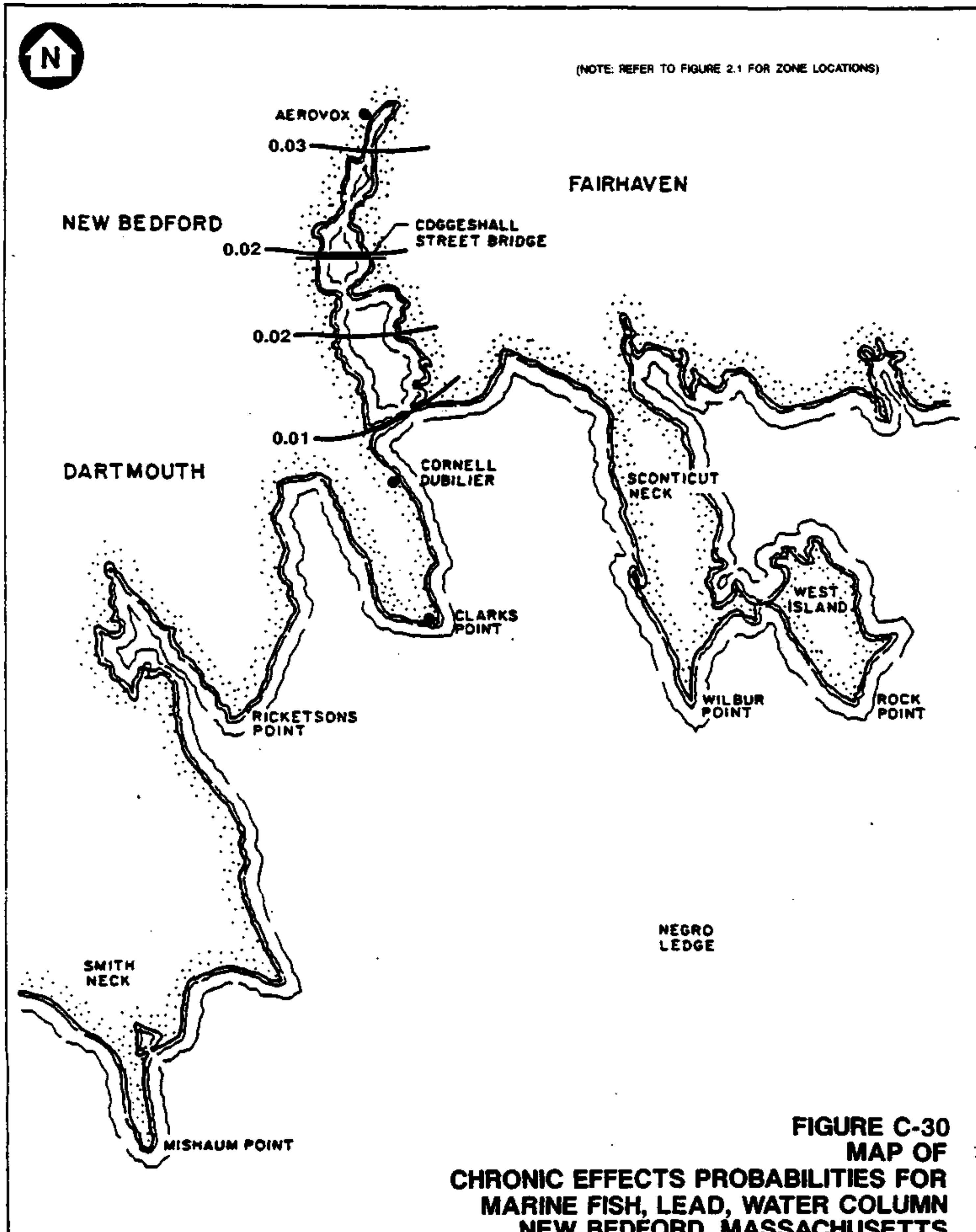


FIGURE C-30
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MARINE FISH, LEAD, WATER COLUMN
NEW BEDFORD, MASSACHUSETTS

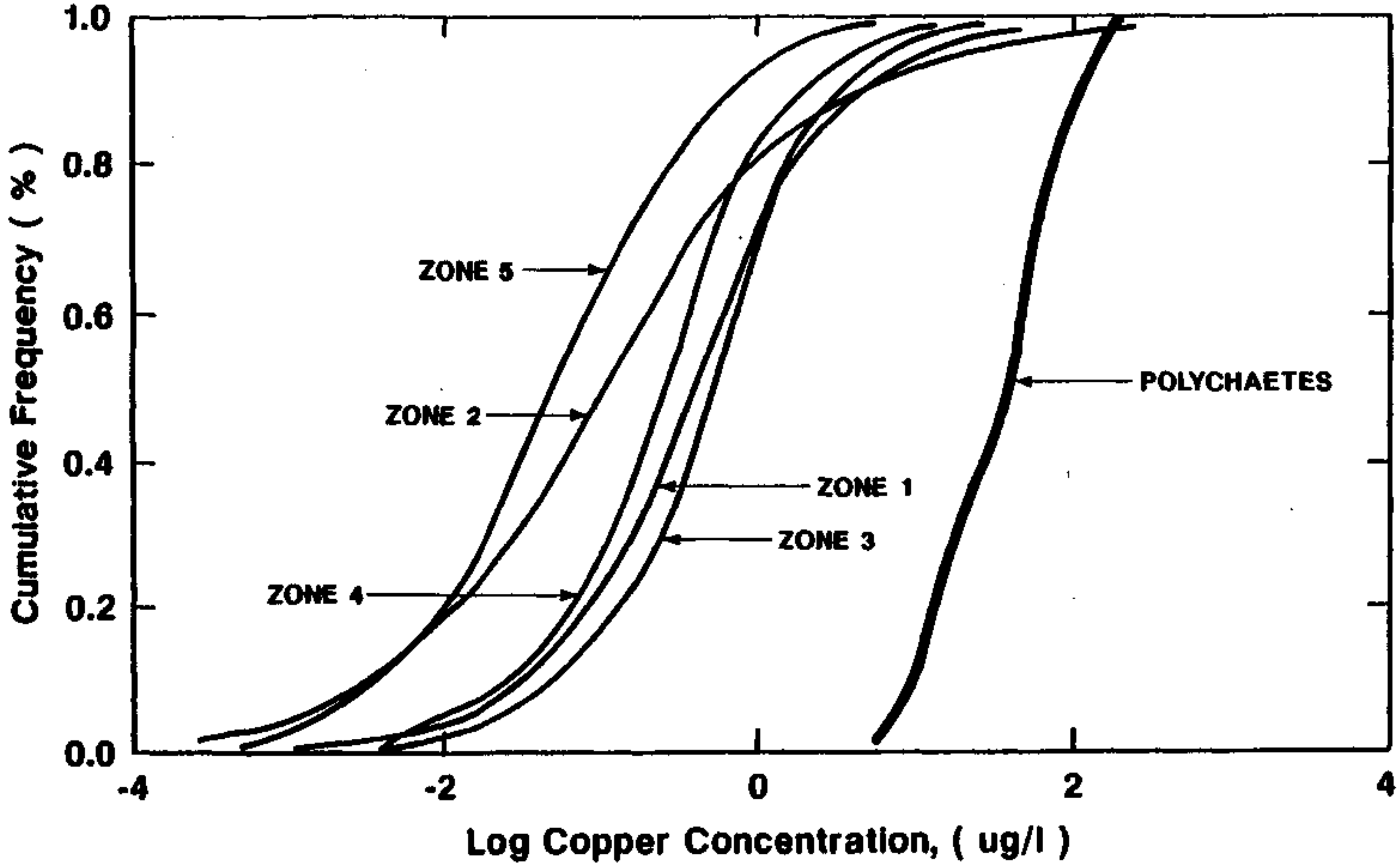


FIGURE C-31
MATC FOR POLYCHAETES AND
EECs FOR ALL ZONES, COPPER, PORE WATER
NEW BEDFORD, MASSACHUSETTS

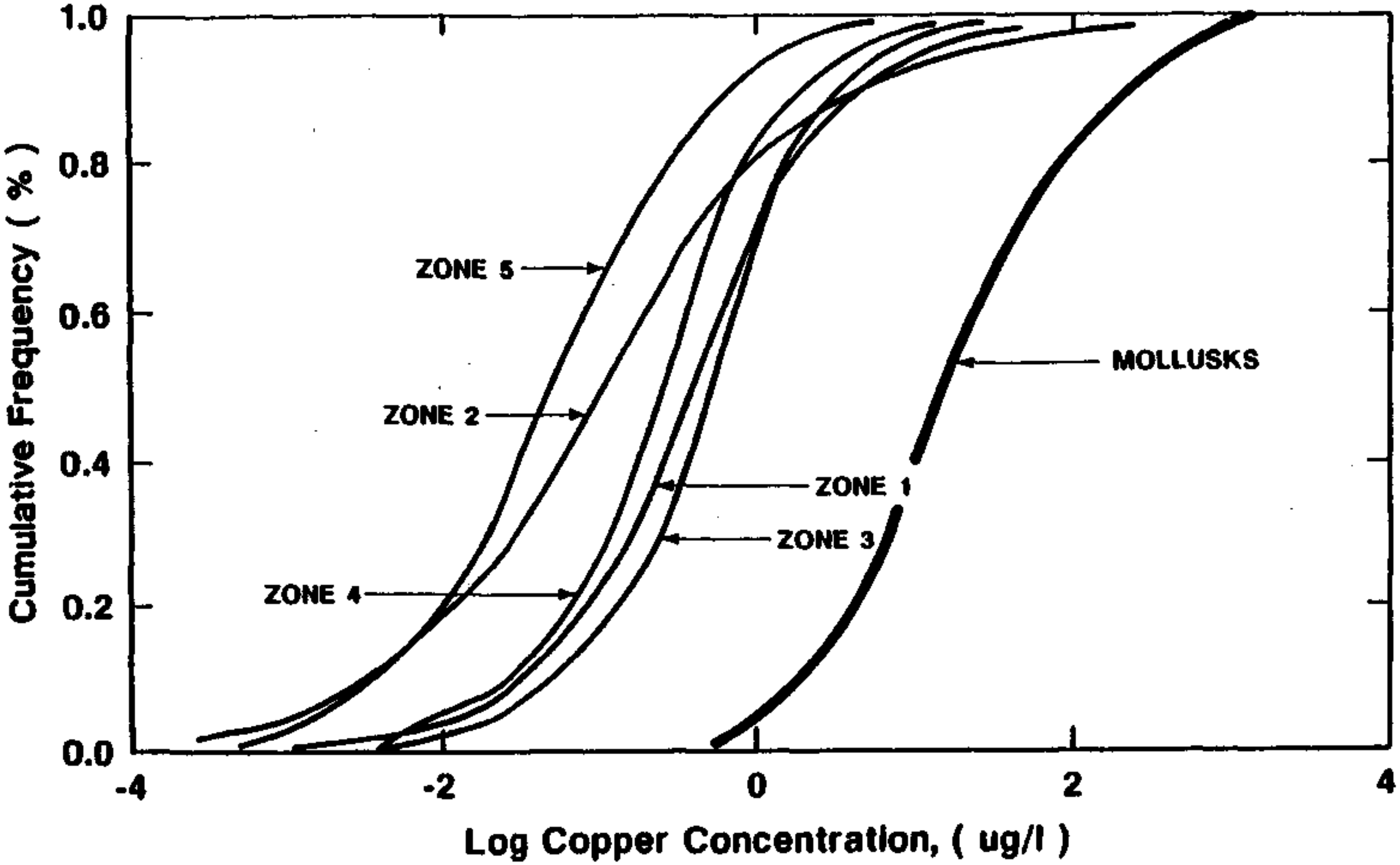


FIGURE C-32
MATC FOR MOLLUSKS AND
EECs FOR ALL ZONES, COPPER, PORE WATER
NEW BEDFORD, MASSACHUSETTS

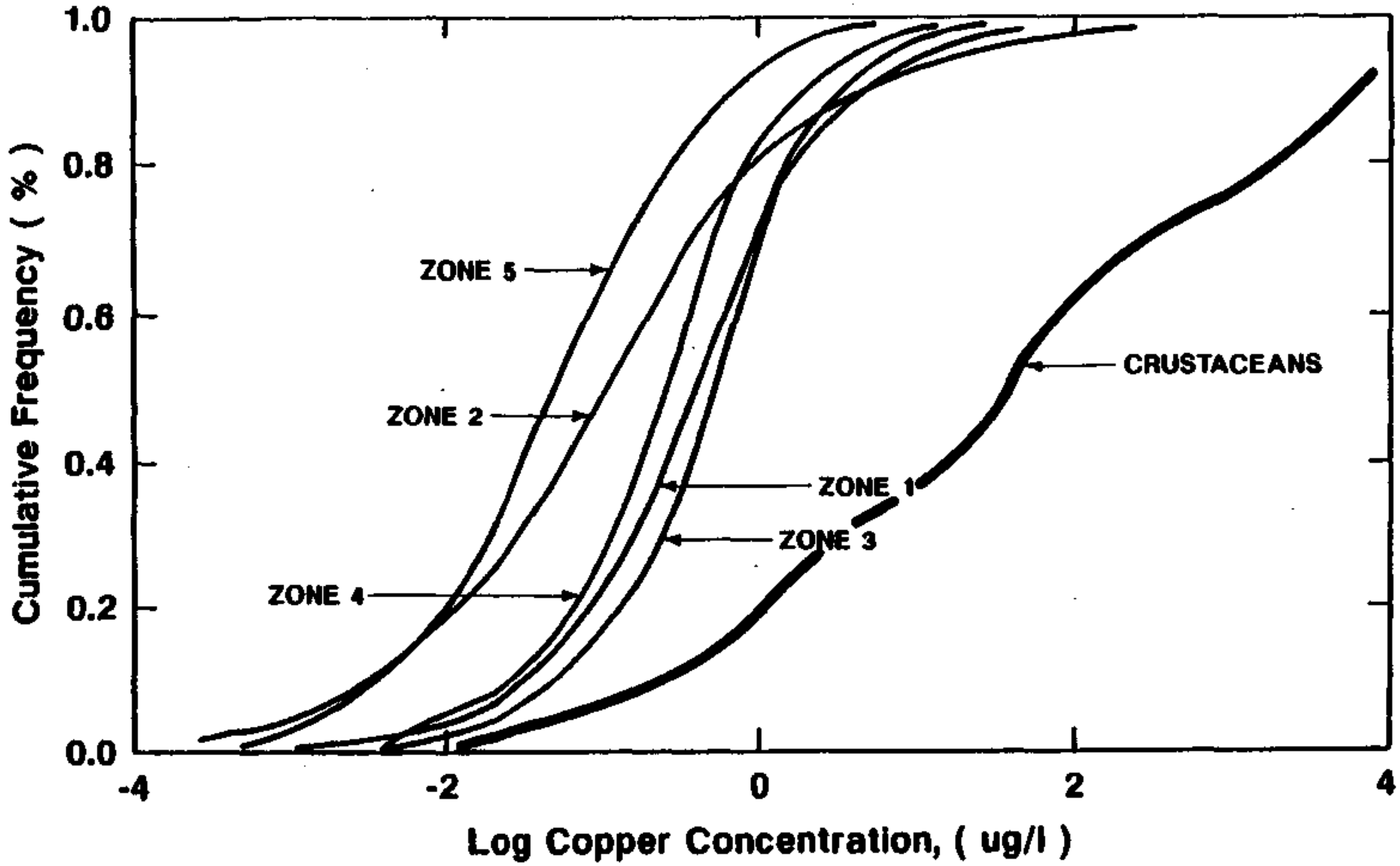


FIGURE C-33
MATC FOR CRUSTACEANS AND
EECs FOR ALL ZONES, COPPER, PORE WATER
NEW BEDFORD, MASSACHUSETTS

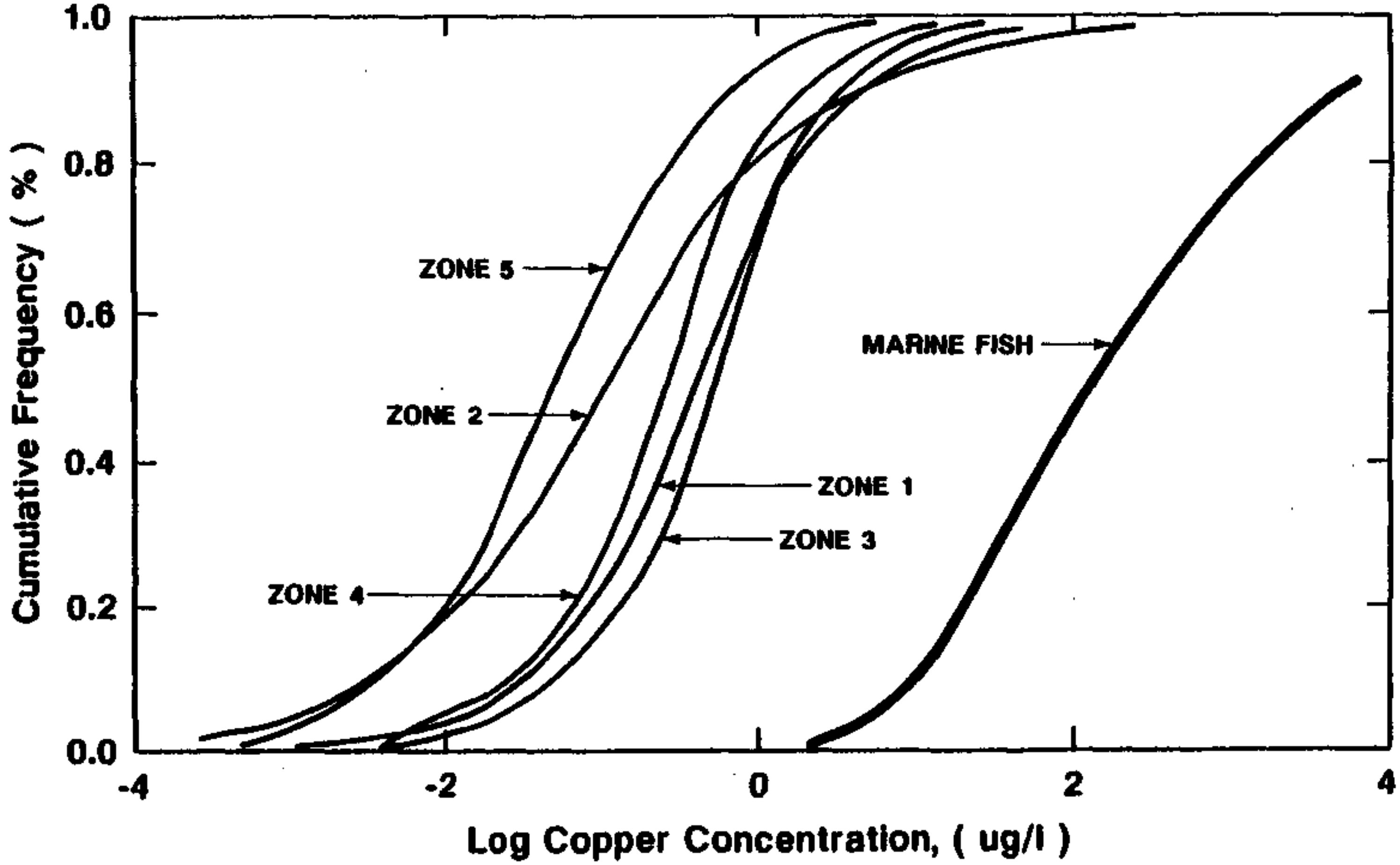


FIGURE C-34
MATC FOR MARINE FISH AND
EECs FOR ALL ZONES, COPPER, PORE WATER
NEW BEDFORD, MASSACHUSETTS

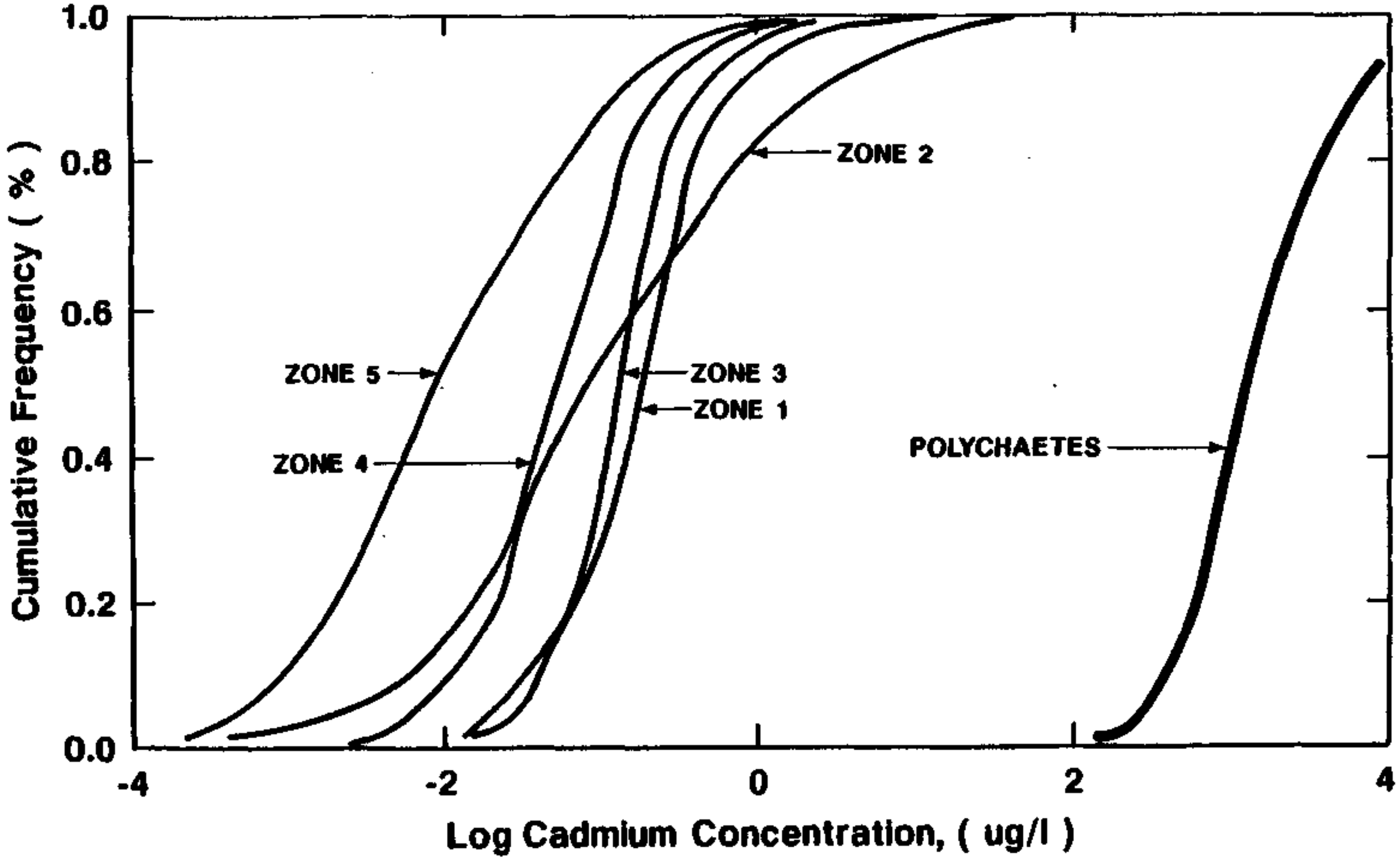


FIGURE C-35
MATC FOR POLYCHAETES AND
EECs FOR ALL ZONES, CADMIUM, PORE WATER
NEW BEDFORD, MASSACHUSETTS

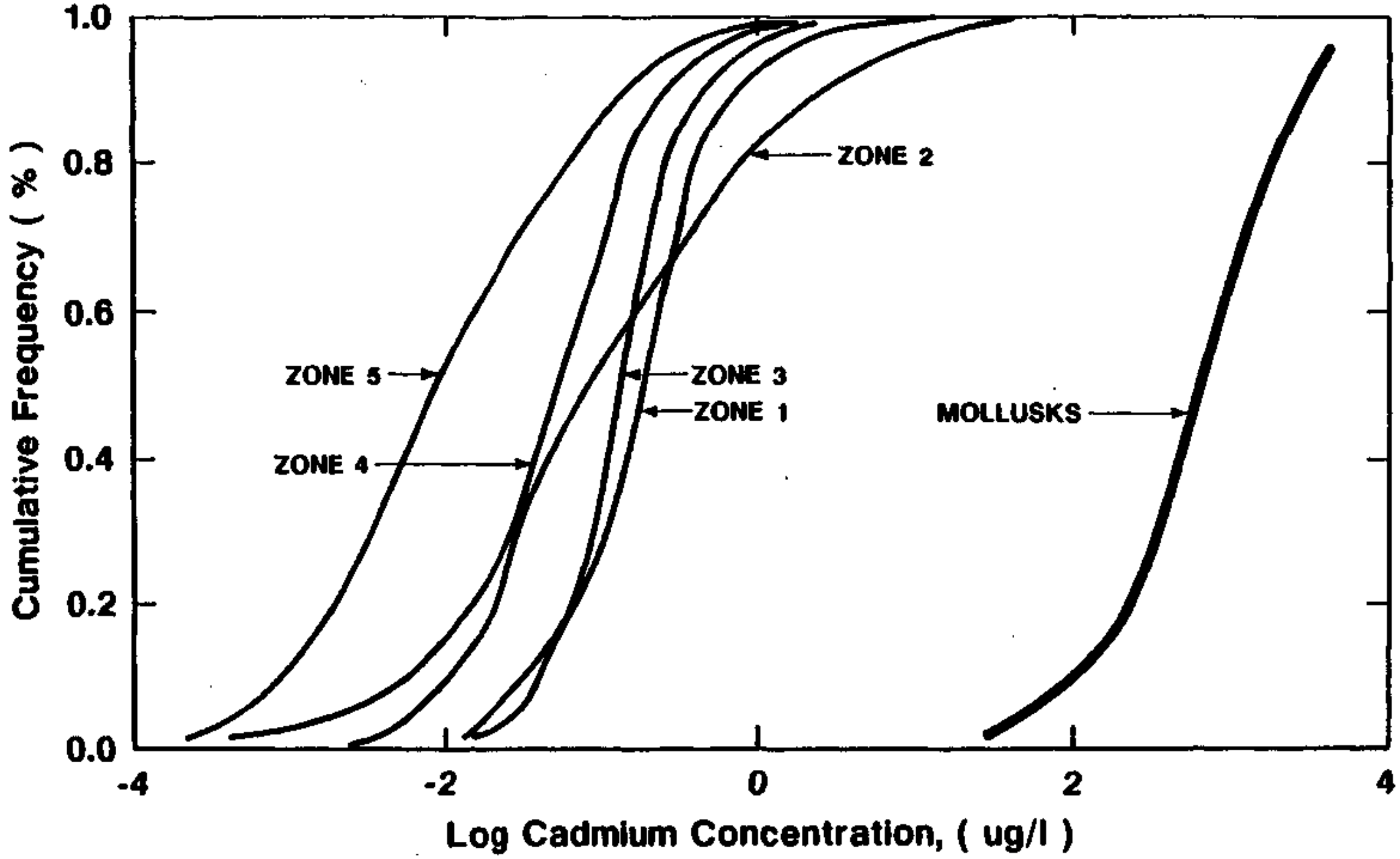


FIGURE C-36
MATC FOR MOLLUSKS AND
EECs FOR ALL ZONES, CADMIUM, PORE WATER
NEW BEDFORD, MASSACHUSETTS

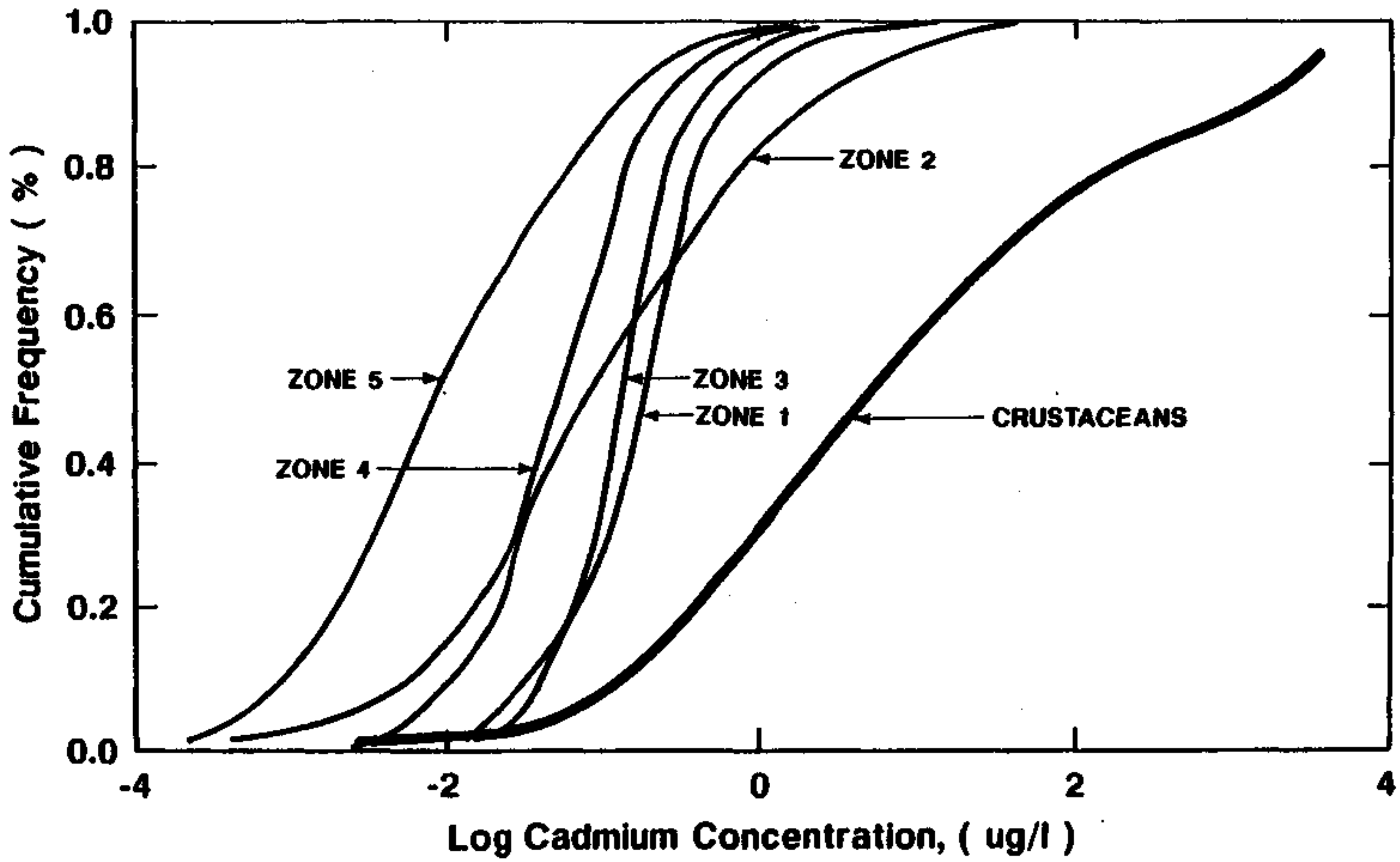


FIGURE C-37
MATC FOR CRUSTACEANS AND
EECs FOR ALL ZONES, CADMIUM, PORE WATER
NEW BEDFORD, MASSACHUSETTS

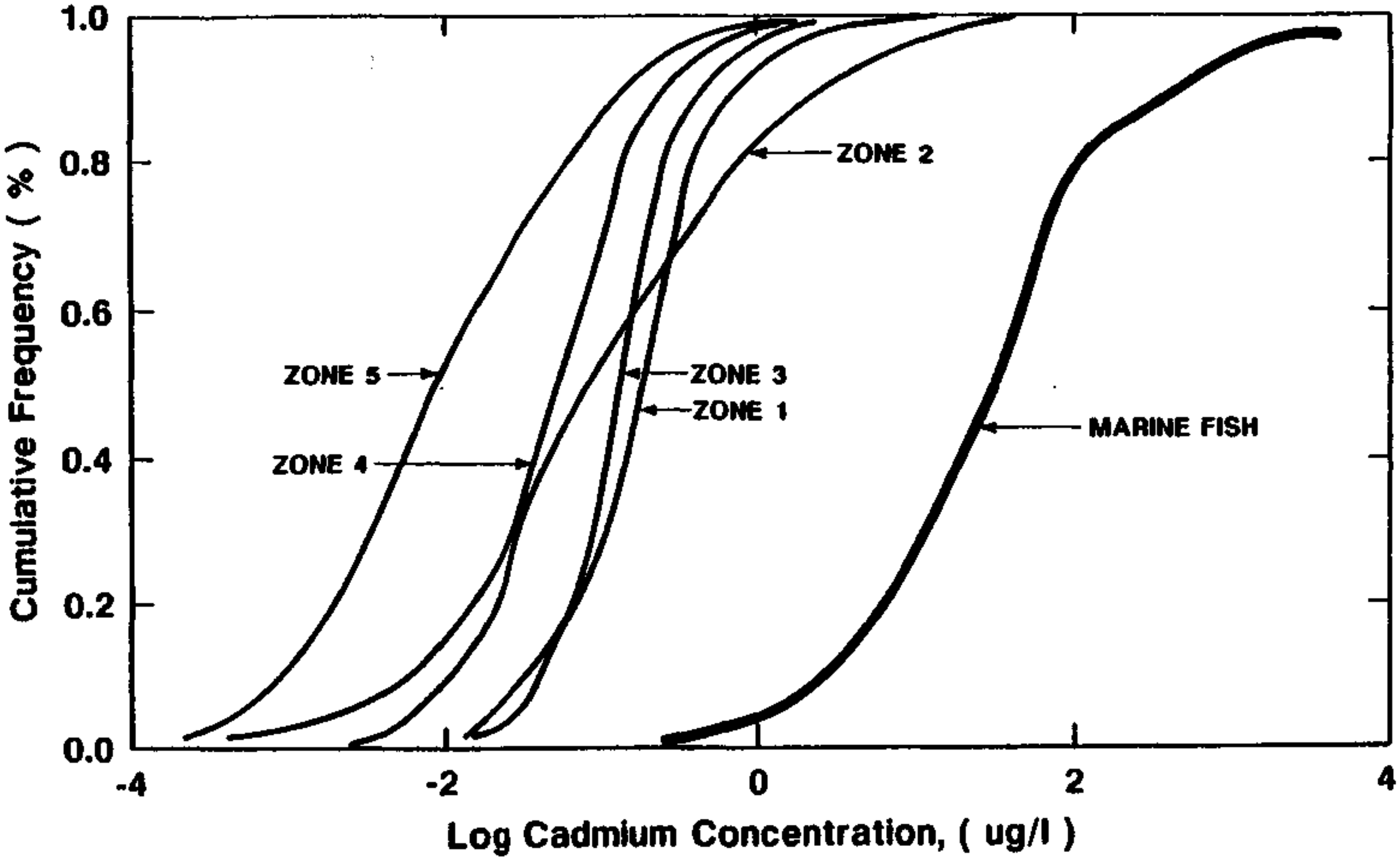


FIGURE C-38
MATC FOR MARINE FISH AND
EECs FOR ALL ZONES, CADMIUM, PORE WATER
NEW BEDFORD, MASSACHUSETTS

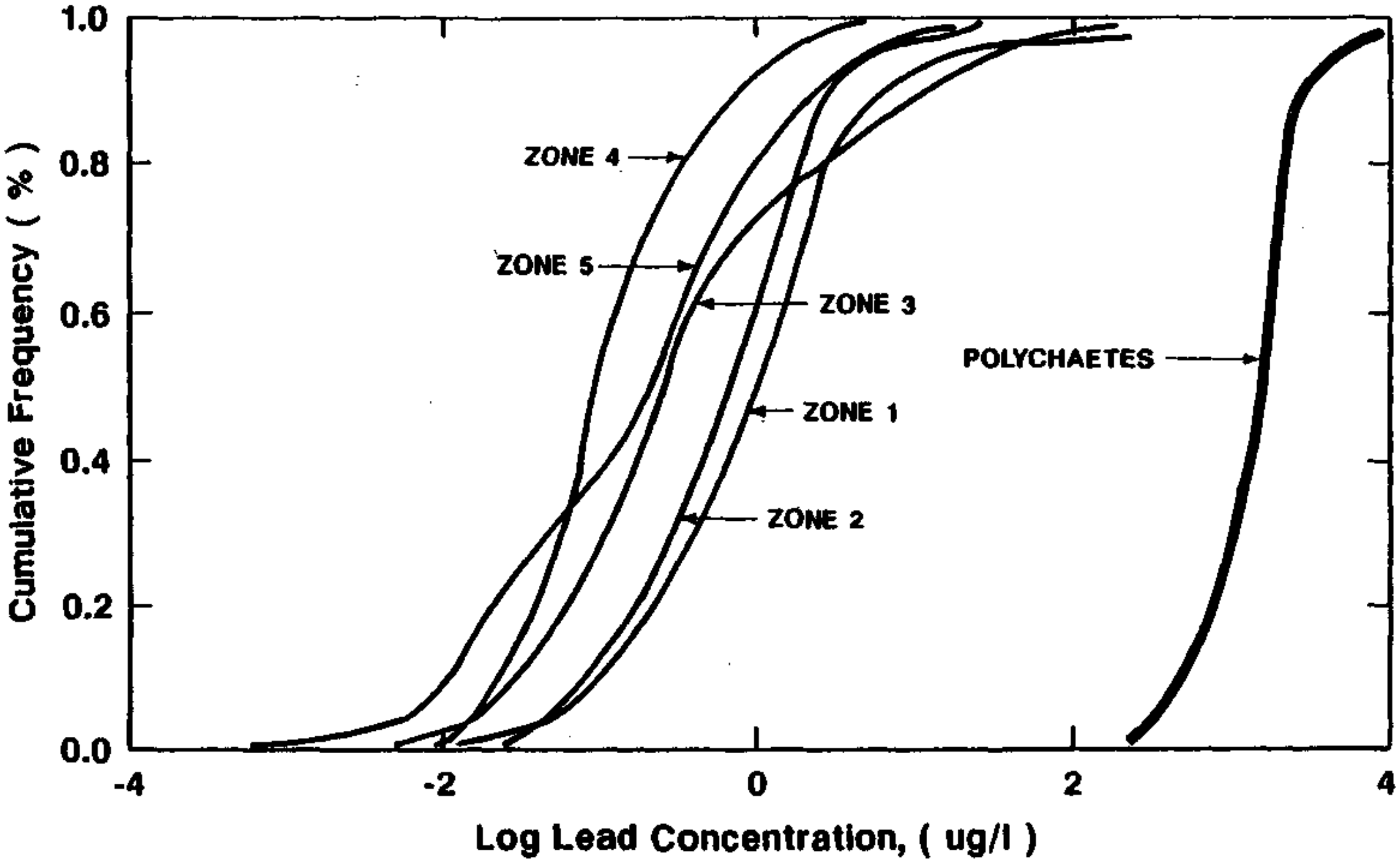


FIGURE C-39
MATC FOR POLYCHAETES AND
EECs FOR ALL ZONES, LEAD, PORE WATER
NEW BEDFORD, MASSACHUSETTS

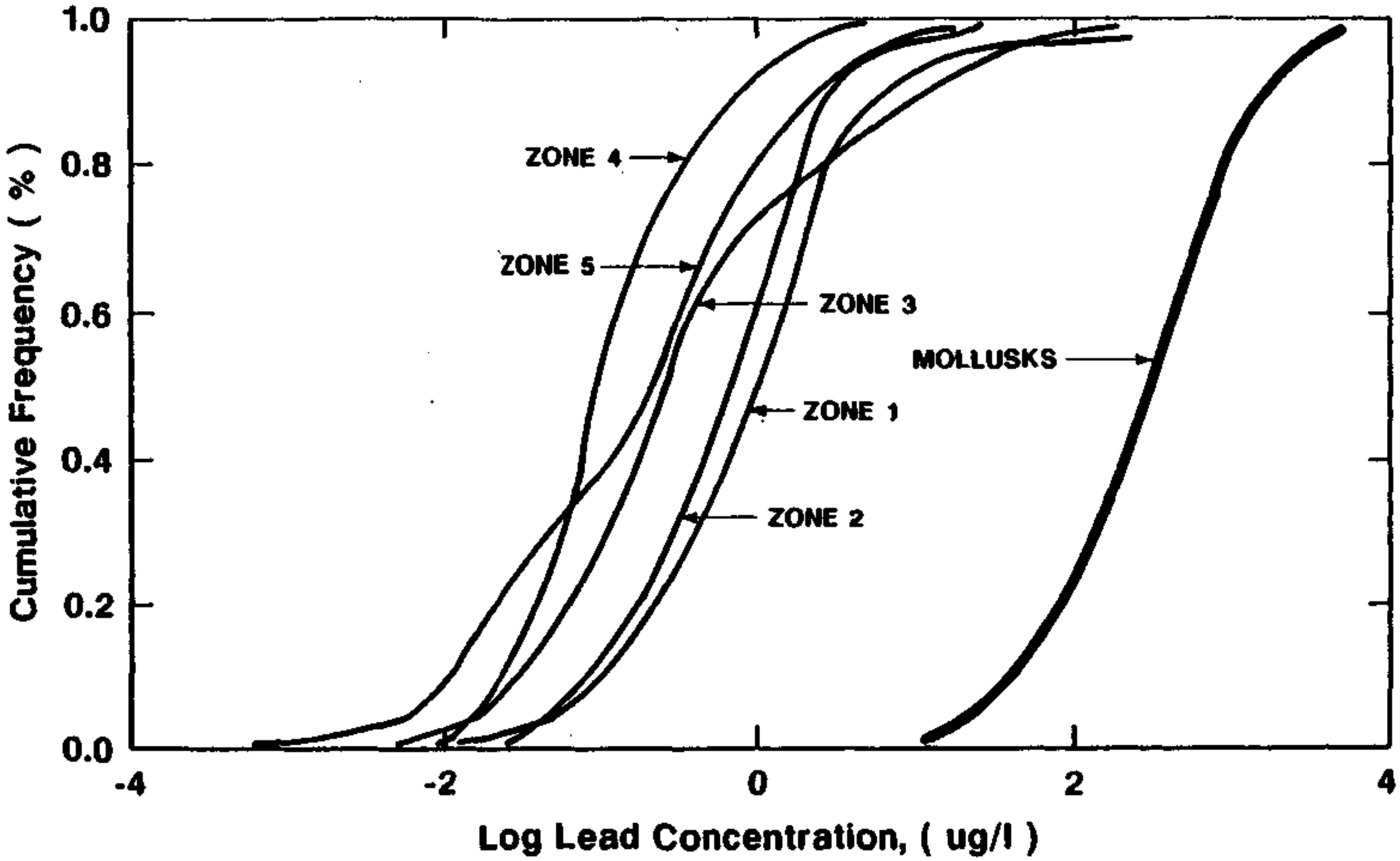


FIGURE C-40
MATC FOR MOLLUSKS AND
EECs FOR ALL ZONES, LEAD, PORE WATER
NEW BEDFORD, MASSACHUSETTS

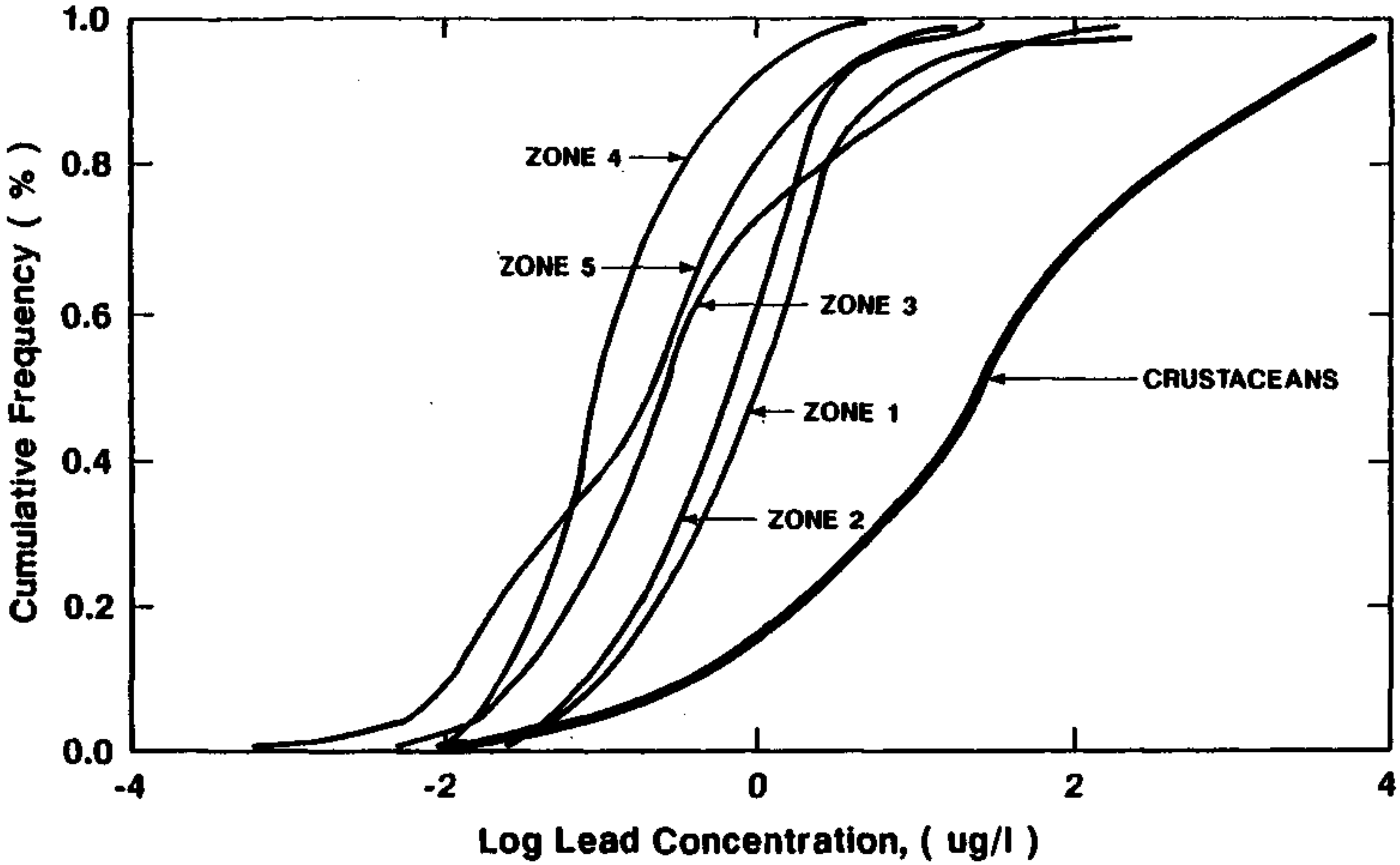


FIGURE C-41
MATC FOR CRUSTACEANS AND
EECs FOR ALL ZONES, LEAD, PORE WATER
NEW BEDFORD, MASSACHUSETTS

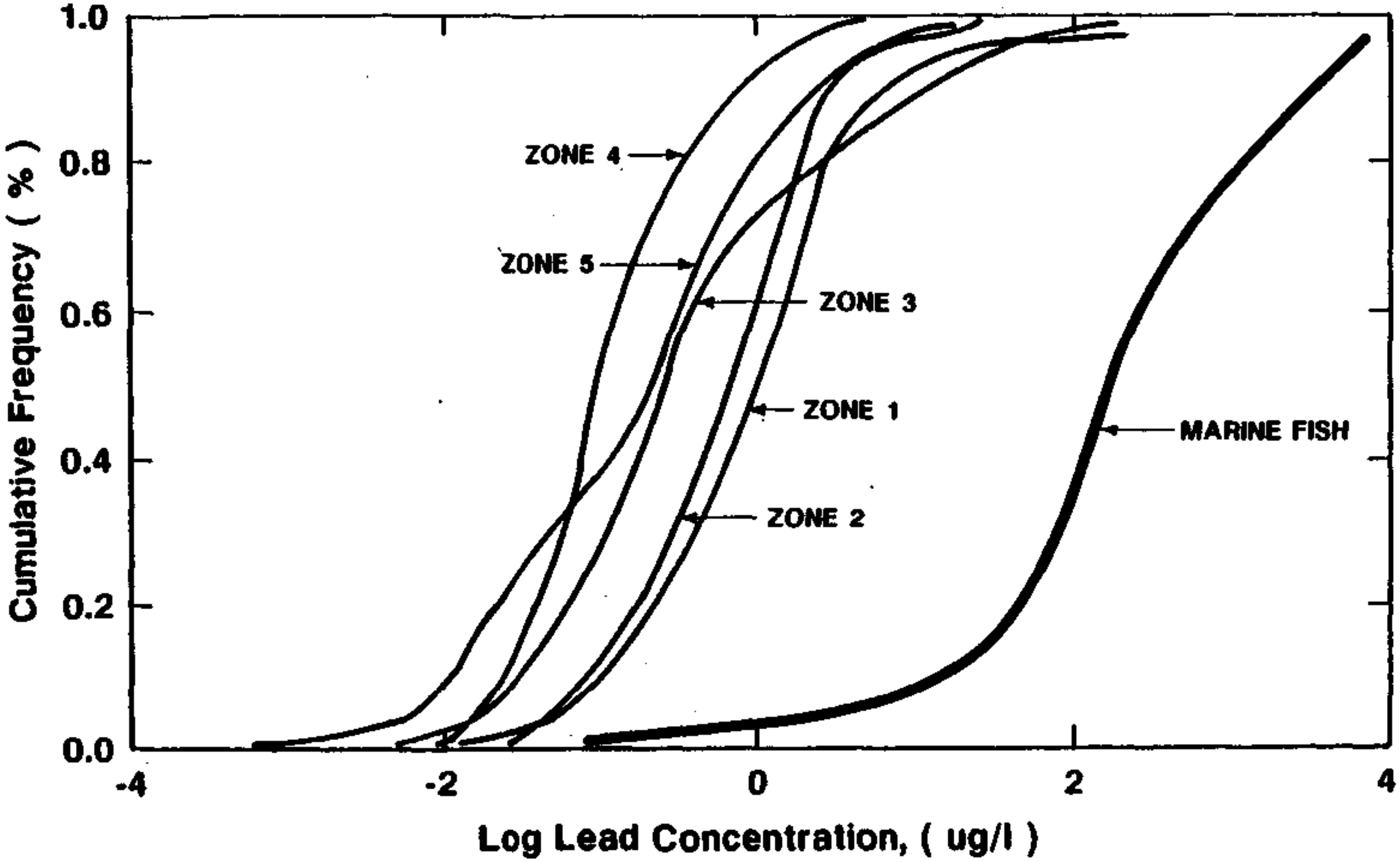


FIGURE C-42
MATC FOR MARINE FISH AND
EECs FOR ALL ZONES, LEAD, PORE WATER
NEW BEDFORD, MASSACHUSETTS

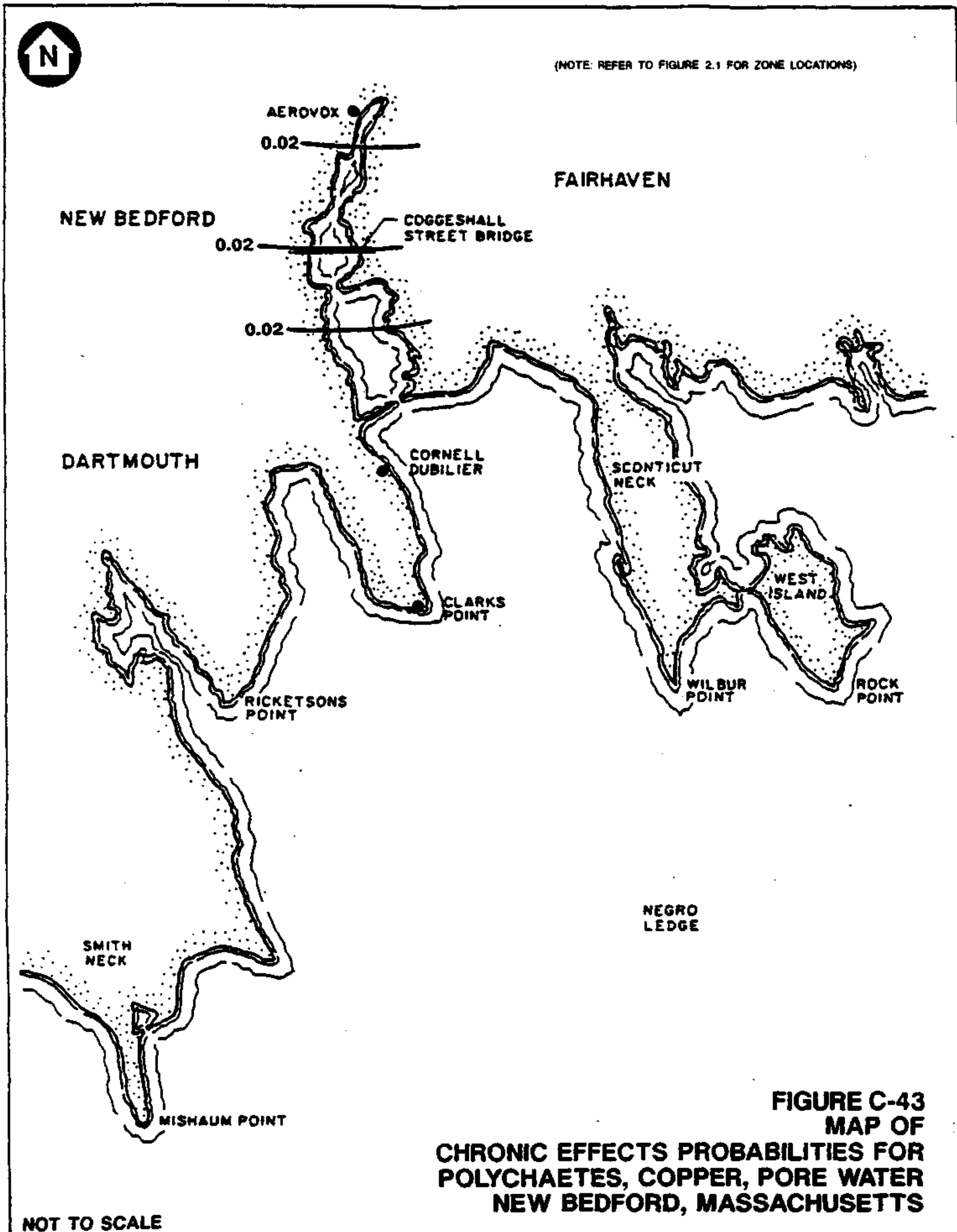


FIGURE C-43
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR POLYCHAETES, COPPER, PORE WATER NEW BEDFORD, MASSACHUSETTS

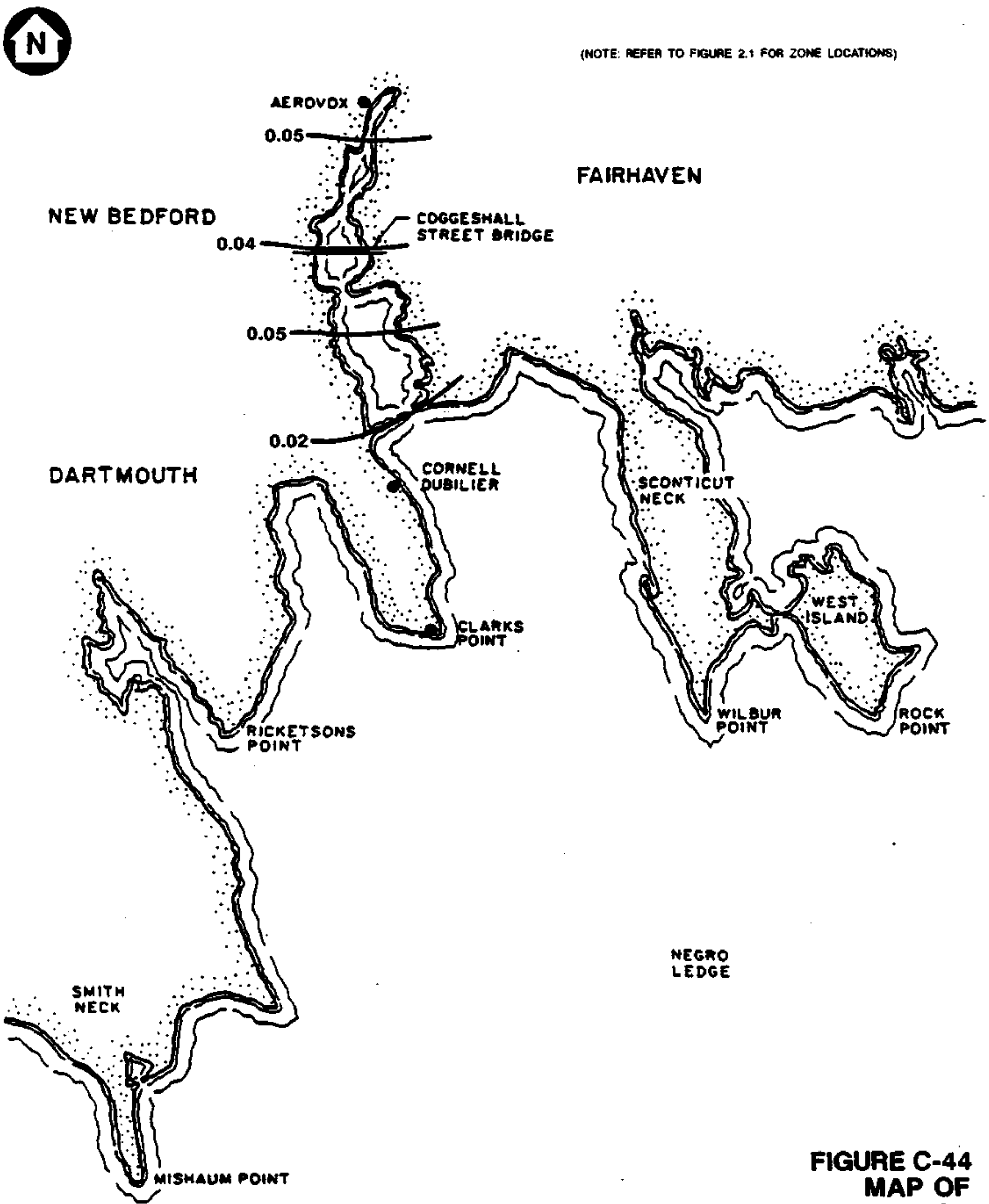


FIGURE C-44
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MOLLUSKS, COPPER, PORE WATER
NEW BEDFORD, MASSACHUSETTS

NOT TO SCALE

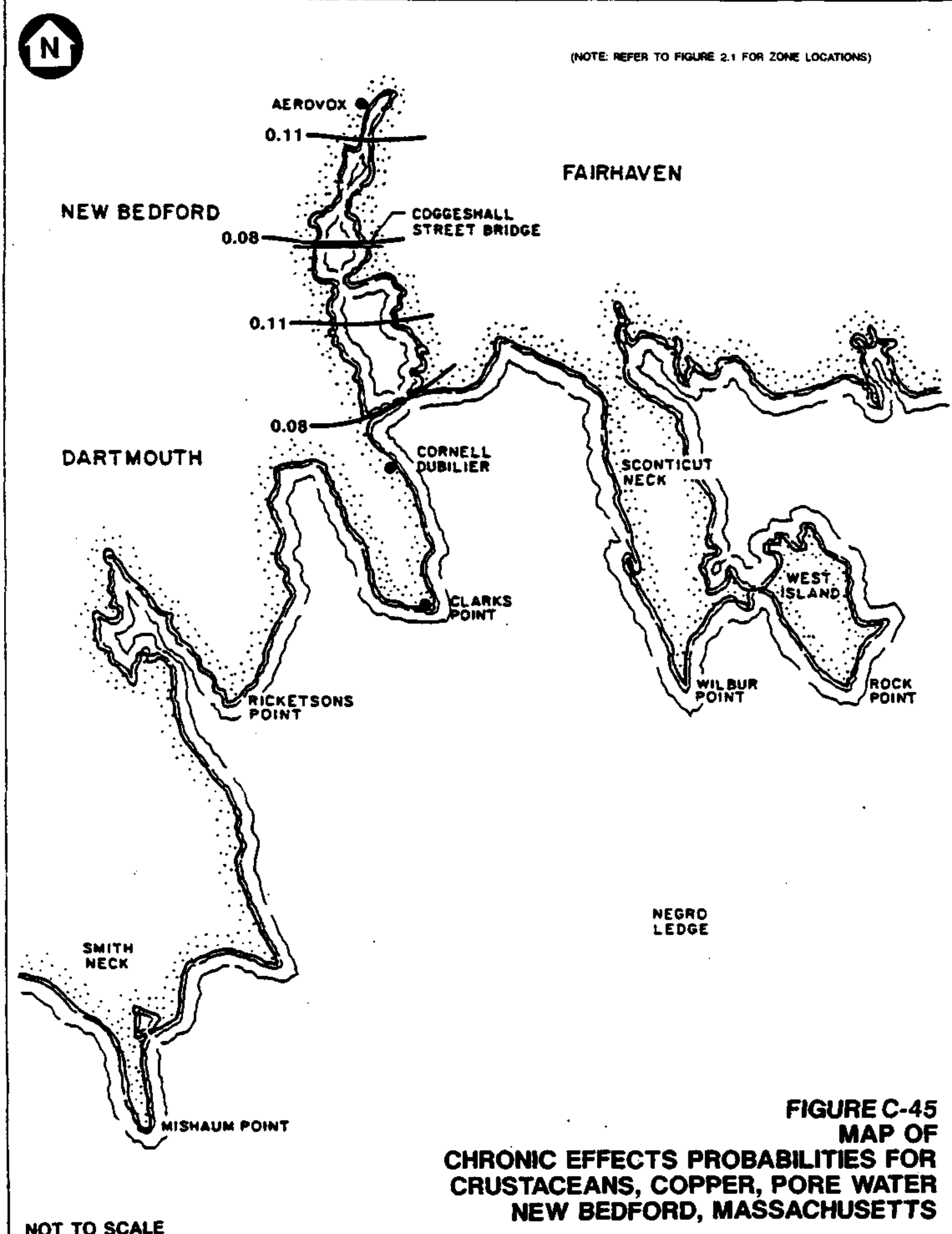


FIGURE C-45
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR CRUSTACEANS, COPPER, PORE WATER
NEW BEDFORD, MASSACHUSETTS

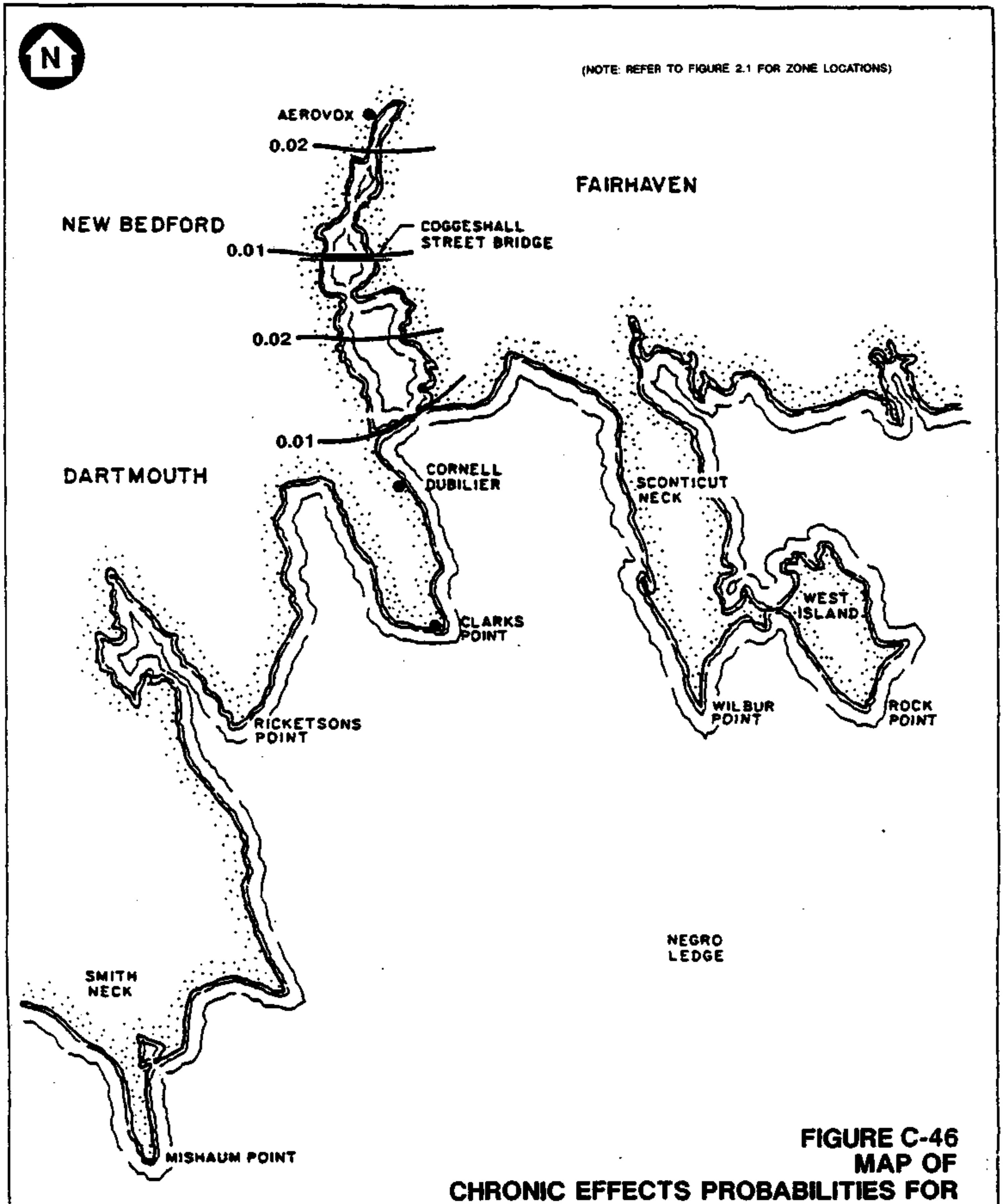


FIGURE C-46
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MARINE FISH, COPPER, PORE WATER
NEW BEDFORD, MASSACHUSETTS

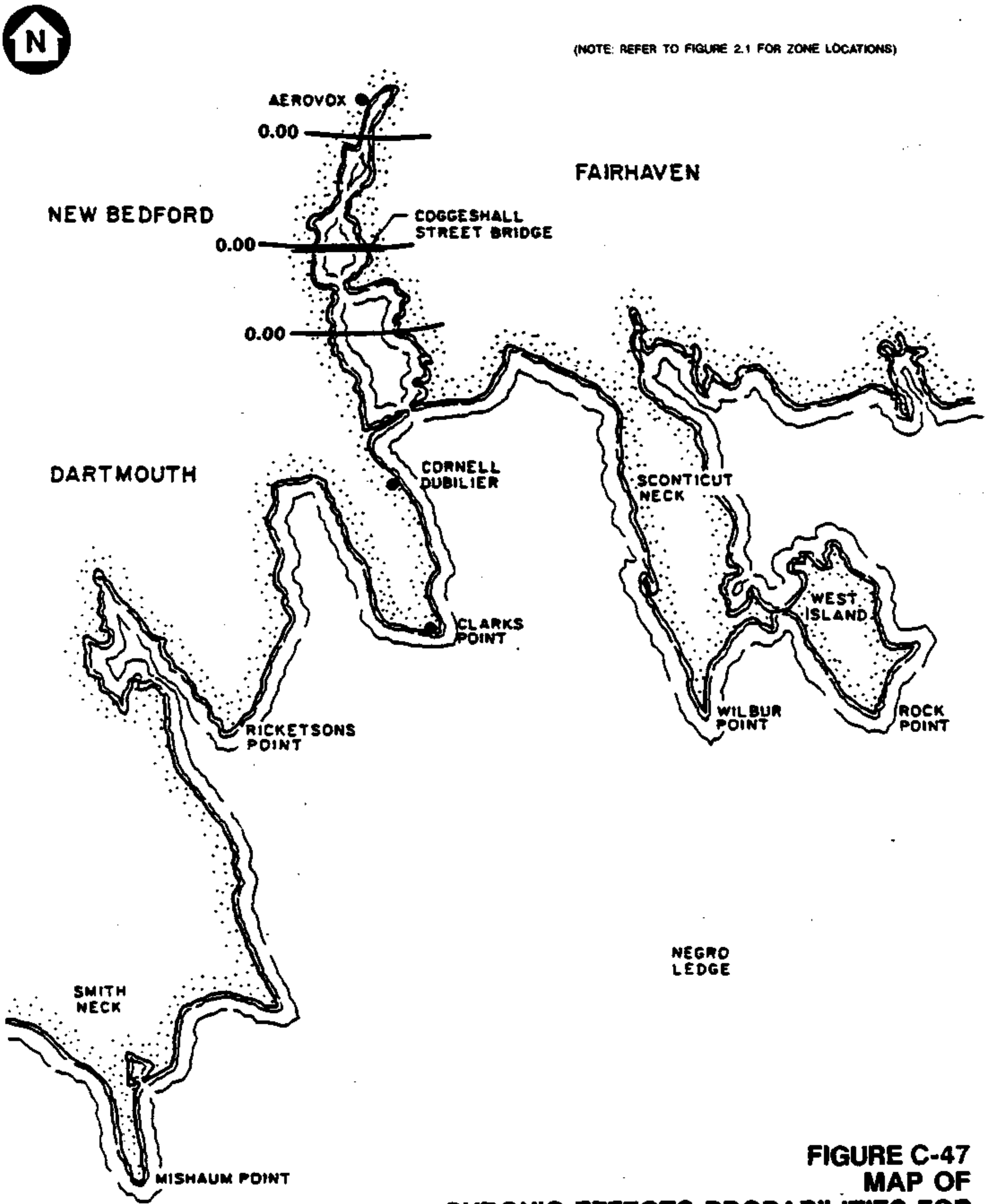


FIGURE C-47
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR POLYCHAETES, CADMIUM, PORE WATER NEW BEDFORD, MASSACHUSETTS

NOT TO SCALE

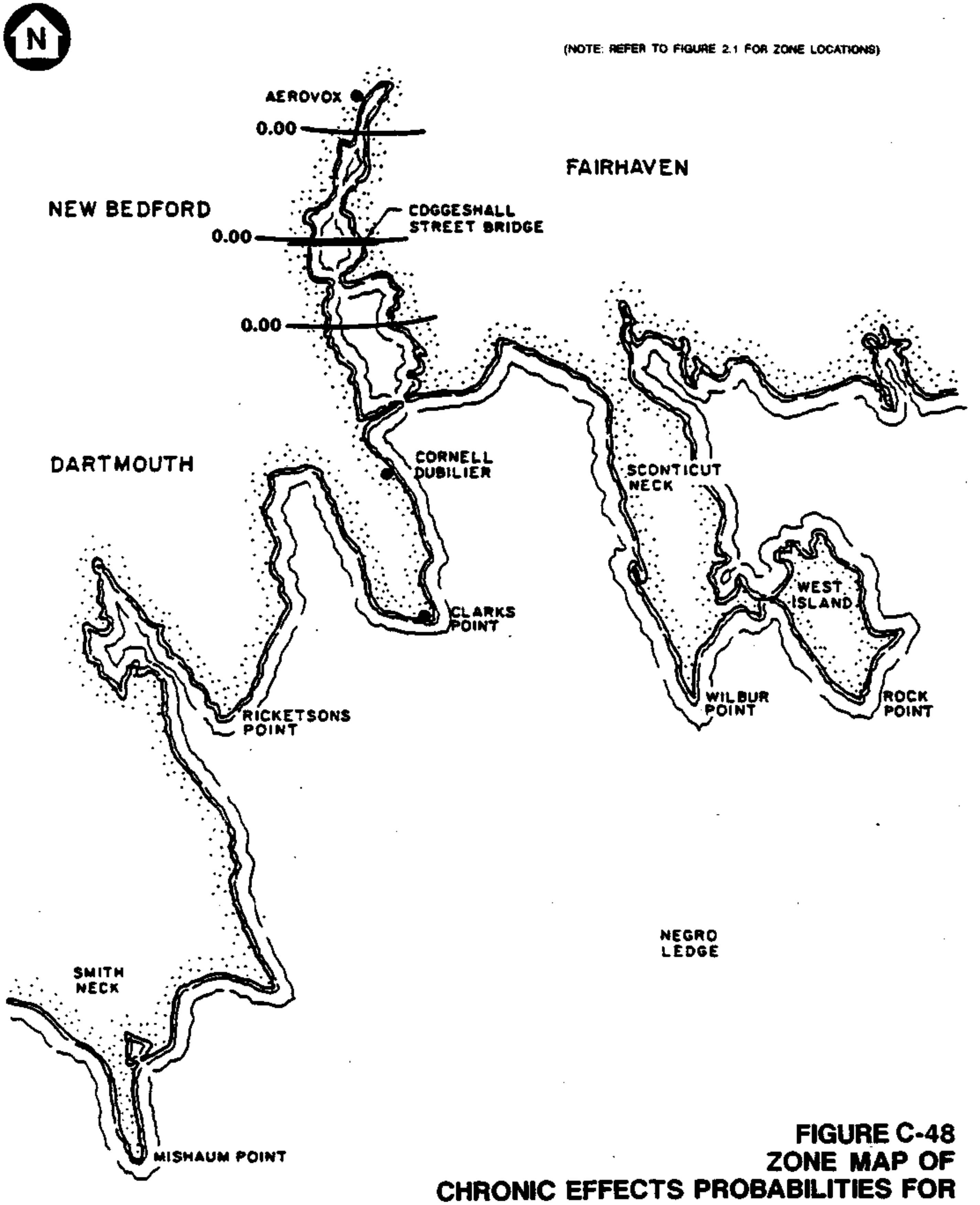


FIGURE C-48
ZONE MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MOLLUSKS, CADMIUM, PORE WATER
NEW BEDFORD, MASSACHUSETTS

NOT TO SCALE

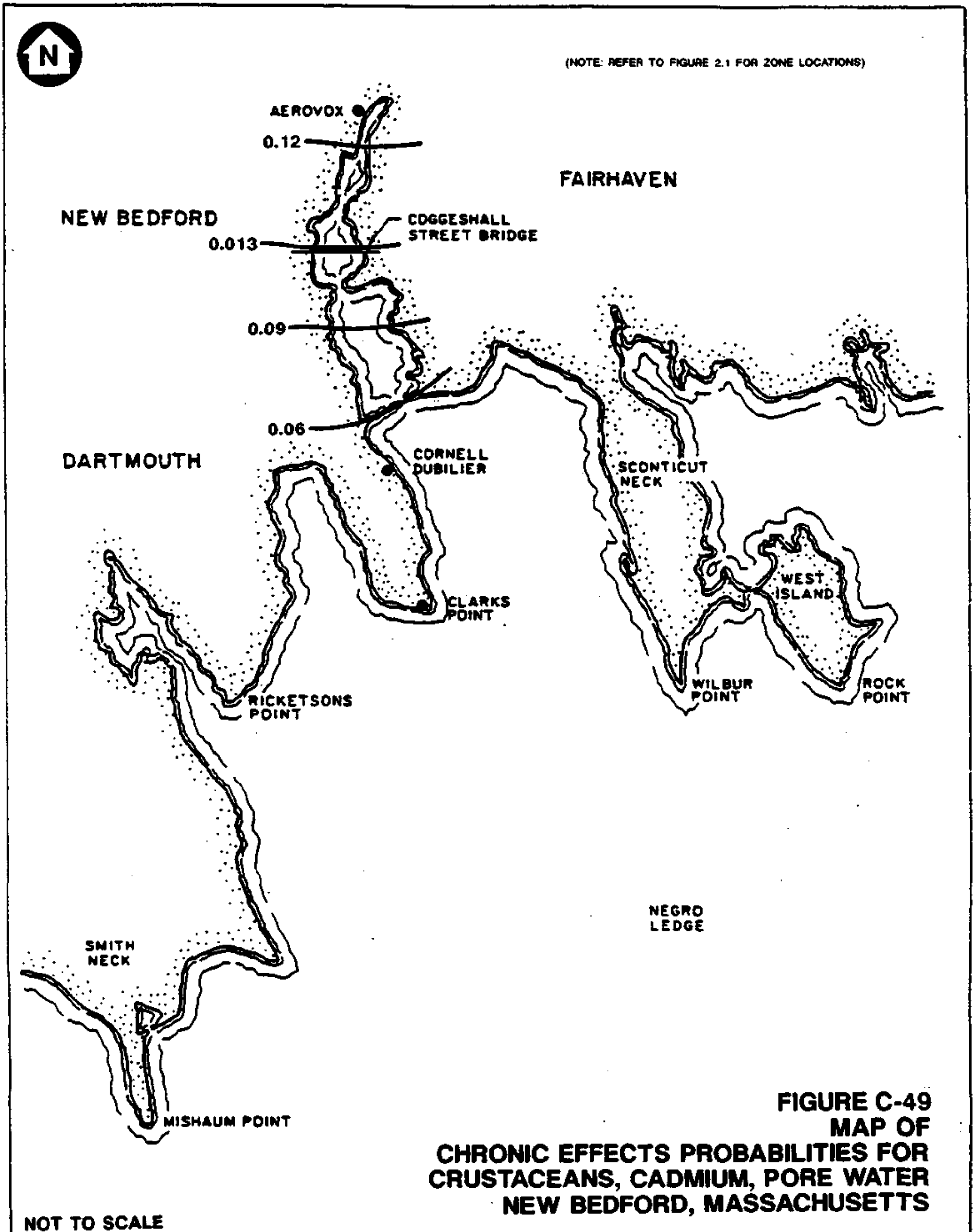


FIGURE C-49
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR CRUSTACEANS, CADMIUM, PORE WATER
NEW BEDFORD, MASSACHUSETTS

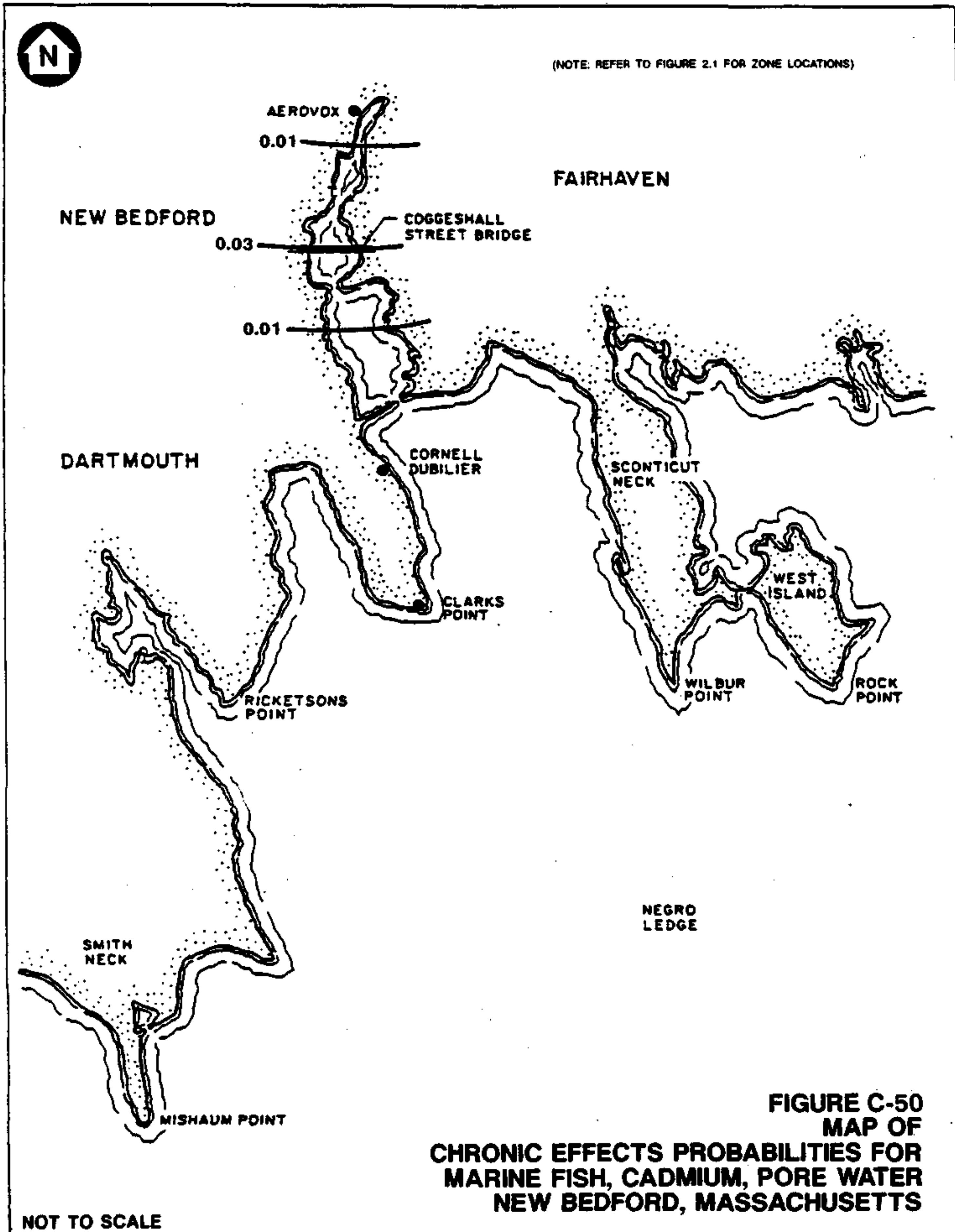


FIGURE C-50
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MARINE FISH, CADMIUM, PORE WATER
NEW BEDFORD, MASSACHUSETTS

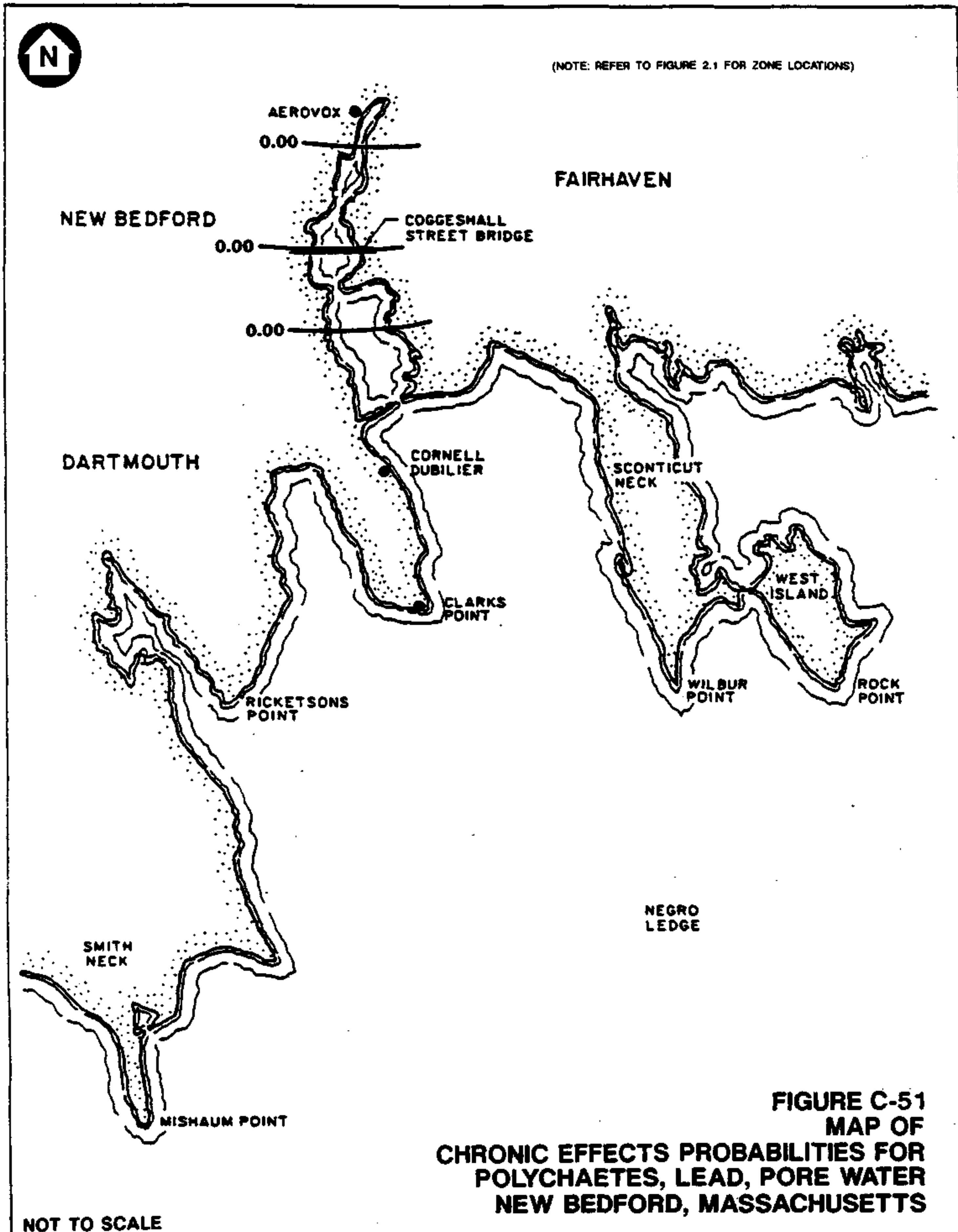


FIGURE C-51
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
POLYCHAETES, LEAD, PORE WATER
NEW BEDFORD, MASSACHUSETTS

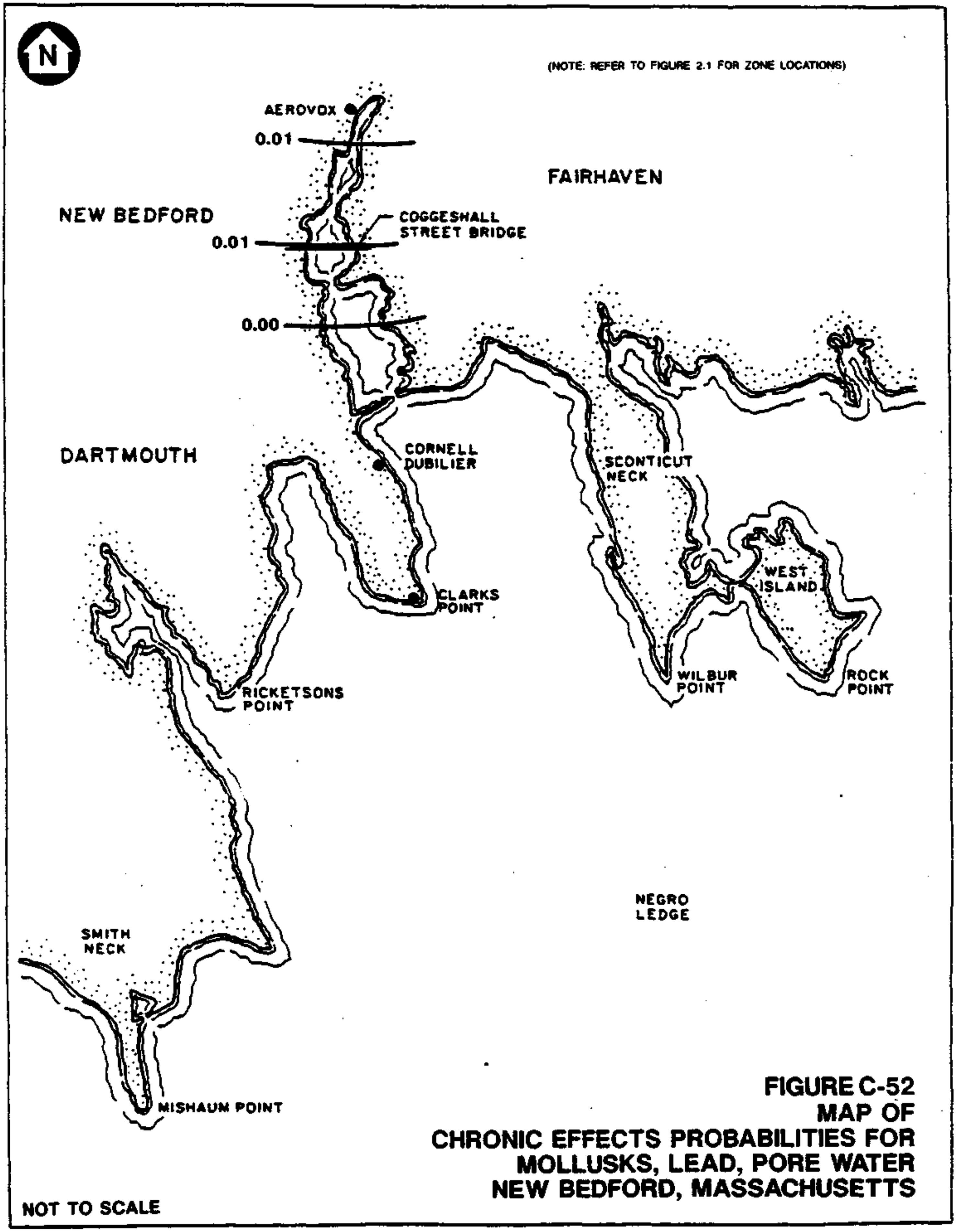


FIGURE C-52
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
MOLLUSKS, LEAD, PORE WATER
NEW BEDFORD, MASSACHUSETTS

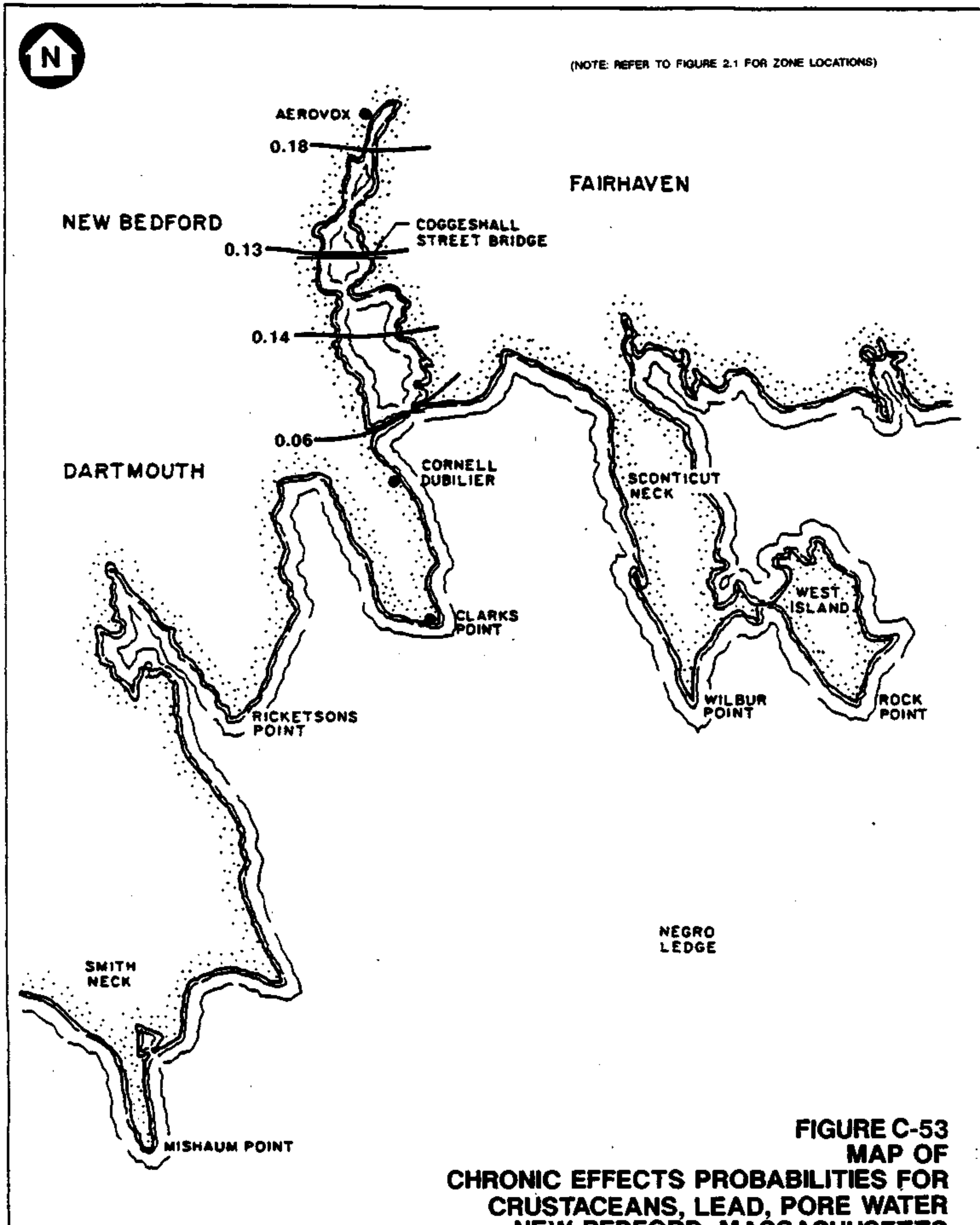


FIGURE C-53
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR
CRUSTACEANS, LEAD, PORE WATER
NEW BEDFORD, MASSACHUSETTS

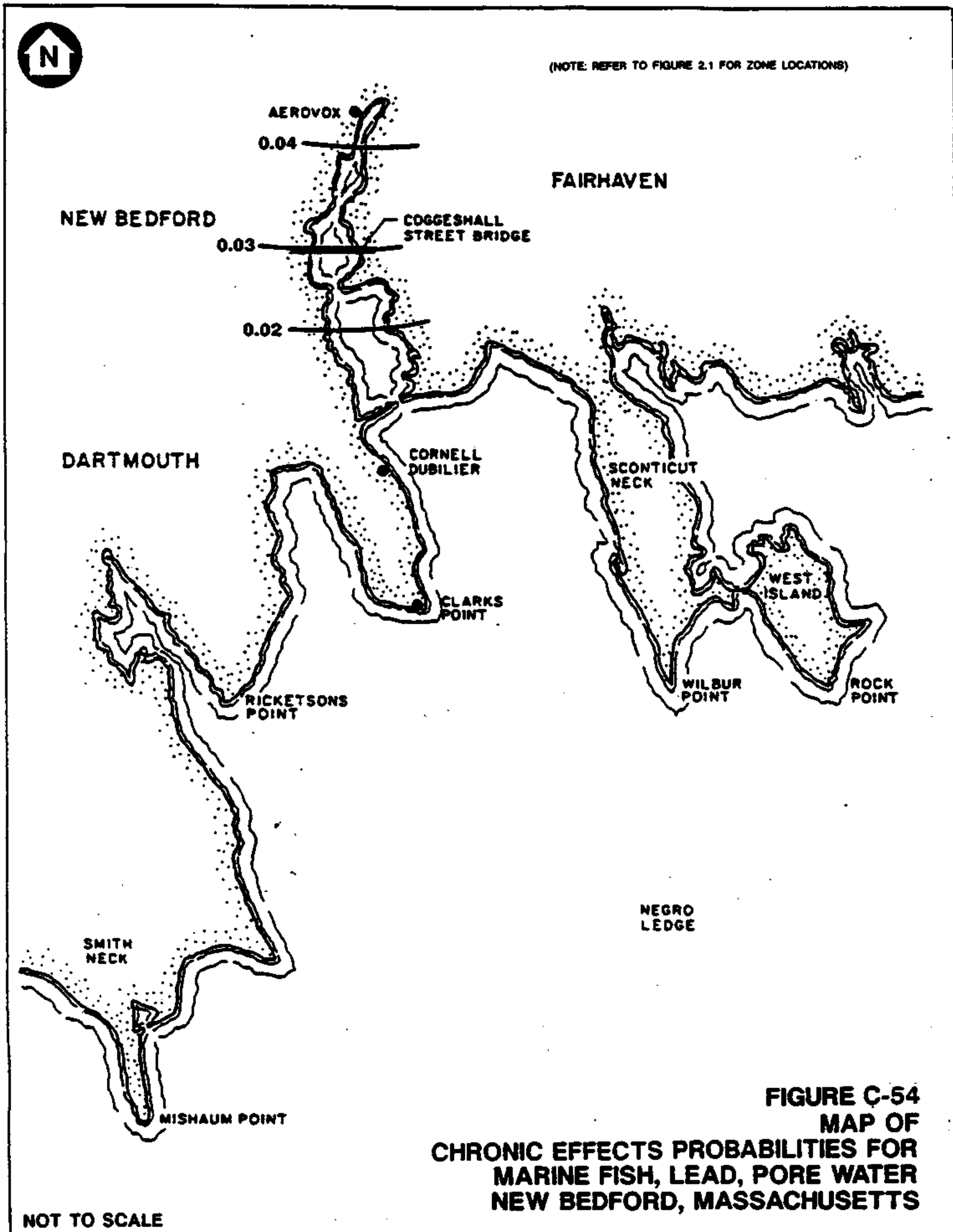


FIGURE C-54
MAP OF
CHRONIC EFFECTS PROBABILITIES FOR MARINE FISH, LEAD, PORE WATER NEW BEDFORD, MASSACHUSETTS

May 2010

US Army Corps of Engineers
Engineer Research and Development Center

Assessment of Contaminant Loss and Sizing for Proposed Lower Harbor Confined Aquatic Disposal (CAD) Cell

New Bedford Harbor Superfund Site Massachusetts

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Prepared for U.S. Environmental Protection Agency, Region 1

Contents

Preface

This report describes the sediment characterization, sequential batch leachate testing (SBLT), modeling and assessment of the lower New Bedford Harbor CAD cell for sizing and contaminant loss. Testing and characterization was conducted on five composite sediment samples collected from New Bedford Harbor dredge management units (DMUs) 3 to 37 and 102 to 105. The sediment specimens were sampled and composited by Jacobs Field Services. Each composite was prepared to represent one year of dredging (at a high annual funding rate). Site water was also collected by Jacobs Field Services at the location of the proposed lower harbor CAD cell. Sediment characterization was performed by GeoTesting Express, Katahdin Analytical Services, and laboratories at the U.S. Army Engineer Research and Development Center (ERDC). GeoTesting Express and ERDC Environmental Laboratory (EL) performed geotechnical analyses. Both Katahdin Analytical Services and laboratories at ERDC EL conducted chemical analysis of the sediment composites and harbor water samples. ERDC EL also conducted SBLT on the five sediment composites to determine the partitioning characteristics of PCB and copper in the sediment. The results of the consolidation testing were used to develop void ratio-effective stress relationships and void-ratio permeability relationships for consolidation analysis. The results of the SBLT were used to develop a single set of partitioning coefficients that are representative of all of the composites for PCB and copper. Consolidation, dredged material placement and contaminant fate and transport modeling for sizing and contaminant loss were performed by ERDC EL. The EPA Remedial Project Manager is Mr. Dave Dickerson of EPA Region 1. The USACE project managers were Mr. Robert Leitch and Mr. Mark J. Anderson, Jr. of the New England District.

Drs. Paul Schroeder and Thomas J. Fredette of the Environmental Engineering Branch (EP-E), Environmental Processes and Engineering Division (EPED), EL; Dr. Carlos Ruiz of the Water Quality and Contaminant Modeling Branch (EP-W), EPED, EL; and Dr. Earl Hayter of the Coastal Processes Branch, Flood and Storm Protection Division, Coastal and Hydraulics Laboratory wrote this report.

This study was conducted under the direct supervision of Ms. Deborah R. Felt, Acting Chief of EP-E, and under the general supervision of Dr. Richard E. Price, Chief of EPED, Dr. Beth Fleming, Director of EL, Dr. James R. Houston, Director of ERDC, and Col. Gary E. Johnston, EN, Commander of ERDC.

The authors would like to acknowledge Mr. Michael G. Channell, Mr. Richard Hudson and Ms. Damarys Acevedo for laboratory support.

Abstract

EPA Region I is evaluating the use of CAD cells as a sediment management alternative for PCB and copper contaminated sediments at the New Bedford Harbor Superfund Site (NBHSS). This report provides EPA with short- and long-term modeling results on estimated contaminant losses and physical sediment behavior during and after filling of a potential lower harbor CAD cell (LHCC). This report also provides verification of CAD cell size for containment of the contaminated sediment and capping materials.

The sizing evaluation determined the surficial footprint of the CAD cell required to contain the sediment and capping material considering the side slope requirements, depth to bedrock, the potential for bulking during dredged material placement, and the potential spreading of the dredged material from its kinetic energy during its collapse in the CAD cell following placement. The contaminant loss evaluation included both short-term losses (prior to capping) and long-term losses (following capping). Short-term losses include displacement of CAD cell water contaminated by resuspension and stripping of dredged material during placement, consolidation of the dredged material, diffusion from the exposed dredged material, diffusion of contaminants to the upper water column from the contaminated CAD cell water, and mixing of the contaminated CAD cell water with the upper water column by turbulent diffusion and thermally induced overturning. Long-term losses include diffusion and consolidation of the dredged material from the pressure load induced by the thick deposit of dredged material and capping material.

A 650 ft x 650 ft x 47 ft CAD cell is sufficiently large to contain 335,000 cubic yards of sediment and 44,000 cubic yards of capping materials plus the potential bulking during dredging and placement. About 10 ft, or 20 to 25% of bulking, is expected, but this volume of bulking will be recovered (i.e., reduced to initial volume) within the proposed three years of placement operations. An additional 11 ft of consolidation is expected after capping as predicted using the U.S. Army Corps of Engineers' (USACE) Primary Consolidation, Secondary Compression and Desiccation of Dredged Fill (PSDDF) model.

Short-term contaminant losses to the water column above the CAD cell resulting from placement operations are predicted to be about 0.08% of the total PCB mass and 0.03% of the total copper mass placed in the CAD cell. Resuspension and stripping of dredged material during placement will increase the dissolved contaminant concentrations in the CAD cell water to be approximately equal to the sediment pore water contaminant concentrations. The losses were predicted using the USACE STFATE model (Short-Term FATE of dredged material placed in open water) to predict sediment resuspension, a partitioning spreadsheet model to compute dissolved contaminant concentrations, and the USACE RECOVERY model to predict losses by diffusion.

Capping with a 3-ft sand layer is sufficient to provide long-term isolation of the contaminants in the dredged sediment from the water column. After capping, the contaminants expelled from the dredged material by consolidation would be contained in the lower foot of the cap as predicted by the USACE CAP model. Without consideration of burial, contaminant breakthrough of the cap at a concentration of 0.01% of the pore water contaminant concentration (e.g., 0.01% of 7 ppb PCB or 0.0007 ppb PCB) will take more than 1800 years as predicted by the USACE RECOVERY model. With burial promoted by the dredged material settlement, the transport of contaminants through the cap and burial material will take tens of thousands of years.

1 — Executive Summary

Objectives

There are two objectives for this CAD cell modeling study of the proposed lower New Bedford Harbor CAD cell: verification of CAD cell size for containment of the contaminated sediment and capping materials, and quantification of contaminant losses during dredged material placement, from consolidating dredged material prior to and after capping, and from long-term diffusion after consolidation becomes insignificant. Containment includes not only capture and storage of the dredged material and capping materials, but also the bulk of the stripped or resuspended materials during placement and the dynamic spreading of the dredged material from the kinetic energy of the discharge during its collapse in the CAD cell. Contaminant losses during placement includes the partitioning of contaminants to the water column from stripped or resuspended dredged material during placement, discharge of pore water from the settled dredged material by consolidation considering the entrainment of water in the dredged material during placement, diffusion of contaminants from the dredged material and through the cap, and the exchange of water in the CAD cell with the overlying water column.

Testing

Testing and characterization was conducted on five composite samples collected from DMUs 3 to 37 and 102 to 105[1]. The sediment specimens were sampled and composited by Jacobs Field Services. Each composite was prepared to approximate one year of dredging (at a high annual rate of funding). Composite 1 was composed of DMUs 3 to 7, and DMUs 102 and 103. Composite 2 was composed of DMUs 8 to 15. Composite 3 was composed of DMUs 16 to 24 and DMUs 104 and 105. Composite 4 was composed of DMUs 25 to 33 and Composite 5 was composed of DMUs 34 to 37. Composites 4 and 5 and a portion of Composite 3 approximate the dredged material under consideration for disposal in a LHCC. Site water was also collected by Jacobs Field Services at the general location under consideration for a LHCC.

Sediment characterization was performed by GeoTesting Express, Katahdin Analytical Services, and laboratories at the U.S. Army Engineer Research and Development Center (ERDC). GeoTesting Express performed the following geotechnical analyses: Moisture Content (ASTM D 2216), Specific Gravity (ASTM D 854), Grain Size Analysis with Hydrometer (ASTM D 422), Atterberg Limits (ASTM D 4318), Flexible Wall Permeability (ASTM D 5084), and Incremental Consolidation (ASTM D 2435). ERDC analyzed the composites for moisture content (ASTM D 2216) and organic content (ASTM D 2974). Both Katahdin Analytical

[1] The original scope for this effort envisioned modeling both an upper and a lower harbor CAD cell. The scope was subsequently revised to focus on the LHCC to better support EPA's remedy decision-making process. Certain parts of this report reflect the original scope and have been retained rather than discarded to memorialize the effort undertaken to date.

Services and laboratories at ERDC conducted chemical analysis of the sediment composites and harbor water samples. ERDC laboratories also conducted Sequential Batch Leaching Testing (SBLT) (ASTM Method D-4793), on the five sediment composites to determine the partitioning characteristics of PCB and copper in the sediment. The results of the consolidation testing were used to develop void ratio-effective stress relationships and void-ratio permeability relationships for each of the five composites. The results of the SBLT were used to develop a single set of partitioning coefficients that are representative of all of the composites for PCB and copper. Results for PCB Aroclors 1242, 1254, and 1248 were reported by Katahdin Analytical Services, the ERDC laboratory, or both and the worst-case values for each Aroclor were used in the modeling. Aroclor 1248 was not included in the original plan, but was provided as part of the ERDC laboratory data reporting package and was thus included in the modeling analyses.

Modeling

Sizing and Filling

Several modeling tasks were conducted to analyze the CAD filling, sizing and contaminant losses. A cut and fill spreadsheet analysis was perform to determine the size of CAD cell needed to contain the proposed volume of dredged material and to estimate the lift thicknesses of the annual fills for consolidation analysis. A 650' x 650' surface footprint was selected with a side slope of 1V:6H for the top 7 ft of depth and 1V:3H for the remaining 47 ft of depth below the existing sediment surface.

Consolidation

The consolidation of the dredged material was analyzed using the USACE PSDDF model. The PSDDF model results showed that the CAD cell size was appropriate to contain the proposed volume of dredged material, considering the entrainment of water in the dredged material, the volume of capping material, spreading of dredged material from the placement dynamics, suspended solids retention, and consolidation prior to capping. The consolidation results were analyzed to determine the predicted pore water expulsion rates for contaminant loss predictions both prior to and after capping.

The CAD sizing analysis showed that the center of the lower harbor CAD cell would be filled with 42 ft of dredged material based on its in situ density. Analysis of potential water entrainment in the dredged material during both dredging and placement through the water column yielded an estimate of bulking or entrainment that would result in placement of 52 ft of dredged material and 3 ft of capping material, a total of 55 ft of material in our cell that is 47 ft deep. However, the PSDDF model predicted that in the center section of the CAD cell, 10.3 ft of pore water would be expelled from the placed dredged material prior to capping, primarily from the 10 ft of water that was predicted to be entrained during dredging and placement through the water column (mostly at depth from the first lift placed). Therefore, the depth of fill immediately after capping is 44.7 ft, providing a freeboard of 2.3 ft. After capping, an additional 7.2 ft of pore water is predicted to be expelled in the first 10 years, 9.4 ft of pore water in the first 20 years and 10.9 ft of pore water in the first 40 years. At 40 years, the dredged material is predicted to be 94% consolidated. Based on the PSDDF model results, much of the contaminant losses would be expected to occur during placement and prior to capping.

Placement

The open water placement of dredged material in the lower harbor CAD cell was modeled using the STFATE model to predict the entrainment of water in the deposited dredged material, the mass of dredged material suspended in the water column, the suspended solids concentration in the water column, the settling time, and the vertical and lateral distribution of suspended solids following a barge discharge of dredged material. STFATE model runs were conducted on 500-cubic yard barge discharges at the beginning and end of each dredging season to simulate the range of placement impacts for each dredging season and to estimate annual contaminant losses during placement. Losses between the beginning and end runs were assumed to exhibit a linear response based on past experience with the model.

The STFATE model results show that about 3 to 4% of the fine-grained fraction of the dredged material remains in suspension about 3 to 4 hours after the barge discharge and disperses in the CAD cell water below the loaded draft depth of the barge, resulting in average TSS concentrations ranging from about 20 mg/L for the first season to 150 mg/L for the third season. The upper 10 ft of the CAD cell water, which is potentially exchangeable with the overlying water column based on higher resolution hydrodynamic modeling of the CAD cell and its surrounding area, is predicted to have average TSS concentrations of about 5 mg/L during the first dredging season, 15 mg/L during the second dredging season and 100 mg/L during the third season, In a shallow saline environment such as New Bedford Harbor and the CAD cell, the TSS concentration will typically decrease to 50 mg/L within a day and to 10 mg/L within a week (NOTE: see results of field plume surveys in Section 5).

The discharge plume collapse dynamics were modeled using the USACE SURGE model to examine whether the momentum of the discharged material was sufficient to cause the dredged material to run up the side slope and out of the CAD cell. All discharges are assumed to be within the area of the level bottom, a 326-ft square, and no closer than 160 ft horizontally from the lip of the CAD cell. The dynamics were examined for all three sediment composites across the range of water depths that would exist during their placement. In all cases the discharged material is not predicted to run up the slope above a depth of about 11 ft below the lip or about 55 ft horizontally from the lip. Therefore, the CAD cell is expected to be capable of confining the dredged material during placement.

Short-Term Partitioning and Contaminant Loss

The contaminants associated with the TSS will partition with the CAD cell water. It is unlikely that the partitioning reaches equilibrium before the particles interact with particles from subsequent discharges, flocculate and settle. The kinetics of PCB desorption in a stagnant water column is sufficiently slow that it may take weeks to reach equilibrium; however, 10 to 20% of the PCB may desorb in the first day. The partitioning of contaminants to the CAD cell water over the large number of discharges in a dredging season is predicted to be sufficient to achieve a contaminant concentration in the CAD cell water approximately equal to the pore water concentration of the sediment or dredged material.

The dissolved contaminants and particulate-associated contaminants in the upper portion of the CAD cell will be lost as the CAD cell water is displaced by subsequent barge discharges. The displacement volumes are likely to be about 10 to 20% greater than the volume of sediment being dredged due to entrained water in the mechanical dredge/excavator bucket. This would amount to about 50,000 cubic yards in Year 1, 180,000 cubic yards in Year 2, and 150,000 cubic yards in Year 3. An additional 25,000 cubic yards of CAD cell water will be displaced in Year 3 by cap placement.

Hydrodynamics modeling yielded only low velocities in the water column above the CAD cell, typically less than 0.3 fps. The velocity is sufficiently great to rapidly exchange the water above the CAD cell, typically in one to 3 hours. The velocity is sufficiently low to limit any mixing in the CAD cell water, mostly in the top few feet. However, higher resolution hydrodynamic modeling of the CAD cell environ performed using the 3-D Environmental Fluid Dynamic Code (EFDC) model set up for NBHSS sediment transport modeling showed the potential to set up a slow vertical eddy in the CAD cell that could provide slow mixing to a depth of 10 feet below the lip of the CAD cell. Therefore, contaminants in the top ten feet of the CAD cell were subjected to turbulent dispersion and exchange with the water column above the lip of the CAD cell. The 0.3 fps current speed from the hydrodynamic modeling was considerably greater than currents measured during 2009 CAD cell field monitoring inside a deployed silt curtain (Dragos 2009). On five separate monitoring events currents inside the silt curtain were less than 0.07 fps while observed currents west and east of the CAD were up to 1.0 and 0.5 fps, respectively.

The predicted losses of PCB (Aroclors 1242, 1248 and 1254) by the placement operations (resuspension and discharge) during the three years of filling the LHCC are 310 g in Year 1 (sediment composite 3), 1,050 g in Year 2 (sediment composite 4) and 1,120 g in Year 3 (sediment composite 5), about 0.038% of the total PCB mass removed from the associated dredging. The released PCB is about 81% Aroclor 1242 (mass loss about 0.06% of Aroclor 1242 total mass placed), 5% Aroclor 1248 (mass loss about 0.009% of Aroclor 1248 total mass placed) and 14% Aroclor 1254 (mass loss about 0.018% of Aroclor 1254 total mass placed). About 85% of the released PCB is predicted to be dissolved. The 0.038% mass loss is a weighted average based on the relative contribution of each Aroclor release (81%, 5%, and 14%) to the total release and their respective mass loss rates (0.06%, 0.01%, and 0.02%). Modeling did not include losses from the capping process, but disturbances from capping are expected to be minimal as the first layer of cap will isolate the majority of contaminated sediments at the surface of the CAD and limit further loss as capping proceeds.

The predicted losses of copper by resuspension and discharge during the three years of filling the LHCC are 1.9 kg in Year 1 (sediment composite 3), 7.5 kg in Year 2 (sediment composite 4) and 34.7 kg in Year 3 (sediment composite 5), about 0.020% of the total mass of copper removed from the associated dredging. About 50% of the released copper is predicted to be dissolved.

Contaminant losses from the CAD cell after placement of the annual lift is driven by turbulent diffusion from the CAD cell to the upper exchangeable water column. The annual loss of contaminants by turbulent diffusion from the lower water column is limited to about the top 118,000 cubic yards (10 feet) of contaminated CAD cell water after the annual placement operation ceases. The CAD cell is expected to contain about 3.3 kg of PCB and 15 kg of copper in 348,000 cubic yards of CAD cell water after Year 1, 1.0 kg of PCB and 6.8 kg of copper in 192,000 cubic yards of CAD cell water after Year 2, and 0.4 kg of PCB and 7 kg of copper in 71,000 cubic yards of CAD cell water after Year 3. Following cap placement, the contaminants in any remaining CAD cell water will be lost by turbulent diffusion.

An additional potential loss of contaminants is the displacement of CAD cell water in the fall or winter by the cold dense water diving into the CAD cell. However, due to the shallow depth of the overlying water column and the mixing that would occur, this mechanism is likely to limit the exchange to no more than 5 feet of water or 71,000 cubic yards in the CAD cell. This would limit the losses to about 20% of the contaminants in the CAD cell water between dredging seasons. Any losses between dredging seasons would be partially offset by decreasing the predicted losses during the next dredging season because the initial contaminant concentration in the CAD cell water at the start of the next dredging season would be lower.

The overall potential contaminant losses resulting from placement (including losses between seasons) are 1.9 kg PCB and 9.5 kg copper from Year 1, 1.9 kg PCB and 13.4 kg copper from Year 2, and 1.4 kg PCB and 40 kg copper from Year 3. These losses represent 0.08% of the total mass of the three PCB Aroclors modeled (0.13% of Aroclor 1242, 0.02% of Aroclor 1248 and 0.03% of Aroclor 1254), and 0.03% of the copper placed in the CAD cell.

Long-Term Contaminant Loss from Capped CAD Cell

The contaminant fate and transport from the capped CAD cell were evaluated in two parts. The first part was evaluated during the period of dredged material consolidation using the USACE CAP model, which considers pore water advection induced by consolidation. Ninety percent of the consolidation is completed only after 30 years, but meaningful contaminant transport by pore water expulsion is limited to the first two to four years. The second part was evaluated for the long term, after significant pore water advection ceases. During the long term, contaminant transport is dominated by diffusion of contaminants from the dredged material and into the cap. Long-term contaminant fate and transport from the capped CAD cell was modeled without considering contaminant degradation or transformation using the USACE RECOVERY model.

The CAP model was run on four separate sections of the CAD cell due to differences in dredged material thickness and predicted settlement. Each section represents about one quarter of the area of the CAD cell. The first section represents the center of the CAD cell and includes the entire section of the cell that has a level bottom. The next three sections are concentric bands around the center covering the sloped area of the CAD cell (see Figure 12). Each band has successively thinner dredged material thicknesses and smaller settlements. The CAP model results showed that the contaminants transported from the dredged material by pore water advection and diffusion would be contained in the lower foot of the cap, even in the center section, which had the largest settlement. The contaminant and sediment profiles from the end of the CAP model runs were used as the initial conditions for the long-term modeling using the RECOVERY model.

The RECOVERY model was used to compute contaminant concentrations in the cap as a function of time and to predict the time required for breakthrough of the contaminants.

Contaminant breakthrough as applied here is based on a limiting contaminant flux or surficial pore water concentration that might start to pose a meaningful risk to receptors; in this case, a relative flux or concentration of 0.01% of the original flux or concentration of the sediment was used to define breakthrough. The RECOVERY model showed that most mobile of the contaminants was PCB Aroclor 1242, followed by copper and PCB Aroclors 1248 and 1254. Contaminant breakthrough through the 3-foot cap by Aroclor 1242 at a concentration of 0.0006 ppb and copper at a concentration of 0.01 ppb is predicted to occur only after 1800 years and 4700 years of diffusion, respectively. The peak concentration in copper is predicted to be only 0.012% of its initial concentration (about 0.012 ppb) and occur at 6500 years. Aroclors 1248 and 1254 at concentrations of 0.000012 and 0.000077 ppb, respectively, are predicted to breakthrough the cap only after more than ten thousand years. The model shows that a stable 3-foot cap is highly effective in isolating the contaminated dredged material. Since about 11 ft of settlement is predicted for the center section of the CAD cell, there is a very large potential for up to 11 ft of burial over the life of the CAD cell. If this burial were considered in the long-term fate and transport modeling, the CAD cell would be effective for all contaminants for tens of thousands of year. In reality, the contaminant concentrations in the surficial cap will be controlled by the deposition of surrounding contaminated materials onto the cap, and not by contaminant migration by the buried dredged material.

Conclusions

1. A 650-foot square CAD cell excavated 47 ft below the existing sediment surface is sufficient in size to hold and cap the sediments proposed for a lower harbor CAD cell and to contain the lateral spread and collapse of the dredged material discharge during placement.

2. About 10 ft of water will be entrained in the dredged material during placement, but all of this water is predicted to be expelled from the consolidating dredged material during the three years of placement.

3. An additional 11 ft of settlement and pore water expulsion is predicted to occur in the first 40 years after cap placement.

4. Dredged material resuspension will occur during placement, resulting in predicted TSS concentrations ranging from 20 to 150 mg/L and both dissolved and particulate-associated contaminant release to the water column overlying the CAD cell.

5. The resuspension predictions appear to be a reasonable and conservative representation of the behavior of actual plumes observed during similar dredged material placement in a City of New Bedford CAD cell in 2009.

6. Dissolved contaminant concentrations in the CAD cell water (but not the overlying water) during filling will become approximately equal to the sediment pore water being placed in the CAD cell.

7. About 2.4 kg of PCB are predicted to be lost during dredged material placement in the lower harbor CAD cell, 85% of which would be dissolved. About 44 kg of copper are predicted to be lost during dredged material placement, 50% of which would be dissolved. These losses represent about 0.038% of the total PCB mass and 0.020% of the total copper mass being placed into the CAD cell.

8. Hydrodynamics modeling yielded only low velocities in the water column above the CAD cell, typically less than 0.3 fps. The velocity is sufficiently great to rapidly exchange the water above the CAD cell, typically in one to 3 hours. The velocity is sufficiently low to limit any mixing in the CAD cell water, mostly in the top few feet. However, higher resolution hydrodynamic modeling of the CAD cell environ performed using the 3-D EFDC model set up for sediment transport modeling showed the potential to set up a slow vertical eddy in the CAD cell. The eddy could provide slow mixing to a depth of 10 feet below the lip of the CAD cell. Therefore, contaminants in the top ten feet of the CAD cell were subjected to turbulent diffusion and exchange with the water column above the lip of the CAD cell.

9. Additional losses due to potential turbulent diffusion and thermally induced displacement over the winter between dredging seasons could result in about 2.7 kg of additional PCB being lost from the CAD cell water prior to capping, resulting in a total loss from placement operations of 0.08% (5.2 kg) of the total PCB mass disposed in the cell. Similarly, an additional loss of about 18 kg copper could be lost by these mechanisms, resulting in a total placement loss of about 0.028% (63 kg) of the total copper mass disposed in the cell.

10. Placement losses are predicted to be one to two orders of magnitude less than typical losses from mechanical dredging operations.

11. After capping, the contaminants expelled from the dredged material by consolidation would be contained in the lower foot of the cap.

12. Without consideration of burial (i.e., the additional sediment deposition that will take place over time into the bowl-shaped CAD cell depression formed by consolidation after the cap is placed), contaminant breakthrough will take more than 1800 years. Again, breakthrough, as used here, is defined as the condition when the contaminant flux or surficial pore water concentration increases to levels of 0.01% of the original flux or sediment bed concentration before dredging and disposal. With burial promoted by the estimated eleven feet of post-cap dredged material settlement, the transport of contaminants through the cap and burial material will take tens of thousands of years to achieve the breakthrough.

13. A stable 3-ft cap would be highly effective in isolating the contaminated dredged material.

14. Reducing the placement schedule from three years to one or two years would increase the size of the CAD cell needed to contain the approximately 300,000 cubic yards of sediment proposed for placement in the lower harbor CAD cell while maintaining conditions to promote settling and stability. The increase in storage requirements is due to shortening the time available for consolidation. Schedule acceleration is also predicted to decrease the contaminant losses due to the reduction in the exposure of contaminated CAD cell water for losses to occur.

2 – Introduction

Background

Report Objectives

The first objective of this report is to provide EPA Region I with short- and long-term modeling results on estimated contaminant losses and physical sediment behavior during and after filling of a proposed CAD cell being considered as a sediment management alternative at the NBHSS. The second objective is to provide verification of CAD cell size for containment of the contaminated sediment and capping materials.

The quantification of contaminant losses was estimated for dredged material placement, from consolidating exposed dredged material prior to capping, and from long-term diffusion following capping after consolidation becomes insignificant. Containment includes not only capture and storage of the dredged material and capping materials, but also the bulk of the stripped or resuspended materials during placement and the dynamic spreading of the dredged material from the kinetic energy of the discharge during its collapse in the CAD cell. Contaminant losses during placement includes the partitioning of contaminants to the water column from stripped or resuspended dredged material during placement, discharge of pore water from the settled dredged material by consolidation (considering the entrainment of water in the dredged material during placement), diffusion of contaminants from the dredged material and through the cap, and the exchange of water in the CAD cell with the overlying water column.

General Setting

New Bedford Harbor, located in southeastern Massachusetts, is a relatively shallow coastal estuary (Figure 2). It is connected to Buzzards Bay to the south. The main freshwater flow enters in the north from the Acushnet River. A 9-m deep (30-ft) Federal navigation channel extends from Buzzards Bay into the harbor along with a 7.6-m deep (25-ft) anchorage and adjacent 4.6-m deep (15-ft) and 3.0-m deep (10-ft) channels, which serve the Town of Fairhaven. The harbor is home to one of the nation's largest commercial fishing fleets.

Modeling Study Background

The alternative under consideration in this report includes a CAD cell in the lower harbor (Figure 2). The CAD cell would be created by excavating into the natural glacial sediments in the bottom of the harbor in order to create storage and isolation for the contaminated sediments. CAD cells are already in use in New Bedford Harbor by the city (USEPA 2009) and have also been successfully used in New England in Boston, Providence, New London, Hyannis, and Norwalk (Fredette 2006). The exact footprint of the lower harbor CAD cell is yet to be determined, but consistent with the state's long term Dredge Material Management Plan would be located between the Rt. 6 and Rt. 195 bridges, and would be sized to dispose approximately 300,000 cy of Superfund dredged material and organic silts from excavation of the upper harbor CAD cell.

The material to be placed in the lower harbor CAD cell would be the less highly contaminated Superfund sediments primarily located in the lower harbor. Filling of the CAD cell is anticipated to extend over two to three years followed by capping to isolate the contaminants from the environment. A perimeter silt curtain is proposed for the LHCC to minimize potential contaminant loss during placement.

CAD Cell Design Used for Modeling

Since the LHCC is only in the evaluation stage (without a specific design), we developed a generic design based on review of the existing CAD cells that have been created by the City of New Bedford. The generic CAD used in the modeling had a 650' x 650' surface footprint and a maximum depth 47 feet deeper than the surrounding harbor floor. Side slopes for the first seven feet of CAD were set at 1V:6H and for the remaining 40 ft of depth we used 1V:3H. Disposal into the CAD cell was based on placement in 500 cubic yard increments from a barge with a draft of eight feet and a hopper 88 feet long. A schematic of the CAD cell scaled to these features is shown in Figure 3.

Study Approach

The study presented here was conducted in two phases. **Phase 1** involved review of existing reports and databases on site characteristics to assess data sufficiency for modeling the short- and long-term loss of contaminants. For each of the proposed models, the necessary input and boundary conditions were considered in light of the available information. Based on the review, several key data gaps were identified leading to recommendations for specific field and laboratory work. In order to fill the data gaps identified in Phase 1, a field sampling and laboratory analysis plan was developed. Sediment cores and site water were collected by Jacobs Field Services during the period of 30 March to 8 April 2009 (Jacobs 2009a). Laboratory analysis proceeded in the following weeks.

Phase 1

The NBHSS project sediment database and technical reports on New Bedford Harbor sediment characteristics, water quality, sub-surface geology, and ground water flow were reviewed to assess the existing information to determine whether any additional data needed to be collected for the planned modeling activities. These sources provided considerable information that could be directly used as part of the modeling efforts (see Phase 1 report, Appendix A). Data types that were determined to be sufficient included foundation properties, sediment copper and PCB concentrations, sediment grain size, water content, specific gravity, and Atterberg limits. Data on sediment pore water contaminant concentration and partitioning to the water column during dredging and disposal were less well understood and were therefore identified as important data gaps.

The specific recommendations identified in the Phase 1 report (Appendix A) were as follows:

Annual Dredging Sediment Composites: Seven[2] sediment composites, five in the Upper Harbor and two in the Lower Harbor, should be collected, representing the average of the sediment DMUs to be dredged in each of the years. Care should be taken to collect sufficient samples from each DMU to form each composite so that each composite is representative of the average PCB, Cu, TOC and DOC concentrations, as well as the average water content, silt and clay content, and oil and grease content of the sediment being dredged each year.

Sediment Analysis Needs for Each Composite: Each composite should be analyzed for its bulk sediment concentration of Total PCB (based on congener analysis), Aroclor 1242, Aroclor 1254, Cu, AVS, Oil and Grease, TPHs, and TOC. Additionally, the pore water of each composite should be analyzed for total and dissolved concentrations of Total PCB, Aroclor 1242, Aroclor 1254, Cu, and Organic Carbon. The pore water should also be analyzed for salinity, TDS, and TSS. Each composite should be characterized for its geotechnical properties, including water content, specific gravity, organic content, Atterberg limits, and grain size distribution.

Site Water Samples: Site water should be collected from the two proposed CAD sites for analysis and use for testing.[3]

Site Water Analysis Needs: The site water samples should be analyzed for total and dissolved concentrations of Total PCB (based on congeners), Aroclor 1242, Aroclor 1254, Cu, Oil and Grease, TPHs, and Organic Carbon. The site water should also be analyzed for salinity, TDS, and TSS.

Testing Needs:

Standard Elutriate Tests should be run on each of the seven sediment composites using the proposed CAD site water to predict short-term losses during disposal. The composites should be analyzed for elutriate total and dissolved concentrations of Total PCB (based on congeners), Aroclor 1242, Aroclor 1254, Cu, Oil and Grease, TPHs, Organic Carbon and also TSS.

Sequential Batch Leaching Tests for partitioning characteristics should be run on each of the seven sediment composites to determine partitioning characteristics for PCB (total based congeners), Aroclor 1242, and Aroclor 1254, and Cu. Four cycles should be used for PCB and seven cycles should be used for Cu. Each composite should be analyzed for leachate total and dissolved concentrations of Total PCB, Aroclor 1242, Aroclor 1254, Cu, Oil and Grease, TPHs, Organic Carbon and also TSS.

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[2] Subsequent to this early assumption of seven composites an analysis of annual dredging volumes and their estimated contaminant concentrations resulted in a decision to reduce the total number of anticipated sediment composites to five; three for the upper harbor and two for the lower harbor. This is discussed in the next section.
[3] See footnote #1: the text here reflects the original rather than the revised scope of work.

Standard Oedometer Consolidation (ASTM D2435) and Permeability Tests should be run on each of the seven sediment composites to determine consolidation properties for consolidation of the dredged material in the CAD sites and for seepage of pore water from the CAD sites.

As a result of the review and the anticipated dredging schedule which would place annual layers in the cells it was determined that data to characterize each lift in more detail would provide greater confidence in the modeling results. This resulted in a plan to collect both sediment and water chemistry data from samples composited to represent each of the proposed annual dredging cycles. The reasoning for collecting sediment chemistry data for these samples, even though sediment chemistry was determined to be adequate during the data gap review, was that understanding the relationship between observed pore water chemistry and chemical partitioning behavior relative to the original sediment matrix was critical.

Phase 2

Phase 2 involved modeling short- and long-term losses using the existing and/or newly collected data. This report focuses on the model results for the lower harbor CAD cell. The models are briefly described here and greater detail on their application is provided in later sections of this report. Model descriptions for STFATE, PSDDF, and RECOVERY/CAP are based on Schroeder et al. (2004).

STFATE. The short-term fate of dredged material model (STFATE) mathematically models the physical processes determining the short-term fate of dredged material disposed at open-water sites within the first few hours after disposal.

Major Capabilities:

- Estimates receiving water concentrations of suspended solids, dredged material liquid and suspended phases, and dissolved contaminants as a function of time and location.
- Estimates the percentage of suspended solids deposited on the bottom as a function of time and location and the thickness of deposition.

SURGE. The SURGE model mathematically predicts the collapse and spread of the discharge cloud after it impacts the bottom using the mass and velocity of the discharge cloud as predicted by the STFATE model. The model is used to determine whether the energy of the discharge is sufficient for material to run up the sides of the CAD cell and out of the cell.

Major Capabilities:

- Predicts the distance that the discharge material will run up the slope, considering the kinetic energy of the discharge, change in potential energy, and frictional losses.
- Predicts deposition location by size class, considering the critical shear stress of each size class and the velocity of the collapsing cloud of discharge material.

PSDDF. The consolidation, compression, and desiccation of dredged fill (PSDDF) model provides a mathematical model to estimate the storage volume occupied by a layer or layers of dredged material in a confined disposal facility (CDF) or for underwater placement as a function of time.

Major Capabilities:

- Determines the final or ultimate thickness and elevation of multiple lifts of dredged material placed at given time intervals.
- Determines the time rate of settlement for multiple lifts and therefore the surface elevation of the dredged material fill as a function of time.
- Determines the water content, void ratio, total and effective stress, and pore pressure for multiple lifts as a function of time.

RECOVERY/CAP. The contaminant release from bottom sediments model (RECOVERY/ CAP) is a screening-level model to assess the long-term impact of contaminated bottom sediments on surface waters. The model couples contaminant interaction between the water column and the bottom sediment, as well as between the contaminated and clean bottom sediments. Processes incorporated in the model are sorption, decay, volatilization, burial, resuspension, settling, bioturbation, and pore-water diffusion.

Major Capabilities:

- Allows for a rapid analysis of recovery scenarios for contaminated sediments and cap evaluations.
- Simulates behavior of organics in a real system with a limited amount of data.
- Predicts desorption of contaminants from sediments.

3 — Data Sources, Collection, Testing and Analysis

Data Sources

The following data sources (reports and data bases) along with other technical reports and background information obtained at *http://www.epa.gov/ne/nbh/techdocs.html* were considered in the development of a sampling and testing plan to gather data for evaluation of the CAD cells. Reviewed reports and data bases (supplied by the New England District) include:

1. Technical Memorandum, Preliminary CAD Cell Volume Capacity Analysis. 2006. Apex Companies and Jacob Engineering Group.

2. Draft CDF C Groundwater Model Technical Memorandum. 2001. Foster Wheeler Corp.

3. 12-Volume Engineering Feasibility Study. 1988-89. Technical Report EL-88-15, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

4. New Bedford, Sawyer Street Quarterly Groundwater Sampling, Analytical Results, March 1992 - March 2001.

5. Quarterly Sampling at Sawyer Street CDF, October 2004-October 2006. 2006. ENSR/AECOM.

6. Overview of the New Bedford Harbor Physical/Chemical Modeling Program, April 1, 1991 (available at *www.epa.gov/ne/nbh*).

7. Volumes, Areas and Properties of Sediment by Management Units. 2003. Foster Wheeler report.

8. Dredged Material Management Plan (DMMP) EOEA No. 11669, Draft Environmental Impact Report (DEIR) for New Bedford and Fairhaven, Massachusetts. April 30, 2002. Prepared for Office of Coastal Zone Management, City of New Bedford, MA and Town of Fairhaven, MA. Prepared by Maguire Group Inc., Foxborough, MA.

9. New Bedford Harbor Superfund Pilot Study, Evaluation of Dredging and Dredged Material Disposal. May 1990. U.S. Army Engineer New England Division.

10. Declaration for the Record of Decision, New Bedford Harbor Superfund Site, Upper and Lower Harbor Operable Unit, New Bedford, Massachusetts. September 1998. U.S. Environmental Protection Agency - Region I, New England.

11. Final Sediment Monitoring Summary Report 2006 Remedial Dredging, Environmental Monitoring, Sampling, and Analysis, New Bedford Harbor Superfund Site, New Bedford Harbor, MA. May 2007. Battelle for USACE New England District.

12. Battelle Sediment Data Base.

The availability of existing data and the sources are summarized in Table 1.

Field Sampling

Pre-plan Dredging Scenario Analysis[4]

As the project proceeded from Phase 1 to the Field Sampling Plan the team discussed the impact of a five-year instead of a seven-year dredging schedule, to determine if sampling costs could be minimized (by collecting five instead of seven composites). The discussion further identified concerns that if modeling were based on a five-year assumption, but the actual schedule turned out to be seven years, that the modeling may not be representative, particularly if the upper harbor segments under the seven-year scenario exhibited much higher contaminant concentrations than they would under the five-year scenario.

In order to assess this possibility, and prior to preparation of the Field Sampling Plan, an analysis of dredging volumes and predicted composite sediment concentrations was conducted to estimate the range of average concentrations among the composites. This analysis used the estimated total dredging volumes (including over-dredge allowance) calculated for each DMU and reported in Foster Wheeler (2003 – Table 1) and sediment chemistry data from the NBHSS project database.

The first step involved discussion with EPA to determine which DMUs were being considered for placement in the CAD cells. This discussion confirmed that sediments from MU1-24 along with MF 102-104 would be isolated in an upper harbor CAD cell (if pursued in the future) and that MU25-37 would be directed to the LHCC. Thus, all DMUs in the Foster Wheeler table except for the four vegetated management units (labeled VU) were further considered.

The next step involved adjusting volumes in the Foster Wheeler-Table 1 to reflect the dredging progress since the original calculations were made. Several DMUs were assumed to be completely dredged (MU1, MU2, MU4, MU11) and others partially dredged (MU102, MU3, MU5, MU9, MU10) based on a 2004-2007 dredging footprint overlay (Figure 4). Based on this information, an estimate of the area remaining to be dredged for the DMUs was used to adjust the original volumes (Table 2). At the time this analysis was done (summer 2008), there was a possibility that portions of MUs 19-24 would be dredged in late 2008 and 2009 (personal communication with Dave Dickerson, NBH RPM, 28 July 2008). To account for this, it was estimated that about two-thirds of the volume of these MUs would be removed. In reality, the volume of dredging conducted in these MUs in 2008 and 2009 was considerably lower than projected in our planning analysis as funding from the American Recovery and Reinvestment Act (ARRA) of 2009 was used to redirect dredging to MUs farther north in the harbor.

[4] See footnote #1: the discussion in this section reflects the original as well as the revised scope of work.

The next step involved geographic grouping of the DMUs into the seven- and five-year scenarios. In the first scenario, the upper harbor would be dredged over five years with a lift of sediment placed into the upper harbor CAD each year and the lower harbor would be dredged over two years with the sediment lifts placed in the lower harbor CAD cell (Table 2, right column). The second scenario would involve accelerating the upper harbor dredging over a three-year timeframe while the lower harbor remained on the same two-year schedule (Table 2, second from right column). DMUs were then grouped based upon volume and geographic proximity to distribute the estimated volumes as evenly among the years (lifts) as possible. For the purpose of this analysis, dredging DMUs were assigned to one year or another with no splitting, although it should be recognized that actual operations may involve partial dredging of DMUs to achieve balanced volumes.

Once the DMUs had been grouped, estimated average values for total PCB (tPCB), Cu, TOC, and percent silt/clay were calculated for each DMU grouping (Table 3). In order to evaluate any differences between the two dredging scenarios and also to assess the impact that higher contaminant concentrations in the upper harbor might have on assumptions for subsequent modeling, two different estimates were created for the upper harbor lift scenarios. One a simple average of the individual DMU concentrations and the second a weighted average based on DMU volume (Table 4).[5]

Data for the DMUs considered not completely dredged were extracted from the NBHSS project database for tPCB, copper, TOC and grain size. Data were filtered to eliminate records with tPCB concentration values below 10 mg/kg, as these were unlikely to be dredged based on the project clean-up goals. Data were also filtered to eliminate those samples that were collected in portions of the DMUs on dates following dredging in those DMUs, as these would likely not represent sediments to be dredged in the future. The number of data points for tPCB ranged from 0 to 204 per DMU (Table 5). Copper (0-7), silt/clay (0-10), and TOC (0-7) had far fewer data points per DMU. Means and standard deviations were calculated for each DMU on tPCB, Cu, percent silt/clay, and TOC. The PCB mean plus two standard deviation data showed extreme heterogeneity in the upper harbor (Figure 5). Overall the tPCB data showed a downward trend from the upper to lower harbor (Figure 5), although Cu concentrations in the lower harbor were higher than in the upper harbor (Tables 3, 4, and 6). The extreme heterogeneity observed for tPCB was a result of DMUs which had one to five samples that were considerably higher than the remainder of the data for those DMUs. For example, DMU102 had one sample at 46,000 mg/kg out of the 59 data records while the next highest reported value was 4,800 mg/kg. DMU3 had five values of 26,000, 12,000, 12,000, 8,800, 7,300 mg/kg out of the 62 data records with all of the other 57 data points below 4,000 mg/kg.

The mean tPCB, Cu, TOC, and percent silt/clay data from each DMU were used to estimate the mean concentration of the five and seven lift scenarios. The average tPCB, Cu, TOC, and percent silt/clay for the two scenarios did not result in either scenario exhibiting markedly higher contaminant concentrations (Table 4). Both the five and three lift scenarios for the upper harbor

[5] The calculation of the DMU group means from individual DMU means can produce a somewhat imprecise estimate of the true mean of the data, but was done for expediency and was considered acceptable for the planning level effort. Subsequent analysis of the DMU group means based on the individual data points across all DMUs in the group showed generally similar results to the "mean of means" analysis and is discussed later.

calculated that the average tPCB concentration in the first lift would be between 1,200 and 1,300 mg/kg with later lifts reflecting the down harbor gradient.

As mentioned earlier, the primary calculations involved a "mean of means" approach, but this was later followed up by averaging all data across each DMU grouping (true mean) in order to make sure that undue bias had not occurred in the initial analysis. Results of these calculations showed slight differences from the previous calculations (Table 6), but from a modeling perspective they were not considered to be of consequence. If there had been differences of an order of magnitude or more, then additional analyses might have been warranted.

As a consequence of these analyses, it was decided by the team to proceed with collection of sediment composites representing the five lift (five year) scenario. Modeling based on this scenario should conservatively represent the reasonably foreseeable range of dredging scenarios. The five groups of DMUs were then used as the basis for the Field Sampling Plan (Figure 6).

Sediment and Water Sampling

Sample collection was under the direction of the New England District and performed under contract by Jacobs Engineering. The contractor was required to prepare addendums to existing project work plans, including the Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Site Specific Safety and Health Plan (SSHP) associated with the field sampling and data collection (Jacobs 2009b).

Sediment collection involved taking cores from 10 locations in each of five identified groups of DMUs to create five composite samples for analytical testing. Each composite sample was created by taking cores from 10 locations to estimated dredging depth. A volume weighted, stratified random selection process was used to select core locations within each group of DMUs. A total of 50 cores were collected as part of this effort. Sediment from each of the 10 locations per group was homogenized to create a single composite per DMU group.

The process used for core location selection was described in the FSP as follows:

> "Locating cores within DMUs was performed with the aid of GIS. For a DMU with one or more cores assigned, the average Z*[6] sediment thickness was calculated for that DMU, GIS was then used to identify Z blocks containing an average Z* thickness (+/- 0.5 feet). Of the Z blocks containing an average Z* thickness (+/- 0.5 feet) GIS was used to randomly select one Z Block and place the first core in that block. For DMUs with multiple cores the second core was randomly placed in a Z block identified as containing greater than average Z* sediment thickness. For a DMU with more than two cores, the third core was randomly assigned using GIS to a Z block containing less than the average Z* thickness of sediment. Several cores were manually shifted to avoid known obstructions such as power cables. Areas assumed to be dredged through 2009 were not considered for sediment core locations. In areas without Z* data, cores were placed randomly within DMUs using GIS. The number of cores placed in DMUs without Z* data was determined on a volume weighted basis similar to the DMUs with Z* data."

[6] "Z*" is the estimated depth of dredging from the design phase of the harbor cleanup

Sufficient sediment was taken in order to provide the necessary volume for the tests specified below and to provide five liters of sediment per composite (total of 25 liters) to ERDC for sequential batch leaching testing to be conducted in Vicksburg, MS. The samples were shipped within seven days of collection or within two days of compositing, as identified in the QAPP/FSP.

The contractor also collected water from the locations of the two CAD cells originally under consideration in NBH. Samples were collected from the mid-water depth for background water quality. Additionally, the contractor collected 50 liters of water from these locations for delivery to ERDC. This consisted of 30 liters from the upper CAD cell location and 20 liters from the vicinity of the LHCC location. This water was preserved and shipped by the contractor to ERDC as specified in the FSP. Pore water samples were collected using centrifugation and filtration. The total concentrations were analyzed following sample centrifugation and the dissolved concentrations were analyzed following filtration.

Sediment characterization was performed by GeoTesting Express, Katahdin Analytical Services, and laboratories at ERDC. GeoTesting Express performed the following geotechnical analyses: Moisture Content (ASTM D 2216), Specific Gravity (ASTM D 854), Grain Size Analysis with Hydrometer (ASTM D 422), Atterberg Limits (ASTM D 4318), Flexible Wall Permeability (ASTM D 5084), and Incremental Consolidation (ASTM D 2435). ERDC analyzed the composites for moisture content (ASTM D 2216) and organic content (ASTM D 2974). Both Katahdin Analytical Services and laboratories at ERDC conducted chemical analysis of the sediment composites and harbor water samples. ERDC laboratories also conducted Sequential Batch Leaching Testing (SBLT) (ASTM Method D-4793) on the five sediment composites to determine the partitioning characteristics of PCB and copper in the sediment. The results of the consolidation testing were used to develop void ratio-effective stress relationships and void-ratio permeability relationships for each of the five composites. The results of the SBLT were used to develop a single set of partitioning coefficients that are representative of all of the composites for PCB and copper. Results for PCB Aroclors 1242, 1248, and 1254 were reported by Katahdin Analytical Services, the ERDC laboratory, or both and the worst-case values for each Aroclor were used in the modeling.

Standard Elutriate Tests were also run on each of the five sediment composites using the appropriate proposed CAD site water to predict short-term losses during disposal. The tests were analyzed for elutriate total and dissolved concentrations of Total PCB (based on congeners), Aroclor 1242, Aroclor 1254, Cu, AVS, Oil and Grease, TPHs, Organic Carbon and also TSS (Jacobs 2009a).

Sample Collection

Samples were collected from New Bedford Harbor from 30 March to 8 April 2009 (Jacobs 2009a). Sediment samples were collected using a vibracore by CR Environmental, a subcontractor to Jacobs Engineering. In addition to the fifty cores, a field duplicate was also collected from DMU group 3. Three sediment samples were also taken from cores in DMU group 1 following alarm indications from the photoionization safety detector that indicated the likely presence of volatile organic compounds. Chemistry, geotechnical, and core log data were presented in Jacobs (2009a).

Copper and tPCB values for the five sediment composites showed comparable trends to those calculated from the historic data as originally shown in Table 6; however, the 2009 composite tPCB data were generally lower than the calculated means of the historic data (Table 7). In contrast, 2009 copper data were generally greater than the historic mean calculations.

Testing and Analysis

Consolidation Testing

GeoTesting Express performed Incremental Consolidation (ASTM D 2435) on the five composites, measuring the void ratios and strains at loadings ranging from 0.01 tons per square foot (tsf) to 8 tsf and calculating the coefficient of consolidation. Using the measured void ratios and strains and the calculated coefficient of consolidation for each loading, the permeability of the sediment was computed for each loading and its corresponding void ratio. For each sediment composite, the results were then fitted to create relationships between void ratio and effective stress and between void ratio and permeability. The results are shown in Figures 7 through 11.

Sequential Batch Leaching Testing

ERDC laboratories conducted SBLT (ASTM Method D-4793) on the five sediment composites in duplicate to determine the partitioning characteristics of PCB and copper in the sediment. In addition to Aroclors 1242 and 1254 as originally planned for analysis, ERDC also determined concentrations of Aroclor 1248. Four cycles were used for PCB and seven cycles were used for copper. The results for four cycles and replicates are given in Table 8 and the three other cycles, which exhibited small changes relative to the first four, are provided in the appendices. The results of the SBLT were used to develop a single set of partitioning coefficients that are representative of all of the composites for PCB and copper. Analysis of the test results yield a K_{oc} of 550,000 L/kg for Aroclor 1248 and 210,000 L/kg for Aroclor 1254 and a K_d of 18,200 L/kg for Copper. Where possible, additional partitioning coefficients were computed from the results of the pore water analysis performed on the sediment composites by Katahdin Analytical Services for Jacobs Field Services (2009a). These analyses were used to confirm the results of SBLT. The analysis yielded a K_{oc} of 39,400 L/kg for Aroclor 1242 and 202,000 L/kg for Aroclor 1254 and a K_d of 21,400 L/kg for Copper. The K_{oc} values for the PCB were within a factor of four of typical values reported in the literature.

4 — Modeling

Modeling Assumptions

This report presents modeling results for the lower harbor CAD cell (LHCC) based on EPA's priority for site evaluation. Since a LHCC is only in the evaluation stage, a preliminary design was not available; therefore, a generic design was developed based on review of the existing CAD cells that have been created by the City of New Bedford and the design report for the upper harbor CAD cell (Apex and Jacobs 2006). The general location of the LHCC is shown as CAD Cell 2 in Figure 2. The generic design used in the modeling for the LHCC had a 650' x 650' surface footprint and a maximum depth below the surrounding harbor bottom of 47 feet as shown in Figure 3. Side slopes for the first seven feet of CAD were set at 1V:6H and for the remaining 40 ft of depth we used 1V:3H. Due to the sloping sides, the CAD cell was divided into 4 sections for modeling consolidation and short-term contaminant loss after capping as shown in Figure 12. The center section comprises 31% of the area and 51% of the storage. Rings 1, 2 and 3 each comprise 23% of the area, but 30%, 15%, and 4% of the storage, respectively.

The disposal operation assumed for the LHCC consisted of mechanical dredging of sediment into 500 cubic yard split hull (bottom dump) barges. Disposal into the CAD cell was based on placement in 500 cubic yard increments from a barge with a draft of eight feet and a hopper 88 feet long; three barge dumps per day was assumed. A scaled schematic of the disposal operation and CAD cell is shown in Figure 3. The barges were assumed to contain about 15% captured water and 85% sediment by volume. The dredged material is assumed to entrain additional water during placement from the descent through the water column and the collapse and spreading of the material on the bottom. The quantity of water that is entrained is a function of the water column depth. More water will be entrained initially when the CAD cell is empty than at the end when the CAD cell is almost full because the discharge will have greater energy and time to entrain water when the CAD cell is less full. Much of the entrained water will be released during the dredging season as the placed material settles and consolidates.

The filling schedule for the LHCC was assumed to consist of Composite 3 sediment in the first year (Time 0; Note: only a portion of the area represented by Composite 3 is envisioned for LHCC disposal). In the next year Composite 4 sediment is placed in the LHCC covering the Composite 3 dredged material, and then the CAD cell is left idle until the next dredging season. Two years after placing the first material, Composite 5 sediment is placed in the LHCC covering the Composite 4 dredged material. The CAD cell is then left idle until the next construction season when the CAD cell is capped with unwashed sand, maintaining the content of fine-grained and organic material. Negligible new deposition on top of the CAD material from outside the CAD cell via bottom load or suspended load is assumed. Similarly, negligible erosion or resuspension of bed sediments or cap materials from the CAD cell is assumed.

During filling, dredged material will be stripped and resuspended from the discharge, releasing both particulates with their associated contaminants and pore water with its dissolved contaminants. The pore water will also contain dissolved organic carbon (DOC) and contaminants associated with the DOC. Facilitated transport of contaminants is not specifically assumed, but the partitioning coefficients developed from the SBLT and pore water analysis include the partitioning associated with the DOC as being part of the dissolved contaminants. The particulates, while suspended, partition their contaminants with the CAD cell water. The suspended particulates slowly flocculate and then settle in the CAD cell, leaving the dissolved contaminants and DOC to accumulate in the CAD cell water. However, new particulates are introduced into the water column two or three times per day during the placement season, creating a near steady suspended solids concentration that increases slowly throughout the season and then decreases in the week or two following cessation of placement operations.

The currents in the CAD cell below the top few feet are assumed to be too low to transport particulates to the surface or to resuspend bedded material. Releases from bedded dredged material are limited to pore water expulsion and diffusion. Bioturbation is assumed only in the long-term evaluation after capping. Water and contaminant exchange are assumed in the upper few feet of the CAD cell by turbulent mixing and by displacement during material placement. After material placement operations cease for the dredging/construction season, diffusion of contaminants from the lower water column to the upper water column of the CAD cell is assumed to occur.

For consolidation modeling purposes, the material placed in a placement season is represented as a single lift at the end of the placement season. The volume of the lift and its void ratio are estimated based on the placement operation and the characteristics of the sediment composite, incorporating the entrainment and densification that occurs during the placement season. The lift is assumed to contain the entire mass of sediment particles dredged, i.e. there were no losses of particulates.

After placement is completed and the dredged material and suspended solids have been allowed to settle and densify, a cap will be placed to close the CAD facility. The required cap thickness is dependent on the cap design objectives, accounting for bioturbation, consolidation, erosion, and operational considerations. For the purposes of this evaluation, the cap thickness was set to be 3 feet. Unwashed, natural sand was chosen for the capping material, which would typically have a small fraction of organic carbon and fines that would improve the retardation of contaminants in the cap.

Modeling Results

<u>Sizing and Filling</u>

A cut and fill spreadsheet analysis (given in Appendix B) was perform to determine the size of CAD cell needed to contain the proposed volume of dredged material and to estimate the lift thicknesses of the annual fills for consolidation analysis. A 650' x 650' surface footprint was selected with a side slope of 1V:6H for top 7 ft of depth and 1V:3H for the remaining 47 ft of depth below the existing sediment surface. The volume of the CAD cell was computed using the formula for the volume of a truncated square pyramid. The volume of each foot of the inverted pyramid was used to compute the average thickness of each lift of material in each of the four modeling sections of the CAD cell shown in Figure 12. The analysis showed that a 650' x 650' surface footprint for the CAD cell would be sufficient to contain the first two lifts (years) of dredged material without bulking and the third lift of dredged material with bulking and provide some freeboard to insure sediment retention and volume for cap placement. Additional freeboard will develop as the dredged material releases its entrained water and consolidates under the loading of the dredged material and capping material.

Consolidation

The consolidation of the dredged material after placement in the CAD cell was analyzed using the USACE PSDDF model. Due to the sloping side walls of the cell, the consolidation was analyzed in four sections as shown in Figure 12. The PSDDF model results showed that the CAD cell size was appropriate to contain the proposed volume of dredged material, considering the entrainment of water in the dredged material, the volume of capping material, spreading of dredged material from the placement dynamics, suspended solids retention, and consolidation prior to capping. The consolidation results were analyzed to determine the predicted pore water expulsion rates for contaminant loss predictions both prior to and after capping.

The CAD sizing analysis showed that the center of the lower harbor CAD cell would be filled with 42 ft of dredged material based on its in situ density. However, analysis of potential water entrainment in the dredged material during both dredging and placement through the water column yielded an estimate of bulking or entrainment that would result in placement of 52 ft of dredged material. The annual lifts and their void ratios are given in Table 9. With 3 ft of capping material, a total of 55 ft of material in our cell that is 47 ft deep. However, the PSDDF model predicted that in the center section of the CAD cell, 10.3 ft of pore water would be expelled from the placed dredged material prior to capping, primarily from the 10 ft of water that was predicted to be entrained during dredging and placement through the water column (mostly at depth from the first lift placed). The fill height of the center section as a function of time is shown in Figure 13 and the fill heights of all four sections after capping are shown in Figure 14 (Note that Time 0 in Figure 14 is after capping whereas Time 0 in Figure 13 is from the start of filling). Therefore, as shown in Figure 15, the depth of fill immediately after capping is approximately 45 ft, providing a freeboard of 2 ft. After capping, an additional 7.2 ft of pore water is predicted to be expelled in the first 10 years, 9.4 ft of pore water in the first 20 years and 10.9 ft of pore water in the first 40 years. At 40 years after capping, the dredged material is predicted to be 94% consolidated. Based on the PSDDF model results, much of the contaminant losses would be expected to occur during placement and prior to capping.

Placement

The open water placement of dredged material in the LHCC was modeled using the USACE STFATE model to predict the entrainment of water in the deposited dredged material, the mass of dredged material suspended in the water column, the suspended solids concentration in the water column, the settling time, and the vertical and lateral distribution of suspended solids following a barge discharge of dredged material. STFATE model runs were conducted on 500 cubic yard barge discharges at the beginning and end of each dredging season to simulate the range of placement impacts for each dredging season and to estimate annual contaminant losses during placement. Results for placements between the beginning and end were assumed to produce results linearly between these two extremes. The predicted resuspension of fine-grained dredged material is shown in Table 10. The STFATE model results indicate that about 3 to 4% of the fine-grained fraction of the dredged material remains in suspension about 3 to 4 hours after the barge discharge and disperses in the CAD cell water below the loaded draft of the barge, resulting in predicted average TSS concentrations ranging from about 20 mg/L for the first lift to 150 mg/L for the third lift. In a shallow saline environment such as New Bedford Harbor and the CAD cell, the TSS concentration will typically decrease to 50 mg/L within a day and to 10 mg/L within a week. However, this should be regarded as a generalization as recent monitoring of a CAD cell in New Bedford Harbor (Dragos 2009) observed suspended solids levels returning to background typically within two hours.

The discharge plume collapse dynamics were modeled using the USACE SURGE to examine whether the momentum of the discharged material was sufficient to cause the dredged material to run up the side slope and out of the CAD cell. All discharges are assumed to be within the area of the level bottom, a 326-ft square, and no closer than 160 ft horizontally from the lip of the CAD cell. The dynamics were examined for all three sediment composites across the range of water depths that would exist during their placement. In all cases the discharged material is not predicted to run up the slope above a depth of about 11 ft below the lip (vertically) or about 55 ft from the lip (horizontally). The results of the collapse modeling are given in Table 11. Therefore, the CAD cell is expected to be capable of confining the dredged material during placement due to the shallow water depth at the site limiting the plume acceleration during descent.

CAD Cell Hydrodynamics

Mixing within the CAD cell will affect the settling of resuspended dredged material and loss of dissolved and particulate-associated contaminants by the placement operations. The nature and intensity of the mixing is a function of the hydrodynamic regime of the site and the CAD cell configuration. Hydrodynamic modeling of New Bedford Harbor was recently conducted to examine sediment and PCB transport. This modeling examined the tide-induced circulation in the proposed lower CAD cell using the general vertical coordinate (GVC) version of EFDC (Environmental Fluid Dynamics Code), which is a 3D public domain surface water modeling system that invokes the hydrostatic pressure assumption (Hamrick, 2007a,b,c,d). The modeling yielded only low velocities in the water column above the CAD cell, typically less than 0.3 fps. The velocity is sufficient to rapidly exchange the water above the CAD cell, typically in one to three hours. The modeling was not sufficient to predict the extent of mixing below the lip of the CAD cell. Therefore, the model was adapted to include the CAD cell with a higher resolution grid to examine the potential mixing in the CAD cell.

The curvilinear-orthogonal grids for the higher resolution EFDC modeling are shown in Figures 16 and 17. This figure shows that the CAD cell is represented using 32 cells, with the size of each cell being approximately 44 m in the lateral direction and 23 m in the longitudinal direction. The lateral/longitudinal directions are with respect to the general north-south orientation of the harbor, with the lateral direction being in the east-west direction. The New Bedford Harbor model used five layers for all grid cells except those used to represent the CAD cell. A vertical slice through the grid along the centerline of the CAD cell is shown in Figure 18. As seen in this figure, 20 vertical layers are used to represent the water column for the eight cells at the center of the CAD cell, and 9 or 13 cells are used in the cells that represent the side slopes of the CAD cell. The use of more vertical layers in the deeper CAD cell allows for a more accurate prediction of the vertical circulation below the lip of the CAD cell.

The EFDC model was run for seven days using a 0.5-sec time step. The tide-induced circulation during the last day of this model run was used to estimate the residence time of water within the CAD cell. Figure 19 shows the vertical velocity distribution in the CAD cell at one time step during an ebb tide. A vertical eddy is seen on the right (i.e., north) side of the CAD cell that is about half the length of the CAD cell in width. The eddy extends approximately 4 m below the lip of the CAD cell. Figure 20 shows a small eddy centered at about 3 m below the lip of the CAD cell in the middle of the cell. The surface velocity vectors indicate that this is near the end of flood tide as the flow direction has already changed to the left (i.e., south) of the CAD cell whereas the flow is still flooding on the north side. An analysis of the tide-induced circulation in the CAD cell indicated that the velocities in the lower half of the CAD cell are very small, typically less than 0.1 ft/s, and as such, mixing with the water in the upper half of the cell will be extremely limited during fair weather conditions. Higher velocities and therefore enhanced mixing would occur during high wind conditions and during heavy rainfall events, e.g., nor'easters, as the runoff into the upper end of the harbor will be significantly increased.

Short-Term Partitioning and Contaminant Loss

Contaminants associated with the TSS resulting from resuspension during placement will partition with the CAD cell water. It is unlikely that the partitioning reaches equilibrium before the particles interact with particles from subsequent discharges, flocculate and settle. Most particles will remain in suspension less than a day. The kinetics of PCB desorption in a stagnant water column is sufficiently slow that it may take weeks to reach equilibrium; however, 10 to 20% of the PCB may desorb in the first day (Gong, et al., 1998; Ghosh, et al., 1999). The partitioning of contaminants to the CAD cell water from the resuspension of the large number of discharges in a dredging season is predicted to be sufficient to achieve a contaminant concentration approximately equal to the pore water concentration of the sediment or dredged material. The predicted dissolved and total concentration of contaminants in the CAD cell as a function of time based on the resuspension and partitioning model results are shown in Figures 21 through 24. The total concentration at the top of the CAD cell will be somewhat lower because the TSS at the top will be appreciably lower than the average for the first two lifts.

The dissolved contaminants and particulate-associated contaminants in the upper portion of the CAD cell will be lost as the CAD cell water is displaced by subsequent barge discharges. The displacement volumes are likely to be about 15 to 20% greater than the volume of sediment being dredged due to entrained water in the mechanical dredge/excavator bucket or overdredging. This would amount to about 50,000 cubic yards in Year 1, 180,000 cubic yards in

Year 2, and 150,000 cubic yards in Year 3; the corresponding target volumes of sediment dredged would be 44,000, 155,400 and 126,200 cubic yards, respectively. An additional 25,000 cubic yards of CAD cell water will be displaced in Year 4 by cap placement. The average contaminant concentrations and mass loss for each lift and contaminant are given in Tables 12 and 13, respectively.

Hydrodynamics modeling yielded only low velocities in the water column above the CAD cell, typically less than 0.3 fps. The velocity is sufficient to rapidly exchange the water above the CAD cell, typically in one to three hours. However, the velocity is sufficiently low to limit mixing in the CAD cell water. Nevertheless, the higher resolution hydrodynamic modeling using the GVC version of the EFDC model showed a potential to establish a slow vertical eddy circulation predominantly in the top ten feet of the CAD cell sufficient to promote turbulent diffusion and slow exchange with the water column above the lip of the CAD cell. The increase in contaminant losses from the CAD cell from this mixing is small because discharge losses during placement is small in the top ten feet of the CAD cell during placement of the first two years of disposal. The predicted TSS in the top two feet is shown in Figure 25 along with the average TSS concentration in the CAD cell.

The predicted losses of PCB (Aroclors 1242, 1248 and 1254) by the placement operations (resuspension and discharge) during the three years of filling the LHCC are 310 g in Year 1 (sediment composite 3), 1,050 g in Year 2 (sediment composite 4) and 1,120 g in Year 3 (sediment composite 5), about 0.038% of the total PCB mass removed from the associated dredging. The released PCB are about 81% Aroclor 1242 (mass loss about 0.06%), 5% Aroclor 1248 (mass loss about 0.009%) and 14% Aroclor 1254 (mass loss about 0.018%). The 0.035% mass loss is a weighted average based in the relative contribution of each Aroclor release (81%, 5%, and 14%) to the total release and their respective mass loss rates (0.06%, 0.01%, and 0.02%). About 85% of the released PCB is predicted to be dissolved. These losses were computed by averaging the predicted concentrations shown in Figures 21 to 23 for each lift and then multiplying the averages by the volume of CAD water displaced by each lift given above.

The predicted losses of copper during the three years of filling the LHCC are 1.9 kg in Year 1 (sediment composite 3), 7.5 kg in Year 2 (sediment composite 4) and 34.7 kg in Year 3 (sediment composite 5), about 0.020% of the copper. About 50% of the released copper is predicted to be dissolved. These losses were computed by averaging the predicted concentrations shown in Figure 24 for each lift and then multiplying the averages by the volume of CAD water displaced by each lift given above.

Contaminant losses from the CAD cell after placement of the annual lift is driven by turbulent diffusion from the CAD cell to the upper exchangeable water column. The annual loss of contaminants by turbulent diffusion from the lower water column is limited to about the top 118,000 cubic yards (10 feet) of contaminated CAD cell water after the annual placement operation ceases. The CAD cell is expected to contain about 3.3 kg of PCB and 15 kg of copper in 348,000 cubic yards of CAD cell water after Year 1, 1.0 kg of PCB and 6.8 kg of copper in 192,000 cubic yards of CAD cell water after Year 2, and 0.4 kg of PCB and 7.0 kg of copper in 71,000 cubic yards of CAD cell water after Year 3. Following cap placement, the contaminants in any remaining CAD cell water will be lost by turbulent diffusion. If all of the contaminants remaining in the top 118,000 cubic yards of CAD cell water after each year of placement were lost by turbulent diffusion, 2.0 kg of PCB and 13 kg of copper would be lost by turbulent diffusion from the CAD cell water contaminated during dredged material placement.

An additional potential loss of contaminants is the displacement of CAD cell water in the fall or winter by cold dense water sinking into the CAD cell. However, due to the shallow depth of the overlying water column and the mixing that would occur, this mechanism is likely to limit the exchange to no more than 5 feet of water or 71,000 cubic yards in the CAD cell. This would limit the losses to about 20% of the contaminants in the CAD cell water between dredging seasons. Any losses between dredging seasons would be partially offset by decreasing the predicted losses during the next dredging season because the initial contaminant concentration in the CAD cell water at the start of the next dredging season would be lower.

The overall potential contaminant losses resulting from placement are 1.9 kg PCB and 9.5 kg copper from Year 1, 1.9 kg PCB and 13.4 kg copper from Year 2, and 1.4 kg PCB and 40 kg copper from Year 3. These quantities represent the sums of the potential losses by the various mechanisms presented above, which when totaled across all three years equals 5.2 kg PCB and 62.5 kg copper. These losses represent 0.08% of the three PCB Aroclors (0.13% of Aroclor 1242, 0.02% of Aroclor 1248 and 0.03% of Aroclor 1254), and 0.03% of the copper placed in the CAD cell.

Long-Term Contaminant Loss from Capped CAD Cell

The contaminant fate and transport from the capped CAD cell were evaluated in two parts. The first part was evaluated during the period of dredged material consolidation using the USACE CAP model, which considers pore water advection induced by consolidation. The consolidation flux and contaminant flux were estimated for the four major areas of the CAD cell (Center, Ring 1, Ring 2, and Ring 3) as shown in Figure 12. In the center section, ninety percent of the consolidation is completed only after 30 years, but meaningful contaminant transport by pore water expulsion is limited to the first two to four years. The three rings contribute contaminant flux over a shorter period of time as compared to the center area of the pit. The consolidation fluxes (pore water expulsion) predicted by the PSDDF model are shown in Figure 26. The second part was evaluated for the long term, after significant pore water advection ceases. During the long term, contaminant transport is dominated by diffusion of contaminants from the dredged material and into the cap. Long-term contaminant fate and transport from the capped CAD cell was modeled without considering contaminant degradation or transformation using the USACE RECOVERY model.

The predictions of long-term contaminant flux from a CAD facility require the physical and chemical characterizations of the dredged material and capping materials. The CAP model for prediction of contaminant flux requires a chemical description of the materials and contaminant partitioning characteristics between the pore water and materials. The chemical characterization and partitioning data are given in Table 14. The contaminant concentrations represent the results of a weighted average composite of the contaminated dredged materials (sediments) in the three composite materials envisioned for the LHCC. Figure 15 shows the material thickness immediately after the placement of the cap.

The CAP model was run on four separate sections of the CAD cell due to differences in dredged material thickness and predicted settlement. Each section represents about one quarter of the area of the CAD cell, with the center section being 31% of the area and each ring being 23% of the area. The first section represents the center of the CAD cell and includes the entire part of the cell that has a level bottom, plus the beginning of the side slopes. The next three sections are concentric bands around the center covering the remainder of the sloped area of the CAD cell. Each band has successively thinner dredged material thicknesses and smaller settlements; the thickness and cumulative settlement of the four sections after capping are shown in Figures 27 and 28 as a function of time. The physical and chemical properties of the three composite materials and the capping material as well as the layer structures for the four sections examined with the CAP model are shown in the conceptual model schematics in Figures 29 to 32.

Contaminant fluxes associated with the advection of water resulting from dredged material consolidation were estimated for a 47-ft deep LHCC using the CAP model. The CAD pit will expel water only upward for the four cell sections as the native harbor bottom sediments forming the walls of the CAD have very low porosity relative to the dredged sediment and therefore the native sediments will resist flow of pore water. Figure 33 shows the flux of Aroclor 1242 (the most mobile of the contaminants) for all four sections during the period of significant advective flux. Figure 34 shows the surficial sediment concentrations in the CAD cell of Aroclor 1242 for all four sections of the cap during the same period. All four sections yield similar fluxes and surficial sediment concentrations for Aroclor 1242; the same is true for the other contaminants of concern. Therefore, the fluxes and surficial sediment concentrations for the other contaminants are only shown for the center section in Figures 35 to 38. All of the predicted fluxes and surficial sediment contaminant concentrations are very small. The flux of contaminants is equivalent to less than 1 gram per year and surficial sediment concentration of contaminants in the cap at the end of the advection dominated period (fifty years after being capped) are about six orders of magnitude smaller than the concentration in the capped sediment. The cap contaminant concentrations fifty years after being capped are predicted to be 7 ng/kg (parts per trillion) Aroclor 1242, 0.00003 ng/kg Aroclor 1248, 0.003 ng/kg Aroclor 1254, and 100 ng/L copper.

The CAP model results showed that the contaminants transported from the dredged material by pore water advection and diffusion would be contained in the bottom of the cap. This is true for all sections of the cap, even in the center section, which had the largest settlement. The contaminant and sediment profiles from the end of the CAP model runs were used as the initial conditions for the long-term, diffusion dominated modeling using the RECOVERY model.

The RECOVERY model was run for a 500-year period of simulation for each contaminant and each section. The performance of each cap section are essentially identical since the upper profile of the section with respect to cap and sediment properties are identical as shown in Figures 29 to 32. To show the long-term performance of the cap, the predicted surficial sediment concentration of Aroclor 1242 is shown in Figure 39. Aroclor 1242 is a conservative representative of all of the contaminants because it is the most mobile. Comparing Figure 39 with Figure 34 shows that the predicted surficial sediment concentration at 500 years is 10 times the concentration predicted at 50 years, indicating that the surficial sediment concentration, flux and pore water concentrations increase nearly linearly. The concentrations predicted for the bioactive zone (i.e., top four inches of cap) throughout the first 500 years of cap life are more than 6 orders of magnitude lower than the concentrations in the sediments being capped.

Figure 40 shows the predicted ratio of Aroclor 1242 concentrations of the pore water in the bioactive zone compared to that below the cap by the RECOVERY model for 500 years. The ratio shows the effectiveness of the cap in reducing contaminant exposures in both the benthic zone and water column. Figure 40 shows that the cap reduces contaminant exposures by at least 6 orders of magnitude throughout the first 500 years. At 500 years, the pore water concentration of dissolved Aroclor 1242 in the bioactive zone of the cap was predicted to be 0.006 ng/L (parts per trillion).

Contaminant breakthrough of the 3-foot cap, defined here as a bioactive zone (mixed layer) pore water concentration greater than 0.01% of the initial sediment pore water concentration (a concentration approaching the long-term risk goal; e.g., 0.01% of 7 ppb PCB or 0.0007 ppb PCB), did not occur in our simulations of 500 years. The simulations were extended to 5000 years and breakthrough was predicted for Aroclor 1242 at 1800 years and copper at 4800 years. The copper concentration achieved its long-term peak cap pore water concentration of 12.3 ng/L at 6500 years. The breakthrough times for Aroclor 1248 and Aroclor 1254 are greater than ten thousands years. Since about 11 ft of settlement is predicted for the center section of the CAD cell, there is a very large potential for up to 11 ft of burial over the life of the CAD cell. If this burial were considered in the long-term fate and transport modeling, the CAD cell would be effective for all contaminants for a much longer period, tens of thousands of years. The three-foot cap thickness assumed for the CAD facility is predicted to be an effective isolation layer for all of the contaminants of concern.

Impacts of an Accelerated Filling Schedule

In the event that project implementation allows for a faster filling schedule (i.e., one or two years for filling rather than the three years of filling modeled) the following discussion estimates the likely impact of such a schedule change. This accelerated schedule was not modeled, but the impacts of using an accelerated schedule can be estimated from the modeling for the original schedule. The likely impacts are:

1. An accelerated schedule would reduce the time available for consolidation of the dredged material after placement in the CAD cell and prior to capping. Examination of the rate of consolidation indicates that consolidation prior to capping could be reduced from about 10.3 ft to about 5 or 6 ft. This would mean that a larger CAD cell would be needed to hold the dredged material and control losses during placement, approximately a 700-ft square instead of a 650-ft square.
2. Since the dredged material will occupy a greater volume prior to capping, it will displace more CAD cell water that will be contaminated by resuspension. The quality of the CAD cell water is not likely to change from the quality predicted for the original schedule because it is predicted to be in equilibrium with the dredged material. Therefore, the increase in placement losses is likely to be in proportion to the change in CAD cell volume or about 20%, increasing the estimated placement

losses during disposal from 2.5 kg PCB to 3.0 kg PCB and from 44 kg Cu to 53 kg Cu.

3. Accelerating the placement schedule will increase the number of loads or the size of the loads. Preferably, the size of the loads will be increased to minimize traffic and improve efficiency. Increasing the number of loads would permit less time for settling and increase the surface water displacement and disturbance by barges and tugs, resulting in an additional loss of suspended sediment and associated contaminants. Increasing the size of the load would have a less detrimental effect on settling and loss of suspended sediment. Larger loads are released deeper in the water column, have less entrainment of water during its descent to the bottom of the CAD cell, and maintain a greater density difference to provide stability on the bottom.

4. Contaminant losses after placement will be greatly reduced because very little CAD cell water would remain after the first year of filling, as little as 3 to 10 ft depending on whether all the filling is done in the first year or if some is done in the second year. In the original schedule, a total of about 28 ft of CAD cell water was predicted to be lost over the three years of placement, yielding a reduction in post-placement losses of about 65 to 90%. This would reduce after-placement losses from about 2.5 kg PCB to 0.3 to 0.9 kg PCB and from about 14 kg Cu to 1.4 to 5 kg Cu.

5. Accelerating the placement schedule is estimated to result in a net decrease in PCB loss of 1.1 to 1.7 kg and net decrease in Cu loss of up to 3.6 kg. However, this savings may not be realized if adequate settling is not maintained due to a loss of quiescent settling time by more frequent disposal events.

6. A reduction in consolidation prior to capping will increase the quantity of consolidation after capping and increase pore water expulsion through the cap. However, the additional mass of contaminants in the pore water expulsion is very small and is not estimated to meaningfully impact the long-term contaminant loss after capping or contaminant breakthrough.

5 — Discussion

Modeling Results and Field Plume Surveys

The modeling results appear to be a reasonable and conservative representation of the behavior of actual plumes. In a separate study, plume monitoring was conducted on five separate events that placed New Bedford Harbor sediment into one of the existing City of New Bedford CAD cells (Dragos 2009). The CAD surveyed had a maximum depth of about 37 feet. The entire CAD cell was surrounded by a silt curtain with access of vessels controlled by one section of the curtain which was used as a gate. Plume monitoring used Acoustic Doppler Current Profilers (ADCP) to measure acoustic backscatter from sediment in the water column and direct water sampling of total suspended solids (TSS) to calibrate the acoustic data. The five events included one occasion in April, three occasions in May, and one in July 2009. Plume transects were conducted by two separate vessels inside and outside of the silt curtain. Monitoring of the plume during these events began before disposal and continued up to 0.75 hr to 1.5 hr after disposal.

Results from the plume monitoring showed initially intense plumes throughout much of the water column within the CAD cell shortly after disposal with maximum measured TSS of 226 mg/l (May 27, 2009 event) and ADCP interpolated values of similar magnitude. In all cases, the plumes were shown to rapidly settle and generally remain within the CAD cell. Results reported from surveys collected approximately 50 minutes following disposal showed plumes as ranging in TSS concentrations from background levels to 50 mg/l and limited largely to the bottom of the CAD.

Although detailed comparison of the model results to the field results was beyond the scope of the present effort, a quick comparison to model results from one of the STFATE model runs was conducted. The model run analyzed used sediment from composite 3 placed into a CAD cell 37 feet deep (by this time the simulated CAD was partially filled), similar to the actual CAD that was surveyed. Results from model output 50 minutes after disposal showed similar, although somewhat higher TSS values than reported by Dragos (2009). Model values showed plume maximums of 8 mg/l TSS at a 3 ft depth, 56 mg/l at 15 ft, 135 mg/l at 25 ft, and 257 mg/l at 35 ft. Based upon this quick analysis it appears the model provides a reasonable projection of plume behavior and possibly a moderate over-prediction of TSS levels.

Relative Magnitude of Contaminant Losses and Uncertainty

The contaminant losses from a CAD cell to the overlying water column are predominantly associated with placement. These losses represent 0.08% of the total mass of PCB disposed in the cell (0.13% of Aroclor 1242, 0.02% of Aroclor 1248 and 0.03% of Aroclor 1254), and 0.03%

of the total mass of copper placed in the cell. The losses are driven by partitioning and the CAD cell water is predicted to approximate the pore water of the sediments being placed. The partitioning results agree well with the measured pore water concentrations, providing confidence in the predictions. The losses would be greater if there were significant exchanges of CAD cell water with the overlying water column on a periodic basis, e.g., in response to storms. These exchanges are not expected, but provide a source of uncertainty. A silt curtain around the perimeter of the CAD cell, if designed to divert flow around and not under the curtain, should help to minimize these exchanges.

The predicted short-term losses are small in comparison to typical losses from mechanical dredging, which range from 0.5 to 2% (Palermo et al., 2008). The placement losses are predicted to be 1 to 2 orders of magnitude smaller. Even when considering all of the uncertainties of dredged material placement, the losses from placement are expected to be much smaller than the losses from dredging.

The long-term contaminant losses after capping are insignificant, even during the initial period (3 years) following cap placement when expulsion of pore water from consolidation is the dominant driver for contaminant transport. As long as the cap is stable and isolation is provided, the long-term losses will be negligible for thousands of years. The only uncertainty in the prediction is the assumption of long-term stability and isolation; however, since the dredged material is predicted to consolidate eleven additional feet after capping, the CAD cell should become more and more stable. In addition, the depression formed by this consolidation will provide a sink for additional sediment deposition, which will increase the "cap" thickness and maintain long-term isolation.

The long-term contaminant losses from the CAD cell is very likely to be controlled by the deposition of new sediment onto the CAD cell cap. The new sediment should resemble the background sediment surrounding the CAD cell and would be expected to have a much higher contaminant concentration than would ever result from diffusion of contaminants from the capped dredged material.

6 — Conclusions

1. A 650-foot square CAD cell excavated 47 ft below the existing sediment surface is sufficient in size to hold and cap the sediments proposed for a lower harbor CAD cell and to contain the lateral spread and collapse of the dredged material discharge during placement.

2. About 10 ft of water will be entrained in the dredged material during placement, but all of this water is predicted to be expelled from the consolidating dredged material during the three years of placement.

3. An additional 11 ft of settlement and pore water expulsion is predicted to occur in the first 40 years after cap placement.

4. Dredged material resuspension will occur during placement, resulting in predicted TSS concentrations ranging from 20 to 150 mg/L and both dissolved and particulate-associated contaminant release to the water column overlying the CAD cell.

5. The resuspension predictions appear to be a reasonable and conservative representation of the behavior of actual plumes observed during similar dredged material placement in a City of New Bedford CAD cell in 2009.

6. Dissolved contaminant concentrations in the CAD cell water (but not the overlying water) during filling will become approximately equal to the sediment pore water being placed in the CAD cell.

7. About 2.4 kg of PCB are predicted to be lost during dredged material placement in the lower harbor CAD cell, 85% of which would be dissolved. About 44 kg of copper are predicted to be lost during dredged material placement, 50% of which would be dissolved. These losses represent about 0.038% of the total PCB mass and 0.020% of the total copper mass being placed into the CAD cell.

8. Hydrodynamics modeling yielded only low velocities in the water column above the CAD cell, typically less than 0.3 fps. The velocity is sufficiently great to rapidly exchange the water above the CAD cell, typically in one to 3 hours. The velocity is sufficiently low to limit any mixing in the CAD cell water, mostly in the top few feet. However, higher resolution hydrodynamic modeling of the CAD cell environ performed using the 3-D EFDC model set up for sediment transport modeling showed the potential to set up a slow vertical eddy in the CAD cell. The eddy could provide slow mixing to a depth of 10 feet below the lip of the CAD cell. Therefore, contaminants in the top ten feet of the CAD cell were subjected to turbulent diffusion and exchange with the water column above the lip of the CAD cell.

9. Additional losses due to potential turbulent diffusion and thermally induced displacement over the winter between dredging seasons could result in about 2.7 kg of additional PCB being lost from the CAD cell water prior to capping, resulting in a total loss from placement operations of 0.08% (5.2 kg) of the total PCB mass disposed in the cell. Similarly, an additional loss of about 18 kg copper could be lost by these mechanisms, resulting in a total placement loss of about 0.028% (63 kg) of the total copper mass disposed in the cell.

10. Placement losses are predicted to be one to two orders of magnitude less than typical losses from mechanical dredging operations.

11. After capping, the contaminants expelled from the dredged material by consolidation would be contained in the lower foot of the cap.

12. Without consideration of burial (i.e., the additional sediment deposition that will take place over time into the bowl-shaped CAD cell depression formed by consolidation after the cap is placed), contaminant breakthrough will take more than 1800 years. Again, breakthrough, as used here, is defined as the condition when the contaminant flux or surficial pore water concentration increases to levels of 0.01% of the original flux or sediment bed concentration before dredging and disposal. With burial promoted by the estimated eleven feet of post-cap dredged material settlement, the transport of contaminants through the cap and burial material will take tens of thousands of years to achieve the breakthrough.

13. A stable 3-ft cap would be highly effective in isolating the contaminated dredged material.

14. Reducing the placement schedule from three years to one or two years would increase the size of the CAD cell needed to contain the approximately 300,000 cubic yards of sediment proposed for placement in the lower harbor CAD cell while maintaining conditions to promote settling and stability. The increase in storage requirements is due to shortening the time available for consolidation. Schedule acceleration is also predicted to decrease the contaminant losses due to the reduction in the exposure of contaminated CAD cell water for losses to occur.

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Figures

Figure 1. New Bedford Harbor.

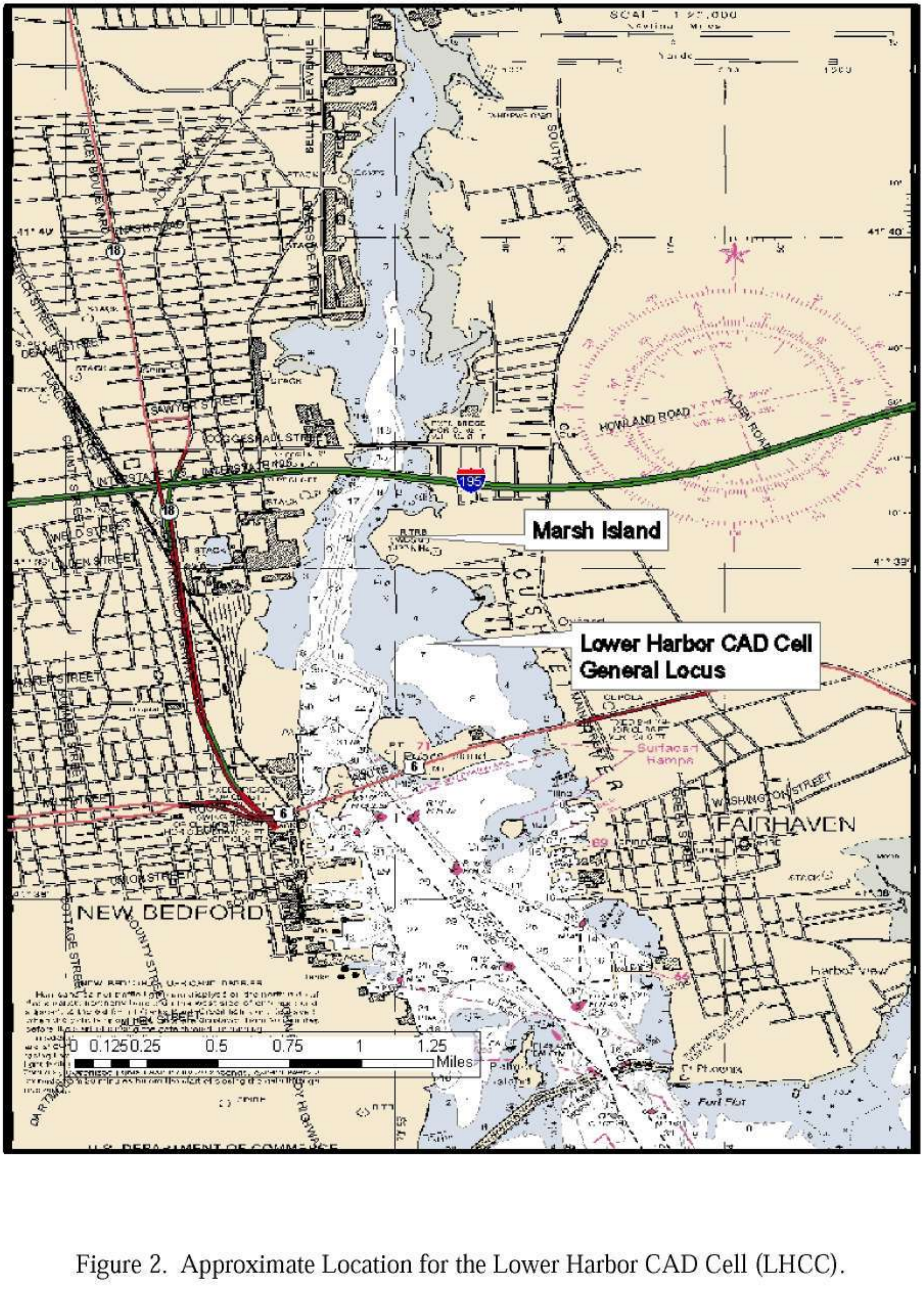


Figure 2. Approximate Location for the Lower Harbor CAD Cell (LHCC).

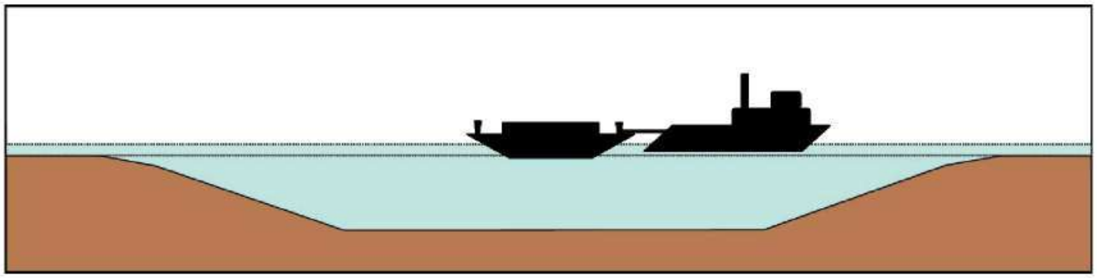


Figure 3. Scaled Graphic of CAD Cell Used for Modeling.

(CAD shown is 650 feet across the top and 47 feet deep. The first seven feet of CAD wall has a side slope of 1V:6H and the remainder of the CAD walls are sloped at 1V:3H. The mean water depth surrounding the CAD is eight feet deep and the barge draft is eight feet (assumes a deeper access route or high tide entry). The barge hopper length is 88 feet with a total barge length shown of 110 feet.).

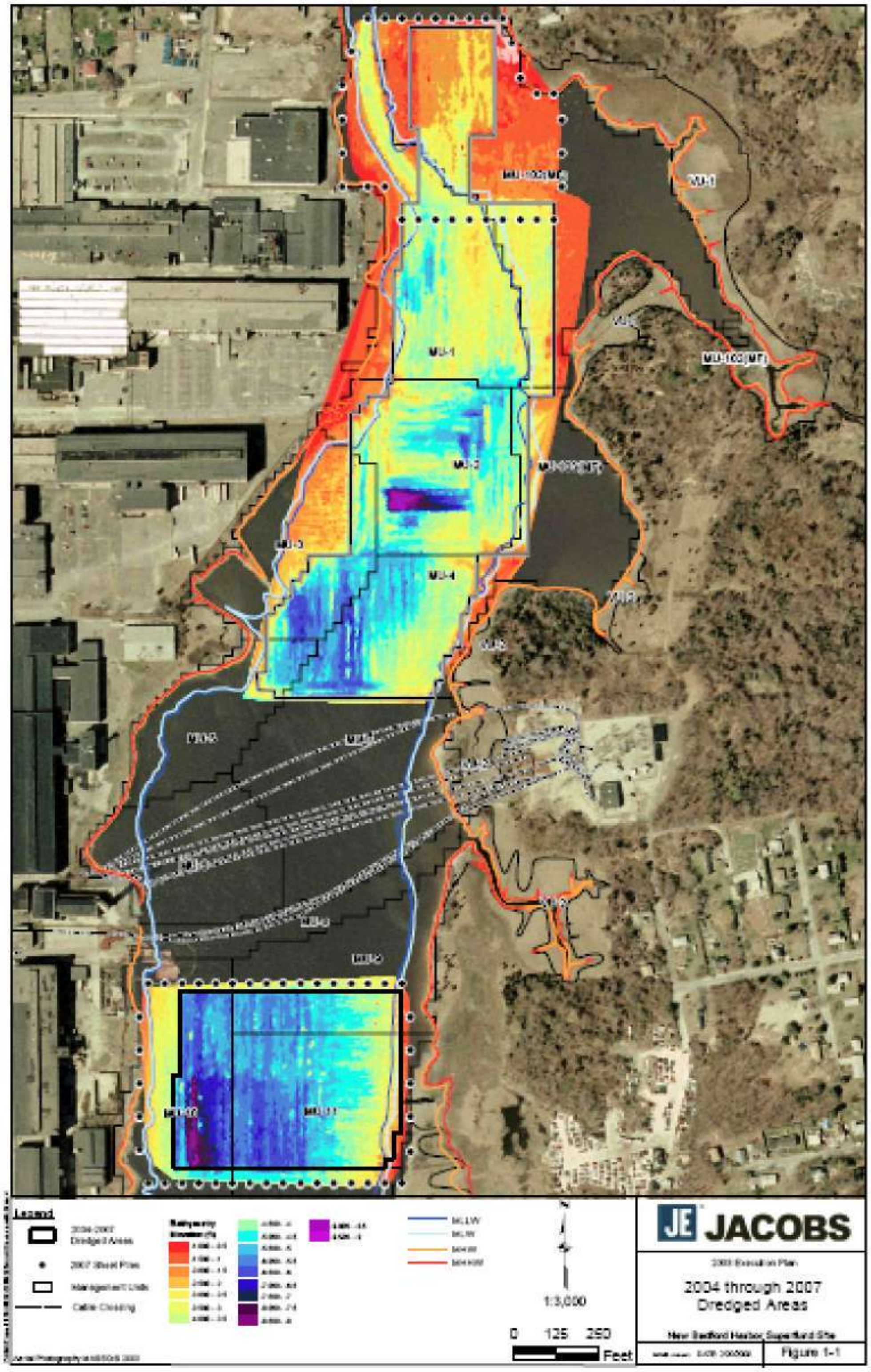


Figure 4. Completed Dredging Areas (2004-2007) and MUs in the Upper Harbor (from Jacobs Engineering).

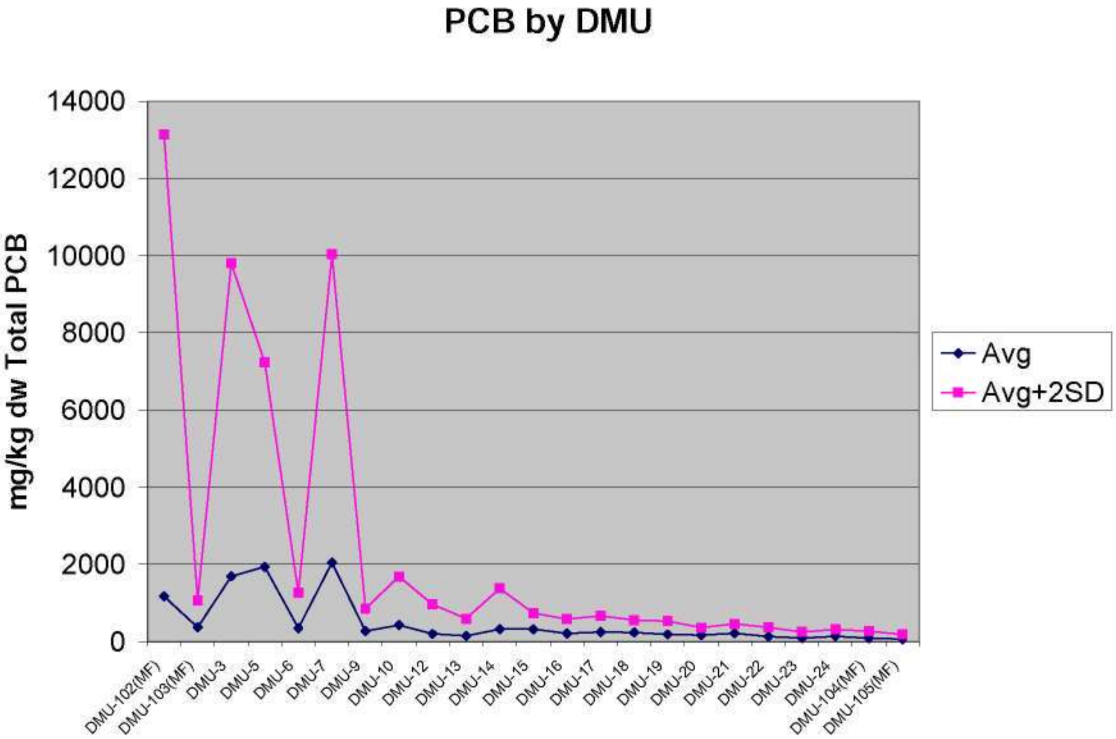
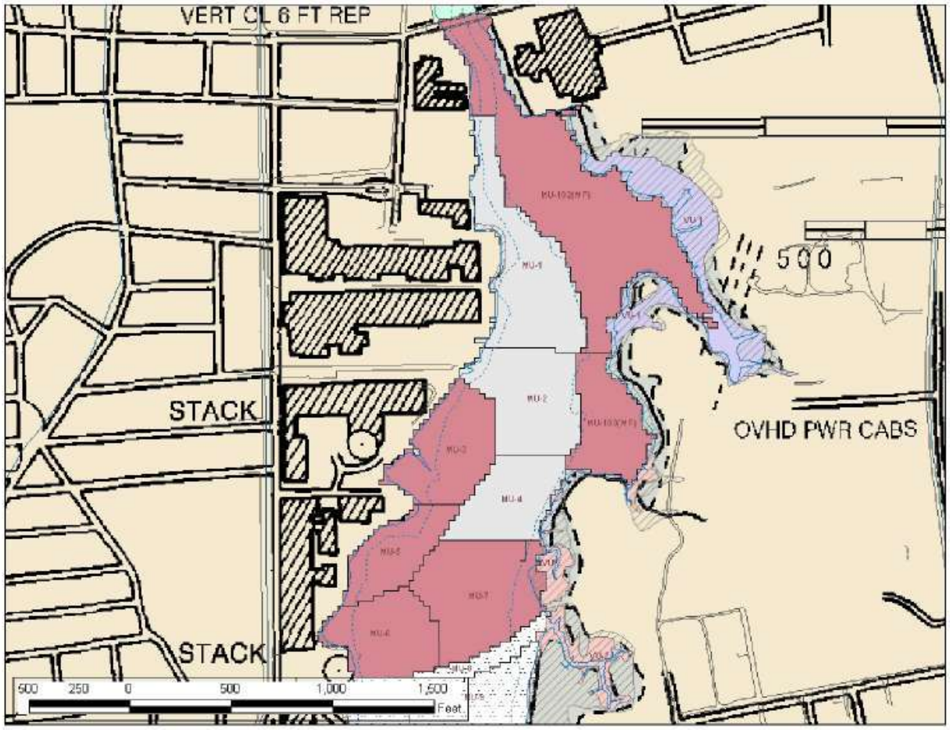


Figure 5. Total PCB Data by DMU.

DMU Composite 1 - Coral Color (Dark)



DMU Composite 2 - Stippled

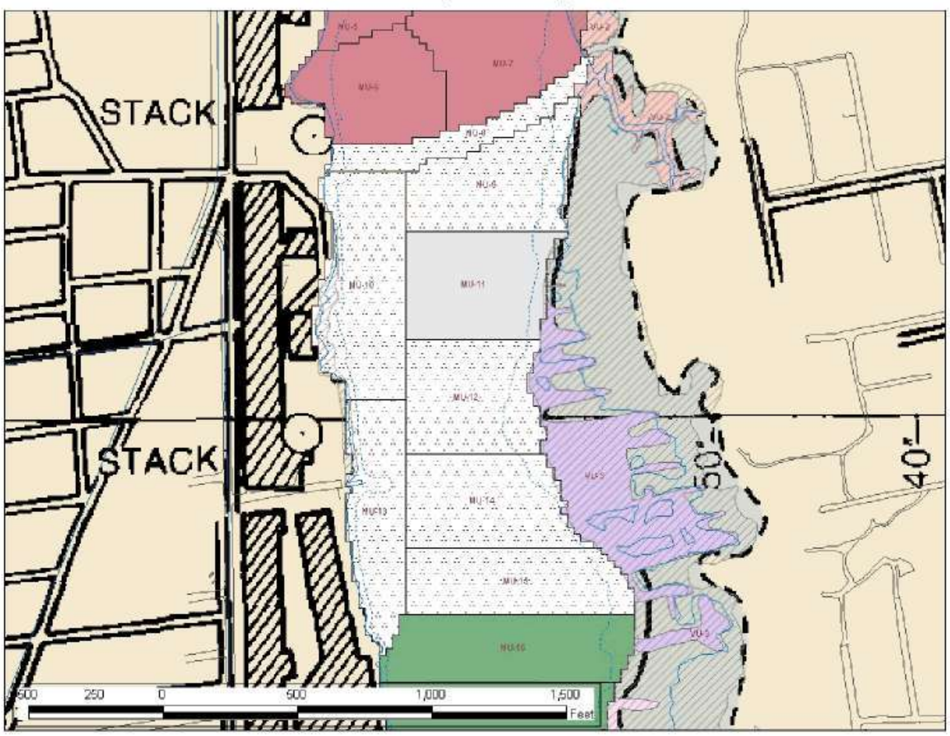
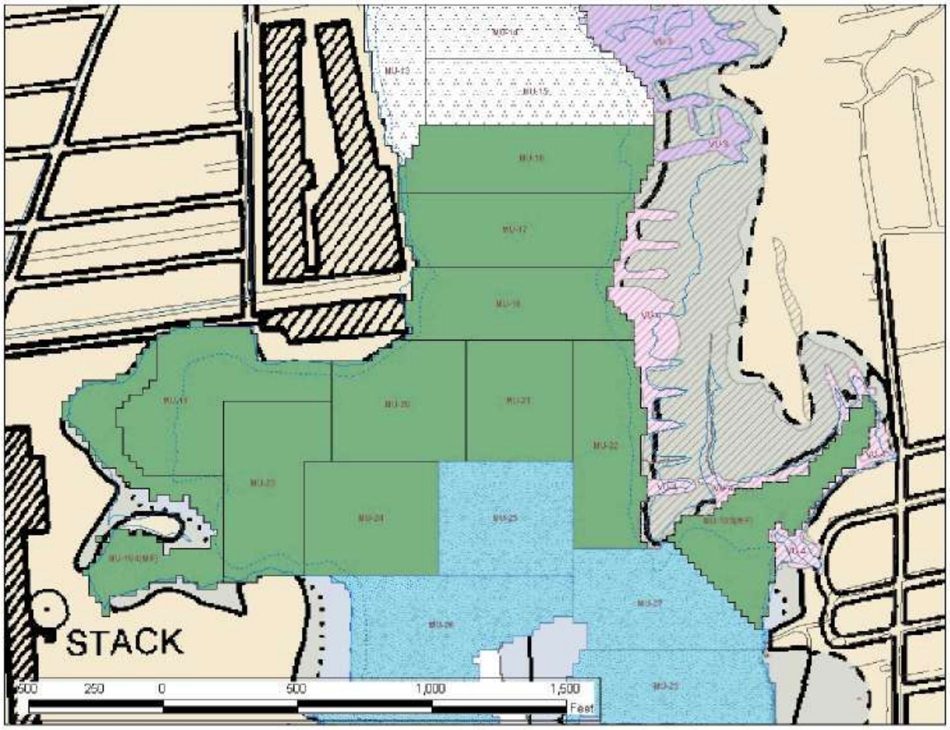


Figure 6. DMU Groupings for Sample Composites.

DMU Composite 3 - Green Color (Dark)



DMU Composite 4 - Blue Stippled Color

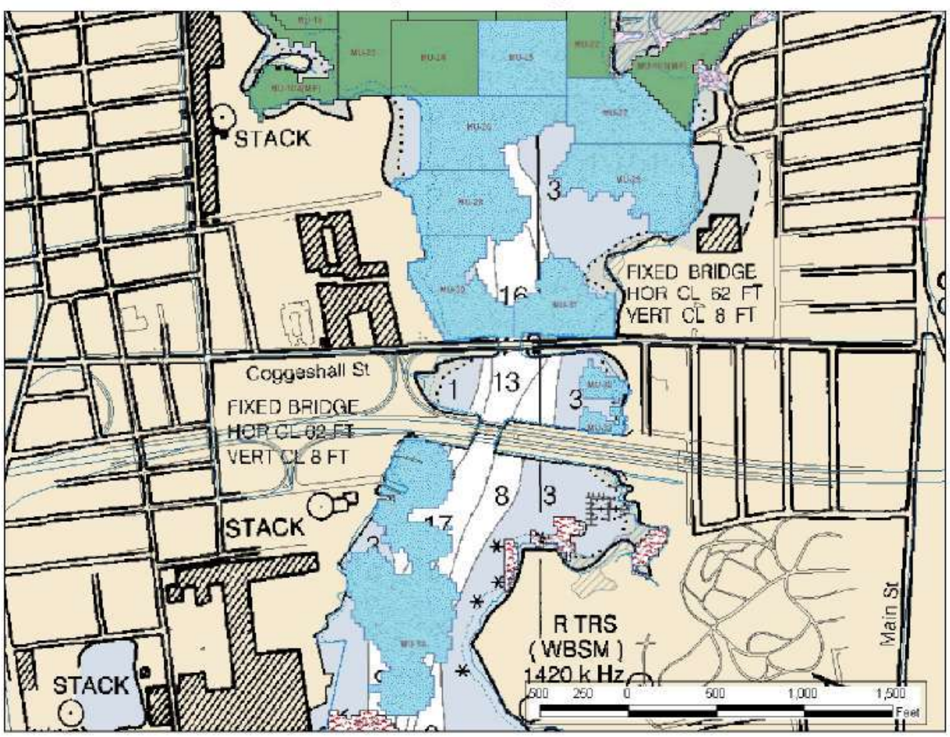


Figure 6. (Continued).

DMU Composite 5 - Blotched

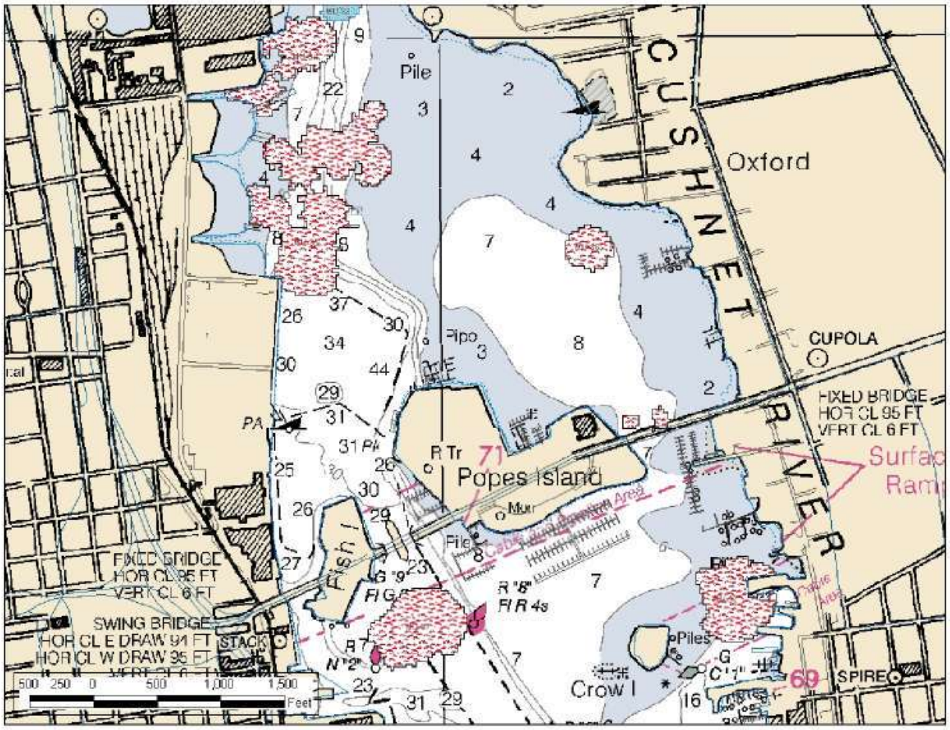
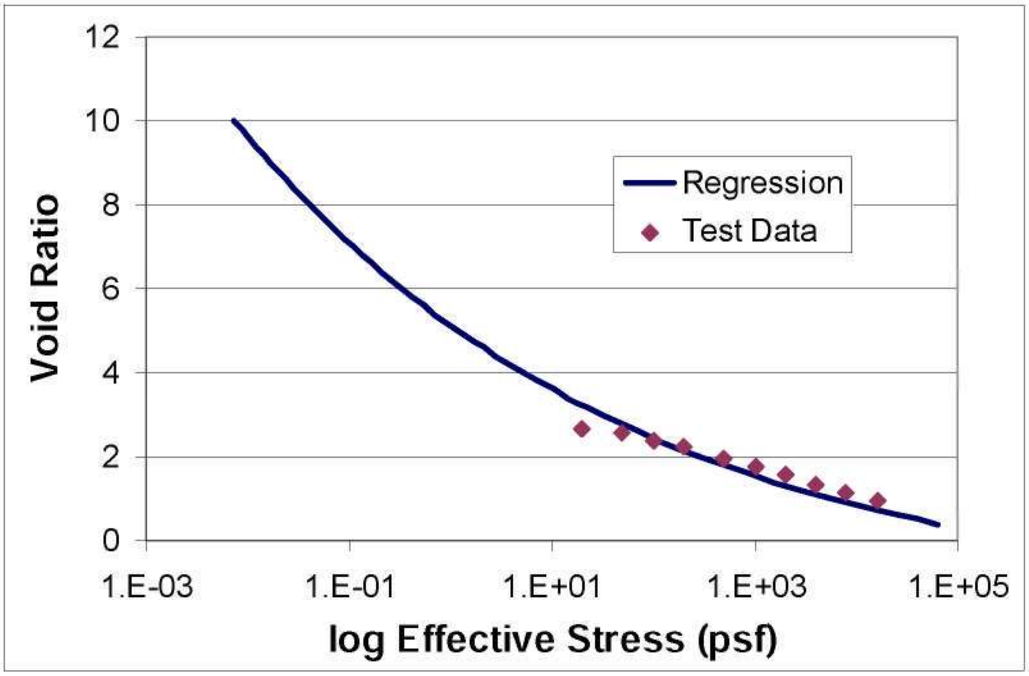


Figure 6. (Continued).



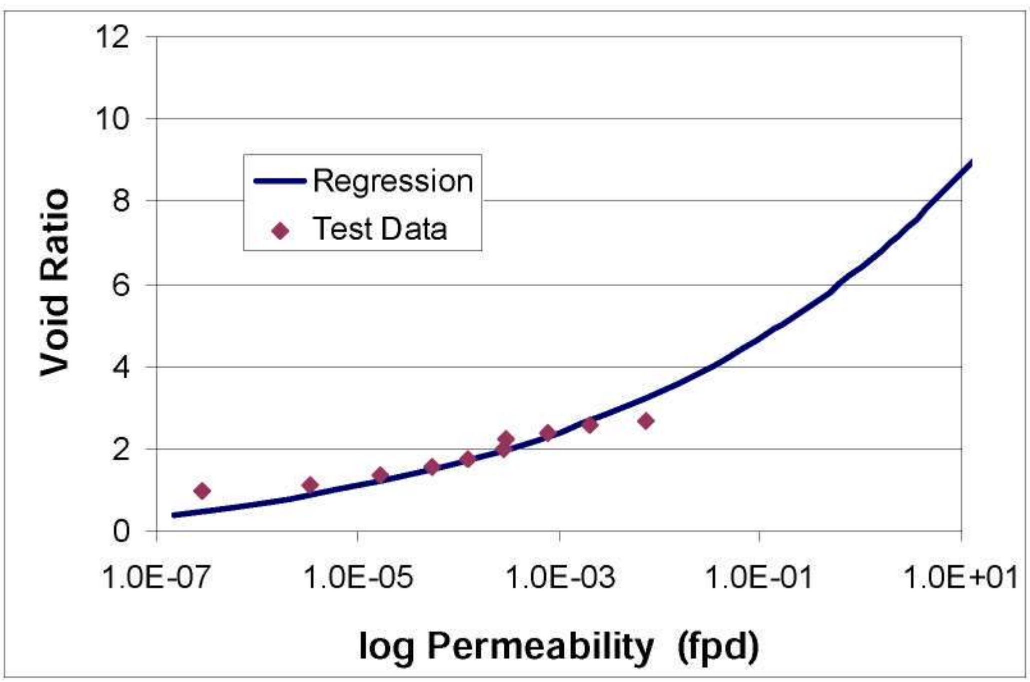
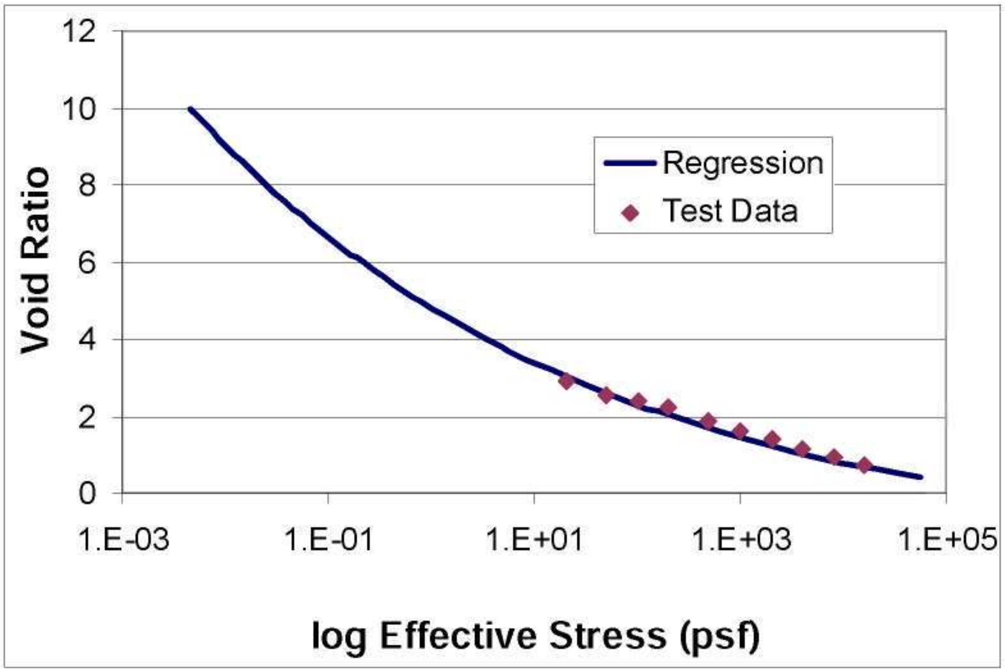


Figure 7. Void Ratio vs. Effective Stress and Void Ratio vs. Permeability Relationships for New Bedford Harbor Sediment Composite 1.



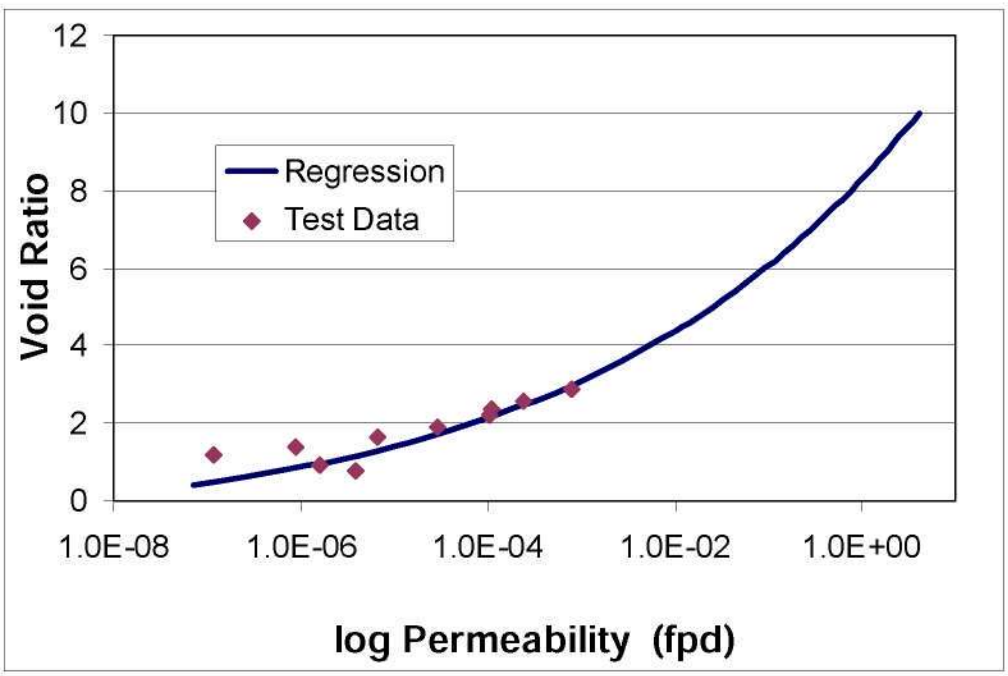
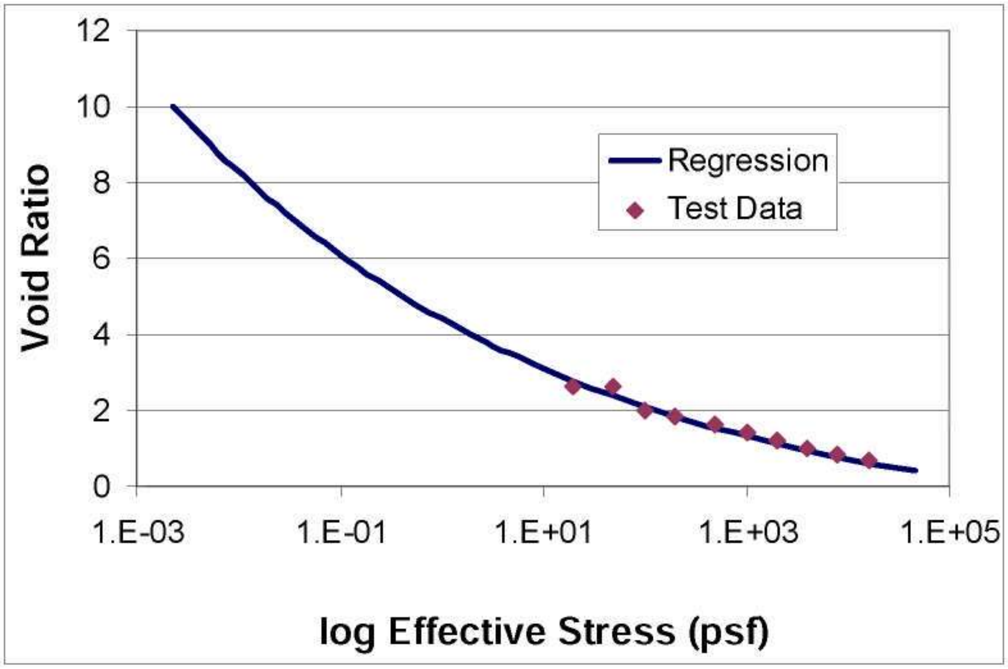


Figure 8. Void Ratio vs. Effective Stress and Void Ratio vs. Permeability Relationships for New Bedford Harbor Sediment Composite 2.



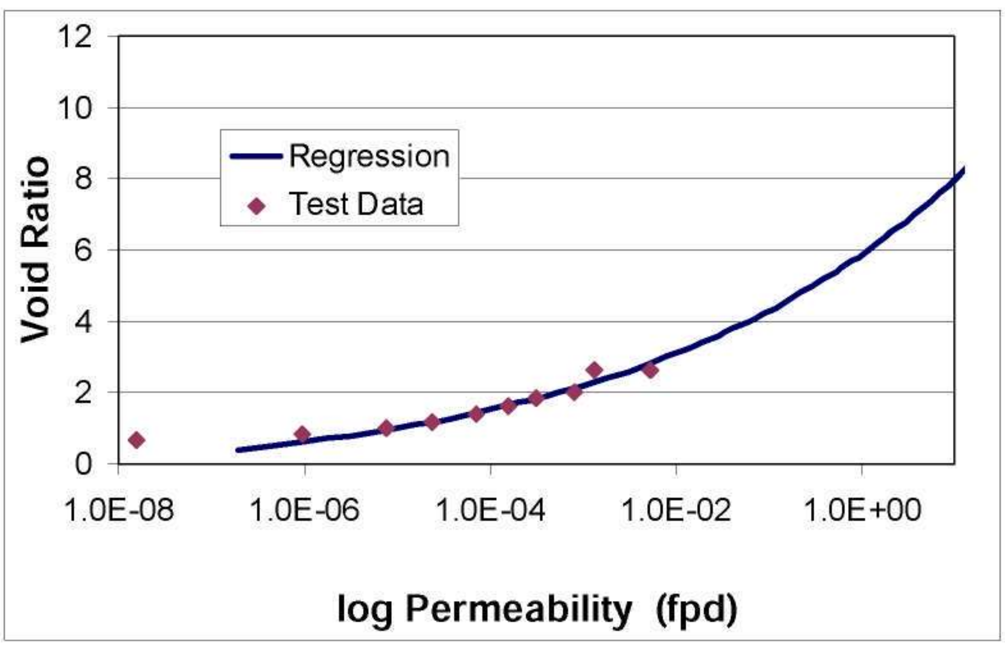
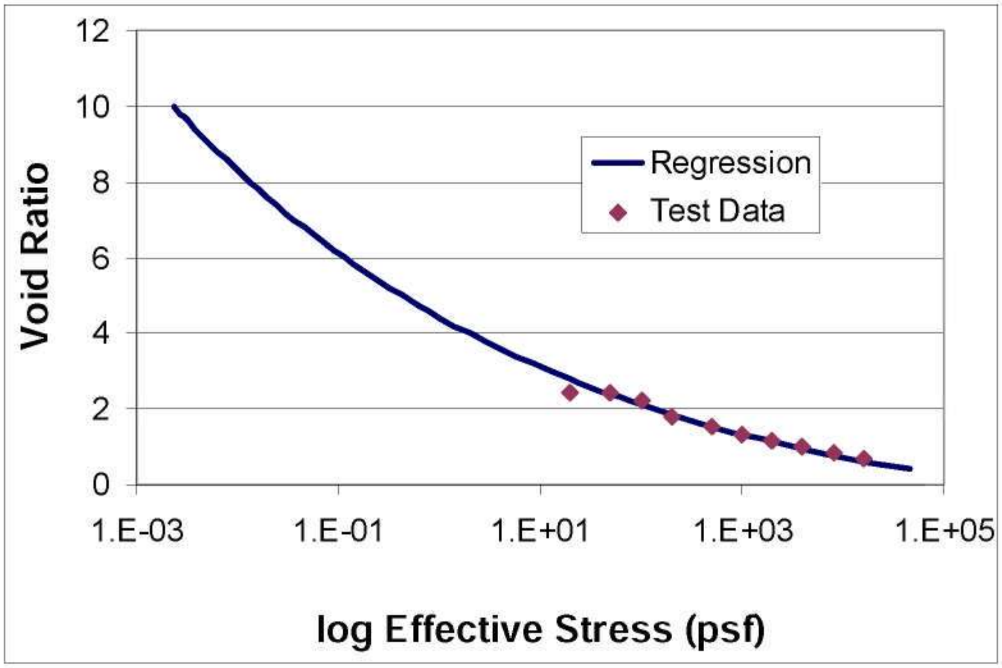


Figure 9. Void Ratio vs. Effective Stress and Void Ratio vs. Permeability Relationships for New Bedford Harbor Sediment Composite 3.



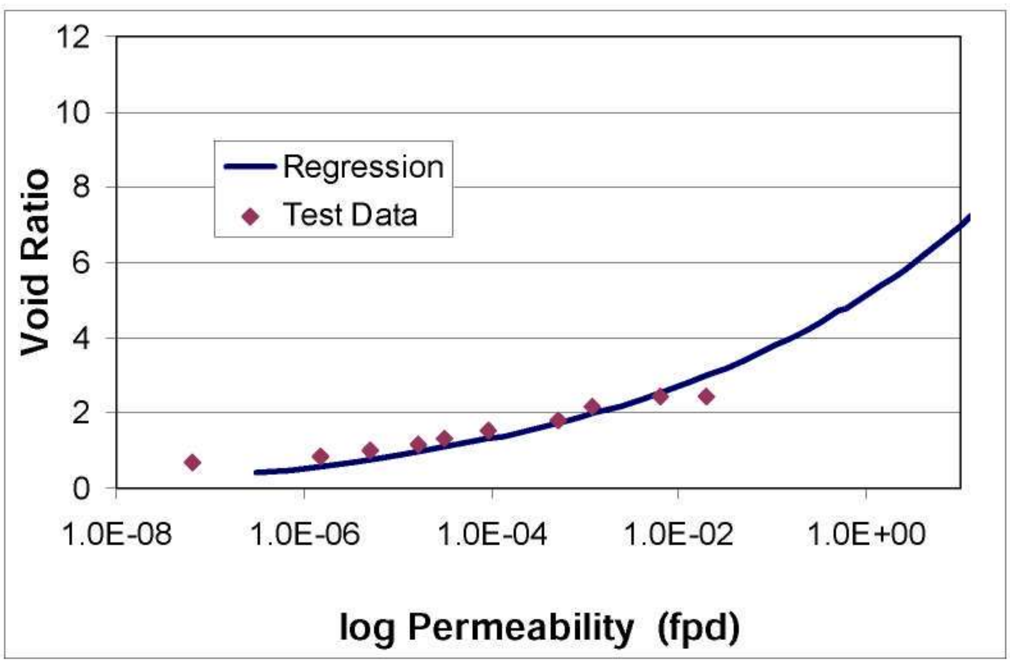
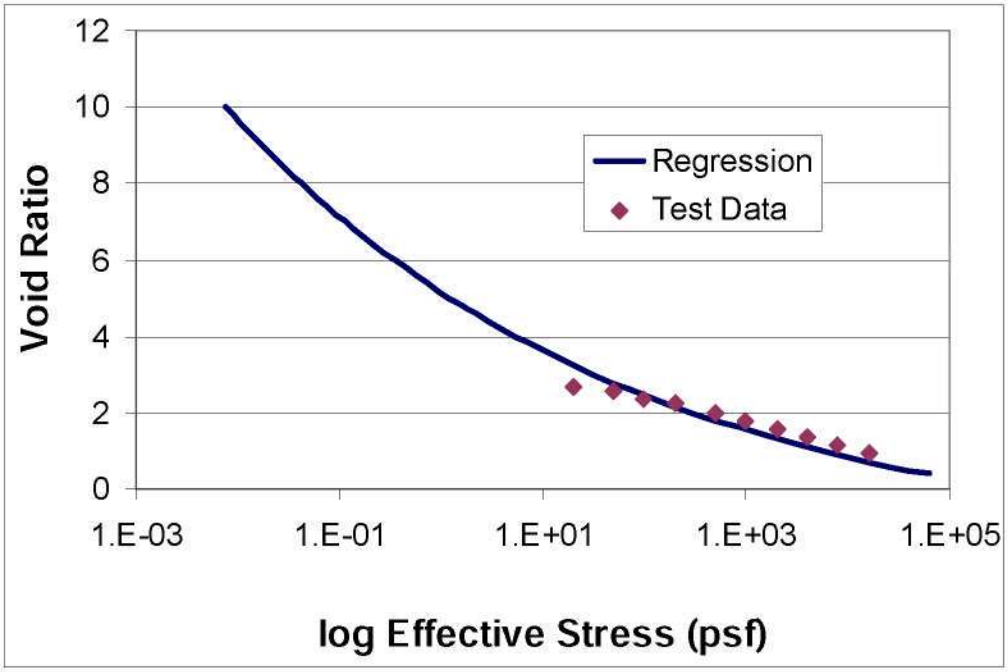


Figure 10. Void Ratio vs. Effective Stress and Void Ratio vs. Permeability Relationships for New Bedford Harbor Sediment Composite 4.



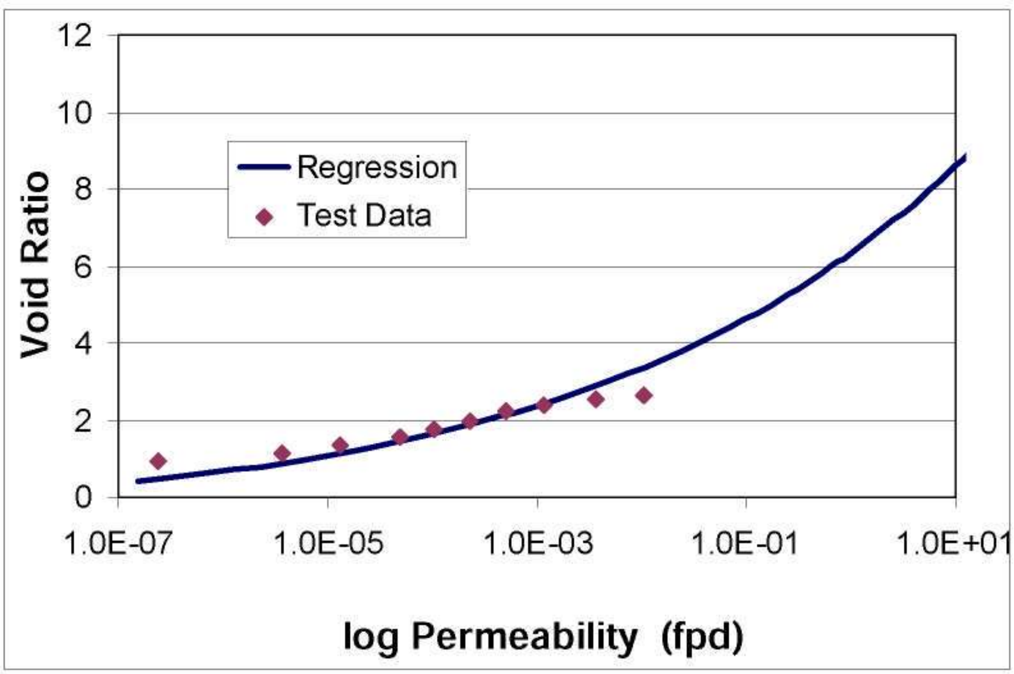


Figure 11. Void Ratio vs. Effective Stress and Void Ratio vs. Permeability Relationships for New Bedford Harbor Sediment Composite 5.

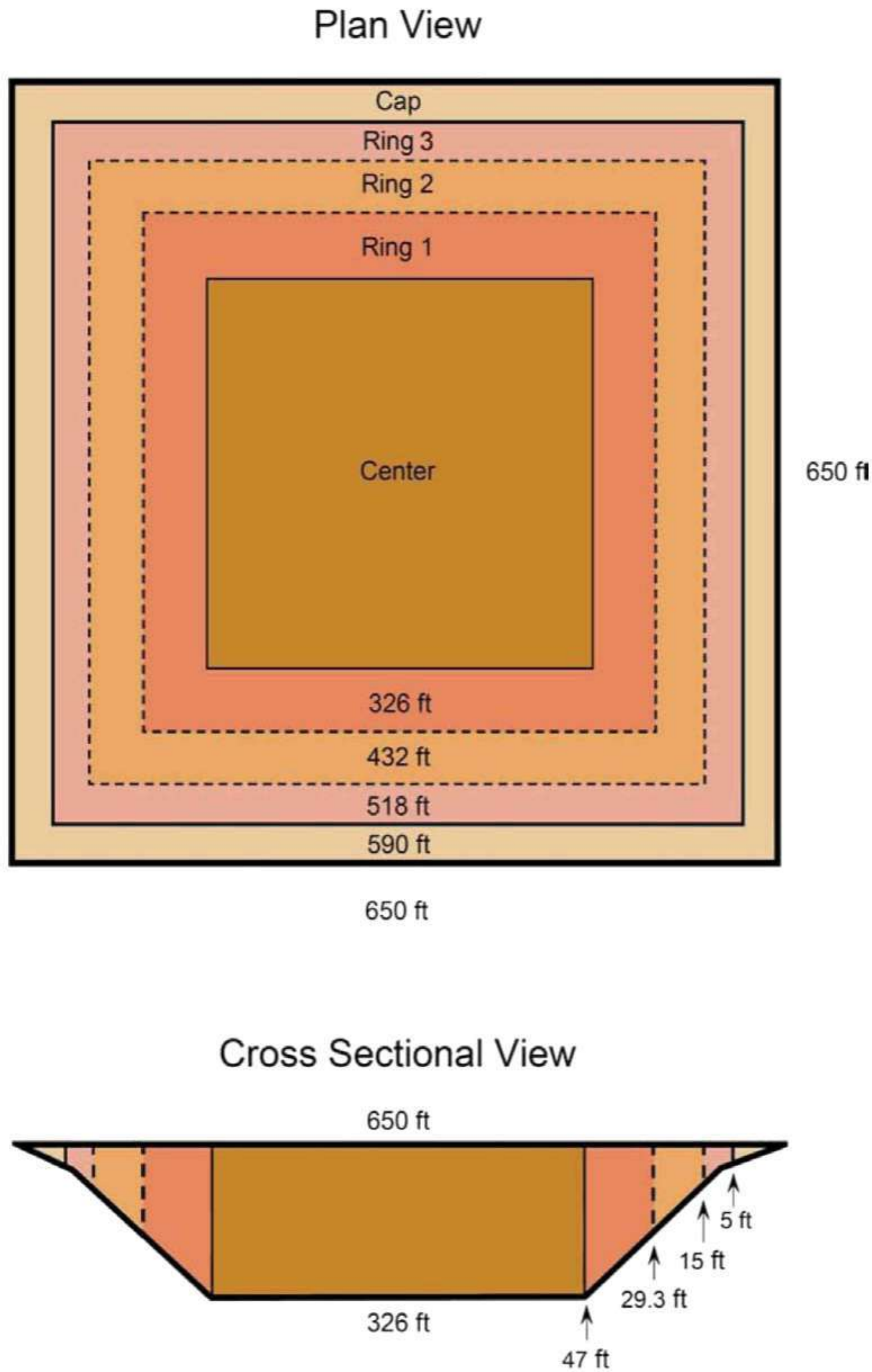


Figure 12. Schematic of CAD Cell Sections for PSDDF and CAP Modeling.

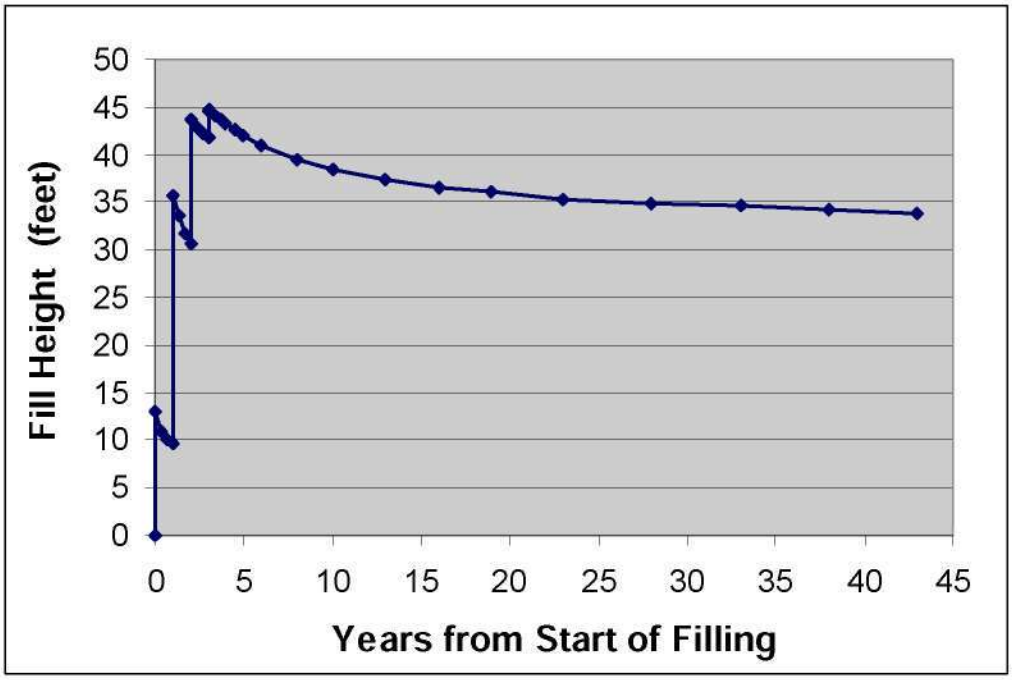


Figure 13. Fill Height History of Center Section of Lower New Bedford Harbor CAD Cell.

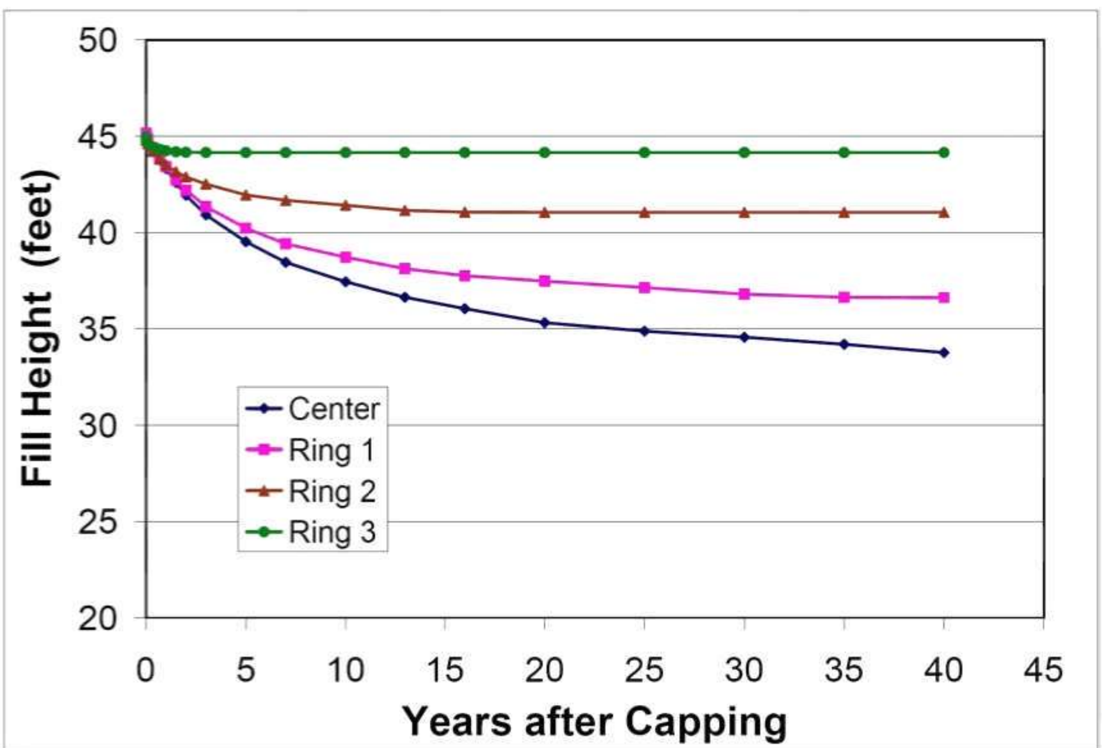


Figure 14. Fill Height History of Four Sections of CAD Cell after Capping.

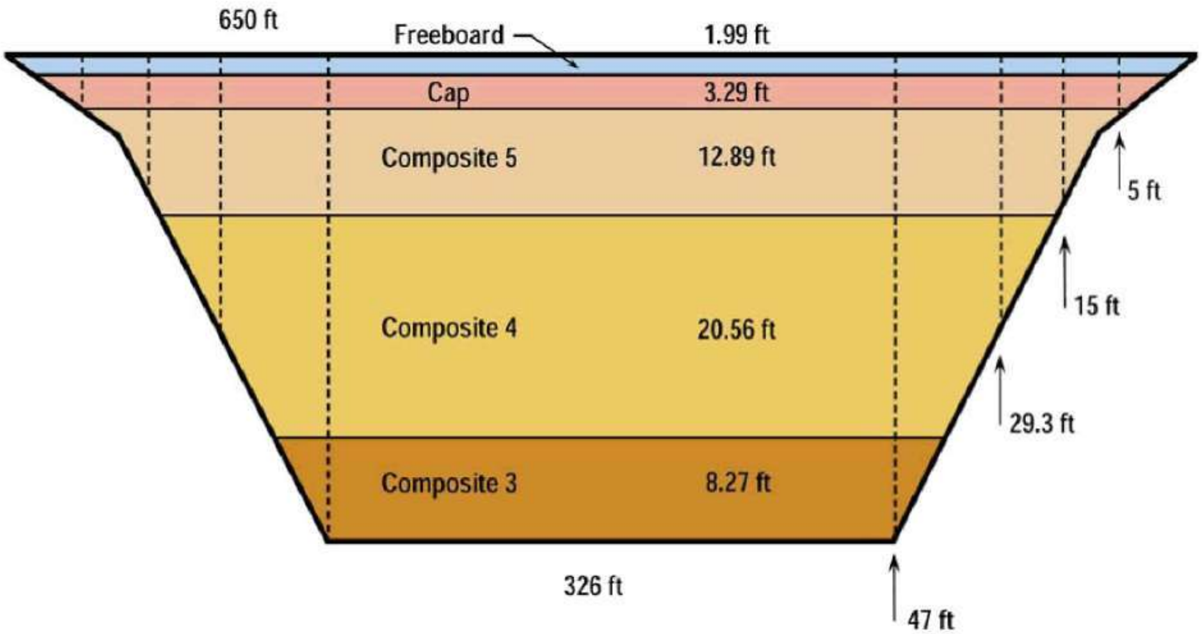


Figure 15. CAD Cell Status Immediately after Cap Placement.

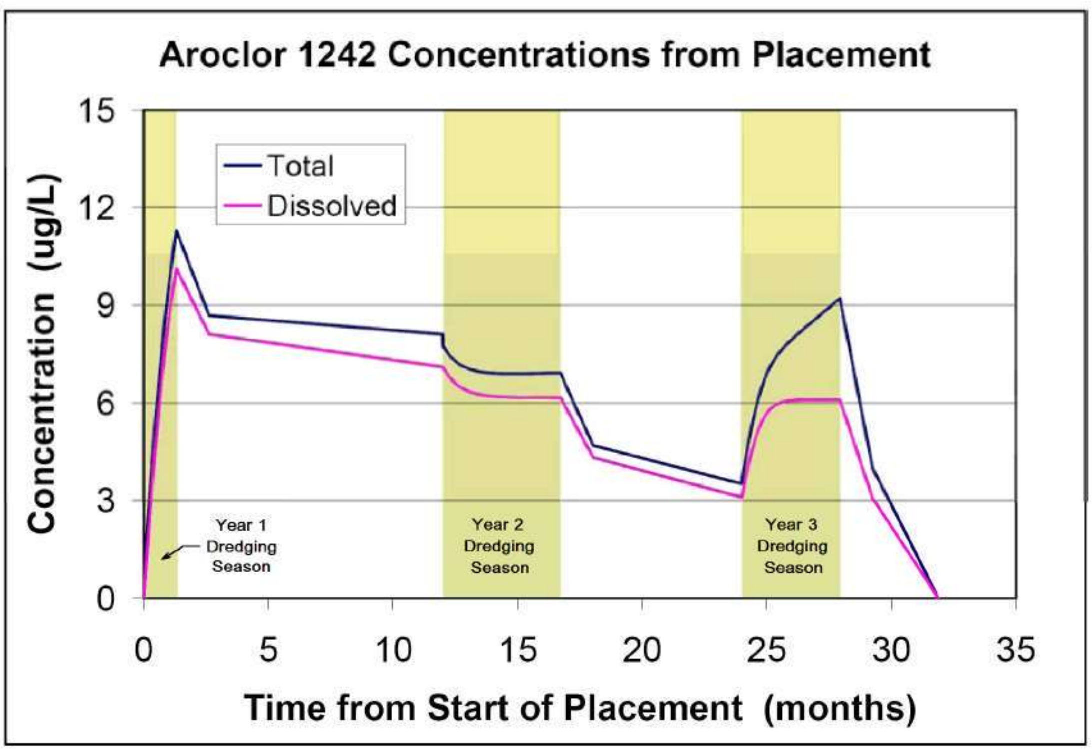


Figure 16. Concentration of PCBs Aroclor 1242 in CAD Cell Water Prior to Capping.

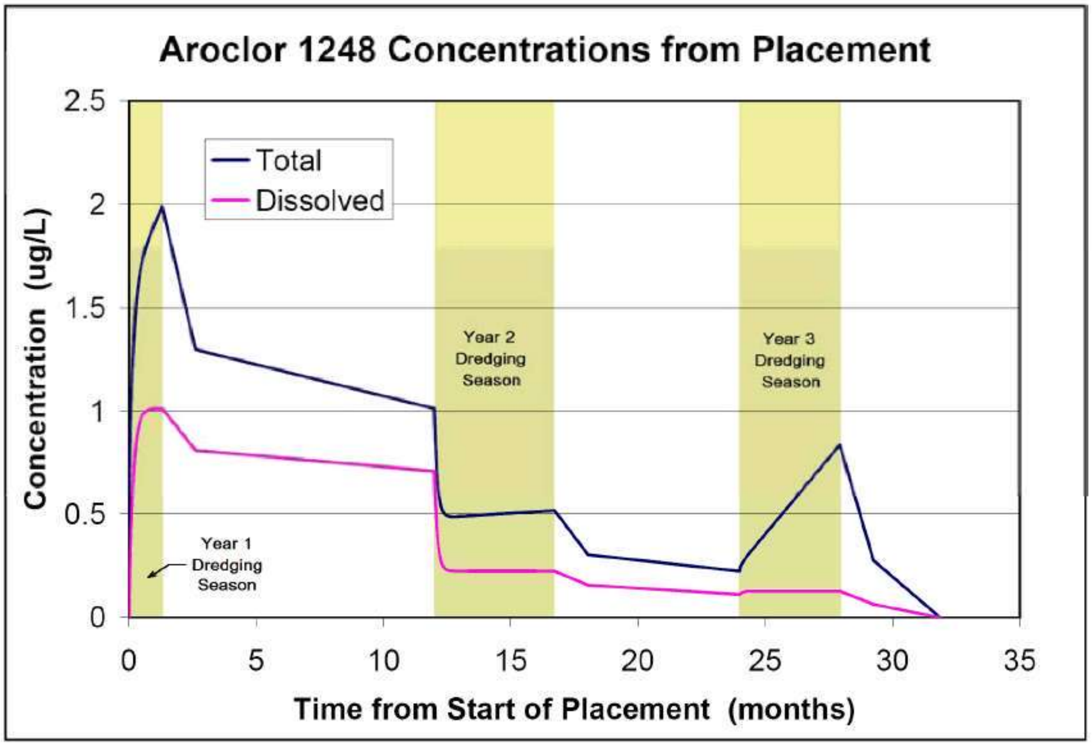


Figure 17. Concentration of PCBs Aroclor 1248 in CAD Cell Water Prior to Capping.

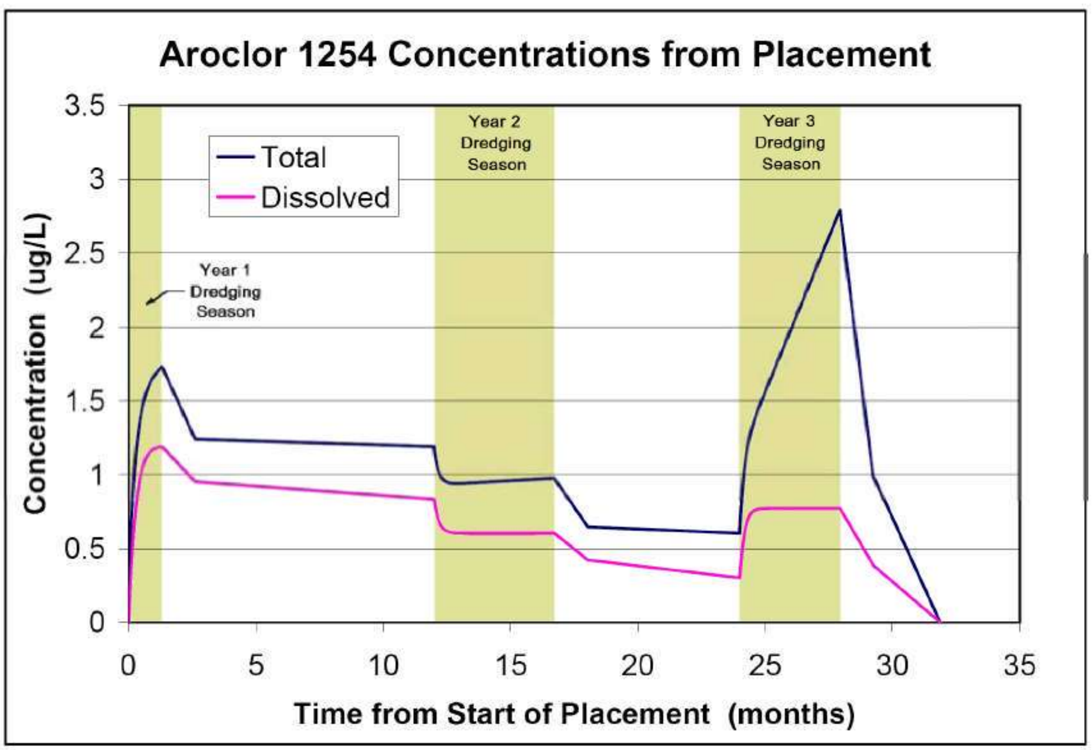


Figure 18. Concentration of PCBs Aroclor 1254 in CAD Cell Water Prior to Capping.

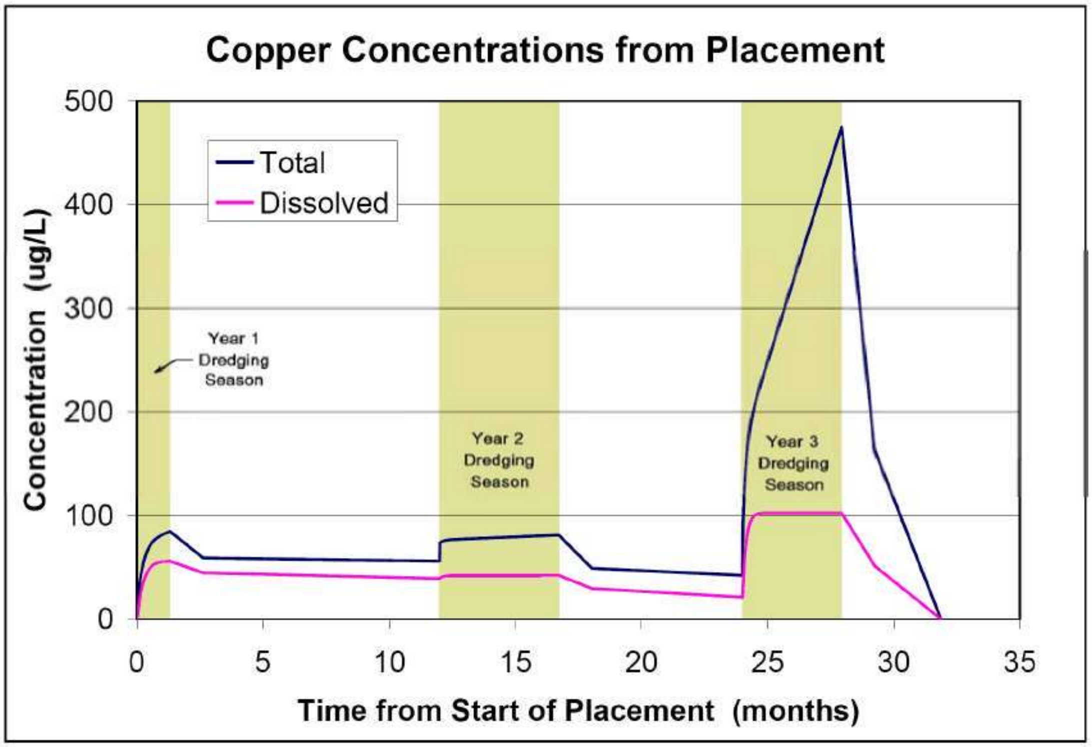


Figure 19. Concentration of Copper in CAD Cell Water Prior to Capping.

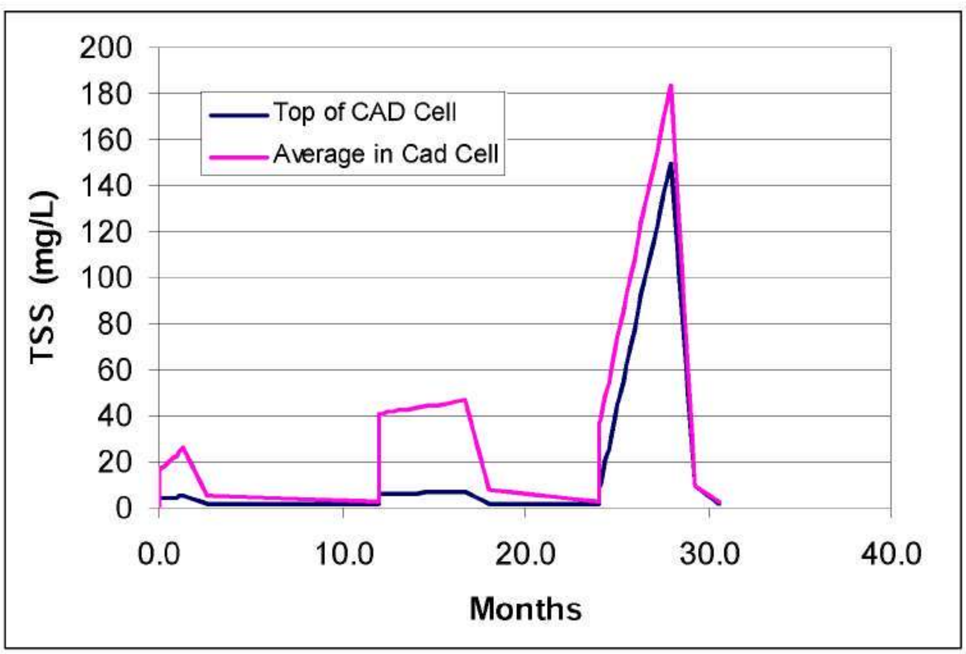


Figure 20. Total Suspended Solids Concentration in CAD Cell as a Function of Time.

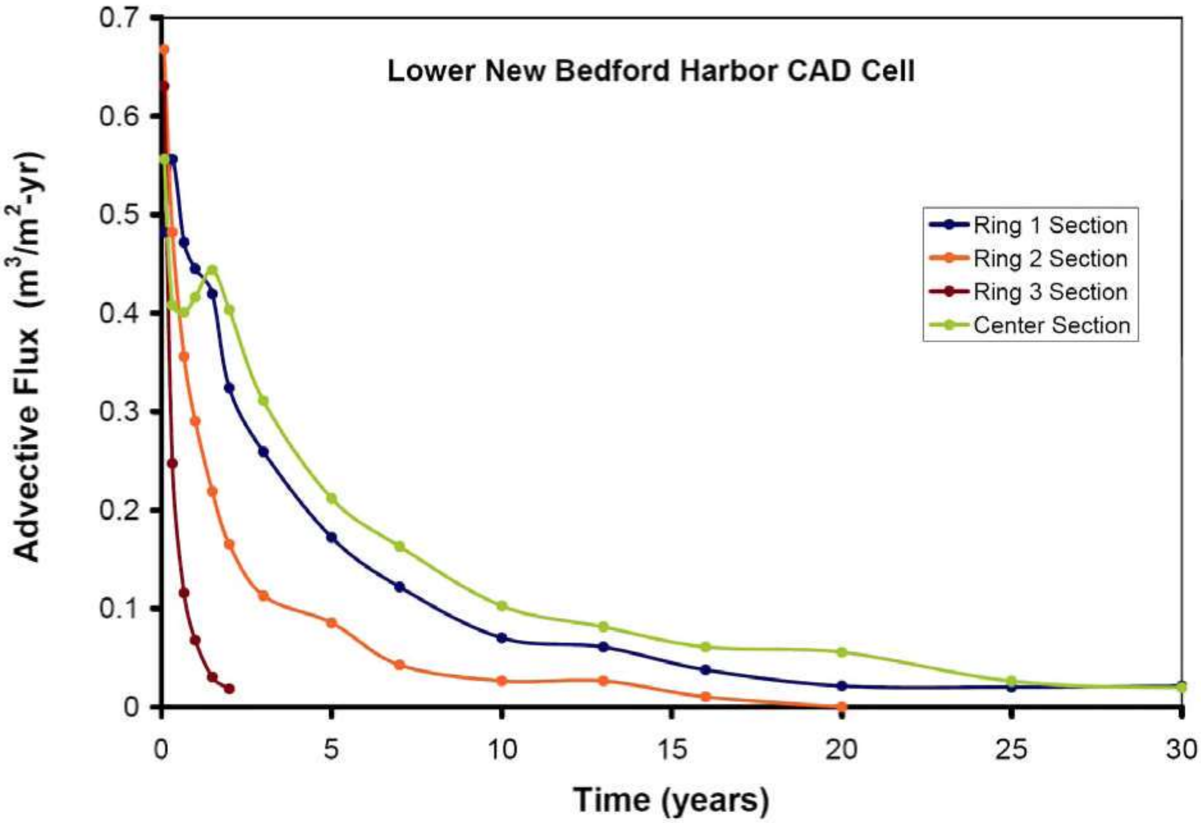


Figure 21. Water Flux through the Four Sections of the Cap as a Function of Time.

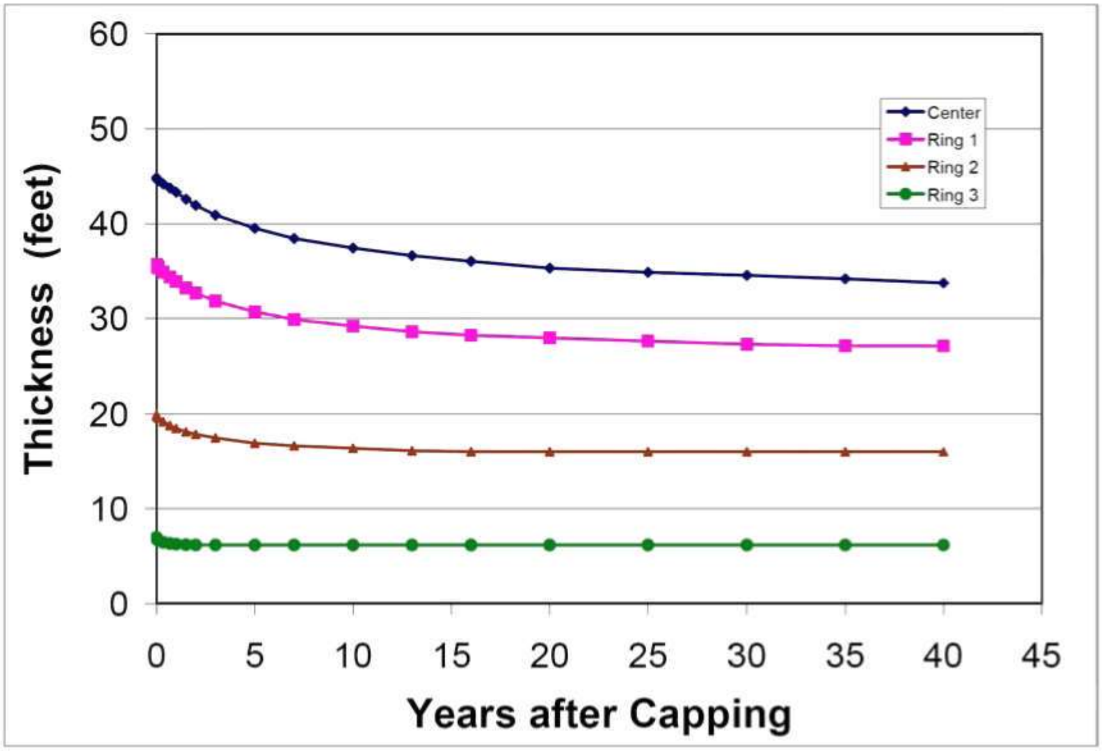


Figure 22. Thickness History of Four Sections of CAD Cell after Capping.

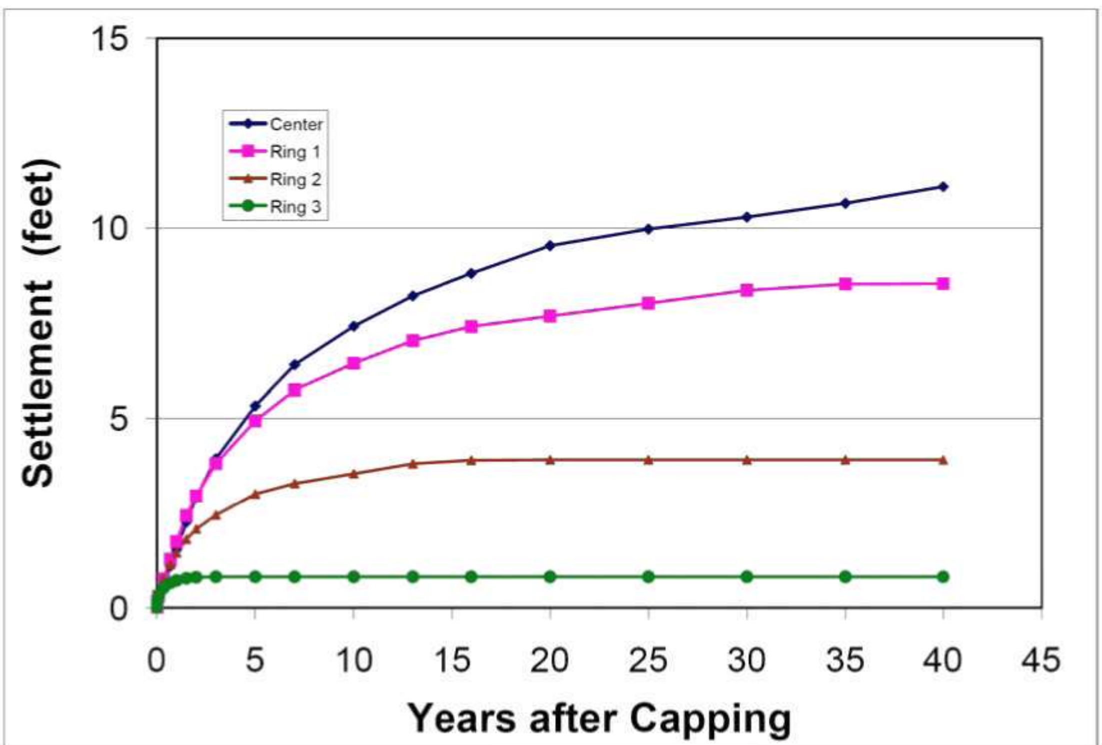


Figure 23. Settlement History of Four Sections of CAD Cell after Capping.

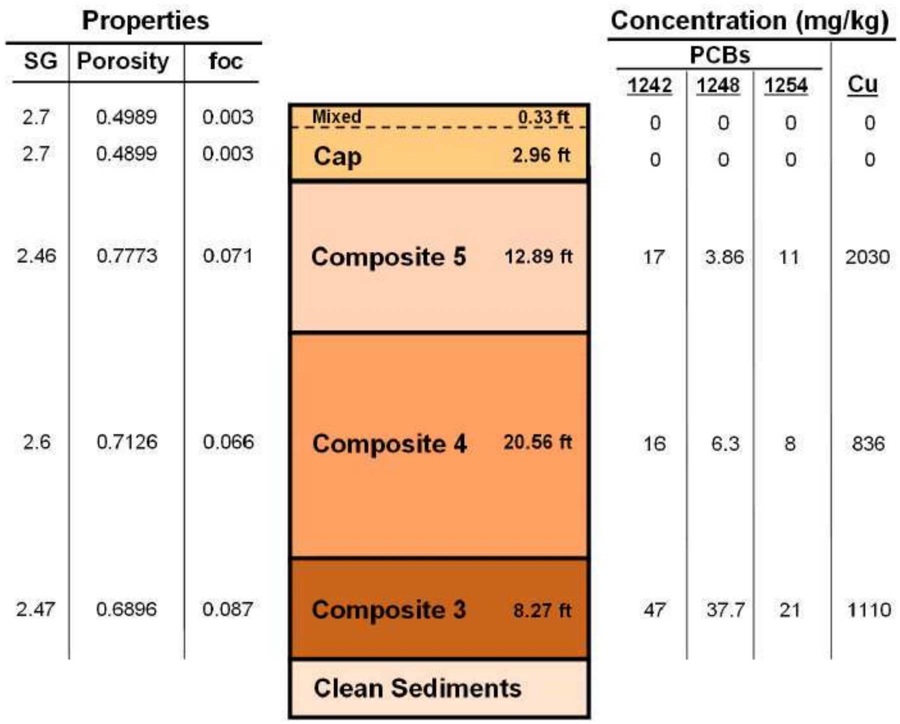


Figure 24. Conceptual Model of the CAD Center Section for PSDDF and CAP Runs.

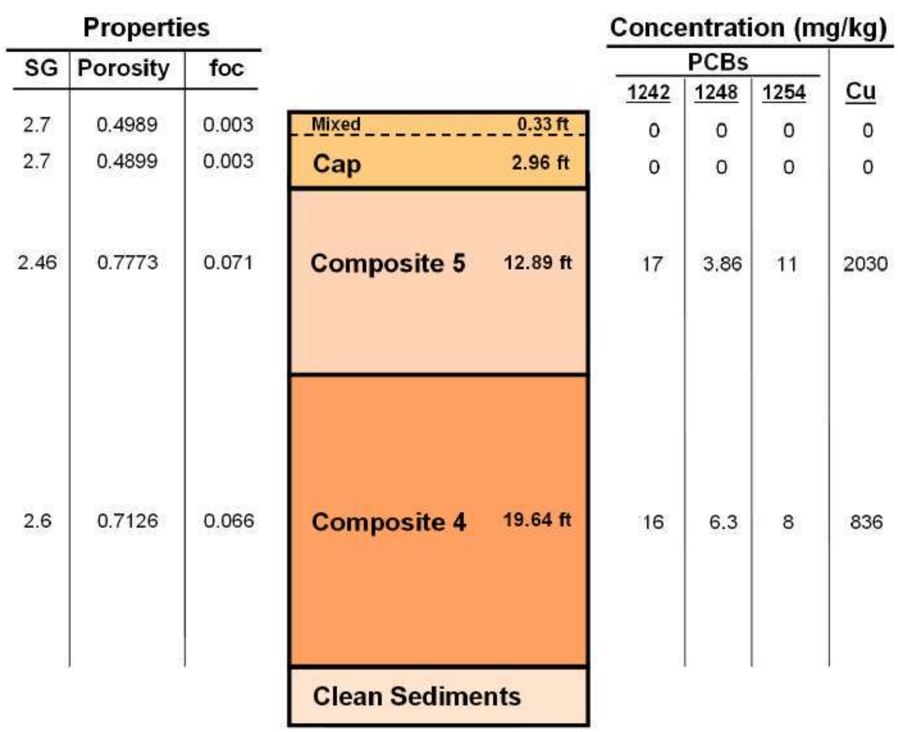


Figure 25. Conceptual Model of the CAD Ring 1 Section for PSDDF and CAP Runs.

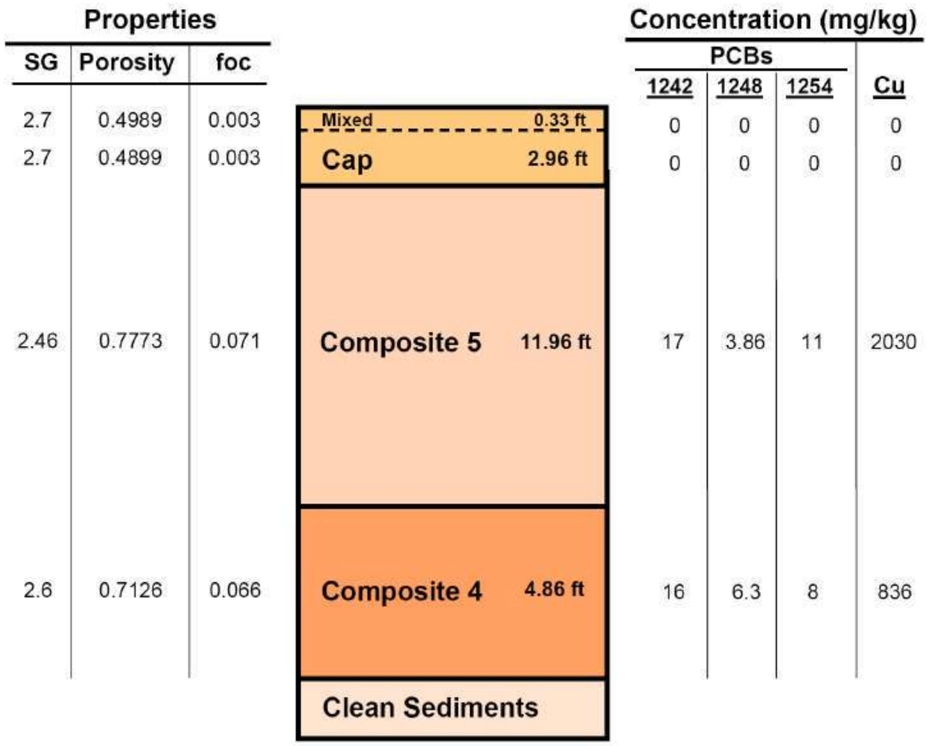


Figure 26. Conceptual Model of the CAD Ring 2 Section for PSDDF and CAP Runs.

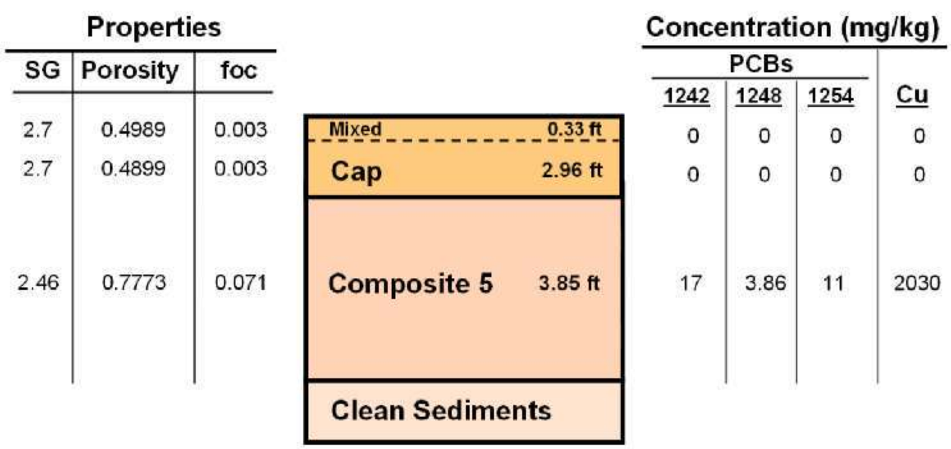


Figure 27. Conceptual Model of the CAD Ring 3 Section for PSDDF and CAP Runs.

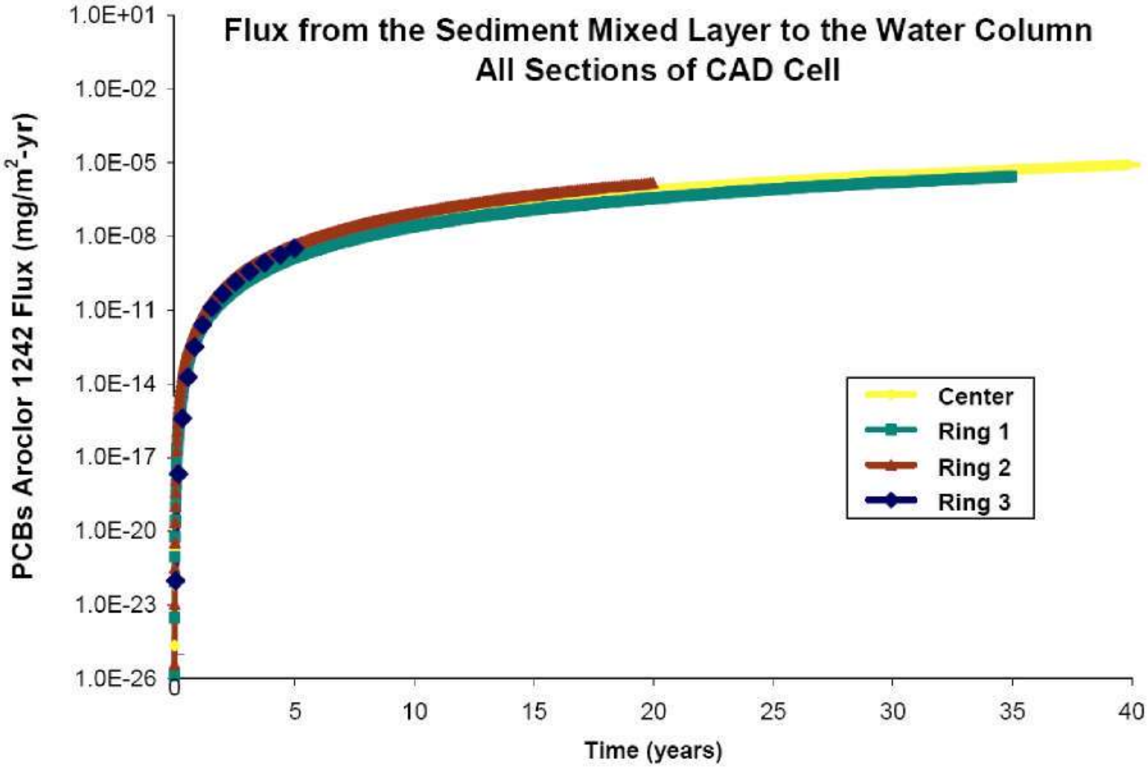


Figure 28. Predicted PCBs Aroclor 1242 Flux from the CAD Cell Mixed Layer.

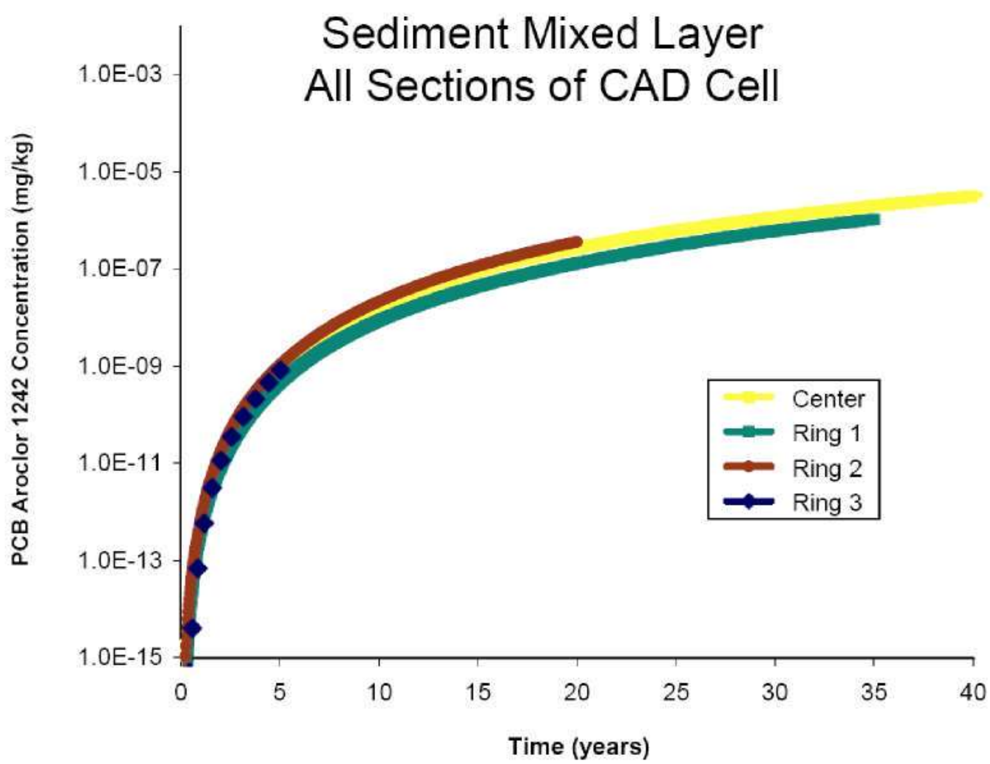


Figure 29. Predicted Mixed Layer PCBs Aroclor 1242 Concentration for the CAD Cell.

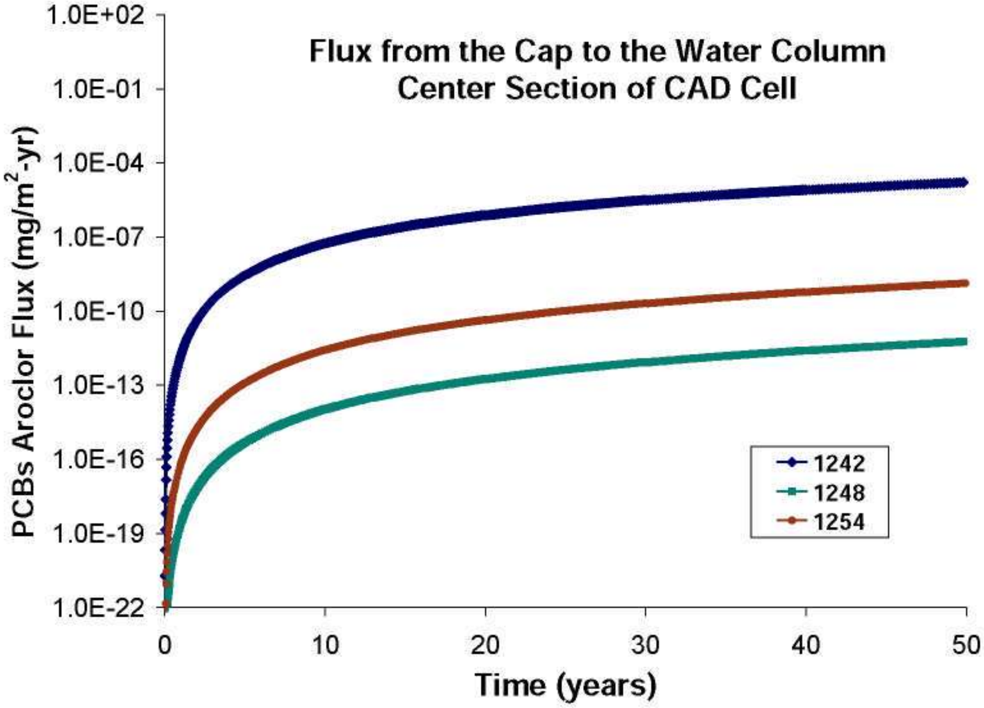


Figure 35. Predicted PCBs Flux from the Center Section of CAD Cell Bioactive Zone.

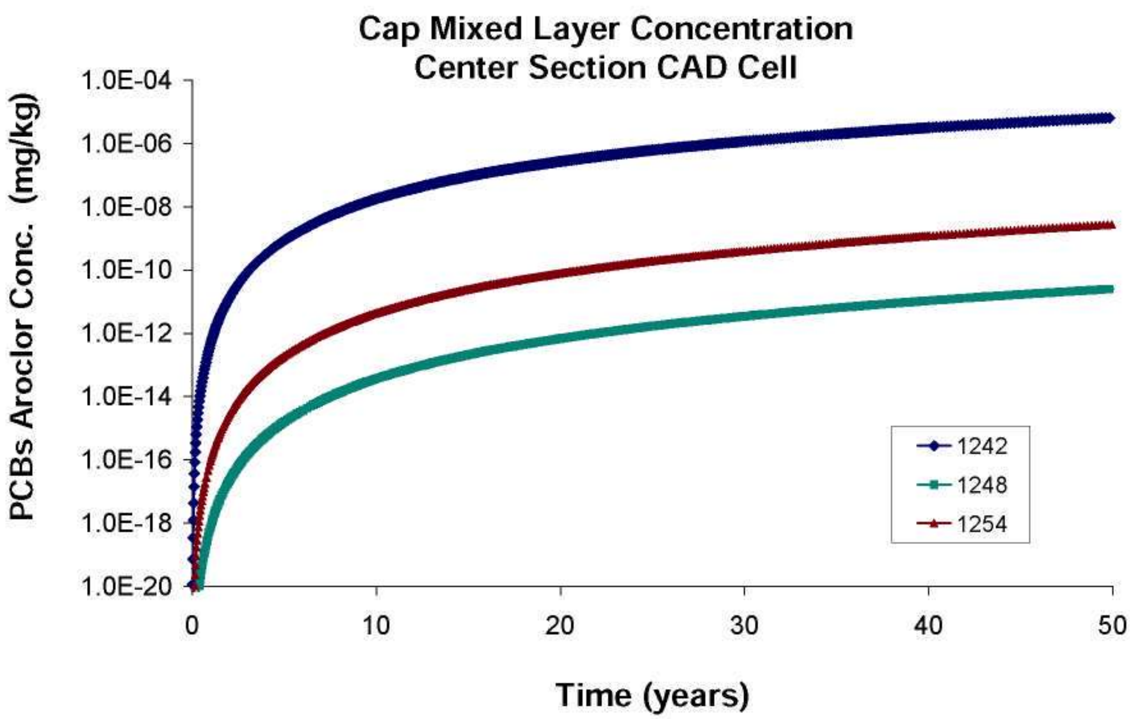


Figure 36. Predicted PCBs Concentrations in Center Section of CAD Cell Bioactive Zone.

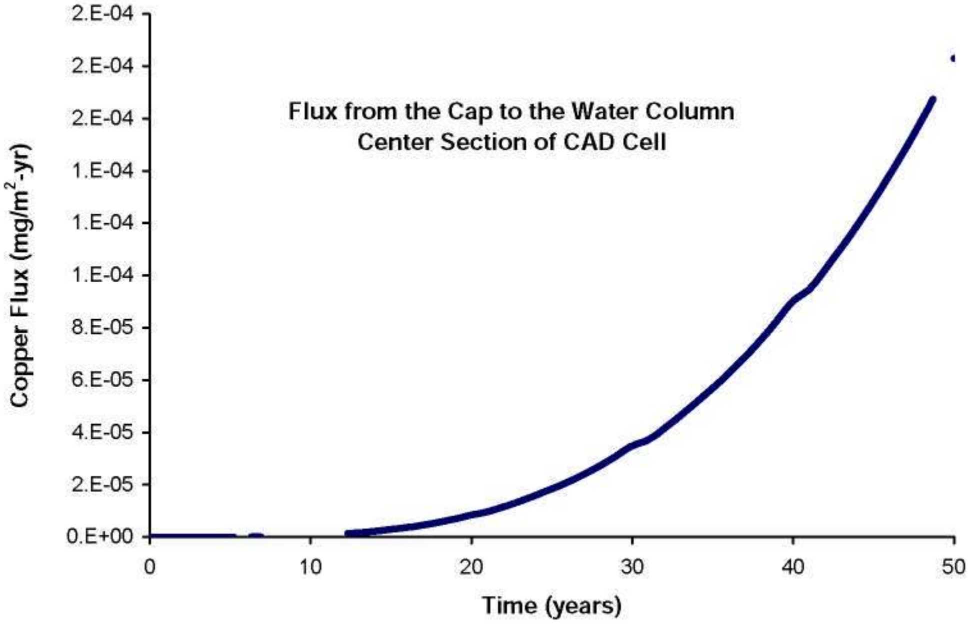


Figure 37. Predicted Copper Flux from the Center Section of CAD Cell Bioactive Zone.

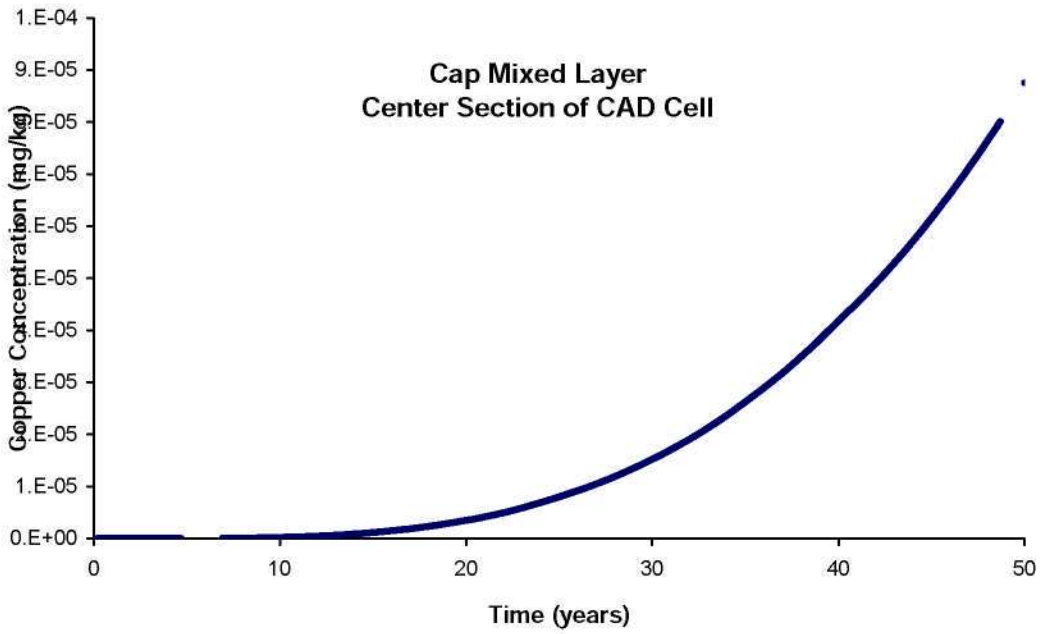


Figure 38. Predicted Copper Concentrations in Center Section of CAD Cell Bioactive Zone.

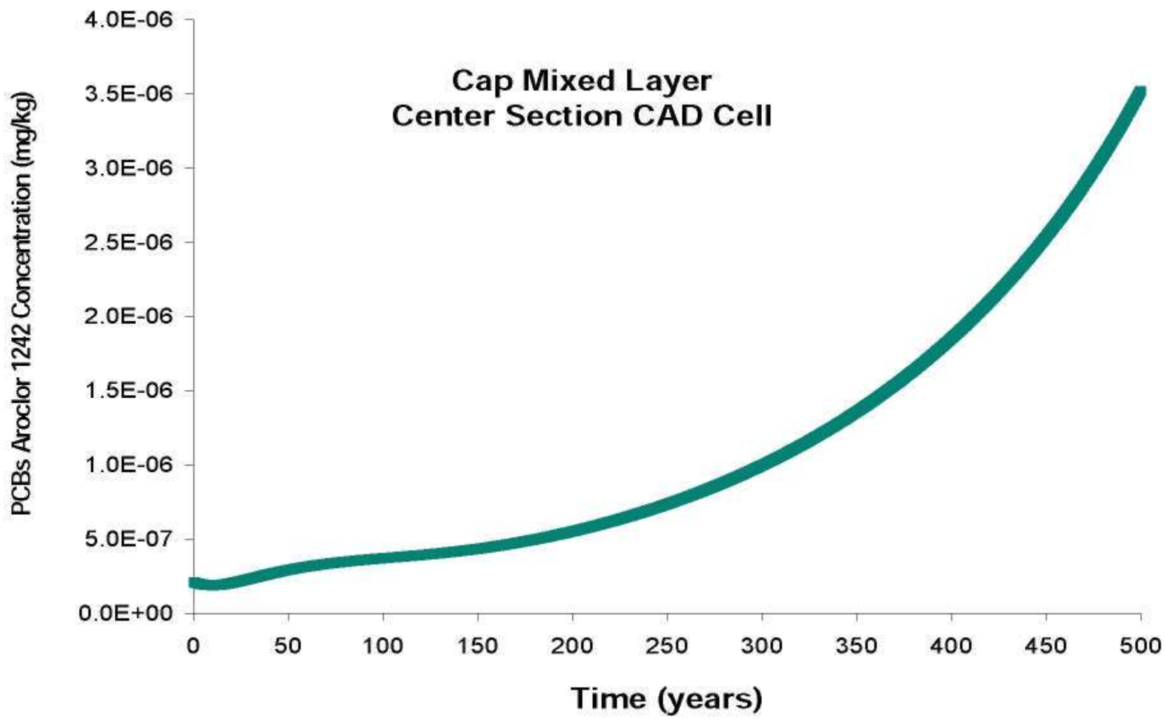


Figure 39. Predicted Long-Term Cap PCBs Aroclor 1242 Concentration for the Lower New Bedford Harbor CAD Cell Bioactive Zone.

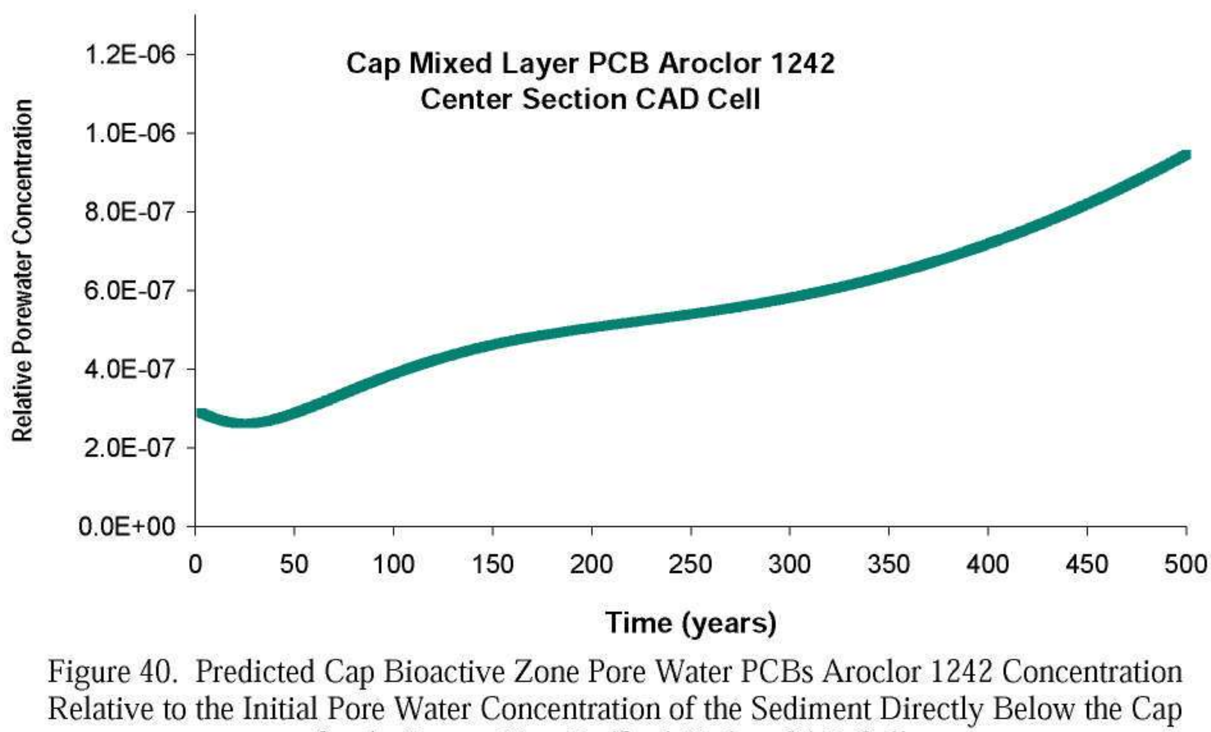


Figure 40. Predicted Cap Bioactive Zone Pore Water PCBs Aroclor 1242 Concentration Relative to the Initial Pore Water Concentration of the Sediment Directly Below the Cap for the Lower New Bedford Harbor CAD Cell.

Tables

Table 1. Existing Data, Sources and Adequacy.

EXISTING DATA			
Parameter	**# of Values**	**Sources**	**Adequacy**
CAD Water PCBs Concentration	3, many during dredging	Technical Report EL-88-15: Report 3; Battelle WQ 2007; 1998 ROD	OK but most data associated with dredging
CAD Water Cu Concentration	3, some during dredging	Technical Report EL-88-15: Report 3; 1998 ROD	OK but most data associated with dredging
Sediment Data			
Sediment PCBs concentration	2 (hot spot and midrange); 57; many others	Technical Report EL-88-15: Report 3 Technical Report EL-88-15: Report 11; Battelle Sediment 2007; 2003 FW Database; 2003 FW Report; 1996 Baseline; 1998 ROD	OK
Sediment Cu concentration	2 (hot spot and midrange); others	Technical Report EL-88-15: Report 3 Technical Report EL-88-15: Report 11; 1996 Baseline; 1998 ROD	OK but need AVS
Pore water PCBs concentration	2 (anaerobic and aerobic midrange)	Technical Report EL-88-15: Report 5 Technical Report EL-88-15: Report 11	Need sampling and testing
Pore water Cu concentration	1 (anaerobic midrange)	Technical Report EL-88-15: Report 5 Technical Report EL-88-15: Report 11	Need sampling and testing
TOC	1 (anaerobic midrange); 57; other OM	Technical Report EL-88-15: Report 3; Battelle Sediment 2007; 2003 FW Report	OK
DOC	2 (anaerobic and aerobic midrange)	Technical Report EL-88-15: Report 5	Need sampling and testing
Cu labile fraction	Maybe 1 can be estimated	Technical Report EL-88-15: Report 5	Need sampling and testing
Cu partitioning coefficient	Maybe 1 can be estimated	Technical Report EL-88-15: Report 5 Technical Report EL-88-15: Report 9	Need sampling and testing
PCBs partitioning coefficient	Separation sample, Midrange PCB conc. composite of Upper Estuary under aerobic and anaerobic conditions	Estes dissertation Technical Report EL-88-15: Report 5	Need sampling and testing

DATA AVAILABILITY AND ADEQUACY (continued)			
Standard elutriate test results	2, hot spot and midrange	Technical Report EL-88-15: Report 3	Need sampling and testing
Water content	1 (midrange composite); numerous moisture contents	Technical Report EL-88-15: Report 3; 2003 FW Report; 1990 NED Report on Evaluation of Dredging Appendix 6-A	OK
Specific gravity	2 (hot spot and midrange); many others	Technical Report EL-88-15: Report 3; 2003 FW Report; 1990 NED Report on Evaluation of Dredging Appendix 6-A	OK
Grain size distribution	2 (hot spot and midrange); 57; many size fractions	Technical Report EL-88-15: Report 3; Battelle Sediment 2007; 2003 FW Report; 1990 NED Evaluation of Dredging Appendix 6-A	OK
Atterberg limits	2 (hot spot and midrange); numerous in 1990 and 2003	Technical Report EL-88-15: Report 3; 2003 FW Report; 1990 NED Evaluation of Dredging Report Appendix 6-A	OK
e-log P relationship		One consolidation test in 1990 NED Evaluation of Dredging Report Appendix 6-A	Need sampling and testing
e-log K relationship			Need sampling and testing
Volume			To be supplied
Order of Disposal/Schedule			To be supplied
Hydrodynamic Data/Model	CAD, RMA-2V and RMA-4; TEMPEST/FLESCOT	Technical Report EL-88-15: Report 2 Battelle 1991	OK, tidal range supplied
Bathymetry Data	limited	Technical Report EL-88-15: Report 2	OK
Density/Salinity Data	limited	Technical Report EL-88-15: Report 2	OK
Groundwater Data/Model			To be examined more closely
Foundation Properties	Incompressible, low permeability till, decomposed bedrock and bedrock	Apex/Jacobs 2006	OK

DATA AVAILABILITY AND ADEQUACY (continued)			
Disposal Operation Data			To be supplied
Disposal Plan/Schedule			To be supplied
CAD Design		Apex/Jacobs 2006	OK
Cap Design			To be determined by modeling

Table 2. Management Unit (MU) Volume Estimates and Annual Dredging Management Unit (Lifts) Groupings (page 1 of 2).

	Est. Volume (cy)*	Estimated or Projected Dredging (cy)	Revised Volume (cy)	3 Lifts Volume (cy)	5 Lifts Volume (cy)
Upper Harbor					
MU-1	29925	29925	0		
MU-2	29842	29842	0		
MU-3	21642	7214	14428		
MU-102	44299	8860	35439		
MU-103	11185		11185		
MU-4	14994	14994	0		
MU-5	8973	897	8076		69128
MU-6	21791		21791		
MU-7	26453		26453	117372	
MU-8	9146		9146		
MU-9	15527	5176	10351		67741
MU-10	34859	8715	26144		
MU-11	17962	17962	0		
MU-12	15700		15700		
MU-13	16297		16297		
MU-14	18954		18954		77095
MU-15	19635		19635	116228	
MU-16	22462		22462		
MU-17	18948		18948		61045
MU-18	17376		17376		
MU-19	15624	10416	5208		
MU-104	11462		11462		
MU-105	8912		8912		
MU-20	14505	9670	4835		
MU-21	16953	11302	5651		
MU-22	10001	6667	3334		
MU-23	18983	12655	6328		
MU-24	20475	13650	6825	111340	69930
Subtotal	532885		344940		

* From Foster Wheeler (2003) Table 1, Total Volume column

Table 2 (continued). Management Unit (MU) Volume Estimates and Annual Dredging Management Unit (Lifts) Groupings.

	Est. Volume (cy)*	Estimated or Projected Dredging (cy)	Revised Volume (cy)	2 Lifts Volume (cy)	
Lower Harbor				2 Lifts	
MU-25	16495				
MU-26	15877				
MU-27	8993				
MU-28	15107				
MU-29	15062				
MU-30	22427				
MU-31	16591				
MU-32	3815				
MU-33	41025			155392	
MU-34	20463				
MU-35	52094				
MU-36	11136				
MU-37	42504			126197	
Subtotal	281589		281589		
Total	814474		626529		

* From Foster Wheeler (2003) Table 1. Total Volume column

Table 3. Estimated Mean Values for tPCB, Cu, Silt/Clay (S/C), and TOC for MUs and MU Groups (page 1 of 2).

			Lift Mean Based on DMU Means												
	3 Lifts Volume (cy)	5 Lifts Volume (cy)	tPCB mg/kg	Mean 3 Lifts	Mean 5 Lifts	Cu mg/kg	Mean 3 Lifts	Mean 5 Lifts	S/C %	Mean 3 Lifts	Mean 5 Lifts	TOC %	Mean 3 Lifts	Mean 5 Lifts
Upper Harbor														
MU-1														
MU-2														
MU-3			1691											
MU-102			1172			598			39.8			7.7		
MU-103			368			881			35.3			9		
MU-4														
MU-5		69128	1940		1293			740			38			8
MU-6			347			954			65.6			11.6		
MU-7	117372		2050	1261		856	822		37	44		10.5	10	
MU-8														
MU-9		67741	271		889	701		837	13.6		39	6.2		9
MU-10			424			932						7.1		
MU-11														
MU-12			199			453			5.6			4.4		
MU-13			147			1085			34.7			9.4		
MU-14		77095	322		273	1191		915	46.7		29	8.8		7
MU-15	116228		322	281			872			25			7	
MU-16			212			941			38.4			7.8		
MU-17		61045	244		259			941			38			8
MU-18			238			757			33			5.1		
MU-19			182											
MU-104			91											
MU-105			62											
MU-20			166			1140			7.1			7.8		
MU-21			213			1120			2.5			7.2		
MU-22			133											
MU-23			91			1199			53.3			10		
MU-24	111340	69930	136	161	146	1100	1043	1063	58.8	32	31	8.8	8	8

Table 3 (continued). Estimated Mean Values for tPCB, Cu, Silt/Clay (S/C), and TOC for MUs and MU Groups.

			tPCB mg/kg	Mean 2 Lifts		Cu mg/kg	Mean 2 Lifts		S/C %	Mean 2 Lifts		TOC %	Mean 2 Lifts
Lower Harbor	2 Lifts Volume (cy)												
MU-25			186			1138			60.3			9.3	
MU-26			167			625			28.9			5.7	
MU-27			28			248			7.2			1.9	
MU-28			68			547			24.3			5.4	
MU-29			60			470			43.7			4.1	
MU-30			432										
MU-31			606										
MU-32			30										
MU-33	155392		99	186		532	593		18.8	31		2.6	4.8
MU-34			61			3209			17			4.1	
MU-35			55			1170			3.6			6.1	
MU-36			64										
MU-37	126197		51	58			2190			10			5.1

Table 4. MU Grouping Means Summary with Volume Weighted tPCB Means.

Lift Analysis Roll-up								
Upper CAD Cell 5 Lifts (Years)	Lift # Year #	Lift Volume CY	Mean Est. tPCB mg/kg	Mean Est. Cu mg/kg	Mean Est. Silt/Clay %	Mean Est. TOC %		Mean PCB Wt'd
	1	69128	1293	740	38	8		1240
	2	67741	889	837	39	9		1230
	3	77095	273	915	29	7		295
	4	61045	259	941	38	7.8		257
	5	69930	146	1063	31	7.8		152
	Total	344940						
Upper CAD Cell 3 Lifts (Years)	1	117372	1261	822	44	10		1257
	2	116228	281	872	25	7.2		435
	3	111340	161	1043	32	7.8		180
	Total	344940						
Lower CAD Cell 2 Lifts (Years)	1	155392	186	593	31	4.8		
	2	126197	58	2190	10	5.1		
	Total	281589						

Table 5. Number of Data Points from Database Used in Assessment. Blanks Indicate no Data Available.

	Number of Data Points Used in Assessment			
	tPCB	Cu	Silt/Clay	TOC
DMU3	62			
DMU5	9			
DMU6	7	2	4	2
DMU7	35	3	7	3
DMU8				
DMU9	12	4	7	4
DMU10	48	1		1
DMU12	23	4	4	4
DMU13	16	6	8	5
DMU14	14	5	7	5
DMU15	7			
DMU16	27	7	9	7
DMU17	25			
DMU18	18	7	10	7
DMU19	29			
DMU20	14	4	1	3
DMU21	9	3	3	3
DMU22	5			
DMU23	21	5	5	5
DMU24	5	1	4	1
DMU25	6	1	4	1
DMU26	8	3	5	3
DMU27	7	5	5	5
DMU28	15	4	7	4
DMU29	16	4	5	4
DMU30	20			
DMU31	4			
DMU32	6			
DMU33	53	4	5	4
DMU34	204	4	5	4
DMU35	45	4	1	3
DMU36	27			
DMU37	40			
MF102	59	7		7
MF103	7	4		4
MF104	42			
MF105	11			

Table 6.
MU Grouping Means Comparison using a Mean of Means Approach and a True Mean Approach (All Data).

Scenario	Lift # Year #	tPCB Mean "M of M" mg/kg	tPCB Mean All Data mg/kg	Cu Mean "M of M" mg/kg	Cu Mean All Data mg/kg
Upper CAD Cell 5 Lifts (Years)	1	1293	1416	740	701
	2	889	1434	837	809
	3	273	315	915	951
	4	259	238	941	941
	5	146	140	1063	1016
Upper CAD Cell 3 Lifts (Years)	1	1261	1498	822	762
	2	281	311	872	901
	3	161	162	1043	996
Lower CAD Cell 2 Lifts (Years)	1	186	156	593	506
	2	58	59	2190	2190

Table 7. Mean of Historic Total PCB and Copper Sediment Chemistry Data in Comparison to 2009 Sediment Composite Data (mg/kg dry weight).

	tPCB Historic Mean	2009 Data	Cu Historic Mean	2009 Data
Composite 1	1498	695	762	914
Composite 2	311	248	901	1090
Composite 3	162	91	996	1110
Composite 4	156	32	506	836
Composite 5	59	40	2190	2030

Table 8. Results of the Sequential Batch Leaching Test.

Contaminant	Sample	End of Cycle Contaminant Concentrations								Kd	Koc
		Cycle 1		Cycle 2		Cycle 3		Cycle 4			
		Dissolved Conc	Solids Conc	Dissolved Conc	Solids Conc	Dissolved Conc	Solids Conc	Dissolved Conc	Solids Conc		
		mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	L/kg	L/kg
Aroclor 1248	Sample 1A	0.00108	139.9958	0.00178	139.9905	0.00156	139.9875	0.00174	139.9829	82672	1093886
	Sample 1B	0.00254	139.99	0.00157	139.99	0.00147	139.99	0.0018	139.98	86769	913034
	Sample 2A	0.00213	127.99	0.00096	127.99	0.00099	127.99	0.0013	127.99	95160	743433
	Sample 2B	0.00229	127.99	0.00218	127.99	0.0013	127.99	0.00183	127.98	67361	526256
	Sample 3A	0.00122	37.69522	0.00056	37.69462	0.00095	37.69168	0.00095	37.68941	40970	441490
	Sample 3B	0.00005	37.6998	0.00114	37.6954	0.00066	37.69447	0.00068	37.69301	59598	642218
	Sample 4A	0.00021	6.299165	0.00015	6.298793	0.00023	6.298052	0.00031	6.29708	27992	341370
	Sample 4B	0.0002	6.299205	0.00027	6.298338	0.00021	6.297784	0.00039	6.296443	23544	287118
	Sample 5A	0.000152	3.859404	0.00011	3.859176	0.00017	3.858656	0.000197	3.858104	24539	323739
	Sample 5B	0.000301	3.85882	0.000237	3.858287	0.000243	3.857641	0.000193	3.857203	15844	209021
Aroclor 1254	Sample 1A	0.0001	38.09961	0.00164	38.09338	0.0015	38.09042	0.00167	38.08601	23760	373434
	Sample 1B	0.00231	38.09	0.00145	38.09	0.00145	38.09	0.0018	38.08	24312	261526
	Sample 2A	0.00164	32.29	0.001	32.29	0.00088	32.29	0.00116	32.29	27599	215618
	Sample 2B	0.00169	32.29	0.00212	32.29	0.00114	32.29	0.00096	32.29	21854	170729
	Sample 3A	0.00114	18.09553	0.00048	18.09514	0.00078	18.09276	0.00084	18.09066	22338	240707
	Sample 3B	0.00005	18.0998	0.00056	18.09768	0.00068	18.09582	0.00043	18.09538	42086	453517
	Sample 4A	0.00033	2.668688	0.00125	2.664071	0.0004	2.663926	0.00048	2.662471	4333	52841
	Sample 4B	0.00033	2.668688	0.00037	2.667558	0.00035	2.666552	0.0006	2.664515	6465	78842
	Sample 5A	0.000111	2.219565	0.00014	2.219164	0.000198	2.218575	0.000332	2.21753	11363	149912
	Sample 5B	0.000278	2.21891	0.000182	2.218562	0.000207	2.217986	0.000344	2.21691	8776	115775
Copper	Sample 1A	0.002	845.9922	0.00297	845.9836	0.00311	845.9767	0.0183	845.9098	128274	
	Sample 1B	0.00637	845.98	0.002	845.98	0.0116	845.94	0.0087	845.92	118026	
	Sample 2A	0.0144	1329.94	0.002	1329.96	0.001	1329.96	0	1329.96	305737	
	Sample 2B	0.0178	1329.93	0.00661	1329.93	0.002	1329.94	0.001	1329.94	194080	
	Sample 3A	0.0116	1289.955	0.0277	1289.861	0.00952	1289.863	0.0212	1289.794	73686	
	Sample 3B	0.0134	1289.947	0.0343	1289.832	0.00441	1289.864	0.00835	1289.84	85337	
	Sample 4A	0.0106	478.9579	0.00979	478.9302	0.0432	478.7698	0.0594	478.5827	15572	
	Sample 4B	0.00817	478.9675	0.0123	478.9271	0.0386	478.7864	0.0531	478.6138	17075	
	Sample 5A	0.00518	590.9797	0.00346	590.973	0.0327	590.8495	0.0814	590.5727	19255	
	Sample 5B	0.00461	590.9819	0.00252	590.9781	0.0281	590.8712	0.077	590.6063	21059	

Table 9. Annual Lift Thicknesses and Void Ratios after Annual Placement Operations.

Year	Material	In Situ Void Ratio	Lift Thickness at In Situ Void Ratio, ft			
			Center	Ring 1	Ring 2	Ring 3
1	ERCOMP-3	3.34	9.5			
2	ERCOMP-4	2.69	21	21	5.5	
3	ERCOMP-5	2.64	11.5	11.5	11.5	4
4	Sand Cap	1	3	3	3	3
Sum of Lift Thicknesses, ft			45	35.5	20	7
Year	Material	As Placed Void Ratio	Lift Thickness at As Placed Void Ratio, ft			
			Center	Ring 1	Ring 2	Ring 3
1	ERCOMP-3	4.01	13			
2	ERCOMP-4	3.35	26	26	6.8	
3	ERCOMP-5	3.49	13	13	13	4.5
4	Sand Cap	1	3	3	3	3
Sum of Lift Thicknesses, ft			55	42	22.8	7.5
Average Bottom Elevation, ft			-47	-37.5	-22	-9

Table 10. Predicted Resuspension during Dredged Material Placement.

Period	Load	Average TSS mg/L	TSS at Top mg/L	Mass TSS kg
Year 1	1	16	4	8998
	100	26	5	8003
	Average	21	4.5	8450
Year 2	1	40.9	6	7454
	360	46.6	7	5037
	Average	43.8	6.5	6245
Year 3	1	34	6	5056
	300	183.5	150	12951
	Average	34	78	9000

Table 11. SURGE Results of Slope Run-up during Placement.

Material	Water Depth Below Lip ft	Lateral Spread ft	Rise or Runup ft	Freeboard ft
ER-3	5	23.2	0.0	5.0
ER-3	8.5	44.6	0.0	8.5
ER-3	37.5	74.4	15.3	22.2
ER-3	47	56.3	18.8	28.2
ER-4	16.5	42.9	4.8	11.7
ER-4	21.3	93.9	5.6	15.7
ER-4	37.5	76.2	15.9	21.6
ER-4	47	57.8	19.3	27.7
ER-5	5	25.7	0.0	5.0
ER-5	8.5	42.4	0.0	8.5
ER-5	16.5	102.4	3.6	12.9
ER-5	21.3	94.0	5.7	15.6

Table 12. CAD Water Contaminant Concentrations.

Load	Average TSS mg/L	Upper TSS mg/L	Total Concentration, ug/L				Dissolved Concentration, ug/L			
			PCBs Aroclor				PCBs Aroclor			
			1242	1248	1254	Cu	1242	1248	1254	Cu
Year 1										
Initial	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	16.0	4	0.75	0.60	0.34	17.76	0.14	0.08	0.05	2.70
6	16.5		1.48	0.95	0.59	30.67	0.85	0.38	0.29	14.51
11	17.0		2.19	1.19	0.80	41.06	1.53	0.59	0.47	23.89
21	18.0		3.56	1.49	1.11	56.05	2.84	0.83	0.75	37.12
31	19.0		4.85	1.64	1.31	65.61	4.07	0.93	0.93	45.15
41	20.0		6.05	1.73	1.45	71.75	5.22	0.98	1.04	49.92
51	21.0		7.15	1.79	1.54	75.77	6.27	1.00	1.10	52.67
66	22.5		8.64	1.86	1.63	79.61	7.67	1.01	1.16	54.73
81	24.0		9.93	1.92	1.68	82.16	8.88	1.01	1.18	55.56
100	25.9	5	11.29	1.99	1.73	84.66	10.13	1.01	1.19	55.92
Average	21.0		6.73	1.67	1.39	68.52	5.84	0.89	0.96	45.82
Upper Avg.		4.5	6.03	1.06	1.05	50.70	5.84	0.89	0.96	45.82
Year 2										
Initial	3.0		10.13	1.01	1.19	55.92	7.09	0.71	0.83	39.14
1	40.9	6	7.75	0.97	1.16	73.34	7.07	0.66	0.82	39.42
6	41.0		7.66	0.76	1.09	74.56	6.99	0.47	0.75	40.47
11	41.1		7.58	0.64	1.04	75.34	6.91	0.36	0.71	41.12
21	41.2		7.45	0.53	0.99	76.21	6.78	0.27	0.65	41.79
31	41.4		7.34	0.50	0.96	76.63	6.67	0.24	0.63	42.05
41	41.5		7.25	0.49	0.95	76.88	6.58	0.23	0.61	42.16
61	41.9		7.12	0.49	0.94	77.20	6.44	0.22	0.61	42.21
81	42.2		7.03	0.49	0.94	77.48	6.35	0.22	0.60	42.22
121	42.8		6.93	0.49	0.95	78.02	6.25	0.22	0.60	42.22
161	43.5		6.89	0.50	0.95	78.55	6.20	0.22	0.60	42.22
201	44.1		6.88	0.50	0.96	79.09	6.18	0.22	0.60	42.22
241	44.7		6.88	0.51	0.96	79.62	6.17	0.22	0.60	42.22
281	45.4		6.89	0.51	0.97	80.16	6.16	0.22	0.60	42.22
321	46.0		6.90	0.51	0.97	80.69	6.16	0.22	0.60	42.22
360	46.6	24	6.91	0.52	0.98	81.21	6.16	0.22	0.60	42.22
Average	43.8		7.00	0.51	0.96	78.65	6.29	0.24	0.61	42.12
Upper Avg.		15	6.54	0.33	0.73	54.64	6.29	0.24	0.61	42.13
Year 3										
Initial	3.0		6.16	0.22	0.60	42.22	3.08	0.11	0.30	21.11
1	34.0	24	3.66	0.24	0.68	90.13	3.13	0.11	0.33	27.66
6	36.5		3.96	0.26	0.84	123.50	3.39	0.12	0.46	53.86
11	39.0		4.25	0.27	0.97	147.66	3.64	0.12	0.56	71.46
21	44.0		4.81	0.30	1.15	178.57	4.11	0.13	0.67	90.49
31	49.0		5.31	0.32	1.26	197.13	4.52	0.13	0.73	98.14
41	54.0		5.76	0.34	1.35	210.46	4.87	0.13	0.75	101.01
61	64.0		6.47	0.38	1.47	232.26	5.41	0.13	0.77	102.36
81	74.0		6.98	0.41	1.59	252.72	5.74	0.13	0.77	102.50
101	84.0		7.34	0.45	1.70	273.04	5.92	0.13	0.77	102.52
121	94.0		7.61	0.49	1.81	293.34	6.02	0.13	0.77	102.52
151	109.0		7.93	0.55	1.97	323.79	6.07	0.13	0.77	102.52
181	124.0		8.20	0.61	2.14	354.24	6.09	0.13	0.77	102.52
211	139.0		8.46	0.66	2.30	384.69	6.09	0.13	0.77	102.52
241	154.0		8.71	0.72	2.47	415.14	6.09	0.13	0.77	102.52
271	169.0		8.97	0.78	2.63	445.59	6.09	0.13	0.77	102.52
300	183.5	176	9.21	0.84	2.79	475.02	6.09	0.13	0.77	102.52
Average	108.8		7.53	0.55	1.94	319.23	5.68	0.13	0.75	99.40
Upper Avg.		100	7.38	0.51	1.85	301.54	5.68	0.13	0.75	99.40

Table 13. CAD Water Contaminant Mass Losses.

Method of Loss	Volume Exchanged cy	Remaining CAD Water Mass Fraction	Contaminant Mass Loss, kg				
			PCB Aroclors				Cu
			1242	1248	1254	Sum	Cu
Year 1							
CAD Water Expulsion	50,000	0.127	0.231	0.041	0.040	0.311	1.938
Turbulent Diffusion	117,500	0.335	0.932	0.110	0.117	1.159	5.577
Thermal Overturn	44,000	0.203	0.364	0.036	0.043	0.443	2.010
Total Losses from Year 1			1.527	0.187	0.200	1.914	9.525
Year 2							
CAD Water Expulsion	180,000	0.514	0.899	0.045	0.101	1.045	7.522
Turbulent Diffusion	117,500	0.602	0.576	0.029	0.066	0.671	4.992
Thermal Overturn	71,000	0.364	0.130	0.005	0.013	0.147	0.889
Total Losses from Year 2			1.605	0.079	0.179	1.863	13.403
Year 3							
CAD Water Expulsion	150,000	0.769	0.847	0.059	0.212	1.118	34.673
Capping Displacement Losses	25,000	0.363	0.122	0.004	0.019	0.145	2.671
Post-Capping Diffusion/Mixing Losses	43,937	1.000	0.103	0.003	0.016	0.122	2.244
Total Losses from Year 3			1.072	0.066	0.246	1.384	39.588
Summary							
Total Contaminant Losses, kg			4.203	0.332	0.626	5.161	62.515
Contaminant Mass Dredged, kg			3350	1503	1790	6643	223672
Percent Loss, %			0.125	0.022	0.035	0.078	0.028

Table 14. Partitioning Data for Model Simulations.

Parameter	Partitioning Coefficients, L/kg			
	PCBs Aroclor			Copper
	1242	1248	1254	
Koc from SBLT results	-	550,000	210,000	18,200 (Kd)
Koc from pore water analysis	39,400	-	202,000	21,400 (Kd)
Koc for Model Simulations	39,352	426,162	201,019	-
Kd for ERCOMP-3	3,439	37,247	17,569	20,000
Kd for ERCOMP-4	2,597	28,127	13,267	20,000
Kd for ERCOMP-5	2,790	30,215	14,252	20,000
Kd for Sand Cap	118	1,278	603	125

Appendices

Appendix A

Assessment of Data Availability and Adequacy for Estimating Contaminant Losses for CAD Cell Alternatives

Reports

Reviewed reports (supplied by the New England District) include:

1. Technical Memorandum, Preliminary CAD Cell Volume Capacity Analysis. 2006. Apex Companies and Jacob Engineering Group.

2. Draft CDF C Groundwater Model Technical Memorandum. 2001. Foster Wheeler Corp.

3. 12-Volume Engineering Feasibility Study. 1988-89. Technical Report EL-88-15, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

4. New Bedford, Sawyer Street Quarterly Groundwater Sampling, Analytical Results, March 1992 - March 2001.

5. Quarterly Sampling at Sawyer Street CDF, October 2004-October 2006. 2006. ENSR/AECOM.

6. Overview of the New Bedford Harbor Physical/Chemical Modeling Program, April 1, 1991 (available at www.epa.gov/ne/nbh).

7. Volumes, Areas and Properties of Sediment by Management Units. 2003. Foster Wheeler report.

8. Dredged Material Management Plan (DMMP) EOEA No. 11669, Draft Environmental Impact Report (DEIR) for New Bedford and Fairhaven, Massachusetts. April 30, 2002. Prepared for Office of Coastal Zone Management, City of New Bedford, MA and Town of Fairhaven, MA. Prepared by Maguire Group Inc., Foxborough, MA.

9. New Bedford Harbor Superfund Pilot Study, Evaluation of Dredging and Dredged Material Disposal. May 1990. U.S. Army Engineer New England Division.

10. Declaration for the Record of Decision, New Bedford Harbor Superfund Site, Upper and Lower Harbor Operable Unit, New Bedford, Massachusetts. September 1998. U.S. Environmental Protection Agency - Region I, New England.

11. Final Sediment Monitoring Summary Report 2006 Remedial Dredging, Environmental Monitoring, Sampling, and Analysis, New Bedford Harbor Superfund Site, New Bedford Harbor, MA. May 2007. Battelle for USACE New England District.

12. Battelle Sediment Data Base.

Other technical reports and background information obtained at:
http://www.epa.gov/ne/nbh/techdocs.html

Modeling Approaches for Modeling Short- and Long-Term Contaminant Losses from Dredged Material Disposal in a CAD Cell

Short-Term Modeling (pre-capping): Processes and Applications of STFATE, SURGE, PSDDF, RECOVERY/CAP and Hydrodynamic Models

Dredged Material Placement: STFATE and SURGE applications

Data Needs: Bathymetry, cell description (size, length, width, depth, side slopes and roughness), density profile, velocity in CAD cell, dredged materials descriptions (water contents, specific gravities, grain size distributions, Atterberg limits, settling characteristics and critical shear velocity as a function of grain size), disposal operation description (barge type, barge size, barge draft, disposal discharge duration per barge, and disposal frequency), standard elutriate tests results and bulk sediment chemistry of sediments particularly for PCBs and copper

Water Column Exchange: Hydrodynamic model application

Data Needs: Calibrated and verified hydrodynamic model and hydrodynamic predictions of exchange rates across opening of CAD cell for range of site conditions (tides, wind, storm, wave and traffic)

Dredged Material Consolidation: PSDDF application

Data Needs: Dredged materials descriptions (water contents, specific gravities, grain size distribution, Atterberg limits, consolidation characteristics from standard oedometer test consisting of void ratio-effective stress relationships for range of dredged materials and void ratio-permeability relationships for range of dredged materials), foundation permeability, regional groundwater model (if foundation is permeable) and pressure head in foundation underlying CAD cell, foundation consolidation properties (if compressible), sediment volumes by type, fill sequence, disposal plan and schedule

Diffusion and Advection of Contaminants from Dredged Material: RECOVERY/CAP application

Data Needs: Bulk sediment concentrations, TOC concentrations, DOC concentrations, specific gravities, water contents, sediment-specific partitioning characteristics, leachable (labile) fractions for copper, groundwater seepage rates through fill, sediment volumes, fill sequence, disposal plan and schedule

Long-Term Modeling (post-capping): Processes and Application of PSDDF and RECOVERY/CAP Models

Dredged Material Consolidation: PSDDF application

Data Needs: Dredged materials and capping materials descriptions [water contents, specific gravities, grain size distribution, Atterberg limits, consolidation characteristics from standard oedometer test consisting of void ratio-effective stress relationships for range of dredged materials and capping materials (if fine-grained) and void ratio-permeability relationships for range of dredged materials and capping materials (if fine-grained)], foundation permeability, regional groundwater model (if foundation is permeable), pressure head in foundation underlying CAD cell, foundation consolidation properties (if compressible), cap design, sediment volumes by type, fill sequence, disposal plan and schedule

Diffusion and Advection of Contaminants from Dredged Material: RECOVERY/CAP application

Data Needs: Cap design, bulk sediment concentrations, TOC concentrations, DOC concentrations, specific gravities, water contents, cap- and sediment-specific partitioning characteristics, leachable (labile) fractions for copper, groundwater/pore water seepage rates through fill, sediment volumes, fill sequence, disposal plan and schedule

DATA NEEDS:

Sediment Data:

Number of materials/classes/types

For each material:
- Volume
- Order of Disposal/Schedule
- Bulk sediment concentration
- Labile fraction
- TOC
- DOC
- Standard elutriate test results
- Partitioning coefficient
- Water content
- Specific gravity
- Grain size distribution
- Atterberg limits
- e-log P relationship
- e-log K relationship

Hydrodynamic/Site Data:

Currents:
- Typical
- Prevailing
- Peak
- Storm

Waves:
- Height
- Frequency or length

Bathymetry:
- Depths
- Tidal ranges

Salinity:
- Profile

Groundwater Data and Foundation Properties (if foundation is permeable or compressible):

Regional groundwater model
Seepage velocity
Pressure head in foundation underlying CAD cell
Foundation permeability
Foundation consolidation properties

Disposal Operation Data and Disposal Plan/Schedule:

Operation description
Sequence of MUs
Production rate
Equipment sizes
Vessel draft
Bucket size
Excavator reach

Cap/CAD Design:

Layers
Thicknesses
Material properties:
- Consolidation
- Permeability
- Specific gravity
- Porosity
- TOC
- Partitioning coefficients

DATA AVAILABILITY AND ADEQUACY			
Parameter	**# of Values**	**Sources**	**Adequacy**
CAD Water PCBs Concentration	3, many during dredging	Technical Report EL-88-15: Report 3; Battelle WQ 2007; 1998 ROD	OK but most data associated with dredging
CAD Water Cu Concentration	3, some during dredging	Technical Report EL-88-15: Report 3; 1998 ROD	OK but most data associated with dredging
Sediment Data	Management Units???		
Sediment PCBs concentration	2 (hot spot and midrange); 57; many others	Technical Report EL-88-15: Report 3 Technical Report EL-88-15: Report 11; Battelle Sediment 2007; 2003 FW Database; 2003 FW Report; 1996 Baseline; 1998 ROD	OK
Sediment Cu concentration	2 (hot spot and midrange); others	Technical Report EL-88-15: Report 3 Technical Report EL-88-15: Report 11; 1996 Baseline; 1998 ROD	OK but need AVS
Pore water PCBs concentration	2 (anaerobic and aerobic midrange)	Technical Report EL-88-15: Report 5 Technical Report EL-88-15: Report 11	Need sampling and testing
Pore water Cu concentration	1 (anaerobic midrange)	Technical Report EL-88-15: Report 5 Technical Report EL-88-15: Report 11	Need sampling and testing
TOC	1 (anaerobic midrange); 57; other OM	Technical Report EL-88-15: Report 3; Battelle Sediment 2007; 2003 FW Report (organic content, not TOC)	OK
DOC	2 (anaerobic and aerobic midrange)	Technical Report EL-88-15: Report 5	Need sampling and testing
Cu labile fraction	Maybe 1 can be estimated	Technical Report EL-88-15: Report 5	Need sampling and testing
Cu partitioning coefficient	Maybe 1 can be estimated	Technical Report EL-88-15: Report 5 Technical Report EL-88-15: Report 9	Need sampling and testing
PCBs partitioning coefficient	Separation sample, Midrange PCB conc composite of Upper Estuary under aerobic and anaerobic conditions	Estes dissertation Technical Report EL-88-15: Report 5	Need sampling and testing

DATA AVAILABILITY AND ADEQUACY (continued)			
Standard elutriate test results	2, hot spot and midrange	Technical Report EL-88-15: Report 3	Need sampling and testing
Water content	1 (midrange composite); numerous moisture contents	Technical Report EL-88-15: Report 3; 2003 FW Report; 1990 NED Report on Evaluation of Dredging Appendix 6-A	OK
Specific gravity	2 (hot spot and midrange); many others	Technical Report EL-88-15: Report 3; 2003 FW Report; 1990 NED Report on Evaluation of Dredging Appendix 6-A	OK
Grain size distribution	2 (hot spot and midrange); 57; many size fractions	Technical Report EL-88-15: Report 3; Battelle Sediment 2007; 2003 FW Report; 1990 NED Evaluation of Dredging Appendix 6-A	OK
Atterberg limits	2 (hot spot and midrange); numerous in 1990 and 2003	Technical Report EL-88-15: Report 3; 2003 FW Report; 1990 NED Evaluation of Dredging Report Appendix 6-A	OK
e-log P relationship		One consolidation test in 1990 NED Evaluation of Dredging Report Appendix 6-A	Need sampling and testing
e-log K relationship			Need sampling and testing
Volume			To be supplied
Order of Disposal/Schedule			To be supplied
Hydrodynamic Data/Model	CAD, RMA-2V and RMA-4; TEMPEST/FLESCOT	Technical Report EL-88-15: Report 2 Battelle 1991	OK, tidal range supplied
Bathymetry Data	limited	Technical Report EL-88-15: Report 2	OK
Density/Salinity Data	limited	Technical Report EL-88-15: Report 2	OK
Groundwater Data/Model			To be examined more closely
Foundation Properties	Incompressible, low permeability till, decomposed bedrock and bedrock	Apex/Jacobs 2006	OK

DATA AVAILABILITY AND ADEQUACY (continued)			
Disposal Operation Data			To be supplied
Disposal Plan/Schedule			To be supplied
CAD Design		Apex/Jacobs 2006	OK
Cap Design			To be determined by modeling

SAMPLING AND TESTING NEEDS:

Annual Dredging Sediment Composites: Seven sediment composites, five in the Upper Harbor and two in the Lower Harbor, should be collected, representing the average of the sediment DMUs to be dredged in each of the years. Care should be taken to collect sufficient samples from each DMU to form each composite so that each composite is representative of the average PCB, Cu, TOC and DOC concentrations, as well as the average water content, silt and clay content, and oil and grease content of the sediment being dredged each year.

Sediment Analysis Needs for Each Composite:
Bulk sediment concentration of Total PCBs (based on 18 PCB congeners as performed for baseline monitoring), Aroclor 1242, Aroclor 1254, Cu, AVS, Oil and Grease, TPHs, and TOC.

Pore water total and dissolved concentrations of Total PCBs (based on 18 PCB congeners), Aroclor 1242, Aroclor 1254, Organic Carbon, and Cu. Also, Salinity, TDS, and TSS.

Geotechnical properties including water content, specific gravity, organic content, Atterberg limits, and grain size distribution.

Site Water Samples: Site water should be collected from the proposed CAD sites for analysis and use for testing.

Site Water Analysis Needs:
Site water total and dissolved concentrations of Total PCBs (based on 18 PCB congeners), Aroclor 1242, Aroclor 1254, Cu, Oil and Grease, TPHs, and Organic Carbon. Also, Salinity, TDS, and TSS

Testing Needs:
Standard Elutriate Tests should be run on each of the seven sediment composites using the appropriate proposed CAD site water to predict short-term losses during disposal. The test should analyzed for elutriate total and dissolved concentrations of Total PCBs (based on 18 PCB congeners), Aroclor 1242, Aroclor 1254, Cu, Oil and Grease, TPHs, Organic Carbon and also TSS.

Sequential Batch Leaching Tests for partitioning characteristics should be run on each of the seven sediment composites to determine partitioning characteristics for PCBs (total based on 18 PCB congeners, Aroclor 1242, and Aroclor 1254) and Cu. Four cycles should be used for PCBs and seven cycles should be used for Cu. The test should analyzed for leachate total and dissolved concentrations of Total PCBs based on 18 PCB congeners, Aroclor 1242, Aroclor 1254, Cu, Oil and Grease, TPHs, Organic Carbon and also TSS.

Standard Oedometer Consolidation (ASTM D2435) and Permeability Tests should be run on each of the seven sediment composites to determine consolidation properties for consolidation of the dredged material in the CAD sites and for seepage of pore water from the CAD sites.

Appendix B

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

03 August 2009

Mike Channel
ERDC -- Vicksburg
ERDC, 3909 Halls Ferry Road
Vicksburg, MS 39180

RE: Channell New Bedford

Enclosed are the results of analyses for samples received by the laboratory on 01-Jun-2009-24-Apr-2009. The samples associated with this report will be held for 90 days from the date of this report. The raw data associated with this report will be held for 5 years from the date of this report. If you need us to hold onto the samples or the data longer then these specified times, you will need to notify us in writing at least 30 days before the expiration dates. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Patty Tuminello
Project Coordinator

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg
ERDC, 3909 Halls Ferry Road
Vicksburg MS, 39180

Project: Channell New Bedford

Project Manager: Mike Channel

Reported:
03-Aug-2009

WORK ORDER SUMMARY

Sample ID	Laboratory ID	Matrix	Date Sampled	Date of Work Order
Upper Harbor -- Dissolved Cu	9042401-01	Water	24-Apr-2009	24-Apr-2009
Lower Harbor -- Dissolved Cu	9042401-02	Water	24-Apr-2009	24-Apr-2009
Upper Harbor -- total Cu	9042401-03	Water	24-Apr-2009	24-Apr-2009
Lower Harbor -- total Cu	9042401-04	Water	24-Apr-2009	24-Apr-2009
Upper Harbor -- total PCBs	9042401-05	Water	23-Apr-2009	24-Apr-2009
Lower Harbor -- total PCBs	9042401-06	Water	23-Apr-2009	24-Apr-2009
Upper Harbor -- dissolved PCBs	9042401-07	Water	23-Apr-2009	24-Apr-2009
Lower Harbor -- dissolved PCBs	9042401-08	Water	23-Apr-2009	24-Apr-2009
Upper Harbor	9042401-09	Water	23-Apr-2009	24-Apr-2009
Lower Harbor	9042401-10	Water	23-Apr-2009	24-Apr-2009
New Bedford Harbor EComp 0001	9042401-11	Soil/Sediment	24-Apr-2009	24-Apr-2009
New Bedford Harbor EComp 0002	9042401-12	Soil/Sediment	24-Apr-2009	24-Apr-2009
New Bedford Harbor EComp 0003	9042401-13	Soil/Sediment	24-Apr-2009	24-Apr-2009
New Bedford Harbor EComp 0004	9042401-14	Soil/Sediment	24-Apr-2009	24-Apr-2009
New Bedford Harbor EComp 0005	9042401-15	Soil/Sediment	24-Apr-2009	24-Apr-2009
NB - 1A - 1	9060107-01	Water	29-May-2009	01-Jun-2009
NB - 1A - 2	9060107-02	Water	29-May-2009	01-Jun-2009
NB - 1A - 3	9060107-03	Water	29-May-2009	01-Jun-2009
NB - 1A - 4	9060107-04	Water	29-May-2009	01-Jun-2009
NB - 1B - 1	9060107-05	Water	29-May-2009	01-Jun-2009
NB - 1B - 2	9060107-06	Water	29-May-2009	01-Jun-2009
NB - 1B - 3	9060107-07	Water	29-May-2009	01-Jun-2009
NB - 1B - 4	9060107-08	Water	29-May-2009	01-Jun-2009
NB - 2A - 1	9060107-09	Water	29-May-2009	01-Jun-2009
NB - 2A - 2	9060107-10	Water	29-May-2009	01-Jun-2009
NB - 2A - 3	9060107-11	Water	29-May-2009	01-Jun-2009
NB - 2A - 4	9060107-12	Water	29-May-2009	01-Jun-2009
NB - 2B - 1	9060107-13	Water	29-May-2009	01-Jun-2009
NB - 2B - 2	9060107-14	Water	29-May-2009	01-Jun-2009
NB - 2B - 3	9060107-15	Water	29-May-2009	01-Jun-2009
NB - 2B - 4	9060107-16	Water	29-May-2009	01-Jun-2009

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

WORK ORDER SUMMARY

Sample ID	Laboratory ID	Matrix	Date Sampled	Date of Work Order
NB - 3A - 1	9060107-17	Water	29-May-2009	01-Jun-2009
NB - 3A - 2	9060107-18	Water	29-May-2009	01-Jun-2009
NB - 3A - 3	9060107-19	Water	29-May-2009	01-Jun-2009
NB - 3A - 4	9060107-20	Water	29-May-2009	01-Jun-2009
NB - 3B - 1	9060107-21	Water	29-May-2009	01-Jun-2009
NB - 3B - 2	9060107-22	Water	29-May-2009	01-Jun-2009
NB - 3B - 3	9060107-23	Water	29-May-2009	01-Jun-2009
NB - 3B - 4	9060107-24	Water	29-May-2009	01-Jun-2009
NB - 4A - 1	9060107-25	Water	29-May-2009	01-Jun-2009
NB - 4A - 2	9060107-26	Water	29-May-2009	01-Jun-2009
NB - 4A - 3	9060107-27	Water	29-May-2009	01-Jun-2009
NB - 4A - 4	9060107-28	Water	29-May-2009	01-Jun-2009
NB - 4B - 1	9060107-29	Water	29-May-2009	01-Jun-2009
NB - 4B - 2	9060107-30	Water	29-May-2009	01-Jun-2009
NB - 4B - 3	9060107-31	Water	29-May-2009	01-Jun-2009
NB - 4B - 4	9060107-32	Water	29-May-2009	01-Jun-2009
NB - 5A - 1	9060107-33	Water	29-May-2009	01-Jun-2009
NB - 5A - 2	9060107-34	Water	29-May-2009	01-Jun-2009
NB - 5A - 3	9060107-35	Water	29-May-2009	01-Jun-2009
NB - 5A - 4	9060107-36	Water	29-May-2009	01-Jun-2009
NB - 5B - 1	9060107-37	Water	29-May-2009	01-Jun-2009
NB - 5B - 2	9060107-38	Water	29-May-2009	01-Jun-2009
NB - 5B - 3	9060107-39	Water	29-May-2009	01-Jun-2009
NB - 5B - 4	9060107-40	Water	29-May-2009	01-Jun-2009
NB - LH - 1 - Blank	9060107-41	Water	29-May-2009	01-Jun-2009
NB - LH - 2 - Blank	9060107-42	Water	29-May-2009	01-Jun-2009
NB - LH - 3 - Blank	9060107-43	Water	29-May-2009	01-Jun-2009
NB - LH - 4 - Blank	9060107-44	Water	29-May-2009	01-Jun-2009
NB - UH - 1 - Blank	9060107-45	Water	29-May-2009	01-Jun-2009
NB - UH - 2 - Blank	9060107-46	Water	29-May-2009	01-Jun-2009
NB - UH - 3 - Blank	9060107-47	Water	29-May-2009	01-Jun-2009
NB - UH - 4 - Blank	9060107-48	Water	29-May-2009	01-Jun-2009

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

WORK ORDER SUMMARY

Sample ID	Laboratory ID	Matrix	Date Sampled	Date of Work Order
NB - UH - 4 - 3A - Blank	9060107-49	Water	29-May-2009	01-Jun-2009
NB - 1A - 1	9060108-01	Water	29-May-2009	01-Jun-2009
NB - 1A - 2	9060108-02	Water	29-May-2009	01-Jun-2009
NB - 1A - 3	9060108-03	Water	29-May-2009	01-Jun-2009
NB - 1A - 4	9060108-04	Water	29-May-2009	01-Jun-2009
NB - 1B - 1	9060108-05	Water	29-May-2009	01-Jun-2009
NB - 1B - 2	9060108-06	Water	29-May-2009	01-Jun-2009
NB - 1B - 3	9060108-07	Water	29-May-2009	01-Jun-2009
NB - 1B - 4	9060108-08	Water	29-May-2009	01-Jun-2009
NB - 2A - 1	9060108-09	Water	29-May-2009	01-Jun-2009
NB - 2A - 2	9060108-10	Water	29-May-2009	01-Jun-2009
NB - 2A - 3	9060108-11	Water	29-May-2009	01-Jun-2009
NB - 2A - 4	9060108-12	Water	29-May-2009	01-Jun-2009
NB - 2B - 1	9060108-13	Water	29-May-2009	01-Jun-2009
NB - 2B - 2	9060108-14	Water	29-May-2009	01-Jun-2009
NB - 2B - 3	9060108-15	Water	29-May-2009	01-Jun-2009
NB - 2B - 4	9060108-16	Water	29-May-2009	01-Jun-2009
NB - 3A - 1	9060108-17	Water	29-May-2009	01-Jun-2009
NB - 3A - 2	9060108-18	Water	29-May-2009	01-Jun-2009
NB - 3A - 3	9060108-19	Water	29-May-2009	01-Jun-2009
NB - 3A - 4	9060108-20	Water	29-May-2009	01-Jun-2009
NB - 3B - 1	9060108-21	Water	29-May-2009	01-Jun-2009
NB - 3B - 2	9060108-22	Water	29-May-2009	01-Jun-2009
NB - 3B - 3	9060108-23	Water	29-May-2009	01-Jun-2009
NB - 3B - 4	9060108-24	Water	29-May-2009	01-Jun-2009
NB - 4A - 1	9060108-25	Water	29-May-2009	01-Jun-2009
NB - 4A - 2	9060108-26	Water	29-May-2009	01-Jun-2009
NB - 4A - 3	9060108-27	Water	29-May-2009	01-Jun-2009
NB - 4A - 4	9060108-28	Water	29-May-2009	01-Jun-2009
NB - 4B - 1	9060108-29	Water	29-May-2009	01-Jun-2009
NB - 4B - 2	9060108-30	Water	29-May-2009	01-Jun-2009

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Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

WORK ORDER SUMMARY

Sample ID	Laboratory ID	Matrix	Date Sampled	Date of Work Order
NB - 4B - 3	9060108-31	Water	29-May-2009	01-Jun-2009
NB - 4B - 4	9060108-32	Water	29-May-2009	01-Jun-2009
NB - 5A - 1	9060108-33	Water	29-May-2009	01-Jun-2009
NB - 5A - 2	9060108-34	Water	29-May-2009	01-Jun-2009
NB - 5A - 3	9060108-35	Water	29-May-2009	01-Jun-2009
NB - 5A - 4	9060108-36	Water	29-May-2009	01-Jun-2009
NB - 5B - 1	9060108-37	Water	29-May-2009	01-Jun-2009
NB - 5B - 2	9060108-38	Water	29-May-2009	01-Jun-2009
NB - 5B - 3	9060108-39	Water	29-May-2009	01-Jun-2009
NB - 5B - 4	9060108-40	Water	29-May-2009	01-Jun-2009
NB - LH - 1 - Blank	9060108-41	Water	29-May-2009	01-Jun-2009
NB - LH - 2 - Blank	9060108-42	Water	29-May-2009	01-Jun-2009
NB - LH - 3 - Blank	9060108-43	Water	29-May-2009	01-Jun-2009
NB - LH - 4 - Blank	9060108-44	Water	29-May-2009	01-Jun-2009
NB - UH - 1 - Blank	9060108-45	Water	29-May-2009	01-Jun-2009
NB - UH - 2 - Blank	9060108-46	Water	29-May-2009	01-Jun-2009
NB - UH - 3 - Blank	9060108-47	Water	29-May-2009	01-Jun-2009
NB - UH - 4 - Blank	9060108-48	Water	29-May-2009	01-Jun-2009
NB - UH - 4 - 3A - Blank	9060108-49	Water	29-May-2009	01-Jun-2009
NB - 1A - 5	9060801-01	Water	05-Jun-2009	08-Jun-2009
NB - 1B - 5	9060801-02	Water	05-Jun-2009	08-Jun-2009
NB - 2A - 5	9060801-03	Water	05-Jun-2009	08-Jun-2009
NB - 2B - 5	9060801-04	Water	05-Jun-2009	08-Jun-2009
NB - 3A - 5	9060801-05	Water	05-Jun-2009	08-Jun-2009
NB - 3B - 5	9060801-06	Water	05-Jun-2009	08-Jun-2009
NB - 4A - 5	9060801-07	Water	05-Jun-2009	08-Jun-2009
NB - 4B - 5	9060801-08	Water	05-Jun-2009	08-Jun-2009
NB - 5A - 5	9060801-09	Water	05-Jun-2009	08-Jun-2009
NB - 5B - 5	9060801-10	Water	05-Jun-2009	08-Jun-2009
NB - 1A - 6	9060801-11	Water	05-Jun-2009	08-Jun-2009
NB - 1B - 6	9060801-12	Water	05-Jun-2009	08-Jun-2009
NB - 2A - 6	9060801-13	Water	05-Jun-2009	08-Jun-2009

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

WORK ORDER SUMMARY

Sample ID	Laboratory ID	Matrix	Date Sampled	Date of Work Order
NB - 2B - 6	9060801-14	Water	05-Jun-2009	08-Jun-2009
NB - 3A - 6	9060801-15	Water	05-Jun-2009	08-Jun-2009
NB - 3B - 6	9060801-16	Water	05-Jun-2009	08-Jun-2009
NB - 4A - 6	9060801-17	Water	05-Jun-2009	08-Jun-2009
NB - 4B - 6	9060801-18	Water	05-Jun-2009	08-Jun-2009
NB - 5A - 6	9060801-19	Water	05-Jun-2009	08-Jun-2009
NB - 5B - 6	9060801-20	Water	05-Jun-2009	08-Jun-2009
NB - 1A - 7	9060801-21	Water	05-Jun-2009	08-Jun-2009
NB - 1B - 7	9060801-22	Water	05-Jun-2009	08-Jun-2009
NB - 2A - 7	9060801-23	Water	05-Jun-2009	08-Jun-2009
NB - 2B - 7	9060801-24	Water	05-Jun-2009	08-Jun-2009
NB - 3A - 7	9060801-25	Water	05-Jun-2009	08-Jun-2009
NB - 3B - 7	9060801-26	Water	05-Jun-2009	08-Jun-2009
NB - 4A - 7	9060801-27	Water	05-Jun-2009	08-Jun-2009
NB - 4B - 7	9060801-28	Water	05-Jun-2009	08-Jun-2009
NB - 5A - 7	9060801-29	Water	05-Jun-2009	08-Jun-2009
NB - 5B - 7	9060801-30	Water	05-Jun-2009	08-Jun-2009
NB - LH - Blank 5	9060801-31	Water	05-Jun-2009	08-Jun-2009
NB - LH - Blank 6	9060801-32	Water	05-Jun-2009	08-Jun-2009
NB - LH - Blank 7	9060801-33	Water	05-Jun-2009	08-Jun-2009
NB - UH - Blank 5	9060801-34	Water	05-Jun-2009	08-Jun-2009
NB - UH - Blank 6	9060801-35	Water	05-Jun-2009	08-Jun-2009
NB - UH - Blank 7	9060801-36	Water	05-Jun-2009	08-Jun-2009

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Upper Harbor -- Dissolved Cu

9042401-01 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.003**	0.005	mg/L	1	27-Apr-2009	18-May-2009	EPA 6020	J

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Lower Harbor -- Dissolved Cu

9042401-02 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Metals by EPA 6000/7000 Series Methods								
Copper	**0.003**	0.005	mg/L	1	27-Apr-2009	18-May-2009	EPA 6020	J

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Upper Harbor -- total Cu

9042401-03 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
				ERDC- EL-EP-C (Environmental Chemistry Branch)				
Metals by EPA 6000/7000 Series Methods								
Copper	**0.003**	0.005	mg/L	1	27-Apr-2009	18-May-2009	EPA 6020	J

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Lower Harbor -- total Cu

9042401-04 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	**0.003**	0.005	mg/L	1	27-Apr-2009	18-May-2009	EPA 6020	J

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USACE ERDC-EP-C
3909 Halls Ferry Road
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ERDC -- Vicksburg	Project: Channell New Bedford	
ERDC, 3909 Halls Ferry Road		**Reported:**
Vicksburg MS, 39180	Project Manager: Mike Channel	03-Aug-2009

Upper Harbor -- total PCBs

9042401-05 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1248	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1254	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1260	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
Surrogate: Decachorobiphenyl [2C]		*28.4 %*	*40-125*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene [2C]		*75.6 %*	*25-140*		*04-May-2009*	*15-May-2009*	*EPA8082*	

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ERDC -- Vicksburg	Project: Channell New Bedford	
ERDC, 3909 Halls Ferry Road		**Reported:**
Vicksburg MS, 39180	Project Manager: Mike Channel	03-Aug-2009

Lower Harbor -- total PCBs

9042401-06 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1248	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1254	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1260	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
Surrogate: Decachorobiphenyl [2C]		*73.0 %*	*40-125*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene		*100 %*	*25-140*		*04-May-2009*	*15-May-2009*	*EPA8082*	

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ERDC -- Vicksburg	Project: Channell New Bedford	
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Vicksburg MS, 39180	Project Manager: Mike Channel	03-Aug-2009

Upper Harbor -- dissolved PCBs

9042401-07 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1248	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1254	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1260	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
Surrogate: Decachorobiphenyl [2C]		*91.6 %*	*40-125*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene		*111 %*	*25-140*		*04-May-2009*	*15-May-2009*	*EPA8082*	

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Lower Harbor -- dissolved PCBs

9042401-08 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1248	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1254	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1260	ND	0.25	ug/L	1	04-May-2009	15-May-2009	EPA8082	U
Surrogate: Decachorobiphenyl [2C]		*71.6 %*	*40-125*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene		*101 %*	*25-140*		*04-May-2009*	*15-May-2009*	*EPA8082*	

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Upper Harbor

9042401-09 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
N-Hexane Extractable Material by Extraction and Gravimetry								
Oil and Grease	ND	5.00	mg/L	1	04-May-2009	11-May-2009	EPA 1664A	
Miscellaneous Physical/Conventional Chemistry Parameters								
Total Petroleum Hydrocarbons	ND	5.00	mg/L	1	04-May-2009	11-May-2009	EPA 1664	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Lower Harbor

9042401-10 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
N-Hexane Extractable Material by Extraction and Gravimetry								
Oil and Grease	**6.00**	5.00	mg/L	1	04-May-2009	11-May-2009	EPA 1664A	
Miscellaneous Physical/Conventional Chemistry Parameters								
Total Petroleum Hydrocarbons	ND	5.00	mg/L	1	04-May-2009	11-May-2009	EPA 1664	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

New Bedford Harbor EComp 0001

9042401-11 (Soil/Sediment)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
N-Hexane Extractable Material by Extraction and Gravimetry								
Oil & Grease	**3530**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Metals by EPA 6000/7000 Series Methods								
Copper	**846**	0.0500	mg/kg	1	20-May-2009	21-May-2009	EPA 6020	
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	21.2	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1221	ND	21.2	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1232	ND	21.2	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1242	ND	21.2	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB 1248 [2C]	**140000**	4240	ug/kg dry	200	04-May-2009	15-May-2009	EPA8082	
PCB-1254	**38100**	4240	ug/kg dry	200	04-May-2009	15-May-2009	EPA8082	
PCB-1260	ND	21.2	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene		*64.6 %*	*40-130*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Surrogate: Decachorobiphenyl [2C]		*101 %*	*60-125*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Miscellaneous Physical/Conventional Chemistry Parameters								
Total Petroleum Hydrocarbons	**1740**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**83100**	50.0	mg/kg	1	10-May-2009	10-May-2009	EPA 9060	
Classical Chemistry Parameters								
% Solids	**39.4**	0.100	g	1	11-May-2009	11-May-2009	% Calculation	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

New Bedford Harbor EComp 0002

9042401-12 (Soil/Sediment)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
N-Hexane Extractable Material by Extraction and Gravimetry								
Oil & Grease	**3170**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Metals by EPA 6000/7000 Series Methods								
Copper	**1330**	0.0500	mg/kg	1	20-May-2009	21-May-2009	EPA 6020	
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	21.9	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1221	ND	21.9	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1232	ND	21.9	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1242	ND	21.9	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1248	**128000**	2190	ug/kg dry	100	04-May-2009	15-May-2009	EPA8082	
PCB-1254	**32300**	2190	ug/kg dry	100	04-May-2009	15-May-2009	EPA8082	
PCB-1260	ND	21.9	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene		*72.2 %*	*40-130*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Surrogate: Decachlorobiphenyl		*96.8 %*	*60-125*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Miscellaneous Physical/Conventional Chemistry Parameters								
Total Petroleum Hydrocarbons	**1870**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**128000**	50.0	mg/kg	1	10-May-2009	10-May-2009	EPA 9060	
Classical Chemistry Parameters								
% Solids	**37.8**	0.100	g	1	11-May-2009	11-May-2009	% Calculation	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

New Bedford Harbor EComp 0003

9042401-13 (Soil/Sediment)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
N-Hexane Extractable Material by Extraction and Gravimetry								
Oil & Grease	**3020**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Metals by EPA 6000/7000 Series Methods								
Copper	**1290**	0.0500	mg/kg	1	20-May-2009	21-May-2009	EPA 6020	
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	19.3	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1221	ND	19.3	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1232	ND	19.3	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1242	ND	19.3	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB 1248 [2C]	**37700**	1930	ug/kg dry	100	04-May-2009	15-May-2009	EPA8082	
PCB-1254	**18100**	1930	ug/kg dry	100	04-May-2009	15-May-2009	EPA8082	
PCB-1260	ND	19.3	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene [2C]		*96.2 %*	*40-130*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Surrogate: Decachlorobiphenyl		*90.8 %*	*60-125*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Miscellaneous Physical/Conventional Chemistry Parameters								
Total Petroleum Hydrocarbons	**1530**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**92800**	50.0	mg/kg	1	10-May-2009	10-May-2009	EPA 9060	
Classical Chemistry Parameters								
% Solids	**42.6**	0.100	g	1	11-May-2009	11-May-2009	% Calculation	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

New Bedford Harbor EComp 0004

9042401-14 (Soil/Sediment)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
N-Hexane Extractable Material by Extraction and Gravimetry								
Oil & Grease	**682**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Metals by EPA 6000/7000 Series Methods								
Copper	**479**	0.0500	mg/kg	1	20-May-2009	21-May-2009	EPA 6020	
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	16.4	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1221	ND	16.4	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1232	ND	16.4	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1242	ND	16.4	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1248	**5300**	82.2	ug/kg dry	5	04-May-2009	15-May-2009	EPA8082	
PCB-1254	**2670**	82.2	ug/kg dry	5	04-May-2009	15-May-2009	EPA8082	
PCB-1260	ND	16.4	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene [2C]		*100 %*	*40-130*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Surrogate: Decachlorobiphenyl		*103 %*	*60-125*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Miscellaneous Physical/Conventional Chemistry Parameters								
Total Petroleum Hydrocarbons	**309**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**82000**	50.0	mg/kg	1	10-May-2009	10-May-2009	EPA 9060	
Classical Chemistry Parameters								
% Solids	**50.2**	0.100	g	1	11-May-2009	11-May-2009	% Calculation	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

New Bedford Harbor EComp 0005

9042401-15 (Soil/Sediment)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
N-Hexane Extractable Material by Extraction and Gravimetry								
Oil & Grease	**890**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Metals by EPA 6000/7000 Series Methods								
Copper	**591**	0.0500	mg/kg	1	20-May-2009	21-May-2009	EPA 6020	
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	17.8	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1221	ND	17.8	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1232	ND	17.8	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1242	ND	17.8	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
PCB-1248	**3860**	88.8	ug/kg dry	5	04-May-2009	15-May-2009	EPA8082	
PCB-1254	**2220**	88.8	ug/kg dry	5	04-May-2009	15-May-2009	EPA8082	
PCB-1260	ND	17.8	ug/kg dry	1	04-May-2009	15-May-2009	EPA8082	U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene		*104 %*	*40-130*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Surrogate: Decachlorobiphenyl		*125 %*	*60-125*		*04-May-2009*	*15-May-2009*	*EPA8082*	
Miscellaneous Physical/Conventional Chemistry Parameters								
Total Petroleum Hydrocarbons	**362**	50.0	mg/kg dry wt.	1	05-May-2009	15-May-2009	EPA 9071B	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**75800**	50.0	mg/kg	1	10-May-2009	10-May-2009	EPA 9060	
Classical Chemistry Parameters								
% Solids	**46.9**	0.100	g	1	11-May-2009	11-May-2009	% Calculation	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1A - 1

9060107-01 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	ND	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	U
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**12.9**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1A - 2

9060107-02 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.003**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**8.90**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1A - 3

9060107-03 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Metals by EPA 6000/7000 Series Methods								
Copper	**0.003**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**6.70**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1A - 4

9060107-04 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.018**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**6.30**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1B - 1

9060107-05 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.006**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**13.7**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1B - 2

9060107-06 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Metals by EPA 6000/7000 Series Methods								
Copper	ND	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	U
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**9.40**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1B - 3

9060107-07 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.012**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**6.50**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1B - 4

9060107-08 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.009**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**6.00**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2A - 1

9060107-09 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.014**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**24.4**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2A - 2

9060107-10 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	ND	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	U
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**16.7**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2A - 3

9060107-11 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	ND	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	U
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**13.0**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2A - 4
9060107-12 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.002**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**10.6**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2B - 1

9060107-13 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	**0.018**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**24.0**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2B - 2

9060107-14 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.007**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**18.3**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2B - 3

9060107-15 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Metals by EPA 6000/7000 Series Methods								
Copper	ND	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	U
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**13.4**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2B - 4

9060107-16 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Metals by EPA 6000/7000 Series Methods								
Copper	ND	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	U
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**9.70**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3A - 1

9060107-17 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	**0.012**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**22.6**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3A - 2

9060107-18 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Copper	**0.028**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	

Miscellaneous Subcontracted Analyses

Total Organic Carbon	**16.6**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3A - 3

9060107-19 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.010**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**8.30**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3A - 4

9060107-20 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.021**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**7.70**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3B - 1
9060107-21 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.013**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	

Miscellaneous Subcontracted Analyses

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Total Organic Carbon	**15.3**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3B - 2

9060107-22 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.034**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	

Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**19.4**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3B - 3

9060107-23 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Copper	**0.004**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J

Miscellaneous Subcontracted Analyses

Total Organic Carbon	**7.30**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3B - 4

9060107-24 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.008**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**6.90**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4A - 1

9060107-25 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
				ERDC- EL-EP-C (Environmental Chemistry Branch)				
Metals by EPA 6000/7000 Series Methods								
Copper	**0.011**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**11.5**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4A - 2

9060107-26 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.010**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**7.40**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4A - 3

9060107-27 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.043**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**6.50**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4A - 4

9060107-28 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.059**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**5.70**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4B - 1

9060107-29 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Copper	**0.008**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J

Miscellaneous Subcontracted Analyses

Total Organic Carbon	**11.6**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4B - 2

9060107-30 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.012**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**7.20**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4B - 3

9060107-31 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.039**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**5.80**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4B - 4

9060107-32 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.053**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**5.30**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5A - 1

9060107-33 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.005**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**20.9**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5A - 2

9060107-34 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.003**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J

Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**9.90**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5A - 3

9060107-35 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.033**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**7.50**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5A - 4

9060107-36 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.081**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**6.80**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5B - 1

9060107-37 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.005**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**19.6**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5B - 2

9060107-38 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.003**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**9.60**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5B - 3
9060107-39 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.028**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**6.90**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5B - 4

9060107-40 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.077**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**5.90**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - LH - 1 - Blank

9060107-41 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Copper	**0.016**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	

Miscellaneous Subcontracted Analyses

Total Organic Carbon	**2.80**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - LH - 2 - Blank

9060107-42 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.004**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**1.60**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - LH - 3 - Blank

9060107-43 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.004**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**2.10**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - LH - 4 - Blank

9060107-44 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Copper	ND	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	U

Miscellaneous Subcontracted Analyses

Total Organic Carbon	**1.70**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - 1 - Blank

9060107-45 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.002**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**2.30**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - 2 - Blank

9060107-46 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.004**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**1.70**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - 3 - Blank

9060107-47 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.005**	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	J
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**1.40**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - 4 - Blank

9060107-48 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Metals by EPA 6000/7000 Series Methods								
Copper	ND	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	U
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**1.50**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - 4 - 3A - Blank

9060107-49 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	ND	0.010	mg/L	20	04-Jun-2009	04-Jun-2009	EPA 6020	U
Miscellaneous Subcontracted Analyses								
Total Organic Carbon	**2.60**	1.00	mg/L	1	10-Jun-2009	11-Jun-2009	EPA 9060	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1A - 1

9060108-01 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.08**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**0.96**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.66**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.00**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1A - 2

9060108-02 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.78**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.30**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**1.00**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.64**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1A - 3

9060108-03 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.56**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.19**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**1.06**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.50**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-04 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.74**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.32**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.93**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.67**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-05 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**2.54**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.80**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**1.40**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**2.31**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-06 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.57**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.16**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.70**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.44**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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9060108-07 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.47**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.09**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.74**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.45**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-08 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.80**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.39**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.85**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.80**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-09 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**2.13**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.29**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.88**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.64**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-10 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.96**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**0.83**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.35**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.00**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-11 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.99**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**0.79**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.47**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**0.88**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-12 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.30**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**0.97**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.62**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.16**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-13 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**2.29**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.43**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.97**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.69**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-14 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**2.18**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**1.83**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**1.27**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**2.12**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-15 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.30**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1248 [2C]	**0.94**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.60**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.14**	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.25	ug/L	1	02-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-16 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.83**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.96**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-17 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.22**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.14**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-18 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.56**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**0.48**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-19 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.95**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**0.78**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060108-20 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.95**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**0.84**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060108-21 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-22 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**1.14**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.56**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-23 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.66**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**0.68**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-24 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.68**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**0.43**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-25 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.21**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**0.33**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-26 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.15**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**1.25**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-27 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.23**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.40**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-28 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.31**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.48**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-29 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.20**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**0.33**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-30 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.27**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB 1254 [2C]	**0.37**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-31 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.21**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.35**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-32 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U
PCB-1248	**0.39**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1254	**0.60**	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	04-Jun-2009	19-Jun-2009	EPA8082	U

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9060108-33 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB 1248 [2C]	**0.15**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1254	**0.11**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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9060108-34 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB 1248 [2C]	**0.11**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB 1254 [2C]	**0.14**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB 1260 [2C]	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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9060108-35 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB 1248 [2C]	**0.17**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1254	**0.20**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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9060108-36 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	**0.20**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1254	**0.37**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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9060108-37 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	**0.30**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB 1254 [2C]	**0.28**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060108-38 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	**0.24**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB 1254 [2C]	**0.18**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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9060108-39 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	**0.24**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB 1254 [2C]	**0.21**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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9060108-40 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Polychlorinated Biphenyls by EPA Method 8082								
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB 1248 [2C]	**0.19**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB 1254 [2C]	**0.34**	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - LH - 1 - Blank

9060108-41 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060108-42 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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ERDC -- Vicksburg	Project: Channell New Bedford	
ERDC, 3909 Halls Ferry Road		**Reported:**
Vicksburg MS, 39180	Project Manager: Mike Channel	03-Aug-2009

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9060108-43 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - LH - 4 - Blank

9060108-44 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - 1 - Blank

9060108-45 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - 2 - Blank

9060108-46 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - 3 - Blank

9060108-47 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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NB - UH - 4 - Blank

9060108-48 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - 4 - 3A - Blank

9060108-49 (Water)

ERDC- EL-EP-C (Environmental Chemistry Branch)

Polychlorinated Biphenyls by EPA Method 8082

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
PCB-1016	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1221	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1232	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1242	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1248	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1254	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U
PCB-1260	ND	0.10	ug/L	1	05-Jun-2009	22-Jul-2009	EPA8082	U

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9060801-01 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.030**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060801-02 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	**0.066**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2A - 5

9060801-03 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.058**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060801-04 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.031**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3A - 5

9060801-05 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.195**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060801-06 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
				ERDC- EL-EP-C (Environmental Chemistry Branch)				
Metals by EPA 6000/7000 Series Methods								
Copper	**0.138**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060801-07 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.122**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

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9060801-08 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.117**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5A - 5

9060801-09 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.172**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060801-10 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
				ERDC- EL-EP-C (Environmental Chemistry Branch)				
Metals by EPA 6000/7000 Series Methods								
Copper	**0.188**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060801-11 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.076**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060801-12 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.080**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

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9060801-13 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.059**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2B - 6

9060801-14 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.063**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3A - 6

9060801-15 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.360**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3B - 6

9060801-16 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.237**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4A - 6

9060801-17 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.051**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4B - 6

9060801-18 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.051**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	Reported: 03-Aug-2009

NB - 5A - 6

9060801-19 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.080**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5B - 6

9060801-20 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.067**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1A - 7

9060801-21 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
				ERDC- EL-EP-C (Environmental Chemistry Branch)				
Metals by EPA 6000/7000 Series Methods								
Copper	**0.048**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 1B - 7

9060801-22 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.103**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2A - 7

9060801-23 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	**0.177**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 2B - 7

9060801-24 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	**0.150**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3A - 7

9060801-25 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.382**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 3B - 7

9060801-26 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
				ERDC- EL-EP-C (Environmental Chemistry Branch)				
Metals by EPA 6000/7000 Series Methods								
Copper	**0.423**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4A - 7

9060801-27 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	**0.056**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 4B - 7

9060801-28 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.098**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5A - 7

9060801-29 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.092**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - 5B - 7

9060801-30 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.077**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - LH - Blank 5

9060801-31 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods								
Copper	**0.012**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	J

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USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - LH - Blank 6

9060801-32 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
		ERDC- EL-EP-C (Environmental Chemistry Branch)						
Metals by EPA 6000/7000 Series Methods								
Copper	**0.011**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	J

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - LH - Blank 7

9060801-33 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.009**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	J

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - Blank 5

9060801-34 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes

ERDC- EL-EP-C (Environmental Chemistry Branch)

Metals by EPA 6000/7000 Series Methods

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
Copper	**0.009**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	J

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - Blank 6

9060801-35 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
ERDC- EL-EP-C (Environmental Chemistry Branch)								
Metals by EPA 6000/7000 Series Methods								
Copper	**0.007**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	J

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

NB - UH - Blank 7

9060801-36 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Prepared	Analyzed	Method	Notes
			ERDC- EL-EP-C (Environmental Chemistry Branch)					
Metals by EPA 6000/7000 Series Methods								
Copper	**0.010**	0.020	mg/L	20	15-Jun-2009	16-Jun-2009	EPA 6020	J

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

N-Hexane Extractable Material by Extraction and Gravimetry - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B905003 - 9071B										
Blank (B905003-BLK1)				Prepared: 05-May-2009 Analyzed: 15-May-2009						
Oil & Grease	ND	50.0	mg/kg dry wt.							

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

N-Hexane Extractable Material by Extraction and Gravimetry - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B905003 - 9071B										
LCS (B905003-BS1)				Prepared: 05-May-2009 Analyzed: 15-May-2009						
Oil & Grease	2390	50.0	mg/kg dry wt.				50-130			

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

N-Hexane Extractable Material by Extraction and Gravimetry - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B905013 - EPA 1664A										
Blank (B905013-BLK1)				Prepared: 04-May-2009 Analyzed: 11-May-2009						
Oil and Grease	ND	5.00	mg/L							

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	Reported: 03-Aug-2009

N-Hexane Extractable Material by Extraction and Gravimetry - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B905013 - EPA 1664A										
LCS (B905013-BS1)				Prepared: 04-May-2009 Analyzed: 11-May-2009						
Oil and Grease	75.6	5.00	mg/L	80.00		94.5	25-125			

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

N-Hexane Extractable Material by Extraction and Gravimetry - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B905013 - EPA 1664A										
LCS Dup (B905013-BSD1)				Prepared: 04-May-2009 Analyzed: 11-May-2009						
Oil and Grease	79.0	5.00	mg/L	80.00		98.8	25-125	4.40	20	

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ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

N-Hexane Extractable Material by Extraction and Gravimetry - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes

Metals by EPA 6000/7000 Series Methods - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B905024 - Default Prep Metals										
Blank (B905024-BLK1)				Prepared: 27-Apr-2009 Analyzed: 18-May-2009						
Copper	ND	0.005	mg/L							U
LCS (B905024-BS1)				Prepared: 27-Apr-2009 Analyzed: 18-May-2009						
Copper	0.025	0.005	mg/L	1.000		2.50	80-120			
Duplicate (B905024-DUP1)	**Source: 9042401-01**			Prepared: 27-Apr-2009 Analyzed: 18-May-2009						
Copper	0.003	0.005	mg/L		0.003			1.48	20	J
Matrix Spike (B905024-MS1)	**Source: 9042401-01**			Prepared: 27-Apr-2009 Analyzed: 18-May-2009						
Copper	0.084	0.005	mg/L	1.000	0.003	8.08	80-120			
Batch B905026 - EPA 3050B										
Blank (B905026-BLK1)				Prepared: 20-May-2009 Analyzed: 21-May-2009						
Copper	ND	0.0500	mg/kg							U
LCS (B905026-BS1)				Prepared: 20-May-2009 Analyzed: 21-May-2009						
Copper	1.04	0.0500	mg/kg	1.000		104	80-120			
Duplicate (B905026-DUP1)	**Source: 9042401-11**			Prepared: 20-May-2009 Analyzed: 21-May-2009						
Copper	894	0.0500	mg/kg		846			5.52	20	
Matrix Spike (B905026-MS1)	**Source: 9042401-11**			Prepared: 20-May-2009 Analyzed: 21-May-2009						
Copper	942	0.0500	mg/kg	98.81	846	97.7	80-120			
Batch B906022 - Default Prep Metals										
Blank (B906022-BLK1)				Prepared & Analyzed: 04-Jun-2009						
Copper	ND	0.010	mg/L							U

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Metals by EPA 6000/7000 Series Methods - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B906022 - Default Prep Metals										
LCS (B906022-BS1)				Prepared & Analyzed: 04-Jun-2009						
Copper	0.026	0.010	mg/L	0.02500		104	80-120			
Duplicate (B906022-DUP1)		**Source: 9060107-01**		Prepared & Analyzed: 04-Jun-2009						
Copper	ND	0.010	mg/L		ND				20	U
Duplicate (B906022-DUP2)		**Source: 9060107-49**		Prepared & Analyzed: 04-Jun-2009						
Copper	0.002	0.010	mg/L		ND				20	J
Matrix Spike (B906022-MS1)		**Source: 9060107-01**		Prepared & Analyzed: 04-Jun-2009						
Copper	0.160	0.010	mg/L	0.2000	ND	80.0	80-120			
Matrix Spike (B906022-MS2)		**Source: 9060107-49**		Prepared & Analyzed: 04-Jun-2009						
Copper	0.166	0.010	mg/L	0.2000	ND	82.8	80-120			
Batch B906054 - Default Prep Metals										
Blank (B906054-BLK1)				Prepared: 15-Jun-2009 Analyzed: 16-Jun-2009						
Copper	ND	0.005	mg/L							U
LCS (B906054-BS1)				Prepared: 15-Jun-2009 Analyzed: 16-Jun-2009						
Copper	0.025	0.005	mg/L	0.02500		100	80-120			
Duplicate (B906054-DUP1)		**Source: 9060801-01**		Prepared: 15-Jun-2009 Analyzed: 16-Jun-2009						
Copper	0.030	0.020	mg/L		0.030			0.523	20	
Matrix Spike (B906054-MS1)		**Source: 9060801-01**		Prepared: 15-Jun-2009 Analyzed: 16-Jun-2009						
Copper	0.352	0.020	mg/L	0.4000	0.030	80.5	80-120			

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Polychlorinated Biphenyls by EPA Method 8082 - Quality Control
ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B905001 - EPA 3535A										
Blank (B905001-BLK1)				Prepared: 04-May-2009 Analyzed: 15-May-2009						
PCB-1016	ND	0.25	ug/L							U
PCB-1221	ND	0.25	ug/L							U
PCB-1232	ND	0.25	ug/L							U
PCB-1242	ND	0.25	ug/L							U
PCB-1248	ND	0.25	ug/L							U
PCB-1254	ND	0.25	ug/L							U
PCB-1260	ND	0.25	ug/L							U
Surrogate: Decachorobiphenyl [2C]	*0.364*		*ug/L*	*0.5000*		*72.8*	*40-125*			
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	*0.494*		*ug/L*	*0.5000*		*98.8*	*25-140*			
LCS (B905001-BS1)				Prepared: 04-May-2009 Analyzed: 15-May-2009						
PCB-1016	1.9	0.25	ug/L	2.500		75.6	25-145			
PCB-1260	2.4	0.25	ug/L	2.500		94.0	30-145			
Surrogate: Decachorobiphenyl [2C]	*0.346*		*ug/L*	*0.5000*		*69.2*	*40-125*			
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	*0.506*		*ug/L*	*0.5000*		*101*	*25-140*			
Batch B905002 - EPA 3545										
Blank (B905002-BLK1)				Prepared: 04-May-2009 Analyzed: 15-May-2009						
PCB-1016	ND	8.30	ug/kg wet							U
PCB-1221	ND	8.30	ug/kg wet							U
PCB-1232	ND	8.30	ug/kg wet							U
PCB-1242	ND	8.30	ug/kg wet							U
PCB-1248	ND	8.30	ug/kg wet							U
PCB-1254	ND	8.30	ug/kg wet							U
PCB-1260	ND	8.30	ug/kg wet							U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene [2C]	*15.9*		*ug/kg wet*	*16.67*		*95.4*	*40-130*			
Surrogate: Decachlorobiphenyl	*18.5*		*ug/kg wet*	*16.67*		*111*	*60-125*			

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Polychlorinated Biphenyls by EPA Method 8082 - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B905002 - EPA 3545										
LCS (B905002-BS1)				Prepared: 04-May-2009 Analyzed: 15-May-2009						
PCB 1016 [2C]	71.3	8.30	ug/kg wet	83.33		85.6	40-140			
PCB 1260 [2C]	78.7	8.30	ug/kg wet	83.33		94.4	60-130			
Surrogate: 2,4,5,6 Tetrachloro-m-xylene [2C]	*16.3*		*ug/kg wet*	*16.67*		*98.0*	*40-130*			
Surrogate: Decachlorobiphenyl	*19.0*		*ug/kg wet*	*16.67*		*114*	*60-125*			
Batch B906007 - EPA 3535A										
Blank (B906007-BLK1)				Prepared: 02-Jun-2009 Analyzed: 19-Jun-2009						
PCB-1016	ND	0.25	ug/L							U
PCB-1221	ND	0.25	ug/L							U
PCB-1232	ND	0.25	ug/L							U
PCB-1242	ND	0.25	ug/L							U
PCB-1248	ND	0.25	ug/L							U
PCB-1254	ND	0.25	ug/L							U
PCB-1260	ND	0.25	ug/L							U
LCS (B906007-BS1)				Prepared: 02-Jun-2009 Analyzed: 19-Jun-2009						
PCB-1016	0.6	0.25	ug/L	1.000		56.4	25-145			
PCB-1260	0.7	0.25	ug/L	1.000		65.6	30-145			
Batch B906019 - EPA 3535A										
Blank (B906019-BLK1)				Prepared: 04-Jun-2009 Analyzed: 19-Jun-2009						
PCB-1016	ND	0.10	ug/L							U
PCB-1221	ND	0.10	ug/L							U
PCB-1232	ND	0.10	ug/L							U
PCB-1242	ND	0.10	ug/L							U
PCB-1248	ND	0.10	ug/L							U
PCB-1254	ND	0.10	ug/L							U
PCB-1260	ND	0.10	ug/L							U

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Polychlorinated Biphenyls by EPA Method 8082 - Quality Control
ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B906019 - EPA 3535A										
LCS (B906019-BS1)				Prepared: 04-Jun-2009 Analyzed: 19-Jun-2009						
PCB-1016	0.5	0.10	ug/L	1.000		53.2	25-145			
PCB-1260	0.7	0.10	ug/L	1.000		65.2	30-145			
Batch B906023 - EPA 3535A										
Blank (B906023-BLK1)				Prepared: 05-Jun-2009 Analyzed: 22-Jul-2009						
PCB-1016	ND	0.10	ug/L							U
PCB-1221	ND	0.10	ug/L							U
PCB-1232	ND	0.10	ug/L							U
PCB-1242	ND	0.10	ug/L							U
PCB-1248	ND	0.10	ug/L							U
PCB-1254	ND	0.10	ug/L							U
PCB-1260	ND	0.10	ug/L							U
LCS (B906023-BS1)				Prepared: 05-Jun-2009 Analyzed: 22-Jul-2009						
PCB-1016	0.6	0.10	ug/L	1.000		57.6	25-145			
PCB-1260	0.7	0.10	ug/L	1.000		67.2	30-145			
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	*0.185*		*ug/L*				*25-140*			

ERDC -- Vicksburg ERDC, 3909 Halls Ferry Road Vicksburg MS, 39180	Project: Channell New Bedford Project Manager: Mike Channel	**Reported:** 03-Aug-2009

Miscellaneous Physical/Conventional Chemistry Parameters - Quality Control

ERDC- EL-EP-C (Environmental Chemistry Branch)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B905003 - 9071B										
Blank (B905003-BLK1)				Prepared: 05-May-2009 Analyzed: 15-May-2009						
Total Petroleum Hydrocarbons	ND	50.0	mg/kg dry wt.							
Batch B905013 - EPA 1664A										
Blank (B905013-BLK1)				Prepared: 04-May-2009 Analyzed: 11-May-2009						
Total Petroleum Hydrocarbons	ND	5.00	mg/L							

ERDC -- Vicksburg	Project: Channell New Bedford	
ERDC, 3909 Halls Ferry Road		**Reported:**
Vicksburg MS, 39180	Project Manager: Mike Channel	03-Aug-2009

Notes and Definitions

U	Analyte included in the analysis, but not detected
J	Detected but below the Reporting Limit; therefore, result is an estimated concentration (CLP J-Flag).
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Technical Memorandum

Date: December 15, 2009

To: Robert Leitch, PE, USACE North Atlantic Division New England District (NAE)

From: Paul Dragos, Battelle

Subject: Turbidity Monitoring and Plume Sampling Results for City Dredge Disposal at the New Bedford Harbor CAD Cell # 2

This Technical Memorandum presents a summary of the turbidity monitoring results for the surveys conducted at the navigational dredging Confined Aquatic Disposal (CAD) cell # 2 in New Bedford, Massachusetts (Figure 1). The turbidity sampling was conducted during disposal of navigational dredged material by the City of New Bedford into the CAD cell on April 14, May 20, 21, & 27, and July 8 of 2009. Dredged material released into the CAD cell during monitoring operations was dredged from the channel north of the Coggeshall Street Bridge, the Niemiec Boat Yard, the Packer Pier, and the Gifford Street Boat Ramp.

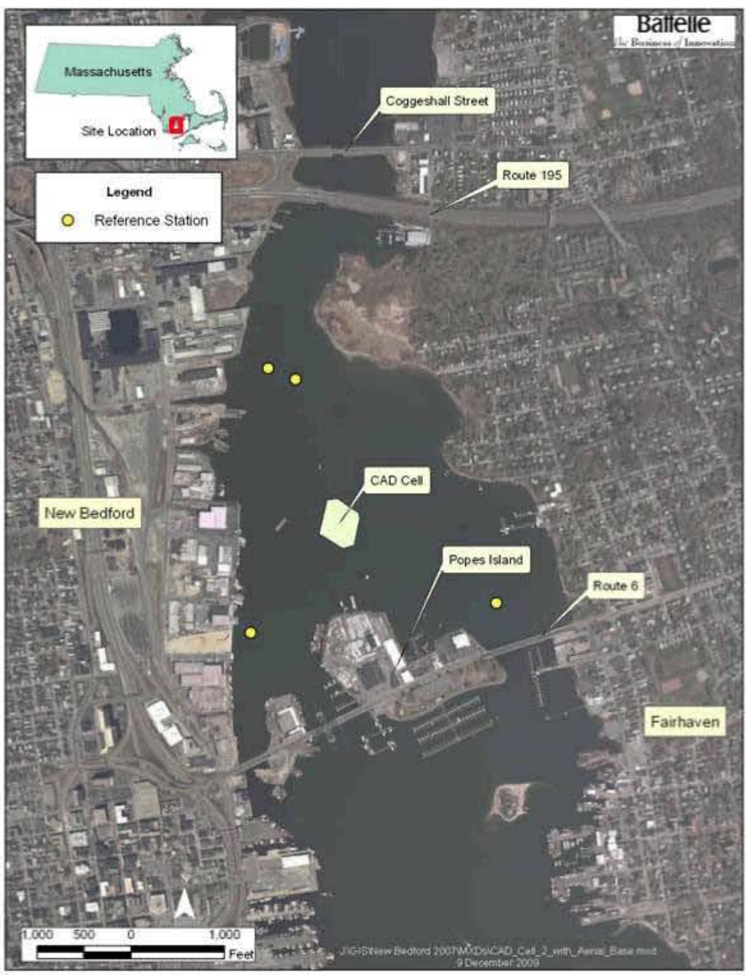

Figure 1. Portion of New Bedford Harbor Showing the Location of the City CAD Cell.

Background

The City of New Bedford was engaged in Phase III of the Harbor Maintenance Dredge Program performing maintenance dredging at various locations in New Bedford Harbor during the spring and summer of 2009. The City dredging was not part of the on-going EPA Superfund remedial dredging project. A number of dredge areas were included in Phase III infrastructure improvements at numerous piers and wharves that serve the fishing, ferry, tourism, and shipping industries. The dredged material was disposed into CAD cell # 2 located north of Popes Island. During the months of disposal operations, the CAD cell was surrounded by a silt curtain made of a porous fabric which was suspended from the water surface and hung to the harbor bottom. The curtain was intended to contain any suspended sediment plumes resulting from disposal of dredged material into the CAD cell. The curtain consisted of 6 or 8 separate sections of fabric. One section acted as a gate which was opened and closed to allow the barge and tug to enter and exit the cell.

Objective

The objective of this effort was to conduct shipboard, real-time tracking of suspended sediment plumes resulting from disposal operations in and around the CAD cell. The presence, extent, and concentration of suspended sediments were determined for plumes both inside and outside the silt curtain. The data obtained during this effort consisted of the following:

- water current velocity from continuous Acoustic Doppler Current Profiler (ADCP) measurements;
- turbidity and suspended sediment concentration derived from continuous ADCP measurements of acoustic backscatter;
- turbidity and total suspended solids (TSS) from whole water samples at plume and reference stations; and
- toxicity from whole water samples collected at plume and reference stations.

Methods

Details on the survey/sampling methods can be found in the project Field Sampling Plan (Battelle, 2009).

The study design incorporated broad scale monitoring of sediment plumes using a ship-mounted ADCP to collect continuous turbidity measurements combined with discrete location water column sampling for post-survey analysis of turbidity, TSS, and toxicity. The ADCP measurements were made as the survey vessels ran a series of transects within and outside (primarily down-current) of the CAD cell from immediately after the time of release until any plume had dissipated (approximately 1 to 1½ hours). The *in situ* ADCP backscatter data was compared to laboratory derived TSS and turbidity data from whole water samples to post-calibrate the instrument and to provide an independent measure of particulate concentration.

Velocity Survey

During the first day of the study and prior to dredged material disposal, a velocity survey was performed to delineate the current structures in the survey area over a tidal cycle. The velocity survey was conducted using one RD Instruments 1200kHz Workhorse Mariner ADCP mounted over the side of the 24 ft vessel *Sea Quest* (Figure 2). The ADCP measured current velocity every 1-2 seconds at 0.5 m vertical intervals throughout the water column while the vessel was underway. A series of harbor transects were occupied once every hour over a complete tidal cycle to determine the three-dimensional current structure throughout the survey area between Popes Island and the Route 195 bridge. The position and real-time current data were collected and displayed on the data collection laptop in real-time

(Figure 3). The tracklines were run 13 times over a period of approximately 13 hours. Current velocity data were processed on shore immediately after the survey and graphical outputs of each hourly run were developed for use by the survey crews during the plume tracking surveys.

Figure 2. ADCP Mounted in Operational Position Over the Side of the *Sea Quest* with the Acoustic Transducers Just Below the Water Surface.

Plume Tracking Surveys

Plume tracking was conducted using two RD Instruments 1200kHz Workhorse Mariner ADCPs mounted on two separate vessels, the *Gale Force* and the *Sea Quest*. The ADCP was used to measure current velocity and acoustic backscatter intensity in decibels (db) every 1-2 seconds at 0.33 m vertical intervals throughout the water column while the vessels were underway. The acoustic backscatter intensity is a function of the suspended sediment concentration in the water column. As the vessels ran transects across the survey area, the ADCP mapped out vertical slices of suspended sediment concentration along those transects. The ADCP concurrently measured velocity of the tidal currents (speed and direction) which was used to aid plume tracking. The ADCP measurements were recorded and displayed in real-time (Figure 3).

Transect locations were determined on-the-fly to maximize the plume coverage in response to plume dynamics. The general procedure during each disposal event was as follows:

1. Prior to beginning of sampling, each boat used the ADCP to monitor current direction and speed and confirm currents determined during the velocity survey. The boat locations were adjusted thereafter to be down-current of the dredged material release point.

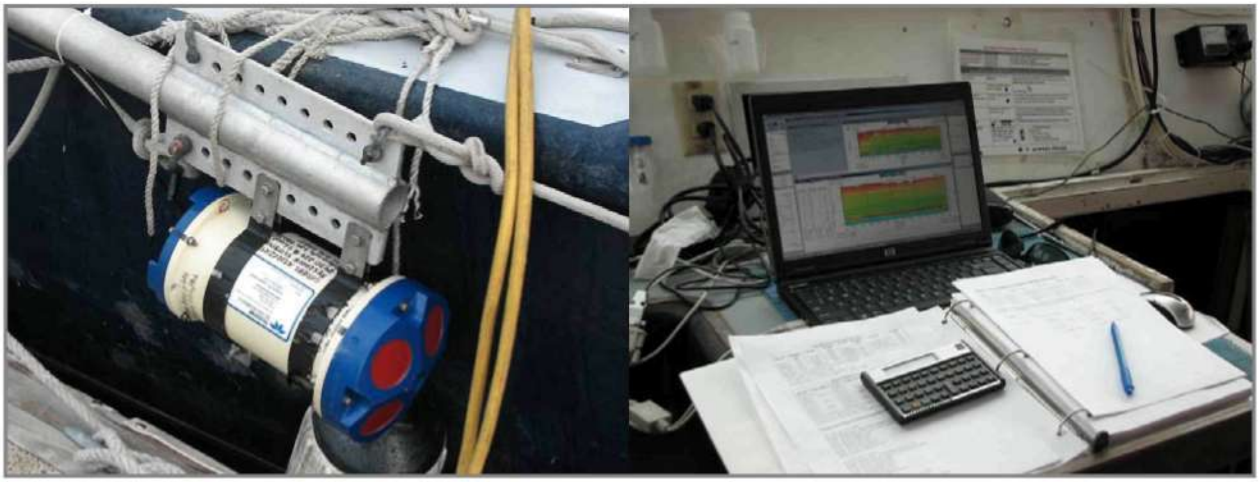

Figure 3. RD Instruments 1200khz Workhorse Mariner ADCP Mounted Over the Side of the Vessel and ADCP Real-Time Display / Data Collection Laptop.

2. Prior to release of the dredged material into the CAD cell, each boat collected whole water samples at mid-depth and near-bottom reference stations along with ADCP backscatter data. During the May 20 disposal event, an additional whole water sample was collected at mid-depth at the up-current reference station for toxicity analysis.
3. Immediately after the release (Figure 4), and for the next 1-1½ hours the *Sea Quest* ran east-west and north-south transects, at the discretion of the Chief Scientist, throughout the CAD cell until the plume was no longer significantly above background.
4. Immediately after the release, and for the next 1-1½ hours the *Gale Force* ran transects outside the CAD cell running east-west, north-south, and along the outside of the curtain, at the discretion of the Chief Scientist.
5. In the CAD cell, whole water samples were collected in the plume centroid and at two other locations within the plume (lateral stations). It was up to the discretion of the Chief Scientist to determine during which transect(s) and how long after release the samples were taken but samples were generally taken while the plume signal was still strong, in most cases during the second transect and again when the plume concentration was more moderate. During the May 20 disposal event, an additional whole water sample was collected at mid-depth in the plume centroid for toxicity analysis.
6. Outside the CAD cell, an attempt was made to collect whole water samples in any plume observed (three stations at two depths) at the discretion of the Chief Scientist. During the May 20 disposal event, an additional whole water sample was collected for toxicity analysis.

Real-time demarcation of the plume with ADCP provided the information needed to select sampling locations and depths. Each vessel collected TSS and turbidity samples from near-bottom (approximately 1 m above the bottom) and mid-depth at three plume stations and two reference stations (summarized in Table 1). Whole water samples were collected with Niskin bottles on hand lines. Three toxicity samples were also collected during the first of the disposal monitoring surveys: one from the plume centroid; one outside the silt curtain; and one at an up-current reference station unimpacted by dredging activities.

Laboratory TSS and Turbidity Testing Methods

The whole water samples collected during the survey were analyzed by Alpha Analytical Laboratory for TSS using U.S. EPA Method 2540 D. A well-mixed sample was filtered through a standard glass fiber filter (GF/F) and the residual retained on the filter was dried and weighed. For each batch of 20 or fewer samples, a laboratory method blank, duplicate, and laboratory control sample (LCS) was processed and analyzed with the field samples[1]. Results are reported on a dry-weight basis.

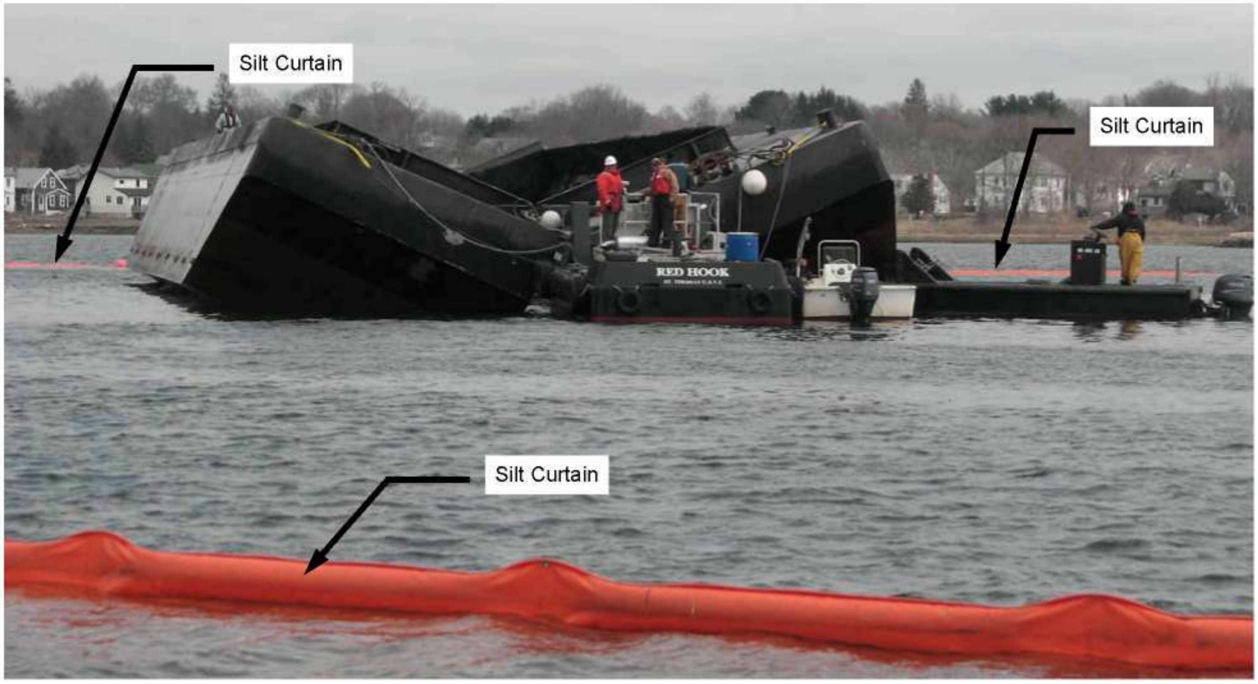

Figure 4. Split Hull Scow Immediately after Placement of Dredged Material into the CAD Cell.

Table 1. Sampling During Each Disposal Event by Each Survey Vessel.

Station	Parameters	Depth	Number of Water Samples	Comments
Turbidity and TSS Samples				
Plume Centroid Station	Turbidity, TSS	Near-bottom and mid-depth	2	Add 5% duplicate sample for QC
Plume Lateral Stations (2)	Turbidity, TSS	Near-bottom and mid-depth	4	
Reference Stations ≥1500 ft up- and down current (2)	Turbidity, TSS	Near-bottom and mid-depth	4	
Toxicity Samples (1 disposal event only)				
Plume Centroid Station	Toxicity	Mid-depth	1	
Plume Station outside Silt Curtain	Toxicity	Mid-depth	1	
Reference Station ≥1500 ft up or down current	Toxicity	Mid-depth	1	

[1] One exception to this QC procedure occurred during analysis of the April 14, 2009 samples when no laboratory duplicate was analyzed.

The whole water samples collected during the survey were also analyzed by Alpha Analytical Laboratory for turbidity using U.S. EPA Method 180.1. A well-mixed sample was analyzed for turbidity using a nephelometer to compare the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension. Results are reported in nephelometric turbidity units (NTU).

Toxicity Testing Methods

Acute and chronic (sub-lethal) exposure screening assays were performed on discrete water samples to evaluate the potential toxicity of the water samples. Assay design included a laboratory control treatment, a site reference sample, and two site samples collected during disposal of dredged material. Samples were evaluated "As Received" without dilutions. Testing was based on programs and protocols developed by the U.S. EPA (2002) primarily designed to provide standard approaches for the evaluation of toxicological effects of discharges on aquatic organisms, and for the analysis of water samples. Testing included the following assays: modified 2 day acute and 7 day chronic assays conducted with the mysid shrimp, *Americamysis bahia*, and the red macro alga, *Champia parvula*, and 60 minute chronic fertilization assays conducted with the purple sea urchin, *Arbacia punctulata*. All mysid and urchin fertilization assays and the acute survival portion of the algal assays were conducted by EnviroSystems, Inc. (ESI) located in Hampton, New Hampshire. Additionally, the acute and chronic algal assays were also conducted by Aquatox Testing & Consulting, Inc. of Guelph, Ontario, Canada in order to provide data in the event that the assay conducted by ESI failed to meet the target endpoints.

Statistical analysis of acute and chronic exposure data was completed using CETIS (Comprehensive Environmental Toxicity Information System) software. The program computes acute and chronic exposure endpoints based on U.S. EPA decision tree guidelines specified in individual test methods. For chronic exposure endpoints statistical significance was accepted at $\propto < 0.05$.

As part of the toxicity testing laboratory quality control program, standard reference toxicant assays are conducted on a regular basis for each test species to provide relative health and response data while allowing for comparison with historic data sets.

ADCP Calibration

Data were collected to calibrate the acoustic ADCP instruments to TSS and turbidity correcting for site-specific factors including particle size distribution, particle type, and particle surface roughness. At whole water sampling stations, Niskin bottles were lowered over the side of the vessel to collect discrete water samples. Simultaneously, the ADCP collected acoustic backscatter data. Turbidity and TSS from water samples at a given depth and time were compared with acoustic backscatter from ADCP at the same depth and time. The sample volumes for turbidity/TSS and backscatter are not the same which, in a turbulent, heterogeneous suspended sediment plume introduces some bias to the calibration. However, the method has been commonly used with good results in many field studies with a range of current velocities, sediment types, and sediment grain size distributions (see the review paper by Poerbandono and Mayerle, 2004).

ADCPs were calibrated for turbidity and TSS against water samples analyzed in the laboratory. All samples available from both boats during all disposal monitoring surveys were used in the calibrations. The ADCP is primarily designed and used to quantify current velocity by measuring the Doppler frequency shift in the acoustic backscatter signal. The acoustic backscatter intensity is measured and recorded but processed no further by the ADCP because only the frequency shift is used to calculate velocity and the frequency shift is independent of the backscatter intensity. The backscatter intensity, however, is dependent on the suspended sediment concentration, but in order to calibrate backscatter to suspended sediment concentration, losses due to acoustic beam spreading and acoustic absorption by water must be accounted for in the backscatter signal. Based on the energy of acoustic intensity, Deines (1999) simplified the active sonar equation from underwater acoustic theory for the broadband ADCP:

$$10 \log_{10}(SSC) = C_k + K_C E + 10 \log_{10}(R^2) + 2\alpha_w R$$

where SSC is suspended sediment concentration, R is the range along the beam to the scatterer, α_w is the attenuation coefficient due to water absorption (primarily dependent on the frequency and provided by the instrument manufacturer), and E is the acoustic echo strength (in instrument counts). The last two terms in the equation represent the effects of acoustic beam spreading and acoustic absorption by water, respectively. C_k and K_C are constants that cannot be measured directly. Least squares regression analysis was used to estimate the best values for the constants C_k and K_C (Figure 5). The estimated values for C_k and K_C are -30.68 mg/L and 0.4371 mg/L/dB, respectively and are within the range suggested by Poerbandono and Mayerle (2004). The error on C_k with 95% confidence is ± 6.76 mg/L. Assuming a linear relationship between turbidity and suspended sediment concentration (Figure 6), an equation of the same form was used for calibration of the ADCP to turbidity (Figure 7). The estimated values for C_k and K_C for turbidity are -34.76 NTU and 0.4351 NTU/dB, and the error on C_k with 95% confidence is ± 6.68 NTU.

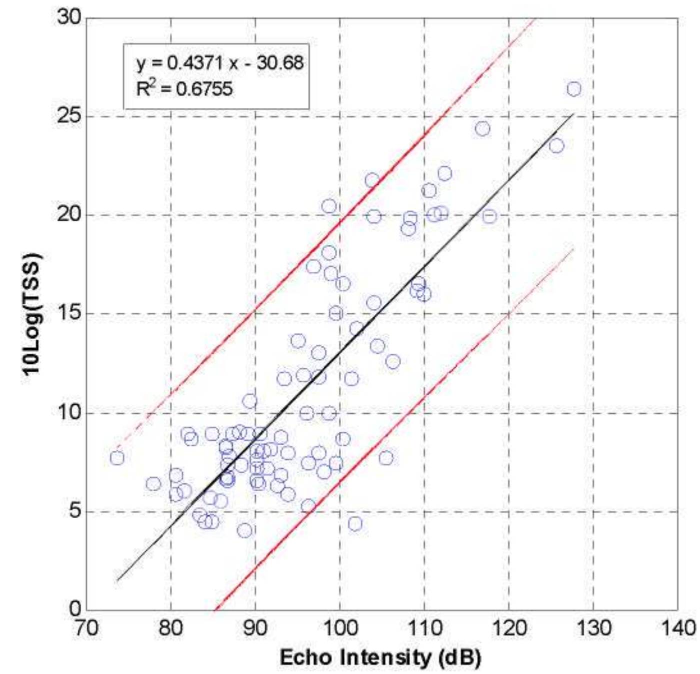

Figure 5. Least Squares Regression Analysis of Total Suspended Solids (TSS) from Whole Water Samples Analyzed in the Laboratory versus ADCP Echo Intensity in Decibels (dB).
Red Lines Indicate the Regression 95% Confidence Interval.

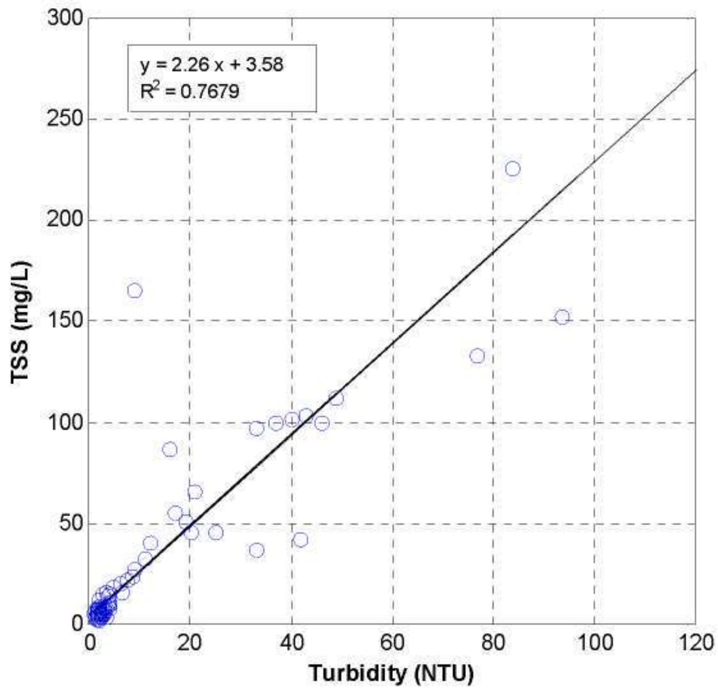

Figure 6. Least Squares Regression Analysis of TSS versus Turbidity from Whole Water Samples Analyzed in the Laboratory.

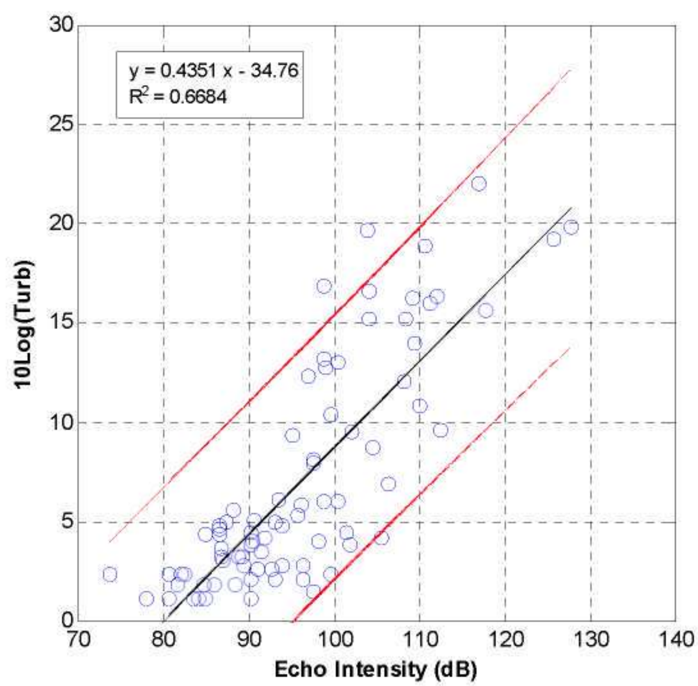

Figure 7. Least Squares Regression Analysis of Turbidity from Whole Water Samples Analyzed in the Laboratory versus ADCP Echo Intensity in Decibels (dB).
Red Lines Indicate the Regression 95% Confidence Interval.

Results

Velocity Survey

Tidal currents dominate the movement of water in New Bedford Harbor and thereby the movement of any suspended sediment in the water column. There exists, however, a generally weak inflow of fresh water from the Acushnet River at the north. This fresh water inflow results in a weak estuarine circulation which is superimposed on the stronger tidal flow. The estuarine circulation is the density driven movement of fresher surface water down the estuary simultaneous with the movement of saltier bottom water up the estuary. In New Bedford Harbor, the combined effect of the tides and the estuarine circulation is vertical shear in the water column velocity, in which the ebb currents are stronger near-surface and flood currents are stronger near-bottom. The Acushnet freshwater inflow varies seasonally and is significantly weaker than the tides except occasionally during large spring freshet events, which did not occur during this study.

A velocity survey was performed on March 27, 2009 using ADCP to delineate the current structure in detail in the survey area between Popes Island and the Route 195 bridge. The results of the velocity survey were used during the plume tracking surveys to provide *a priori* estimates of plume movement. Appendix A presents the results of that survey as a series of hourly velocity vectors along the harbor transects over a complete tidal cycle for the near-surface and mid-depth locations. Peak near-surface tidal flows were generally less that 35 cm/s (0.7 kts) in the immediate vicinity of the CAD cell and less than 55 cm/s (1.1 kts) in the navigation channel. The mid-depth tidal flows were slightly weaker that the near-surface flows with the strongest less that 30 cm/s (0.6 kts) near the CAD cell and less than 50 cm/s (1.0 kts) in the navigation channel. The configuration of the harbor results in a flow which diverges around Popes Island just below the CAD cell. During the ebb tide (southward flow) the currents diverge near Popes Island with most of the flow moving southwestward following the navigation channel and some moving southeastward around Popes Island to the east. During the flood tide (northward flow) the pattern reverses.

Current velocities inside the curtained CAD cell were too weak to measure accurately with ADCP at speeds less than 2 cm/s.

Turbidity and Suspended Sediment Results

Turbidity and TSS results from laboratory analysis of whole water samples collected at reference and plume stations during the plume tracking surveys are summarized in Appendix B. The data passed all laboratory quality control criteria. The relative percent differences (RPD) in field duplicate turbidity and TSS were acceptable; average RPD for turbidity was 22% and average RPD for TSS was 53%. This is typical given the small values being measured at reference stations (where small absolute differences can result in large RPDs) and the heterogeneous nature of the plume sampled at plume stations. The turbidity and TSS results presented in Appendix B are discussed throughout the rest of this technical memo.

Toxicity Testing Results

Toxicity results from the acute and chronic (sub-lethal) exposure assays performed on site water samples collected during disposal activities are summarized in Table 2. Results are presented for the test endpoints: survival, growth, development and reproduction. Results for test endpoints for each sample were statistically compared to those from both the event-specific site reference sample and the laboratory control sample. Assay results for the laboratory control sample met the minimum test acceptability criteria for the acute and chronic exposure assays, indicating the test was in control and that healthy test organisms were used. Assay results for the site water samples collected on May 20, 2009 during disposal activities at the City's CAD cell showed no significant reduction in endpoints for any of the test species between the reference and CAD sampling sites (Table 2). There were no measurable acute or sub-lethal impacts from exposure of the test species, *A. punctalata*, *A. bahia*, and *C. parvula*, to water collected during disposal activities.

Table 2. Summary of Toxicity Test Results, May 20, 2009 Water Samples

Sample	Time After Release (min)	Turbidity from ADCP (NTU)	Toxicity Results: Sea Urchin (*A. punctulata*)	Mysid (*A. bahia*)			Red alga (*C. parvula*)	
			mean fertilization (%)	48-hr mean survival (%)	7-day mean survival (%)	7-day mean biomass (mg/mysid)	48-hr mean survival (%)	7-day mean reproduction (cystocarp/ plant)
Lab Control	na	na	97.1	100	84.4	0.431	100	34.0
Site Reference	na	< 2	93.5[1]	100	82.5	0.462	100	34.0
Outside silt curtain	49	~12	95.0[1]	100	97.5	0.519	100	34.1
Inside silt curtain	20	~70	94.1[1]	97.5	87.5	0.435	100	34.7
Acceptance Criteria (for Lab Control)			> 70	≥ 90	≥ 80	>0.2	no necrosis	≥ 10

[1] Assay result significantly different compared to the laboratory control sample.

Disposal Plume Turbidity and Suspended Sediment

Background Turbidity

Prior to beginning each disposal sampling event, each boat collected reference samples at two stations (Figure 1) at two depths (mid-depth and near-bottom) at least 1500 ft from the CAD cell and away from any other dredge activity. The turbidity and TSS measured in the laboratory from whole water samples are presented in Appendix B. The reference levels were low and consistent across the study area. The mean background turbidity was 2.1 NTU and the mean background TSS was 5.7 mg/L. With the exception of one profile in the channel south of the CAD cell the background turbidity was approximately 1 – 3.2 NTU and the background TSS was approximately 2 – 12 mg/L.

Plume Measurements

Five disposal plumes were monitored in and around the CAD cell on five different days. In the series of figures presented in Appendix C, suspended sediment measurements collected during the plume surveys using ADCP are presented. For each disposal event, a series of 5 to 7 figures show water column observations made pre-release and at various times after releases. Included in each figure are three panels presenting the locations of measurements and vertical contours of observed turbidity inside and outside the CAD cell silt curtain. The location panel shows the CAD cell boundaries, the approximate location of the dredge barge at the time of release, and the locations of both the inner and outer boat transects at the time of the measurements as indicated. The two vertical contour panels present the calibrated turbidity in NTU and TSS in mg/L along each vessel transect. The contours are labeled and oriented west to east (or east to west) based on the end points of the transect. In the following sections, TSS values in mg/L are referenced alongside corresponding turbidity values.

Disposal Plume April 14, 2009

On April 14, 2009, a disposal plume was surveyed during a dredged material release from a split hull barge at the New Bedford Harbor CAD cell. The material placed into the CAD cell was from City dredging operations north of the Coggeshall Street Bridge. The release took place at 16:47 hours and monitoring was carried out during the approximately 1 hour period of weak northerly currents that followed (published low tide for the day was 16:59). The currents outside the cell were weak and variable (< 10 cm/s) with a slight northward component particularly on the west of the cell in the navigation channel. Currents inside the silt curtain were too weak to measure at speeds less than 2 cm/s. In the presence of little current to transport and disperse the suspended sediment, the disposal plume stayed close to the point of release, transported primarily by its own momentum.

Part 1 of Appendix C documents the suspended sediment plume observed in the water column after the release. In it, a series of five figures are presented showing the results from five sets of concurrent inner and outer transects selected at intervals over a period of approximately 45 minutes until the plume dissipated. Figure 1-1 presents background conditions before the release showing two transects run just inside and outside the silt curtain on the north side of the CAD cell. Water column turbidity was observed at background levels during both transects, although an offset bottom echo is visible in the inner transect which should not be confused with any water column turbidity[2]. By 8 to 11 minutes after release (Figure 1-2), the disposal plume was observed at approximately 25 NTU (62 mg/L) inside the silt curtain north of the point of release. Seen in the outer turbidity profile, there was a very weak turbidity signal, just above background (< 5 NTU; 12 mg/L), visible leaking from one of the seam slits in the silt curtain. By 19 to 22 and 27 to 39 minutes after release (Figures 1-3 and 1-4), the inner boat was measuring turbidity at approximately 15 NTU (38 mg/L) near bottom and the outer boat could find no trace of the plume. By 40 to 44 minutes after release (Figure 1-5), the plume had settled and water column turbidity had returned to background levels.

Disposal Plume May 20, 2009

On May 20, 2009, a disposal plume was surveyed during a dredged material release from a hopper barge. The material placed into the CAD cell was dredged during City dredging operations at the Niemiec Boat Yard just north of Popes Island. The barge hoppers were opened at 07:50 hours, however, some of the dredged material did not fall readily through the hopper doors. An excavator was used to shovel material out of some hopper bins and to dump water into the bins to wash away the material that was adhering to the sides.

The currents in the harbor were at ebb during the approximately 90 minute monitoring period (published high tide was 04:51). Outside the cell currents were as strong as 30 cm/s to the south on the west side of the cell and 15 cm/s to the south on the east side. Currents inside the silt curtain were too weak to measure at speeds less than 2 cm/s.

Part 2 of Appendix C documents the turbidity and TSS observations at the CAD cell on May 20th. In it, a series of seven figures are presented with the results of seven sets of concurrent inner and outer transects selected at intervals over a period of approximately 90 minutes until the plume dissipated. Figure 2-1 presents background conditions before the release. Inside and outside the silt curtain, turbidity was < 2 NTU and TSS was <5 mg/L. Figure 2-2 presents turbidity observed 3 to 6 minutes after release where a very strong plume signal can be seen inside the silt curtain, near-bottom, south of the barge with turbidity as high as 70 NTU (175 mg/L)[3]. Outside the silt curtain to the south, a filament of slightly elevated turbidity (< 5 NTU; <12 mg/L) was visible near the curtain gate. Between 10 and 24 minutes after release (Figures 2-3 and 2-4) the plume spread within the cell and the concentration remained high (70 NTU; 175 mg/L)[3]. The use of the excavator to liberate the dredged material stuck in the hopper bins probably contributed to the elevated turbidity in the cell. Outside the silt curtain there was no evidence of

[2] Bottom echoes occasionally appear reflected in the water column as a result of surface acoustic reflections or software inability to correctly identify sharp depth changes. However, these 'bright lines' are not easily confused with water column plumes because of their linear nature.

[3] A uniform color scale was used in all figures unless otherwise noted. These peak values are offscale on the figure.

the plume at that time, suggesting that the previously seen filament of the plume near the gate was short lived. By 39 minutes after release (Figure 2-5), turbidity within the CAD cell was reduced to approximately 30 NTU (75 mg/L) near bottom and by 55 minutes after release (Figure 2-6) it was further reduced to 20 NTU (50 mg/L). During both these intervals some evidence of elevated turbidity was seen just outside the CAD cell, probably emanating from seam slits in the silt curtain or possibly caused by some low-level turbidity seepage through the curtain itself. Even so, the highest turbidity observed outside was approximately 12 NTU (30 mg/L). Finally after 84 minutes (Figure 2-7), turbidity within the CAD cell was approaching background at 10 NTU (25 mg/L).

Disposal Plume May 21, 2009

On May 21, 2009, a disposal plume was surveyed during a dredged material release from a hopper barge. The material placed into the CAD cell was dredged during City dredging operations at the Gifford Street Boat Ramp, located just north of the hurricane barrier. The barge hoppers were opened at 08:18 hours and no excavator was necessary to help release the material. The currents in the harbor were at ebb during the approximately 1 hour monitoring period (published high tide was 05:48). Outside the cell, currents were as strong as 30 cm/s to the south on the west side of the cell and 15 cm/s to the south on the east side. Currents inside the silt curtain were too weak to measure at less than 2 cm/s.

Part 3 of Appendix C documents the turbidity and TSS observations at the CAD cell on May 21th. Figure 3-1 presents background conditions before the release. Inside and outside the silt curtain, turbidity was < 2 NTU and TSS was <5 mg/L. Figure 3-2 presents turbidity observed 1 to 6 minutes after release; a very strong plume signal was present near-bottom inside the silt curtain (65 NTU; 136 mg/L)[3]. Outside the silt curtain there was no evidence of the plume. Between 5 and 9 minutes after release (Figure 3-3), the plume concentration remained high at approximately 50 NTU (125 mg/L) near-bottom as well as higher in the water column near the center of the cell. During this time interval, elevated turbidity was seen outside the CAD cell at concentrations as high as 20 NTU (50 mg/L). These were the highest values observed outside the cell during any of the surveys. They are probably the result of some of the plume escaping when the gate was opened to allow the tug and barge to exit. By 18 minutes after release (Figure 3-4), turbidity inside the CAD cell had dissipated to approximately 25 NTU (62 mg/L), by 39 minutes after release (Figure 3-5) it had dissipated to 15 NTU (38 mg/L), and by 51 minutes after release (Figure 3-6) it had further dissipated in size if not in concentration (15 NTU; 38 mg/L). Outside the silt curtain there was no evidence of the plume at these times. Finally, after 57 minutes (Figure 3-7) turbidity within the CAD cell was observed just above background at approximately 8 NTU (20 mg/L).

Disposal Plume May 27, 2009

On May 27, 2009, a disposal plume was surveyed during release of dredged material from the City dredging project at the Niemiec Boat Yard. The dredged material was released from a hopper barge although an excavator was used to help push some of the material out of some of the hopper bins. The barge hoppers were opened at 08:16. The currents in the harbor were at flood during the approximately 70 minute monitoring period (published low tide was 04:37). Outside the cell currents were 20-25 cm/s to the north on the west side of the cell and weak and variable to 10 cm/s northward on the east side. Currents inside the silt curtain were less than 2 cm/s.

Part 4 of Appendix C documents the turbidity and TSS observations at the CAD cell on May 27th. Figure 4-1 presents background conditions before the barge entered the CAD cell. Inside and outside the silt curtain, turbidity was < 2 NTU and TSS was <5 mg/L. Figure 4-2 presents turbidity observed 3 to 6 minutes after release; a very strong plume signal was present near-bottom inside the silt curtain (110 NTU; 260 mg/L)[3]. Note the change in the turbidity scale used in this figure and the next. Outside the silt curtain there was no evidence of the plume. Between 5 and 9 minutes after release (Figure 4-3), the plume concentration remained high at approximately 100 NTU (247 mg/L) near-bottom. Again there was no evidence of the plume outside the silt curtain. By 31 minutes after release (Figure 4-4), turbidity inside the CAD cell had dissipated to approximately 25 NTU (62 mg/L) and by 50 and 54 minutes after release (Figure 4-5 and 4-6) it had further dissipated to 15 NTU (38 mg/L). Outside the silt curtain there was no evidence of the plume. Finally, after 63 minutes (Figure 4-7) turbidity within the CAD cell was nearing background at approximately 13 NTU (32 mg/L).

Disposal Plume July 8, 2009
On July 8, 2009, a disposal plume was surveyed during a dredged material release from a hopper barge. The material placed into the CAD cell was dredged during City dredging operations at the Packer Pier, located on the New Bedford Harbor shoreline between the Route 6 and Route 195 bridges. The silt curtain gate was left open during the dump and the survey; the silt curtain being no longer required at this time of year under the conditions of the dredging permit. The barge hoppers were opened at 12:04 and no excavator was necessary to help release the material. The barge had been on a mooring in the CAD cell since the previous afternoon and it was not moved out of the CAD cell after release. In addition, two other barges were moored in the cell alongside the dredged material barge. As a result, the inner survey boat did not have access to the center area of the CAD cell. The currents in the harbor were at ebb during the approximately 1 hour monitoring period (published high tide was 09:20). Outside the cell, currents were 20-25 cm/s to the south on the west side of the cell and 10-20 cm/s to the south on the east side. Currents inside the silt curtain were less than 2 cm/s.

Part 5 of Appendix C documents the turbidity and TSS observations at the CAD cell on July 8th. Figure 5-1 presents background conditions before the release. Inside and outside the silt curtain, turbidity was < 2 NTU and TSS was <5 mg/L. Figure 5-2 presents turbidity observed 1 to 4 minutes after release; a strong plume signal was present inside the silt curtain near-bottom at 45 NTU (112 mg/L) extending to near the surface at 18 NTU (45 mg/L). Outside the silt curtain there was no evidence of the plume. Between 9 and 16 minutes after release (Figure 5-3), the plume had nearly dissipated inside the cell except for a relatively high concentration (20 NTU; 50 mg/L) within 1 m of the bottom. No plume was observed outside the cell at this time. The transects performed 15, 26, and 46 minutes after release (Figures 5-4 through 5-6) all observed low turbidity concentrations (<20 NTU; <50 mg/L) inside the cell and no turbidity above background outside the cell. Finally, after 58 minutes (Figure 5-7), turbidity within the CAD cell was just above background at approximately 6 NTU (15 mg/L).

That no evidence of the plume was observed outside the open curtain gate seemed at first surprising, but there were factors that kept the plume contained despite the open gate. First, the plume dissipated quickly and after the first few minutes it was limited to the lower ¼ of the water column within the excavated part of the cell where it was confined by the shoulder slope; and second, the gate was located on the west side of the cell where the tidal current in large part simply passed by the gate without flowing into or out of the cell.

Summary

A number of general observations can be made and conclusions drawn based on an overview of the results from the five CAD cell disposal plume surveys performed during this study, including:

- Water column plumes created during disposal of dredged material into the CAD cell were nearly completely contained within the CAD cell silt curtain.
- Inside the silt curtain, turbidities were observed as high as 110 NTU with TSS concentrations as high as 260 mg/L.

- Outside the silt curtain, the highest turbidities observed were only 20 NTU with TSS concentration of 50 mg/L and then only within close proximity to the cell in small filaments of plume which appear to have escaped the silt curtain at one of its seams.
- The presence of the silt curtain nearly eliminated any tidal current within the CAD cell; currents inside the cell were less than 2 cm/s and too weak to measure.
- Within the CAD cell, the bulk of the turbidity plumes were limited to the lower half of the water column, down within the excavated cell, with the highest values usually within 1 or 2 meters of the bottom.
- All the plumes dissipated to near background levels within 1 to 1-1½ hours.
- During near slack tide conditions the disposal plumes largely pooled beneath the barge within the cell but during flood or ebb tides some of the plume collected against the inside of the silt curtain on the north or south side, respectively.
- There were no significant reductions in endpoints for any of the toxicity test species, indicating that there were no measurable acute or sub-lethal impacts to marine organisms from exposure to the plume samples collected.

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APPENDIX A

New Bedford Harbor Tidal Velocity Structure
Measured with ADCP
March 27, 2009

Part 1: Near-Surface Tidal Velocity

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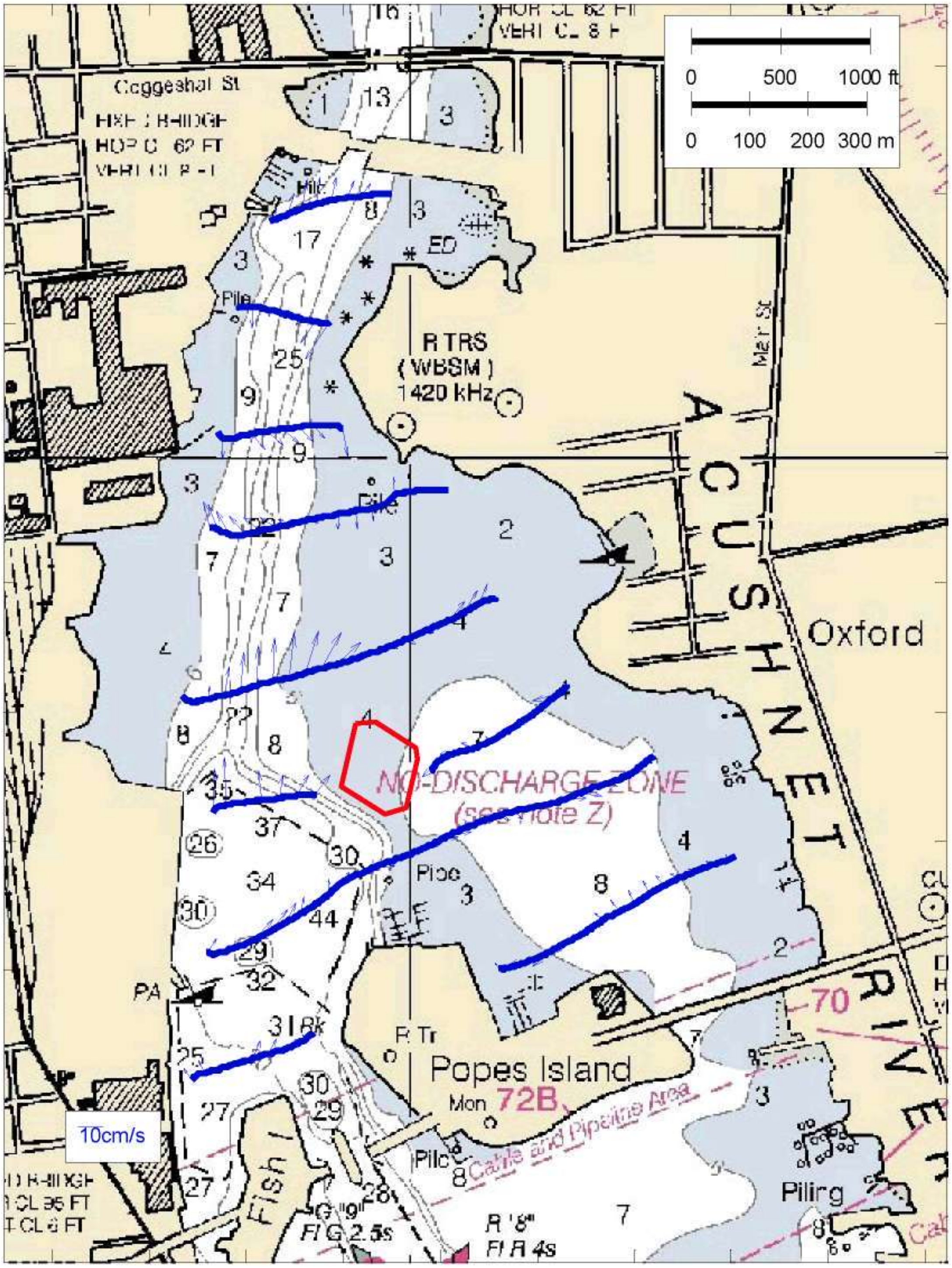
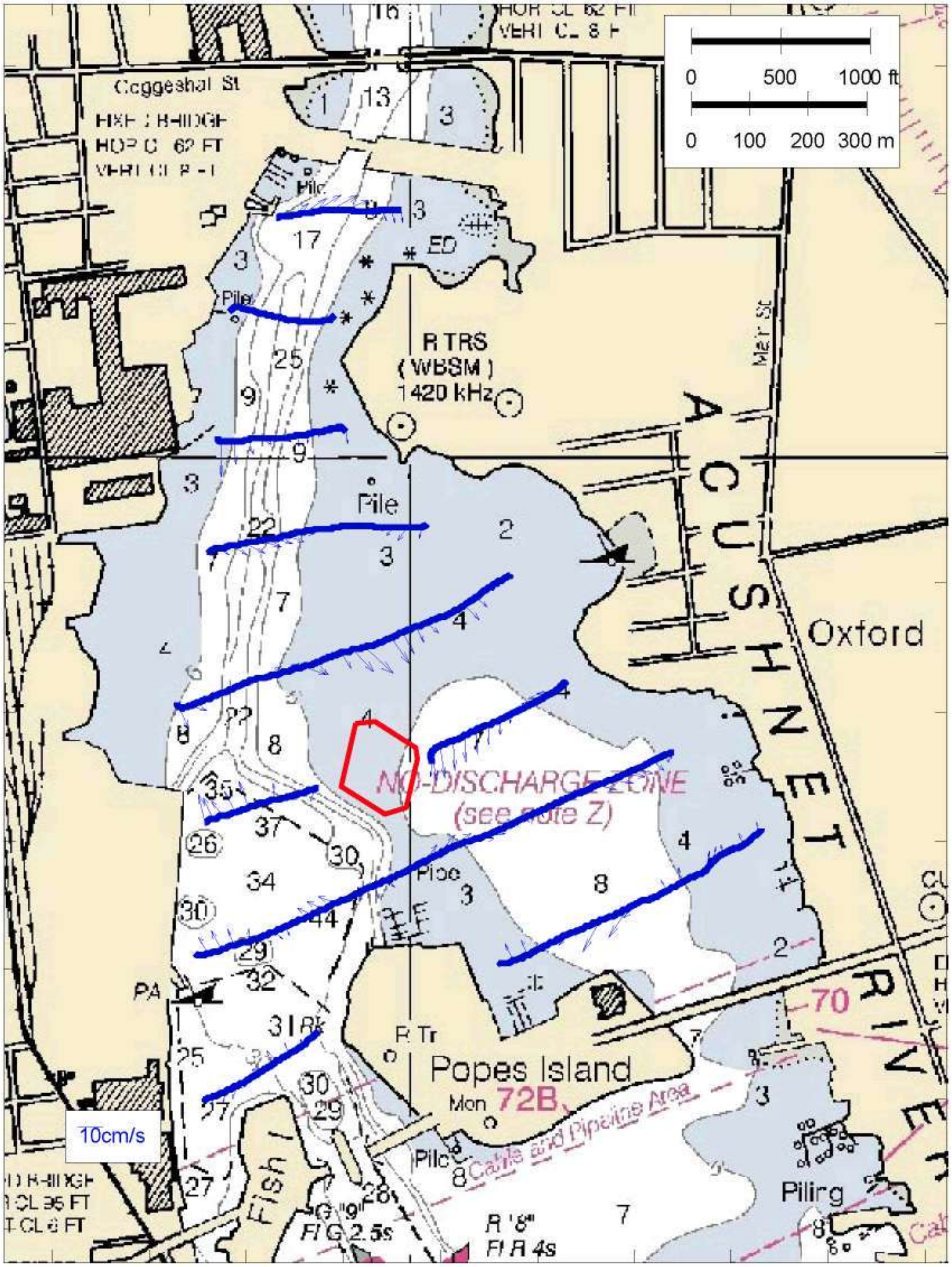
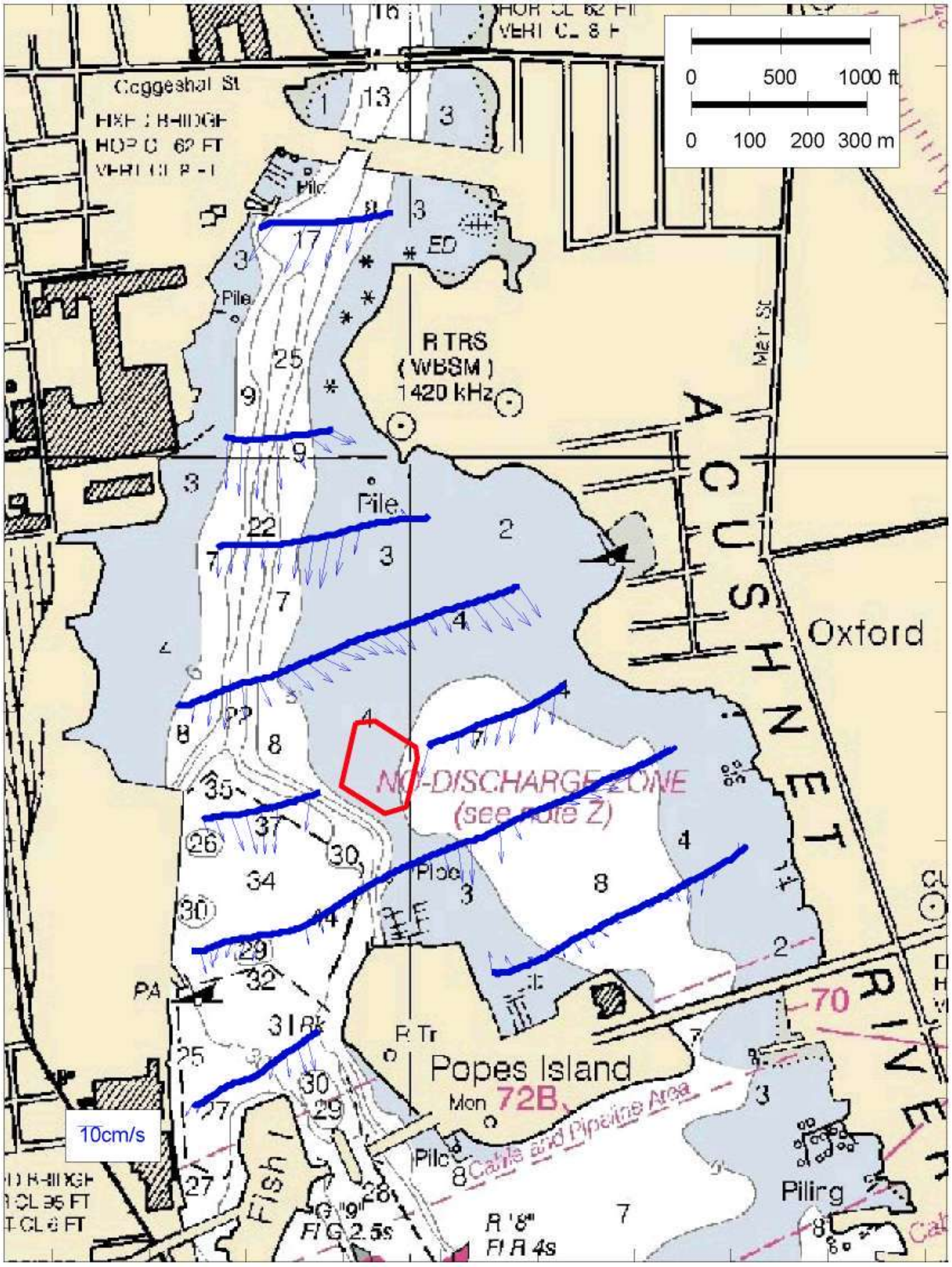
2 HOURS BEFORE HIGH SLACK - Depth 1.21m



1 HOUR BEFORE HIGH SLACK - Depth 1.21m



HIGH SLACK - Depth 1.21m



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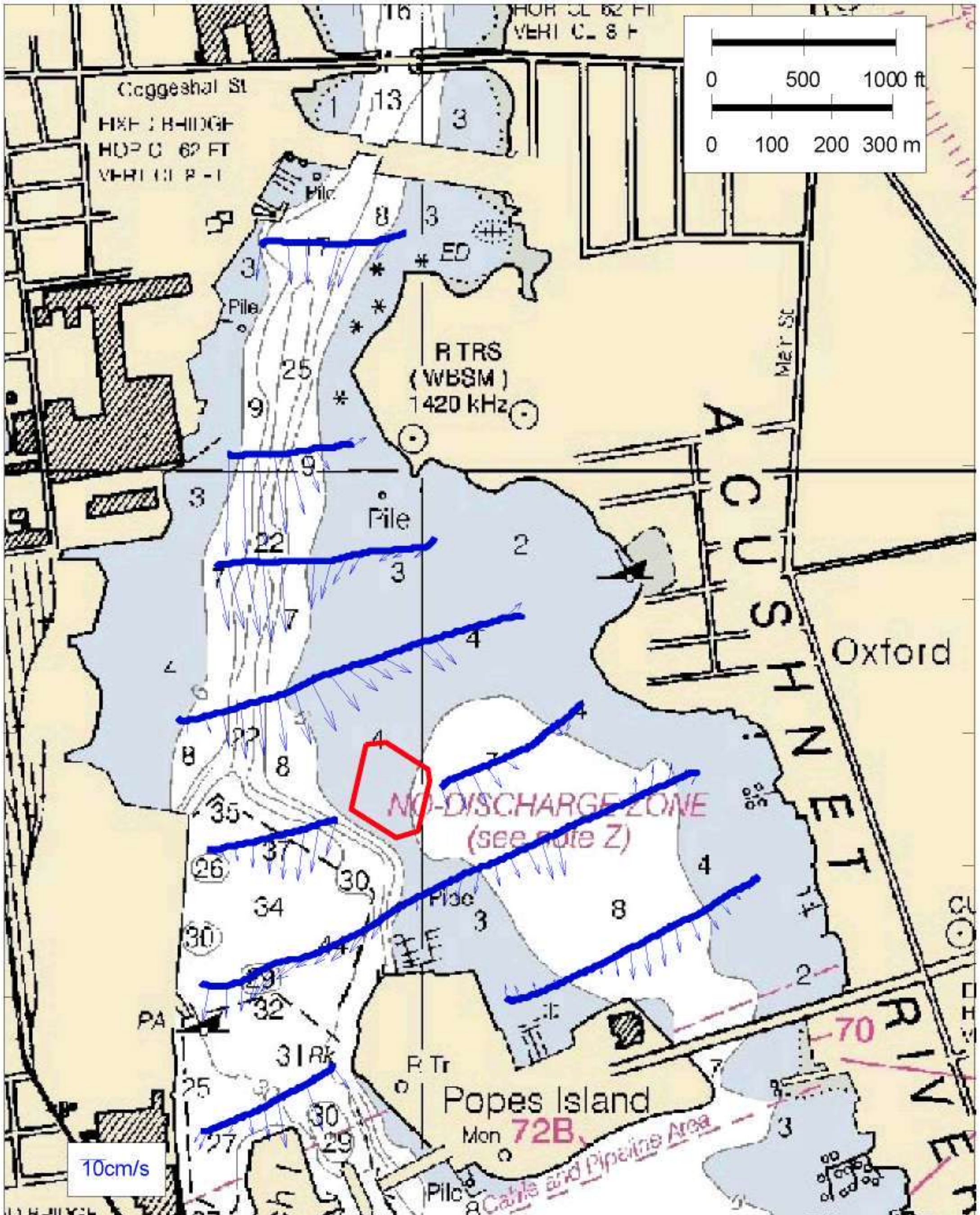
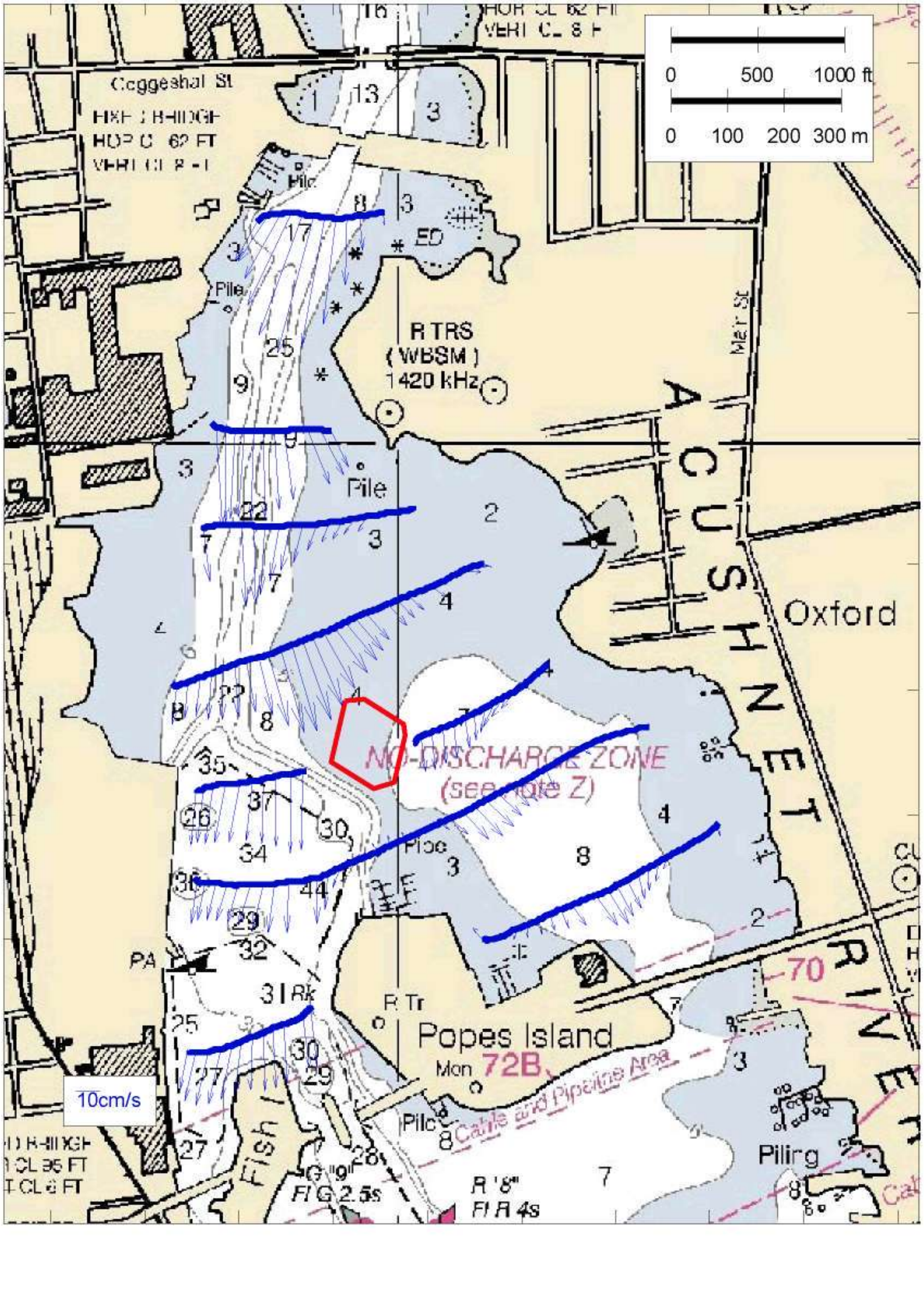
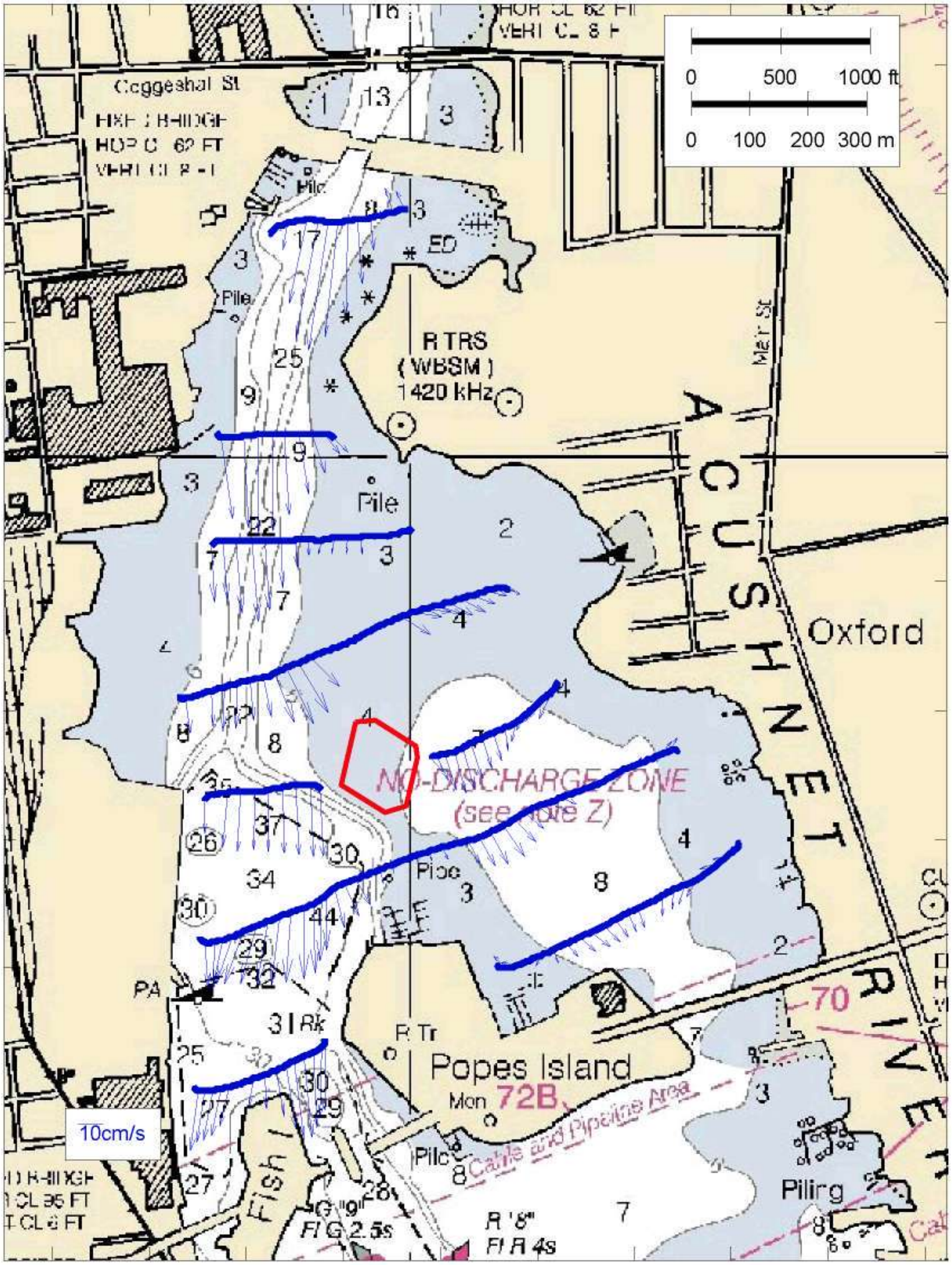


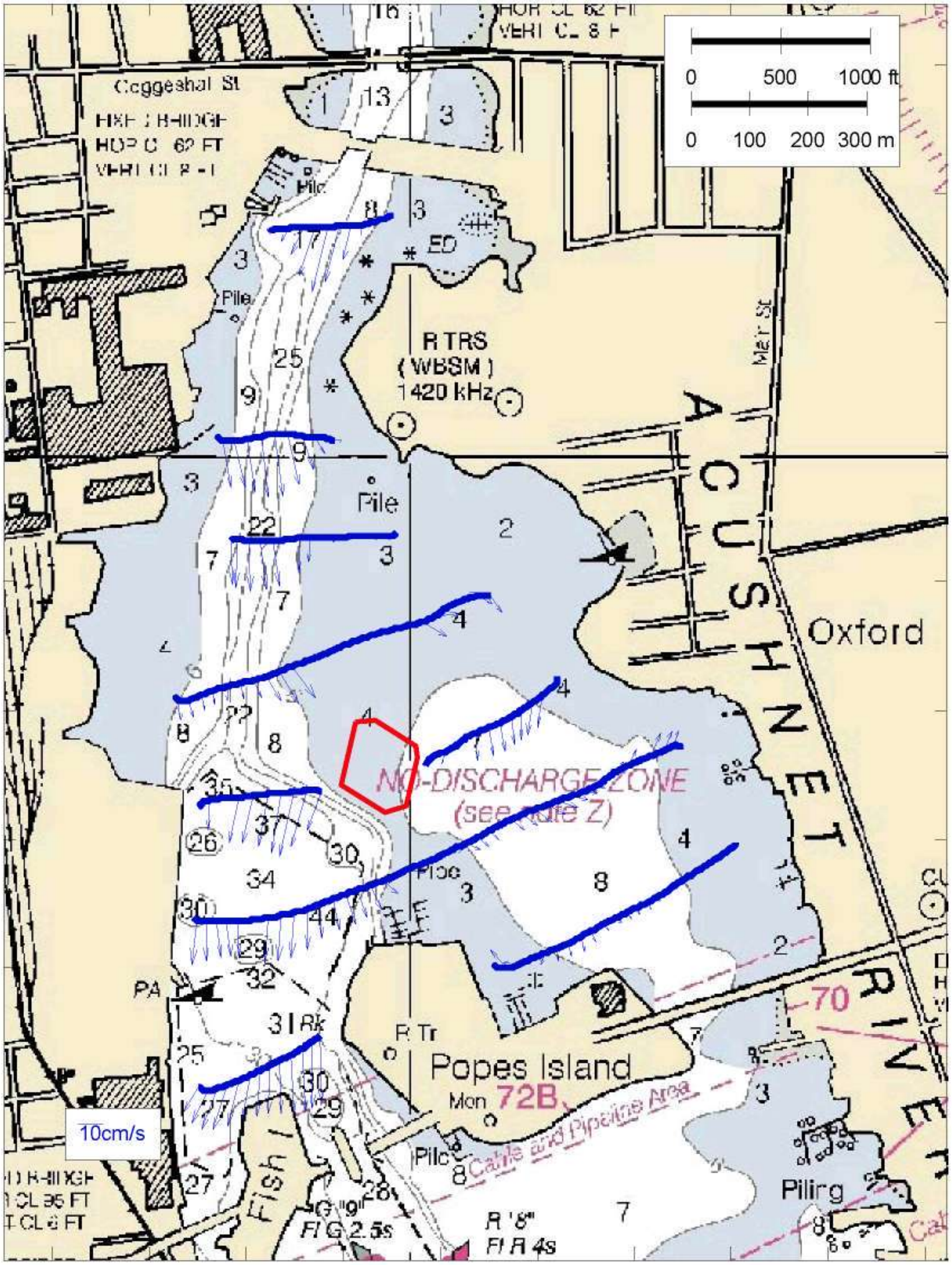
2 HOURS AFTER HIGH SLACK - Depth 1.23m



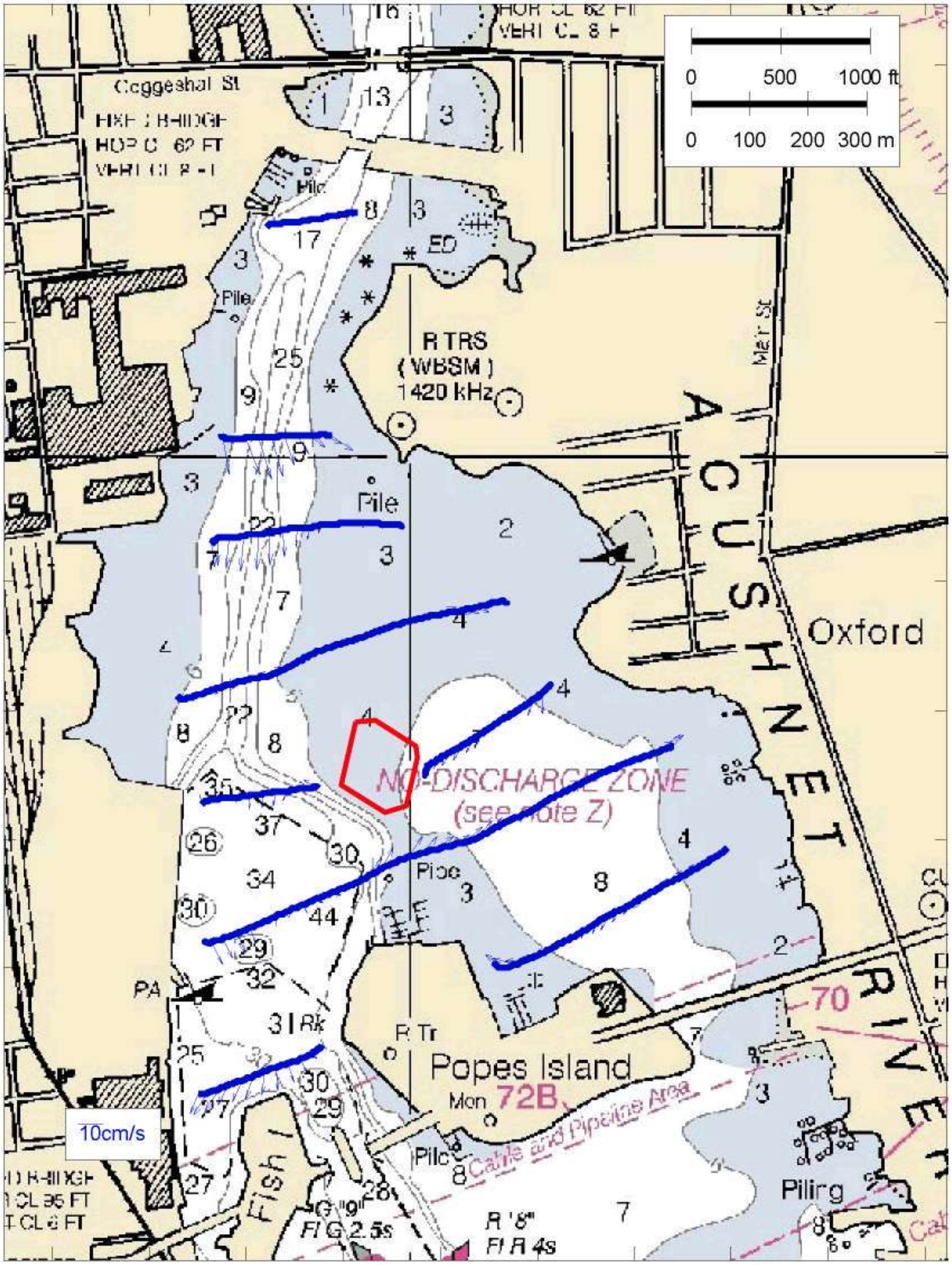
3 HOURS AFTER HIGH SLACK - Depth 1.24m



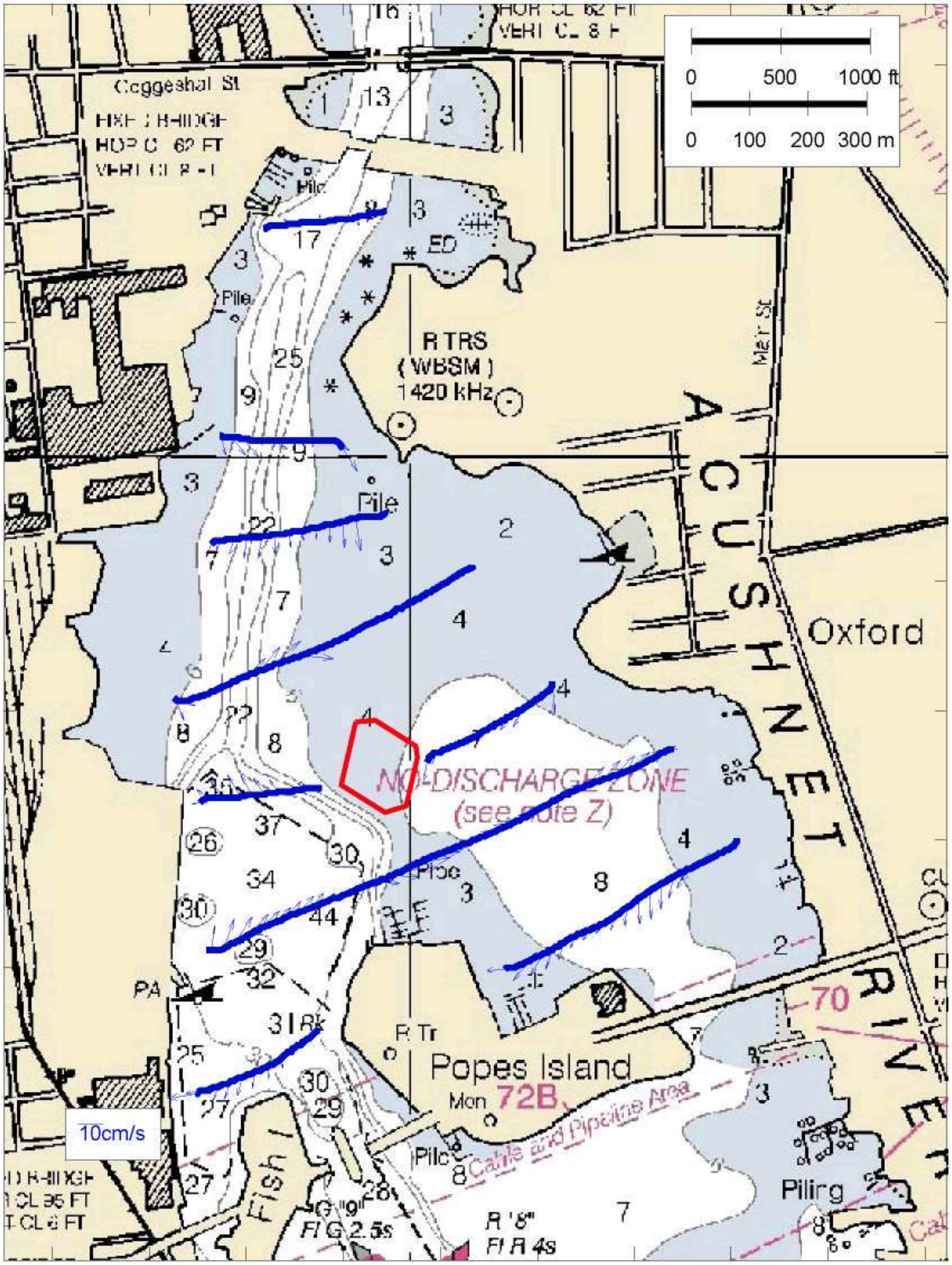
4 HOURS AFTER HIGH SLACK - Depth 1.24m



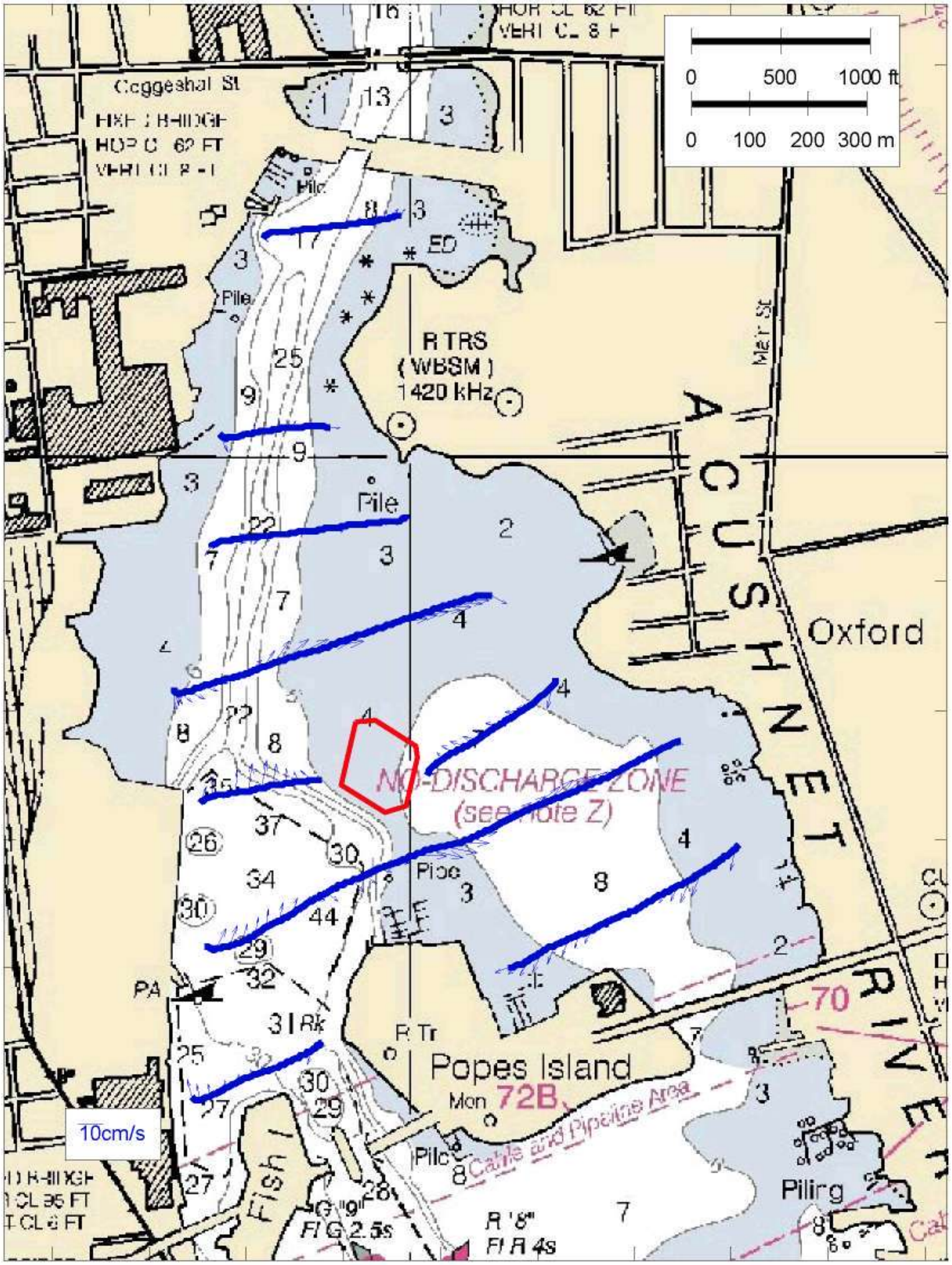
5 HOURS AFTER HIGH SLACK - Depth 1.24m



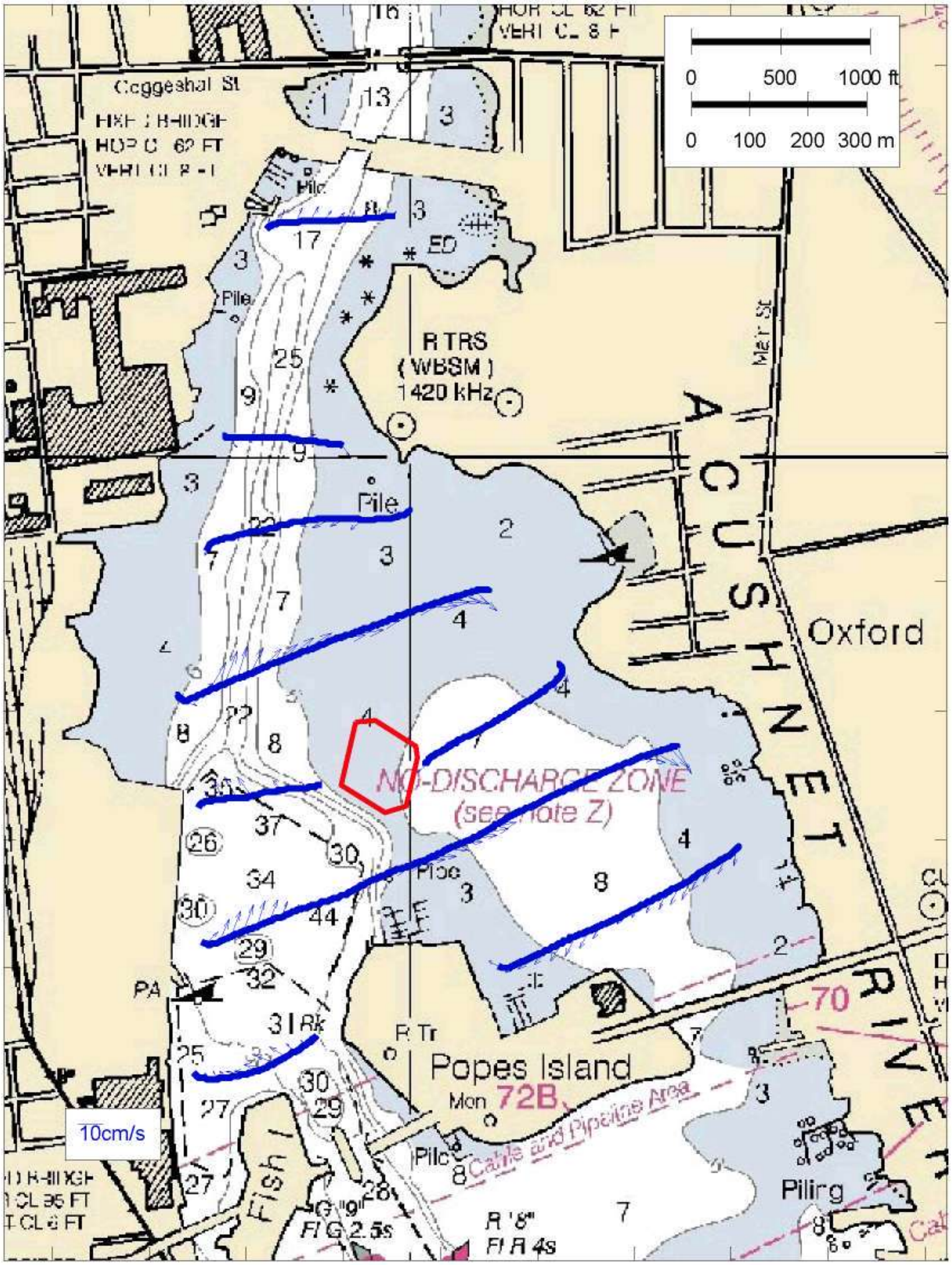
0.5 HOURS AFTER LOW SLACK - Depth 1.24m



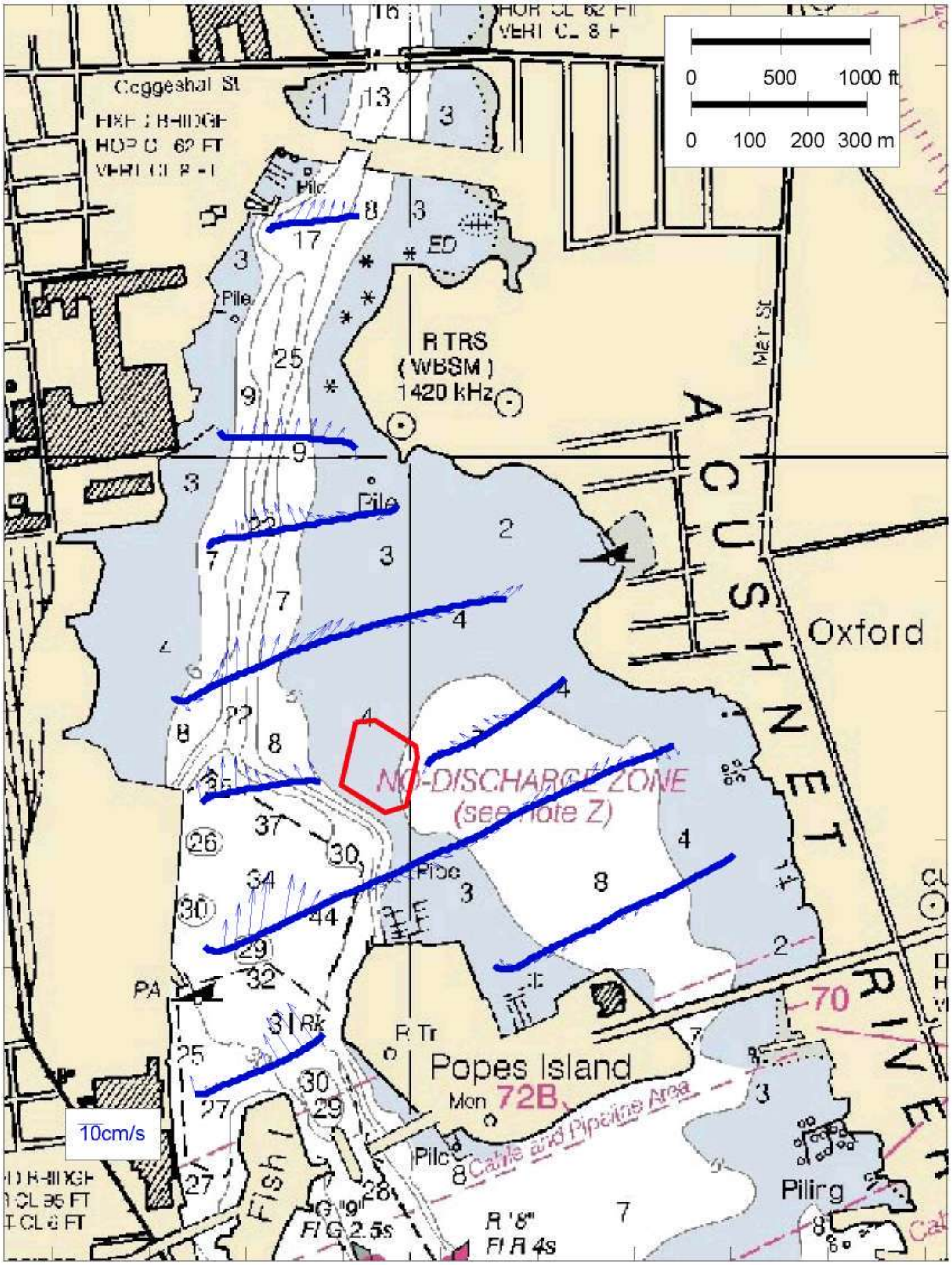
1.5 HOURS AFTER LOW SLACK - Depth 1.24m



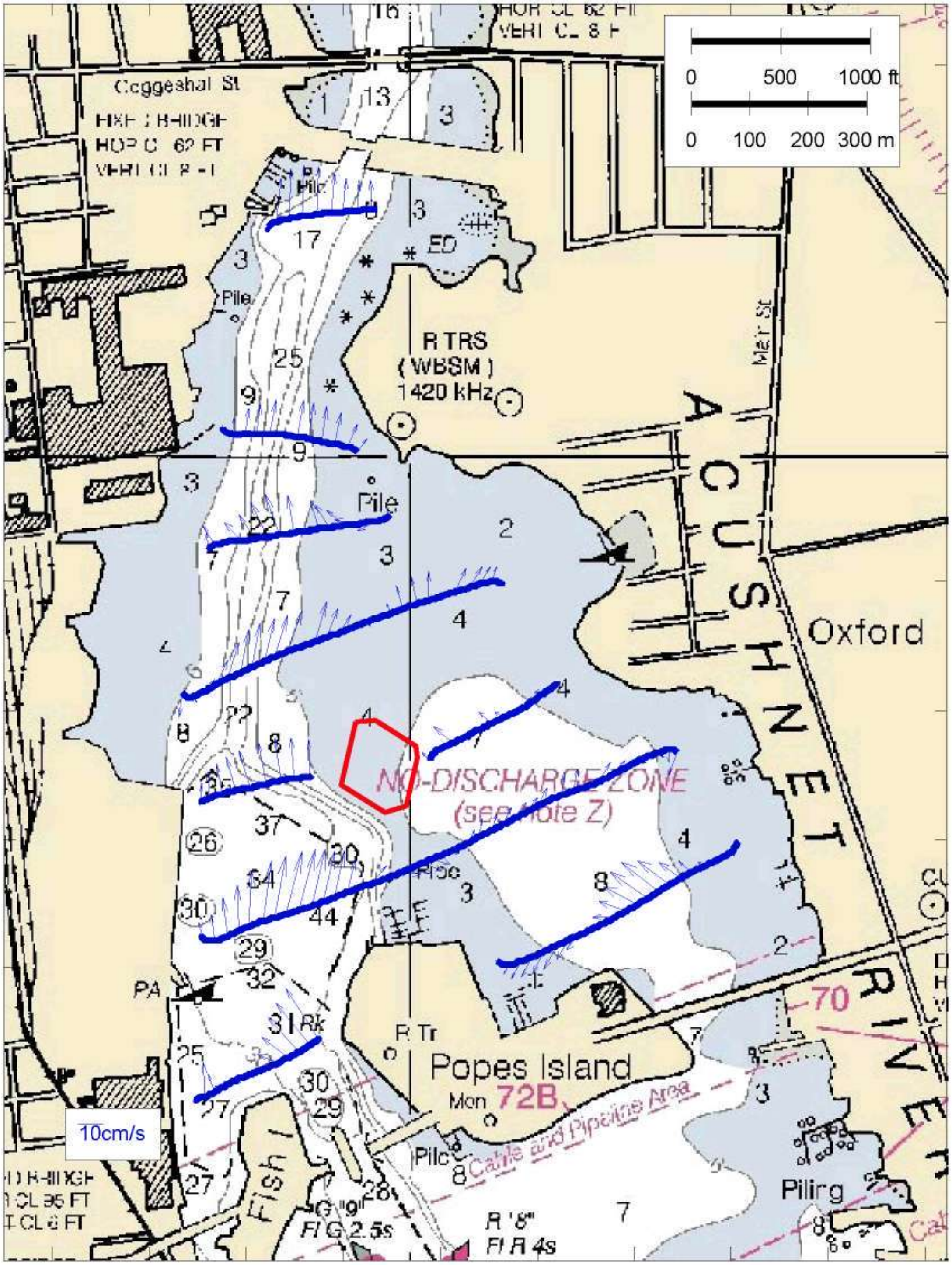
2.5 HOURS AFTER LOW SLACK - Depth 1.24m



3.5 HOURS AFTER LOW SLACK - Depth 1.24m



4.5 HOURS AFTER LOW SLACK - Depth 1.24m



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Part 2: Mid-Depth Tidal Velocity

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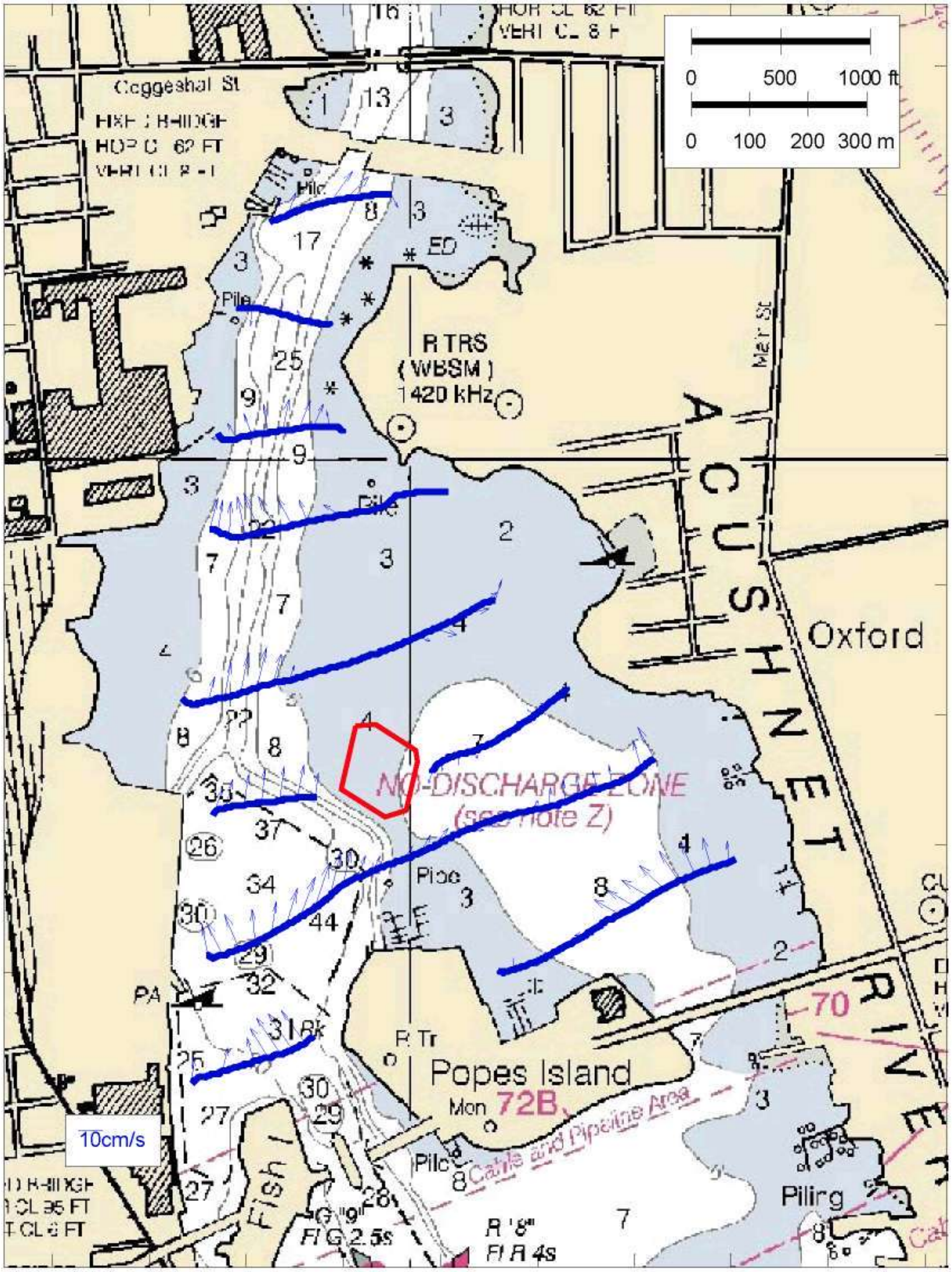
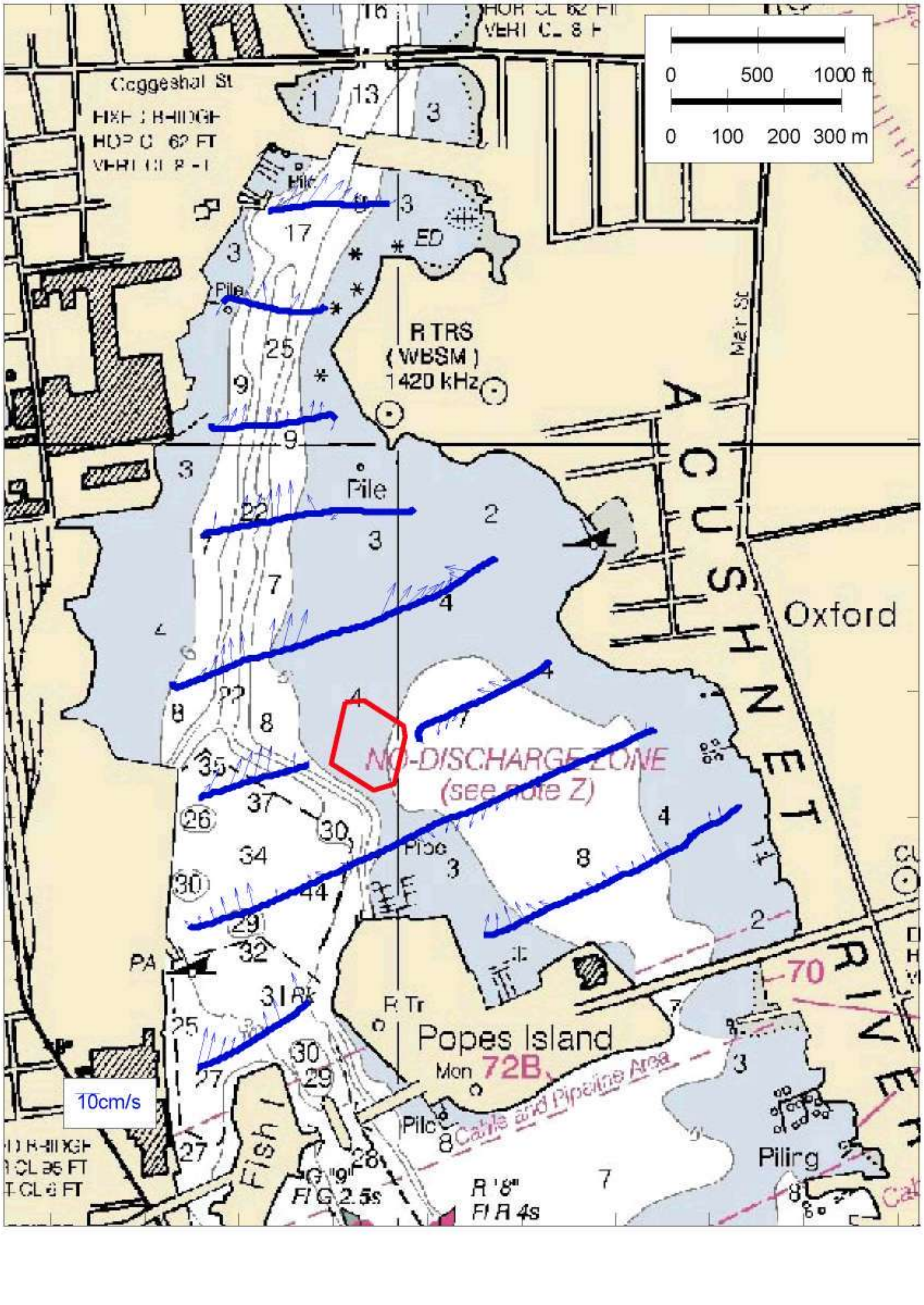
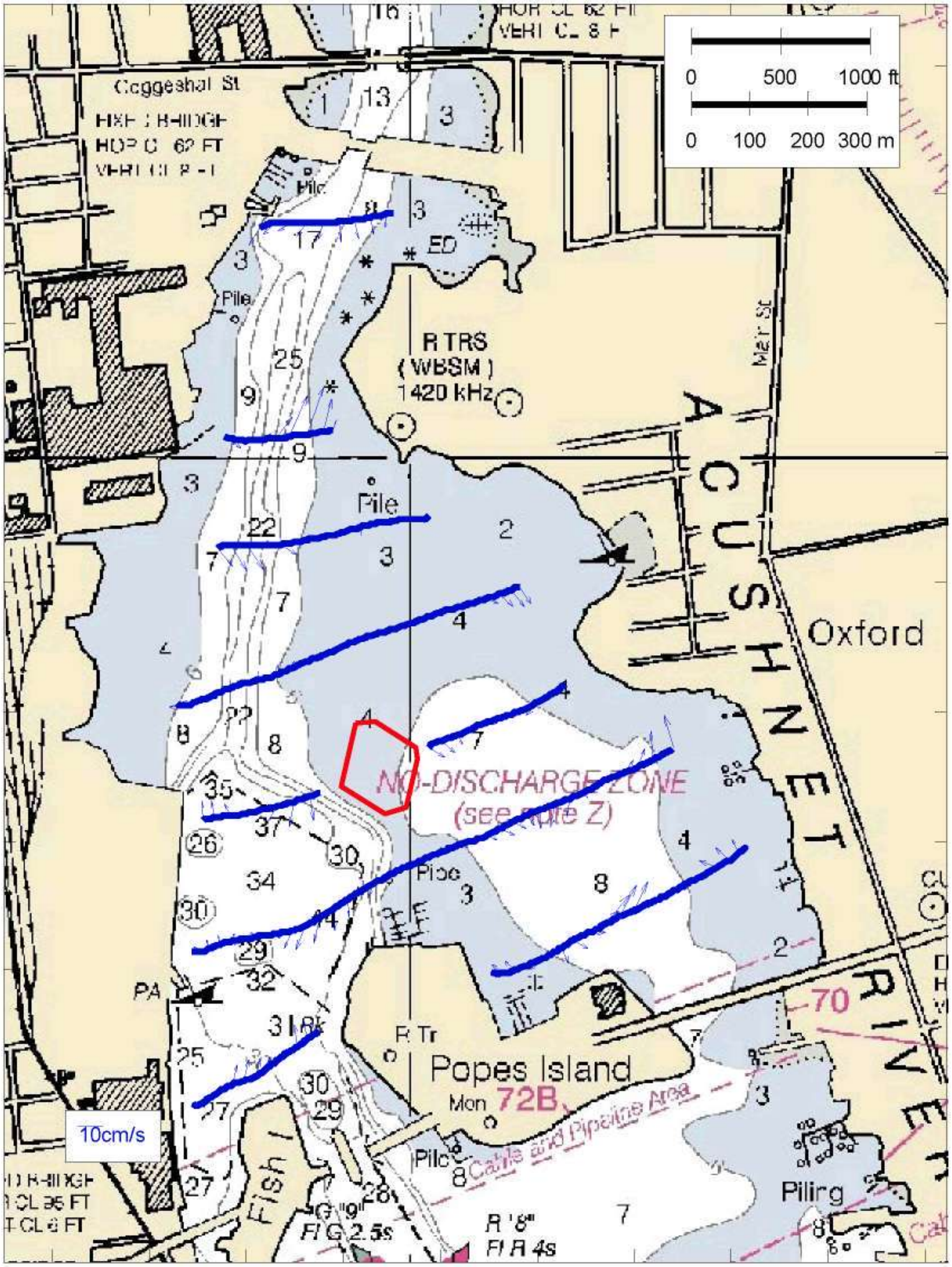
2 HOURS BEFORE HIGH SLACK - Depth 2.21m



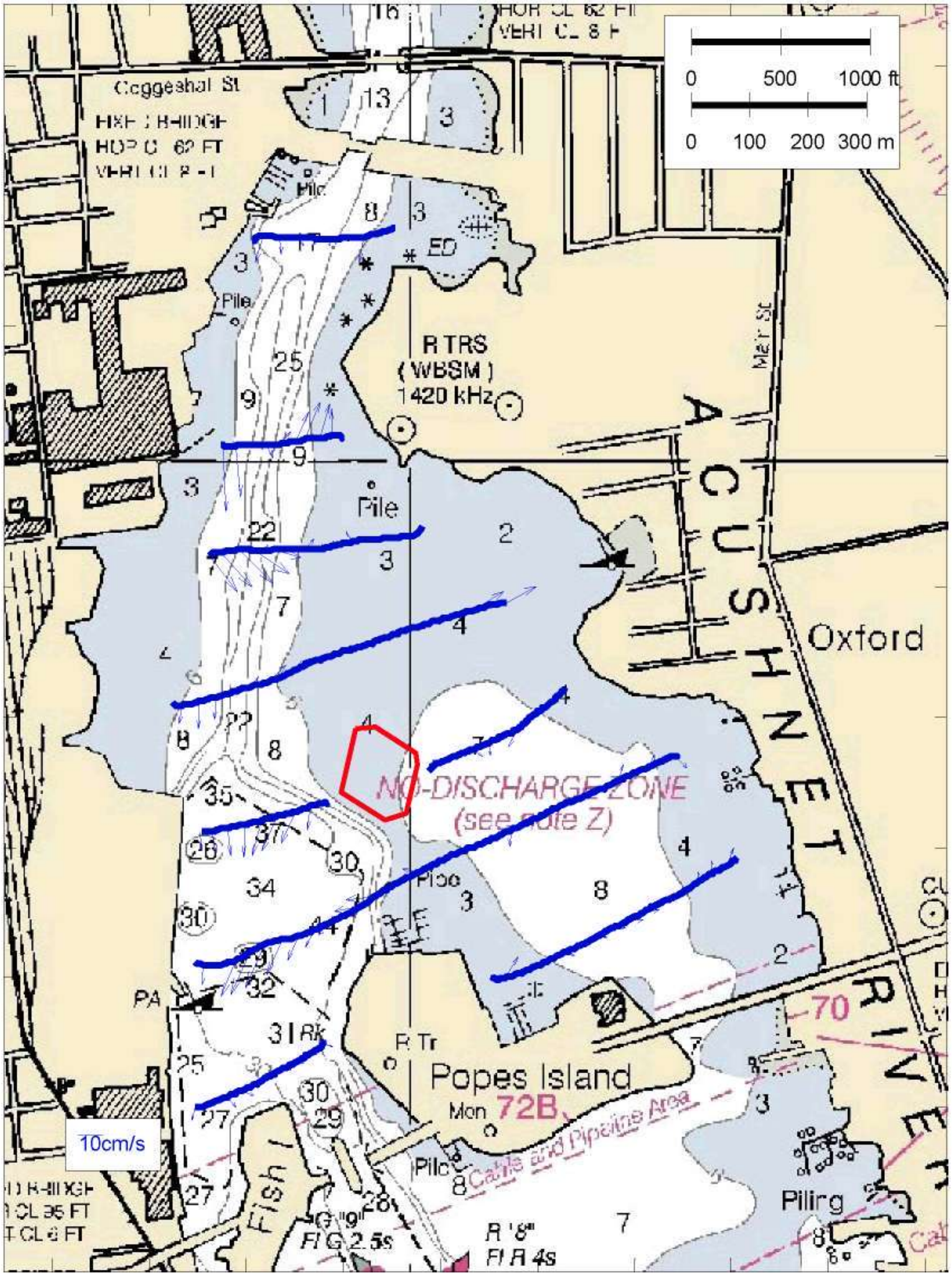
1 HOUR BEFORE HIGH SLACK - Depth 2.21m



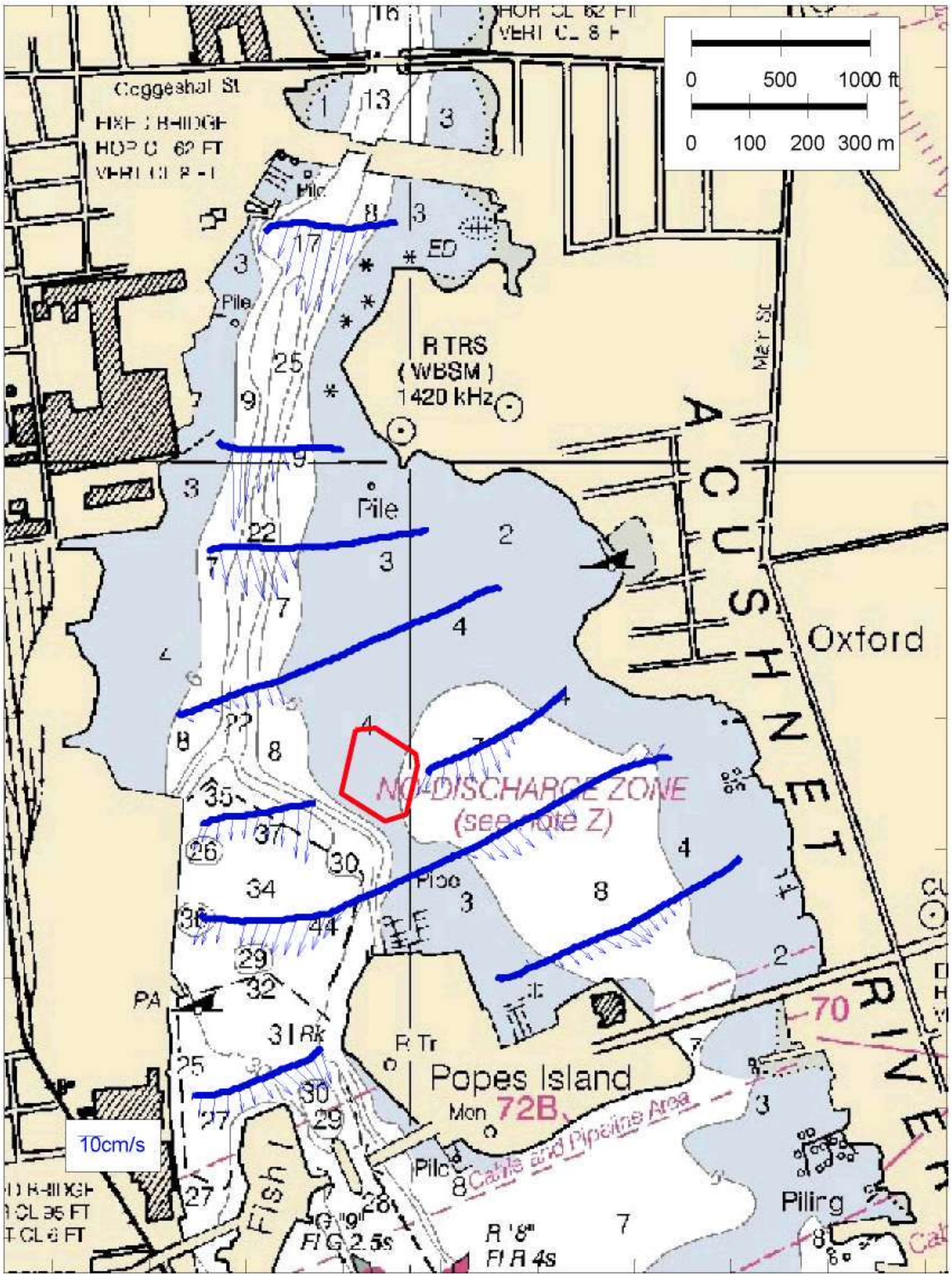
HIGH SLACK - Depth 2.21m



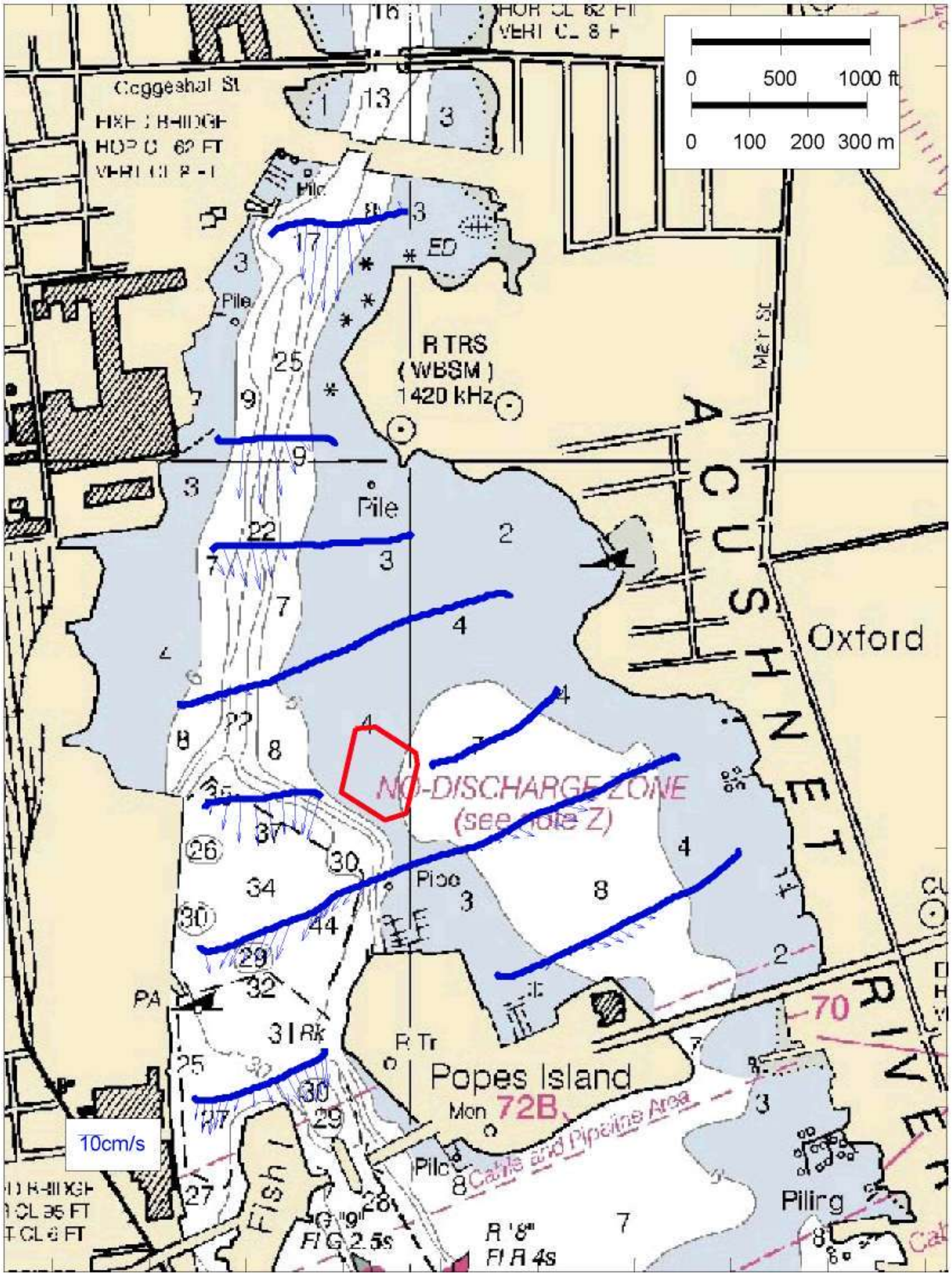
1 HOUR AFTER HIGH SLACK - Depth 2.21m



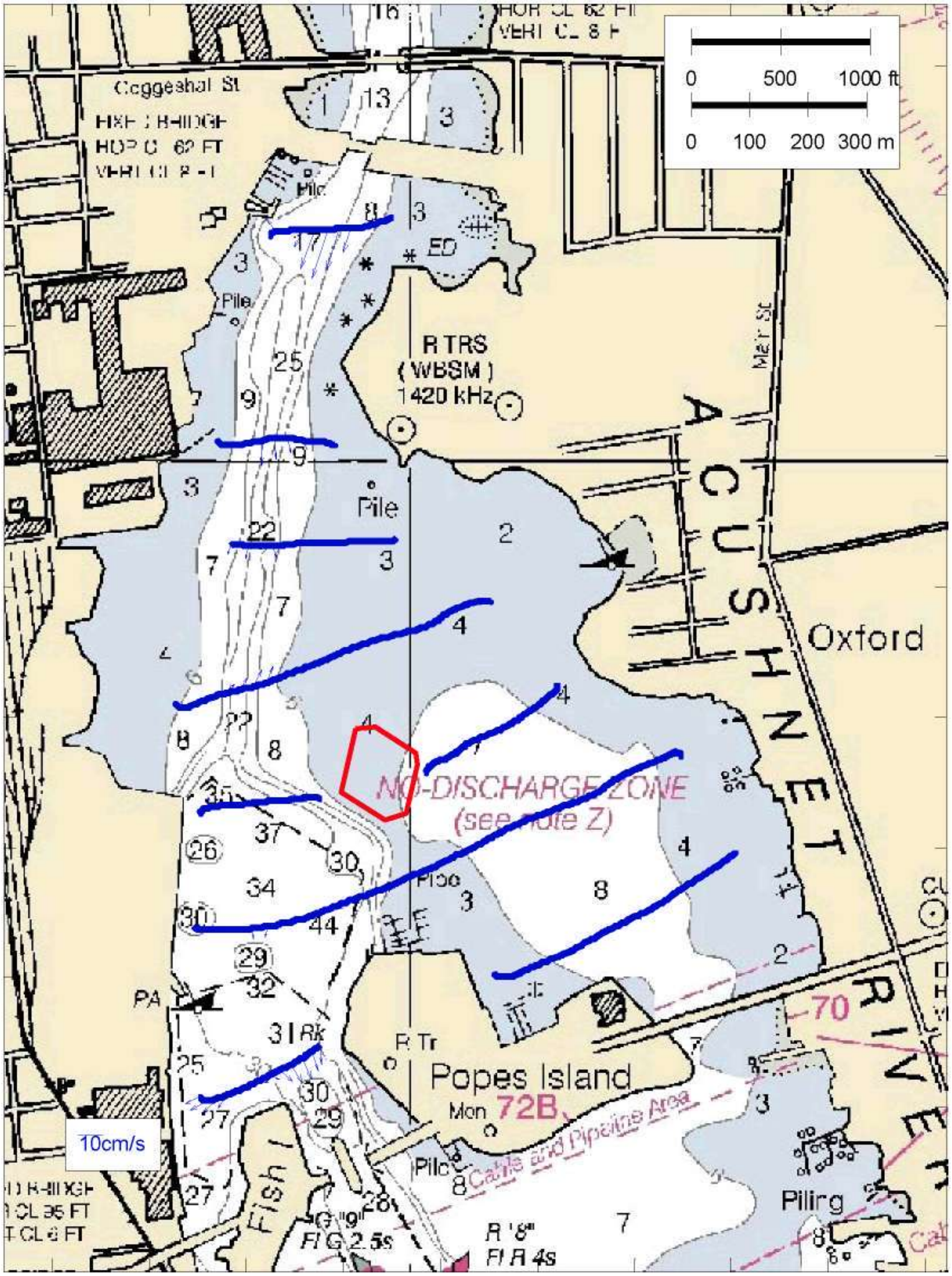
2 HOURS AFTER HIGH SLACK - Depth 2.23m



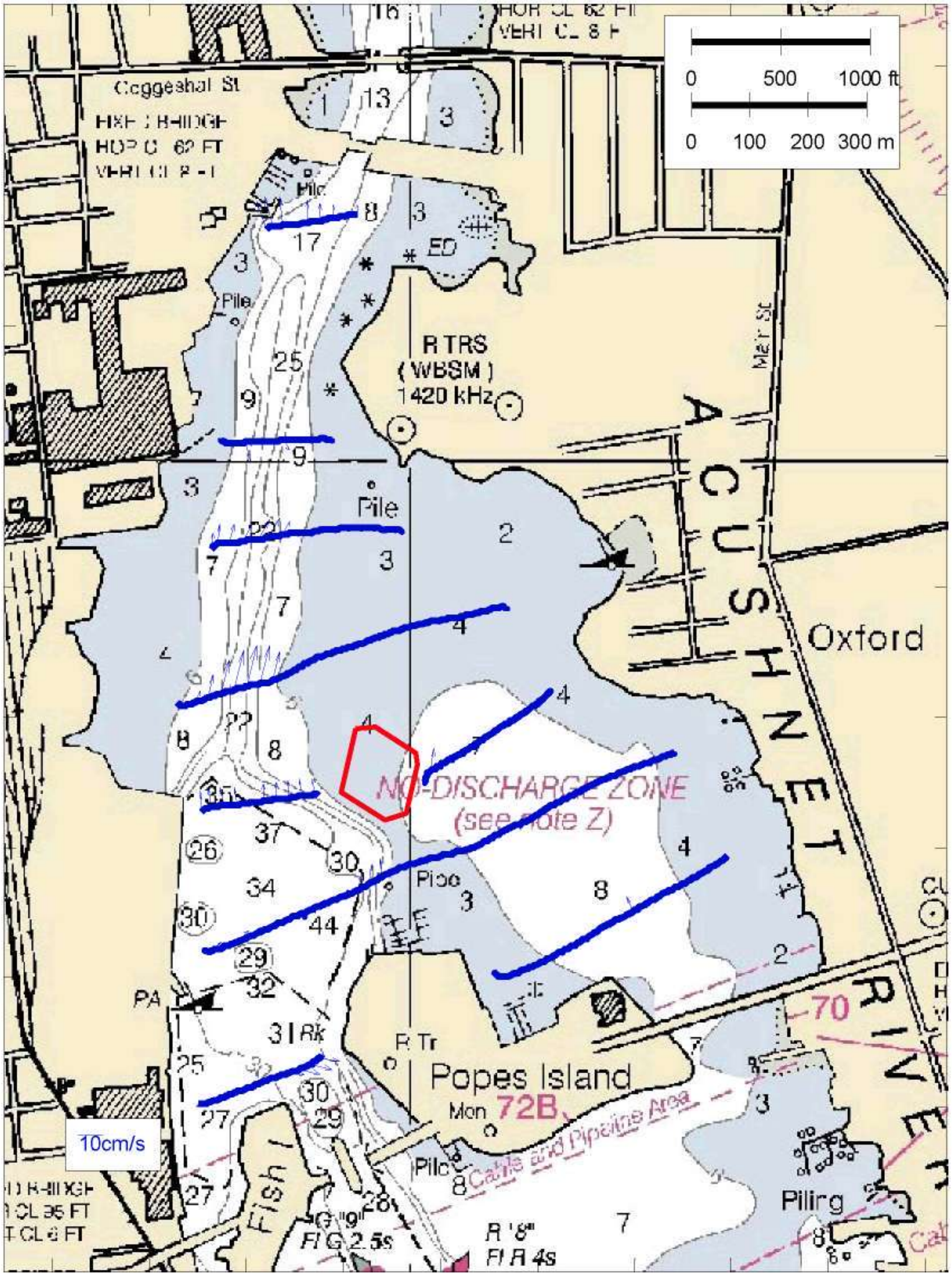
3 HOURS AFTER HIGH SLACK - Depth 2.24m



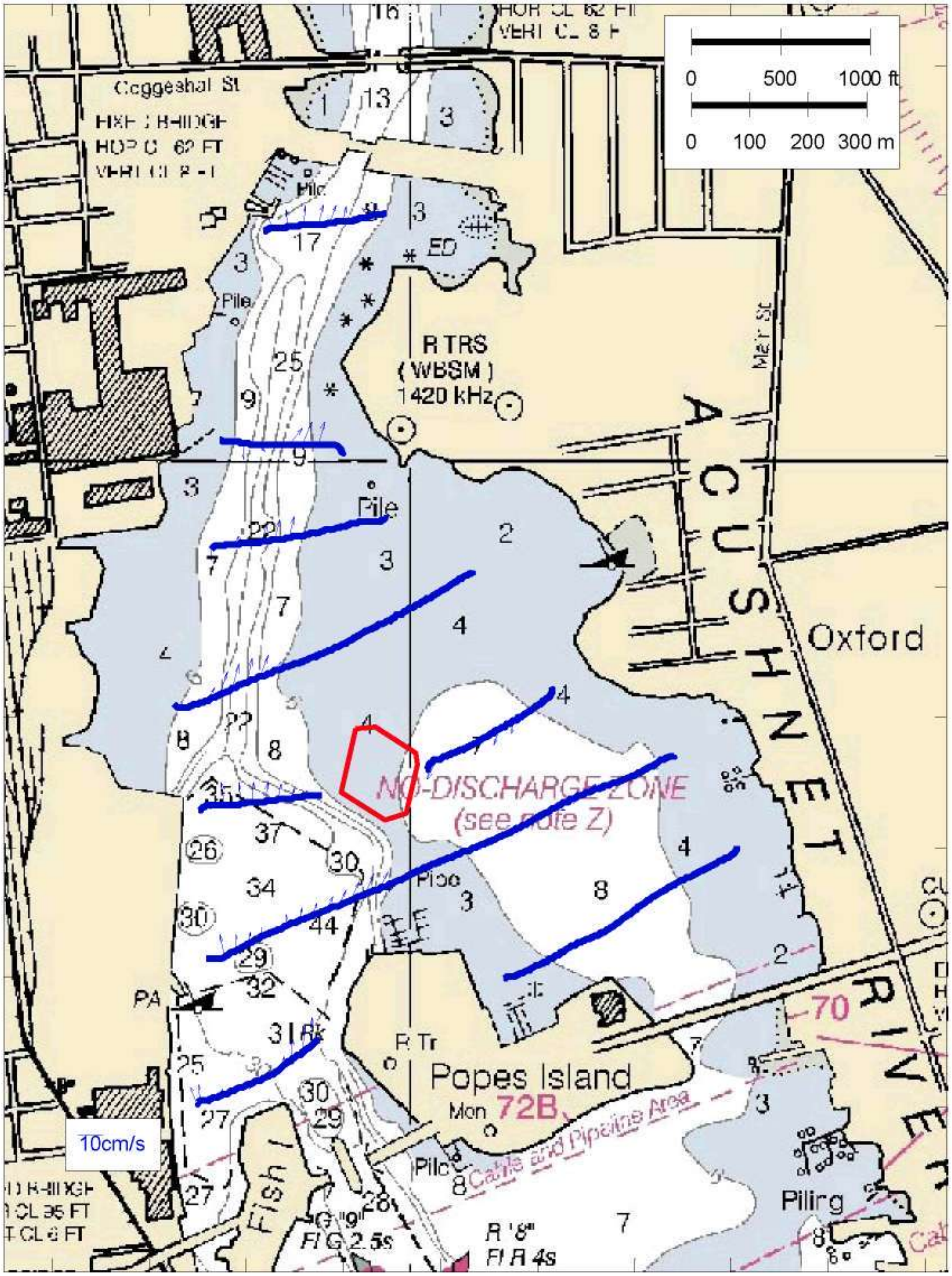
4 HOURS AFTER HIGH SLACK - Depth 2.24m



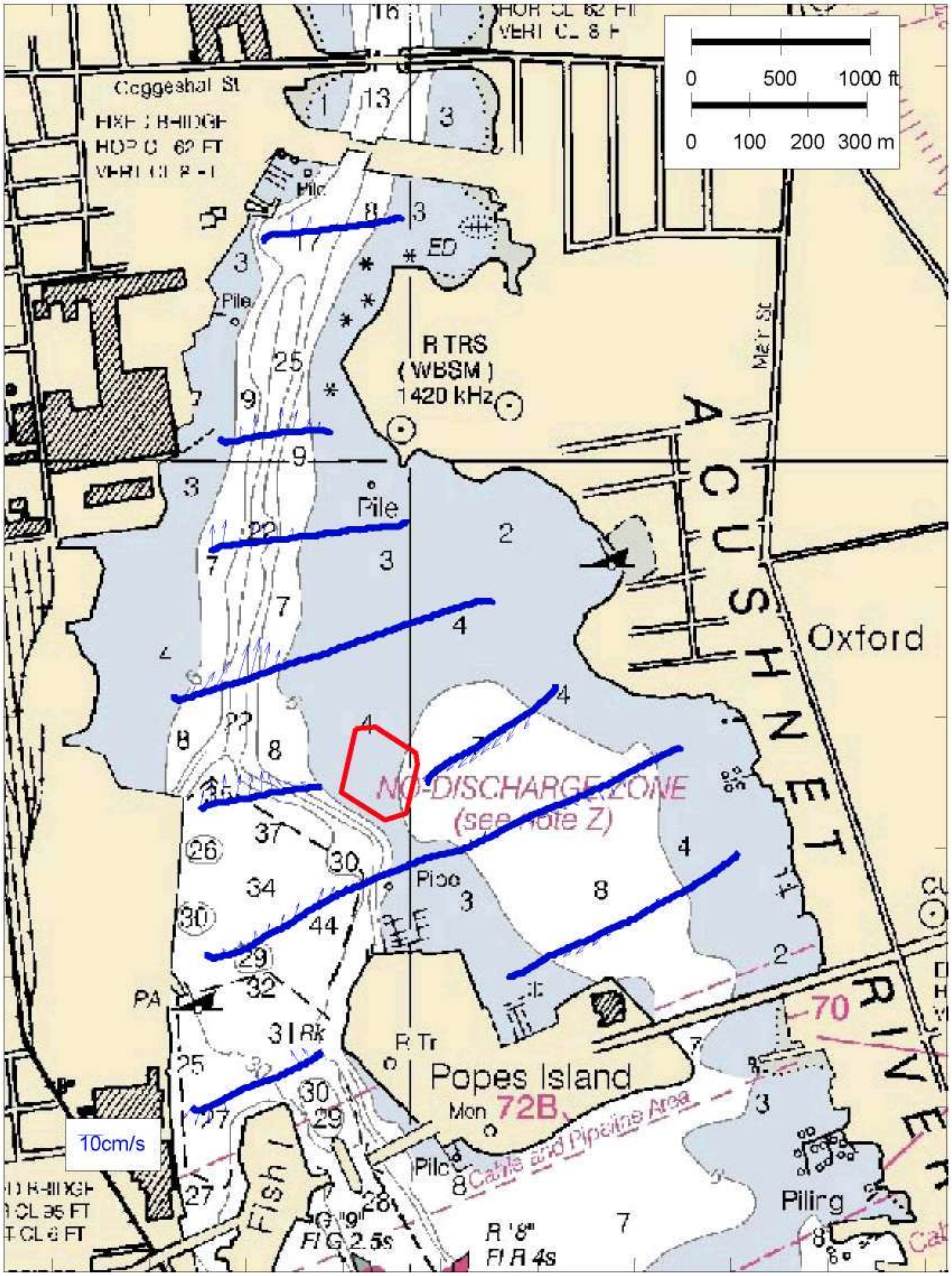
5 HOURS AFTER HIGH SLACK - Depth 2.24m



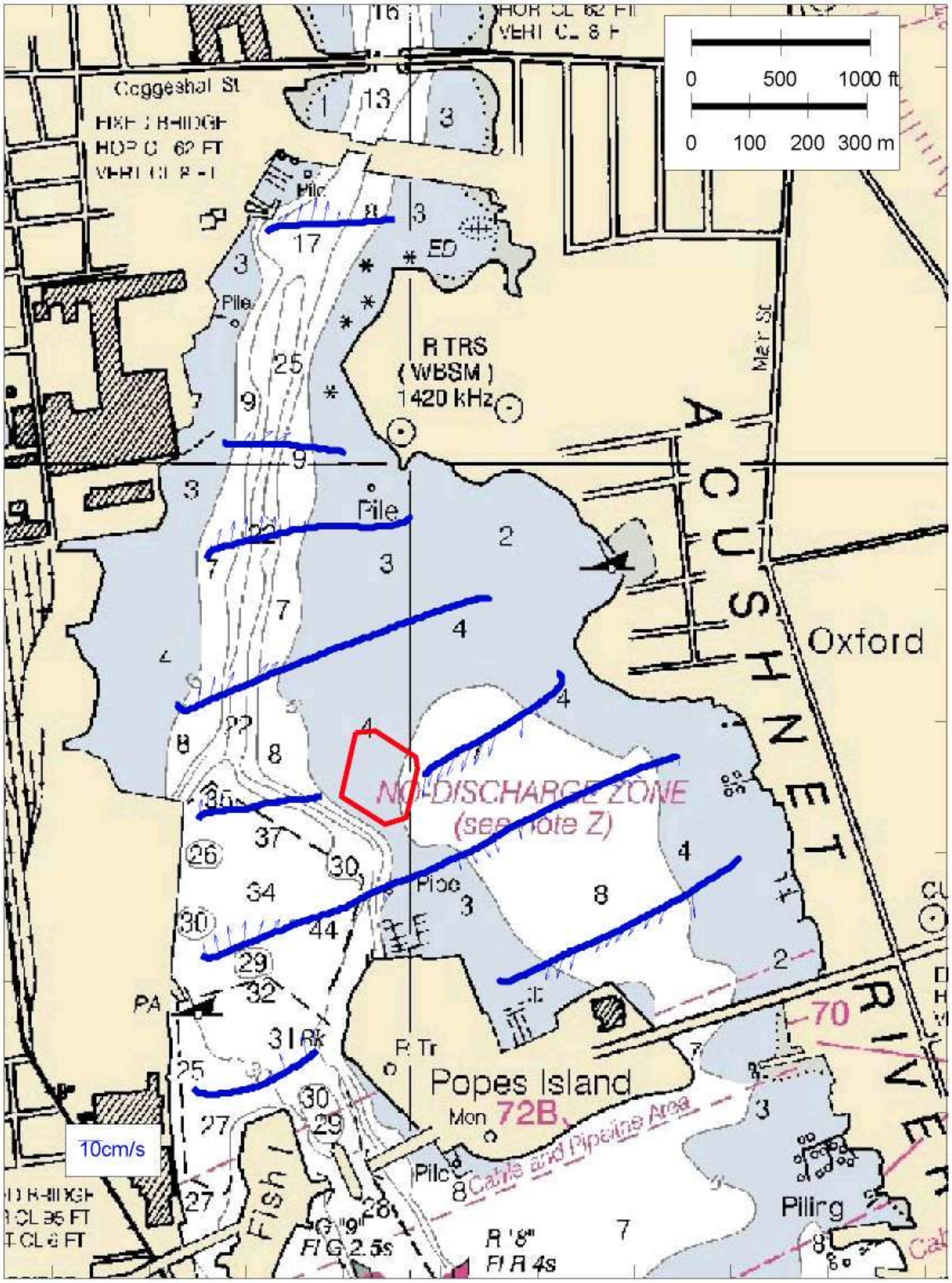
0.5 HOURS AFTER LOW SLACK - Depth 2.24m



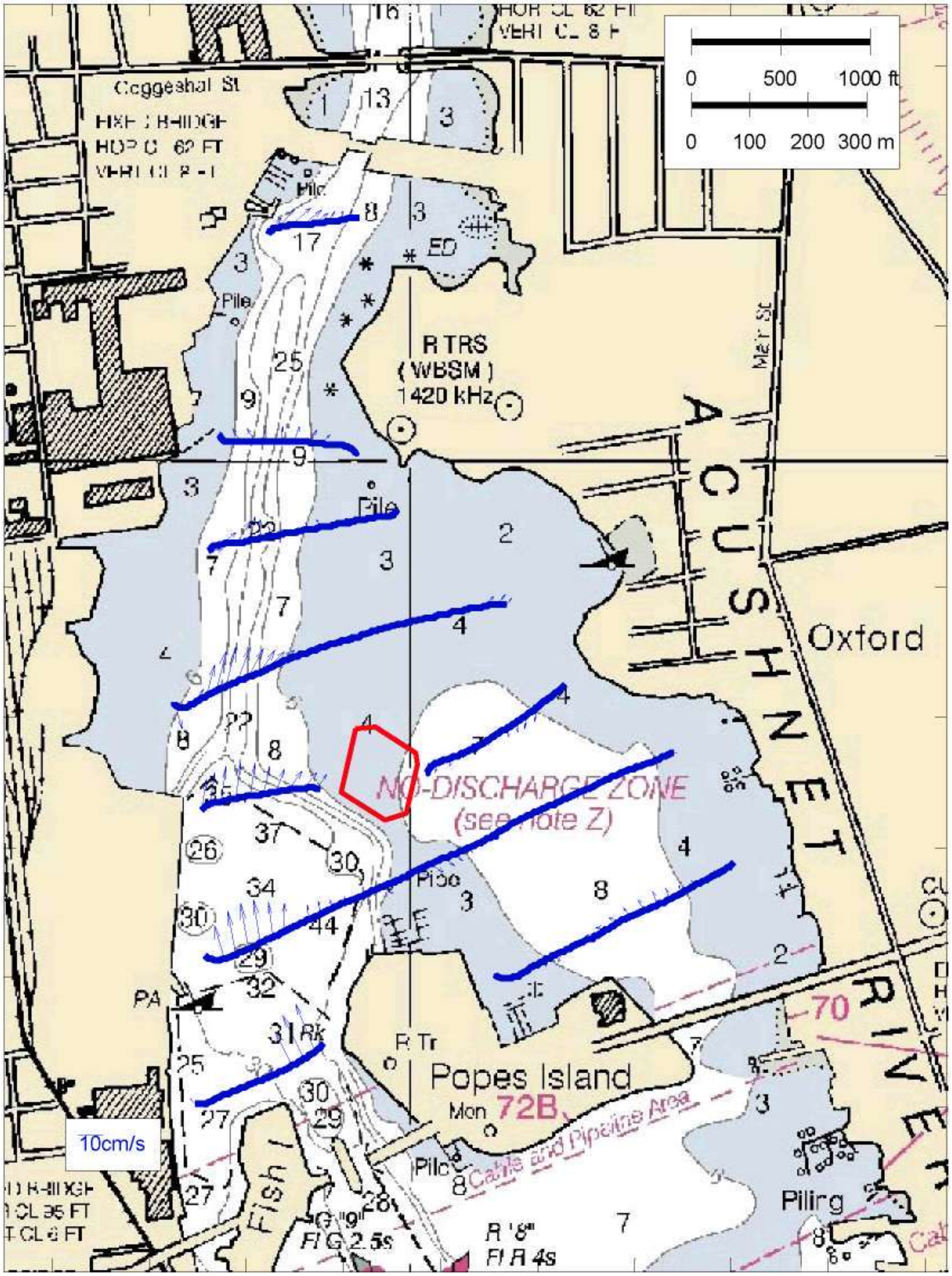
1.5 HOURS AFTER LOW SLACK - Depth 2.24m



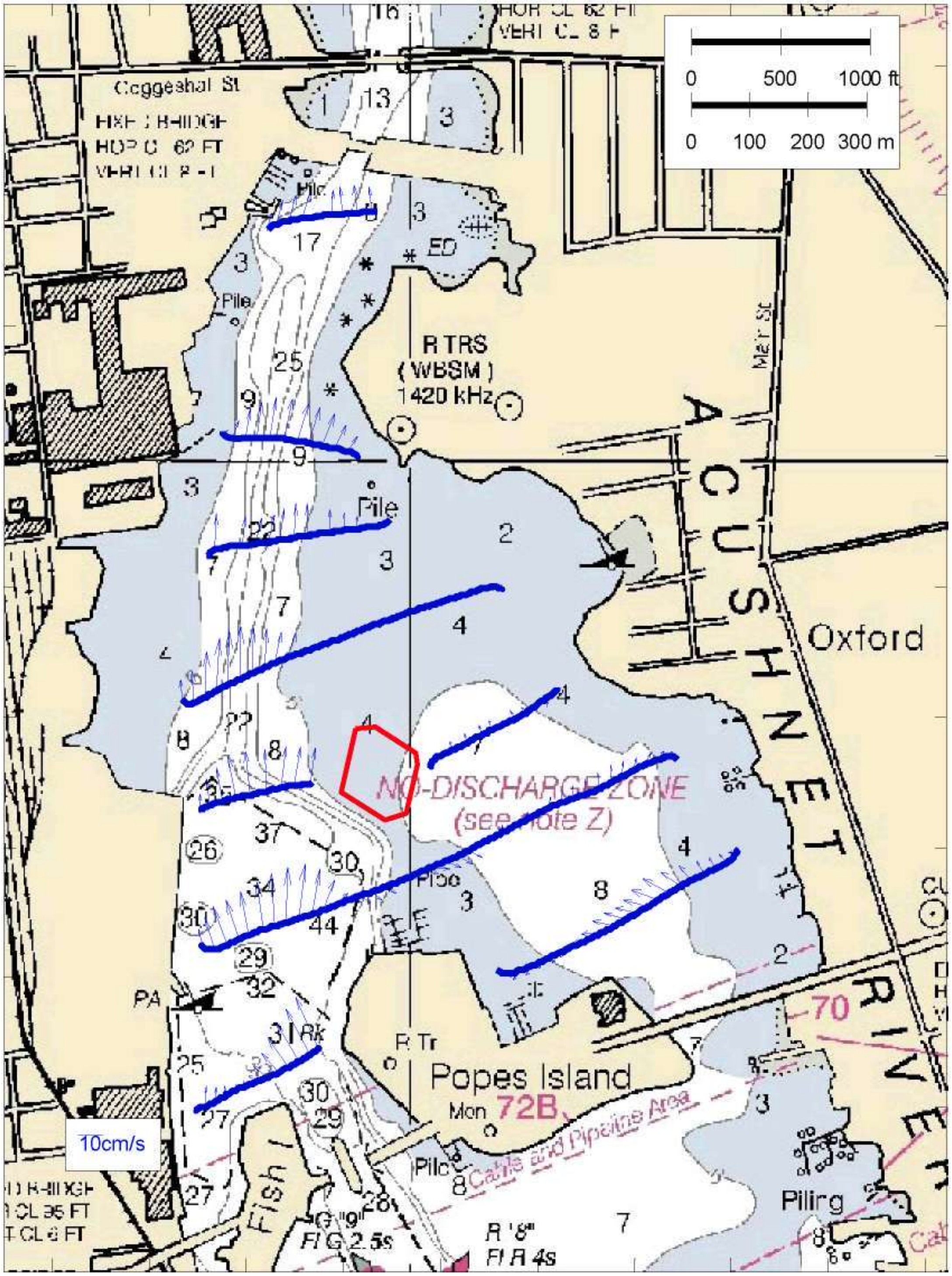
2.5 HOURS AFTER LOW SLACK - Depth 2.24m



3.5 HOURS AFTER LOW SLACK - Depth 2.24m



4.5 HOURS AFTER LOW SLACK - Depth 2.24m



APPENDIX B

New Bedford Harbor
Laboratory Turbidity and TSS Results
April 14, May 20, 21, 27, and July 8, 2009

New Bedford Harbor Laboratory Turbidity and TSS Results

Date	Time	Depth (ft)	Turbidity (NTU)	TSS (mg/L)	Station ID	Station Type	ADCP File Name
Event (NB1) Date: April 14, 2009							
Sea Quest – inside silt curtain							
4/14/2009	16:00	5	1.3	4.3	1460	North Reference	NB09A034.mat
4/14/2009	16:00	10	1.3	2.8	1460	North Reference	NB09A034.mat
4/14/2009	16:14	15	4.1	14.8	1461	South Reference	NB09A034.mat
4/14/2009	16:14	30	4.9	18.2	1461	South Reference	NB09A034.mat
4/14/2009	17:07	15	7.5	21.7	S019	Plume Lateral	NB09A035.mat
4/14/2009	17:07	30	25	44.9	S019	Plume Lateral	NB09A035.mat
4/14/2009	17:22	15	1.9	5.5	S020	Plume Lateral	NB09A036.mat
4/14/2009	17:22	30	94	152	S020	Plume Lateral	NB09A036.mat
4/14/2009	17:40	4	1.5	4	S021	Plume Centroid	NB09A036.mat
4/14/2009	17:40	8	1.5	3.5	S021	Plume Centroid	NB09A036.mat
Gale Force – outside silt curtain							
4/14/2009	15:55	9	3	4.6	17	North Reference	NB09B014.mat
4/14/2009	15:55	18	1.9	11.5	17	North Reference	NB09B014.mat
4/14/2009	16:17	4	1.7	5.8	18	South Reference	NB09B015.mat
4/14/2009	16:17	9	1.3	2.8	18	South Reference	NB09B015.mat
4/14/2009	17:01	4	1.3	3	19	Plume Centroid	NB09B018.mat
4/14/2009	17:01	8	1.5	3.7	19	Plume Centroid	NB09B018.mat
4/14/2009	17:05	4	1.3	3.8	20	Plume Lateral	NB09B018.mat
4/14/2009	17:05	2	1.6	2.5	20	Plume Lateral	NB09B019.mat
4/14/2009	17:10	4	1.2	3	21	Plume Lateral	NB09B019.mat
4/14/2009	17:10	2	0.95	4.8	21	Plume Lateral	NB09B019.mat
4/14/2009	17:12	2	1.3	2.2	22	Dup	NB09B019.mat
Event (NB2) Date: May 20, 2009							
Sea Quest – inside silt curtain							
5/20/2009	7:40	5	1.7	7.8	1460	North Reference	NB09A043.mat

New Bedford Harbor Laboratory Turbidity and TSS Results

Date	Time	Depth (ft)	Turbidity (NTU)	TSS (mg/L)	Station ID	Station Type	ADCP File Name
5/20/2009	7:40	9	2.1	7.7	1460	North Reference	NB09A043.mat
5/20/2009	8:10	15	17	54.8	S023	Plume Centroid	NB09A045.mat
5/20/2009	8:10	30	84	226	S023	Plume Centroid	NB09A045.mat
5/20/2009	8:25	10	3.4	15.3	S025	Plume Lateral	NB09A047.mat
5/20/2009	8:25	18	33	97.1	S025	Plume Lateral	NB09A047.mat
5/20/2009	8:38	15	20	45.1	S026	Plume Lateral	NB09A049.mat
5/20/2009	8:38	30	43	103	S026	Plume Lateral	NB09A049.mat
5/20/2009	9:45	12	1.8	6.3	S027	South Reference	NB09A054.mat
5/20/2009	9:45	25	1.3	6.3	S027	South Reference	NB09A054.mat
Gale Force – outside silt curtain							
5/20/2009	7:43	9	2.2	5.2	26	North Reference	NB09B023.mat
5/20/2009	7:43	17	2.1	2.5	26	North Reference	NB09B023.mat
5/20/2009	8:24	5	1.8	5.7	28	Plume Lateral	NB09B025.mat
5/20/2009	8:24	3	1.9	3.7	28	Plume Lateral	NB09B025.mat
5/20/2009	8:27	6	2	1.8	29	Plume Lateral	NB09B025.mat
5/20/2009	8:27	3	1.6	3.5	29	Plume Lateral	NB09B025.mat
5/20/2009	8:31	5	2.4	5.8	30	Plume Centroid	NB09B025.mat
5/20/2009	8:31	10	1.9	6.5	30	Plume Centroid	NB09B025.mat
5/20/2009	9:42	3	1.7	2.5	32	South Reference	NB09B025.mat
5/20/2009	9:42	3	1.6	1.8	32	South Reference	NB09B025.mat
5/20/2009	9:42	6	1.6	6.3	32	South Reference	NB09B025.mat
Event (NB3) Date: May 21, 2009							
Sea Quest – inside silt curtain							
5/21/2009	7:03	5	1.7	7.3	S028	North Reference	NB09A057.mat
5/21/2009	7:03	8	2	6	S028	North Reference	NB09A057.mat
5/21/2009	7:19	15	1.3	6.3	S029	South Reference	NB09A058.mat
5/21/2009	7:19	28	1.6	4.5	S029	South Reference	NB09A058.mat
5/21/2009	8:27	16	37	99.5	S031	Plume Centroid	NB09A062.mat

New Bedford Harbor Laboratory Turbidity and TSS Results

Date	Time	Depth (ft)	Turbidity (NTU)	TSS (mg/L)	Station ID	Station Type	ADCP File Name
5/21/2009	8:27	30	160	278	S031	Plume Centroid	NB09A062.mat
5/21/2009	8:40	15	8.9	26.8	S032	Plume Lateral	NB09A064.mat
5/21/2009	8:40	26	77	133	S032	Plume Lateral	NB09A064.mat
5/21/2009	8:52	13	4	10	S033	Plume Lateral	NB09A065.mat
5/21/2009	8:52	25	46	99.7	S033	Plume Lateral	NB09A065.mat
Gale Force – outside silt curtain							
5/21/2009	7:01	10	2	5.2	34	North Reference	NB09B029.mat
5/21/2009	7:01	20	2	8.7	34	North Reference	NB09B029.mat
5/21/2009	7:15	9	1.8	4.2	36	South Reference	NB09B029.mat
5/21/2009	7:15	5	1.5	5.4	36	South Reference	NB09B029.mat
5/21/2009	8:31	9	6.2	20	38	Plume Lateral	NB09B031.mat
5/21/2009	8:31	18	11	31.8	38	Plume Lateral	NB09B031.mat
5/21/2009	8:31	9	6.5	15.2	38	Plume Lateral-dup	NB09B031.mat
5/21/2009	8:36	15	1.6	4.8	39	Plume Lateral	NB09B031.mat
5/21/2009	8:36	30	1.4	6.5	39	Plume Lateral	NB09B031.mat
5/21/2009	8:45	15	4	7.3	40	Plume Centroid	NB09B031.mat
5/21/2009	8:45	30	1.7	5.5	40	Plume Centroid	NB09B031.mat
Event (NB4) Date: May 27, 2009							
Sea Quest – inside silt curtain							
5/27/2009	7:17	5	2.5	4.3	S034	North Reference	NB09A073.mat
5/27/2009	7:17	8	2.6	6.5	S034	North Reference	NB09A073.mat
5/27/2009	7:34	12	2.4	2.7	S035	South Reference	NB09A074.mat
5/27/2009	7:34	24	1.6	3.3	S035	South Reference	NB09A074.mat
5/27/2009	8:25	8	2.6	5.8	S036	Plume Centroid	NB09A078.mat
5/27/2009	8:25	18	97	442	S036	Plume Centroid	NB09A078.mat
5/27/2009	8:43	16	16	86.5	S038	Plume Lateral	NB09A080.mat
5/27/2009	8:43	30	9.1	165	S038	Plume Lateral	NB09A080.mat
5/27/2009	9:01	15	42	41.8	S039	Plume Lateral	NB09A082.mat

Date	Time	Depth (ft)	Turbidity (NTU)	TSS (mg/L)	Station ID	Station Type	ADCP File Name
5/27/2009	9:01	30	40	101	S039	Plume Lateral	NB09A082.mat
Gale Force – outside silt curtain							
5/27/2009	7:15	13	2.2	4.2	42	North Reference	NB09B037.mat
5/27/2009	7:15	7	3.2	3	42	North Reference	NB09B037.mat
5/27/2009	7:15	7	2.6	6.3	42	North Reference-dup	NB09B037.mat
5/27/2009	7:34	4	2.1	1.7	44	South Reference	NB09B037.mat
5/27/2009	7:34	8	1.8	1.6	44	South Reference	NB09B037.mat
5/27/2009	8:33	4	3.2	7.8	45	Plume Lateral	NB09B041.mat
5/27/2009	8:33	8	19	50.6	45	Plume Lateral	NB09B041.mat
5/27/2009	8:42	8	2.8	14.7	47	Plume Centroid	NB09B041.mat
5/27/2009	8:42	4	2.5	5	47	Plume Centroid	NB09B041.mat
5/27/2009	8:56	3	3.9	9	48	Plume Lateral	NB09B041.mat
5/27/2009	8:56	7	3.8	13.7	48	Plume Lateral	NB09B041.mat
Event (NB5) Date: July 8, 2009							
Sea Quest – inside silt curtain							
7/8/2009	11:35	5	2.7	7.7	S040	North Reference	NB09A096.mat
7/8/2009	11:35	10	2.8	5.2	S040	North Reference	NB09A096.mat
7/8/2009	11:44	12	1.9	3.8	S041	South Reference	NB09A097.mat
7/8/2009	11:44	25	1.4	6.2	S041	South Reference	NB09A097.mat
7/8/2009	12:12	10	49	112	S042	Plume Centroid	NB09A100.mat
7/8/2009	12:12	20	12	39.8	S042	Plume Centroid	NB09A100.mat
7/8/2009	12:25	12	3.8	10	S043	Plume Lateral	NB09A102.mat
7/8/2009	12:25	25	21	65.3	S043	Plume Lateral	NB09A102.mat
7/8/2009	12:38	11	8.6	23	S044	Plume Lateral	NB09A104.mat
7/8/2009	12:38	20	33	36	S044	Plume Lateral	NB09A104.mat
Gale Force – outside silt curtain							
7/8/2009	11:29	6	2.7	6.6	55	North Reference	NB09B051.mat
7/8/2009	11:29	12	3.1	7.5	55	North Reference	NB09B051.mat

New Bedford Harbor Laboratory Turbidity and TSS Results

Date	Time	Depth (ft)	Turbidity (NTU)	TSS (mg/L)	Station ID	Station Type	ADCP File Name
7/8/2009	11:41	5	1.7	4.8	56	South Reference	NB09B052.mat
7/8/2009	11:41	9	2.1	4.7	56	South Reference	NB09B052.mat
7/8/2009	12:39	8	3.6	8	57	Plume Centroid	NB09B055.mat
7/8/2009	12:39	16	3	6.2	57	Plume Centroid	NB09B055.mat
7/8/2009	12:42	4	3.1	7.7	58	Plume Lateral	NB09B055.mat
7/8/2009	12:42	7	2.9	6.8	58	Plume Lateral	NB09B055.mat
7/8/2009	12:47	6	2.4	5.7	59	Plume Lateral	NB09B055.mat
7/8/2009	12:47	11	2.3	4.5	59	Plume Lateral	NB09B055.mat
7/8/2009	12:47	11	2.3	5.4	59	Plume Lateral-dup	NB09B055.mat

APPENDIX C

New Bedford Harbor
Observations of Turbidity
Measured with ADCP
April 14, May 20, 21, 27, and July 8, 2009

Part 1: Turbidity Survey April 14, 2009

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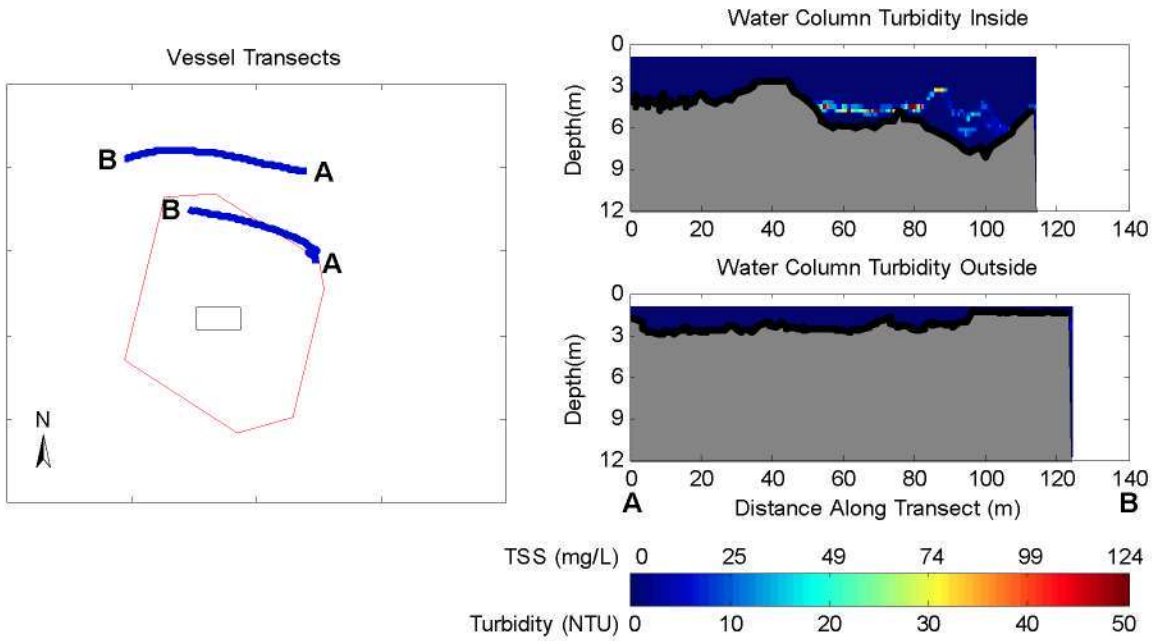

Figure 1-1. Observations Before Release During April 14, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

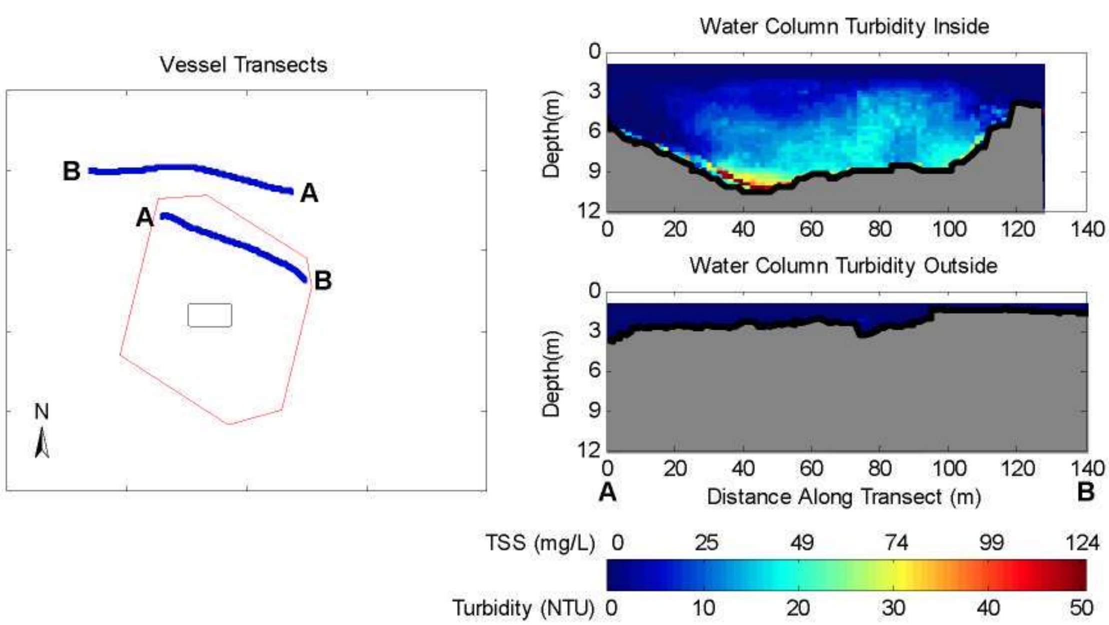

Figure 1-2. Observations from 8 to 11 Minutes after Release During April 14, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

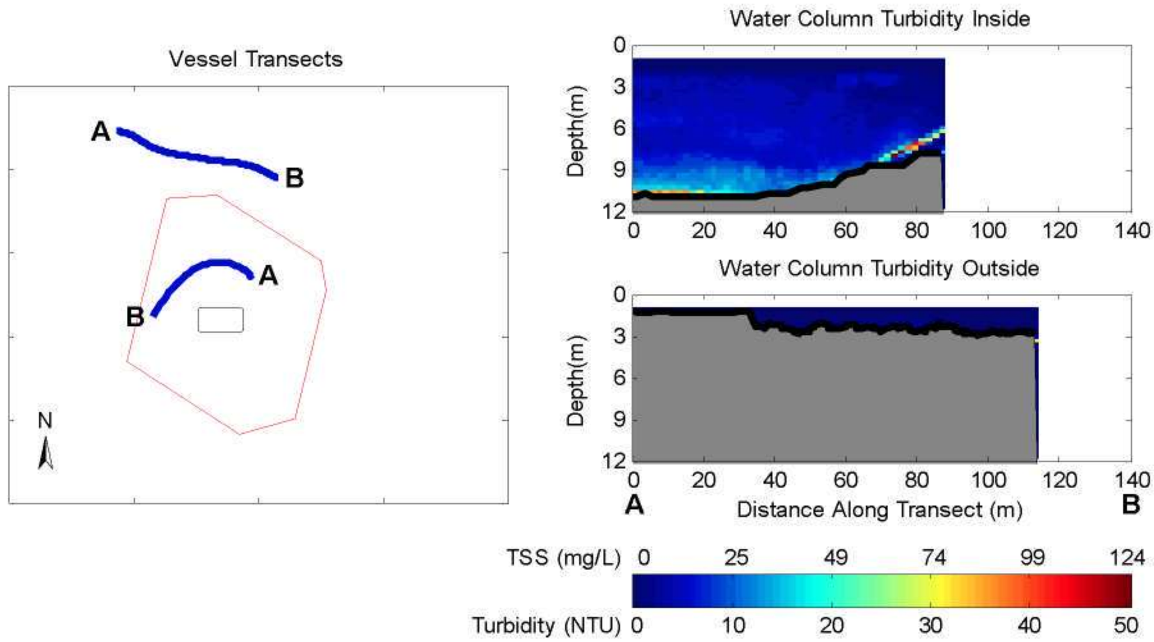

Figure 1-3. Observations from 19 to 22 Minutes after Release During April 14, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

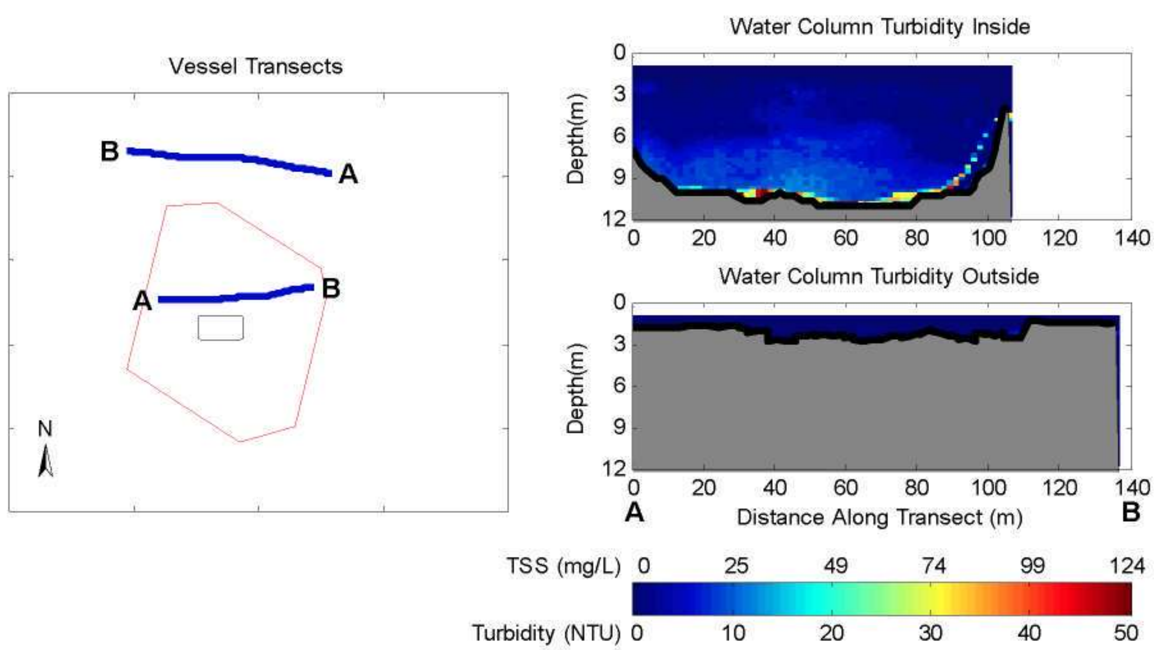

Figure 1-4. Observations from 27 to 39 Minutes after Release During April 14, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

New Bedford Harbor Turbidity Survey April 14, 2009

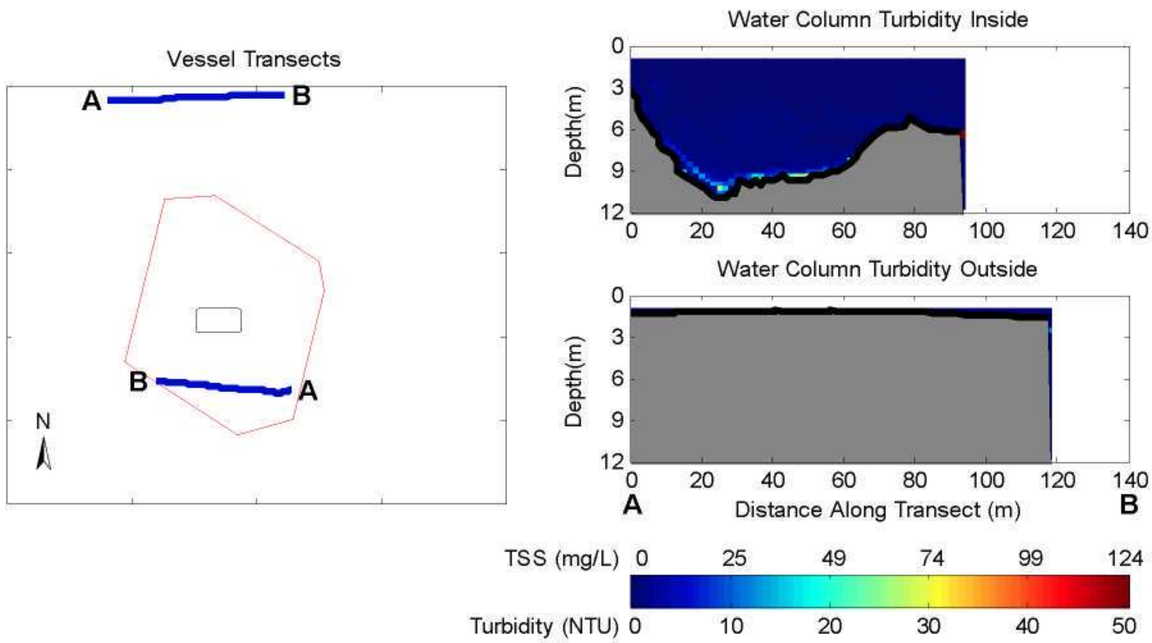

Figure 1-5. Observations from 40 to 44 Minutes after Release During April 14, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

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Part 2: Turbidity Survey May 20, 2009

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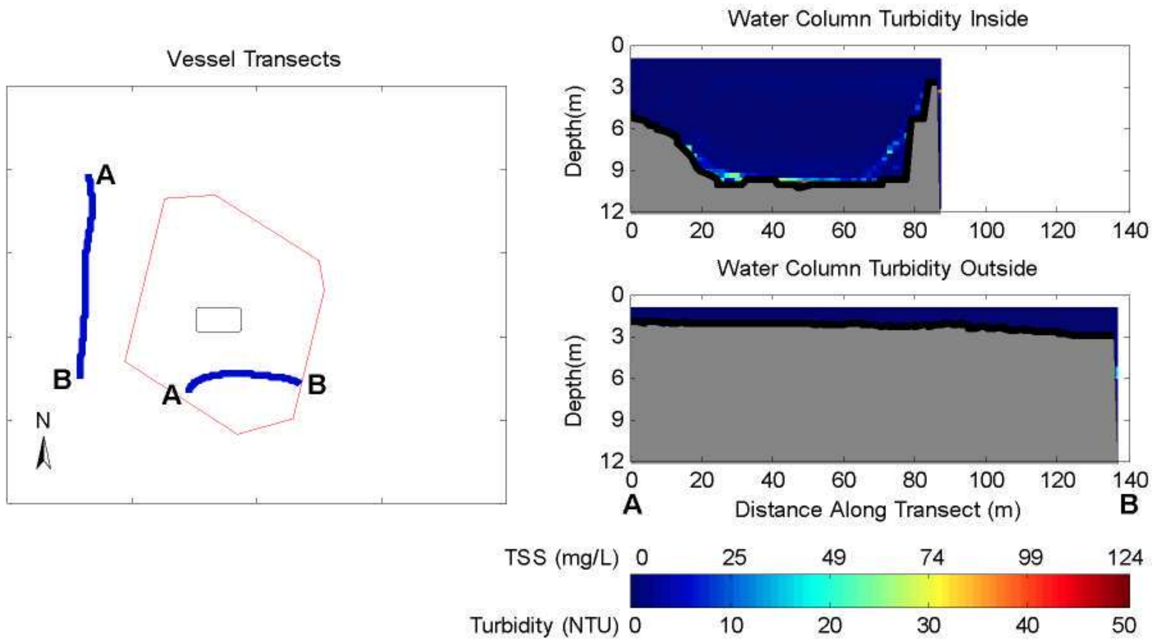

Figure 2-1. Observations Before Release During May 20, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

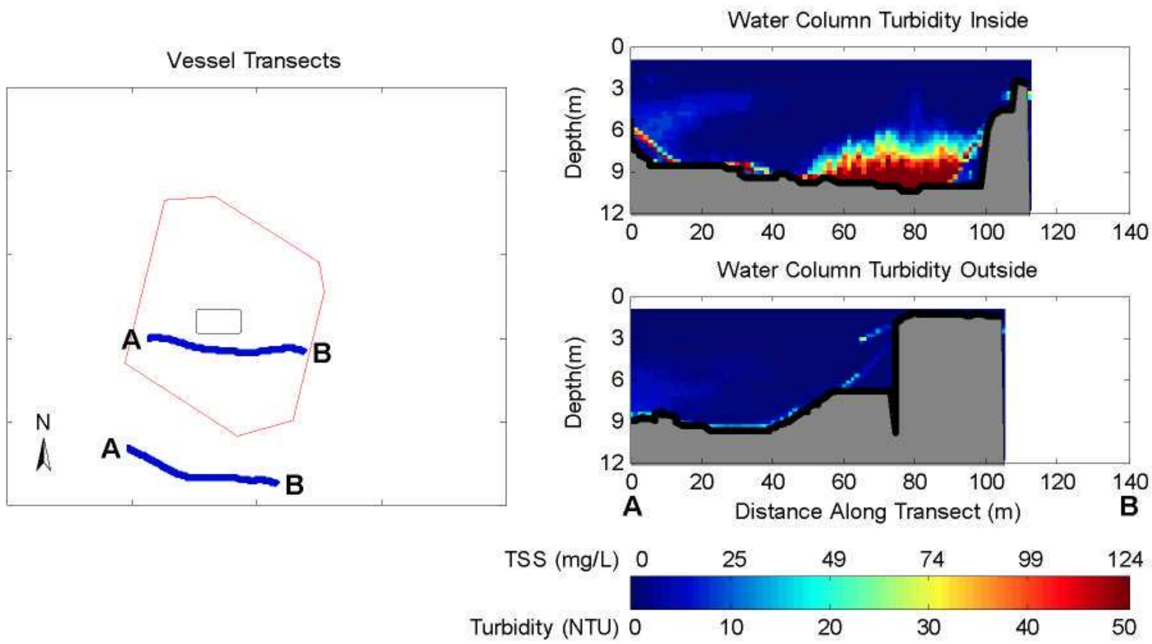

Figure 2-2. Observations from 3 to 6 Minutes after Release During May 20, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

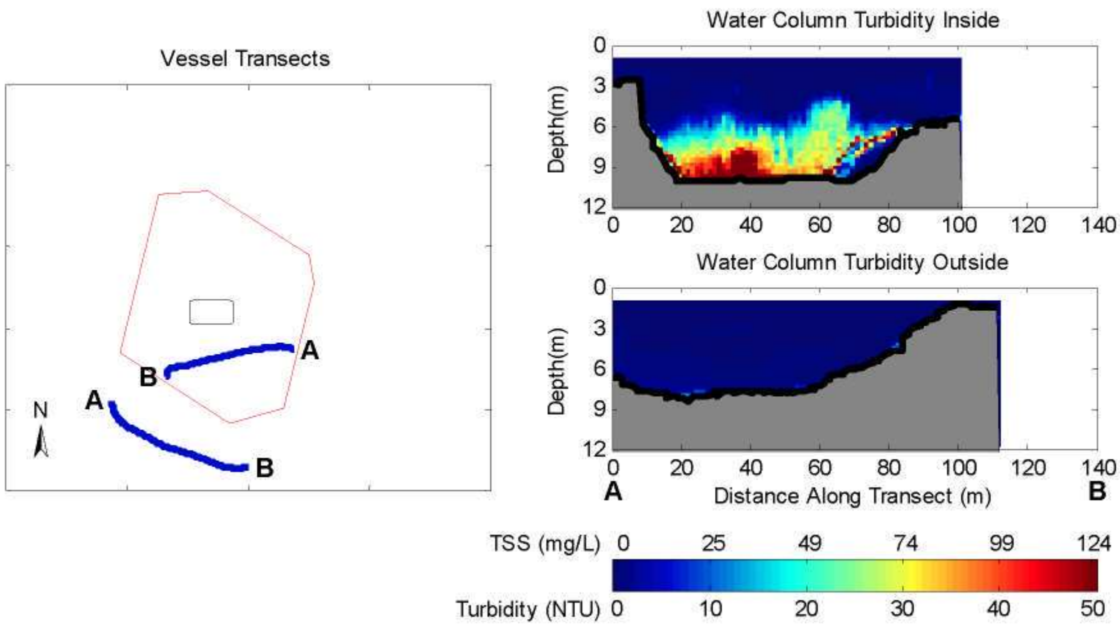

Figure 2-3. Observations from 10 to 12 Minutes after Release During May 20, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

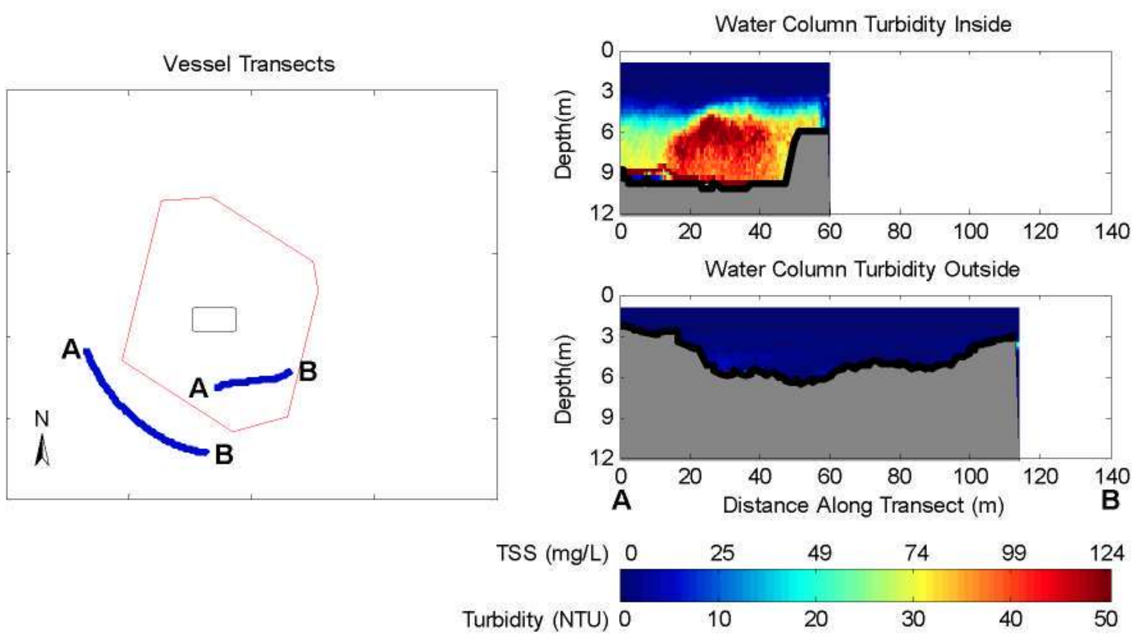

Figure 2-4. Observations from 18 to 24 Minutes after Release During May 20, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

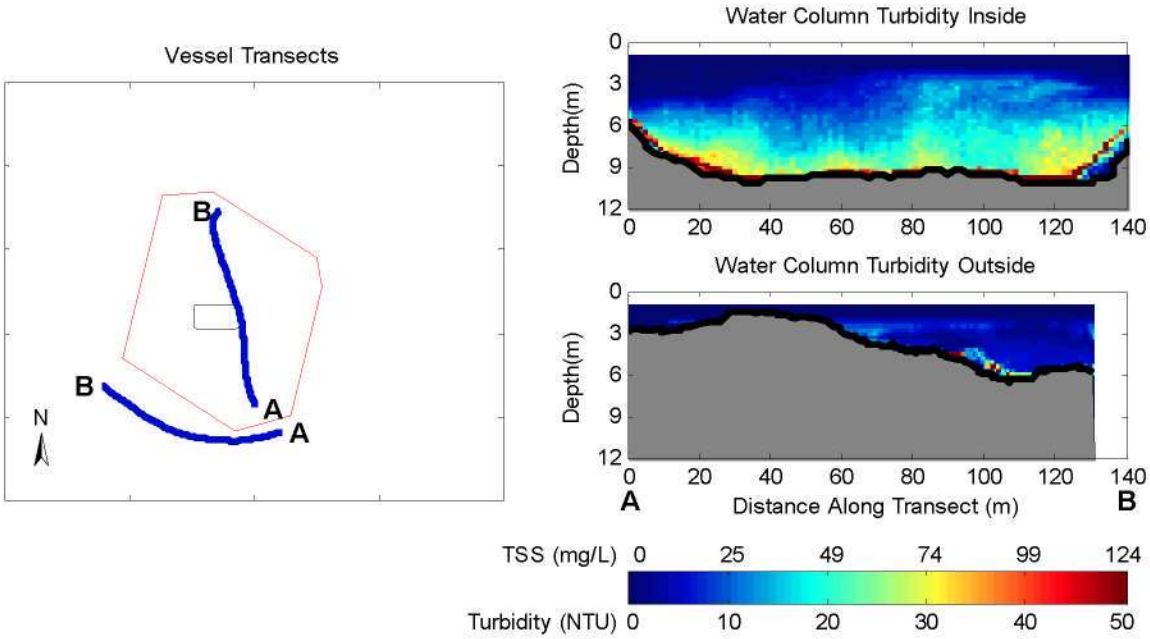

Figure 2-5. Observations from 39 to 43 Minutes after Release During May 20, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

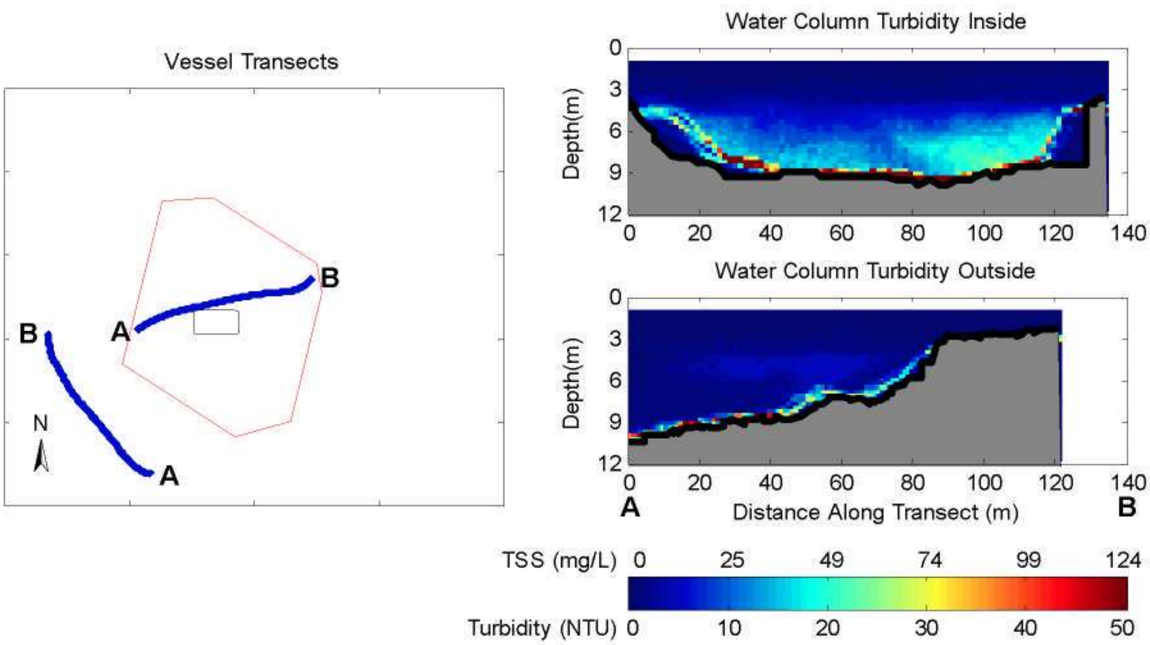

Figure 2-6. Observations from 55 to 57 Minutes after Release During May 20, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

New Bedford Harbor Turbidity Survey May 20, 2009

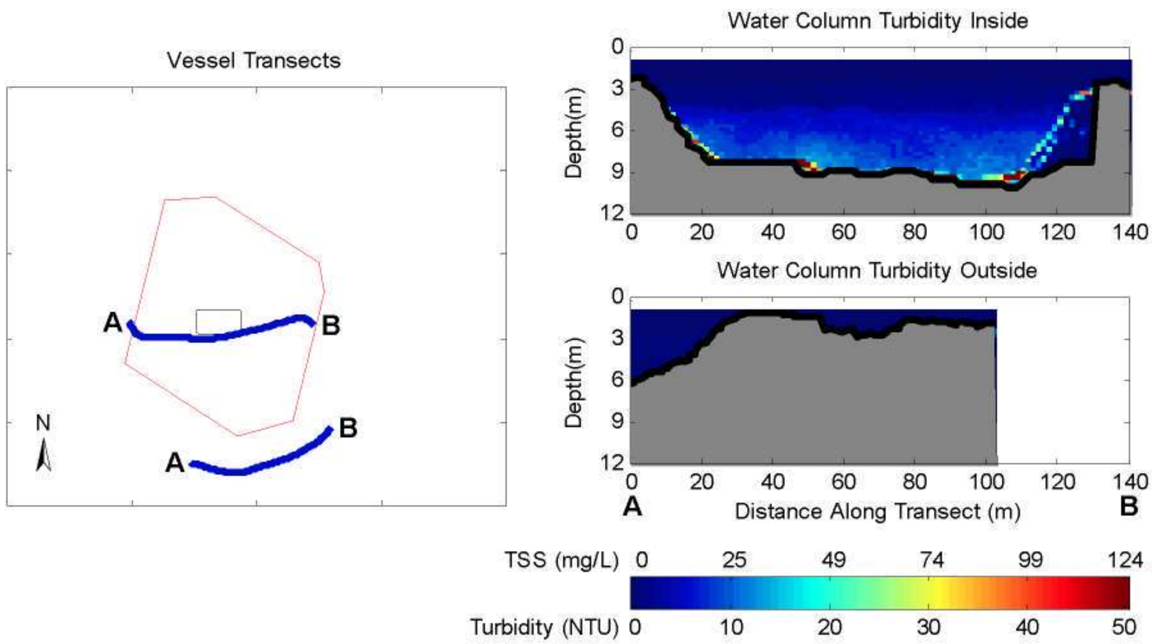

Figure 2-7. Observations from 84 to 87 Minutes after Release During May 20, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

Part 3: Turbidity Survey May 21, 2009

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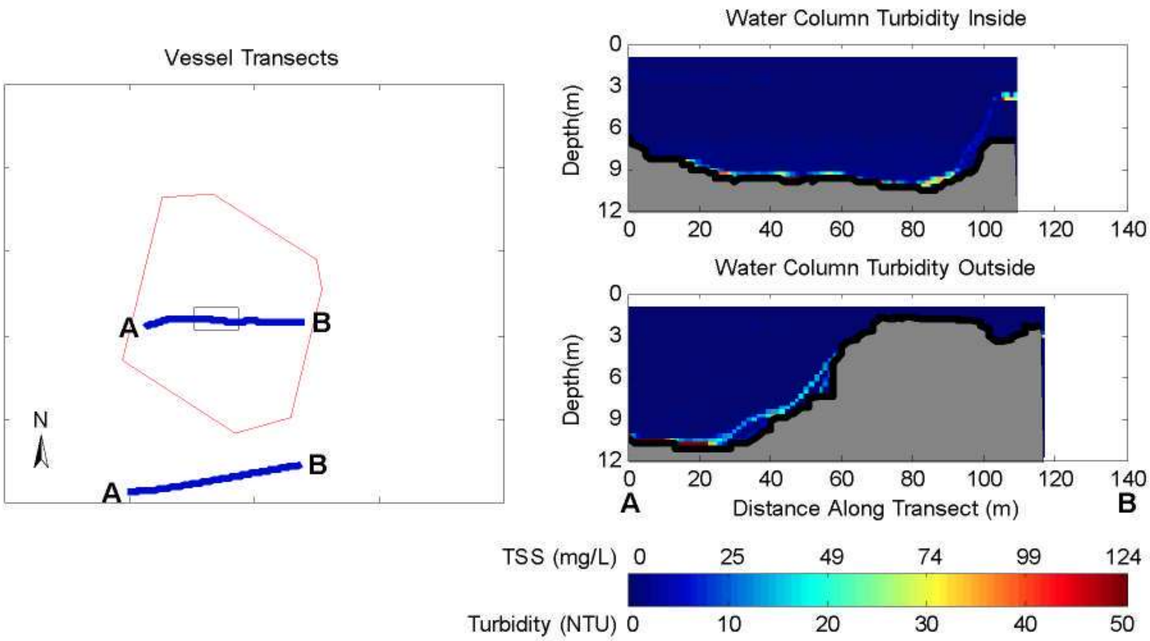

Figure 3-1. Observations Before Release During May 21, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

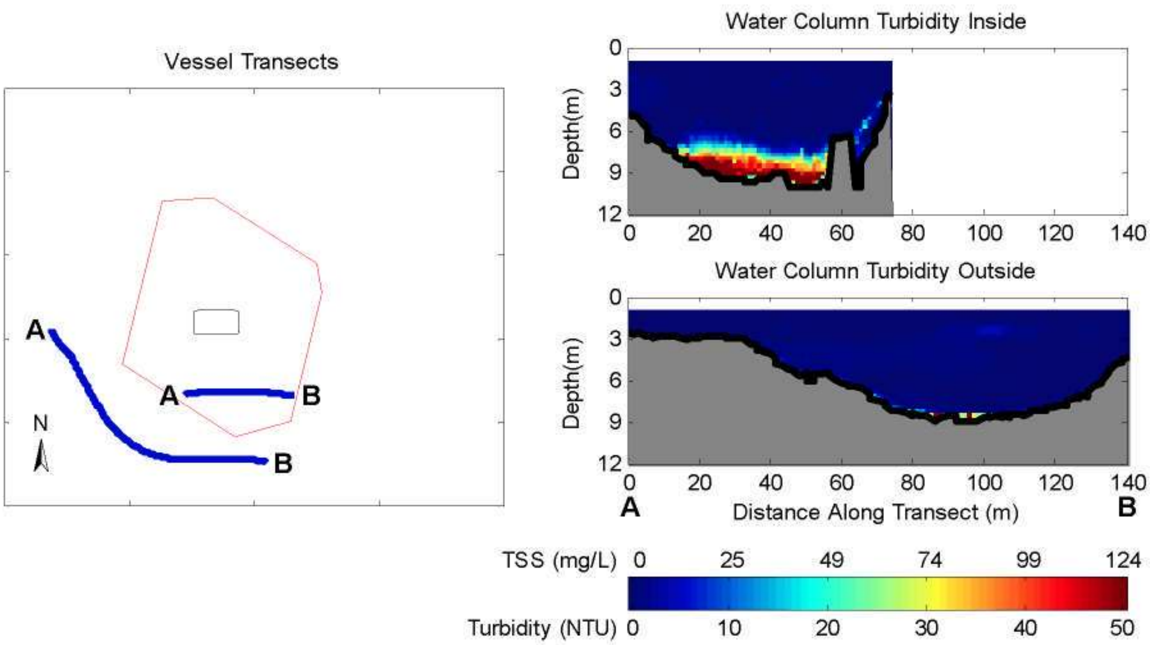

Figure 3-2. Observations from 1 to 6 Minutes after Release During May 21, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

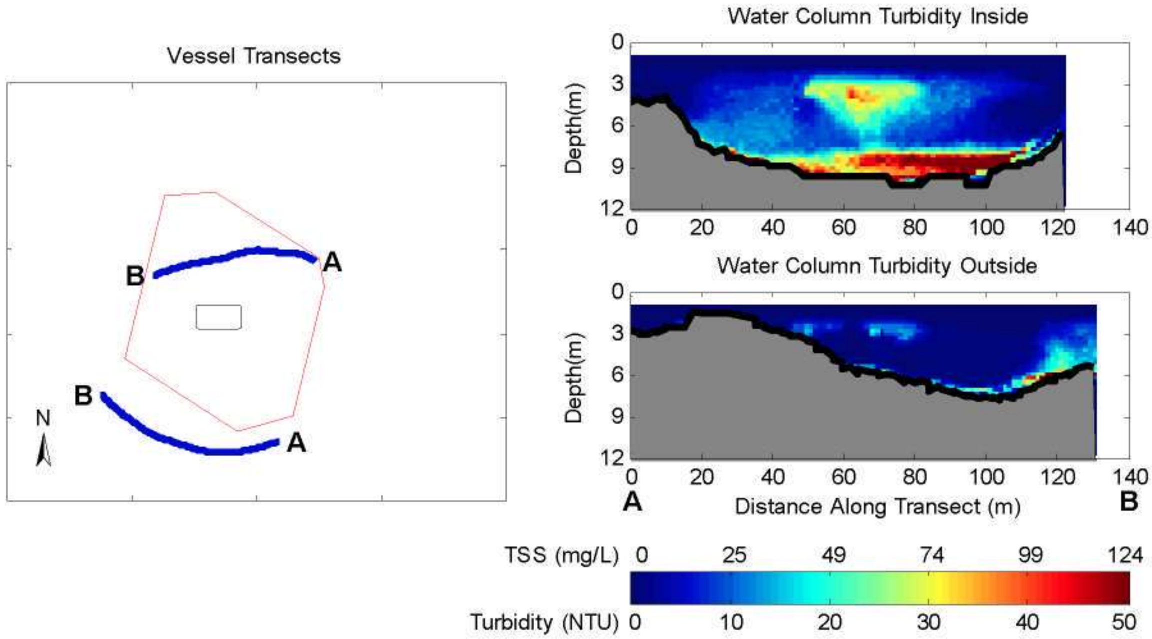

Figure 3-3. Observations from 5 to 9 Minutes after Release During May 21, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

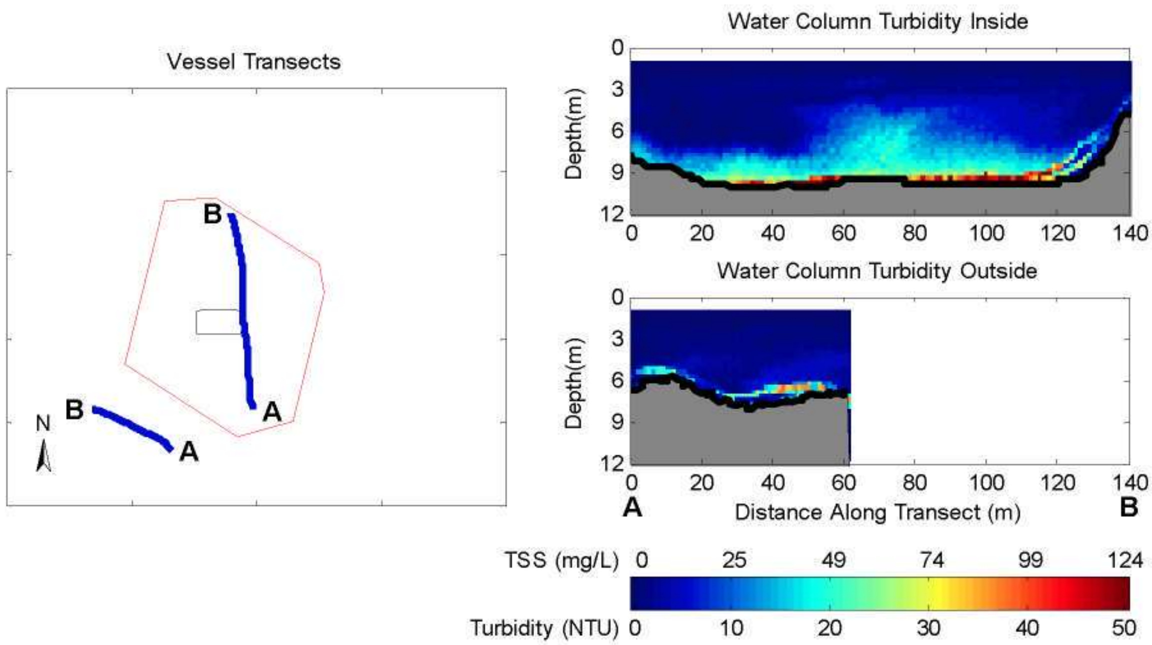

Figure 3-4. Observations from 18 to 21 Minutes after Release During May 21, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

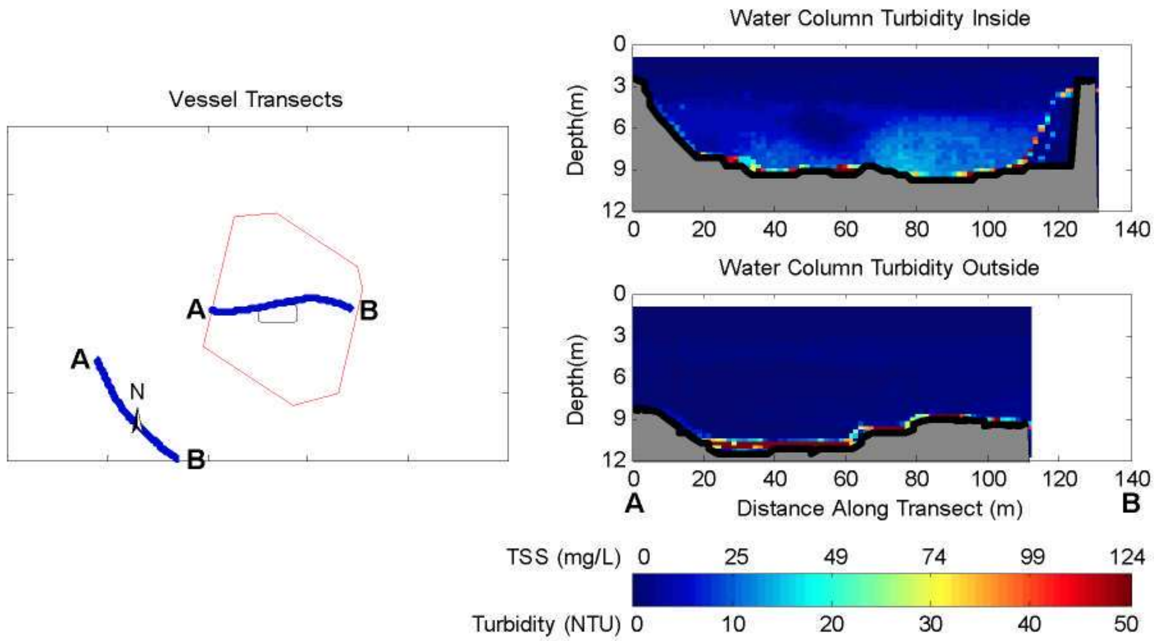

Figure 3-5. Observations from 39 to 42 Minutes after Release During May 21, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

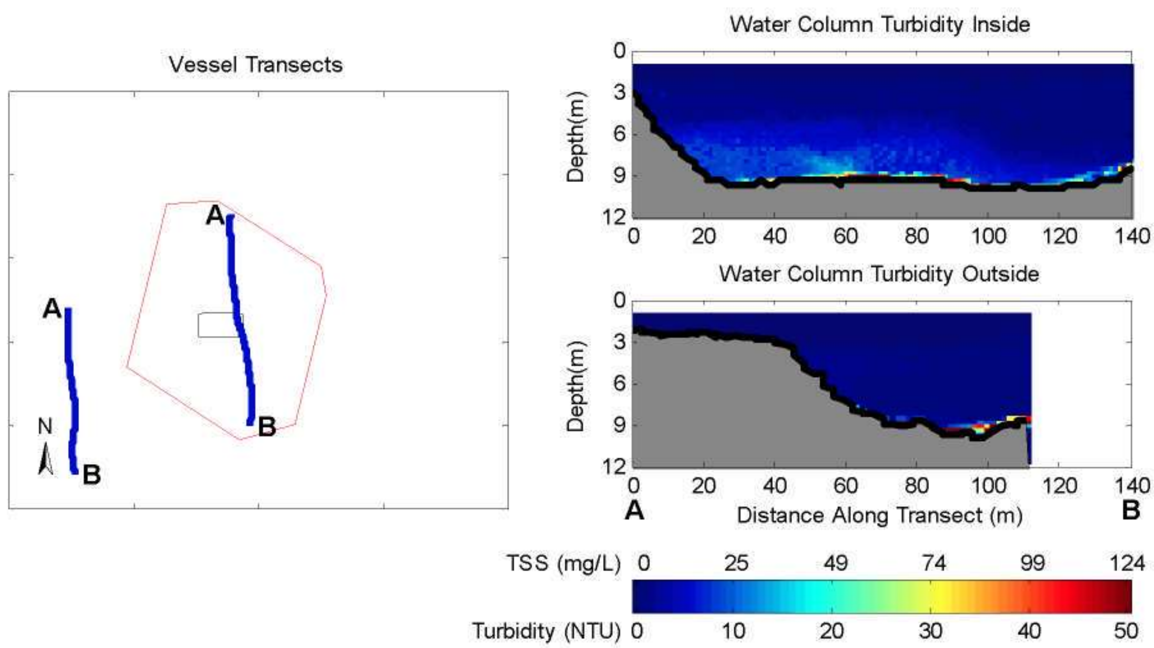

Figure 3-6. Observations from 51 to 54 Minutes after Release During May 21, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

Turbidity Survey May 21, 2009

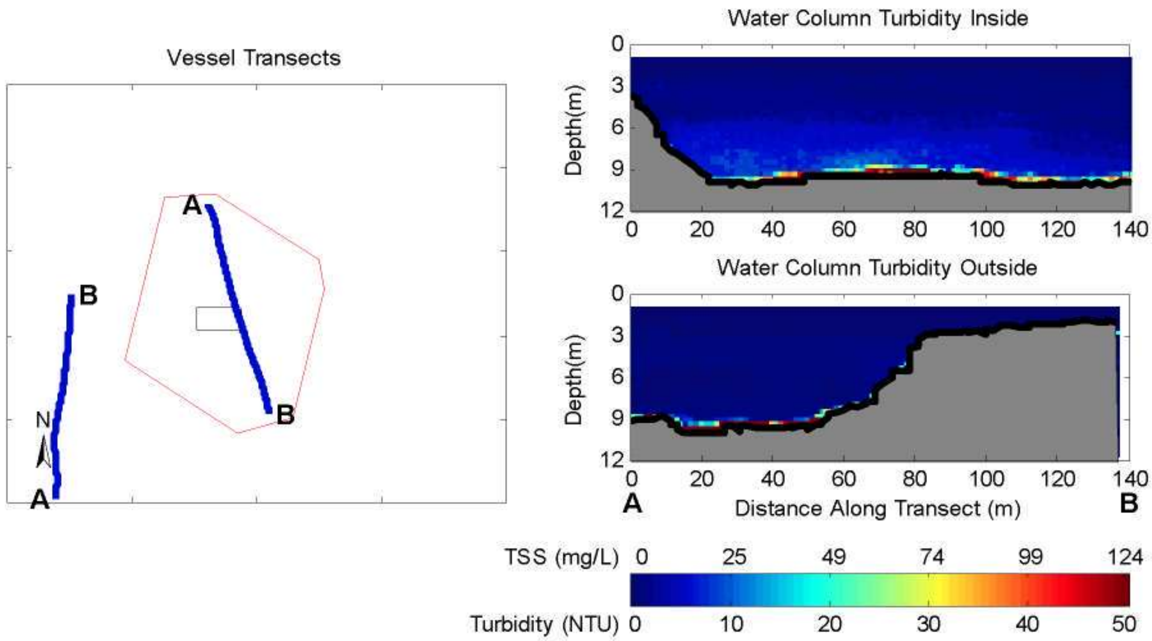

Figure 3-7. Observations from 57 to 59 Minutes after Release During May 21, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

Part 4: Turbidity Survey May 27, 2009

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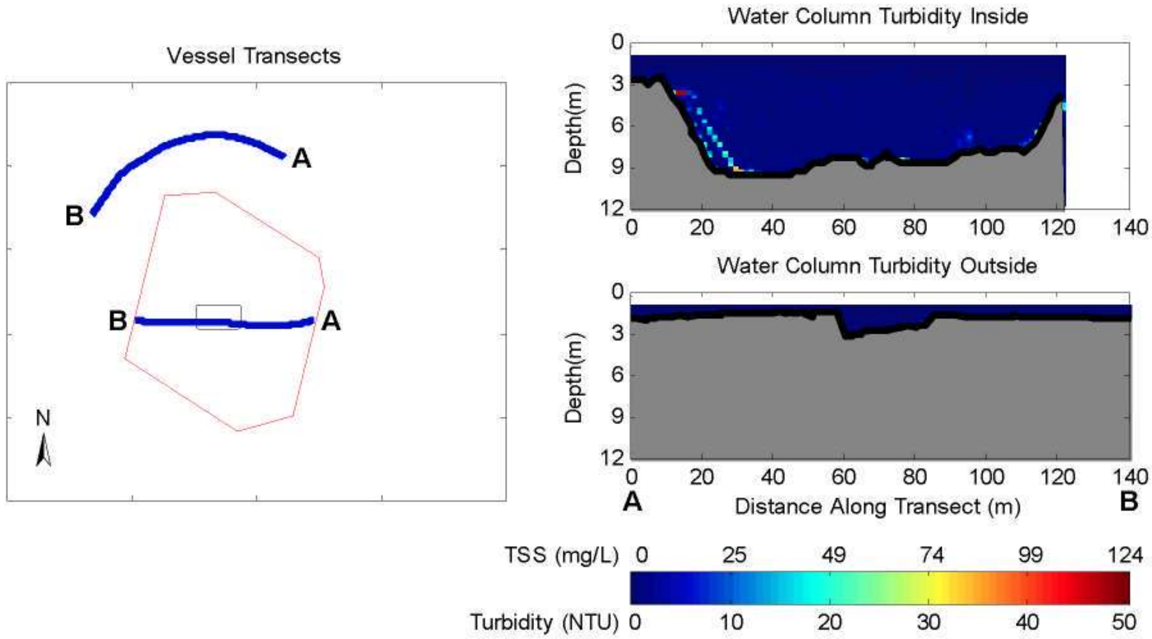

Figure 4-1. Observations Before Release During May 27, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

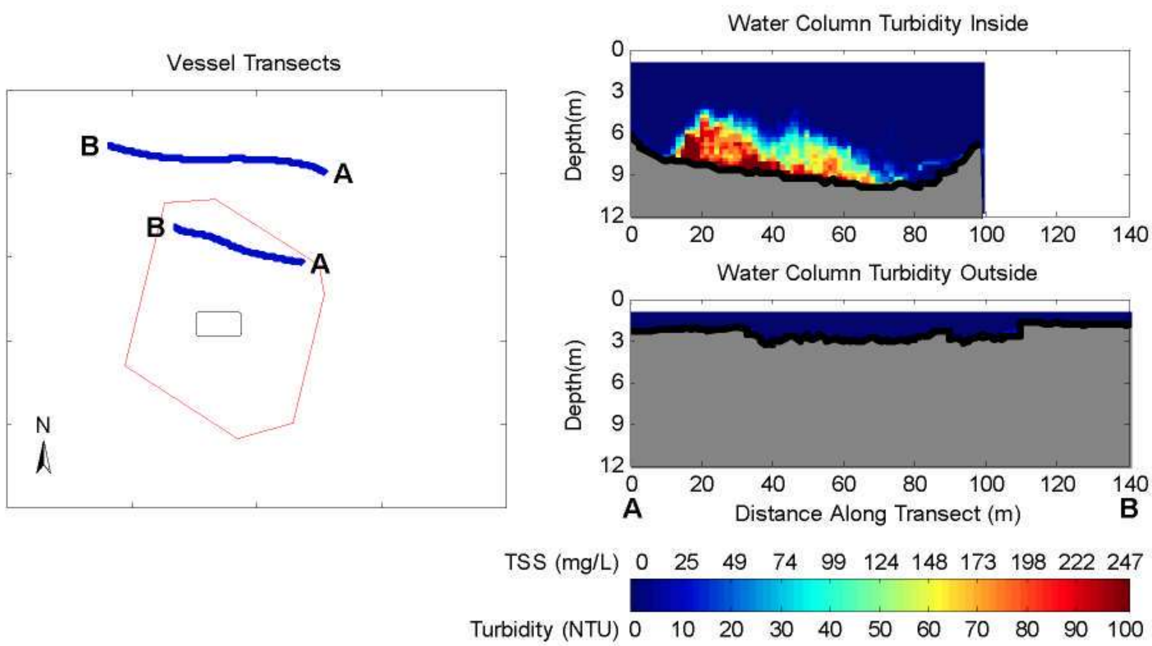

Figure 4-2. Observations from 3 to 6 Minutes after Release During May 27, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect. Note change in turbidity scale.

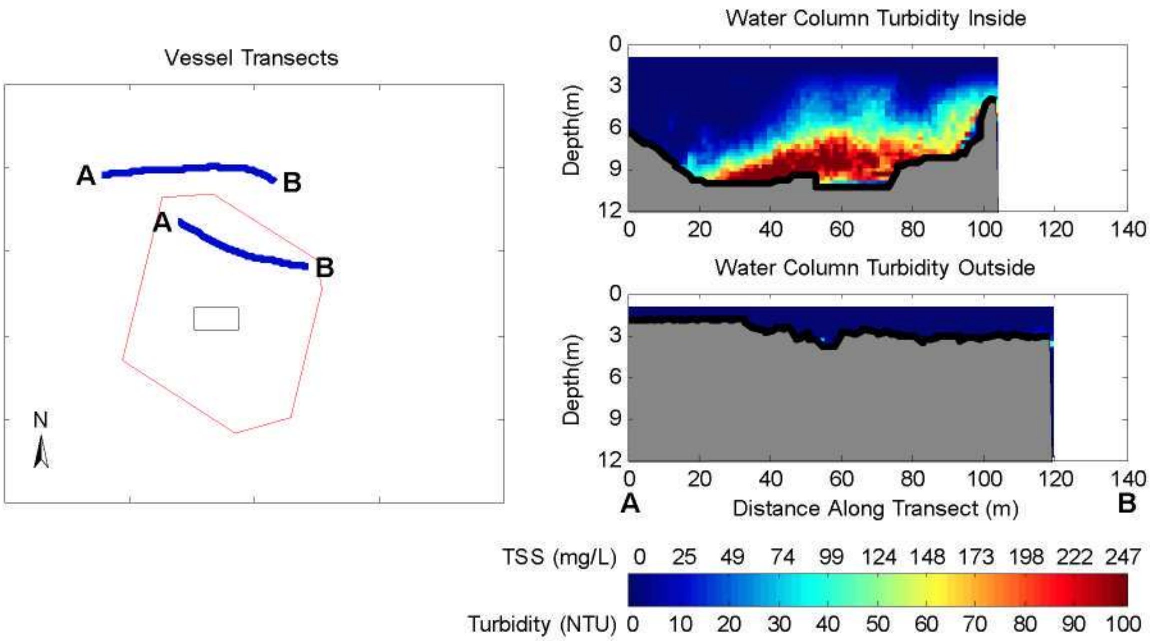

Figure 4-3. Observations from 5 to 9 Minutes after Release During May 27, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect. Note change in turbidity scale.

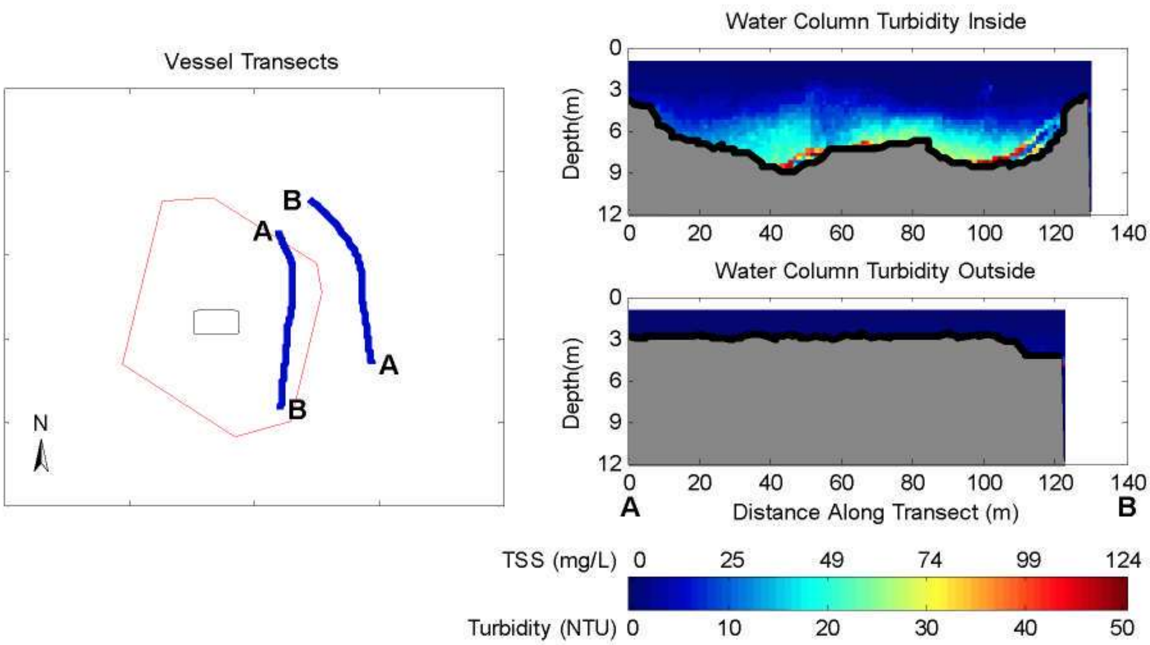

Figure 4-4. Observations from 31 to 34 Minutes after Release During May 27, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

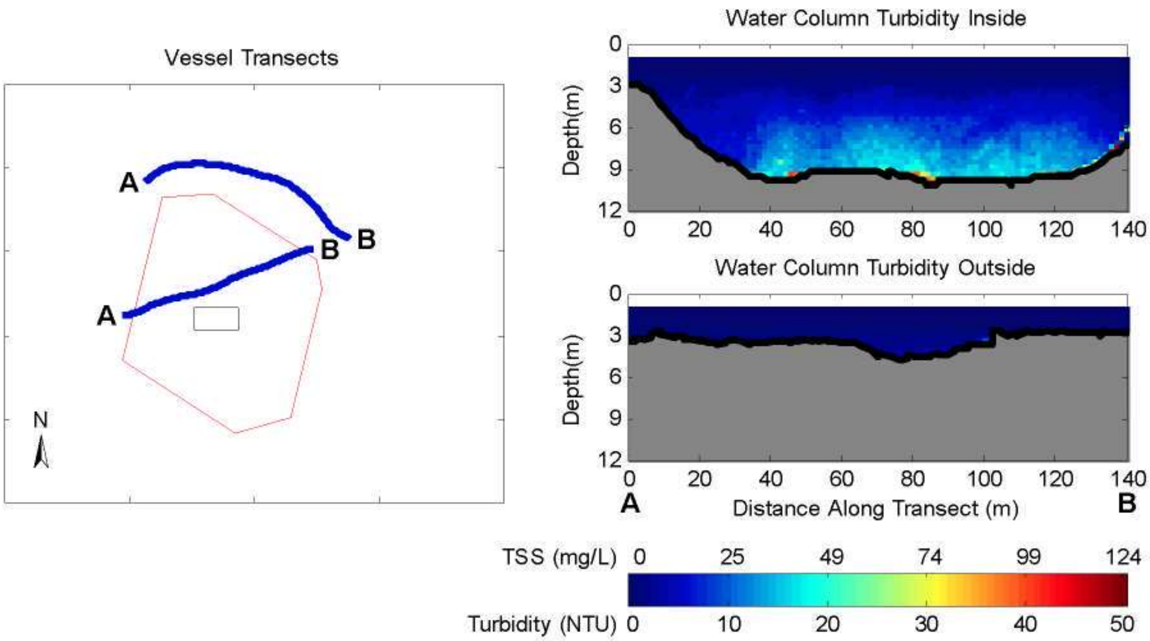

Figure 4-5. Observations from 50 to 53 Minutes after Release During May 27, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

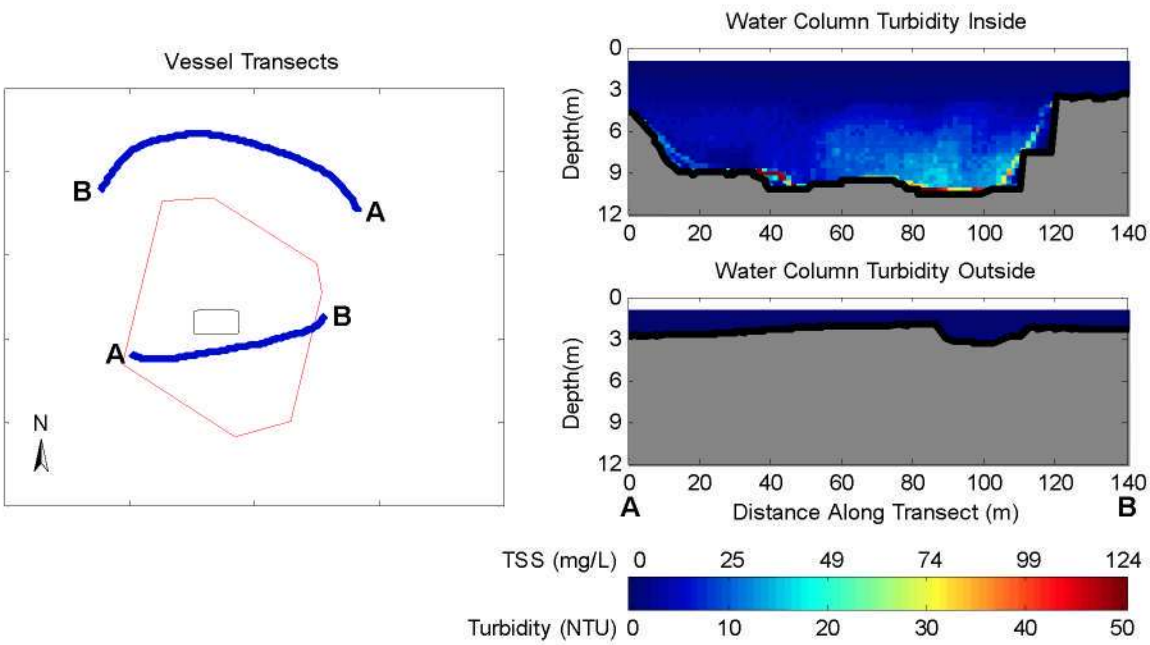

Figure 4-6. Observations from 54 to 57 Minutes after Release During May 27, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

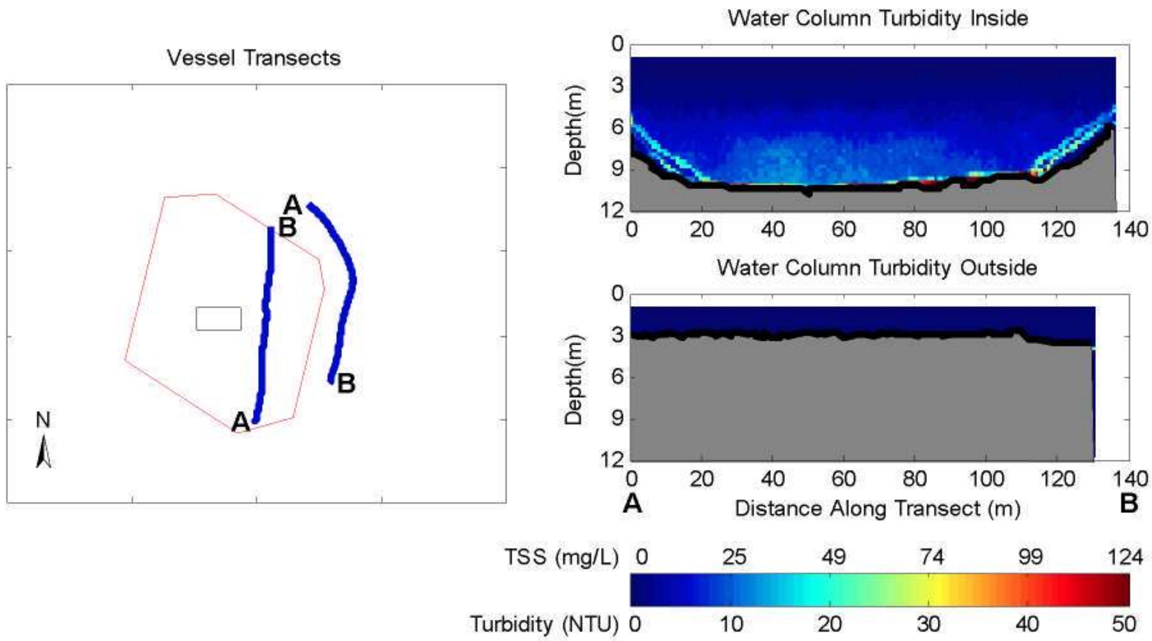

Figure 4-7. Observations from 63 to 67 Minutes after Release During May 27, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

Part 5: Turbidity Survey July 8, 2009

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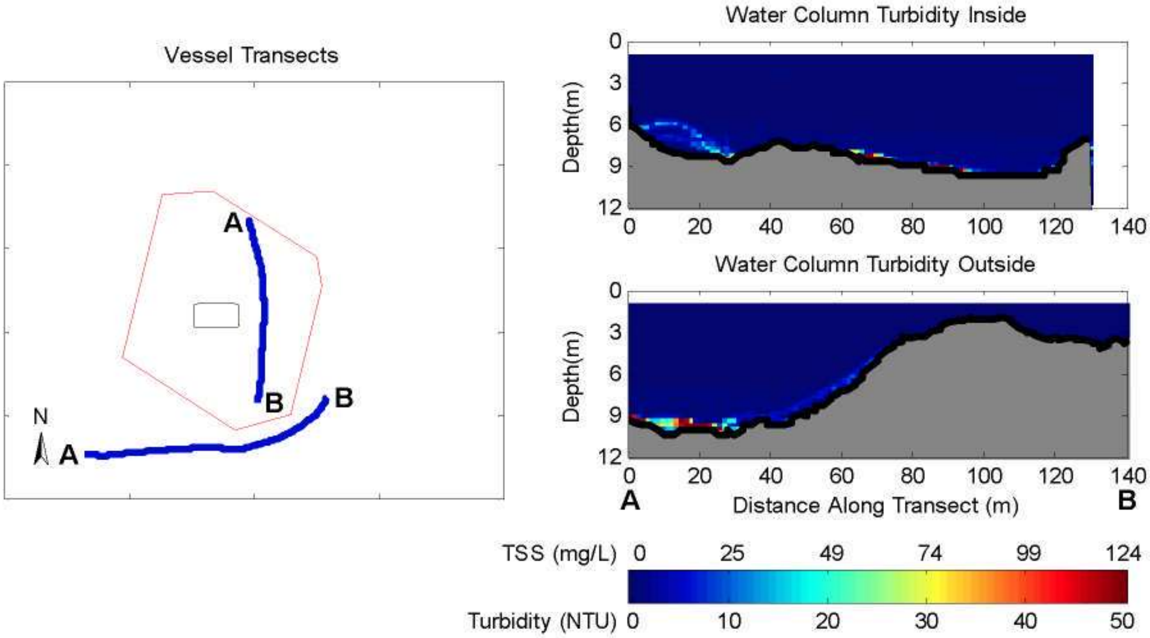

Figure 5-1. Observations Before Release During July 8, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

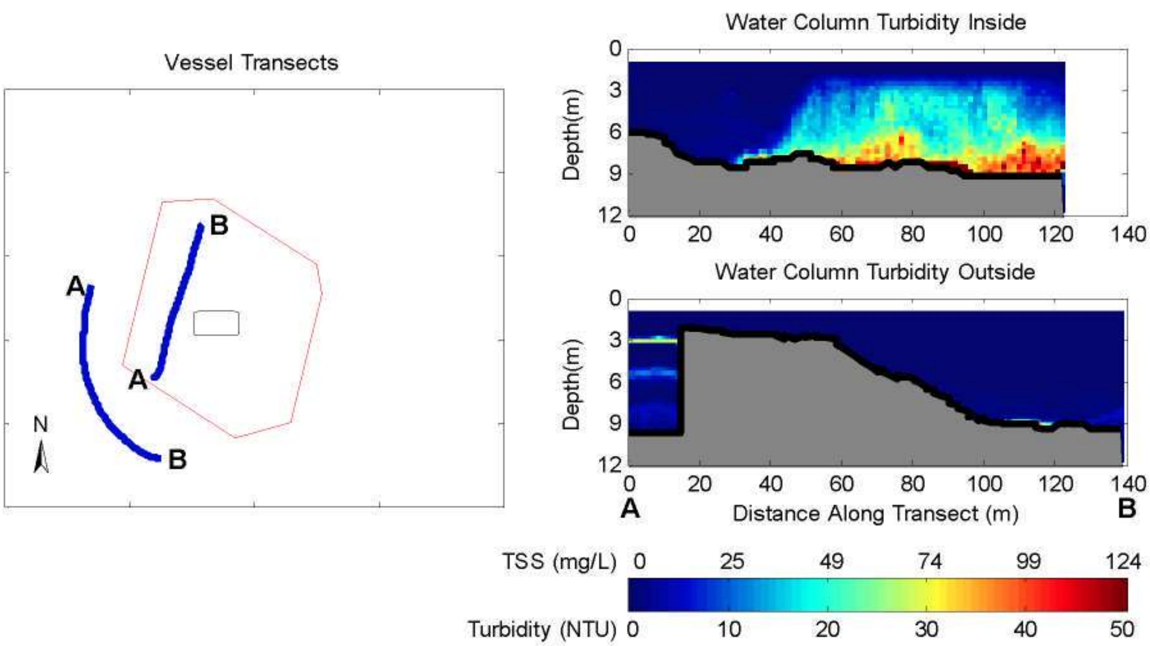

Figure 5-2. Observations from 1 to 4 Minutes after Release During July 8, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

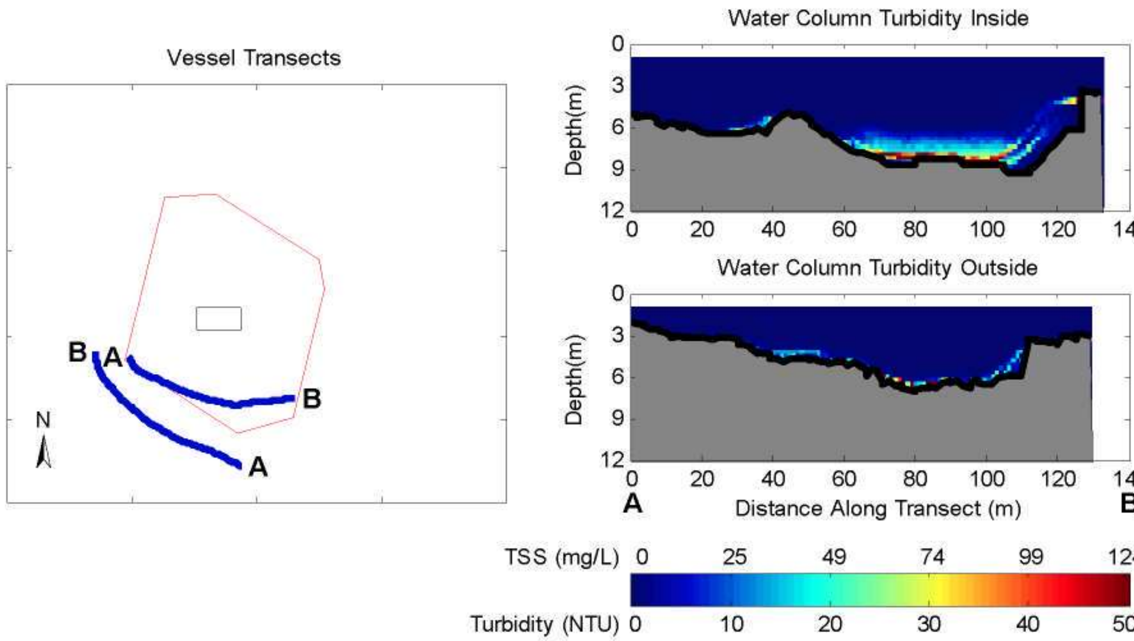

Figure 5-3. Observations from 9 to 16 Minutes after Release During July 8, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

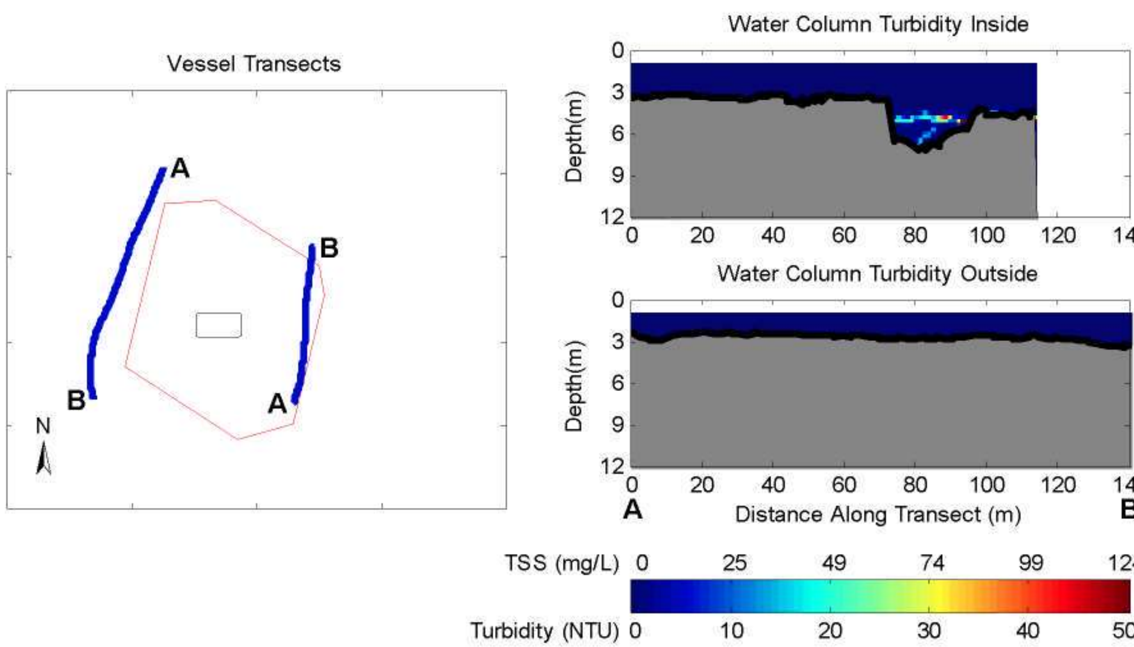

Figure 5-4. Observations from 15 to 18 Minutes after Release During July 8, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

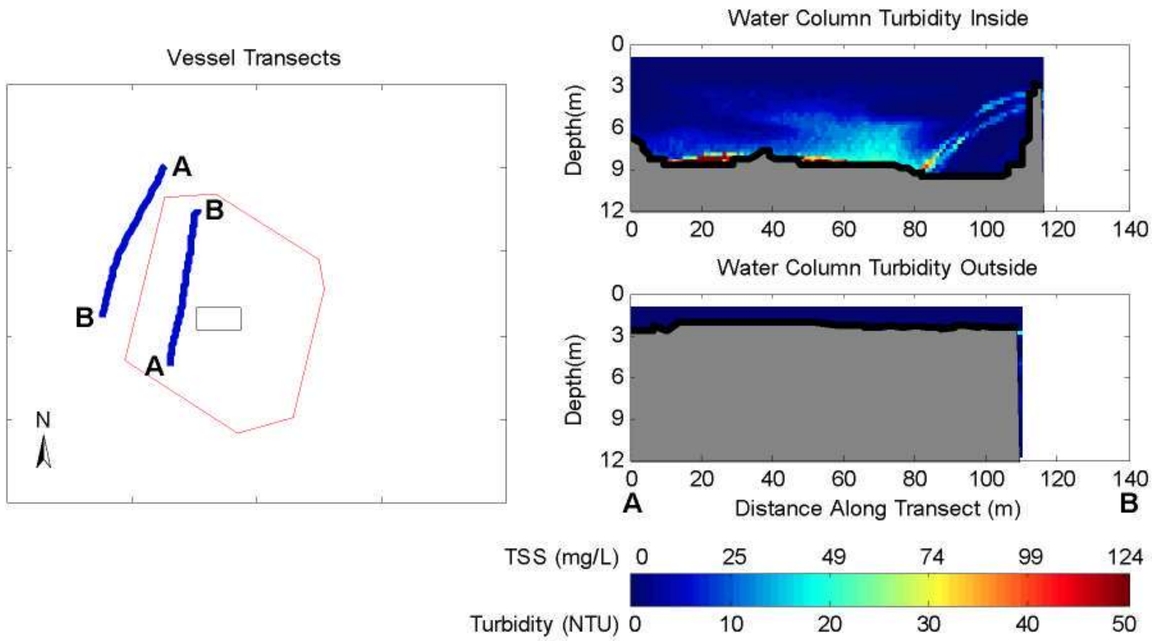

Figure 5-5. Observations from 26 to 29 Minutes after Release During July 8, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

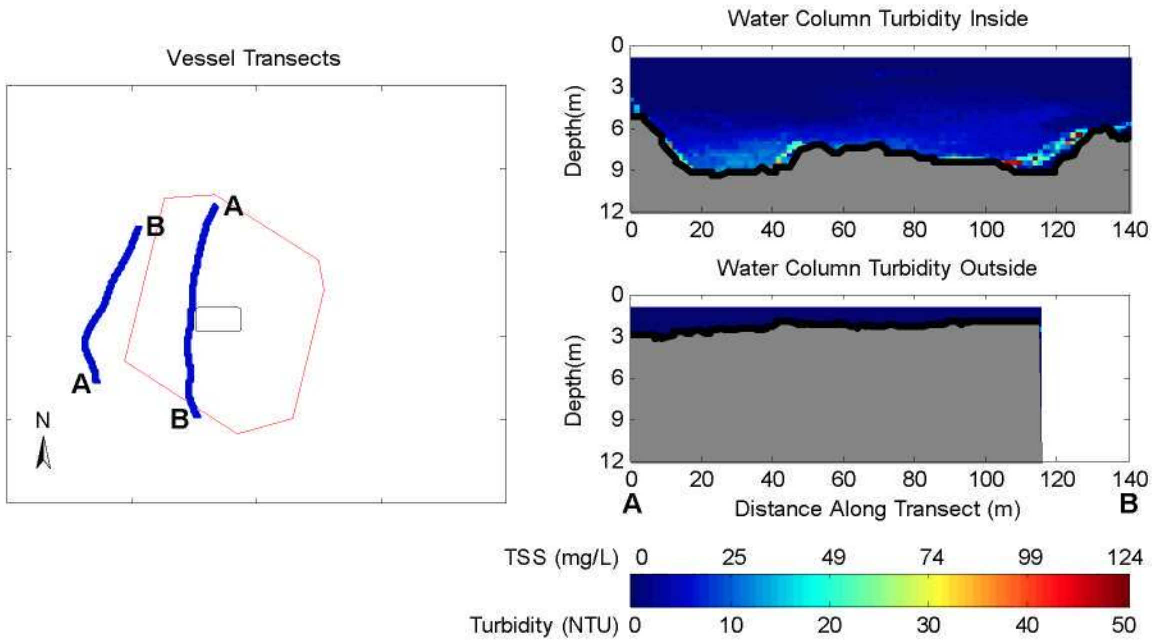

Figure 5-6. Observations from 46 to 49 Minutes after Release During July 8, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

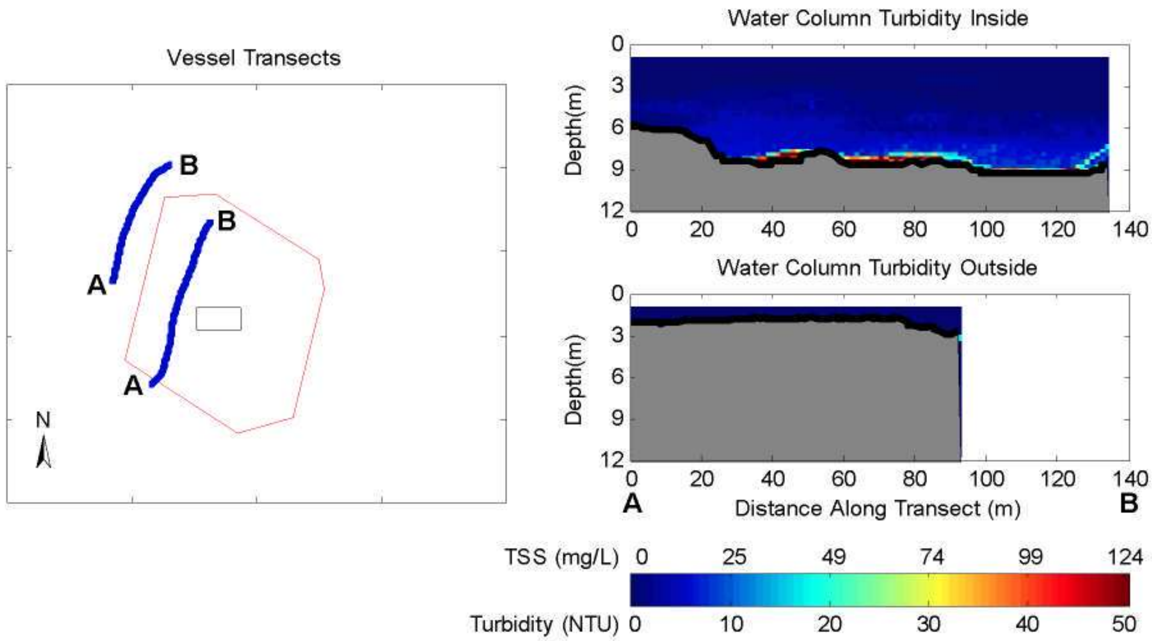

Figure 5-7. Observations from 58 to 61 Minutes after Release During July 8, 2009 Disposal into the New Bedford Harbor CAD Cell. The left panel shows concurrent inner and outer vessel transects. The right panel shows vertical slices of calibrated turbidity and TSS measured with ADCP along each vessel transect.

64502

TECHNICAL MEMORANDUM

4959-50

New Bedford
4.2
64502

DATE: April 3, 1989

SDMS DocID 64502

TO: Siegfried Stockinger, Ebasco Services

FROM: Hans Krahn/Douglas Allen, E.C. Jordan

SUBJECT: Estimate of Mass of PCBs in New Bedford Harbor

This memorandum summarizes the work Jordan has conducted in refining the estimate of PCB mass in the Hot Spot, [Acushnet River] Estuary, and Lower Harbor/Bay that was originally calculated (Technical Memorandum, September 19, 1988).

The estimate of PCBs presented in this memorandum is based upon PCB concentration maps developed by E.C. Jordan. These isopleth concentration maps represent a compilation of data sets from USACE-NED, Battelle-Duxbury, USEPA-83, Woods Hole Oceanographic Institute-82, GCA-82, USCG-82, and DWPC-81.

Data points were plotted on the maps at one foot intervals. Values were estimated when the actual sampling depth overlapped these one foot zones. Sediment concentrations are given based on the USACE grid system, delineating 250x250 foot grids in the Upper Estuary. Each grid was assigned a given PCB concentration, based on an average from data points found within the given grid and those in adjacent grids. Actual PCB volumes were calculated on a dry weight basis.

Where data was lacking in a specific grid, data in adjacent grids alone were used to calculate that grid's concentration. The absence of data became more prevalent with depth and also with distance away from the Hot Spot toward the Coggeshall Street Bridge.

The estimate of PCB mass for the Lower Harbor was derived solely from the isopleth maps generated. An average concentration for a given range of PCBs was used to calculate the PCBs. Individual grids were not used in this effort.

ESTIMATE OF PCB MASS IN NEW BEDFORD HARBOR

AREA	MASS OF PCBS (LBS)	% OF TOTAL MASS
Hot Spot	134,636	45
Estuary (exclusive of Hot Spot)	146,824	49
Lower Harbor	17,000	6
Total:	298,460	100

USACE Sediment Analysis and Associated Leaching Test Analysis

Composite Sample ID	Total PCBs in Sediment (mg/kg)	Total PCBs in Leached Pore Water (µg/L)				Massachusetts Contingency Plan Method 1 Standards for PCBs in Groundwater (µg/L)
		Cycle 1	Cycle 2	Cycle 3	Cycle 4	GW-3
Sample 1A	178.1	1.18	3.42	3.06	3.41	10
Sample 1B	178.1	4.85	3.02	2.92	3.6	10
Sample 2A	160.3	3.77	1.96	1.87	2.46	10
Sample 2B	160.3	3.98	4.3	2.44	2.79	10
Sample 3A	55.8	2.36	1.04	1.73	1.79	10
Sample 3B	55.8	0.1	1.7	1.34	1.11	10
Sample 4A	7.97	0.54	1.4	0.63	0.79	10
Sample 4B	7.97	0.53	0.64	0.56	0.99	10
Sample 5A	6.08	0.263	0.25	0.368	0.529	10
Sample 5B	6.08	0.579	0.419	0.45	0.537	10

Notes:

1). Data summarzied in this table is from "Assessment of Contaminant Loss and Sizing for Proposed Lower Harbor Confined Aquatic Disposal (CAD) Cell", U.S. Army Research and Development Center, May 2010.

2). 5 composites of 10 vibracores each were collected by USACE from various locations within the New Bedford Superfund Site and analyzed for PCB via Aroclors.

3). Two samples groups (A and B) were collected from each of the 5 composites, and 4 cycles of Sequential Batch Leaching Tests were performed on each of the sample groups.

4). Leachate generated during the Sequential Batch Leaching Tests was analyzed for PCB via Aroclors.

5). Total PCBs for both sediment and leached pore water are the sum of detected Aroclors.

6). Massachusetts Contingency Plan Method 1 Standards are not applicable in New Bedford Harbor, and are provided for comparison only. MCP Method 1 GW-3 Standard is intended to be protective of surface water quality.

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Understanding the physical and environmental consequences of dredged material disposal: history in New England and current perspectives

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Abstract

Thirty-five years of research in New England indicates that ocean disposal of dredged material has minimal environmental impacts when carefully managed. This paper summarizes research efforts and resulting conclusions by the US Army Corps of Engineers, New England District, beginning with the Scientific Report Series and continuing with the Disposal Area Monitoring System (DAMOS). Using a tiered approach to monitoring and a wide range of tools, the DAMOS program has monitored short- and long-term physical and biological effects of disposal at designated disposal sites throughout New England waters. The DAMOS program has also helped develop new techniques for safe ocean disposal of contaminated sediments, including capping and confined aquatic disposal (CAD) cells. Monitoring conducted at many sites in New England and around the world has shown that impacts are typically near-field and short-term. Findings such as these need to be disseminated to the general public, whose perception of dredged material disposal is generally negative and is not strongly rooted in current science.
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Keywords: Dredged material; Environmental assessment; Monitoring; Management; New England

1. Introduction

The environmental impacts from dredging and disposal of sediments has been a controversial and often politically charged arena for much of the last four decades. An emphatic example of this was the 1981 *Sports Illustrated* article which showed the dismembered body of a sea turtle stuck in the cutter of a suction dredge (Rudloe, 1981). Dredging has clearly damaged seagrass beds and coral reefs (Bak, 1978; Brown et al., 1990; Onuf, 1994; Long et al., 1996). Over the years countless acres of wetlands, once considered wastelands, were filled with dredged sediments (Kennish, 2001; Summers et al., 2002). And it is clear that sediments impacted by contaminants we placed into our waterways during years of unrestrained industrialization accumulated in waterway sediments and have had persistent and severe adverse impacts (e.g., New Bedford Harbor, MA, Black Rock Harbor, CT, Bridgeport Harbor, CT, Providence Harbor, RI). However, setting aside the sensationalism and rhetoric that is sometimes used, we have made tremendous advances in our ability to evaluate and minimize the environmental impacts of dredging projects through development of testing protocols, scientific investigations, and development of management techniques and beneficial uses for sediments. While specific dredging projects often still generate considerable public debate and political wrangling, there are also many projects that are successfully completed without much fanfare because of our ability to intelligently apply the lessons we have learned as best management practices.

In New England, much of what we know about the potential for environmental impact of dredged material, and the means to minimize impacts, has been derived from a considerable body of technical investigations that were specifically developed to improve our environmental stewardship. These efforts began in 1968, initiated by people who clearly were visionaries, well before any of the existing environmental legislation was created. This series of studies, funded by the New England Division

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(now the New England District) of the US Army Corps of Engineers was recorded in a 59-report series (e.g., Saila et al., 1969; Rhoads, 1972; Bokuniewicz et al., 1976) that culminated in 1980 (Karp et al., 1980). In 1977 and for the past 25 years these studies have continued more formally under the Disposal Area Monitoring System (DAMOS). Indeed, while much of this work has had site specific application many of the findings have helped to form the foundation of our scientific beliefs in this arena.

Dredging and disposal are not without some level of environmental impact and proposed projects in New England do not escape controversy, but the information developed as a result of years of investigation has greatly minimized the uncertainties and has increased the confidence of both environmental resource agencies and the public in the ability of the Corps of Engineers to successfully conduct such projects without undue risk to the environment. In the following discourse we review the emergence of our knowledge related to dredged material management and its evolution, as society's perspectives of the environment also evolved.

2. The scientific report series

Much of our early understanding of dredged material disposal processes and impacts was derived from studies sponsored by the New England Corps of Engineers office (Table 1). The work that contributed to the Scientific Report (SR) Series resulted in cornerstone papers that established conclusions on which we continue to base our principles and decisions. The earliest of these studies developed preliminary information on multiple aspects of the impacts of sediment disposal at a site in Rhode Island Sound (Saila et al., 1969, 1971; Pratt et al., 1973; Sissenwine and Saila, 1973, 1974). The physical process of disposal and loss of sediments in a plume was first described by Gordon (1973, 1974). Bohlen and associates conducted fundamental work on plume transport and dispersion (Bohlen and Tramontano, 1974a,b; Bohlen et al., 1979; Tramontano and Bohlen, 1982). Rhoads and his students provided the foundation for understanding both benthic recovery processes and geochemical impacts (e.g., Gordon et al., 1972; Fisher and McCall, 1973; Rhoads, 1974a,b, 1976; Rhoads, 1974b). Morton and colleagues initiated the first efforts to manage contaminated sediments (Cook et al., 1977; Morton, 1980).

3. Emergence of the DAMOS program

The monitoring of dredged material disposal was formalized in the New England Corps of Engineers office in 1977 with the creation of the Disposal Area Monitoring System (DAMOS). DAMOS is a multi-disciplinary environmental monitoring program whose primary purpose is to manage and monitor New England's 10 offshore dredged material disposal sites from Long Island Sound to Maine. Since its inception, the program has produced more than 140 technical reports (the DAMOS contribution series), 80 journal or conference papers, brochures and a video, and also maintains an active mailing list and a web site (www.nae. usace.army.mil/environm/damos/splash_page.htm). Program efforts respond to concerns expressed by interested members of the public, federal resource agencies (such as the US Environmental Protection Agency), and the environmental departments of New England coastal states. The earliest objectives of the program focused on understanding the basic behavior of disposed sediment and its near-field, short-term impacts. Today the program addresses longer range, cumulative impact questions, such as food web impacts of contaminants, beneficial fishery

Table 1
Selected SR reports and related publications

SR report number	SR report authors	Related publication
4	Sissenwine and Saila (1973)	Sissenwine and Saila (1974)
7	Gordon et al. (1972)	Rhoads (1976)
8	Bokuniewicz et al. (1974)	Bokuniewicz and Gordon (1979, 1980)
12	Fisher and McCall (1973)	McCall (1976)
16	Rhoads (1974a)	Rhoads et al. (1978)
19	Gordon (1973)	Gordon (1974)
21	Bohlen and Tramontano (1974a)	Bohlen et al. (1979)
22	Bohlen and Tramontano (1974b)	Tramontano and Bohlen (1982)
23	Nalwalk et al. (1974)	Paskausky et al. (1974c)
24	Paskausky et al. (1974b)	Paskausky et al. (1974c)
25	Paskausky et al. (1974a)	Paskausky et al. (1974c)
43	Rhoads et al. (1975)	Rhoads et al. (1977)
50	Bokuniewicz et al. (1976)	Bokuniewicz and Gordon (1980)
51	Rhoads and Yingst (1976)	Rhoads et al. (1978), Yingst and Rhoads (1978)
57	Morton (1980)	Morton (1983, 1988)

effects, and long-term cap effectiveness. In addition to monitoring the 10 active New England disposal sites, DAMOS studies disposal at infrequently used sites, such as Tupper Ledge (SAIC, 2002), alternative use sites, including beneficial mudflat creation at Sheep Island (Ray et al., 1994, 1995) and Boston Harbor confined aquatic disposal (Fredette et al., 1999).

Overarching program objectives include:

- monitoring dredged material disposal sites in New England by empirical methods to ensure that no significant adverse environmental impacts result from disposal operations;
- developing an understanding of the processes and mechanisms affecting dredged material in the marine environment;
- developing an understanding of the interaction between dredged material and the biota of the disposal site;
- utilizing this knowledge to develop management techniques that will minimize the adverse effects of disposal; and
- distributing the results of the DAMOS program to provide better public understanding of the effects of dredged material disposal.

The DAMOS program employs a tiered approach to monitoring, which is designed to address: (1) compliance with disposal permit regulations; (2) model verification to check the validity of predictions and assumptions underlying the tiered sampling design; and (3) identification of long-term trends in the environment that might be related to disposal activity. In this approach, higher tiers are required only when results from lower tiers are ambiguous. The approach is designed so that monitoring efforts and costs are minimized in the lower tiers to provide rapid data return to guide management decisions. The approach recommends monitoring techniques and provides clearly defined decision points based on the data collected. The decision points require a comparison of the data collected (e.g., recolonization status) to the expected conditions (reference and model predictions). Expected results confirm predictions and invoke another assurance check at a later time, while unexpected results prompt a search for an explanation and monitoring at the next tier (e.g., more intensive or a different type of monitoring) (Fredette et al., 1993; Germano et al., 1994).

To accomplish its monitoring goals, DAMOS employs a wide range of tools and technology, including bathymetric surveys, side scan sonar, underwater photography, divers, sediment analyses, sediment profile photography, biological analyses, and submersible vessels. One crucial tool in DAMOS monitoring is the sediment-profile imaging (SPI) (Rhoads and Cande, 1971). SPI is a benthic sampling technique used to detect and map the distribution of thin (<20 cm) dredged material layers, delineate benthic disturbance gradients, and monitor the process of benthic recolonization at dredged material disposal mounds (SAIC, 2003). This instrument provides in situ imaging of organism–sediment relationships on the seafloor by making a vertical slice of the sediment–water interface and imaging the sediment in profile (Germano, 1983). These images provide measures of boundary roughness, depth of camera penetration, and area of the oxidized sediment [mean redox potential discontinuity (RPD) depth] (Germano et al., 1984). Benthic infauna may also be observed, allowing for insight into recolonization. From this information, a sample can be assigned a ranking in the organism sediment index (OSI), which uses RPD, benthic successional stage, and oxygenation information to characterize overall habitat quality. A high OSI indicates that disposed sediments were correctly evaluated pre-disposal as environmentally compatible for open water disposal. Where abnormal recovery is observed, follow-up studies and appropriate management actions are undertaken.

Another important monitoring tool is precision bathymetry. Depth-difference plots comparing pre- and post-disposal conditions are used to verify disposal of dredged material in discrete mounds on the seafloor and placement of cap sediments. Long-term bathymetry comparisons are used to confirm that the dredged material mounds are stable over time, including after extreme storm events. For the DAMOS monitoring program, most bathymetric surveying is accomplished using single-beam echosounders with line spacing of 25 m, while surveys requiring more detail employ multibeam systems, where overlapping lane spacing provides 150% coverage of the seafloor. Bathymetric surveys are accurate within 10–20 cm in the 20–90 m water depths surveyed. For shallow mounds and for determining the lateral extent of freshly deposited material, other survey techniques are used in conjunction with bathymetry, such as sediment profile photography, grab sampling, and coring.

Physical, chemical, and biological measurements have permitted detection of short- and long-term changes at disposal sites. This information is invaluable in daily permitting and management decisions concerning whether, where, and how dredged material should be deposited in marine waters. Examples of specific uses of monitoring information include: determination of proposed method and time (season) of dredging, appraisal of environmental conditions at or near the proposed disposal site, and assessment of quantity and degree of contamination of the material to be dredged. Monitoring is also used to avoid creating shallow depths that would be a hazard to navigation.

4. Lessons learned

Thirty-five years of monitoring and research has demonstrated that dredged material, evaluated through pre-project testing and deposited in properly located ocean disposal sites, will remain where it is placed and have no unacceptable adverse effects on nearby marine resources. The only discernible adverse impacts have been near-field and short-term. These conclusions are based on the magnitude of disposal activity relative to natural (e.g., storms) and other anthropogenic (e.g., outfalls) impacts (Rhoads, 1994; Rhoads et al., 1995) and the low level of disposal-related impacts that have been documented (Fredette et al., 1993).

Physical monitoring has revealed that disposed sediments are quickly transported to bottom, and short-term losses of sediment to dispersion are only 1–5% of total sediment deposited (Gordon, 1974; Bokuniewicz and Gordon, 1980) (Fig. 1). Thus, water column impacts are minimal and short-term (Tramontano and Bohlen, 1982; Arimoto and Feng, 1983). Tidal current regimes at carefully selected sites are insufficient to significantly erode the deposited sediment. When some erosion does occur, finer sediments are winnowed out of surface sediments, but a lag deposit of coarser grained sediments develops to armor the remaining sediments from erosion (Fredette et al., 1993). Mounds remain stable even after the passage of storms.

Impacts to the benthic community have been carefully studied employing a variety of techniques, mostly notably SPI (Rhoads and Germano, 1990). Direct effects of disposal have been detected only within a few hundred m of the disposal point. Farther from the disposal point, where only thin (<50 cm) layers of sediment are deposited, benthic organisms can burrow through overburden. Near the disposal point, recolonization generally proceeds rapidly. Benthic recovery proceeds in three predictable stages. Stage I assemblages consist of dense aggregations of near-surface, tube-dwelling polychaetes, which are typically associated with a shallow redox boundary. These assemblages are eventually replaced by Stage II infaunal deposit feeders. Stage III consists of deeper-dwelling invertebrates typically found in low-disturbance regimes. They generally feed head-down and thus serve to aerate the sediment, consequently deepening the redox horizon (Rhoads and Germano, 1990).

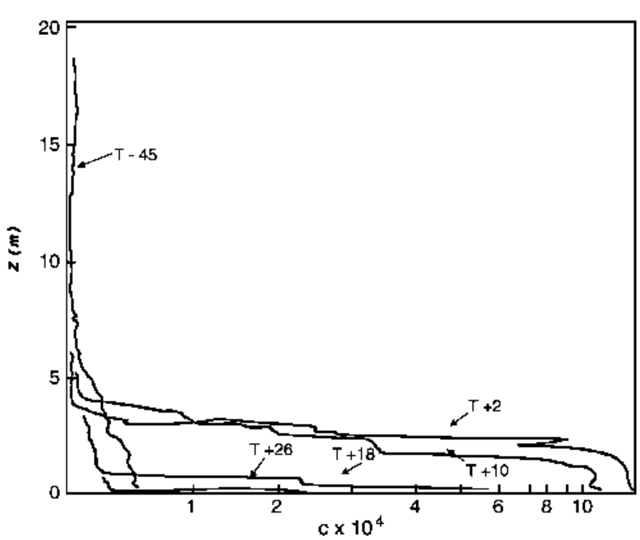

Fig. 1. Example of successive sediment concentration profiles in the water column before ($T-45$) and after barge disposal used to estimate plume losses. T, time in minutes; z, height in m above seafloor; c, concentration in weight fraction. Redrawn from Gordon (1974).

The combination of benthic activity type, redox horizon, absence of gas (methane) bubbles, and other factors have been used to develop an organism sediment index (OSI) that can be used to track benthic recovery (Rhoads and Germano, 1990). Sediments recolonizing normally attain and maintain an OSI above six (6) (Fig. 2). Sediments that have persistent OSI values less than six represent abnormal recolonization that may be an indication of adverse sediment contamination, though other factors such as systemic hypoxia or sediment disturbance (storms, trawling, etc.) also need to be evaluated.

Impacts to organisms via the water column are also generally minimal. Studies of mussel bioaccumulation have found that mussels usually show no significant bioaccumulation of contaminants (Fig. 3). However, when significant bioaccumulation has been observed, contaminant levels of affected mussels returned to those at reference locations shortly after cessation of disposal (Feng, 1982, 1983, 1984). Studies of reproductive tissue of mussels deployed at disposal sites also show little or no reproductive impairment compared to reference areas (Arimoto and Feng, 1983).

DAMOS has also surveyed a historic disposal site to assess the lingering effects of disposal. One example, the Bridgeport Disposal Site in Long Island Sound was closed in 1977 after receiving approximately 4.2 million m^3 of dredged material over a 25 year period. In 1992 a one-day survey was conducted using side-scan sonar and SPI. Side-scan sonar results indicated relic dredged material in low relief, but no well-defined mounds. SPI photographs provided evidence of past physical and biological disturbance, yet it revealed a largely healthy benthic community similar to those of reference areas. More extensive, recent work at this site and another historic site supports these earlier conclusions (Battelle, 2002, 2003a,b). These results support expectations for recovery for historic disposal sites (SAIC, 1996). Today's active disposal sites may fare even better in the future because testing protocols for dredged material were not in place when the Bridgeport Disposal Site was active.

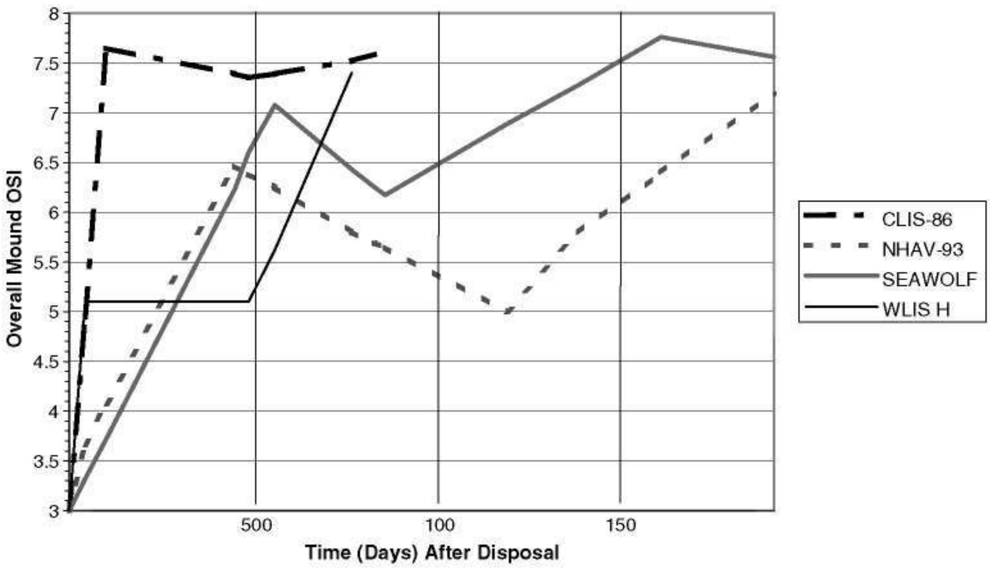

Fig. 2. Examples of change in sediment benthic conditions at four disposal mounds. The slower recovery at NHAV-93 prompted continued monitoring and assessment. Slower recovery at WLIS H attributed to regional hypoxia. Organism sediment index (OSI) used as the indicator for recovery. Origin set at three for graphical purposes.

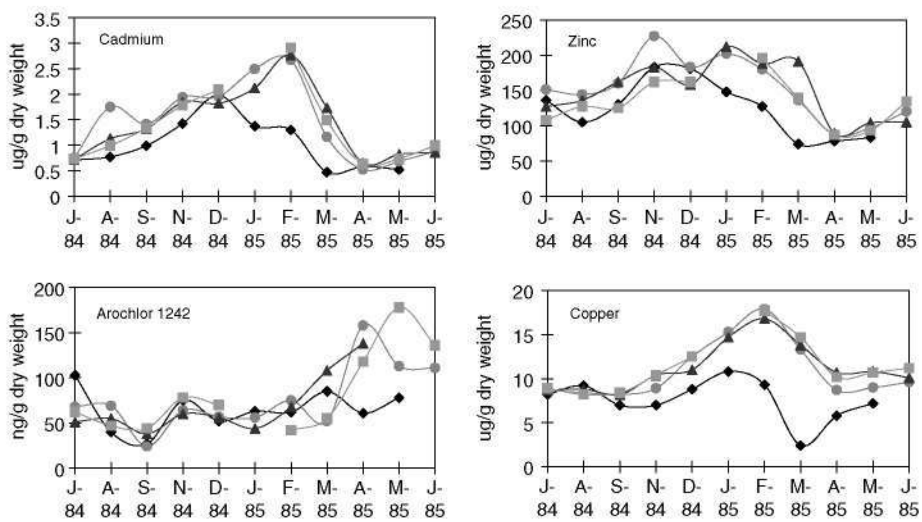

Fig. 3. Contaminant levels (cadmium, zinc, arochlor 1242, and copper) in *Mytilus edulis* tissue before and during disposal at four different locations. ▲ Near disposal mound, ■ 500 m west of mound, ● Nearby reference, ◆ Distant reference. Disposal occurred from January to June 1985. Based on data in Feng (1988).

5. Recent and on-going investigations

5.1. Capping

The capping of contaminated sediment dates back to approximately the inception of DAMOS. Extensive studies were conducted to determine whether highly contaminated sediments could be disposed and covered by relatively uncontaminated sediments, thus isolating the contaminants from the environment. The first carefully monitored project entailed capping sediment from Stamford Harbor at two separate disposal points within the Central Long Island Sound Disposal Site. Caps were comprised of fine-grained sediment from inner and outer New Haven Harbor. DAMOS monitoring of the first and subsequent capping activities resulted in the development of the following capping management procedures: (1) use of taut-wire buoys to confine contaminated material, (2) bathymetric and SPI surveys to determine sediment distribution and to design cap placement, and (3) follow-up monitoring to assure capping success and benthic community recovery (Fredette et al., 1993).

Comprehensive monitoring has demonstrated the effectiveness of caps in isolating contaminated sediment from the marine environment. In Long Island Sound, for instance, cores were collected from capped mounds created 7 and 11 years prior to sampling. Cap material was generally clearly distinguishable, both visually and chemically, from mound material (Fig. 4). There was no conclusive evidence of physical disturbance or chemical migration, although chemical heterogeneity of the cap and mound sediments and the 20 cm homogenates made the interface less distinct in some cores (Fredette et al., 1992). Geotechnical analysis has shown that although mound elevation can decrease over time, this decrease is due to consolidation rather than erosion, and the fluid expelled from the consolidated contaminated material is contained within the cap materials (Bokuniewicz, 1989; Silva et al., 1994). Further evidence of contaminant containment is provided by Feng (1982), who found that mussels deployed at capped sites one year after capping showed no higher contaminant tissue concentrations than those at reference sites.

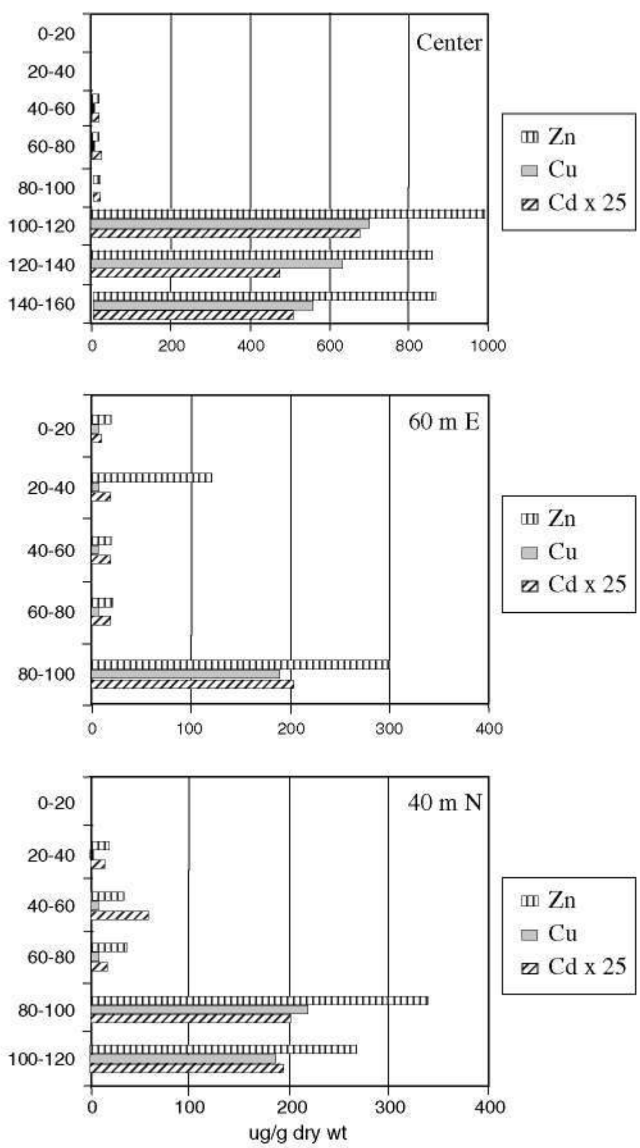

Fig. 4. Chemical profiles of zinc, copper, and cadmium (×25) from 20 cm core sections at the Stamford–New Haven capped mound 11 years after capping. Cores shown are from the mound center, 60 m east of center, and 40 m north of center. Core sections with no data shown were not analyzed. Top of core is set at 0 cm. Based on data in Sumeri et al. (1991).

DAMOS is now assessing the feasibility of capping in deeper waters. Two pilot projects have been conducted recently. For the purpose of these demonstrations, uncontaminated sediment was used as the "unacceptable" dredged material in both projects. In 1995 to 1997 a capping demonstration project was conducted at the Portland Disposal Site in 64 m of water (Morris et al., 1998). Prior to this project, capping has generally occurred in waters 14–24 m deep. A combination of survey techniques revealed a discrete disposal mound with a distinct cap. More recently, investigations have begun at an even deeper site, the Massachusetts Bay Disposal Site at 90 m depth, with sediment from Cohasset Harbor, Cohasset, MA. A postcap survey has been conducted, and feasibility of future capping is being assessed.

Another technique related to capping that has benefited from DAMOS monitoring is the creation of "rings" of mounds at disposal sites to create basins to contain dredged material (Morris et al., 1996). DAMOS bathymetry studies have assisted in guiding scows to dispose of sediment in such a way as to create a ring. Sediment unsuitable for unconfined disposal may then be placed in the rings and then capped. This technique impedes the lateral spread of unsuitable material.

5.2. CAD cells

The DAMOS program has also been instrumental in the development of confined aquatic disposal (CAD) cell techniques. CAD cells are used to contain contaminated sediment in-place. The first large scale use of CAD cells was at Boston Harbor. When the Harbor needed deepening, an environmental impact statement (EIS) determined that the use of CAD cells would have the least environmental impact for sediment unsuitable for unconfined ocean disposal. DAMOS assisted in the development, monitoring, and refinement of techniques for this burgeoning technology. A pilot study for construction of one CAD cell in 1997 was conducted first, and applying lessons learned, techniques were modified for Phase II in 1998 and 1999. Sediment was excavated in cells beneath the shipping channel to well below maximum channel depth, and the top layer of unsuitable material was stored on a barge. The deeper, clean sediment was transported for offshore disposal. Cell excavation continued into Boston Blue Clay, a homogeneous, high strength greenish gray clay with low water content and low permeability (CDM, 1991). The unsuitable material from that pit and surrounding areas was placed in the pit, and clean sandy sediment from the Cape Cod

Canal was placed on top. CAD cells were dredged and filled using clamshell dredges and bottom dumping barges, whereas capping involved slow release from hopper dredge equipment to minimize resuspension of contaminated sediment. Sand cap effectiveness was intensively evaluated using several different techniques, including multibeam bathymetry, sub-bottom profiling, coring, and side-scan sonar. Placement and capping operations successfully minimized the potential for exposure of contaminants to the environment. From Phases I and II the following recommendations for future construction were developed: (1) use a moving barge or vessel to slowly dispose the sand over the silt material; (2) increase the time between silt disposal and capping to allow greater consolidation to increase the bearing capacity of the dredged material; (3) continue to use multiple methods to assess cap coverage, including sub-bottom acoustic profiling and coring; (4) use an open clamshell bucket for dredging the silts to minimize the amount of water mixed into the barge. In addition, many recommendations were made for improvements in monitoring techniques (Fredette et al., 1999).

6. Related work

The scientific investigations conducted in New England represent only one part of the enormous body of literature that has been amassed over the last four decades. Considerable work has been done throughout the world to address these same issues. This includes work exceeding $200 million conducted under the Corps of Engineers sponsored research programs (Table 2). Internationally, several countries have made substantial contributions (e.g. The Netherlands, Great Britain, Canada, Germany) (Steeghs et al., 1989; Beckwith et al., 1995; Kothe, 1995; Ridden, 1995). In addition, global oversight is provided under the international London Convention treaty. The convention provides a consistent framework that both member and non-member coastal countries can apply to their individual programs and regulations.

Table 2
Major US Army Corps of Engineers dredged material research programs

Program	Years conducted
Dredged Material Research Program (DMRP)	1973–1978
Field Verification Program (FVP)	1982–1988
Long-term Effects of Dredging (LEDO)	1981–present
Dredging Research Program (DRP)	1988–1995
Dredging Operations Environmental Research Program (DOER)	1998–present

7. Discussion

Dredging and sediment disposal acquired an ignoble reputation that has become almost indisputable. This reputation, while originally based on truth of historic practices, needs to be reconsidered and challenged in light of the tremendous changes that have been made in both the scientific knowledge and the environmentally conscious approach that is now taken for such projects. This is not to say that environmental damage cannot nor will not occur from dredging projects, but the days of large-scale impacts and ignorant decision-making are gone. It is time that the popular opinion surrounding dredging projects change to reflect the existing practices and capabilities. We have learned to evaluate, consider, and balance the impacts from dredging activities. The research effort devoted to environmental impacts of dredging is vast. We have developed methods to make dredging projects result in positive gains for the environment through the isolation of contamination and the restoration and creation of habitats. We have developed methods to monitor environmental consequences and take remedial actions where warranted. Evidence of severe and large-scale unexpected consequences of dredging projects is rare. Monitoring conducted at scores of sites around the world has shown that impacts are typically near-field and short-term.

However changes in public perception come about slowly and will not occur from technical publications. Industry and government need to reach out to the public through multiple communication channels. We believe that steps we have taken in New England to produce brochures and videos (US Army Corps of Engineers, 1999), provide presentations and exhibits, talk one-on-one, and develop web content (www.nae.usace.army.mil/environm/damos/splash_page.htm) have helped to shape New England regional perspectives. The reality of dredging and disposal project management has undergone significant change. The positive and balanced role that dredging now plays in our society's welfare deserves greater recognition.

Acknowledgements

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Why Confined Aquatic Disposal Cells Often Make Sense

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ABSTRACT

Confined aquatic disposal (CAD) cells are increasingly becoming the selected option for the management of unacceptably contaminated sediments. CAD cells are selected as the preferred alternative because this approach provides an acceptable compromise when cost, logistics, regulatory acceptance, environmental risk, and perception of various alternatives are considered. This preference for CAD cells often occurs even when other alternatives with similar risk reduction and less cost, such as an open water capping alternative, are considered as options. This paradox is largely a result of subjective factors that affect regulatory acceptance such as public perceptions.

Keywords: Confined aquatic disposal   Contaminated sediment   Environmental risk   Capping

Special Section

INTRODUCTION

Confined aquatic disposal (CAD) cells are constructed to reduce the risk from unacceptably contaminated sediments (UCSs) by storing them in a depression in the bottom of an aquatic system (Figure 1). Confined aquatic disposal cells may be constructed from (1) naturally occurring bottom depressions; (2) sites from previous mining operations, such as beach nourishment borrow sites; or (3) new dredging operations created expressly for the containment structure. Confined aquatic disposal cells can reduce the risk from UCSs by confining the sediments to a smaller footprint, increasing contaminant diffusion times, removing UCSs farther from physical processes that can result in transport, and providing a means to effectively cap the sediments. All of these factors can contribute to the reduction or elimination of exposure pathways and the reduction of contaminant transfer rates, which results in a reduction in risk to human health and the environment.

Confined aquatic disposal cells are being selected as the alternative of choice by a growing number of navigation dredging and sediment remediation projects such as harbors in Boston, Massachusetts, USA; Providence, Rhode Island, USA; and Los Angeles, California, USA (USACE, MPA 1995; USACE 2001, 2002; Alfageme et al. 2002; Moore et al. 2002), and the Puget Sound Naval Shipyard, Bremerton, Washington, USA; St. Louis River–Duluth Tar Site, Duluth, Minnesota, USA (USEPA 2000; MPCA 2004); and Hong Kong airport (Whiteside et al. 1996; Shaw et al. 1998) sediment clean-up projects. Selection of the CAD cell alternative is often made from a suite of alternatives that includes open water placement, followed by capping, enhanced natural recovery, diked confined disposal facilities, upland placement, treatment, and no action. This article discusses some of the factors that have lead to the increasing popularity of the CAD cell alternative as well as some of the disadvantages that need to be considered before its implementation.

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REGULATORY FACTORS

A primary consideration for any alternative that is being evaluated by a project proponent is whether the alternative will be acceptable to the relevant permitting agencies. Usually permitting for aquatic sediment disposal involves seeking approval under the Clean Water Act (CWA) or the Marine Protection, Research, and Sanctuaries Act and reviews by the US Army Corps of Engineers, US Environmental Protection Agency (USEPA), and relevant state environmental agencies. Local approvals may also be necessary from conservation commissions, boards of health, or other relevant agencies. Various federal, state, nongovernmental organizations, and the public are also involved during project review.

Proposed locations for CAD cells are often near the dredging location in inland waters regulated by the CWA (e.g., within the confines of rivers, harbors, estuaries, and bays), whereas open water capping alternatives often involve consideration of deeper-water, offshore sites regulated by the Marine Protection, Research, and Sanctuaries Act (ocean waters within and beyond the territorial sea). When this situation arises, the current USEPA policy that capping is not an acceptable management method under the Marine Protection, Research, and Sanctuaries Act favors the selection of the CAD cell alternative.

Other regulatory factors that favor selection of CAD cells over other alternatives include consideration of adjacency issues and transportation effects. Confined aquatic disposal cells are often proposed close to the area where the UCS are currently lying and thus the area may already be ecologically impaired. As a result, no new area is affected by creation of the CAD cell, and the UCS sediments are kept close to their source and handled "on site." Under the CWA regulations, adjacency, in addition to the limitation of impacting new areas, can be an important decision factor favoring CAD cell use. For many environmental remediation projects, on site alternatives

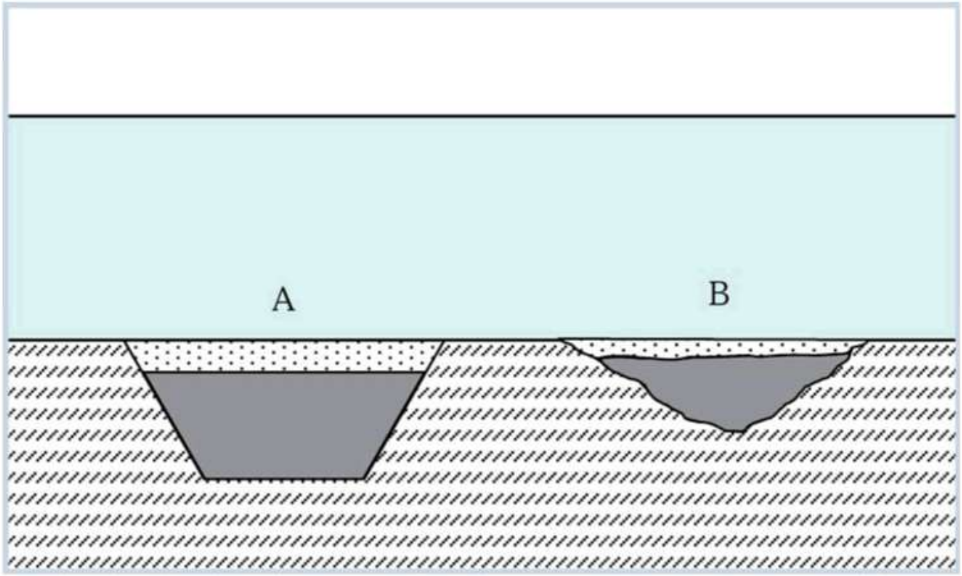

Figure 1. Schematic confined aquatic disposal (CAD) cells. **(A)** Cell dredged to meet specific project needs. **(B)** Cell using existing bottom depression or old borrow pit.

receive preferential consideration under both federal and state remediation legislation.

The CAD cell alternative results in fewer transportation effects than do most other alternatives because of relatively shorter transport distances and the use of barges. Consequently, fossil fuel use is lessened, as are the concomitant air quality effects, in comparison to either longer transport routes or the use of truck transport. Direct human exposure to truck-related traffic accidents and heavy truck use damage to roadways are also avoided.

PERCEPTION

Perception is a factor of enormous importance when a permitting agency weighs the public interest aspects of a project relative to other balancing criteria. Public acceptance is oftentimes contrary to alternative rankings based on objective technical comparisons of alternatives. In many instances in which decisions are made on controversial projects, the public acceptance factors, as well as concomitant political pressure, carry much greater weight than does any other factor.

Even when CAD cells offer no technical advantages, my observation has been that the general public has greater comfort with the CAD cell concept; other alternatives that may be similar or better technically, such as open water capping, often do not result in the same level of comfort. In my view, people are comfortable with the concept of boxes, bowls, and containers, and CAD cells generally fall into that category for most of the general public. CAD cells provide a feature with clearly defined limits, which can result in a certain degree of psychological comfort, and they also can appear to provide greater protection from major natural events such as waves, storms, and floods. Technical analysis may show that other alternatives can equal or exceed protection from such natural events, but the public does not always find those arguments convincing enough to overcome established perceptions.

COST

The CAD cell alternative, although often more expensive than are open water alternatives, is usually within the lower range of alternative costs (USACE 2001). As a consequence, project proponents often accept the CAD cell option as economically feasible.

In cases in which the proposed CAD cell utilizes an existing bottom depression, the cost of the CAD cell alternative may be similar to or less than open water disposal with capping. When a CAD cell must be dredged to accommodate the UCS, the disposal costs are usually 2 to 3 times that of open water capping options. However, other alternatives are usually 5 to 100 times the cost of open water options, unless sufficient economies of scale exist owing to large project size. Thus, although the cost differential between open water capping and CAD cells can be substantial, project proponents have often found that the added cost is acceptable when balanced with public acceptance, regulatory acceptance, and expediency.

ENVIRONMENTAL AND HUMAN HEALTH RISK

Environmental and human health risk assessment of the CAD cell alternative has shown that it can provide one of the lowest risk options compared with other alternatives (Kane-Driscoll et al. 2002). Relative to upland disposal, there is less rehandling of material and fewer contaminant transfer pathways: upland disposal can result in greater dermal contact, volatile emissions, and groundwater pathways. Upland disposal also increases risks of highway accidents, which can lead to injury and death. Compared with many other environmental and human health risk predictions used to evaluate dredging projects (trophic transfer rates, fish species residence time at disposal sites), highway accident risks can be quantified with little uncertainty by use of existing accident rate statistics.

In comparison to the no-action alternative, CAD cells, even when uncapped, result in a reduced surface area for contaminant release and less potential for direct contact by humans and biological resources, resulting in lower risks. Certainly the potential for diffusion of contaminants out of a CAD cell or for groundwater transport need to be evaluated, although these pathways are likely to be very slow (initial exit times measured in decades or centuries) and of low magnitude (for analysis of cap transport rates, see Murray et al. 1994).

LOGISTICS

CAD cells can usually be constructed by using readily available, conventional construction equipment with a minimum of transport and rehandling. Mechanical dredging equipment, especially clamshell bucket dredges, are most readily compatible with CAD cell construction. In regions where clamshell dredges are less commonly available, however, the challenges of creating a CAD cell with hydraulic equipment can severely limit design options. These include the inability to create steep CAD wall side slopes and the inability to dredge much deeper than 20 m (T.J. Fredette, personal observation on a proposed project for the Port of Santos, Brazil).

Transport distances from the UCS dredging site to the CAD cell may also be relatively short, leading to less transport conflicts in comparison to either longer haul distances for offshore sites or highway traffic effects for upland options. In addition, the sites often proposed for CAD cells have less land-use conflicts than do nearshore or offshore diked facilities and upland locations. Real estate costs, rehandling facility requirements, containment structure construction, abutter/neighbor conflicts, and transport route logistics are usually not necessary or are less problematic for CAD cell alternatives.

CHALLENGES OF USING CAD CELLS

The use of CAD cells does present some unique challenges for consideration before they are selected for use. For example, when the proposed site of a CAD cell is within a navigation channel, the uses of the channel and the future plans to deepen the channel must be part of the evaluation and design. In such instances, the future channel depths may require limiting the elevation to which the CAD cell is filled or possibly may require the future relocation of some of the CAD cell sediments. Also, in locations where tugs may need to apply extreme power to maneuver ships over the CAD cell, the need for protective armoring should be evaluated.

The CAD cell selection can also be drastically limited by subsurface geological conditions, especially the depth to bedrock. In addition, when the width of the area in which the CAD cell is proposed is narrow, such as in a channel, the necessary side slopes for wall stability may limit the effective depth to which a CAD cell can be constructed. Evaluation of the effect of CAD cell excavation on aquifers or the transport of contaminants from groundwater flow also may be relevant in certain situations.

Construction issues associated with CAD cells include evaluating effects to existing infrastructure, planning for sufficient storage volume, surging of material outside the CAD cell during filling, and applying a cap. Planning of CAD cells in both the Boston and Providence harbors required consideration of effects to the structural integrity of nearby piers and seawalls so that geotechnical failure would not damage these facilities (USACE, MPA 1995; USACE 2001).

The CAD cell design should provide volume contingency, although planning for bulking of the material may be unnecessary. Sizing a CAD cell to closely match the dredging volume creates a risk that the cell will be filled before the dredging is completed. This can occur when the dredging volume was underestimated because of survey inaccuracies or when additional sediment was deposited into the area after the volume survey was completed. The capacity of the cell can also be affected when water is added to the sediment during the dredging process (bulking), creating a greater volume than initially expected. However, depending on the length of time over which a CAD cell is filled, the 1st material placed into the CAD cell may become compressed relative to its dredging area in situ volume, which may compensate for any bulking that occurs in material added to the cell later in the process. However, because the estimate of the volume to be dredged is imprecise, providing additional volume capacity (contingency) in the CAD cell is prudent.

Surging of sediments beyond the limits of the CAD cell has been documented (Germano 2003) and may require the modification of placement procedures as the cell approaches its fill capacity. Alternatively, surge loss could be handled by clean-up dredging around the CAD cell once the main portion of the project is complete or by the application of a cap over the lost material.

Although not likely, the potential effect to aquifers or the potential for groundwater flow to transport contaminants should be considered. Usually, the sediments being placed into the CAD cell will be fine grained with relatively low permeability. In that event, groundwater flow is likely to be diverted around the cell rather than through it.

Over the long term, the number of locations at which CAD cells can be constructed in a particular harbor or region may have limitations that will restrict the ability to use this alternative once the available sites are taken. For this reason, CAD cells may represent only an intermediate-term solution and should be used only for sediments that have clearly been shown to be in need of special management.

CONFINED AQUATIC DISPOSAL CELL SUCCESS

The CAD cells have been used successfully at several locations around the world, including Hong Kong; Los Angeles, California, USA; Bremerton, Washington, USA; Newark, New Jersey, USA; Boston; Hyannis, Massachusetts, USA; and Providence, Rhode Island, USA. We have seen both successful and less-than-fully successful (mixing of cap and UCS instead of covering) placement of caps on CAD cells, which has demonstrated the need to plan for sufficient consolidation of the sediment to be capped (Myre et al. 1998; Fredette et al. 1999, 2000, 2002). Nonetheless, even when CAD cells are uncapped, the contained sediments will almost always be farther removed from the physical forces that result in transport to other areas compared with the initial, no-action situation. Because the top surface of a CAD cell will almost always be below the surrounding bottom, physical forces will affect the surrounding bottom before affecting the sediments in the CAD cell. Thus, when the surrounding bottom is being resuspended, the CAD cell will likely act as a sediment receptor. It is difficult to envision a plausible scenario in which substantial erosion from a CAD cell is likely. Risk reduction through smaller footprints of the sediment exposed to the water column and reduced or eliminated exposure and transport pathways with less mass transport are also beneficial.

CONCLUSION

The CAD cell alternative is likely to be chosen for a rapidly increasing number of projects that must manage UCSs. This trend will result from this alternative best meeting the nexus of regulatory acceptance, public perception, cost, risk reduction, and feasibility.

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UNDERWATER ARCHEOLOGICAL REMOTE SENSING SURVEY NEW BEDFORD HARBOR SUPERFUND SITE

New Bedford, Massachusetts

January 2000
(Revised March 2001)

Prepared for

Foster Wheeler Environmental Corporation
133 Federal Street
Boston, Massachusetts 02110

and

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ABSTRACT

This report describes the results of an underwater archeological remote sensing survey carried out for the New Bedford Harbor Superfund Project in the towns of New Bedford, Fairhaven and Acushnet. Tasks performed included: a review of documentary and background research; development of a maritime historical overview of New Bedford Harbor; and magnetic and acoustic remote sensing of portions of the Upper, Lower, and Outer harbors with follow-up target analysis. In addition, seismic (sub-bottom) and bathymetric data were collected during fieldwork activities. The purpose of these investigations was to determine the presence or absence of submerged cultural resources potentially eligible for the National Register of Historic Places that might be affected by dredging to remove contaminated sediments. Analysis of remote sensing data identified sixty magnetic and/or acoustic targets. The vast majority of the targets appear to be related to isolated, single source objects, modern debris, or shoreline-related objects. Two of the remote sensing targets are suggestive of submerged cultural resources. If avoidance at these two target locations is not possible, additional underwater archeological investigation is recommended.

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1.0 INTRODUCTION

1.1 Site/Project Location

The New Bedford Harbor Superfund Site (the site) is located in Bristol County, Massachusetts. It extends from the shallow northern reaches of the Acushnet River estuary south through the commercial port of New Bedford Harbor and adjacent areas of Buzzards Bay. The harbor is flanked by the City of New Bedford on the west and the Town of Fairhaven on the east. The main portion of the harbor, the area between the Route 6 bridge and the hurricane barrier (see Figure 1-1), is naturally deep and is the home for one of the largest commercial fishing fleets in the country. In addition to the commercial fishing vessels, hundreds of recreational sail and powerboats are berthed and moored at marinas and in the various coves that are located across New Bedford Harbor. The sediments in the harbor are contaminated with high concentrations of many pollutants, notably PCBs and heavy metals from the industrial and urban development surrounding the harbor.

The site has been divided into three areas - Upper, Middle, and Outer Harbor - based on geographical features and levels of contamination (see Figure 1-1). The Upper Harbor extends from an area slightly north of the Wood Street Bridge to the Coggeshall Street Bridge. The Middle Harbor extends from Coggeshall Street Bridge to the Route 6 bridge. The Outer Harbor is the area between the hurricane barrier and an imaginary line drawn from Rock Point southwesterly to Negro Ledge and then southwesterly to Mishaum Point.

1.2 Project Background Information

From the 1940s into approximately the 1970s, two electrical capacitor manufacturing plants in the New Bedford area discharged PCB waste either directly into the harbor or indirectly through discharges to the city's sewerage system. In the mid-1970s, as a result of EPA sampling, PCBs were identified in the sediments and the seafood in the New Bedford Harbor area. In 1979, the Massachusetts Department of Public Health issued regulations prohibiting fishing and lobstering throughout the site due to high levels of PCB contamination ranging from below detection limits to higher than 100,000 parts per million (ppm) in various parts of the harbor. The site was included on the Superfund National Priorities List (NPL) in September 1983. EPA's site-specific investigations were initiated in 1983-1984, and included engineering feasibility studies of alternative dredging methods and disposal of contaminated sediments, pilot dredging and disposal studies to field test different dredging and disposal technologies for the contaminated sediments, and extensive physical and chemical computer modeling of the site.

The EPA and USACE entered into an Inter-Agency Agreement in February 1998 that gives the USACE responsibility to provide technical assistance to EPA on New Bedford Harbor. In October 1998, EPA authorized the USACE to perform remedial design activities associated with the Upper and Lower New Bedford Harbor cleanup.

1.3 Project Description

In September 1998, after years of study, public debate, and consensus building, EPA selected a cleanup remedy for the entire Upper and Lower Harbor areas as a solution to the widespread PCB contamination in New Bedford Harbor. The remedy involves the dredging of about 170 acres and containment of approximately 450,000 cubic yards (cy) of PCB contaminated sediment in CDFs. In the Upper Harbor north of Coggeshall Street, sediments with PCB concentrations above 10 ppm will be dredged, and in the Lower Harbor and in salt marshes, sediments above 50 ppm will be dredged. Intertidal sediments in specific areas adjacent to homes and in areas prone to beachcombing will be removed if PCB levels are above 1 and 25 ppm, respectively.

Dredged sediments will be removed from the harbor and pumped to four confined disposal facilities (CDFs) to be constructed along the New Bedford Harbor shoreline. The CDFs will be used to permanently isolate the sediments from the public and the marine environment. The limits of the project areas and the approximate locations of the four CDFs are shown in Figure 1-2. Note that wetland areas subject to beachcombing and areas adjacent to residential areas that may require remediation have not been identified for the Lower Harbor. No dredging is presently planned for the portion of the Lower Harbor south of the Route 6 bridge and north of the hurricane barrier. Each of the CDFs will be capped following the completion of dredging operations and an appropriate period for sediment consolidation.

The CDFs in the Upper Harbor include A, B, and C with layouts as shown in Figure 1-3, 1-4, and 1-5. The conceptual design for CDFs A, B, and C includes earthen embankments on the water side and sheet pile walls on the land side. The structures will isolate the sediments from the environment through a combination of sediments with inherently low permeability and flexible membrane liner (FML) material placed on the interior slopes of the CDFs.

The largest CDF (CDF D) will be located in the Lower Harbor. The conceptual design for this facility includes sheet pile walls on each of four sides of the structure. The long-term objective for this CDF is to facilitate economic development of the New Bedford Harbor waterfront.

In addition to the design and construction of the CDFs, the project includes the relocation of storm drains (SDs) and combined sewer overflows (CSOs), and construction and operation of water treatment facilities to treat the water generated during the dredging and sediment dewatering processes. The water treatment systems will be designed to treat the supernatant from the CDFs.

1.4 The Cultural Resources Program

The USACE has tasked its contractor, Foster Wheeler Environmental Corporation (Foster Wheeler), with a number of pre-engineering and engineering design tasks required to implement the selected cleanup remedy. As per 40 CFR 300.400e, Foster Wheeler is not required to obtain permits and/or waivers from federal, state, or local regulatory agencies for on-site environmental activities associated with EPA's remedial action at the New Bedford Harbor Superfund Site. All activities associated with the CDF, CSO, SD, and associated utility relocations are proximate enough to the site to be considered "on-site activities" related to the remedial action for the New Bedford Harbor Superfund Site. However, as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), EPA, USACE, and their contractors must address and comply with Applicable or Relevant and Appropriate Requirements (ARARs) including the National Historic Preservation Act (NHPA).

Foster Wheeler has contracted with John Milner Associates, Inc. (JMA) to provide assistance and support in collecting, interpreting, and analyzing information about cultural resources which can, in turn, be used by EPA and USACE to satisfy those agencies' obligations under Section 106 of the

National Historic Preservation Act. JMA is being assisted by Dolan Research, Inc. in the area of underwater archeological research (including interpretation and analysis of remote-sensing data) and maritime history. JMA and Dolan Research are also being assisted by CR Environmental (CR). CR, as a subcontractor to JMA, was responsible for providing and operating vessels and the majority of remote sensing equipment used during the cultural resources program. To date, Foster Wheeler has contracted with JMA to prepare a background literature review and archeological sensitivity study, perform an architectural historical survey and inventory, and conduct a marine geophysical/archeological survey.

On July 21, 1999 personnel from JMA, Foster Wheeler, Dolan Research and USACE met with staff representatives of the Massachusetts Historical Commission (MHC) and the Massachusetts Board of Underwater Archaeological Resources (MBUAR) to discuss various aspects of the project. Topics covered included permitting of proposed upland and underwater archeological investigations, proposed scopes of work, and the definition of an Area of Potential Effect (APE) for the project.

This report describes the results of the underwater archeological remote sensing survey and background research related to the maritime history of the project area. On August 29, 1999, Dolan Research submitted a reconnaissance permit application to the MBUAR. The MBUAR subsequently advised Dolan Research that a permit would not be required for the level of investigation being proposed.

The results of the architectural/historical survey and inventory and the archeological literature review and sensitivity study are presented in separate reports.

2.0 MARITIME HISTORICAL OVERVIEW

2.1 Methodology

Prior to conducting fieldwork investigations, background research was undertaken to develop a generalized historic maritime context of the New Bedford Harbor for evaluation of potential historic submerged sites. In addition to inspecting primary and secondary historical data, background research efforts included a records check for known archeological sites and National Register properties in the New Bedford project area and vicinity, and a review of Massachusetts state underwater archeological site files and prior technical reports.

While the emphasis of background research focused on maritime activity in the New Bedford Harbor, a broad-based historic overview was essential for providing the proper framework for assessing the potential significance of submerged cultural resources. Historic maps, secondary and primary shipwreck lists, primary historical accounts, newspapers, and county and thematic histories helped to identify a set of expected resources in New Bedford Harbor. During the course of background research staff contacted local archaeologists, watermen, sport and commercial divers, knowledgeable professional and avocational historians, and interested lay persons who may possess knowledge of the harbor area. Project staff also visited local and county libraries and historical societies. National repositories were also consulted while compiling data for the historic overview. At the National Archives, a variety of record groups contain information on shipwrecks, ship construction, naval activity, and maritime trade activities. Site specific research, pertaining to individual vessels was reviewed at Peabody Essex Museum, Salem, Massachusetts; New Bedford Whaling Museum, New Bedford, Massachusetts; and Independence Seaport Museum, Philadelphia, Pennsylvania. At each repository, computer indexes were inspected for references to specific ship-types, and maritime activity in and around New Bedford. In addition, sources were checked for data concerning potential shipwreck sites in New Bedford. Primary and secondary sources for shipwreck sites were also accessed during the collection of background data.

Information gathered during the background research was used to generate a framework for the project vicinity. The historical framework identified types of resources that may have been deposited in the New Bedford Harbor vicinity, and to determine the nature and extent of subsequent activities that may have removed or disturbed such resources. Each target or site identified during the fieldwork was analyzed and evaluated for potential historical significance within the context of this framework.

2.2 Maritime Historical Overview – New Bedford Harbor

Europeans first documented the Acushnet River and vicinity in 1602 when Englishman Bartholomew Gosnold, aboard the bark *Concord* sailed into the region after sailing from Falmouth, England (Baker, 1980). However, the first permanent European settlement in the study area did not start until 1652 when settlers from Plymouth bought the land presently encompassing Dartmouth, New Bedford, Fairhaven and Westport. New Bedford was part of Dartmouth until the old township was divided in 1787. Fairhaven and New Bedford remained as one township until 1812 (Ricketson, 1858). New Bedford's spacious and naturally deep harbor became an ideal location for the development of the fisheries industry. Whaling soon became the primary industry in New Bedford and Fairhaven. The first whalers in the colonies left from Nantucket and New Bedford as early as 1690.

The country's whaling fleet initially centered on Nantucket Island, began to consolidate on the mainland at and around New Bedford after the Revolutionary War. In 1765, there were only two or three small vessels employed in the whale fishery at New Bedford. In that year, Joseph Russell operated the sloops *Nancy*, *Polly*, *Greyhound*, and *Hannah* (all between 40 and 60 tons) in the local whaling industry. Other boats built and operated by Mr. Russell include; *Joseph & Judith*, *Patience*, *No Duty on Tea*, *Russell*, and *Rebecca*. Russell was instrumental in founding the town of New Bedford to serve as homeport for his growing fleet of whaling vessels. As the principle landowner, Russell had designed the town from the start to be a whaling center. In sub-dividing and selling off his tract, Russell provided sites for shipwrights, boatbuilders, blacksmiths, coopers and other artisans essential to the fishery industry. (Kugler, 1980). Other notable early vessels launched at New Bedford include the merchant vessel *Dartmouth*. She was owned by Francis Roth and later became one of the vessels involved in the Boston Tea Party demonstration in Boston Harbor (Ricketson, 1858).

Another prominent family associated with the formation of New Bedford was the Rotch family. Joseph Rotch and his sons, initially of Nantucket, moved to New Bedford in 1767. They soon became the leading whaling merchants in the colonies. In 1768, Rotch also built New Bedford's first candleworks (Kugler, 1980).

By 1775, almost 50 boats were involved with the expanding whaling industry. However, the British destroyed the eighteenth century whaling industry in Massachusetts during the Revolutionary War. Almost the entire whaling fleet of New Bedford was wiped out during the Revolution: only four or five ships remained out of 200 sail before the war; the rest were lost, buried or captured (Morisson, 1921).

New Bedford was active during the Revolutionary War. Early in the war, New Bedford and Fairhaven inhabitants constructed a fort on the east-side of the Acushnet River at Nobscot. Many privateers were fitted out of Boston and Providence, and many of the prize vessels they captured were sent to New Bedford. Once the British discovered the town was stored with prize goods of every description, Sir Henry Clinton dispatched an expedition under the command of General Gray. On September 5, 1778, a British fleet that consisted of 32 vessels, the largest of which was a 40-gun ship, entered Clark's Cove and formed a bridge of boats to the shore. Approximately 4,000 or 5,000 British soldiers and sailors landed at New Bedford to destroy the vessels in the harbor. Local resident, Mr. Gilbert Russell listed 34 ships that the British destroyed: seven ships, one barque, one snow, eight brigs, seven schooners, and 10 sloops (Russell, cited in Ricketson, 1858).

After the war, the whaling industry slowly revived. It took several years after the peace before any vessels were fitted out in New Bedford. In 1787, there was only one ship (180 tons) and 2 or 3 brigs in the business; but soon after this period the whaling industry revived (Ricketson, 1858). In the last decade of the eighteenth century, both New Bedford and Fairhaven competed with Nantucket and began their rise to world prominence in the whale trade. In 1789, more than 100 whaling vessels operated out of Massachusetts, mostly from Nantucket and New Bedford. In the 1790s New England whalers headed into the Pacific Ocean for the first time. Related maritime industries sprung up in New Bedford, and particularly Fairhaven, in support of the whaling industry, including shipbuilding, ropewalks, and candle factories.

In addition to whaling, merchants also began to ship cargo out of New Bedford after the Revolutionary War. In 1802, some 20 square-rigged merchantmen were sailing from New Bedford. They were carrying cargoes from New York and the southern ports of Europe. Occasionally, voyages were made to the East and West Indies directly from New Bedford. By 1807, New Bedford's waterfront had seven commercial wharves, between 90 and 100 ships and brigs, containing each on an average 250 tons, and between 20 and 30 small vessels: Twelve of the ships were whalers. By that year, three ropewalks were established in New Bedford and one in Fairhaven. Water depth in the harbor was reported between 18 and 24 feet (Ricketson, 1858).

During the War of 1812, the Navy Department provided four Jeffersonian gunboats for defense in Massachusetts; two at Newburyport and two at New Bedford. However, they proved useless. The two New Bedford boats remained hidden in the Acushnet River and did not even attack the *Nimrod* when she stranded on Great Ledge offshore New Bedford. Quaker shipowners who made fortunes by neutral trading before 1812, perceived the future of commerce trading from New Bedford was limited and refitted most of their vessels' as whalers. Typically, local shipowners converted their merchant ships that had outlived their usefulness in the trade service into whalers, a shiptype that required capacity rather than speed as its main attribute (Morison, 1921).

In 1796, a company was created to construct the first bridge across the Acushnet River to connect New Bedford with Fairhaven and Oxford. The bridge was 4,000 feet long including abutments and the two islands it crossed over. The initial bridge was swept away in March, 1807 and was rebuilt later that year. In September, 1815, the second bridge was also washed away. A third bridge was built over the Acushnet River in 1819 and was still being used as of 1858. It was reported that the bridge significantly contributed to the shoaling up of the harbor (Ricketson, 1858). Despite the presence of a bridge, ferries connecting Fairhaven and New Bedford remained active for more than 100 years. The last of these ferries, the Fairhaven, a small side wheel steamer was launched into service on February, 24, 1896. Typically, she made 19 daily roundtrips across the Acushnet River (Whitman, 1994).

New Bedford was made a city in 1847. Whaling was the primary industry and remained so for most of the nineteenth century. In 1838 there were 170 whaling vessels in New Bedford. By 1857, New Bedford's whaling fleet surpassed all other Massachusetts ports combined with 329 whalers, with a tonnage of 111,364 (Sayer, 1889). Fairhaven provided most of the support services required by the whaling industry. With oil refineries, coopers shops, tool works and the other industries subsidiary to whaling, New Bedford Harbor became a center of industry. It became the fifth largest port for shipping in the country. Whaling and the manufacture of whaling products became the leading industry in Massachusetts after shoes and cotton and provided commerce with an important export medium (Morison, 1921). However, by 1888, whaling had declined dramatically. Only 74 whalers worked out of New Bedford in that year, with a tonnage of 18,911 (Sayer, 1889).

New Bedford was an urban center and was served by several steamboat lines during the nineteenth and twentieth centuries. Steamboat service from New Bedford to Nantucket dates to 1829, when Jacob Barker's steamer *Marco Bozzaris* made three trips a week. The New Bedford and Martha's Vineyard Steamboat Company was formed in 1846. In that year, the steamer *Naushon* made three trips a week between Edgartown and New Bedford, with a stop at Woods Hole (Foster & Weiglin, 1989). Steamboat service between New Bedford and New York began in 1853. The New Bedford and New York Steamship Company occupied a long, narrow roofed over wharf that could accommodate the large steamers operating in Long Island Sound (Whitman, 1994). Their boats connected with the Boston, Clinton & Fitchburg Railroad. In 1879 the Old Colony Steamboat Line took over the New Bedford-New York line (Foster & Weiglin, 1989). A second steamboat line, New Bedford, Martha's Vineyard and Nantucket Steamboat Company started service between New Bedford and the two islands in 1854. Assets from this company passed thorough several mergers and were acquired by the New England Steamship Company in 1945. Ships from the Fall River Steam Ship Line also served New Bedford.

Overfishing, a cheaper source of oil, and the Civil War, (Confederate Commerce Raiders captured and destroyed a vast number of New Bedford whalers on the high seas) combined to reduce the role of the whale industry and related maritime commerce. More than 50 whaling vessels were captured by rebel cruisers, 28 of which sailed out of New Bedford. All but a few of the whalers were burned. In June 1865, Confederate Cruiser *Shenandoah* alone captured 25 whalers in Behring strait. Many other whalers were bought by the government during the Civil War. Forty New Bedford whalers purchased by the United States formed the major portion of the two famous stone fleets which in 1861 were sunk off the harbors of Charleston and Savannah to impede blockade runners and privateers (Sayer, 1889). Numerous whalers were also lost in Arctic ice. In September 1871, 33 whaling ships (22 from New Bedford) were crushed by ice in the Arctic Ocean. Arctic mishaps in 1876 and 1888, claimed 17 more whaling ships. Ultimately, the future of whaling as a source of oil was sealed once Colonel Drake discovered oil in the ground in northwestern Pennsylvania in 1859.

By the end of the nineteenth century, whaling had given way to textile mills as the leading industry in the New Bedford economy. Cotton mills, ushered in with the advent of the Industrial Revolution, began to replace the fish-processing and candle-making plants on the New Bedford waterfront. And with the decline of whaling, the shipyards and associated maritime industries were slowly abandoned. It was not until the after the First World War when the introduction of diesel powered fishing boats allowed vessels to economically reach the rich offshore fishing banks that New Bedford once again became a prominent fishing port.

3.0 SUBMERGED CULTURAL RESOURCES

3.1 National Register of Historic Places Evaluation Criteria

Nautical vessels and shipwreck sites are generally, excepting reconstructions and reproductions, considered historic if they are eligible for listing in the National Register of Historic Places. As set forth at 36 CFR 60.4, to be eligible for the National Register of Historic Places, a vessel or site must be significant "in American history, architecture, archeology, engineering, or culture" and "possess integrity of location, design, setting, materials, workmanship, feeling, and association" and meet one or more of the following criteria:

a. be associated with events that have made a significant contribution to the broad patterns of our history; or

b. be associated with the lives of persons significant in our past; or

c. embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

d. have yielded, or may be likely to yield, information important in prehistory or history.

National Register of Historic Places Bulletin 20 clarifies the National Register review process with regard to shipwrecks and other submerged cultural resources. Shipwrecks must meet at least one of the above criteria and retain integrity of location, design, settings, materials, workmanship, feelings and association. Determining the significance of a historic vessel depends on establishing whether the vessel is:

1. the sole, best, or a good representative of a specific vessel type; or

2. is associated with a significant designer or builder; or

3. was involved in important maritime trade, naval recreational, government, or commercial activities.

Properties that qualify for the National Register must have significance in one or more "Areas of Significance" that are listed in *National Register Bulletin* 16A. Although 29 specific categories are listed, only some are relevant to the submerged cultural resources in New Bedford Harbor. Architecture, commerce, engineering, industry, invention, maritime history and transportation are potentially applicable data categories for the type of submerged cultural resources that may be expected in the Acushnet River study area.

3.2 Shipwrecks in the New Bedford Vicinity

A wide variety of shipwrecks may exist in New Bedford's harbor. Historic records indicate that maritime activity in the region's waterways dates to the first decade of the seventeenth century. The first documented shipwreck losses in the region are associated with Revolutionary War activity in September 1778. In the nineteenth century, New Bedford became the principal whaling port in the country and was home for hundreds of square-rigged whalers. Although whaling was phased out as an industry by the end of the nineteenth century, New Bedford has remained a preeminent commercial fishing port throughout the twentieth century. Shipwrecks undoubtedly occurred in and around New Bedford harbor during each phase of the port's historical development. However, it is highly unlikely that any intact wrecks remain within the navigable portions of the harbor, since they would have been removed long ago as a hazard to navigation. Nonetheless, a list of shipwrecks and derelict vessels provides insights into the expected vessel types that might be found in and around New Bedford.

A number of sources were accessed during the compilation of wrecked vessels in New Bedford's Harbor. The lists have been divided according to the sources. In all, more than 65 different vessels are documented as wrecked in or around New Bedford Harbor.

The following is a shipwreck list maintained at the Massachusetts Board of Underwater Archaeological Resources (MBUAR). It was provided by Mr. Victor Mastone, MBUAR Director. The vast majority of the sites included in the list were derived from data gathered by Mr. Brad Luther, local expert on New Bedford Harbor, and Mr. John Fish, an underwater researcher.

Name	Date	Type	Where
Wasp	6/12/1903	Barge	New Bedford
Thomas H. Lawrence	9/21/1938	Schooner	West of Palmer's Island, New Bedford Harbor
H.M.S. *Nimrod*	1815		Mass. Location Database
Unidentified	1/7/1844	Schooner	Near New Bedford
Rival	10/14/1844	Brig	Ashore at New Bedford
Caravan	11/6/1847	Schooner	Off New Bedford
Chopaquoit	1947	Ketch	Off West Beach, Westport
Aloha	3/13/1870	Bark	New Bedford
A. Francis Edwards	5/26/1892	Schooner	New Bedford
Freeman	9/15/1898	Schooner	New Bedford
Rattler	10/13/1915	Oil	New Bedford
Sally W. Ponder	10/9/1916	Schooner	New Bedford
Lorna	11/1923	Gas	New Bedford
Mogadore	9/11/1930	Gas	New Bedford
Althea Louke	12/4/1932		New Bedford
Eurybia	8/9/1935	Gas	New Bedford
Winifred	9/21/1938	Oil	New Bedford
Alma Bell	9/14/1944	Oil	New Bedford
Marion Dorothy	9/14/1944	Oil	New Bedford
Alice May	1950		New Bedford
Debbie II	8/1954	Gas	New Bedford
Rose Mary Mello	8/31/1954	Oil	New Bedford
Phillip R.	11/15/1954	Barge	New Bedford
Onward	3/17/1956	Oil	New Bedford
Mariner	1956	Yacht	Fairhaven, 1 mile east of West Island
Francis Edward	5/1892		Fairhaven

Shipwrecks listed for the New Bedford/Fairhaven vicinity in *Encyclopedia of American Shipwrecks* (Berman, 1972) include:

Lizzie W. Hannum, a two-masted schooner, wrecked at Great Ledge, Buzzards Bay on April 10, 1895
Marjorie Parker, an oil screw vessel, 76 tons, built in 1923, foundered at Fairhaven on August 31, 1954
Olive M. Williams, an oil screw fishing boat, 50 tons, built in 1928, sank in a storm at Fairhaven on September 1, 1954.
Sally W. Ponder, schooner, 107 tons, built in 1855, foundered at New Bedford on October 9, 1916.
Sankaty, steam screw, 677 tons, built in 1911, burned at New Bedford on June 30, 1924.
Wm A. Grozier, schooner, 116 tons, built in 1865, foundered off New Bedford on July 1, 1913.

Local New Bedford resident, Mr. Gilbert Russell listed by name and type each vessel that was destroyed by the British expedition on September 5, 1778 (in Ricketson, 1858, pg. 75).

Leopard, Ship
Spaniard, Ship
Caesar, Ship
Nanny, Barque
Rosin, Brig
Sally, Fishing Brig
Simeon, Snow
Sally, Continental Brig
Adventure, Schooner
Loyalty, Continental Schooner
Nelly, Sloop
Fly Fish, Sloop
Captain Lawrence, Sloop
Defiance, Schooner
Captain Jenny, Schooner
No Duty on Tea, Brig
Sally, Schooner
Bowers, Sloop
Sally (12 guns), Sloop
Ritchie, Brig
Dove, Brig
Holland, Brig
Joseph R, Sloop
Bociron, Sloop
Pilot Fish, Sloop
The Other Side, Schooner
Sally, Brig
Retaliation, Sloop
J. Brown's, Sloop
Eastward, Schooner

Other documented wrecks in the vicinity include:

Capt. Lavoeiro, 75-foot long New Bedford fishing vessel sank at the State Pier on December 26, 1984, after it struck a barge outside the harbor and returned to the pier where it sank. However, salvagers used a crane and divers to raise it three days later (Quinn, 1988)

3.3 Removal of Derelict Vessels

In 1989, a project was conducted to identify and remove derelict vessels from around the harbor. Parson, Brinckerhoff, Quade, & Douglas, Inc., (Parsons) organized the project that removed 13 derelict boats from New Bedford Harbor, in the municipalities of Fairhaven and New Bedford (Parsons 1989). Seven of those vessels were located in Fairhaven and six were in New Bedford.

One of the derelict vessels, the 85-foot long *Evelina Goulart*, in Fairhaven, was raised on May 25, 1989. She was towed to the Essex Shipbuilding Museum where it was to be restored, near where it was launched in 1927, as one of the last sail-driven fishing schooners.

Other derelict vessels that were removed in 1989 include:

1. a 30-foot wood hull boat (Fairhaven),
2. three construction barges, approximately 60-feet x 20-feet (Fairhaven),
3. a 40-foot fiberglass (Fairhaven),
4. a 20-foot wood vessel (Fairhaven),
5. a barge, approximately 150-feet x 32-feet (New Bedford),
6. a fishing vessel, *Alydar*, approximately 92-feet x 26-feet (New Bedford),
7. a fishing trawler, *Plymouth*, approximately 100-feet x 28 feet (New Bedford),
8. two barges, each approximately 150-feet x 32-feet (New Bedford),
9. a Navy Launch, approximately 150-feet x 32-feet (outside of Hurricane Barrier, New Bedford).

3.4 Potential Submerged Cultural Resource Types

Recorded maritime activity in the New Bedford region dates to the first decade of the seventeenth century. However, it was not until the middle of the eighteenth century that the port of Dartmouth/New Bedford became a prominent fishing harbor. From that era to present, the harbor in the Acushnet River has hosted a consistently high volume of maritime traffic.

Historic documentation confirms that many types of ships and vessels were wrecked in the New Bedford vicinity. A preliminary list of documented vessels wrecked or lost in New Bedford (see Section 3.2) provides an indication of the quantity and types of shipwreck sites that have been deposited on the bottom of the waterway. Drawing from a variety of primary and secondary sources, these lists, while far from comprehensive, give an indication of the wide variety of shipwrecks that have been lost in the waterway over the last 225 years.

Potential shipwreck types in/near New Bedford may include a variety of material dating from Revolutionary War-era through the twentieth century. To discuss the types of vessels potentially present, it is necessary to include vessels from all phases of the commercial and naval activity in this portion of Massachusetts. Wood-hulled ships, ranging from small fishing sloops, shallops, brigs, recreational sailing craft, gas/diesel powered fishing trawlers and coastal schooners, to ship-rigged whalers, have been likely lost near New Bedford. Numerous steamers and ferries also plied the Acushnet River for well over 150 years. Iron-hulled vessels, including paddle wheel and screw steamboats, have been used extensively in the harbor. Indigenous, small rowed- and sailed-vessels were also used throughout all active harbors. Since such a wide range of vessels has been used in New Bedford over such an extended time period, it is almost impossible to feature one particular type of vessel type most likely to be found. Many of these types of vessels would lend historic insights into a wide-range of maritime-related topics and would be considered historically significant.

4.0 PREVIOUS UNDERWATER ARCHEOLOGICAL INVESTIGATIONS

MBUA files contained information on only one previous underwater archeological survey in the project vicinity. Robert Cembrola served as the Principal Investigator for the Marine Archaeological Report that was completed for the New Bedford Phase II Facilities Plan (Cembrola, 1989). Potential submerged cultural resources were identified within a three-mile vicinity of two candidate outfall diffuser sites and within 0.5 miles on either side of the proposed outfall pipeline alignment that extended from the southern tip of New Bedford out 3.5 miles into Buzzards Bay. Two known wrecks sites, the *Margeret Kehoe*, a 62-ton fishing boat sank near Church Rock in 1963, and the *Yankee*, a 6,225 ton, 391-foot steam ship ran aground and sank on Great Ledge on September 23, 1908, were identified in Buzzards Bay, near the mouth of the Acushnet River. The wrecks were outside the area affected by the outfall pipeline and no additional fieldwork was conducted.

5.0 FIELDWORK INVESTIGATION

The remote sensing survey area was divided into three parts: the Outer Harbor (on the outside of the Hurricane Seawall at the entrance to New Bedford Harbor); the Middle Harbor (between the Route 6 bridge and the I-195 bridge); and the Upper Harbor (above the I-195 and Coggshall Street bridges) (Figure 5-1). Water depth varied from 30 feet deep in the outer harbor to areas of less than one foot in sections of the upper harbor. All survey work in the shallow sections of the upper harbor was conducted at or near high tide.

Fieldwork investigations were conducted in the Acushnet River from August 30 – September 11, 1999. The goal of the remote sensing survey was to identify remote sensing targets in the three survey areas and determine if any were suggestive of submerged cultural resources.

5.1 Description of Fieldwork Methodology

John H. Ryther, Jr., managed CR Environmental's field effort and worked closely with the project underwater archeologist, Lee Cox (Dolan Research), and Foster Wheeler geophysicists, Jay Borkland and Richard Funk. CR provided U.S. Coast Guard licensed vessel captain/navigators, Mr. Andrew Spinale or Eric Steele and experienced side-scan sonar/sub-bottom profiler technicians, Mr. Vince Capone or Chris Wright. CR and DR provided all the required equipment for the survey and were familiar with all equipment operations. Foster Wheeler personnel operated the X-Star sub-bottom profiler during survey operation. All CR and Dolan personnel were OSHA health and safety trained and complied with all applicable OSHA and Foster Wheeler Site Specific Safety and Health Plan (SSHP) requirements. All personnel participated in a site orientation and health and safety briefing with Tom Hawthorne, the site Health & Safety officer prior to the survey operation.

Field operations for the remote sensing survey in the outer, middle, and portions of the upper New Bedford Harbor were performed from the 32-foot aluminum survey vessel *Cyprinodon*. This vessel has a large pilothouse for electronics, a five-kilowatt generator, a hydraulic winch, an A-frame for the deployment of equipment, and can accommodate a five or six man survey crew. The vessel is shallow draft, and the mast and A-frame easily fold down permitting access under the I-195 and Coggshall Street Bridges. During the survey operations, the vessel navigated all the required portions of the outer and lower harbor. In the upper harbor, above the Coggshall Street Bridge, the vessel operated at high tide periods in water depths of three to four feet.

On the mud flats in the upper harbor project area, in water depths of one to three feet and in the shallow coves of the middle harbor, a 16-foot aluminum jon boat was utilized to support the survey operation. The vessel accommodated a survey crew of three and was used for side scan sonar, sub-bottom profiling and marine magnetometer surveys in these shallow water areas. The vessel has a 15 horsepower gas outboard and was operated in depths of less than one foot. The vessel was outfitted with a plywood enclosure to house the survey equipment and a Honda generator in the bow. Magnetometer, sonar, and sub-bottom operations were performed at separate times due to space limitations.

A Geometrics, G-881, cesium magnetometer, capable of +/- .001 gamma resolution, was employed to collect magnetic remote sensing data. A 1-second sampling rate by the magnetometer's towed sensor, coupled with a three to four knot vessel speed, assured a magnetic sample every four to five feet. Sonar data was collected with an Edgetech DF-100 dual frequency towfish with a Digital Control Interface (DCI). The DCI board was installed in a Triton Elics Isis Sonar Data Acquisition and Processing System. Sub-bottom data was also collected with an Edgetech Geo-Star Sub-Bottom Profiler with a SB-216S towfish. Navigation positioning for the survey was accomplished with a Trimble Pathfinder Pro XL Global Positioning System with the Pro Beacon providing differential corrections. Line spacing for the entire project was maintained at 50-foot offsets.

Horizontal positioning for the survey was accomplished with a Trimble Pathfinder Pro XR Global Positioning System with the Pro Beacon (DGPS). With this system, differential corrections were obtained from the Coast Guard Beacons and sub-meter accuracy was achieved. The NEMA data output from the Trimble GPS was output to a NEMA splitter box and navigation strings were furnished to the side-scan sonar, sub-bottom profiler, and HYPACK navigation software.

5.2 Analysis of Remote Sensing Data

Analysis of remote sensing signatures identified during the survey was based on several criteria. Magnetometer data were contour plotted and each anomaly was analyzed according to: magnetic intensity (total distortion of the magnetic background measured in gammas); pulse duration (detectable signature duration); signature characteristics (negative monopolar, positive monopolar, dipolar, or multi-component); and spatial extent (total area of disturbance). Acoustic targets were analyzed according to their spatial extent (total area of disturbance), signature characteristics (shape, relief above the bottom, strength of return and contrast with the background) and environmental context. Seismic (sub-bottom) data were collected primarily for the geophysical survey of the project areas (FWENC 2001). Analysis of this data was useful in mapping the depth of bedrock. Dolan Research did not identify any potential shipwreck sites or other submerged cultural resources during the analysis of the seismic data.

Criteria for analyzing remote sensing targets have been developed from a database of target signatures that have been compiled over the last three decades. Starting in the 1960s, archaeologists primarily relied on magnetic remote sensing data, collected with proton procession magnetometers, to locate submerged cultural resources. However, magnetic data collected alone often provides inconclusive evidence on submerged cultural resource sites. Underwater archeological research conducted over the last two decades indicates that shipwreck sites may produce a variety of magnetic signatures. Furthermore, modern debris often generates magnetic signatures that may share similar characteristics with certain types of shipwreck sites.

The ambiguous nature of magnetic signatures has led researchers to use acoustic and occasionally sub-bottom remote sensing equipment in conjunction with a magnetometer on most underwater archeological surveys. Side-scan sonar units gather acoustic data by processing sound waves emitted into the water column on both sides of the submerged sensor. The sound waves are then bounced back off the bottom surface and exposed objects. State of the art digital sonar units produce high-resolution records that are almost photographic in quality. However, a certain degree of structural integrity of a shipwreck site must remain above the bottom to produce a reliable shipwreck signature on side scan sonar. Where no structure survives above the bottom surface, researchers must rely on magnetic data to help locate shipwreck remains. Additional data provided by acoustic instruments frequently permits target identification to be made solely from remote sensing information. A combination of magnetic and acoustic remote sensing data has proven to be the most effective method to accurately identify and assess submerged archeological sites. Typically, the most attractive targets produce both a defined magnetic and acoustic signature.

In preparing the technical report, remote sensing targets were characterized according to potential significance. Target locations that generated signature characteristics suggestive of submerged cultural resources were designated as High Probability Targets. All other targets, including single source objects and modern debris, were simply listed as targets. Additional underwater archeological investigations were recommended at the former type of targets.

5.3 Findings of Remote Sensing Survey

Targets have been listed according to the survey area where they were found (Outer Harbor, Middle Harbor, and Upper Harbor). Each target has been designated with a number that was derived from the lane number where the signature was most intense, followed by a colon and the corresponding event number along that survey lane. Types of targets refer to magnetic (m) targets, sonar (s) targets; and combined (m/s) magnetic targets with an associated sonar image. Also included in the target list are the position coordinates for each target, expressed in Massachusetts State Plane Coordinate System (NAD83) and target characteristics and comments.

Magnetic samples were collected at one-second intervals. Boat speed during the survey did not exceed four knots, assuring a magnetic sample every four to five feet. The two-channel 500 kHz side scan sonar sensor had an effective range of 150 feet in either channel. Lane spacing for the survey was established at 50-foot offsets.

Sixty (60) remote sensing targets were identified during the survey. Of that number, 10 targets were found in the Outer Harbor, 27 targets in Middle Harbor, and 23 targets in Upper Harbor. Two targets, both in the Middle Harbor Area, generated remote sensing signatures that are suggestive of submerged cultural resources. Additional underwater archeological investigation is recommended at these locations.

The remaining targets were identified as an assortment of modern debris objects, shore related noise, and sections of pipe or pieces of wire rope. Many other sources of magnetic and acoustic anomalies were not classified as target sites. These objects and features include: barges, power lines, rocks and rock outcroppings, outfall pipes, power transmission lines, submerged pipelines, wharves, moored fishing vessels and sailboats, and iron bulkheads. However, many of these features and other assorted objects *were* designated as targets during a separate review of project data conducted by Foster Wheeler Environmental Corporation geophysicists. A list of these magnetic and acoustic contacts is presented in FWENC (2001). Dolan Research has reviewed these lists and associated data and concluded they contain no additional targets that could represent potentially significant submerged cultural resources.

At the two potentially significant target locations, a Phase II underwater archeological investigation with divers is recommended if the Project will affect the targets. The goal of the diver investigations will be to identify the nature of the material/object that generated the remote sensing signature and to determine if the site has potential to satisfy the National Register of Historic Places eligibility criteria. No further underwater archeological investigation is recommended for the other targets.

5.3.1 Outer Harbor Project Area

Survey work at the Outer Harbor project area was conducted on August 30 & 31, 1999. Large-scale magnetic variations were recorded across much of the Outer Harbor survey area. The background magnetic changes were likely related to geological features, such as rock outcrops, that were present on both shorelines. Sonar records indicate the presence of numerous large rocks in the cove next to the west end of the Hurricane barrier. Due to the presence of these large rock formations in shallow water, no survey lanes were completed next to the New Bedford Harbor hurricane barrier (Figure 5-2). It appears that much of Outer Harbor project area had a hard bottom, making it unlikely that historical material would have survived intact in the high-energy environment present at the mouth of the Acushnet River. Ten magnetic targets were identified during the survey (Figure 5-3). However, target signatures at each site lacked duration and intensity, indicating single-source, isolated objects. None of the ten targets (Table 5-1) were considered to be suggestive of submerged cultural resources. A side scan sonar mosaic plan of the outer harbor project area was also generated (Figure 5-4). No targets of potential significance were identified. No additional underwater archeological investigation is recommended.

5.3.2 Middle Harbor Project Area

Survey work at the Middle Harbor project area was conducted on September 1–3, 1999 (Figure 5-5). In the Middle Harbor survey area, magnetic noise was generated by multiple factors (Figure 5-6). These include; metal bulkheading along much of New Bedford's waterfront and Pope Island, the Fairhaven bridge, steel-hulled fishing boats tied up to wharves at New Bedford and Pope Island, several large moored barges and tugs, moored sailboats, submerged pipeline crossings, and the presence of a fleet of derelict vessels abandoned adjacent to the New Bedford waterfront at the proposed location of CDF D. These sites were not considered remote sensing targets. Buried submerged cultural resources may exist in these areas, but their presence would be masked by the large-scale magnetic disturbances generated by those objects.

Twenty-seven remote sensing targets were identified in the Middle Harbor project area (Table 5-2). All but two of those were dismissed as modem, noise- or debris-related. Two of the magnetic targets generated remote sensing signatures with extended duration and significant ferrous mass to be considered suggestive of submerged cultural resources.

The two magnetic targets of potential significance were designated 27:196 & 66:161. They are shaded in Table 5-2. If this target will be affected by the Project, underwater archeological investigation is recommended to identify the material/object(s) that were responsible for generating the remote sensing signature. Once the target source has been identified, researchers will evaluate each site's potential historical significance according to National Register criteria.

A side scan sonar mosaic plan of the middle harbor project area was generated (Figure 5-7). While no potential historically significant shipwreck sites were found on the side scan data, inspection of the acoustic data confirmed the presence of a short section of railroad tracks close to the New Bedford shoreline (Figure 5-8). This site was designated Target 24:693. The presence of the structure appears to corroborate anecdotal evidence from town records and rumors from long-time residents that a section of railway track that once spanned the river south of the Coggshall Street Bridge – and was destroyed by a mid-century hurricane – may have been left in the harbor. Sonar records also indicate the presence of several pipeline crossings under the

Acushnet River. Very shallow water along the Fairhaven side of the harbor, north of the cove with the moored pleasure boats, required the use of a small 16-foot aluminum jon boat to complete remote sensing survey coverage.

5.3.3 Upper Harbor Project Area

Magnetic survey work at the Upper Harbor project area was conducted on September 4 and 11, 1999. (Figure 5-11). Limited sonar data were collected on September 3, 1999. All survey work was conducted from the 16-foot jon boat.

Twenty-three magnetic targets were identified during the survey (Figure 5-9)(Table 5-3). However, none of the targets generated signatures that are typically associated with submerged cultural resources. Large magnetic anomalies were identified adjacent to CDF A. (39:609 and 52:141) and CDF B (39:235, 41:444, and 41:348). However, the intensity of the target signatures suggest the target sources are related to modern debris or shoreline-related noise. In the northern end of the Upper Harbor project area, several power lines crossed the Acushnet River and generated large linear magnetic disturbances. Numerous shoreline-related magnetic anomalies were recorded along the western shoreline of the river, particularly adjacent to CDF C.

Much of the Upper Harbor survey area had shallow water conditions that limited the collection of sonar data. Sonar equipment was only deployed in areas that had a minimum six-foot depth. A side scan sonar mosaic plan of the upper harbor project area was also generated (Figure 5-13). However, no targets of potential significance were identified.

5.3.4 Derelict Vessels in Former Shipyard Adjacent to CDF D

A fleet of derelict vessels has been abandoned along a portion of the New Bedford waterfront known as the Melville Shipyard (Plate 1). The collection of fishing boats, tugs, and barges survive in varying states of disrepair. Additional information on the origin of the abandoned boats was obtained from correspondence with Chip Ryther (CR Environment); and Marty Manly (harbormaster at the Pope Island Marina).

The following boats and boat types have been identified in the shipyard:

> Five "eastern rig" wooden-hull scalloper fishing vessels. All appear to date to ca. 1950. They are approximately 60- to 70-feet long. At least three of them are partially submerged; including the *Commonwealth* (Plates 2 and 3), *Geraldine*, and *Alcha*.
>
> Other fishing vessels include the *Neisha Ann*, (a fiberglass boat, approximately 40-feet long); *Green Acres* (a modern western rig fishing boat); a second unidentified western rig fishing boat; (Plate 4). and *Jeroni*, (a 50-foot gill netter fishing boat).
>
> Two partially submerged barges; one was outfitted with what appears to be a fish processing plant (Plate 5).
>
> A small coastal tug, (ca. 1930, approximately 70-feet long); and an unidentified larger tug.
>
> An aluminum boat, approximately 45-feet long, on the shore under a shed.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Historic sources confirm a sustained level of maritime activity in New Bedford harbor since the middle of the eighteenth century. Dozens of vessels were documented as having been stranded, foundered, burned, capsized and destroyed in the New Bedford vicinity. Secondary sources have listed numerous wrecks in the project vicinity. Many of these vessels, including a number of Revolutionary War wrecks, were lost in the section of the harbor between the Route 6 bridge and the Hurricane Wall – outside the limits of this project. In addition, large portions of the harbor have been dredged during navigational improvements and many potential submerged sites were likely removed long ago as hazards to navigation. Since New Bedford is still a very busy commercial port, it is unlikely that potentially significant submerged cultural resources have been deposited within New Bedford harbor and have remained undetected and unknown. Local residents and watermen familiar with the harbor were unaware of any potential wreck sites within the harbor. Nonetheless, the harbor potentially contains cultural material from each phase of the port's extensive maritime history.

In an effort to identify submerged cultural resources that may be affected by the dredging of the Acushnet River and New Bedford Harbor, a comprehensive Phase I remote sensing survey was conducted across three project areas: Outer Harbor, Middle Harbor, and Upper Harbor. Magnetic and acoustic remote sensing records were processed and correlated to determine the presence of targets that possessed signature characteristics suggestive of submerged cultural resources. Although analysis of the remote sensing data identified 60 magnetic and/or acoustic targets in the three project areas, only two remote sensing targets (27:196 & 66:161) were considered to be significant targets. Both of the targets were located in the Middle Harbor project area. Both targets generated magnetic signature characteristics suggestive of submerged cultural resources and were designated as High Probability Targets where additional archeological investigation or avoidance, if possible, should be considered.

Avoidance of the two specified target locations during dredging activities should be given consideration. If site avoidance is not a viable option, additional archeological investigation at these targets is recommended to determine the nature of the object(s) responsible for generating the remote sensing signatures. The goal of the ground truthing of these targets would be to determine National Register-eligibility status of the submerged sites. After the object(s) have been identified and documented, field data would be correlated with background historical information. Each site's historical context and the field data documenting their respective integrity, qualities, associations, and characteristics, would be used to confirm National Register eligibility requirements. The National Register criteria could then be applied to provide recommendations pertaining to the eligibility or ineligibility of each of the sites. Sites with the potential for inclusion in the National Register, would then become the focus of a more detailed archeological investigation.

A fleet of derelict vessels has been abandoned adjacent to New Bedford waterfront in the Middle Harbor project area. Eastern rig- and western rig-fishing boats, tugboats, and barges comprise the cluster of half submerged boats that are located in an area that has become known as the Melville shipyard. The location of the shipwreck cluster is within the boundaries of CDF D. While the majority of the vessels have little or no historical value, one of the tugboats and one or more of the eastern-rigged fishing vessels may have historical significance. Additional documentary research about the vessels and vessel-types, and a complete photographic documentation of those two sites, is recommended. This information is necessary to determine if either site satisfies

National Register eligibility criteria. Appropriate vessels should be documented on inventory forms as per the BUAR in order to document National Register eligibility.

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TABLES

Table 5-1. Remote-sensing targets identified in the Outer Harbor portion of the project area.

Target #	Type	Coordinates (Mass NAD 83)	Comments:
17:375	M	E 818,663 N 2,687,563	99 gamma positive, monopolar signature; 9 sample intervals, near boat channel, appears to be an isolated object
25:317	M	E 818,663 N 2,687,563	56 gamma negative, monopolar signature; 7 sample intervals, small, isolated object
34:125	M	E 818,818 N 2,687,087	70 gamma positive, monopolar signature; 6 sample intervals, isolated object
39:110	M	E 818,412 N 2,686,308	61 gamma positive, monopolar signature; 8 sample intervals, also detected in lane 40, likely associated with debris
42:154	M	E 818,791 N 2,686,512	98 gamma positive, monopolar signature; 6 sample intervals
42:198	M	E 818,562 N 2,686,242	80 gamma negative, monopolar signature; 5 sample intervals, small isolated object
48: 59	M	E 818,638 N 2,685,988	47 gamma positive, monopolar signature; 5 sample intervals, very small , isolated object
49:42	M	E 818,466 N 2,685,763	125 gamma dipolar signature; 6 sample intervals, isolated object
52:162	M	E 819,256 N 2,686,309	126 gamma dipolar signature; 7 sample intervals, isolated object
54: 32	M	E 819,560 N 2,686,495	77 gamma negative, monopolar signature; 12 sample intervals, broad, likely associated with a boat turn

Table 5-2. Remote-sensing targets identified in the Middle Harbor portion of the project area.

Target #	Type	Coordinates (Mass NAD 83)	Comments:
16:61	S	E 814,446 N 2,697,277	linear hard object that becomes buried in bottom, possible pipeline
24:241	S	E 814,450 N 2,695,582	isolated rectangular object lying flat on the bottom, located near bulkhead
24:693	S	E 814,602 N 2,698,873	A 55-foot section of railway track is lying flat on the bottom next to a large rock pile (Figure 5-8). The rails do no appear to be from a marine railway, but rather may be debris from a former railway bridge that crossed the river south of the Coggshall Street Bridge. That bridge was destroyed by a hurricane in the middle of the twentieth century.
25:535	M	E 814,617 N 2,697,643	144 gamma negative, monopolar signature; 5 sample intervals, small, isolated object
26:390	S	E 814,596 N 2,696,787	three small hard objects, one may be a mooring anchor; also identified during lane 30 @ event #339
24:689	S	E 814,487 N 2,694,892	small hard object located 35 meters out in left channel, target location is in the middle of the channel and is considered to be modern debris
27:196	**M**	**E 814,617 N 2,697,643**	**515 gamma dipolar signature; 12 sample intervals, large, buried target; evidence of the broad target signature was found in several lanes; if this target will be affected by the Project, underwater archeological investigation is recommended**
31:30	M	E 814,886 N 2,698,320	50 gamma positive, monopolar signature; 5 sample intervals, small, isolated object
33:143	S	E 814,785 N 2,695,438	isolated circular object lying flat on the bottom, located in the middle of the channel and is considered to be modern debris
33:721	S	E 814,984 N 2,699,107	small, hard rectangular object, lying flat on the bottom, possibly associated with object at 33:736, modern debris
33:736	S	E 814,986 N 2,699,198	small, hard rectangular object, lying flat on the bottom' possibly associated with object at 33:721, modern debris
37:372	M	E 815,042 N 2,696,680	248 gamma positive, monopolar signature; 4 sample intervals, small, isolated object
42:482	M/S	E 815,279 N 2,697,639	128 gamma positive, monopolar signature; 11 sample intervals, noisy associated targets found in 2 nearby lanes, likely associated with a pipeline crossing – see targets 45:123 & 47:421
45:123	M	E 815,273 N 2,697,267	152 gamma dipolar signature; 9 sample intervals, noisy associated targets found in 3 nearby lanes, likely associated with a pipeline crossing – see targets 42:482 & 47:421
47:421	M	E 815,385 N 2,697,936	286 gamma positive, monopolar signature; 6 sample intervals, noisy associated targets found in 2 nearby lanes, likely associated with a pipeline crossing – see targets 45:123 & 42:482
49:229	M	E 815,326 N 2,696,352	14 gamma dipolar signature; 6 sample intervals, small, isolated object
51:167	S	E 815,821 N 2,695,457	small wreck-like image; possibly a small boat that was abandoned near marina, all indications point to a modern boat
66:161	M	**E 815,602 N 2,696,988**	**282 gamma positive, monopolar signature; 14 sample intervals, although near a mooring buoy this signature appears to have a separate, extended duration component; if this target will be affected by the Project, underwater archeological investigation is recommended**
72:269	M	E 815,657 N 2,696,095	48 gamma dipolar signature; 10 sample intervals, 8 feet deep, small, isolated object

80:147	M	E 815,895 N 2,696,676	117 gamma negative, monopolar signature; 12 sample intervals, next to moored sailing boat, likely associated with mooring anchor and/or boat
84:136	M	E 815,983 N 2,696,144	554 gamma multi-component signature; 5 sample intervals, noise-related target signature with 2 positive spikes
84:199	M	E 815,959 N 2,695,740	55 gamma positive, monopolar signature; 5 sample intervals, small, isolated
87:66	M	E 816,072 N 2,695,956	46 gamma negative, monopolar signature; 6 sample intervals, small, isolated
88:60	M	E 816,125 N 2,695,664	114 gamma negative, monopolar signature; 9 sample intervals, noisy, possibly related to shoreline debris
92:20	M	E 816,392 N 2,697,562	59 gamma negative, monopolar signature; 6 sample intervals, small, isolated object
94:103	M	E 816,419 N 2,696,973	653 gamma dipolar signature; 18 sample intervals, associated with shoreline noise, located in very shallow water
94:170	M	E 816,419 N 2,696,973	194 gamma multi-component signature; 6 sample intervals, associated with shoreline noise, very shallow water

Table 5-3. Remote-sensing targets identified in the Upper Harbor portion of the project area.

Target #	Type	Coordinates (Mass NAD 83)	Comments:
14:28	M	E 814,626 N 2,702,290	243 gamma positive, monopolar signature; 5 sample intervals, small, and located in very shallow water in cove above CDF C
14:42	M	E 814,631 N 2,702,218	126 gamma negative, monopolar signature; 4 sample intervals, small and located in very shallow water in cove above CDF C
32:132	M	E 815,032 N 2,701,438	846 gamma negative, monopolar signature; 4 sample intervals, intense, no duration, likely related to object(s) associated with CDF C
32:147	M	E 815,033 N 2,701,311	230 gamma negative, monopolar signature; 3 sample intervals, intense, no duration, likely related to object(s) associated with CDF C
33:184	M	E 815,096 N 2,701,741	40 gamma positive, monopolar signature; 4 sample intervals, small, isolated object
34:117	M	E 815,097 N 2,701,199	448 gamma dipolar signature; 12 sample intervals, intense, noisy target likely related to object(s) associated with CDF C
34:56	M/S	E 815,098 N 2,700,745	695 gamma positive, dipolar signature; 12 sample intervals, rockpile/pipeline site extending from shoreline
36:119	M	E 815,134 N 2,701,547	279 gamma negative, monopolar signature; 4 sample intervals, intense, no duration, isolated object
39:150	M	E 815,209 N 2,702,975	113 gamma dipolar signature; 7 sample intervals, intense, limited duration, related to shoreline object(s)
39:235	M	E 815,183 N 2,703,733	136 gamma dipolar, monopolar signature; 8 sample intervals, intense, related to shoreline object(s), possibly a pipe; likely associated with target 41:444
39:607	M	E 815,029 N 2,705,557	60 gamma dipolar signature; 6 sample intervals, small, limited duration signature, related to shoreline object(s)
40:248	M	E 815,253 N 2,702,746	297 gamma negative, monopolar signature; 10 sample intervals, intense, likely associated with shoreline object(s)
41:348	M	E 814,981 N 2,704,675	680 gamma dipolar signature; 10 sample intervals, very intense, related to shoreline object(s), suggestive of a pipe
41:444	M	E 815,057 N 2,703,922	584 gamma negative, monopolar signature; 12 sample intervals, very intense, related to shoreline object(s), suggestive of a pipe; likely associated with target 39:235
45:229	M	E 815,498 N 2,702,146	149 gamma dipolar signature; 6 sample intervals, small isolated object
46:425	M	E 815,532 N 2,702,386	246 gamma dipolar signature; 6 sample intervals, small, isolated object
48:401	M	E 815,627 N 2,701,017	99 gamma noisy dipolar signature; 12 sample intervals, noise spikes typically associated with modern debris
52:141	M	E 815,667 N 2,706,454	85 gamma positive, monopolar signature; 4 sample intervals, may be associated with submerged object crossing the river; possible association with target 59:148 and 63:73; target location is adjacent to CDF A
54: 32	M	E 819,560 N 2,686,495	77 gamma negative, monopolar signature; 12 sample intervals, broad, however, it is likely associated with a boat turn
55:171	M	E 815,747 N 2,707,133	405 gamma multi-component signature; 14 sample intervals, intense signature likely related to shoreline debris
59:148	M	E 815,836 N 2,706,395	107 gamma dipolar signature; 7 sample intervals, may be associated with submerged object crossing the river; possible association with target 52:141 and 63:73; target location is adjacent to CDF A

63:73	M	E 815,901 N 2,706,438	250 gamma positive, monopolar signature; 8 sample intervals, may be associated with submerged object crossing the river; possible association with target 52:141 and 59:148; target location is adjacent to CDF A
73:129	M	E 816,030 N 2,706,611	60 gamma negative, monopolar signature; 4 sample intervals, small, isolated signature likely related to shoreline debris

FIGURES

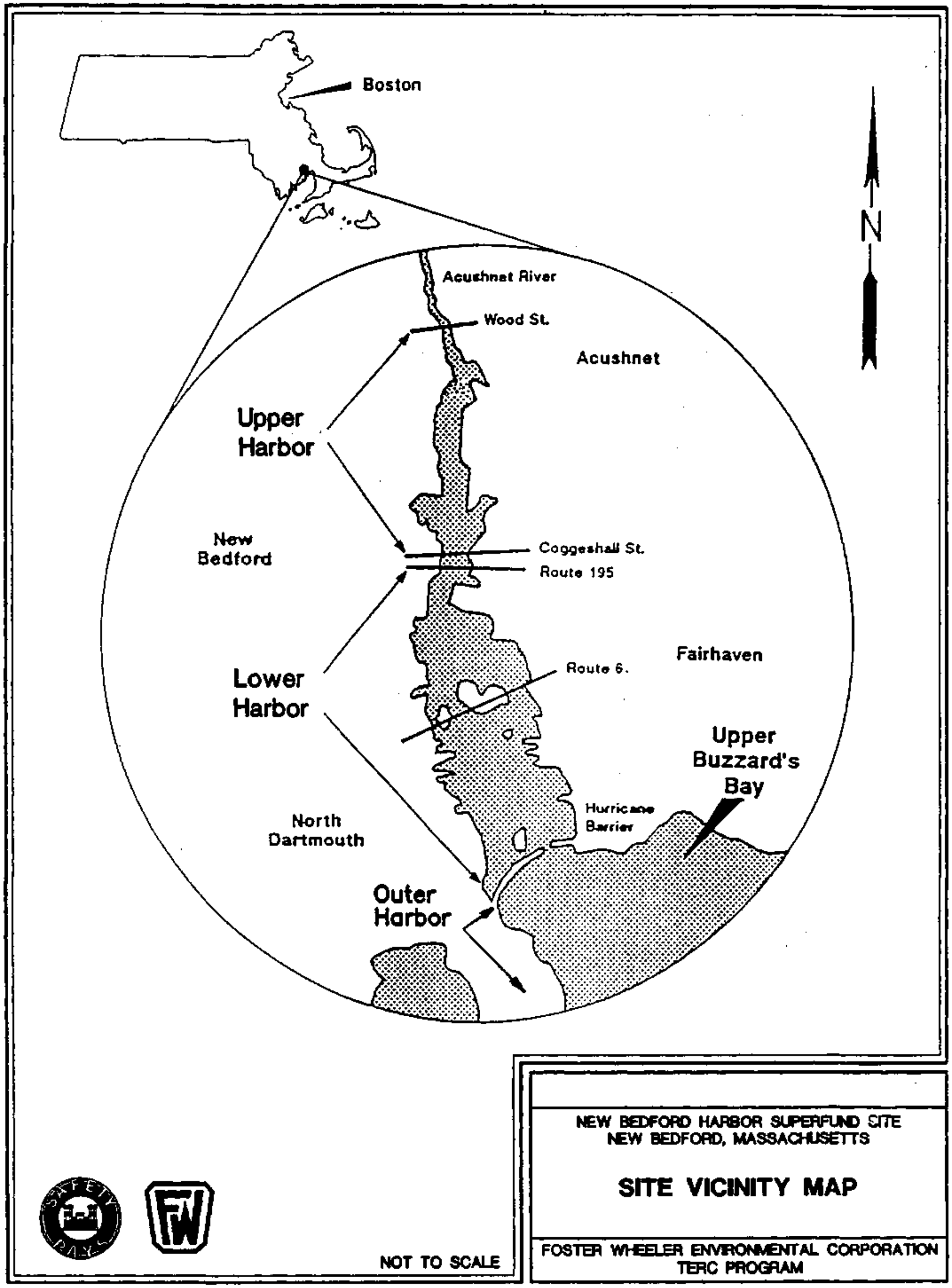


Figure 1-1. Site Vicinity Map.

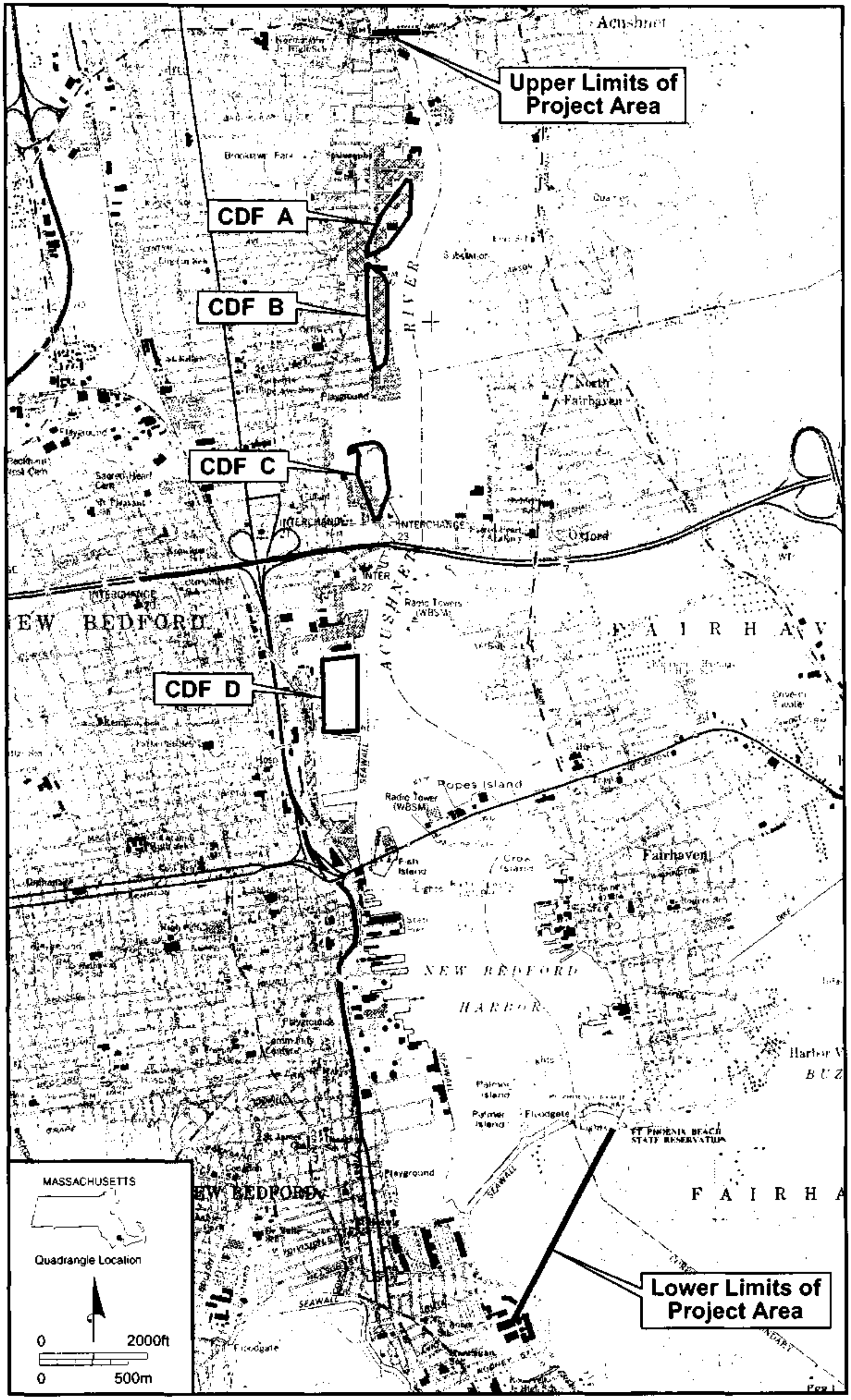


Figure 1-2. Locations of Proposed CDFs and Limits of Proposed Dredging.

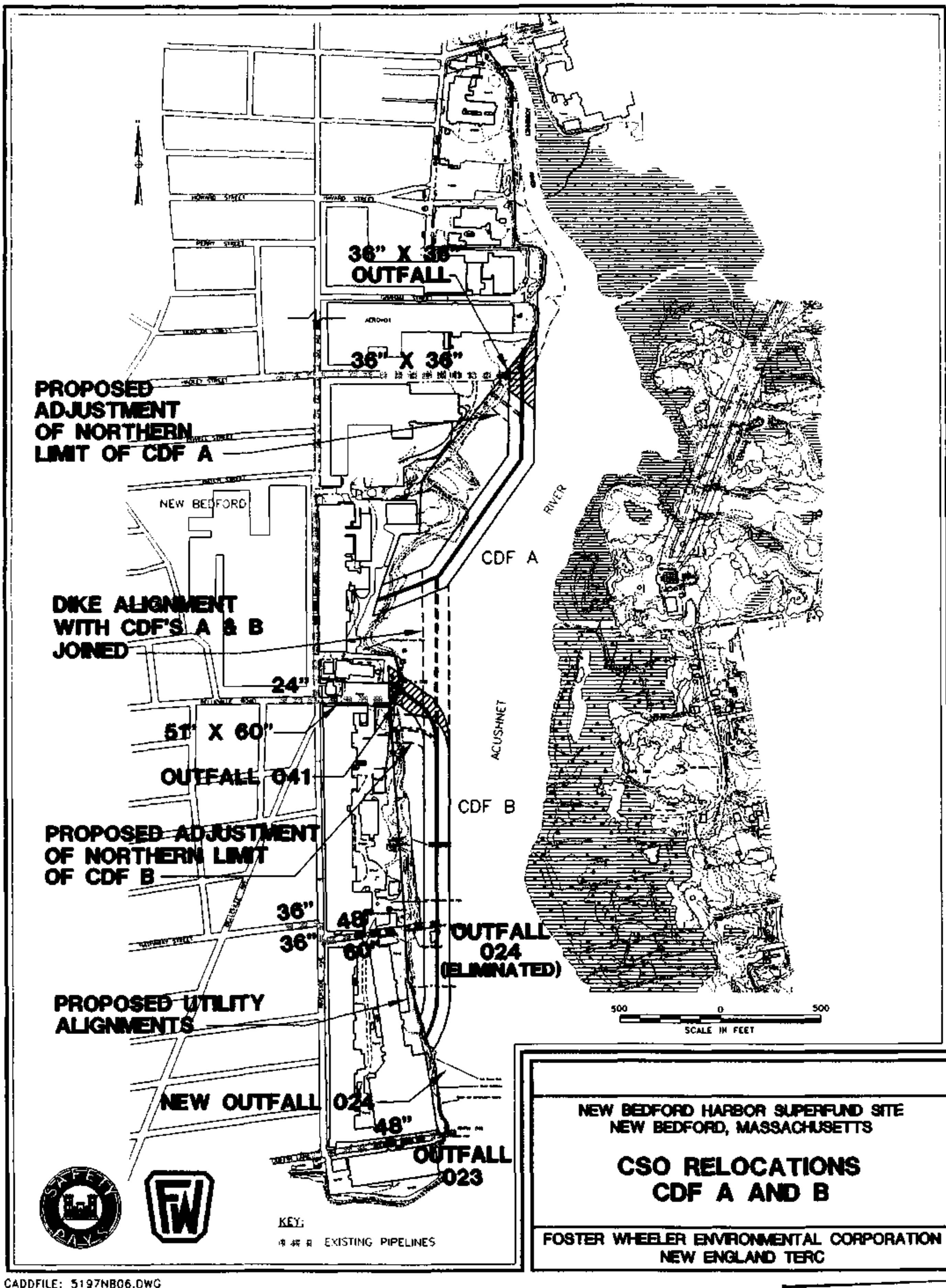


Figure 1-3. CSO Relocations, CDF A and B.

Originals in color.

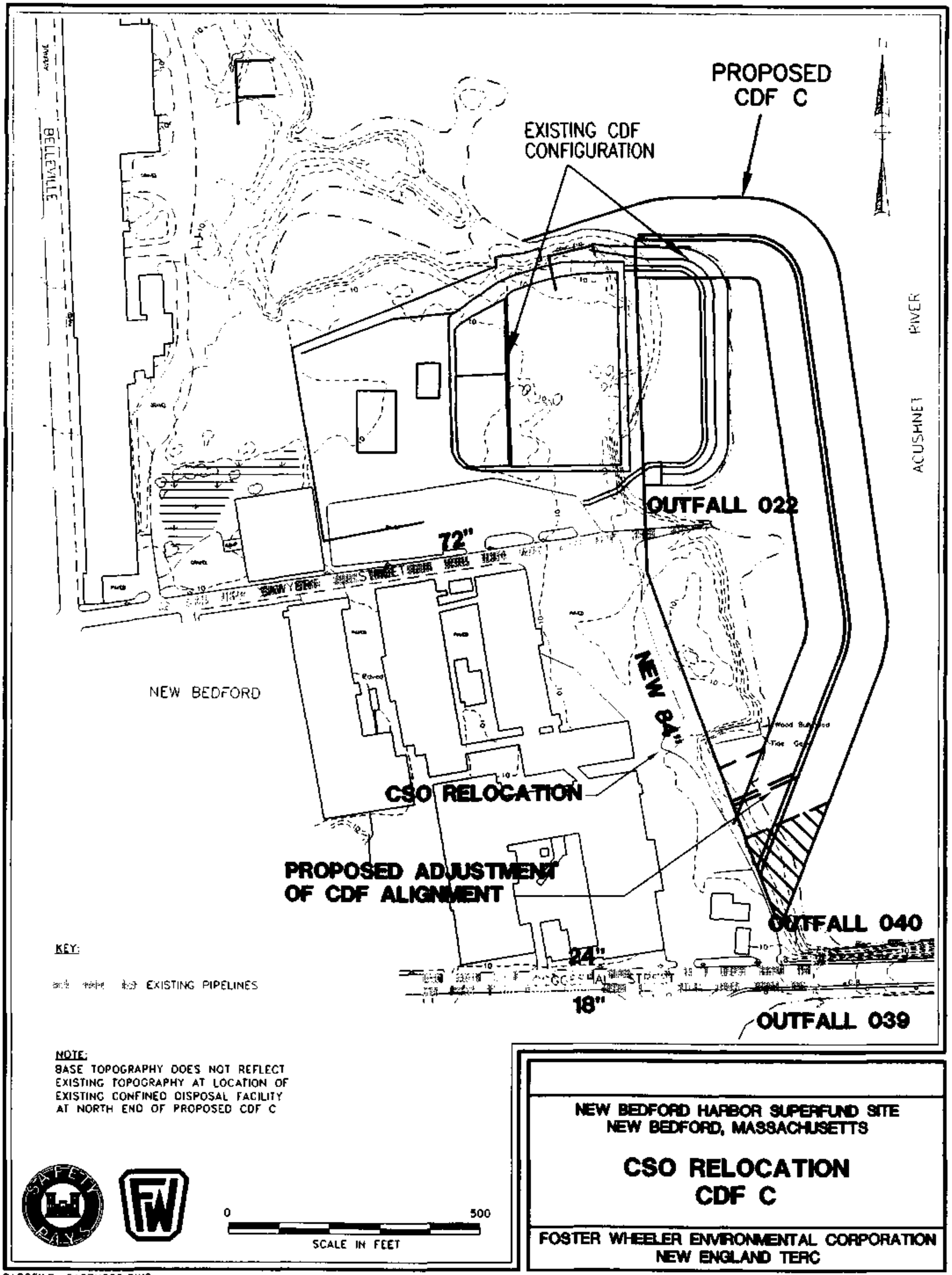


Figure 1-4. CSO Relocation, CDF C.

Or· ·inals in color.

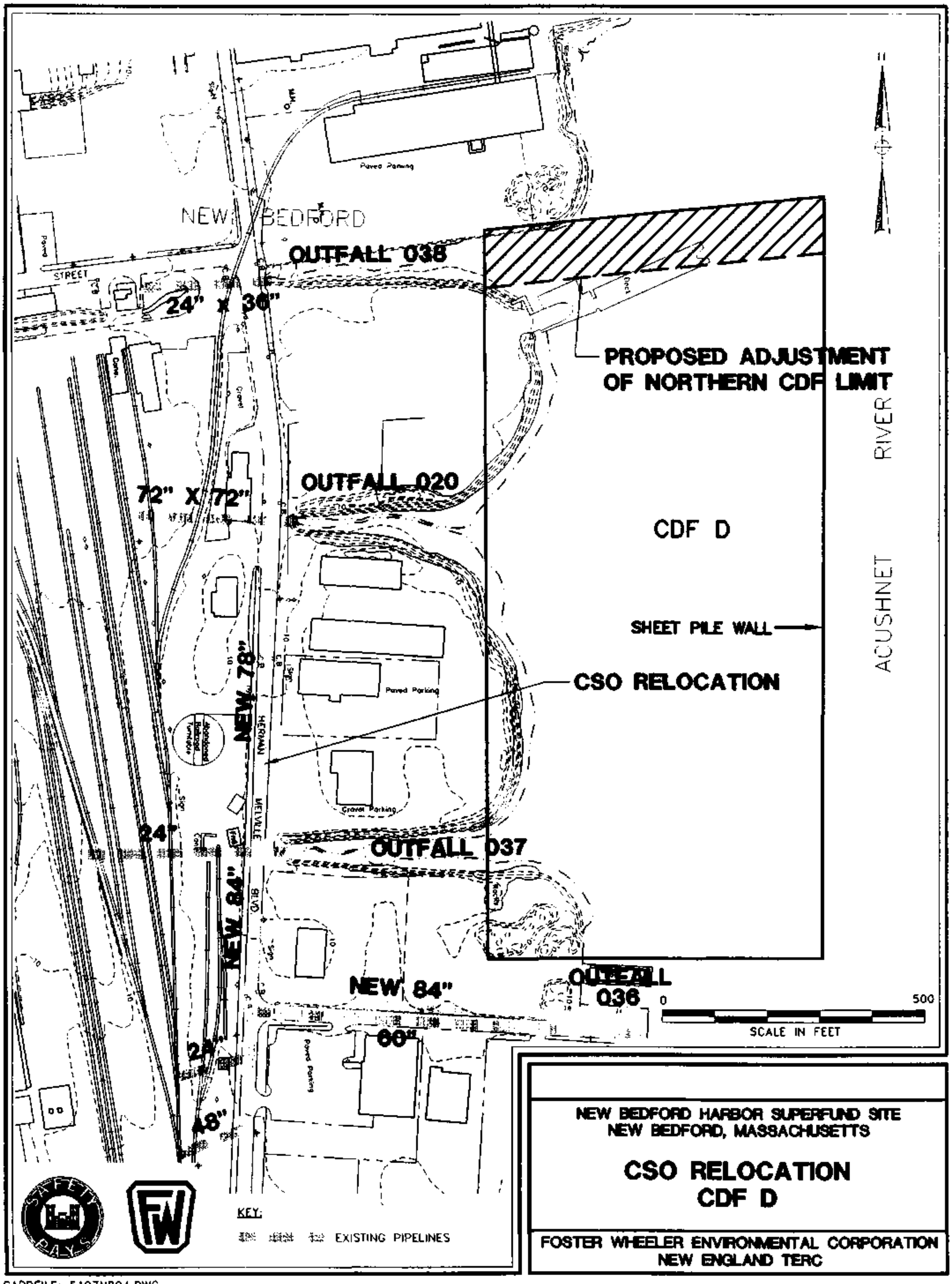
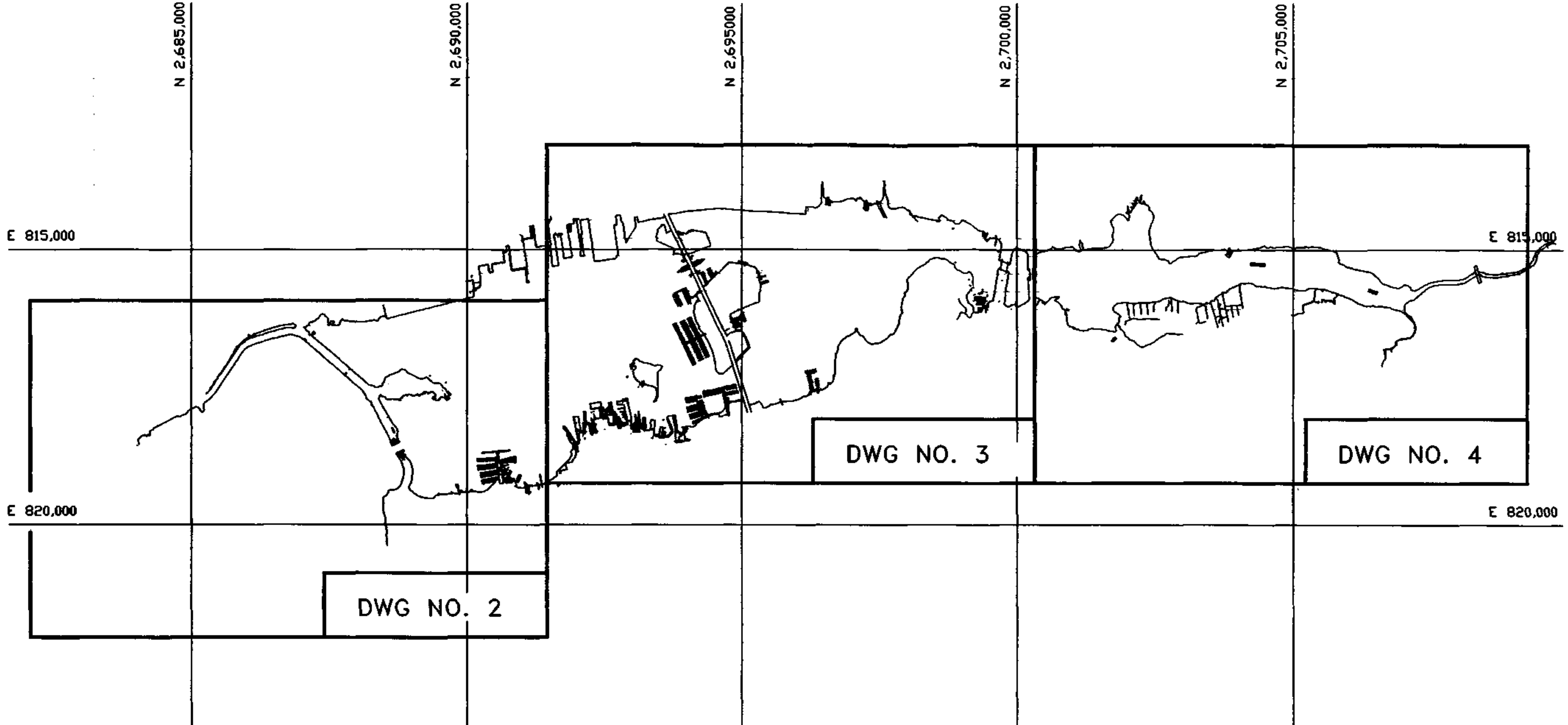


Figure 1-5. CSO Relocation, CDF D.

Originals in color.



NOTES:

1. HORIZONTAL CONTROL PROVIDED BY FOSTER WHEELER, INC., MASSACHUSETTS MAINLAND TRAVERSE MECATOR PROJECTION - NAD 83 - ZONE 2001 - INDICATED IN FEET

2. BACKGROUND INFORMATION PROVIDED BY FOSTER WHEELER, INC.

LOCATION MAP

SCALE IN FEET

2000 0 2000

1000

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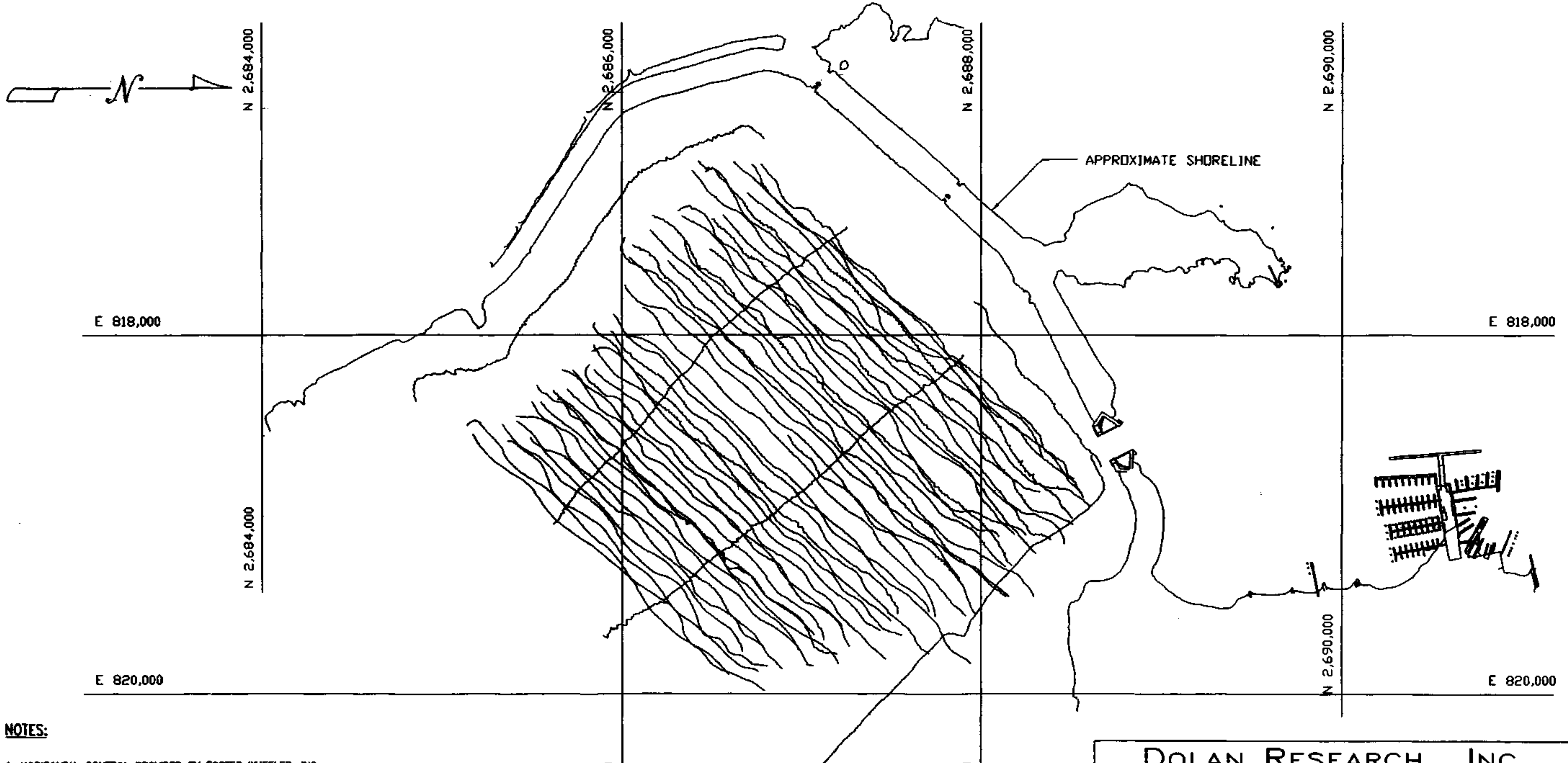
PHASE 1 SUBMERGED CULTURAL RESOURCES INVESTIGATION

NEW BEDFORD HARBOR, ACUSHNET RIVER
NEW BEDFORD, MA

Figure 5-1. Location Map.

DWG. NO. 1



NOTES:

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2. BACKGROUND INFORMATION PROVIDED BY FOSTER WHEELER, INC.
3. SURVEY CONDUCTED ON: 08/31 & 09/01/99.

TRACK PLOT

SCALE IN FEET

600 0 600

300

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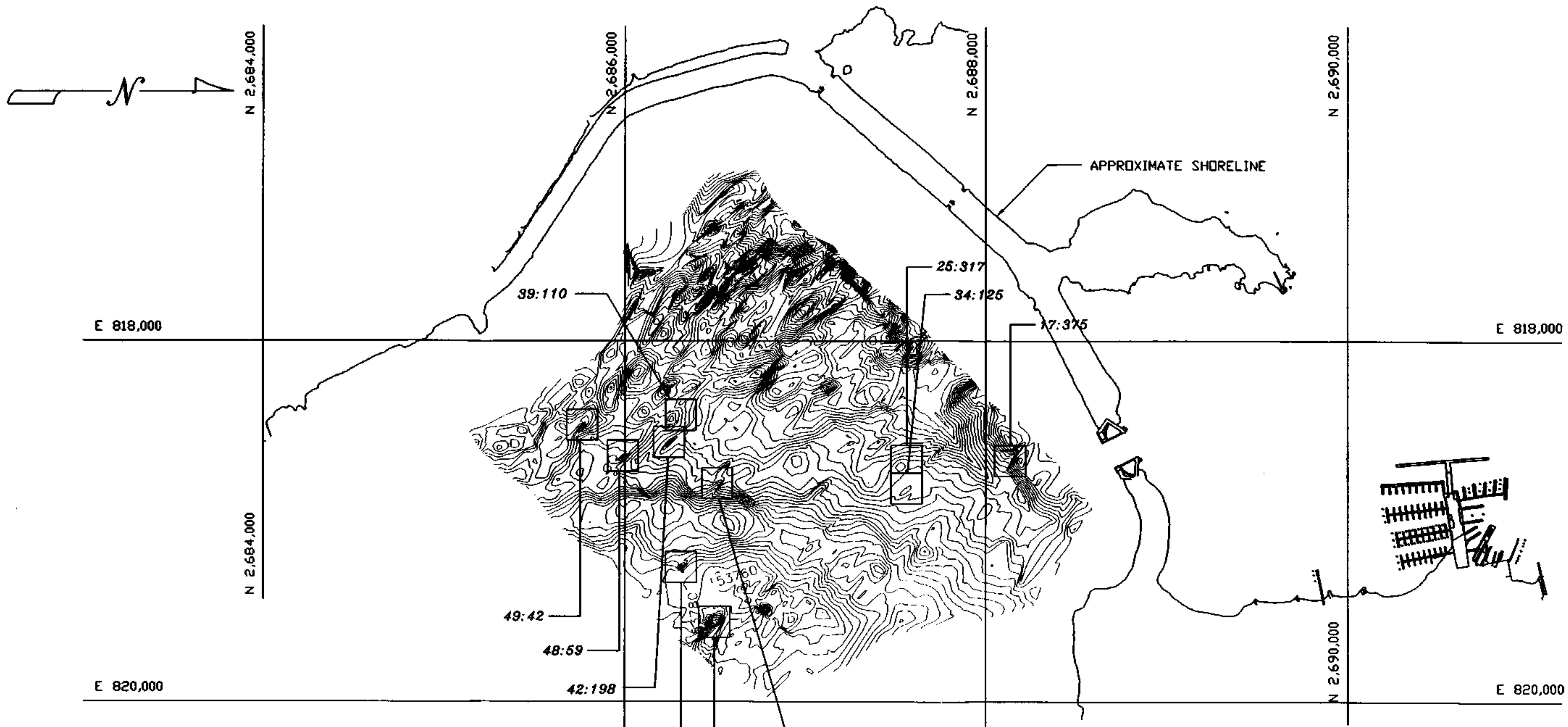
NEW BEDFORD, MA

Figure 5-2. Outer Harbor Area–Track Plot.

DWG. NO. 2



NOTES:

1. HORIZONTAL CONTROL PROVIDED BY FOSTER WHEELER, INC., MASSACHUSETTS MAINLAND TRAVERSE MECATOR PROJECTION – NAD 83 – ZONE 2001 – INDICATED IN FEET
2. BACKGROUND INFORMATION PROVIDED BY FOSTER WHEELER, INC.
3. SURVEY CONDUCTED ON: 08/30 & 08/31/99.
4. ◎ MAGNETIC TARGET

MAGNETIC CONTOUR AND TARGET MAP

SCALE IN FEET

600 0 600

300

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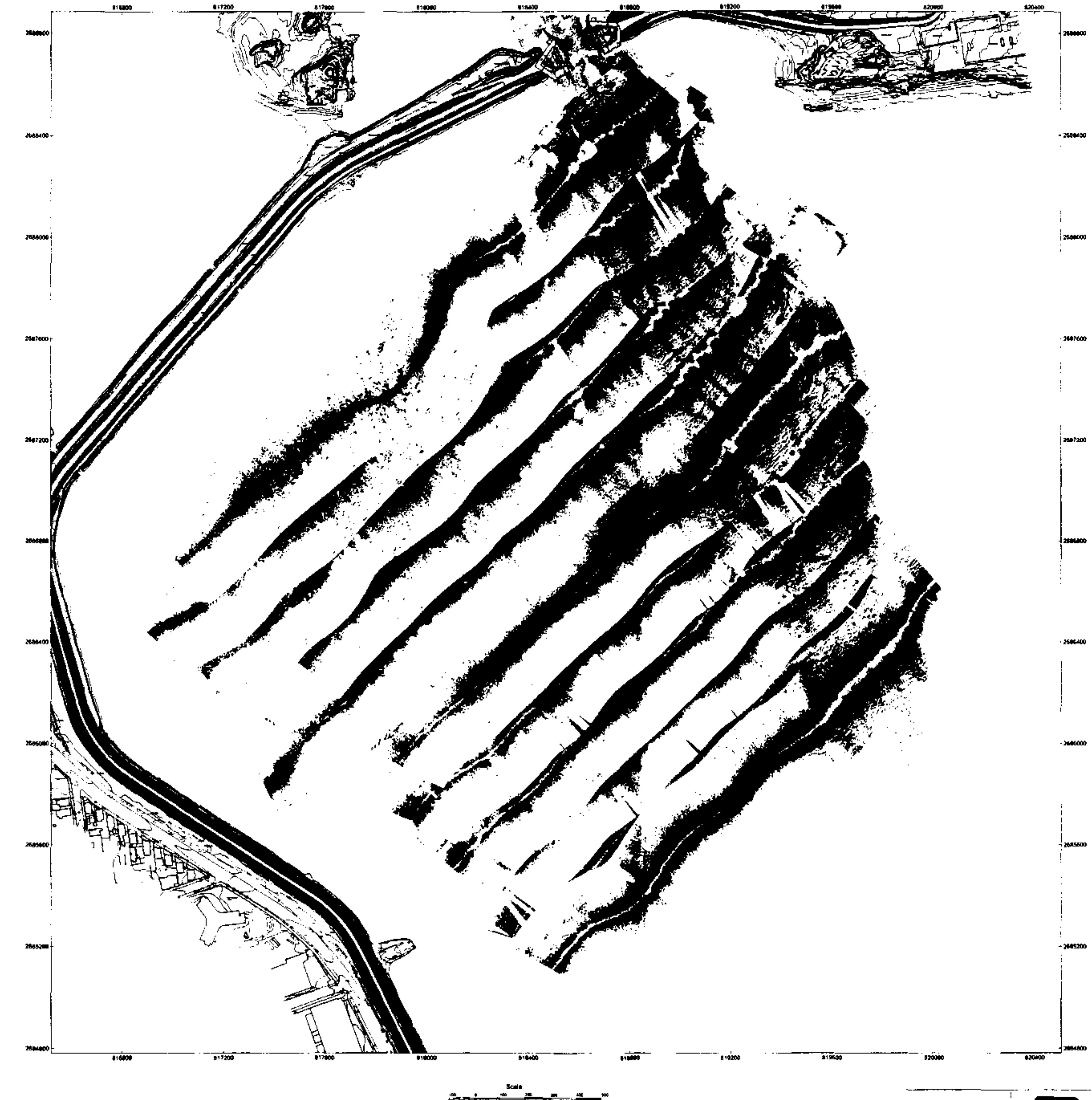
NEW BEDFORD, MA

Figure 5-3. Outer Harbor Area–Magnetic Contour and Target Map.

DWG. NO. 3



FOSTER WHEELER

US Army Corps
of Engineers
New England District

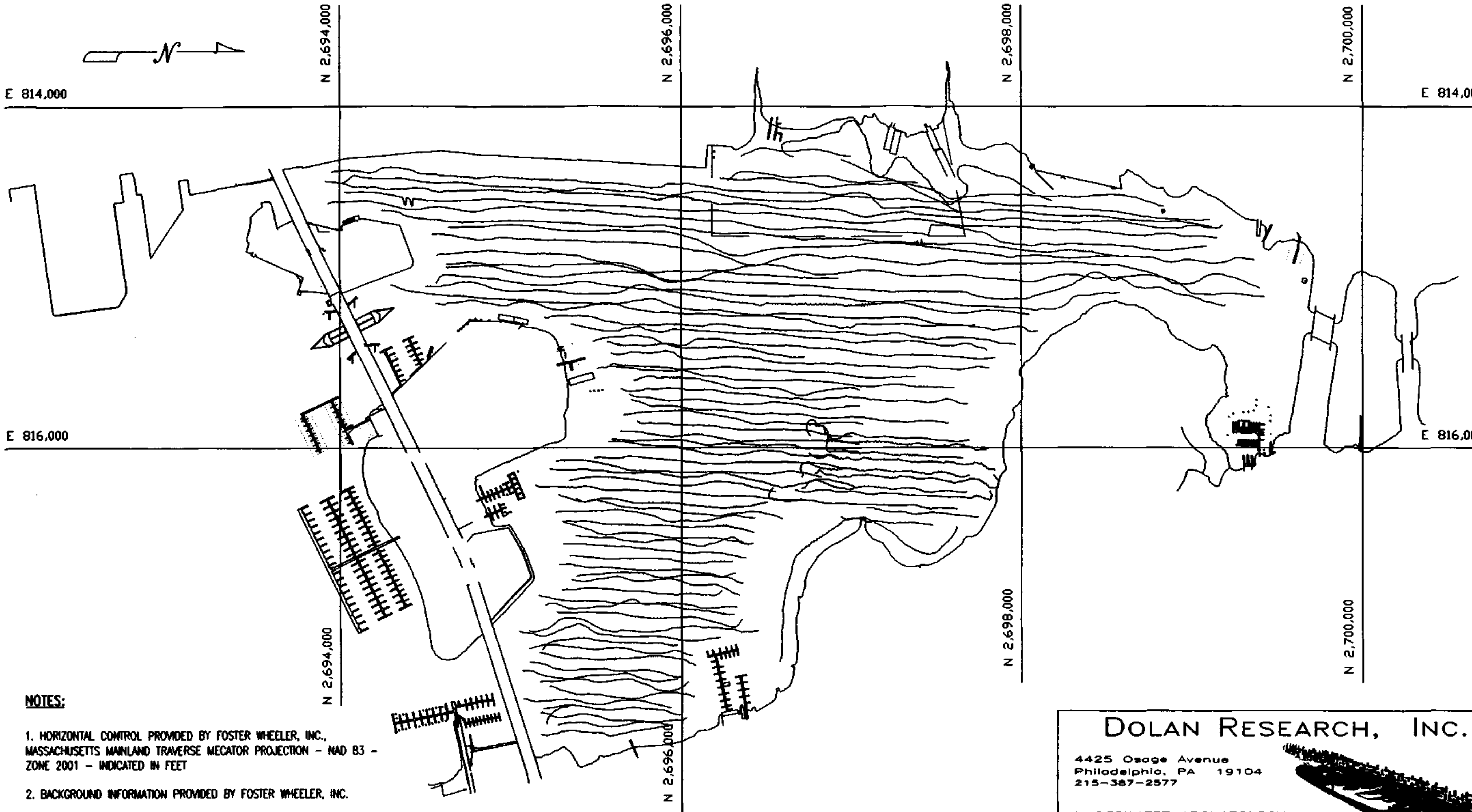
FIGURE 5-4

New Bedford Harbor Superfund Site
New Bedford, Massachusetts
OUTER HARBOR AREA OF INTEREST

SIDE SCAN SONAR MOSAIC PLAN MAP

FWENC Geophysics

Originals in color.



NOTES:

1. HORIZONTAL CONTROL PROVIDED BY FOSTER WHEELER, INC., MASSACHUSETTS MAINLAND TRAVERSE MECATOR PROJECTION – NAD 83 – ZONE 2001 – INDICATED IN FEET
2. BACKGROUND INFORMATION PROVIDED BY FOSTER WHEELER, INC.
3. SURVEY CONDUCTED ON: 09/01, 09/02 & 09/03/99.

TRACK PLOT

SCALE IN FEET

600 0 600

300

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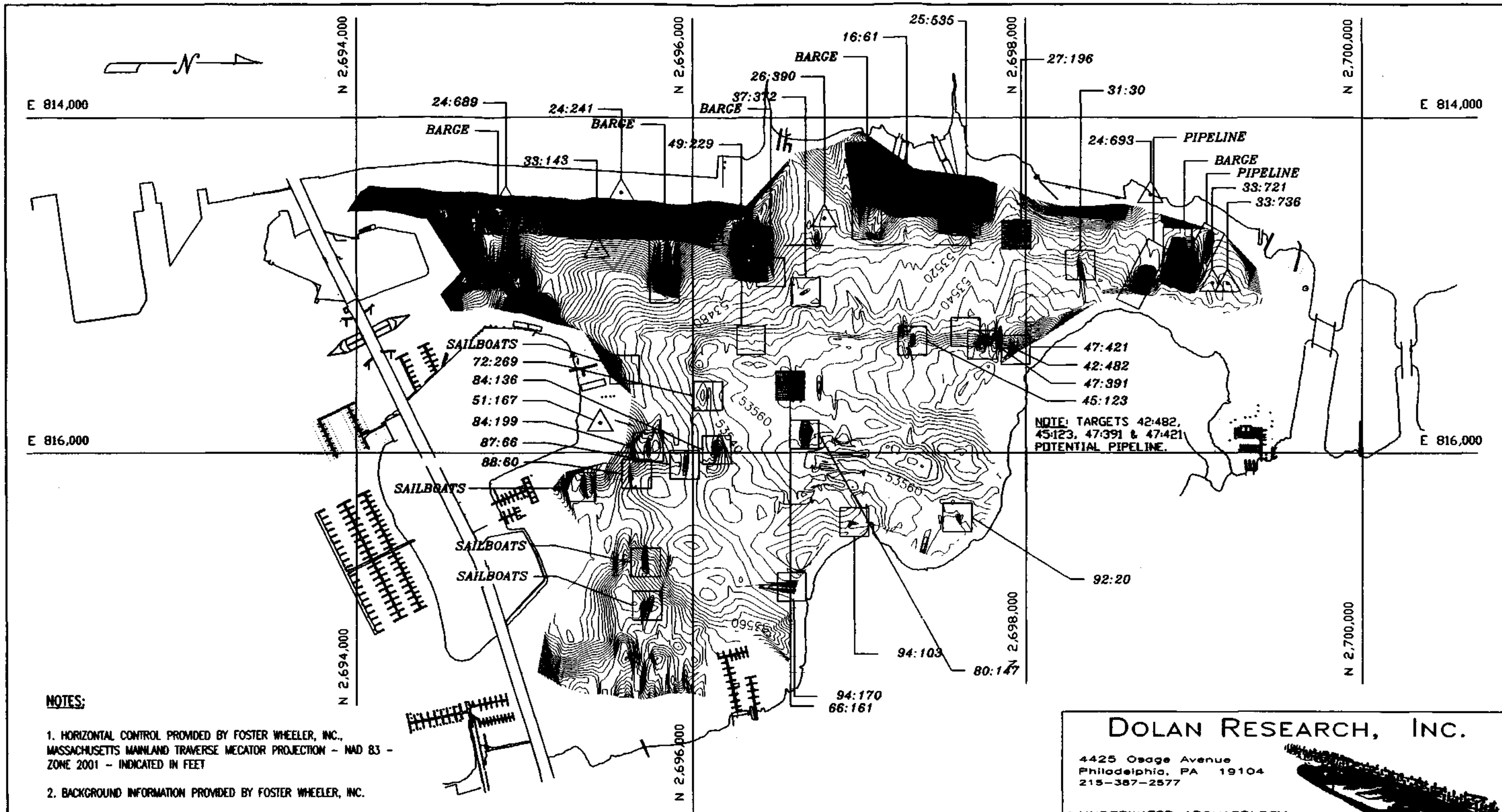
NEW BEDFORD HARBOR, ACUSHNET RIVER
NEW BEDFORD, MA

Figure 5-5. Middle Harbor Area–Track Plot.

DWG. NO. 4



NOTES:

1. HORIZONTAL CONTROL PROVIDED BY FOSTER WHEELER, INC., MASSACHUSETTS MAINLAND TRAVERSE MECATOR PROJECTION - NAD 83 - ZONE 2001 - INDICATED IN FEET

2. BACKGROUND INFORMATION PROVIDED BY FOSTER WHEELER, INC.

3. SURVEY CONDUCTED ON: 09/01, 09/02 & 09/03/99.

4. MAGNETIC TARGET

5. HIGH PROBABILITY TARGET

6. SONAR TARGET

MAGNETIC CONTOUR AND TARGET MAP

SCALE IN FEET

600 0 600

300

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NEW BEDFORD, MA

Figure 5-6. Middle Harbor Area–Magnetic Contour and Target Map.

DWG. NO. 5

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New England District

FIGURE 5-7

New Bedford Harbor Superfund Site
New Bedford, Massachusetts
MIDDLE HARBOR AREA OF INTEREST

SIDE SCAN SONAR MOSAIC PLAN MAP

FWENC Geophysics

Originals in color.

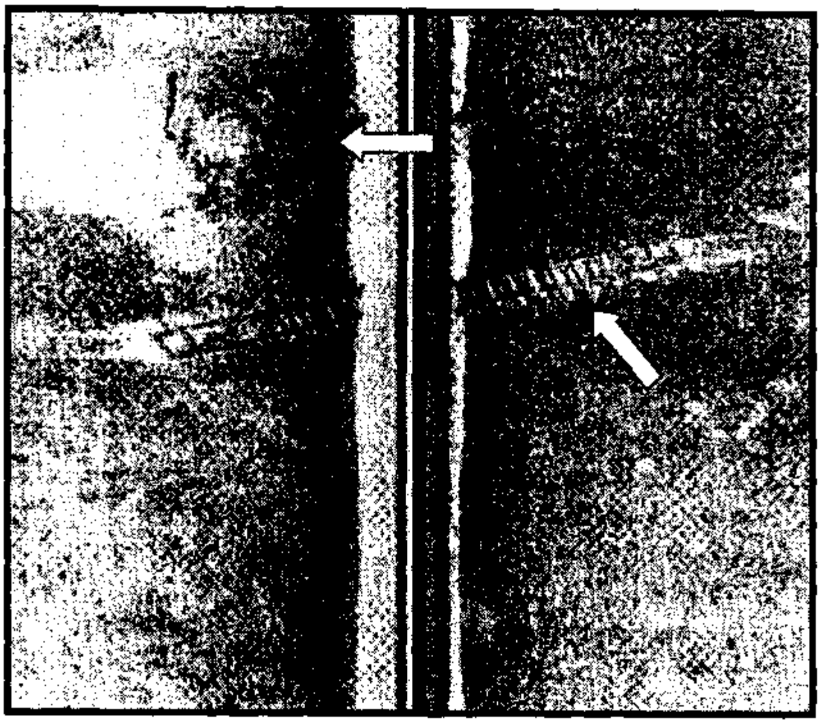
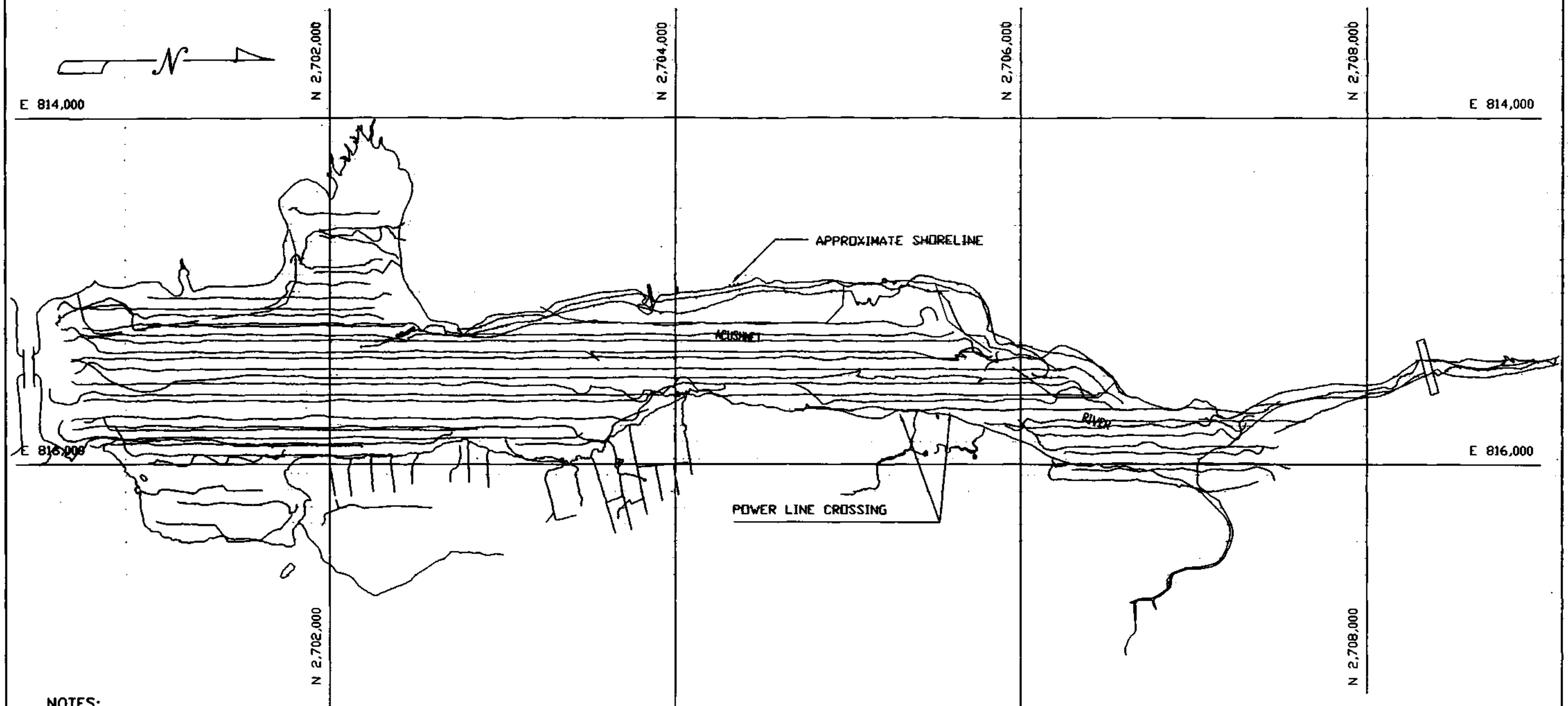


Figure 5-8. Sonar Image - Target 24:693. An 57-foot long section of railroad tracks adjacent to a rock pile.



NOTES:

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2. BACKGROUND INFORMATION PROVIDED BY FOSTER WHEELER, INC.

3. SURVEY CONDUCTED ON: 09/04 & 09/11/99.

TRACK PLOT

SCALE IN FEET

600 0 600

300

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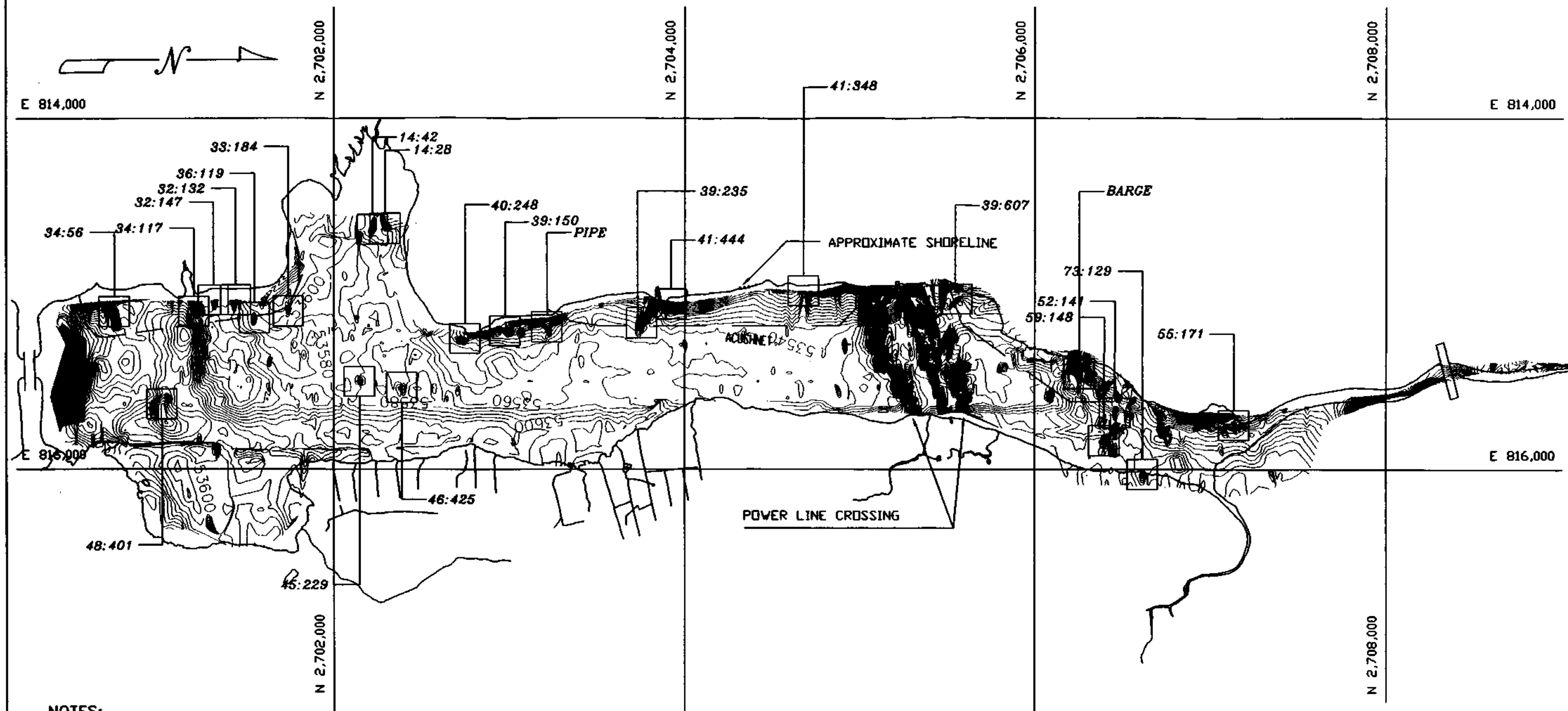
NEW BEDFORD HARBOR, ACUSHNET RIVER
NEW BEDFORD, MA

Figure 5-9. Upper Harbor Area–Track Plot.

DWG. NO. 6



NOTES:

1. HORIZONTAL CONTROL PROVIDED BY FOSTER WHEELER, INC., MASSACHUSETTS MAINLAND TRAVERSE MECATOR PROJECTION – NAD 83 – ZONE 2001 – INDICATED IN FEET
2. BACKGROUND INFORMATION PROVIDED BY FOSTER WHEELER, INC.
3. SURVEY CONDUCTED ON: 09/04 & 09/11/99.
4. ◎ MAGNETIC TARGET

MAGNETIC CONTOUR AND TARGET MAP

SCALE IN FEET
600 0 600
300

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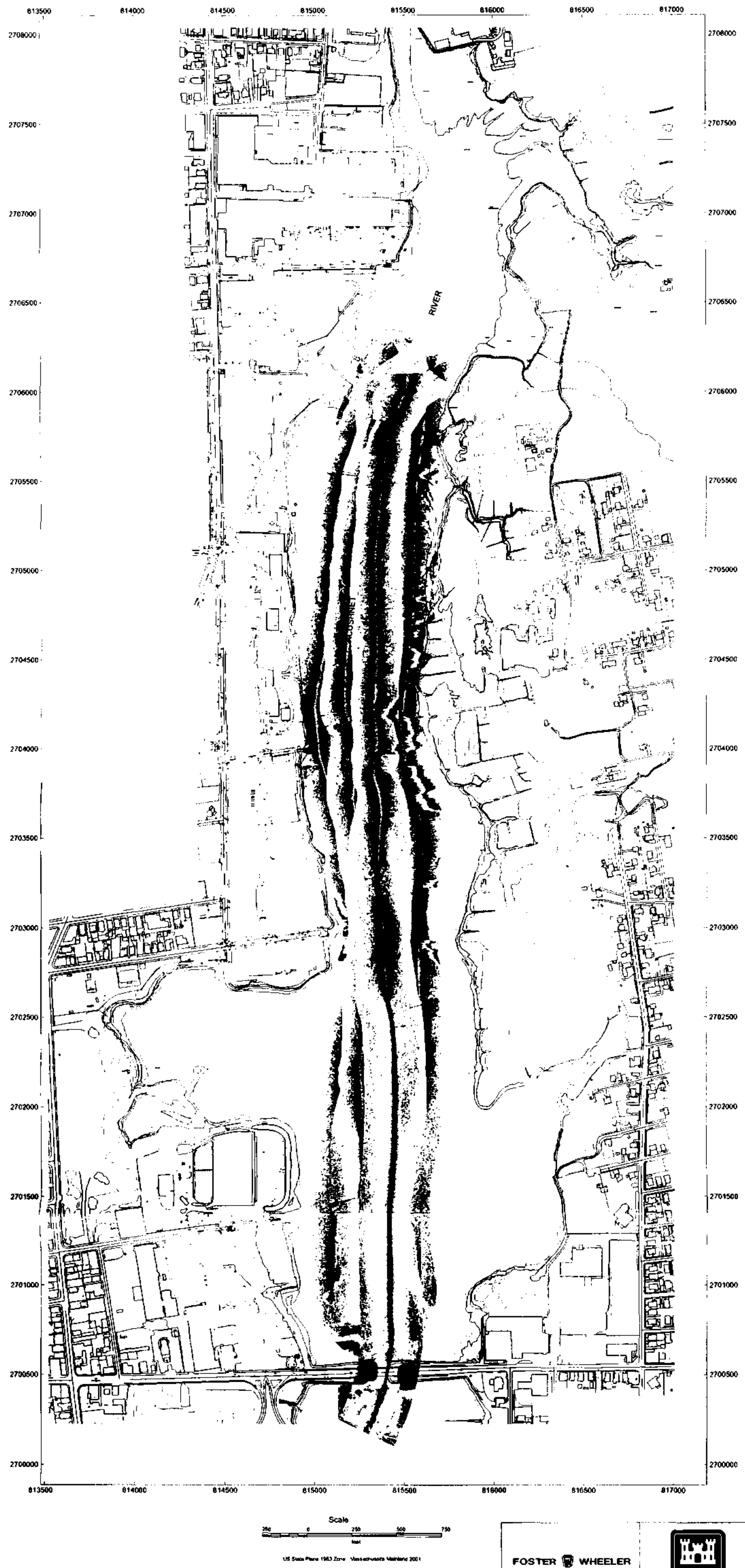
NEW BEDFORD HARBOR, ACUSHNET RIVER
NEW BEDFORD, MA

Figure 5-10. Upper Harbor Area–Magnetic Contour and Target Map.

DWG. NO. 7



Originals in color.

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New England District

FIGURE 5-11

New Bedford Harbor Superfund Site
New Bedford, Massachusetts
UPPER HARBOR AREA OF INTEREST

SIDE SCAN SONAR MOSAIC PLAN MAP

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PLATES

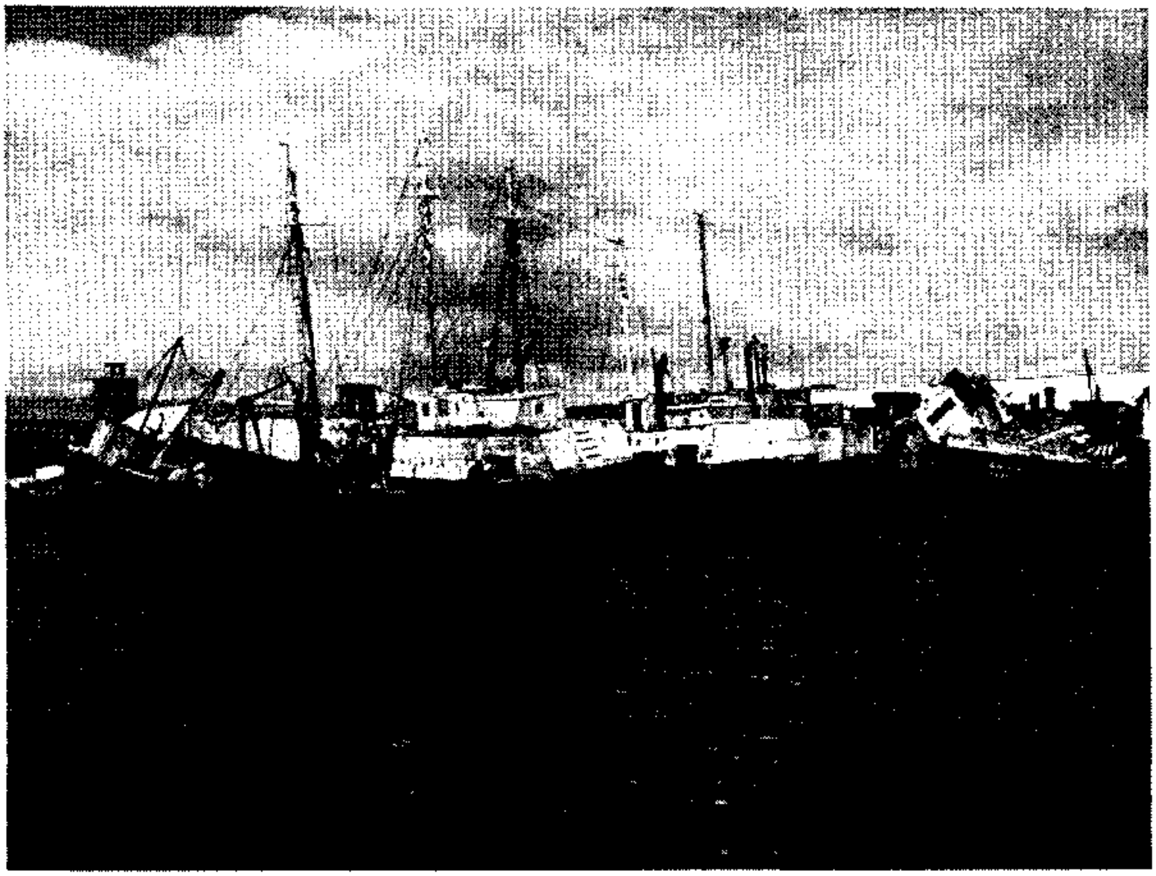

Plate 1. Derelict vessels at Melville shipyard.

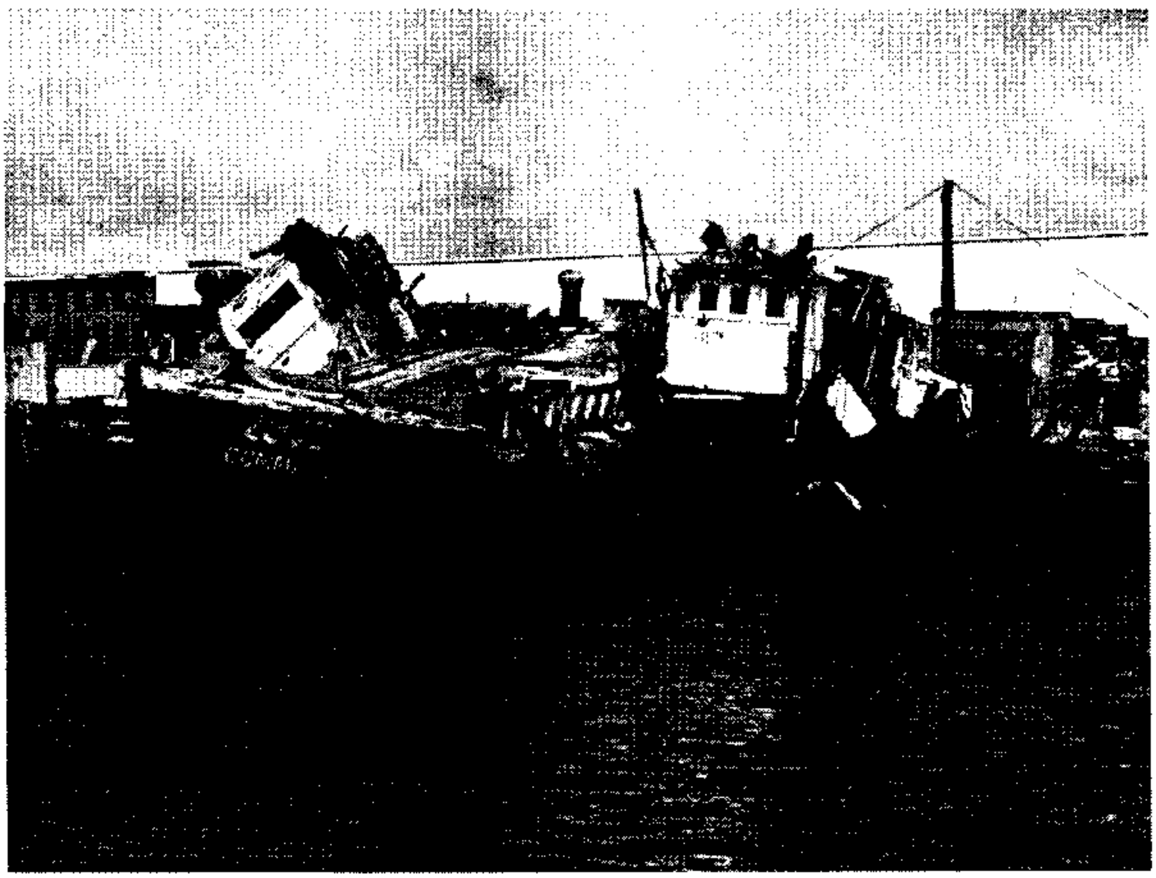

Plate 2. *Commonwealth*, "eastern-rigged fishing vessel.

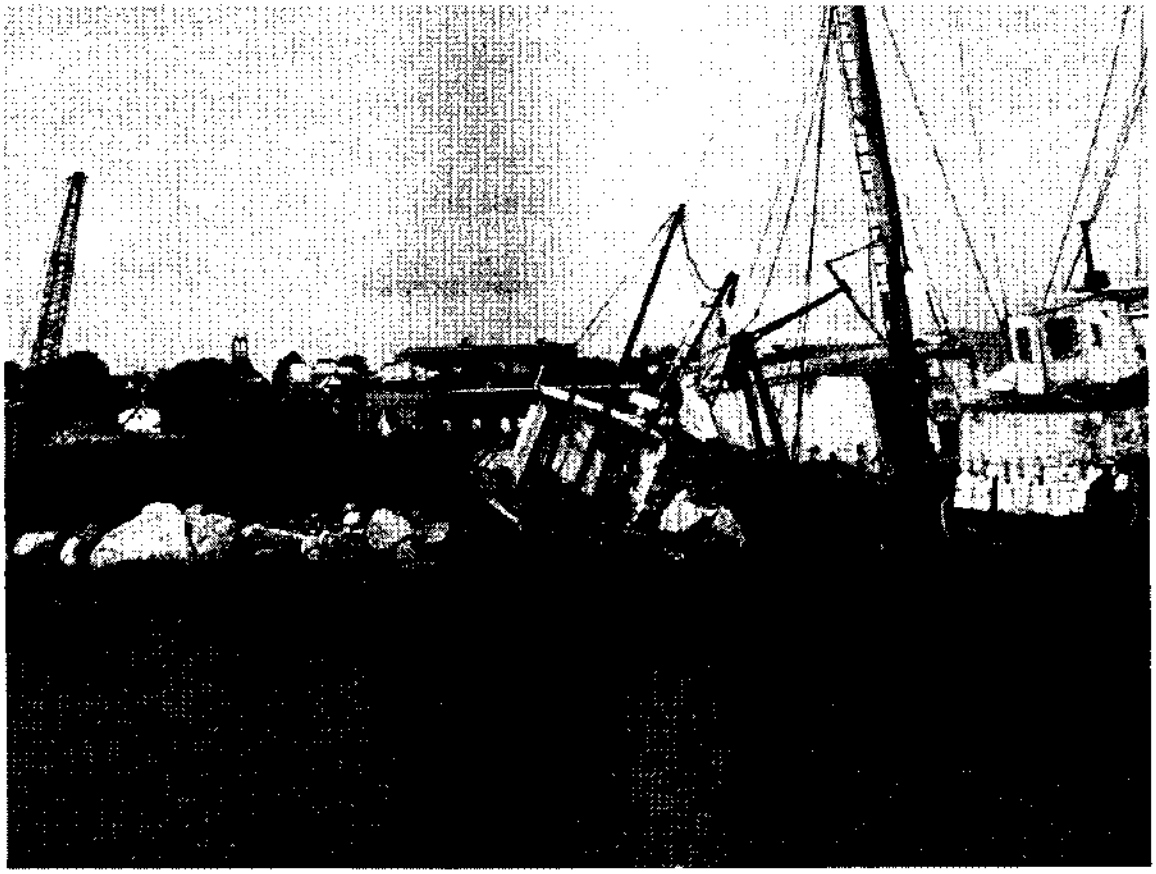

Plate 3. Stern view of two unidentified "eastern-rigged" fishing vessels.

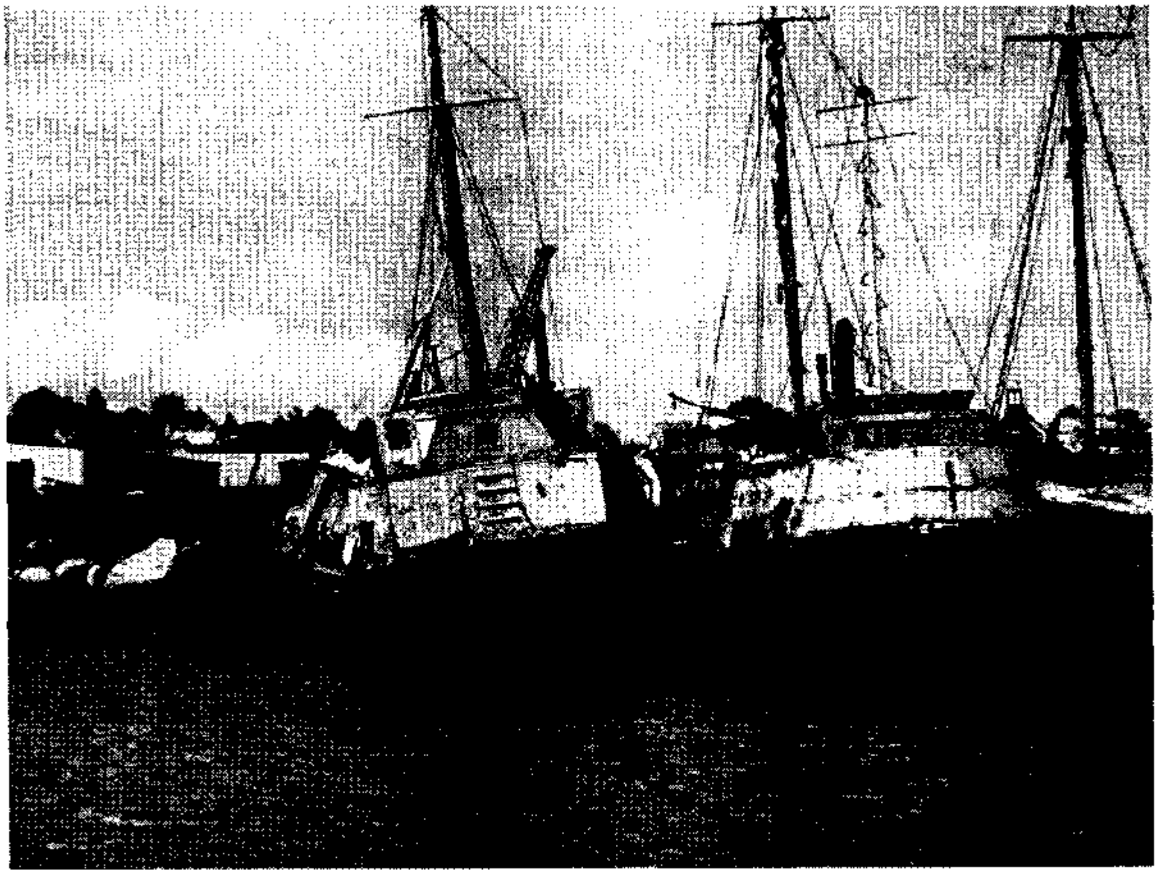

Plate 4. Unidentified "western-rigged" fishing vessel.

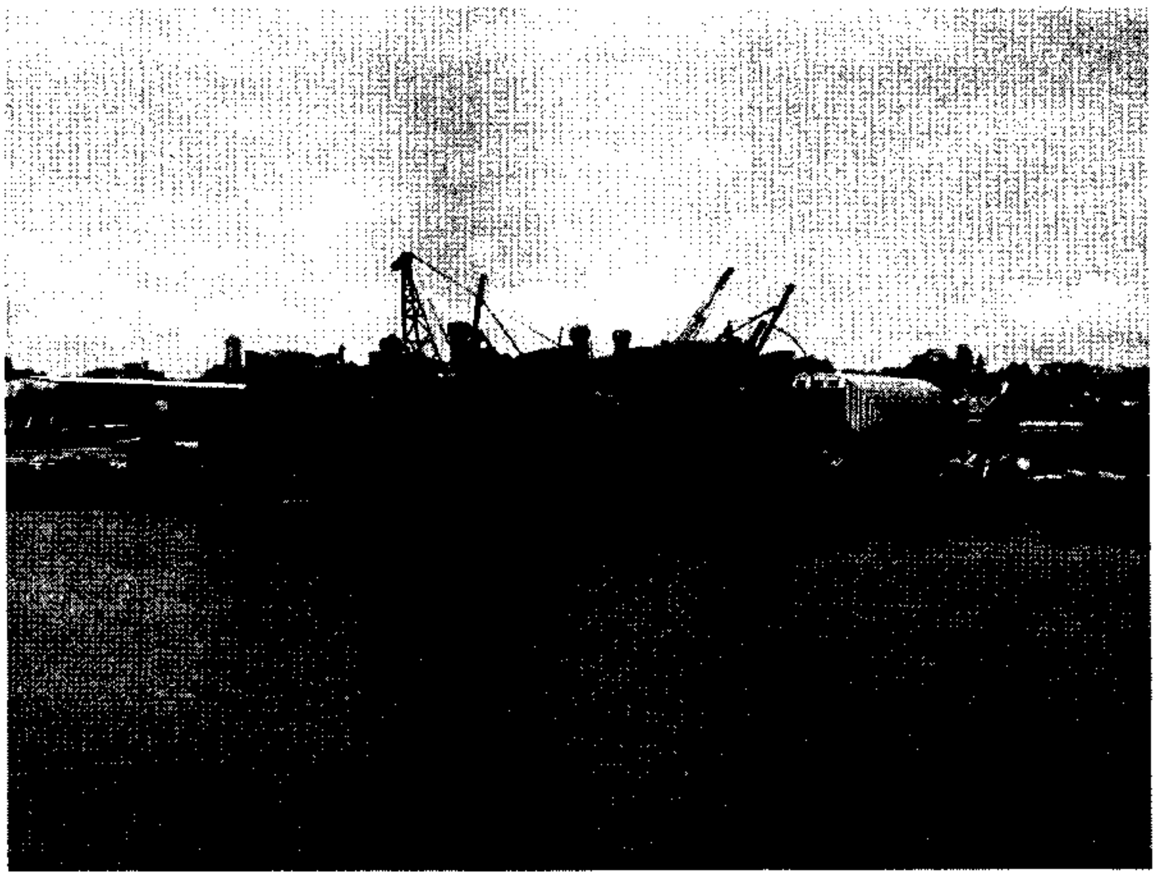

Plate 5. Barge with a fish processing plant.

UNDERWATER ARCHEOLOGICAL &
HAZARDS ANALYSIS
REMOTE SENSING SURVEY

DREDGED MATERIAL MANAGEMENT
PROGRAM (DMMP)
NEW BEDFORD, MASSACHUSETTS SITE

Prepared for:

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And

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March 2003

EXECUTIVE SUMMARY

A focused, multi-phase marine geophysical survey of two areas of New Bedford Harbor, Massachusetts was conducted by Apex Environmental, Inc. and its subcontractors. There are two purposes of the survey; to determine the presence or absence of submerged cultural resources potentially eligible for the National Register of Historic Places; and to identify possible hazards to future dredging activities. The presence of submerged cultural resources may affect future dredging operations and harbor development including the removal contaminated sediments or hazards (natural or manmade) on the harbor bottom and the construction of the proposed Confined Aqueous Disposal Cells (CAD) in New Bedford Harbor.

The surveys covered the areas of interest using two different geophysical survey techniques: Side Scan Sonar and Magnetometer. The data was processed and interpreted by geophysicists, and potential targets, which may represent hazards to the future operations, were identified and registered on summary maps of the areas. These target summary maps, included in this report as Figure 7 for the Channel Inner Area and Figure 8 for the Popes Island North, display the locations of the potential targets identified on a basemap of New Bedford Harbor. Specific results of the processing and interpretation of the data collected by each of the two geophysical methods are presented in this report as Figures 1 through 6 and in Appendices A and B. These maps and appendices display the processed images of the data, which were used to identify potential targets and to generate the final summary maps.

Numerous targets of interest, which may represent hazards to the future dredging or construction operations were identified on the summary maps. These targets included both potentially manmade and natural objects and features. The "cultural" objects identified include: linear features which are thought to be indicative of the presence of pipes and cables; individual targets thought to generally represent stand-alone features such as mooring blocks, anchors, and miscellaneous dropped objects; and groups of targets clustered together and thought to generally represent modern vessel debris. Analysis of remote sensing data identified 43 magnetic and/or acoustic targets in the two survey areas. The vast majority of the targets appear to be isolated single source objects, modern debris, or geologically-related objects. While three of the remote sensing targets found in the Channel Inner Survey Area generated magnetic signatures suggestive of submerged cultural resources, they are located within the dredged portion of the federal channel. This indicates that the target sources are very likely modern debris since such areas are subjected to periodic maintenance dredging, as needed.

Therefore, it is recommended that an archaeological monitor be present during dredging operations to ensure that no shipwreck sites are impacted during dredge operations.

Plotting of the targets interpreted from each of the geophysical data sets on the summary maps of the harbor revealed that many of the targets were identified using both geophysical methods. This correspondence between the geophysical surveys lends confidence to the interpretations. The targets where localized Magnetic anomalies are coincident with localized Side Scan anomalies are presumed to be either metallic or contain significant metallic parts. Objects or features, which are identified by such coincident localized anomalies, are interpreted as being manmade.

From the geophysical data collected during this study, numerous features were identified which may represent significant hazards to future dredging and/or CAD cell construction operations. None of the remote sensing targets are suggestive of submerged cultural resources. No additional underwater archeological investigation is recommended.
It is anticipated that the plans and information presented within this report will be utilized by various project stakeholders in the design of future projects at the New Bedford Harbor Site. Several of the targets identified (such as large sections of old dock), may represent significant and difficult issues for future dredging or other-project operations, and may require further investigation to determine exactly how these features may impact future operations.

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1.0 INTRODUCTION

1.1 Site/Project Location

The New Bedford Dredged Material Management Plan Site is comprised of two proposed locations in New Bedford Harbor, Bristol County, Massachusetts (see Illustration I). Popes Island North Area is located in the middle harbor north of Popes Island and the Route 6 Fairhaven/New Bedford Bridge. It is bounded on the east by the Fairhaven shoreline and extends approximately 1500' west. The western edge of the study area borders the Federal Channel at the southern portion, and bears east (away from the federal channel) at the northern portion. The Channel Inner Area lies in the main portion of the harbor and is bounded by Palmers Island to the south and the New Bedford shoreline to the west. The study area extends approximately 1500' east to the eastern edge of the main federal channel and almost 4000' north to the New Bedford State Pier. The entire study area is located within the designated federal navigation channel and associated maneuvering and 30' anchorage areas. This area has been maintained by the US Army Corps of Engineers (USACE) with dredging of portions of this area occurred as recently as 2002 (State Pier Dredge Project) in which areas of the federal channel and anchorage was dredged by the City of New Bedford to a depth below -30' MLLW.

The harbor is flanked by the City of New Bedford on the west and the Town of Fairhaven on the east. The main portion of the harbor, the area between the Route 6 Bridge and the hurricane barrier (Illustration I), is naturally deep and is the home for one of the largest commercial fishing fleets in the country. In addition to the commercial fishing vessels, hundreds of recreational sail and powerboats are seasonally berthed and moored at marinas and in the various coves that are located in New Bedford Harbor.

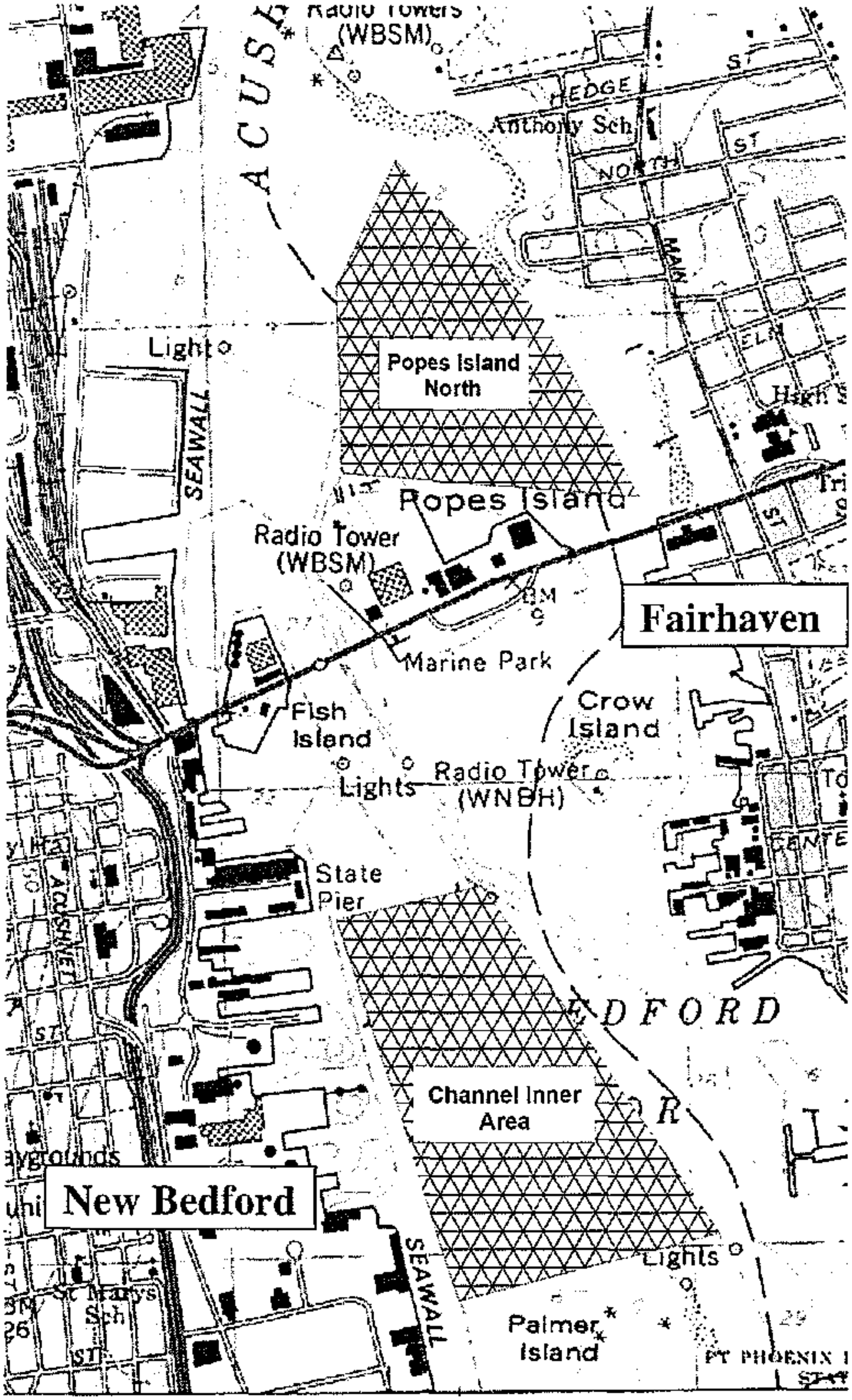

Illustration I - Overview of the Survey Area
New Bedford, Massachusetts

1.2 Project Background Information

This "Report of Marine Cultural Resources & Hazards Analysis Surveys: Side Scan Sonar, and Magnetics" was prepared by Apex Environmental, Inc. for Maguire Group, Inc. The work was completed as part of the Dredged Material Management Plan (DMMP) for New Bedford Harbor. As part of the maintenance for the Upper and Lower New Bedford Harbors it is expected that sediments contaminated with PCBs will be dredged in sections of the harbor and placed in Confined Aqueous Disposal (CAD) cells. The areas of interest for this investigation are Popes Island North and Channel Inner Area in New Bedford, Massachusetts (Illustration I).

Marine geophysical surveys were conducted at New Bedford Harbor to identify possible cultural anomalies and hazards to future dredging activities within the areas.

The information generated by this investigation represents background data that will be used for the following purposes:

- Cultural resources screening of the harbor area prior to dredging and CAD cell construction;
- Hazard/obstruction screening of the harbor areas affected by dredging and CAD cell construction;

This report presents the analysis of the geophysical data for identifying significant cultural and natural features lying on the harbor bottom that could pose an obstacle or a hazard to dredging.

1.3 Report Structure

Sections 1 through 4 will address Background information and field practices used in the collection, processing and Interpretation of data used to identify both Cultural Resources and Potential Hazards to future work. This report incorporates targets from both programs into a single set of maps (Sheets 1 to 8). Section 5 provides additional specific information on Cultural Resources. Section 6 summaries the findings and recommendations of the investigations. Section 7 presents the limitations of the program. Appendices show in greater detail the Side Scan Sonar Images. Section 8 lists the references cited throughout this report. A CD containing AutoCAD versions of the project drawings, target tables and processed datasets is included at the end of the report.

2.0 FIELDWORK INVESTIGATIONS

The following section outlines the fieldwork methodology used to acquire the geophysical data for the Cultural Resources and Hazards Analysis Survey. The geophysical methods utilized for this characterization were Acoustic (Side Scan Sonar) and Magnetometry. The Side Scan Sonar instrument creates images the surface of the harbor bottom, and the magnetometer identifies metallic objects (such as anchors, pipe, cables, moorings, or miscellaneous metallic debris) on the bottom or in the shallow subsurface.

2.1 Survey Operations

Field operations for the New Bedford Harbor Marine Geophysical Survey were conducted from October 21 through October 24, 2002. The marine surveys were conducted from a survey vessel outfitted with Side Scan Sonar and a Magnetometer. Shipboard systems were integrated with a Differential Global Positioning System (DGPS) so that the geophysical data collected from the instruments could be tagged with precise position information at regular intervals.

The survey operations were conducted with a team of Apex and specialty subcontractors onboard the survey vessels. CR Environmental, Inc. (a marine survey and equipment contractor) provided the survey vessels (including a boat captain), the DGPS system with navigation software, and the geophysical equipment (Side Scan Sonar). Dolan Research, Inc. (specialists in marine cultural resource projects) provided a magnetometer and an experienced archaeologist. Apex provided a qualified shipboard geophysicist to oversee and coordinate the collection of the marine geophysical data.

2.2 Survey Equipment

2.2.1 Survey Vessel

The principal survey vessel was the *R/V Cyprinodon*, a 32-foot aluminum workboat. This vessel was equipped with a large pilothouse for protection of the instrumentation and electronics from the elements, a hydraulic winch and A-frame for ease of deployment of equipment into the water, on-board power, and could accommodate two to three on-board scientists and boat captain required for the work.

The survey vessel was outfitted with equipment capable of producing accurate and detailed images of the harbor bottom and shallow sub-bottom. Side Scan Sonar was utilized to produce picture-like acoustic images of the harbor bottom in order to map bottom features and objects. A magnetometer was used to produce magnetic field maps of the harbor areas to detect metallic objects on the harbor bottom or in the shallow harbor sub-bottom. Both geophysical instruments were integrated with a DGPS for accurate location referencing information. The following provides a summary of the equipment used to complete the task.

2.2.2 Side Scan Sonar

The Side Scan Sonar system used included an Edgetech TD-374 dual frequency Side Scan Sonar tow-fish matched with an Edgetech Digital Control Interface (DCI). The Side Scan tow fish was towed off a stern A-frame in the Channel Inner Area to allow flying depths of approximately 10 feet. In the Popes Island North Area the bow pulpit was utilized to accommodate the shallow water depths and to minimize wake noise. The DCI board was connected to a computerized Side Scan Sonar data acquisition and processing system for shipboard data collection and processing. Chesapeake Technologies SonarWizz software was used for digital data recording from the tow fish and integrated the data with navigation inputs for real-time viewing of the Side Scan image in pseudo-map format. The data was stored digitally for future post-processing and interpretation using Chesapeake's Technologies SonarWeb. The data was recorded and displayed as digital location-corrected pseudo-maps of the acoustic response of the harbor bottom.

2.2.3 Magnetometer

Magnetic data was collected with a Geometrics G-881 Cesium Marine Magnetometer system consisting of a high-sensitivity in-water marine magnetic sensor coupled to a digital data processing computer system running Geometrics MagSea processing software. The MagSea software was utilized to calibrate the system and to record and display the raw digital magnetic data. The G-881 system was designed for shallow water applications (<50m) and is easily deployed from small survey vessels. The magnetic sensor was deployed from the stern of the survey vessel far enough behind the vessel (~45-50 feet) to be beyond the effects of the magnetic field generated by the boat's engines and electronics. In shallow water the depth of the sensor was controlled by attaching the cable leader to a floatation device such that the swim depth of the sensor remained constant, approximately one to two feet below the water surface. This allowed for the survey to be conducted in both shallow and deep-water conditions without the risk of hitting the bottom of the harbor with the sensor. The system was set up to output the raw digital magnetic signature values to a computer screen for on-board real-time initial interpretation and to the project positioning system computer (running HYPACK software) for permanent data storage and later post-processing and interpretation. The HYPACK system logged the raw magnetic data, time stamping each reading and tagging it with DGPS navigation positions obtained from the survey positioning system. Readings were collected at a rate of once per second. The sensor tow fish "layback" was entered into the HYPACK system and the correct position of the sensor was calculated and logged.

2.2.4 Positioning System

Horizontal positioning and navigation for the project was accomplished using a Trimble Ag DGPS. The DGPS consisted of a satellite beacon and radio transmitter mounted on the roof of the vessel and the Trimble Ag processing system mounted shipboard. Satellite positioning data was logged at a rate of once per second, and differential corrections were obtained from the nearest Coast Guard Beacon and processed with the data in real-time for sub-meter position accuracy. The DGPS generated a constant stream of corrected position information which was output to all ship board systems, including the Side Scan System, the Magnetics system, and the HYPACK navigation system. The HYPACK software was utilized to store the time-tagged position data in both latitude-longitude format and in the project datum (US State Plane – NAD83, Zone - Massachusetts Mainland 2001, NGVD-29, US survey feet). The HYPACK system also provided real-time vessel position status on a helmsman's display for the running of track-lines. An outline of the harbor superimposed with the proposed data collection lines (track-lines) were entered into the HYPACK system at the start of the field program. These proposed track-lines were then retrieved onto the helmsman's display as the survey was in progress. The position of the vessel, as determined by the DGPS system, was superimposed in real-time onto the track-line layout, so that the vessel Captain could "steer-to" navigate to stay on course and run straight and accurate data collection lines.

2.3 Study Area Definition and Spacing

Marine geophysical data for this survey was collected from the two areas of New Bedford Harbor which are of interest to the project: Popes Island North and Channel Inner Area (*Illustration I*). *Lines showing the ship's track path are superimposed onto the Magnetic* Maps (Channel Inner Area - Figure 1, Popes Island North - Figure 4) generated for each area.

Prior to mobilization, a review of all available information was conducted. This review indicated that the appropriate track-line spacing for the survey was 50-feet for the collection of magnetic data and 100-feet for side scan data (due to swath data collection). The survey direction was primarily north to south, along the length of the harbor. The following number of lines and line-miles were surveyed in each of the harbor segments:

- Channel Inner: 43 survey lines (north-south), total nautical mileage of approximately 19.9 nautical miles.
- Popes Island North: 32 survey lines (north-south), total nautical mileage of approximately 11.6 nautical miles.

3.0 SURVEY PROCEEDURES

3.1 Field Data Collection

Geophysical data was collected with both instrument systems (Side Scan Sonar, and Magnetometer) running concurrently. Sequencing of the work required consideration of the tide cycles. In the shallower portions of the Popes Island North Area (mostly near the Fairhaven shoreline), the survey had to be accomplished in pieces as low tides prohibited the entire area from being surveyed at one time. The field data collection occurred between October 21 and October 24, 2002. Daily equipment calibrations, and functional checks, were conducted daily with all field personal prior to starting field surveys. Operations were continuous during the day, except for minor periods of occasional equipment malfunction or loss of DGPS satellite coverage. Over the 4-day survey period over 30 nautical miles of data was collected in the two areas of interest. Water depths over the survey areas ranged from 3 feet to greater than 30 feet.

3.2 Data Processing

Initial data processing and interpretation was carried out as the survey was in progress to ensure that good quality data was being collected and that data quality objectives were being met. The initial shipboard data processing and interpretation varied between the instruments:

- Side Scan Sonar data was processed using the SonarWeb software into pseudo-map images along the data path. The initially processed data appeared as geo-referenced strip images of the harbor bottom displayed on a computer screen. The Side Scan operator would monitor the data collection at all times to ensure that the image was as clear as possible, and to make initial interpretations of the data in real-time. Targets (features of the bottom appearing as anomalous from the rest of the data) were "captured" digitally by the operator using the computerized target capture feature, and were cataloged and stored for later post-processing and enhancement. The Side Scan data was also stored digitally for later post-processing and more intensive interpretation.

- Magnetic data was initially processed in the field by the Edgetech MagSea system. Uncorrected magnetic data was then displayed on a computer screen in cross-sectional form so that the magnetometer operator could make observations concerning the data stream as it appeared on the screen. The magnetometer operator noted and cataloged any significant raw magnetic anomalies (deviations of the magnetic signal from background) identified as the survey was in progress. The magnetic data was also stored digitally for later post-processing and more intensive interpretation.

The initial interpretations of the data made in the field were utilized by the field team to continually assess the data collected and make minor modifications to the field program in order to ensure the highest possible data quality. Both the initial field interpretations and the raw field data were brought into the office for further post-processing and interpretation upon completion of the survey.

Complete data processing and interpretation was carried out by Apex geophysicists and Dolan Research, Inc. archaeologists. The geophysical data required extensive computer reduction prior to interpretation. The basic processes for reduction of the digitally recorded data are summarized in the sections below.

3.2.1 Magnetics

The magnetic data collected in the field was stored on the navigation system computer in a HYPACK file. The data consisted of the x and y positions of the magnetic sensor, the total field magnetic reading (once per second), and the time that each reading was collected. Because the magnetic field of the earth (which is the parameter measured) varies with time and location, a series of corrections must be made to the raw field data before it can be displayed in map form and contoured. The following steps were involved in the processing of the magnetic data:

- Data files for each survey area were checked for proper geometry and recording interval and any lines corrupted by equipment malfunction or prematurely aborted were weeded out. Coordinate transformations, if necessary, were performed, and position "outliers or fliers" were removed from the data sets.
- A file of magnetic (diurnal) corrections was constructed using data from a magnetic base station that was operating during the field program and data from a U.S. Geological Survey Magnetic Recording Station. The corrections file was time-tagged for later merging with the raw data file from the survey.
- The position-corrected raw data was then merged with the file of magnetic corrections. This was accomplished by matching up the time–tag for each element of the two data sets. The result of the merging of the raw data and corrections was the creation of a file containing the corrected magnetic measurement data for the survey.
- The corrected data set (x, y position, raw and corrected magnetic reading) was then input into Geosoft's Oasis Montaj data processing software. Montaj creates maps of the magnetic readings, grids the data set, and produces a color-coded contour map of the magnetic intensity readings of the survey areas for interpretation.
- Filtering and data manipulation was performed to enhance any anomalies present in the data sets. Targets/anomalies within the data set were then identified by an experienced geophysicist.
- Once the interpreter was satisfied that all anomalies were identified, a target list was generated consisting of x and y positions in the project datum. This

target list was output as a data table for inclusion in this report and as a DXF file for the plotting of a Target Location Plan on the project base map of the harbor.

3.2.2 Side Scan Sonar

The Side Scan data collected in the field was stored as raw data for post-processing. The data was merged with the position data in real-time as the data was collected, so that position-corrected strip images of the bottom were also created in real-time. These strip images are gray tone representations of the strength of the returned acoustic signal from the bottom as the survey was in progress. The Side Scan data files were further processed in the office to enhance the image quality, and mosaic images were created by digitally pasting together the strip images into a pseudo-map of the entire harbor bottom. The following steps were involved in the further processing and interpretation of the Side Scan data:

- All of the Side Scan data files were played back using the Sonar Web software in the office by an experienced geophysicist. The images were "cleaned up" by playing back the data using optimal imaging parameters to create as accurate an image as possible.
- Targets were identified through visual assessment by an experienced geophysicist of the replayed, enhanced strip images. The target images were then "captured" and output to an image enhancement program for final presentation and hard-copy printing.
- A "Side Scan mosaic" was then created by taking all of the Side Scan strip images from each area and merging them together into a single map. One mosaic was generated for each of the areas surveyed.
- The resulting position-corrected Side Scan Mosaic for each area was then output as a geo-referenced image "GeoTIF" file and was overlain on the project standard survey maps of the harbor edge, thus generating an acoustic map image of the harbor bottom features referenced to the shoreline.

Finally, an output file of the locations of all of the targets identified from the Side Scan data interpretation was created for inclusion in the text of this report. A "DXF" file of the target locations was also generated and overlain, along with the magnetics data, on the base map for the project.

3.3 Interpretation Techniques

Preliminary analysis and interpretation of the geophysical survey information was performed each day in order to plan the remaining work or modify the survey program in specific areas. The objective of the data analysis and interpretation phase was to characterize the responses from the geophysical data in terms of their most probable sources (i.e., rock, buried object, pipe, cable, etc.). An integrated approach to the analysis and interpretation phase was implemented for this project, in which targets and features detected by Magnetic and Side Scan imagery were collectively interpreted. This strategy allowed targets and features detected by both instruments to be more accurately characterized in terms of depth and probable source. The magnetic and Side Scan data was also analyzed and interpreted in concert with the historic structure pattern and lithologic and geotechnical sampling data existent for the harbor.

Experienced geophysicists identified target and feature responses within the data and generated color–coded maps and target anomaly lists of the geophysical anomalies. The software used for the processing, analysis, and interpretation of the magnetic data was Oasis Montage, a geophysical data analysis program developed by Geosoft, Inc. Montage allows intensive mathematical and statistical analysis of geophysical data. The Side Scan data was analyzed on an office based PC using the software SonarWeb for post-processing and data enhancement. Representative symbols of the targets or features of interest were transcribed onto a summary plan map of the Site.

4.0 ANALYSIS OF REMOTE SENSING DATA

Analysis of remote sensing signatures identified during the survey was based on several criteria. Magnetometer data were contour plotted and each anomaly was analyzed according to: magnetic intensity (total distortion of the magnetic background measured in nanotesla-nT); pulse duration (detectable signature duration); signature characteristics (negative monopolar, positive monopolar, dipolar, or multi-component); and spatial extent (total area of disturbance). Acoustic targets were analyzed according to their spatial extent (total area of disturbance), signature characteristics (shape, relief above the bottom, strength of return and contrast with the background) and environmental context.

Criteria for analyzing remote sensing targets have been developed from a database of target signatures that have been compiled over the last three decades. Starting in the 1960s, archaeologists primarily relied on magnetic remote sensing data, collected with proton procession magnetometers, to locate submerged cultural resources. However, magnetic data collected alone often provides inconclusive evidence on submerged cultural resource sites. Underwater archeological research conducted over the last two decades indicates that shipwreck sites may produce a variety of magnetic signatures. Furthermore, modern debris often generates magnetic signatures that may share similar characteristics with certain types of shipwreck sites.

The ambiguous nature of magnetic signatures has led researchers to use acoustic and occasionally sub-bottom remote sensing equipment in conjunction with a magnetometer on most underwater archeological surveys. Side-scan sonar units gather acoustic data by processing sound waves emitted into the water column on both sides of the submerged sensor. The sound waves are then bounced back off the bottom surface and exposed objects. State of the art digital sonar units produce high-resolution records that are almost photographic in quality. However, a certain degree of structural integrity of a shipwreck site must remain above the bottom to produce a reliable shipwreck signature on side scan sonar. Where no structure survives above the bottom surface, researchers must rely on magnetic data to help locate shipwreck remains. Additional data provided by acoustic instruments frequently permits target identification to be made solely from remote sensing information. A combination of magnetic and acoustic remote sensing data has proven to be the most effective method to accurately identify and assess submerged archeological sites. Typically, the most attractive targets produce both a defined magnetic and acoustic signature.

In preparing the technical report, remote sensing targets were characterized according to potential significance. Target locations that generated signature characteristics suggestive of submerged cultural resources were designated as High Probability Targets. All other targets, including single source objects and modern debris, were simply listed as targets. Additional underwater archeological investigations were recommended at the former type of targets.

It must be noted that the entire Channel Inner Area is located within the federally maintained 30' channel MLLW. All targets found within this area were considered debris-related.

4.1 Findings of Remote Sensing Survey

Analysis of the Acoustic and Magnetics data collected during this phase of the geophysical work was completed by Apex geophysicists and the results are summarized on the Geophysical Target Summary Plan Maps presented as Figures 7 and 8 of this report. These plans were generated in order to provide easy and rapid reference and location information on all of the targets identified as a result of the analysis of the both data types.

The targets identified from the data sources fall into two primary categories:

- Those objects or features which appear to be of cultural origin (manmade); and
- Those objects or features, which are natural.

The "natural" objects are thought to consist primarily of large boulders either resting on the harbor bottom or buried in the shallow sub-bottom.

The "cultural" objects identified were of several different types. Linear features are thought to consist mostly of pipelines and cables. Individual targets are thought to generally represent stand-alone features such as mooring blocks, anchors, and miscellaneous dropped objects.

The remote sensing survey identified 43 targets, of them 20 were magnetic and 18 acoustic with 5 having both an acoustic and magnetic signature. The Channel Inner Area had 13 magnetic targets and 17 acoustic targets identified in the survey area. Of these targets identified 2 targets were recorded as coincident targets that possess both a magnetic and an acoustic signature. Appendix A has enlarged images of each of the Side Scan anomalies identified in the Channel Inner Area. The Popes Island North Area had 12 magnetic targets and 6 acoustic targets identified. Three of these targets were coincidence magnetic and acoustic anomalies. Enlarged Side Scan Sonar images identified in the Popes Island North Area can be seen in Appendix B.

Examination of the remote sensing data found no clear evidence of targets in either survey area that would be considered suggestive of potentially significant submerged cultural resources. While no additional underwater archaeological investigations are recommended, an archaeological monitor should be present during dredging operations to ensure no archaeological site are encountered during dredging operations.

The following tables in this section summarize the various anomalies identified for the Cultural and Hazards Analysis. Each of the anomalies will be further described in the following chapters.

Table 1. Channel Inner Area – Side Scan Sonar Targets

Side Scan Target ID	X Easting	Y Northing	Image Size (ft)	Image Characteristic	Associated Magnetic Signature/Target ID
C6-1	815825	2690708	6' x 3'	Debris	Small magnetic signature
C8-1	816258	2689933	<3'	Multiple Rocks	-
C12-1	816365	2690168	<4'	Rocks	-
C18-1	816449	2690409	4' x 6'	Channel Marker	Magnetic signature
C20-1	816822	2690147	20'	Two Pipes/Debris	Magnetic signature
C24-1	817016	2690424	6'	Rocks	-
C29-1	817271	2690460	10'	Rocks	-
C31-1	817408	2690383	10'	Rocks	-
C31-2	817203	2690719	4' x 6'	Channel Marker	Magnetic signature
C33-1	816579	2692460	35'	Section of Dock or Railing	Magnetic signature
C37-1	816881	2691984	25'	Wooden Pile	-
C35-3	817261	2690931	<3'	Area of Rocks	-
C37-2	817581	2690537	<3'	Multiple Tires/Debris	CM-2
C39-1	816841	2692258	20'	Pipe/Debris	CM-12
C39-2	817091	2691809	30'+	Cabling	Small magnetic signature
C39-3	817181	2691592	4' x 7'	Tires/Debris	CM-11
C41-1	817838	2690646	<16'	Multiple Tires/Debris	Small magnetic signature

Table 2. Channel Inner Area – Magnetic Targets

Magnetic ID	X Easting	Y Northing	Anomaly Characteristic	Anomaly Size (nT)	Comments	Side Scan Target ID
CM-1	816030	2690989	dipole	24	Anomalies seen across several lines up to 23 fiducials long. Anomalies extend to CM-7	-
CM-2	817685	2690538	positive monopole	21	small anomaly, 6 fiducials, seen across 3 lines associated with debris	C37-2
CM-3	816580	2690950	positive monopole	50	intense short anomaly seen across two lines (20 fidicals)	
CM-4	817475	2691191	dipole	89	broad intense anomaly across 2 lines (40 fidicals)	
CM-5	817193	2691224	positive monopole	39	intense anomaly, 20 fiducials	-
CM-6	817024	2691336	dipole	46	anomaly, 27 fiducials, seen across multiple lines	-
CM-7	816217	2691067	dipole	24	medium intense anomaly, 10 fiducials possibly associated with CM-1	-
CM-8	817083	2691928	positive monopole	56	medium intense anomaly,12 fiducials, seen across 3 lines	-
CM-9	815631	2691940	positive monopole	30	intense med/large anomaly, 20 fiducials seen across 3 lines	-
CM-10	816264	2690629	dipole	46	large broad anomaly 35 fiducials, possibly a geological effect	
CM-11	817202	2691515	multi component	19	small anomaly greatly influence by nearby anomaly	C39-3
CM-12	816902	2692251	positive monopole	60	Character influenced by nearby anomalies	C39-1
CM-13	816727	2691385	negative monopole	38	small anomaly seen over 16 fiducials, seen across a single line	

Table 3. Popes Island North – Side Scan Sonar Targets

Side Scan Target ID	X (Easting)	Y (Northing)	Image Size	Image Characteristic	Assocaiated Magnetic Target
P4-1	815854	2695524	10' x 4'	Debris	Small magnetic signature
P4-2	815720	2695563	60'	Possible Pipe	PM-4
P8-1	816370	2695103	<3'	Multiple Rocks	-
P13-1	815591	2696601	20' x 3'	Debris	PM-6
P22-1	816424	2696140	26'	Possible piling	-
P24-1	817257	2695397	5'	Rocks w/relief	-
P24-2	817184	2695448	5'	Rocks w/relief	-
P26-1	816293	2696661	8' x 4'	Possible sunken wooden boat	-
P28-1	817014	2695934	12'	Debris	PM-1
P28-2	816403	2696829	5'	Rocks	-
P30-1	816345	2697039	<3'	Multiple Rocks/tires/small Debris	-
P30-2	817583	2695503	10'	Rock	-

Table 4. Popes Island North – Magnetic Targets

Magnetic ID	X Easting	Y Northing	Anomaly Characteristic	Anomaly Size (nT)	Comments	Side Scan Target ID
PM-1	817009	2695936	dipole	34	short slight anomaly (6 fiducials), probable small metallic debris	P28-1
PM-2	816499	2695362	monopole	101	medium intense anomaly, 18 fiducials	-
PM-3	816132	2695638	monopole	140	large intense anomaly, 21 fiducials, seen across 3	-
PM-4	815718	2695565	dipole	680	large broad anomaly seen across 5 lines, associated with side scan image. Nearby moored barge may have influenced or altered the anomaly	P4-2
PM-5	815554	2696489	monopole	57	small intense anomaly, 12 fiducials	-
PM-6	815627	2696592	monopole	57	large intense anomaly, 26 fiducials associated with debris side scan	P13-1

4.2 Side Scan Sonar

Composite mosaic images for each of the areas of interest are presented as Side Scan Mosaics on Figures 3, (Channel Inner Area), and Figure 6 (Popes Island North Area).

Because the objects and features of interest to this project are relatively small compared with harbor plan maps, and are difficult to pick out in any detail from the mosaic maps, enlarged "blow-up" images of all of the relevant targets identified from the Side Scan data are included in Appendix A and B. These blow-ups indicate in some detail the nature of many of the objects identified from the Side Scan data and are described below.

4.2.1 Channel Inner Area

- The survey area revealed many areas of rocks (C8-1, C24-1, C29-1, C31-1, C35-3), which could be indicative of a shallow bedrock surface. Some of the rocks imaged (C29-1 and C1-1) are large in size and show relief indicating that they protrude from the harbor bottom.

- Image C6-1 shows a very strong acoustic return from a square object with a small associated magnetic anomaly. This is interpreted to be a wooden object with a small amount of metal.

- C18-1 and C31-2 are aids to navigation (Federal Channel markers) and were used as QA/QC checks in the field and through out the processing and interpretation phases.

- Two images shown are indicative of metallic pipes (C20-1 and C39-1) approximately 20' in length with associated magnetic signature.

- Image C37-1 has similar characteristics to the pipes (C20-1 and C39-1) but has no associated magnetic signature indicating that it could be a possible wooden piling. The image is approximately 25' long and is seen protruding off the harbor bottom.

- Image C33-1 has a definite structure and relief off the harbor bottom. This is interpreted to be a large piece of debris 5' x 35' and is thought to be a section of dock or railing since several similar sections of dock have been removed from the harbor in the vicinity of this target. There is a small coincident magnetic anomaly with this object possibly from the metallic fasteners used to secure the timbers together.

- Images C37-2, C39-3 and C41-1 show collections of debris including miscellaneous metallic items and tires. There are variable magnetic responses to these areas of debris and could indicate the presence of a large amount of metallic items.

- Image C39-2 shows a possible metal cable over 30' in length. There is a slight magnetic response.

4.2.2 Popes Island Area

- Two possible small wooden dinghies were imaged (P4-1 and P26-1). Target P4-1 has a corresponding small magnetic anomaly associated with it.
- Image P4-2 shows a possible pipe approximately 60' in length with a strong corresponding magnetic signature.
- Images P8-1, P24-1, P24-2, P28-2, P30-1 and P30-2 show collections of small rocks (less than 5').
- Two images (P13-1 and P28-1) are large pieces of metallic debris approximately 12' and 20' in length respectively. P13-1 is a rectangular object, approximately 12'X3' with a small debris field clustered nearby. P28-1 is a linear object, 12' long with a hinged piece at one end of the object. They both have large magnetic anomalies associated with them.
- Image P22-1 is a linear object 26' long that is likely a wood piling or timber (no associated magnetic signature).

4.3 Magnetics

Color Contour maps of the magnetic data are presented as Figures 1 & 2, and 4 & 5 in the figures section of this report. Figure 1 and 4 depict the Total Magnetic Intensity (TMI) in the Channel Inner Area and the Popes Island North Area, respectively. The maps display the raw (diurnally corrected) data and illustrate the broad larger trends, which tend to mask the smaller anomalies of interest. From this data the change in TMI is calculated and displayed as a color coded image with 2nT contours (Figures 2 and 5). These maps better depict the smaller anomalies and are used as the main magnetic interpretive tool in conjunction with the TMI maps. The magnetic maps display the data as color-coded magnetic intensity: magnetic highs are displayed as oranges, reds, and pinks; while the magnetic lows are depicted as blues, with greens acting as neutral. TMI maps of both areas show strong geological (long wavelength) anomalies or effects from possible undulating bedrock. The trends of these geological anomalies are predominately northeast – southwest trending and can complicate or alter smaller subsurface anomalies of interest to this report.

Potential anomalies were picked by experienced geophysicists utilizing the mapping software, Oasis Montaj. Targets were generally identified by picking anomalies that displayed a significant and localized shift in magnetic intensity from the background data. In particular, anomalies with localized extreme magnetic highs, extreme magnetic lows, or coupled highs with lows adjacent to one another were interpreted as being indicative of a magnetic target. Anomalies depicted by a cross on figures 2 and 5 indicate an anomaly caused by a surface mooring or boat as observed and noted in the field. Due to the mooring field located north of Popes Island a significant number of anomalies are identified as being moorings. Additional small anomalies in this area are due to sunken moorings.

4.3.1 Channel Inner Area

Due to the sensitivity of the instrument various surface metallic objects and shoreline structures can cause anomalies and are depicted by a cross symbol on Figure 2. At the southern portion of the survey area many magnetic anomalies can be seen and are probably due to shallow bedrock combined with shallow water depths allowing the sensor very close to the harbor bottom.

- CM-1 and CM-7 may be associated with multiple dipole signatures across 5 lines indicating the presence of a possible subsurface pipe or cable.
- CM-2 is a small anomaly associated with an area of debris seen in the Side Scan Target C37-2.
- CM-3 is a moderate anomaly seen across 3 lines probably associated with cable in the subsurface. CM-5 and CM-6 are similar type anomalies possibly enhanced by the geologic feature. While all three generated well-defined magnetic signatures, they are located within the federal channel that has been dredged to a 30' depth. They are not considered to be associated with an historic site.
- CM-10 is a medium intense broad anomaly that could be associated with geological effects or a large deep anomaly.
- CM-11 is a small anomaly, which is distorted by the nearby drilling barge. The anomaly is associated with Side Scan target C39-3 (collection of small metallic and non-metallic modern debris)
- CM-12 is a medium anomaly associated with Side Scan target C39-1 and is a possible metallic pipe/pole.
- CM-13 is a small negative anomaly possibly due to a change in survey boat speed when the data was collected. The anomaly can only be seen across a single line.

4.3.2 Popes Island North Area

Due to the sensitivity of the instrument numerous surface objects and shoreline structures cause anomalies especially within the mooring field. Anomalies caused by boats and moorings are noted as a cross on Figure 5.

- PM-1, PM-4 and PM-6 are anomalies associated with modern debris, as seen in the associated Side Scan Images.

- PM-2, PM-3 and PM-5 show a similar magnetic signature to the moorings in the area. It is suspected that this anomaly could be due to a sunken mooring or mooring anchor.

5.0 CULTURAL RESOURCES PROGRAM

5.1 MARITIME HISTORICAL OVERVIEW

5.1.1 Methodology

Prior to conducting fieldwork investigations, background research was undertaken to develop a generalized historic maritime context of the New Bedford Harbor for evaluation of potential historic submerged sites. However, much of historical research that follows was initially collected and submitted for a very similar study was completed in 2001 (Cox, 2001).

In addition to inspecting primary and secondary historical data, background research efforts included a records check for known archeological sites and National Register properties in the New Bedford project area and vicinity, and a review of Massachusetts state underwater archeological site files and prior technical reports.

While the emphasis of background research focused on maritime activity in the New Bedford Harbor, a broad-based historic overview was essential for providing the proper framework for assessing the potential significance of submerged cultural resources. Historic maps, secondary and primary shipwreck lists, primary historical accounts, newspapers, and county and thematic histories helped to identify a set of expected resources in New Bedford Harbor. During the course of background research staff contacted local archaeologists, watermen, avocational historians, and interested laypersons who may possess knowledge of the harbor area. Project staff also visited local and county libraries and historical societies. Site-specific research, pertaining to individual vessels was reviewed at Peabody Essex Museum, Salem, Massachusetts; New Bedford Whaling Museum, New Bedford, Massachusetts; and Independence Seaport Museum, Philadelphia, Pennsylvania. At each repository, computer indexes were inspected for references to specific ship-types, and maritime activity in and around New Bedford. In addition, sources were checked for data concerning potential shipwreck sites in New Bedford. Primary and secondary sources for shipwreck sites were also accessed during the collection of background data.

Information gathered during the background research was used to generate a framework for the project vicinity. The historical framework identified types of resources that may have been deposited in the New Bedford Harbor vicinity, and to determine the nature and extent of subsequent activities that may have removed or disturbed such resources. Each target or site identified during the fieldwork was analyzed and evaluated for potential historical significance within the context of this framework.

5.1.2 Maritime Historical Overview – New Bedford Harbor

Europeans first documented the Acushnet River and vicinity in 1602 when Englishman Bartholomew Gosnold, aboard the bark *Concord* sailed into the region after sailing from Falmouth, England (Baker, 1980). However, the first permanent European settlement in the study area did not start until 1652 when settlers from Plymouth bought the land presently encompassing Dartmouth, New Bedford, Fairhaven and Westport. New Bedford was part of Dartmouth until the old township was divided in 1787. Fairhaven and New Bedford remained as one township until 1812 (Ricketson, 1858). New Bedford's spacious and naturally deep harbor became an ideal location for the development of the fisheries industry. Whaling soon became the primary industry in New Bedford and Fairhaven. The first whalers in the colonies left from Nantucket and New Bedford as early as 1690.

The country's whaling fleet initially centered on Nantucket Island, began to consolidate on the mainland at and around New Bedford after the Revolutionary War. In 1765, there were only two or three small vessels employed in the whale fishery at New Bedford. In that year, Joseph Russell operated the sloops *Nancy*, *Polly*, *Greyhound*, and *Hannah* (all between 40 and 60 tons) in the local whaling industry. Other boats built and operated by Mr. Russell include; *Joseph & Judith*, *Patience*, *No Duty on Tea*, *Russell*, and *Rebecca*. Russell was instrumental in founding the town of New Bedford to serve as homeport for his growing fleet of whaling vessels. As the principle landowner, Russell had designed the town from the start to be a whaling center. In sub-dividing and selling off his tract, Russell provided sites for shipwrights, boat builders, blacksmiths, coopers and other artisans essential to the fishery industry. (Kugler, 1980). Other notable early vessels launched at New Bedford include the merchant vessel *Dartmouth*. She was owned by Francis Roth and later became one of the vessels involved in the Boston Tea Party demonstration in Boston Harbor (Ricketson, 1858).

Another prominent family associated with the formation of New Bedford was the Rotch family. Joseph Rotch and his sons, initially of Nantucket, moved to New Bedford in 1767. They soon became the leading whaling merchants in the colonies. In 1768, Rotch also built New Bedford's first candleworks (Kugler, 1980).

By 1775, almost 50 boats were involved with the expanding whaling industry. However, the British destroyed the eighteenth century whaling industry in Massachusetts during the Revolutionary War. Almost the entire whaling fleet of New Bedford was wiped out during the Revolution: only four or five ships remained out of 200 sail before the war; the rest were lost, buried or captured (Morisson, 1921).

New Bedford was active during the Revolutionary War. Early in the war, New Bedford and Fairhaven inhabitants constructed a fort on the east side of the Acushnet River at Nobscot. Many privateers were fitted out of Boston and Providence, and many of the prize vessels they captured were sent to New Bedford. Once the British discovered the town was stored with prize goods of every description, Sir Henry Clinton dispatched an expedition under the command of General Gray. On September 5, 1778, a British fleet that consisted of 32 vessels, the largest of which was a 40-gun ship, entered Clark's Cove and formed a bridge of boats to the shore. Approximately 4,000 or 5,000 British soldiers and sailors landed at New Bedford to destroy the vessels in the harbor. Local resident, Mr. Gilbert Russell listed 34 ships that the British destroyed: seven ships, one barque, one snow, eight brigs, seven schooners, and 10 sloops (Russell, cited in Ricketson, 1858).

After the war, the whaling industry slowly revived. It took several years after the peace before any vessels were fitted out in New Bedford. In 1787, there was only one ship (180 tons) and 2 or 3 brigs in the business; but soon after this period the whaling industry revived (Ricketson, 1858). In the last decade of the eighteenth century, both New Bedford and Fairhaven competed with Nantucket and began their rise to world prominence in the whale trade. In 1789, more than 100 whaling vessels operated out of Massachusetts, mostly from Nantucket and New Bedford. In the 1790s New England whalers headed into the Pacific Ocean for the first time. Related maritime industries sprung up in New Bedford, and particularly Fairhaven, in support of the whaling industry, including shipbuilding, ropewalks, and candle factories.

In addition to whaling, merchants also began to ship cargo out of New Bedford after the Revolutionary War. In 1802, some 20 square-rigged merchantmen were sailing from New Bedford. They were carrying cargoes from New York and the southern ports of Europe. Occasionally, voyages were made to the East and West Indies directly from New Bedford. By 1807, New Bedford's waterfront had seven commercial wharves, between 90 and 100 ships and brigs, containing each on an average 250 tons, and between 20 and 30 small vessels: Twelve of the ships were whalers. By that year, three ropewalks were established in New Bedford and one in Fairhaven. Water depth in the harbor was reported between 18 and 24 feet (Ricketson, 1858).

During the War of 1812, the Navy Department provided four Jeffersonian gunboats for defense in Massachusetts; two at Newburyport and two at New Bedford. However, they proved useless. The two New Bedford boats remained hidden in the Acushnet River and did not even attack the *Nimrod* when she stranded on Great Ledge offshore New Bedford. Quaker ship owners who made fortunes by neutral trading before 1812, perceived the future of commerce trading from New Bedford was limited and refitted most of their vessels' as whalers. Typically, local ship owners converted their merchant ships that had outlived their usefulness in the trade service into whalers, a ship type that required capacity rather than speed as its main attribute (Morison, 1921).

In 1796, a company was created to construct the first bridge across the Acushnet River to connect New Bedford with Fairhaven and Oxford. The bridge was 4,000 feet long including abutments and the two islands it crossed over. The initial bridge was swept away in March, 1807 and was rebuilt later that year. In September, 1815, the second bridge was also washed away. A third bridge was built over the Acushnet River in 1819 and was still being used as of 1858. It was reported that the bridge significantly contributed to the shoaling up of the harbor (Ricketson, 1858). Despite the presence of a bridge, ferries connecting Fairhaven and New Bedford remained active for more than 100 years. The last of these ferries, the Fairhaven, a small side-wheel steamer was launched into service on February, 24, 1896. Typically, she made 19 daily roundtrips across the Acushnet River (Whitman, 1994).

New Bedford was made a city in 1847. Whaling was the primary industry and remained so for most of the nineteenth century. In 1838 there were 170 whaling vessels in New Bedford. By 1857, New Bedford's whaling fleet surpassed all other Massachusetts ports combined with 329 whalers, with a tonnage of 111,364 (Sayer, 1889). Fairhaven provided most of the support services required by the whaling industry. With oil refineries, coopers shops, tool works and the other industries subsidiary to whaling, New Bedford Harbor became a center of industry. It became the fifth largest port for shipping in the country. Whaling and the manufacture of whaling products became the leading industry in Massachusetts after shoes and cotton and provided commerce with an important export medium (Morison, 1921). However, by 1888, whaling had declined dramatically. Only 74 whalers worked out of New Bedford in that year, with a tonnage of 18,911 (Sayer, 1889).

New Bedford was an urban center and was served by several steamboat lines during the nineteenth and twentieth centuries. Steamboat service from New Bedford to Nantucket dates to 1829, when Jacob Barker's steamer *Marco Bozzaris* made three trips a week. The New Bedford and Martha's Vineyard Steamboat Company was formed in 1846. In that year, the steamer *Naushon* made three trips a week between Edgartown and New Bedford, with a stop at Woods Hole (Foster & Weiglin, 1989). Steamboat service between New Bedford and New York began in 1853. The New Bedford and New York Steamship Company occupied a long, narrow roofed over wharf that could accommodate the large steamers operating in Long Island Sound (Whitman, 1994). Their boats connected with the Boston, Clinton & Fitchburg Railroad. In 1879 the Old Colony Steamboat Line took over the New Bedford-New York line (Foster & Weiglin, 1989). A second steamboat line, New Bedford, Martha's Vineyard and Nantucket Steamboat Company started service between New Bedford and the two islands in 1854. Assets from this company passed thorough several mergers and were acquired by the New England Steamship Company in 1945. Ships from the Fall River Steam Ship Line also served New Bedford.

Over fishing, a cheaper source of oil, and the Civil War, (Confederate Commerce Raiders captured and destroyed a vast number of New Bedford whalers on the high seas) combined to reduce the role of the whale industry and related maritime commerce. More than 50 whaling vessels were captured by rebel cruisers, 28 of which sailed out of New Bedford. All but a few of the whalers were burned. In June 1865, Confederate Cruiser *Shenandoah* alone captured 25 whalers in Behring strait. Many other whalers were bought by the government during the Civil War. Forty New Bedford whalers purchased by the United States formed the major portion of the two famous stone fleets which in 1861 were sunk off the harbors of Charleston and Savannah to impede blockade runners and privateers (Sayer, 1889). Numerous whalers were also lost in Arctic ice. In September 1871, 33 whaling ships (22 from New Bedford) were crushed by ice in the Arctic Ocean. Arctic mishaps in 1876 and 1888, claimed 17 more whaling ships.

Ultimately, the future of whaling as a source of oil was sealed once Colonel Drake discovered oil in the ground in northwestern Pennsylvania in 1859.

By the end of the nineteenth century, whaling had given way to textile mills as the leading industry in the New Bedford economy. Cotton mills, ushered in with the advent of the Industrial Revolution, began to replace the fish-processing and candle-making plants on the New Bedford waterfront. And with the decline of whaling, the shipyards and associated maritime industries were slowly abandoned. It was not until the after the First World War when the introduction of diesel powered fishing boats allowed vessels to economically reach the rich offshore fishing banks that New Bedford once again became a prominent fishing port.

5.2 SUBMERGED CULTURAL RESOURCES

5.2.1 National Register of Historic Places Evaluation Criteria

Nautical vessels and shipwreck sites are generally, excepting reconstructions and reproductions, considered historic if they are eligible for listing in the National Register of Historic Places. As set forth at 36 CFR 60.4, to be eligible for the National Register of Historic Places, a vessel or site must be significant "in American history, architecture, archeology, engineering, or culture" and "possess integrity of location, design, setting, materials, workmanship, feeling, and association" and meet one or more of the following criteria:

a. be associated with events that have made a significant contribution to the broad patterns of our history; or

b. be associated with the lives of persons significant in our past; or

c. embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

d. have yielded, or may be likely to yield, information important in prehistory or history.

National Register of Historic Places Bulletin 20 clarifies the National Register review process with regard to shipwrecks and other submerged cultural resources. Shipwrecks must meet at least one of the above criteria and retain integrity of location, design, settings, materials, workmanship, feelings and association. Determining the significance of a historic vessel depends on establishing whether the vessel is:

1. the sole, best, or a good representative of a specific vessel type; or

2. is associated with a significant designer or builder; or

3. was involved in important maritime trade, naval recreational, government, or commercial activities.

Properties that qualify for the National Register must have significance in one or more "Areas of Significance" that are listed in *National Register Bulletin* 16A. Although 29 specific categories are listed, only some are relevant to the submerged cultural resources in New Bedford Harbor. Architecture, commerce, engineering, industry, invention, maritime history and transportation are potentially applicable data categories for the type of submerged cultural resources that may be expected in the Acushnet River study area.

5.2.2 Shipwrecks in the New Bedford Vicinity

A wide variety of shipwrecks may exist in New Bedford's harbor. Historic records indicate that maritime activity in the region's waterways dates to the first decade of the seventeenth century. The first documented shipwreck losses in the region are associated with Revolutionary War activity in September 1778. In the nineteenth century. New Bedford became the principal whaling port in the country and was home for hundreds of square-rigged whalers. Although whaling was phased out as an industry by the end of the nineteenth century, New Bedford has remained a preeminent commercial fishing port throughout the twentieth century. Shipwrecks undoubtedly occurred in and around New Bedford harbor during each phase of the port's historical development. However, it is highly unlikely that any intact wrecks remain within the navigable portions of the harbor, since they would have been removed long ago as a hazard to navigation. Nonetheless, a list of shipwrecks and derelict vessels provides insights into the expected vessel types that might be found in and around New Bedford.

A number of sources were accessed during the compilation of wrecked vessels in New Bedford's Harbor. The lists have been divided according to the sources. In all, more than 65 different vessels are documented as wrecked in or around New Bedford Harbor.

The following is a shipwreck list maintained at the Massachusetts Board of Underwater Archaeological Resources (MBUAR). It was provided by Mr. Victor Mastone, MBUAR Director. The vast majority of the sites included in the list were derived from data gathered by Mr. Brad Luther, local expert on New Bedford Harbor, and Mr. John Fish, an underwater researcher.

Vessel Name	Date	Type	Location
Wasp	6/12/1903	Barge	New Bedford
Thomas H. Lawrence	9/21/1938	Schooner	West of Palmer's Island, New Bedford Harbor
H.M.S. Nimrod	1815		Mass.
Unidentified	1/7/1844	Schooner	Near New Bedford
Rival	10/14/1844	Brig	Ashore at New Bedford
Caravan	11/6/1847	Schooner	Off New Bedford
Chopaquoit	1947	Ketch	Off West Beach, Westport
Aloha	3/13/1870	Bark	New Bedford
A. Francis Edwards	5/26/1892	Schooner	New Bedford
Freeman	9/15/1898	Schooner	New Bedford
Rattler	10/13/1915	Oil	New Bedford
Sally W. Ponder	10/9/1916	Schooner	New Bedford
Lorna	11/1/23	Gas	New Bedford
Mogadore	9/11/1930	Gas	New Bedford
Althea Louke	12/4/1932		New Bedford
Eurybia	8/9/1935	Gas	New Bedford
Winifred	9/21/1938	Oil	New Bedford
Alma Bell	9/14/1944	Oil	New Bedford
Marion Dorothy	9/14/1944	Oil	New Bedford
Alice May	1950		New Bedford
Debbie II	8/1/54	Gas	New Bedford
Rose Mary Mello	8/31/1954	Oil	New Bedford
Phillip R.	11/15/1954	Barge	New Bedford
Onward	3/17/1956	Oil	New Bedford
Mariner	1956	Yacht	Fairhaven, 1 mile east of West Island
Francis Edward	5/1892		Fairhaven

Shipwrecks listed for the New Bedford/Fairhaven vicinity in *Encyclopedia of American Shipwrecks* (Berman, 1972) include:

Lizzie W. Hannum, a two-masted schooner, wrecked at Great Ledge, Buzzards Bay on April 10, 1895
Marjorie Parker, an oil screw vessel, 76 tons, built in 1923, foundered at Fairhaven on August 31, 1954
Olive M. Williams, an oil screw fishing boat, 50 tons, built in 1928, sank in a storm at Fairhaven on September 1, 1954.
Sally W. Ponder, schooner, 107 tons, built in 1855, foundered at New Bedford on October 9, 1916.
Sankaty, steam screw, 677 tons, built in 1911, burned at New Bedford on June 30, 1924.
Wm A. Grozier, schooner, 116 tons, built in 1865, foundered off New Bedford on July 1, 1913.

Local New Bedford resident, Mr. Gilbert Russell listed by name and type each vessel that was destroyed by the British expedition on September 5, 1778 (in Ricketson, 1858, pg. 75).

Leopard, Ship
Spaniard, Ship
Caesar, Ship
Nanny, Barque
Rosin, Brig
Sally, Fishing Brig
Simeon, Snow
Sally, Continental Brig
Adventure, Schooner
Loyalty, Continental Schooner
Nelly, Sloop
Fly Fish, Sloop
Captain Lawrence, Sloop
Defiance, Schooner
Captain Jenny, Schooner
No Duty on Tea, Brig
Sally, Schooner
Bowers, Sloop
Sally (12 guns), Sloop
Ritchie, Brig
Dove, Brig
Holland, Brig
Joseph R, Sloop
Bociron, Sloop
Pilot Fish, Sloop
The Other Side, Schooner
Sally, Brig
Retaliation. Sloop
J. Brown's, Sloop
Eastward, Schooner

Other documented wrecks in the vicinity include:

Capt. Lavoeiro, 75-foot long New Bedford fishing vessel sank at the State Pier on December 26, 1984, after it struck a barge outside the harbor and returned to the pier where it sank. However, salvagers used a crane and divers to raise it three days later (Quinn, 1988)

5.2.3 Removal of Derelict Vessels

In 1989, a project was conducted to identify and remove derelict vessels from around the harbor. Parson, Brinckerhoff, Quade, & Douglas, Inc., (Parsons) organized the project that removed 13 derelict boats from New Bedford Harbor, in the municipalities of Fairhaven and New Bedford (Parsons 1989). Seven of those vessels were located in Fairhaven and six were in New Bedford.

One of the derelict vessels, the 85-foot long *Evelina Goulart*, in Fairhaven, was raised on May 25, 1989. She was towed to the Essex Shipbuilding Museum where it was to be restored, near where it was launched in 1927, as one of the last sail-driven fishing schooners.

Other derelict vessels that were removed in 1989 include:

1. a 30-foot wood hull boat (Fairhaven),
2. three construction barges, approximately 60-feet x 20-feet (Fairhaven),
3. a 40-foot fiberglass (Fairhaven),
4. a 20-foot wood vessel (Fairhaven),
5. a barge, approximately 150-feet x 32-feet (New Bedford),
6. a fishing vessel, *Alydar*, approximately 92-feet x 26-feet (New Bedford),
7. a fishing trawler, *Plymouth*, approximately 100-feet x 28 feet (New Bedford),
8. two barges, each approximately 150-feet x 32-feet (New Bedford),
9. a Navy Launch, approximately 150-feet x 32-feet (outside of Hurricane Barrier, New Bedford).

In 2001/2002, 16 derelict and abandoned vessels at the Melville Ship Yard in New Bedford were removed and destroyed as part of the ongoing Superfund Clean-Up of New Bedford Harbor. An archaeological project documented each of the derelict vessels and evaluated their significance in terms of National register of Historic Places eligibility criteria (Cox, 2001a). The report concluded that none of the vessels satisfied NRPA criteria.

5.2.4 Potential Submerged Cultural Resource Types

Recorded maritime activity in the New Bedford region dates to the first decade of the seventeenth century. However, it was not until the middle of the eighteenth century that the port of Dartmouth/New Bedford became a prominent fishing harbor. From that era to present, the harbor in the Acushnet River has hosted a consistently high volume of maritime traffic.

Historic documentation confirms that many types of ships and vessels were wrecked in the New Bedford vicinity. A preliminary list of documented vessels wrecked or lost in New Bedford (see Section 3.2) provides an indication of the quantity and types of shipwreck sites that have been deposited on the bottom of the waterway. Drawing from a variety of primary and secondary sources, these lists, while far from comprehensive, give an indication of the wide variety of shipwrecks that have been lost in the waterway over the last 225 years.

Potential shipwreck types in/near New Bedford may include a variety of material dating from Revolutionary War-era through the twentieth century. To discuss the types of vessels potentially present, it is necessary to include vessels from all phases of the commercial and naval activity in this portion of Massachusetts. Wood-hulled ships, ranging from small fishing sloops, shallops, brigs, recreational sailing craft, gas/diesel powered fishing trawlers and coastal schooners, to ship-rigged whalers, have been likely lost near New Bedford. Numerous steamers and ferries also plied the Acushnet River for well over 150 years. Iron-hulled vessels, including paddle wheel and screw steamboats, have been used extensively in the harbor. Indigenous, small rowed- and sailed-vessels were also used throughout all active harbors. Since such a wide range of vessels has been used in New Bedford over such an extended time period, it is almost impossible to feature one particular type of vessel type most likely to be found. Many of these types of vessels would lend historic insights into a wide-range of maritime-related topics and would be considered historically significant.

5.3 PREVIOUS UNDERWATER ARCHEOLOGICAL INVESTIGATIONS

MBUA files contained information on four previous underwater archeological surveys in the project vicinity. Robert Cembrola served as the Principal Investigator for the Marine Archaeological Report that was completed for the New Bedford Phase II Facilities Plan (Cembrola, 1989). Potential submerged cultural resources were identified within a three-mile vicinity of two candidate outfall diffuser sites and within 0.5 miles on either side of the proposed outfall pipeline alignment that extended from the southern tip of New Bedford out 3.5 miles into Buzzards Bay. Two known wrecks sites, the *Margeret Kehoe*, a 62-ton fishing boat sank near Church Rock in 1963, and the *Yankee*, a 6,225 ton, 391-foot steam ship ran aground and sank on Great Ledge on September 23, 1908, were identified in Buzzards Bay, near the mouth of the Acushnet River. The wrecks were outside the area affected by the outfall pipeline and no additional fieldwork was conducted.

J, Lee Cox, Jr., served as the Principal Investigator for the other three local underwater archaeology projects. Two of the projects were completed in conjunction with the New Bedford Harbor Superfund Project in the towns of New Bedford, Fairhaven and Acushnet. The primary project was a magnetic and acoustic remote sensing investigation to determine the presence or absence of submerged cultural resources potentially eligible for the National Register of Historic Places that might be affected by dredging to remove contaminated sediments (Cox, 2001). Analysis of remote sensing data identified sixty magnetic and/or acoustic targets. The vast majority of the targets appear to be related to isolated, single source objects, modern debris, or shoreline-related objects. Two of the remote sensing targets are suggestive of submerged cultural resources. However, divers confirmed that modern debris was the target source at both locations.

In conjunction with Superfund Project, archaeologists also documented the derelict vessels at the Melville Shipyard, New Bedford (Cox, 2001a). Sixteen vessels were documented and evaluated according to NRHP criteria. The report concluded that none of the vessels satisfied NRHP criteria.

A remote sensing investigation was conducted by Apex Environmental for the New Bedford State Pier Dredge Project. Mr. Cox served as the Principal Investigator for the project. The report concluded that several miscellaneous objects were present on the river bottom within the 800'-long by 150'-wide project area, along the New Bedford waterfront. However, all of the objects were scattered pieces of debris that were not suggestive of historically significant submerged cultural resources (Cox, 2001b).

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Cultural Resources

Historic sources confirm a sustained level of maritime activity in New Bedford harbor since the middle of the eighteenth century. Dozens of vessels were documented as having been stranded, foundered, burned, capsized and destroyed in the New Bedford vicinity. Secondary sources have listed numerous wrecks in the project vicinity. Many of these vessels, including a number of Revolutionary War wrecks, were lost in the section of the harbor between the Route 6 Bridge and the Hurricane Wall. However, large portions of the harbor have been dredged during navigational improvements and many potential submerged sites were likely removed long ago as hazards to navigation. Since New Bedford is still a very busy commercial port, it is unlikely that potentially significant submerged cultural resources have been deposited within New Bedford harbor and have remained undetected and unknown. Local residents and watermen familiar with the harbor were unaware of any potential wreck sites within the harbor. Nonetheless, the harbor potentially contains cultural material from each phase of the port's extensive maritime history.

In an effort to identify submerged cultural resources that may be affected by the construction of CAD Cells in New Bedford Harbor, a comprehensive Phase I remote sensing survey was conducted across two project areas: Channel Inner Area and Pope Island North Area. Magnetic and acoustic remote sensing records were processed and correlated to determine the presence of targets that possessed signature characteristics suggestive of submerged cultural resources. Although analysis of the remote sensing data identified 43 magnetic and/or acoustic targets in the two project areas, only three of the targets were considered to be significant targets (CM-3, CM-5 and CM-6). However, the three magnetic targets are located within the Channel Inner Area which has been previously dredged. The source of the target signatures is therefore considered to be either debris-related material or associated with a geological feature. No additional underwater archaeological investigations are recommended. All of the rest of the target signatures were suggestive of modern debris, geologic features or isolated, single source targets.

Examination of the remote sensing data found no clear evidence of targets that would be considered suggestive of potentially significant submerged cultural resources. Numerous objects were identified on sonar records; however each sonar target appeared to be associated with debris or discared objects. There were also numerous magnetic anomalies found. In the opinion of Principal Investigator, none of the magnetic anomalies generated signatures clearly suggestive of submerged cultural resources. However, prominent geologic features found throughout the project areas generated magnetic signatures that could have masked the presence of submerged cultural resources.

While the project area has very likely been dredged and the historic waterfront filled in over the last 200 years, the historic significance of the port should be taken into consideration when evaluating the potential presence of submerged cultural resources. While remote sensing records do not indicate the presence of potentially significant targets, archaeological sites could remain undetected in these sections of the New Bedford harbor. During the Revolutionary War dozens of ships that were reportedly destroyed along this New Bedford waterfront close to the Channel Inner Area.

While no additional underwater archaeological investigation is proposed, it is recommended that an archaeological monitor be present during dredging operations to ensure that no undetected shipwreck sites or other archaeological sites are impacted during dredge operations.

6.2 Hazards Analysis

Numerous targets were identified in this remote sensing survey as shown in Figures 7 and 8. It can be seen that a large number of the identified targets are located outside of the current CAD cell footprints. Several of the targets identified may represent significant issues to future work performed in the vicinity of these targets. For example, a large section of dock identified as target C33-1 located just north of the current CAD footprint as well as several pipes and piles (C20-1, C37-1 and C39-1) could potentially impact dredging and construction operations.

Additionally, it can be seen from Side Scan mosaics and the Change in Total Magnetic Intensity maps that there are numerous smaller debris (both metallic and non-metallic) that may effect dredging operations.

Finally, it should be noted that interpretations stated in this report are not necessarily exclusive but are rather the best-fit interpretations of the currently available information and data. This interpretation may be improved upon as additional information becomes available.

7.0 LIMITATIONS

The following limitations apply to all geophysical surveys conducted by Apex Environmental, Inc, its subsidiaries and subcontractors. Every attempt has been made to conduct this survey in such a fashion so as to maximize the quality of the data collected and the interpretations rendered. However, a geophysical investigation is an indirect method of subsurface exploration whereby subsurface characteristics are inferred or interpreted from measurements collected at the ground or water surface. Many variables may affect these measurements. Due to the indirect, interpretive nature of geophysics, findings are generally considered precursory and subject to verification by more direct methods of investigation such as test borings or test pits. The following limitations are considered when evaluating geophysical data:

1. Subsurface features can be interpreted from the appropriate geophysical methods only insofar as they produce a discernible geophysical signature. They must have adequate homogeneity, size, and appropriate physical or chemical properties sufficient to contrast with the surrounding medium and be within reasonable proximity to the sensors. Additionally, their signature must be distinguishable from and not masked by background noise or interference.

2. Lithologic data inferred on the basis of geophysical data may not be identical to geologic or hydrogeologic data. Lithologies are generally interpreted from some geophysical signature (e.g., velocity differences) that may be the result of many factors (including density, susceptibility, angle to the sensors, amount of weathering, etc.). Lithology divisions based upon seismic velocity for example may not necessarily be identical to lithology changes identified by drilling. The discrepancy is generally related to formation density and/or compaction (i.e., a dense till may have a higher density than a weathered bedrock, and the difference can be difficult to resolve with seismic data).

3. Complex geological configurations may be impossible to resolve with surface geophysical methods. The resolution of geophysical data is limited by the spatial geometry of sensors, strength of signal, and distance of the object or layer of interest from the energy source and the sensor array used. Resulting interpretations are rendered by modeling geophysical response to known or presumed geometric relationships. The complexity of the relationships that can be modeled is limited by the resolution allowed by the method and geometry of equipment layout used, and the limitations of the software used.

4. Apex Environmental, Inc. is not responsible for data quality in areas having excessive "background noise" which affect the specific physical parameters that are being measured by a particular geophysical technique. Examples of background noise include: water traffic (large fishing boat); or underground utilities (such as electric lines, tunnels, sewers, etc.), which can interfere with magnetic instrumentation.

No guarantee or warranty (other than that stipulated in the contract under which this work was promulgated), expressly stated or implied, is given concerning the data and interpretations rendered in this report. All information is presented as "for information only". Apex Environmental, Inc., or any subsidiary, is not liable for any losses resulting from the misuse, misrepresentation, or misinterpretation of any information presented in this report by any person or entity.

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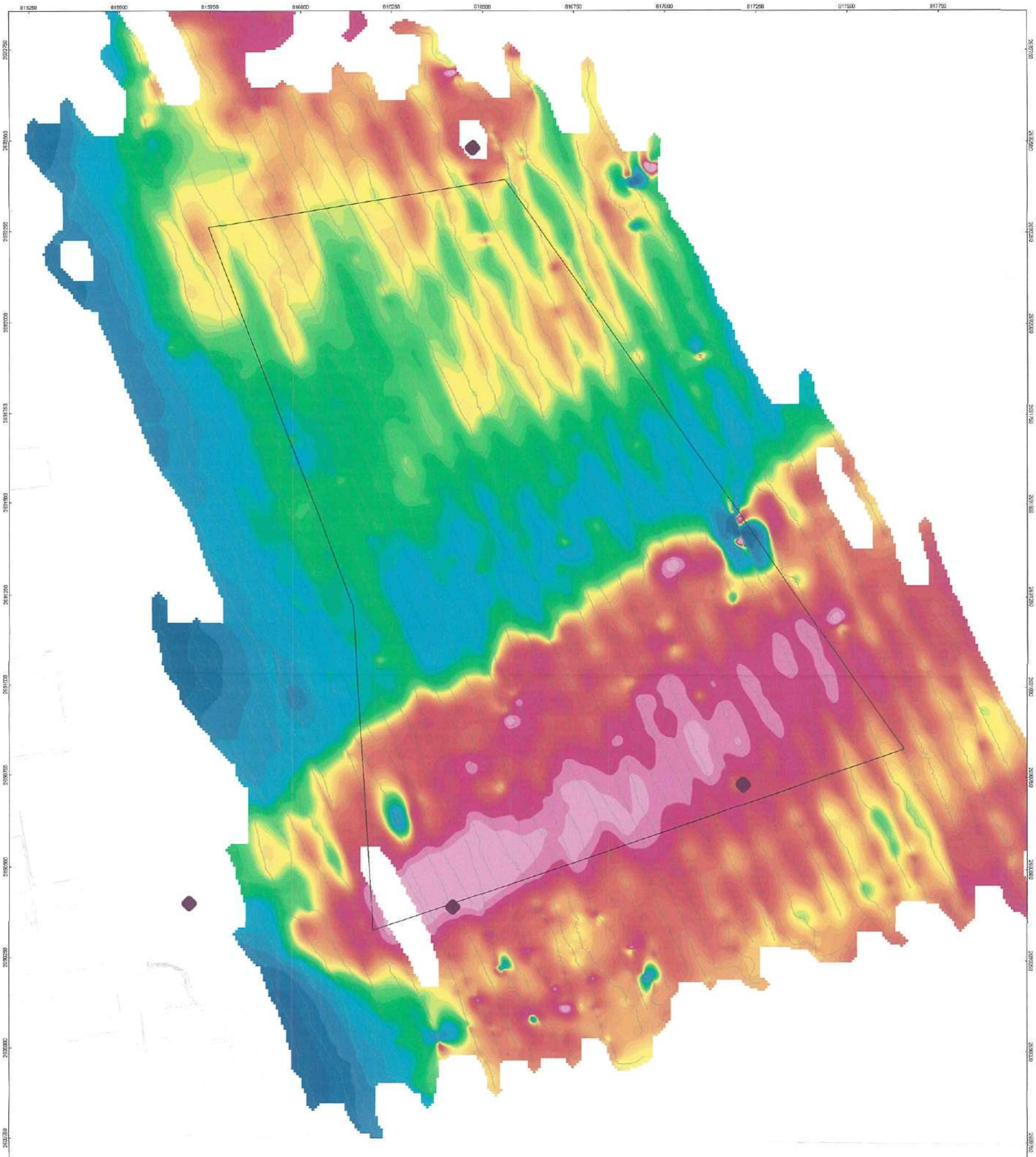


NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been feild verified.

2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).

3. Data was collected over a four day period between October 21-24, 2002 using a G-881 Cesium magnetometer flown at a depth of approximately 6 feet. Planned line spacing of 50 feet.

LEGEND:

- ◇ Aids To Navigation
- — Area of Proposed Cell
- Survey Line Path

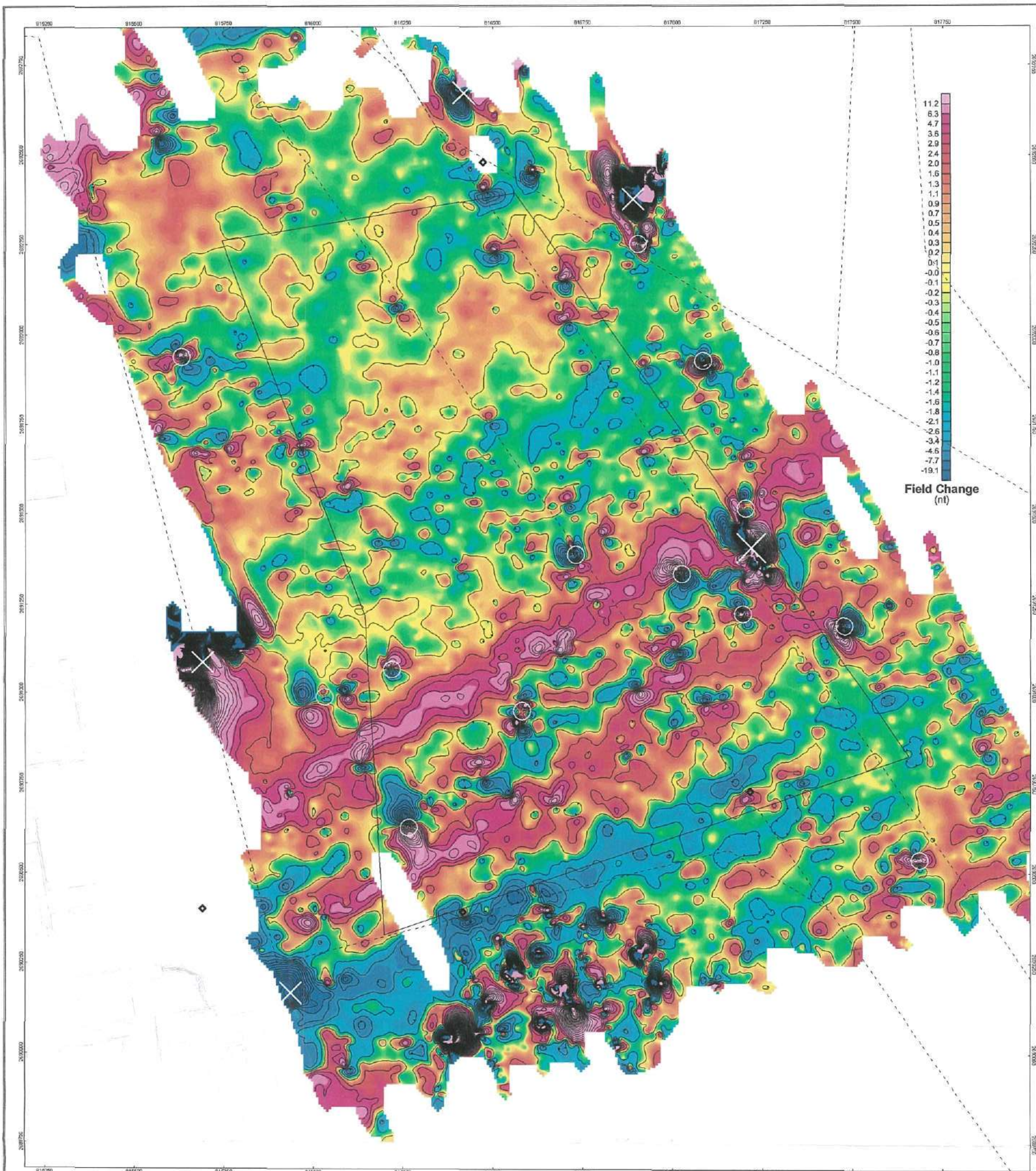
HAZARDS & CULTURAL IDENIFICATION - MAGNETICS

CHANNEL INNER AREA
NEW BEDFORD HARBOR, MA

TOTAL MAGNETIC INTENSITY (TMI)

Apex environmental inc.
374 Congress St.
Suite 500
Boston MA 02210
(617) 728-0070

SCALE: 1"=300'	DRAWN BY:	DESIGN BY:	CHECKED BY:	PROJECT: 6510.002
DATE: 12-20-02	TM	TM	JAB	SHEET 1 OF 8



NOTES:

1. *Base Plan of the New Bedford harbor area obtained from the* US Army Corps of Engineers and has not been feild verified.

2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001,Referenced to the 1983 North American Datum (NAD83).

3. Data was collected over a four day period between October 21-24, 2002 using a G-881 Cesium magnetometer flown at a depth of approximately 6 feet. Planned line spacing of 50 feet.

LEGEND:

- Aids To Navigation
- Area of Proposed Cell
- 2nT Contour
- Magnetic Anomaly
- Anomaly Due To Surface Boats
- Federal Navigation Channel

Scale 1:3600

US survey feet

REV	DESCRIPTION	BY	DATE

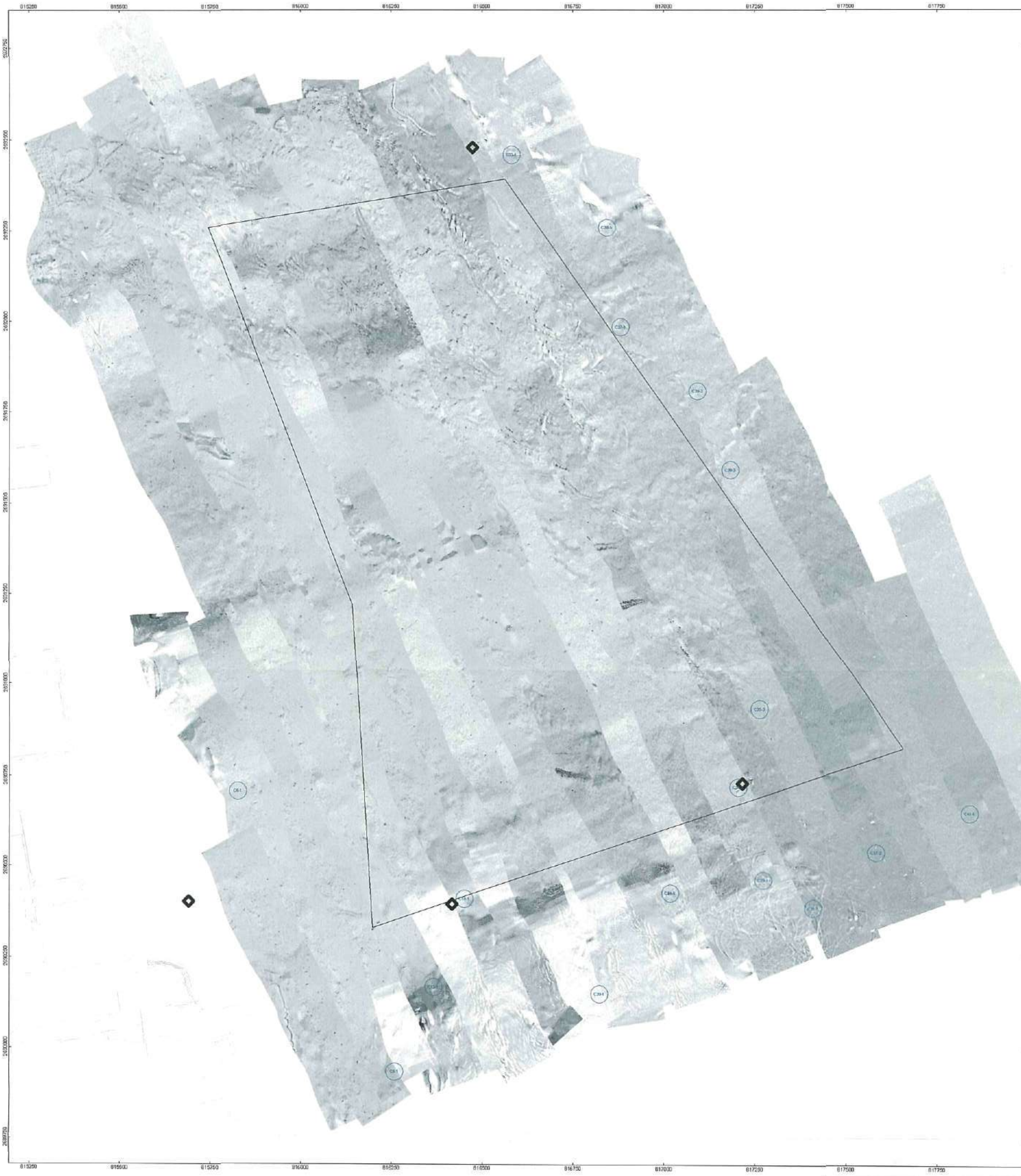
HAZARDS & CULTURAL IDENIFICATION - MAGNETICS

CHANNEL INNER AREA
NEW BEDFORD HARBOR, MA

CHANGE IN TOTAL MAGNETIC INTENSITY

Apex environmental inc.
374 Congress St
Suite 500
Boston MA 02210
(617) 728-0070

SCALE: 1"=300'	DRAWN BY:	DESIGN BY:	CHECKED BY:	PROJECT: 6910.002
DATE: 12-20-02	TM	TM	JAB	SHEET 2 OF 8



NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been feild verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001,Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using an EdgeTech 272TD towfish operating at 500kH flown at a depth of approximately 10 feet. Planned line spacing of 100 feet.

LEGEND:

- Aids To Navigation
- Area of Proposed Cell
- Side Scan Target

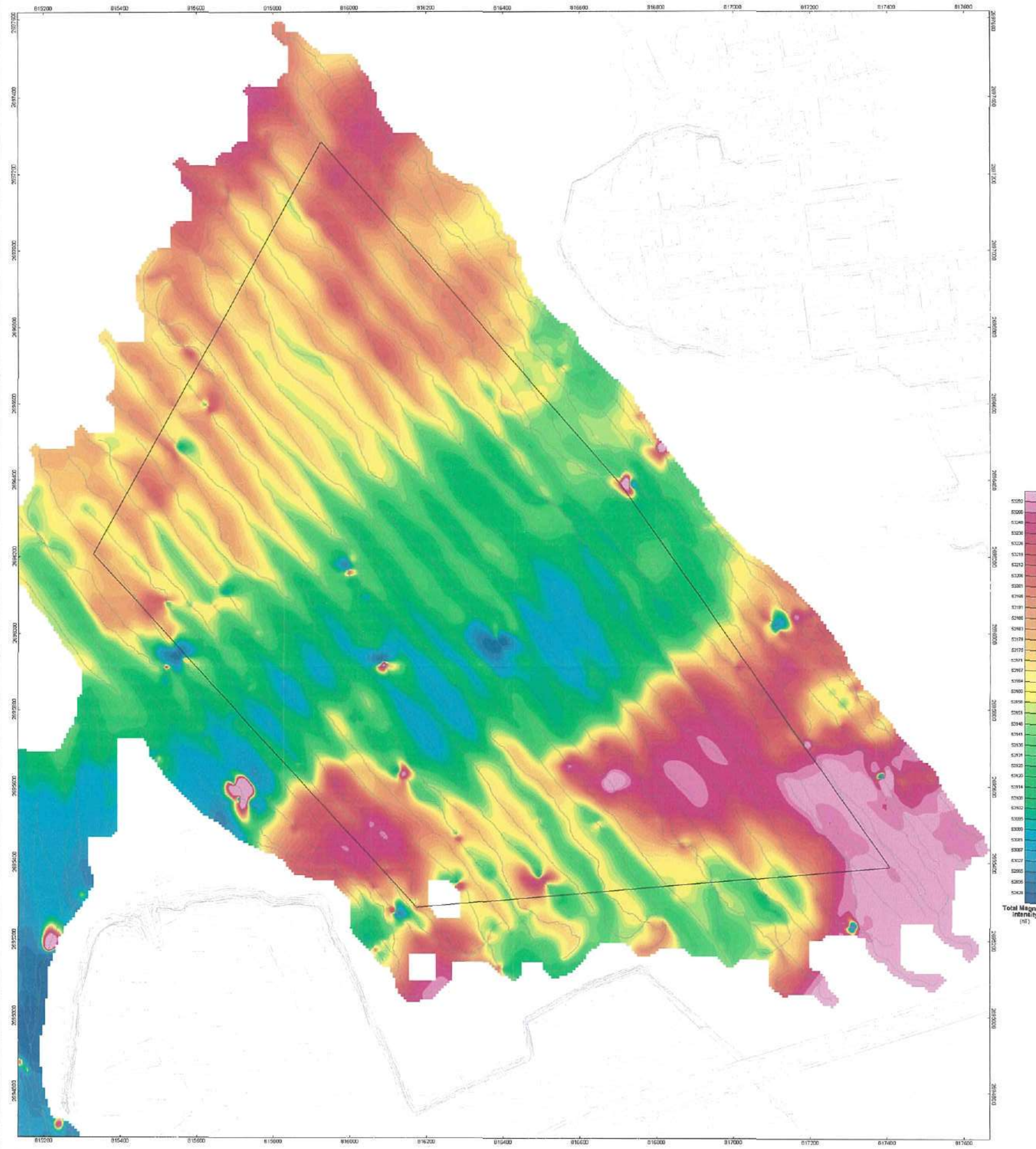
HAZARDS & CULTURAL IDENIFICATION - SIDE SCAN

CHANNEL INNER AREA
NEW BEDFORD HARBOR, MA

SIDE SCAN SONAR MOSAIC

Apex environmental inc.
374 Congress St
Suite 500
Boston MA 02210
(617) 728-0070

SCALE: 1"=300'	DRAWN BY:	DESIGN BY:	CHECKED BY:	PROJECT: 6510.002	ISSUE
DATE: 12-20-02	TM	TM	JAB	SHEET 3 OF 8	



NOTES

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been feild verified.

2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).

3. Data was collected over a four day period between October 21-24, 2002 using a Geometrics G-881 Cesium magnetometer flown on the water surface. Planned line spacing of 50 feet.

LEGEND

AREA OF PROPOSED CAD CELL

SURVEY LINE PATH

Scale 1:3600

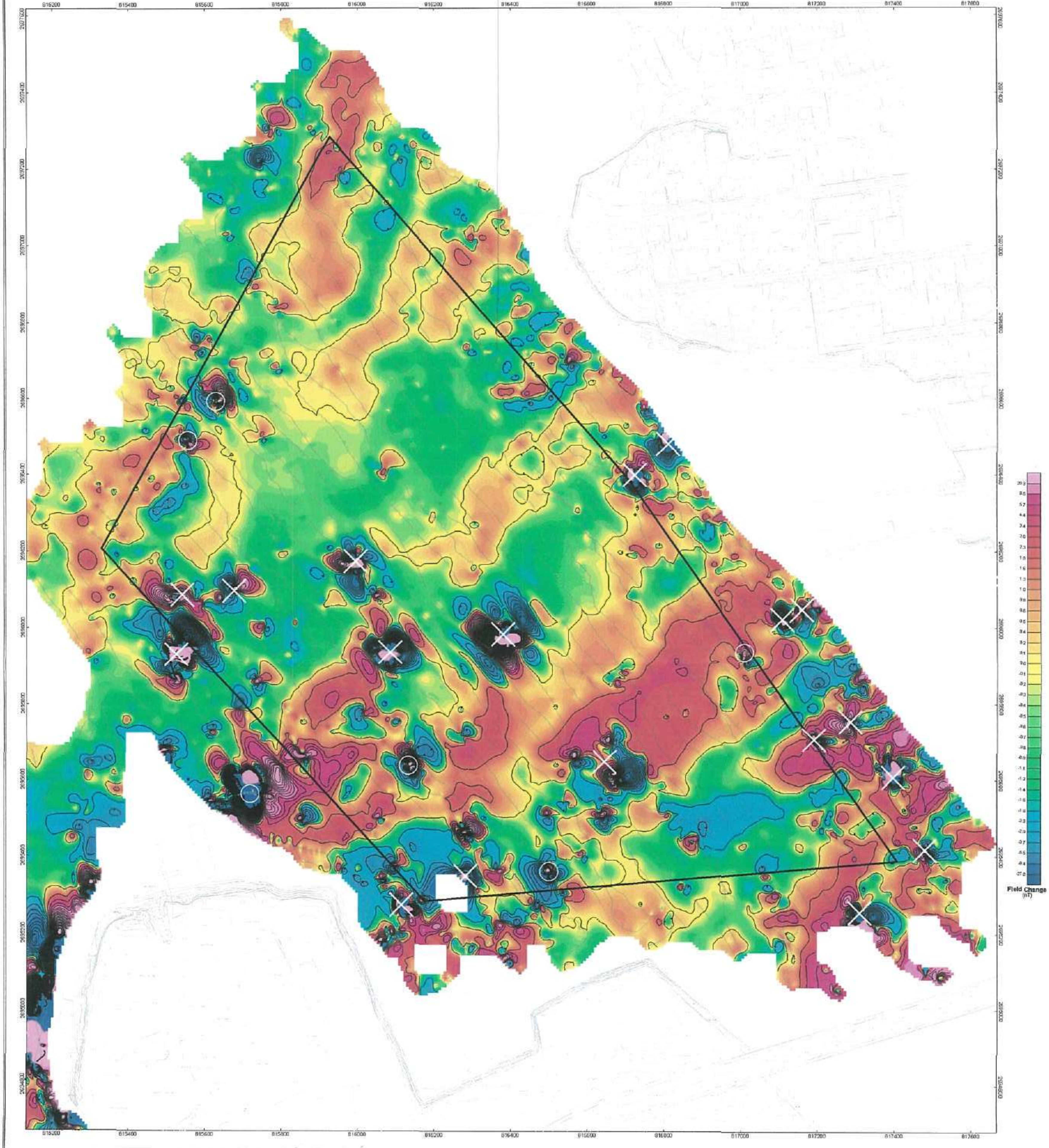
HAZARDS & CULTURAL IDENTIFICATION - MAGNETICS

POPES ISLAND NORTH AREA
NEW BEDFORD HARBOR, MA

TOTAL MAGNETIC INTENSITY (TMI)

Apex environmental, inc.
374 Congress St
Suite 500
Boston MA 02210
(617) 728-0070

SCALE: 1"=300'	DRAWN BY:	DESIGN BY:	CHECKED BY:	PROJECT: 6510.002
DATE: 12-20-02	TM	TM	JAB	SHEET 4 OF 8



NOTES

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been feild verified.

2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).

3. Data was collected over a four day period between October 21-24, 2002 using a Geometrics G-881 Cesium magnetometer flown on the water surface. Planned line spacing of 50 feet.

LEGEND:

- AREA OF PROPOSED CAD CELL
- ANOMALY DUE TO MOORING OR PLEASURE BOAT
- 2 nT CONTOUR
- SURVEY LINE PATH
- MAGNETIC TARGET

Scale 1:3600

US survey feet

REV.	DESCRIPTION	BY:	DATE:

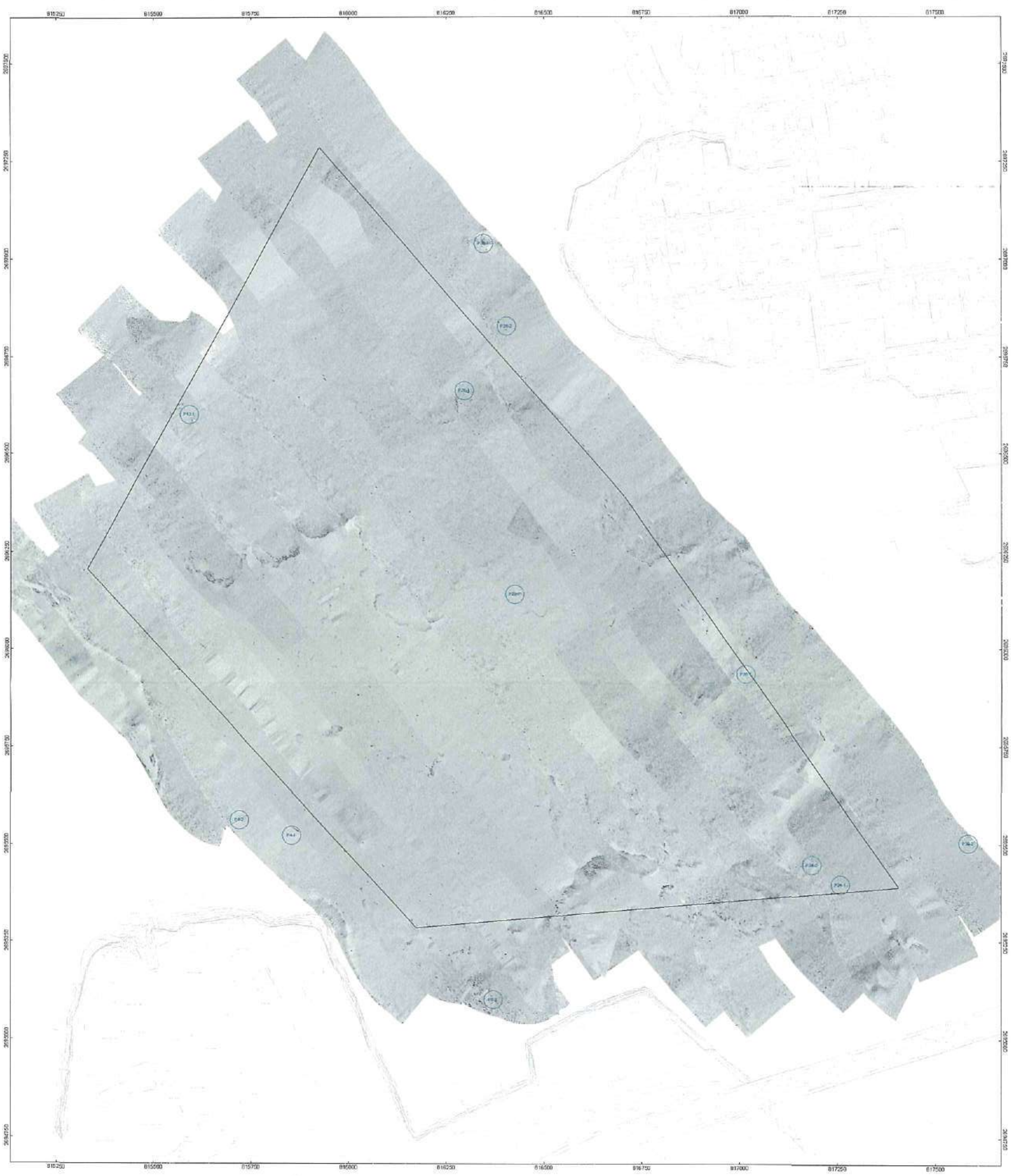
HAZARDS & CULTURAL IDENTIFICATION - MAGNETICS

POPES ISLAND NORTH AREA
NEW BEDFORD HARBOR, MA

CHANGE IN TOTAL MAGNETIC INTENSITY

Apex environmental, inc.
374 Congress St
Suite 500
Boston MA 02210
(617) 728-0070

SCALE: 1"=300'	DRAWN BY:	DESIGN BY:	CHECKED BY:	PROJECT: 6510.002
DATE: 12-20-02	TM	TM	JAB	SHEET 5 OF 8



NOTES

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been feild verified
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83)
3. Data was collected over a four day period between October 21-24, 2002 using a Edgetech 272D towfish operating at 500kH flown at a depth of approximately 6 feet. Planned line spacing of 100 feet.

LEGEND:

AREA OF PROPOSED CAD CELL

POSSIBLE TARGET

N

Scale 1:3600

REV.	DESCRIPTION	BY:	DATE

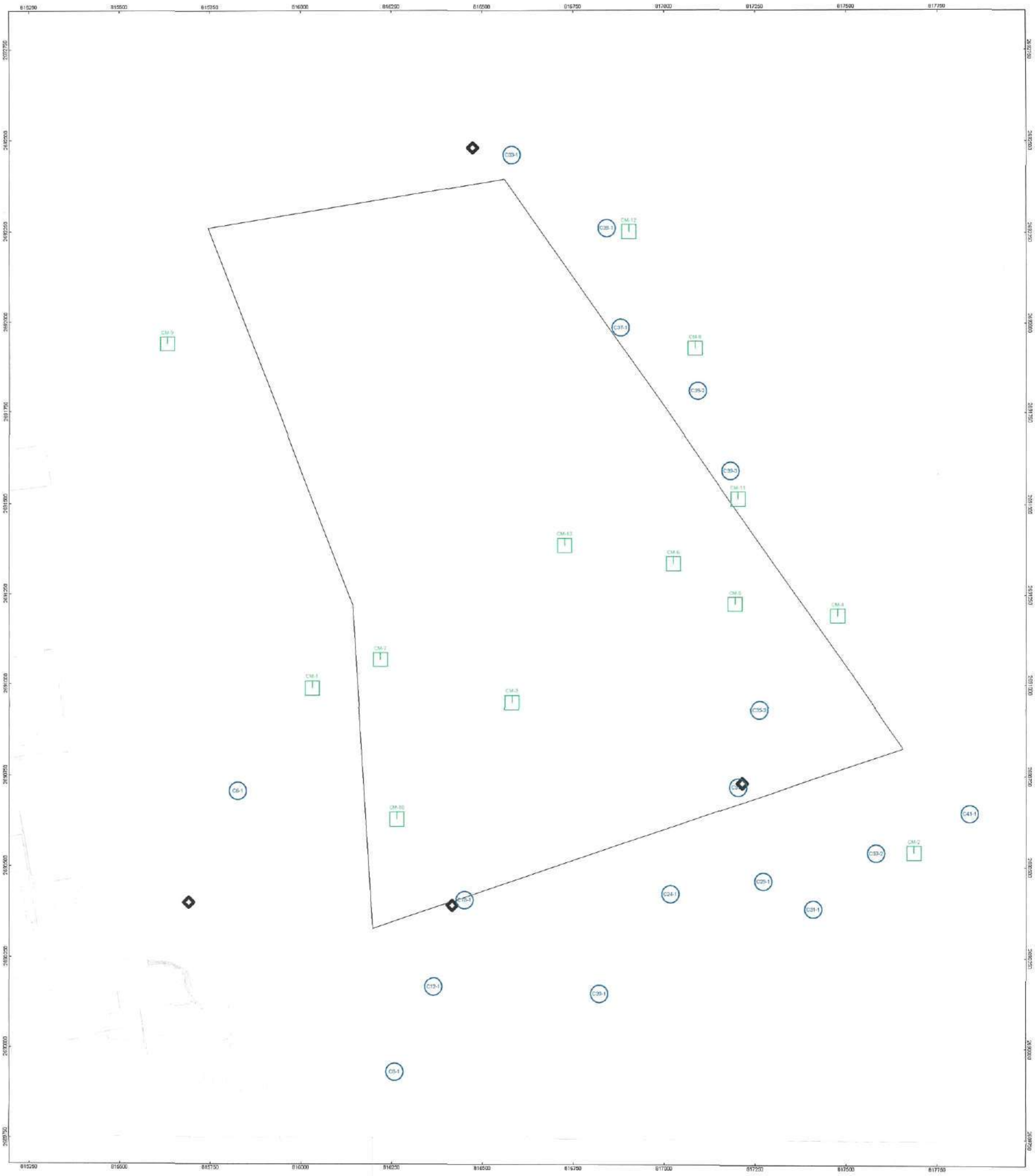
HAZARDS & CULTURAL IDENTIFICATION - SIDE SCAN

POPES ISLAND NORTH AREA
NEW BEDFORD HARBOR, MA

SIDE SCAN SONAR MOSAIC

Apex environmental inc.
374 Congress St
Suite 500
Boston MA 02210
(617) 728-0070

SCALE: 1"=300'	DRAWN BY:	DESIGN BY:	CHECKED BY:	PROJECT: 6510.002	ISSUE
DATE: 12.04.02	TM	TM	JAB	SHEET 6 OF 8	



NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been feild verified.

2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).

LEGEND:

- ◇ Aids To Navigation
- — Area of Proposed Cell
- Magnetic Anomaly
- ○ Side Scan Soanr Target

Scale 1:3600

REV	DESCRIPTION	BY	DATE

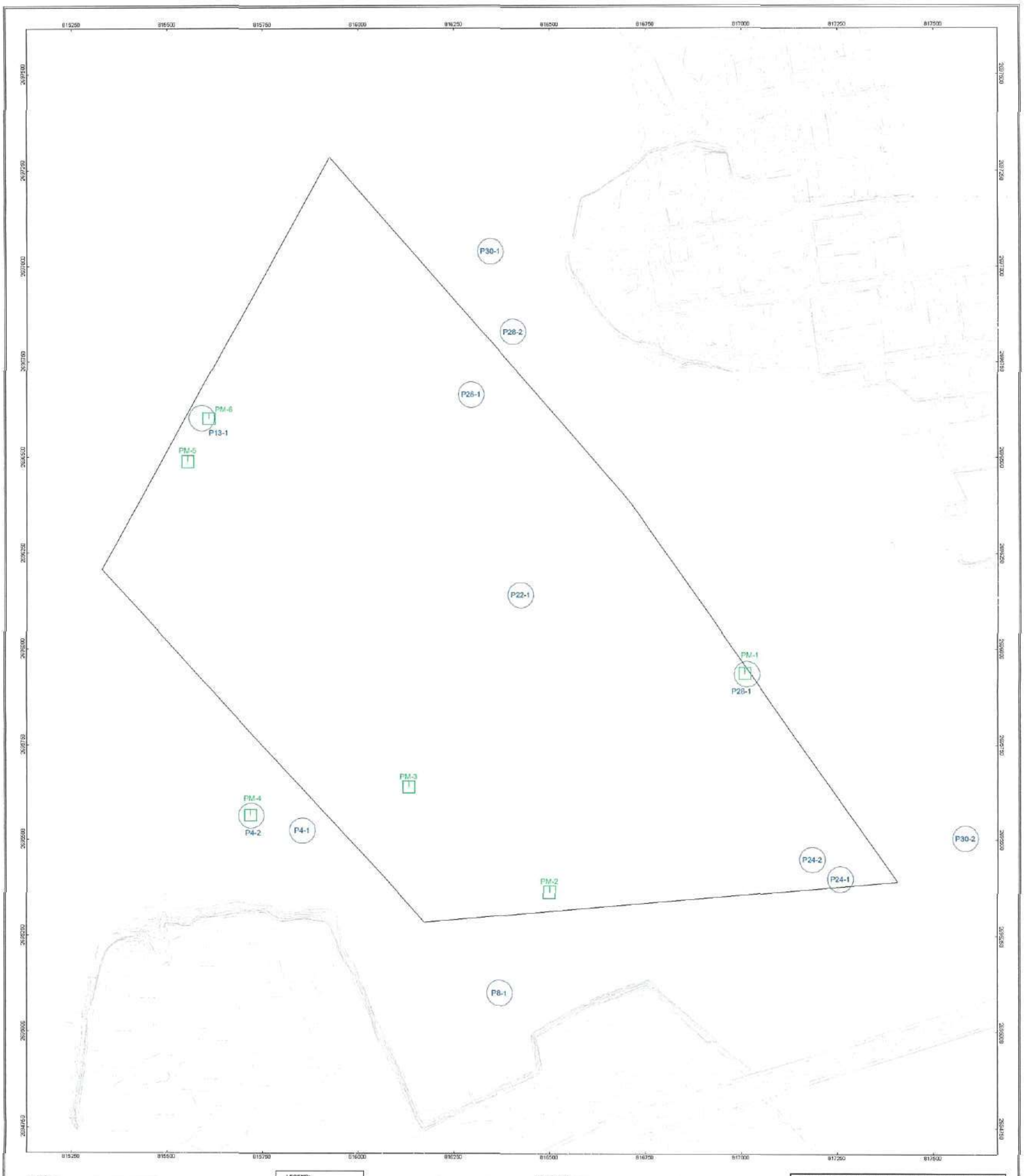
HAZARDS & CULTURAL IDENIFICATION - MAGNETICS

CHANNEL INNER AREA
NEW BEDFORD HARBOR, MA

INTERPRETED TARGETS

Apex Environmental, Inc.
374 Congress St
Suite 500
Boston MA 02210
(617) 728-0070

SCALE: 1"=300'	DRAWN BY:	DESIGN BY:	CHECKED BY:	PROJECT: 6510.002
DATE: 12.20.02	TM	TM	JAB	SHEET 2 OF 8



NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been feild verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using a Geometrics G-881 Cesium magnetometer flown on the water surface. Planned line spacing of 50 feet.

REV	DESCRIPTION	BY	DATE

HAZARDS & CULTURAL IDENTIFICATION - SUMMARY

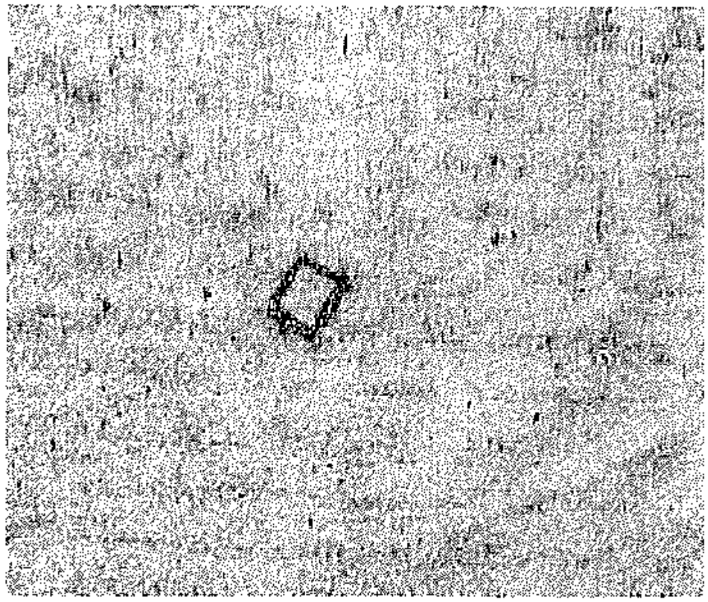
POPES ISLAND NORTH AREA
NEW BEDFORD HARBOR, MA

INTERPRETED TARGETS

Apex environmental inc.
374 Congress St.
Suite 500
Boston MA 02210
(617) 728-0070

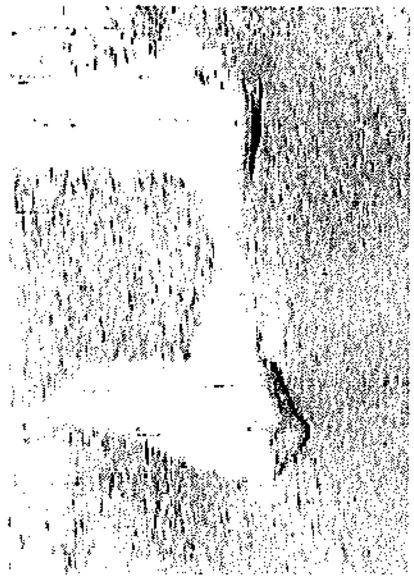
SCALE: 1"=300'	DRAWN BY:	DESIGN BY:	CHECKED BY:	PROJECT: 6510.002	ISSUE
DATE: 12-20-02	TM	TM	JAB	SHEET 8 OF 8	

APPENDIX A
Detail Side Scan Images
Channel Inner Area

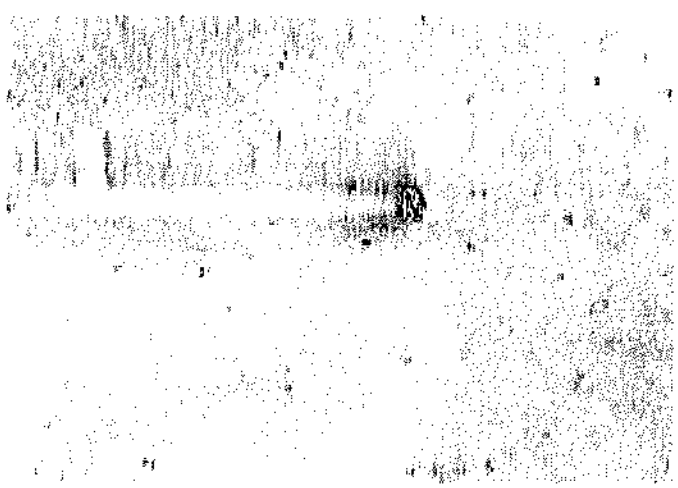


Target # C6-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\06chan-BAC.CMN
First Target Ping Num: 2225 at 10/22/2002 20:14:13
Target Location: 41° 37.7976' N 070° 54.9543' W

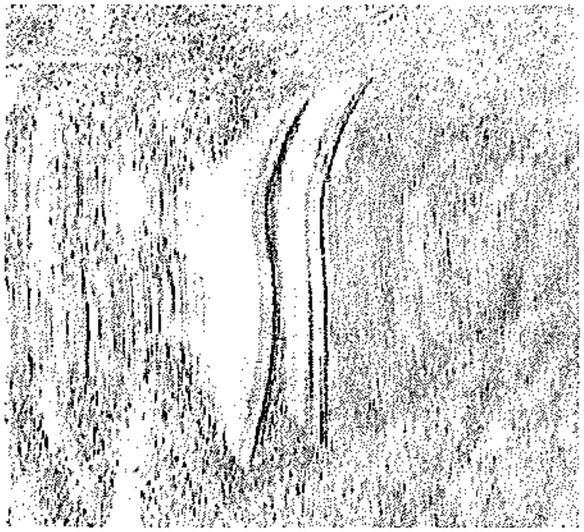
Target # C8-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\08chan-BAC.CMN
File Creation Time: 11/19/02 15:24:27
First Target Ping Num: 50 at 10/22/2002 20:08:03
Target Location: 41° 37.6653' N 070° 54.8564' W

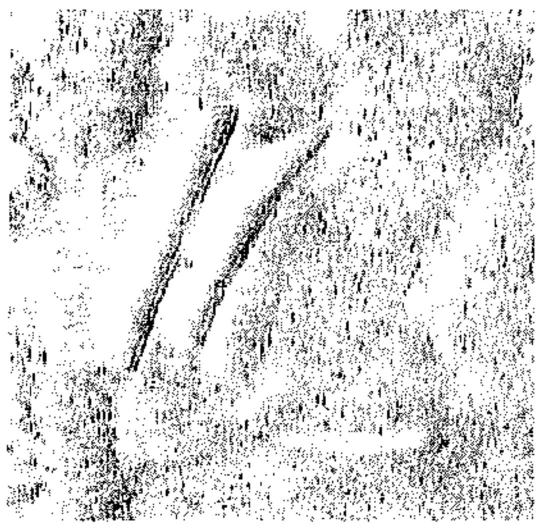


Target # C12-1
Sonar Web V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\12chan-BAC.CMN
File Creation Time: 11/19/02 15:26:30
First Target Ping Num: 1060 at 10/22/2002 19:50:27
Target Location: 41° 37.7051' N 070° 54.8291' W

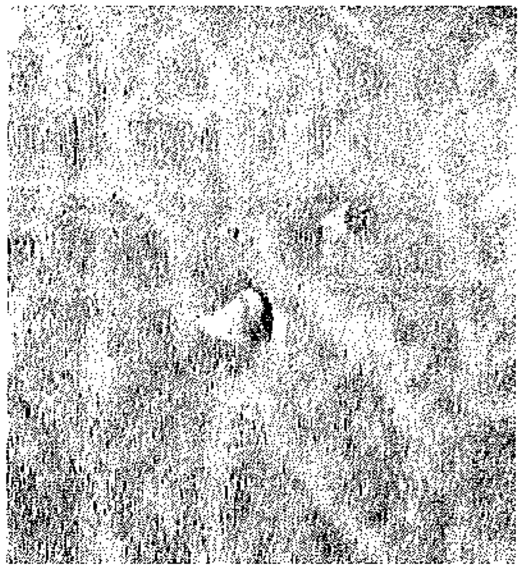


Target # C18-1
Sonar Web V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\18chan-BAC.CMN
File Creation Time: 11/19/02 15:27:25
First Target Ping Num: 13340 at 10/22/2002 17:39:49
Target Location: 41° 37.6982' N 070° 54.7568' W

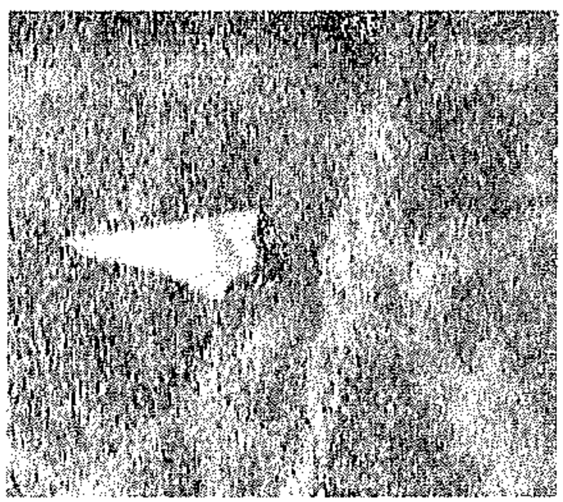




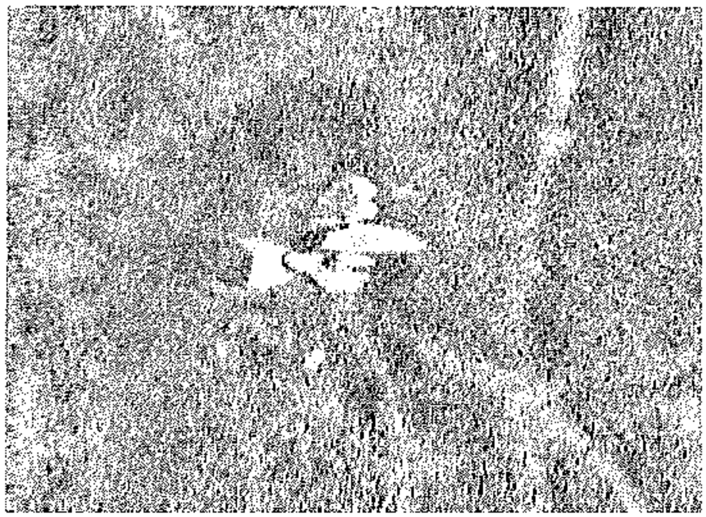
Target # C20-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\20chan-BAC.CMN
File Creation Time: 11/19/02 15:29:51
First Target Ping Num: 678 at 10/22/2002 14:26:09
Target Location: 41° 37.7034' N 070° 54.7302' W



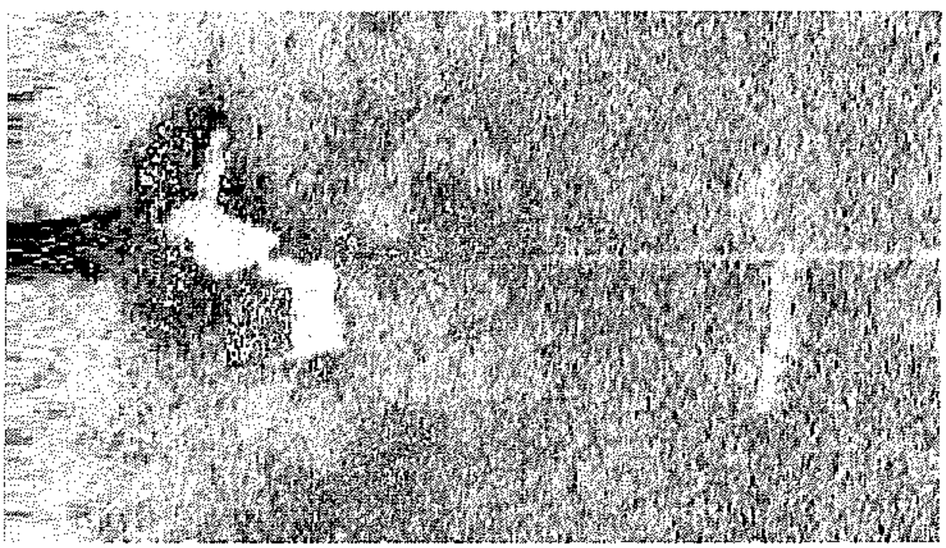
Target # C24-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\24chan-BAC.CMN
File Creation Time: 11/19/02 15:31:15
First Target Ping Num: 10626 at 10/22/2002 17:59:10
Target Location: 41° 37.7471' N 070° 54.7098' W



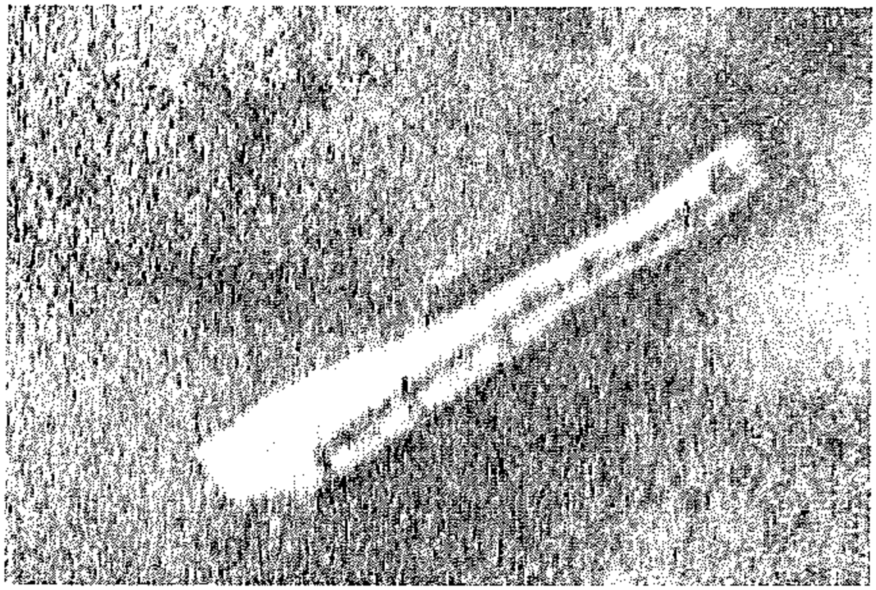
Target # C29-1
Sonar Web V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\29chan-BAC.CMN
File Creation Time: 11/19/02 15:32:42
First Target Ping Num: 10276 at 10/21/2002 14:49:02
Target Location: 41° 37.7495' N 070° 54.6542' W

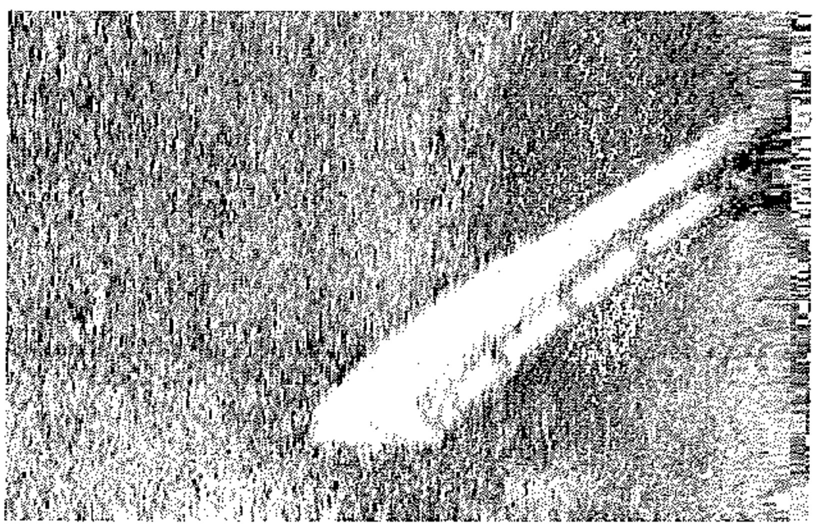


Target # C31-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\31chan-BAC.CMN
File Creation Time: 11/19/02 15:33:07
First Target Ping Num: 139 at 10/21/2002 14:51:05
Target Location: 41° 37.7317' N 070° 54.6163' W

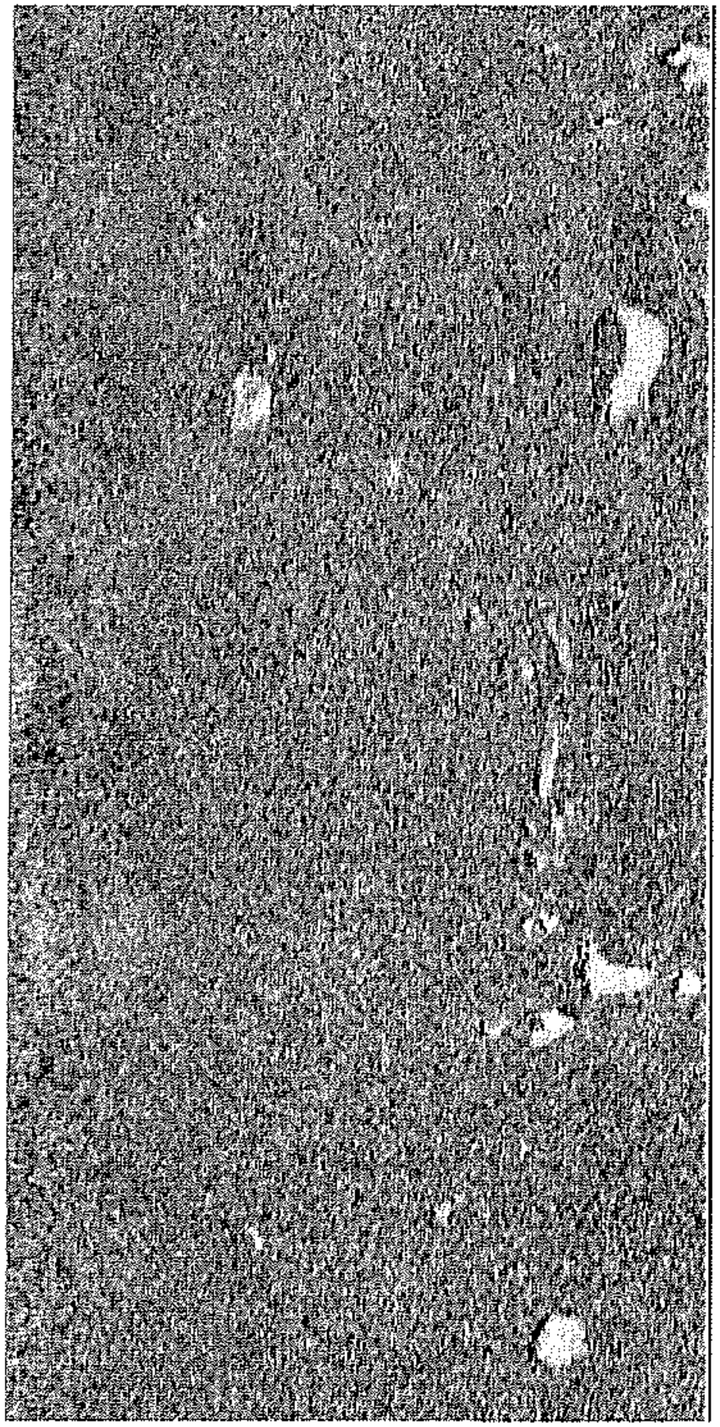


Target # C31-2
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\31chan-BAC.CMN
File Creation Time: 11/19/02 15:33:27
First Target Ping Num: 2399 at 10/21/2002 14:52:29
Target Location: 41° 37.7909' N 070° 54.6584' W

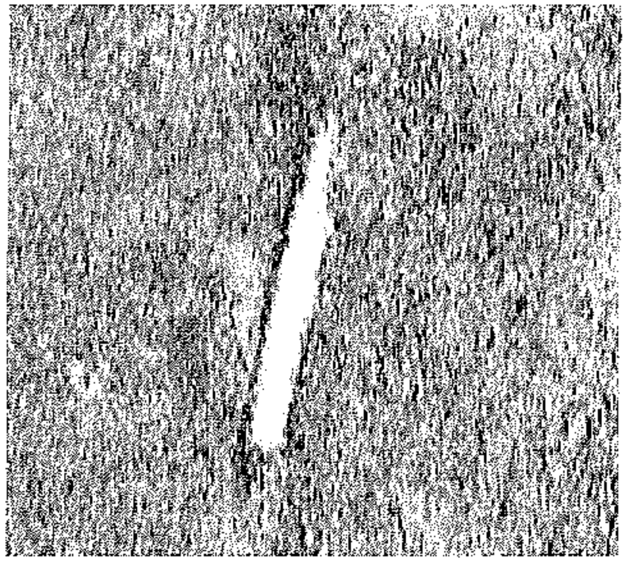


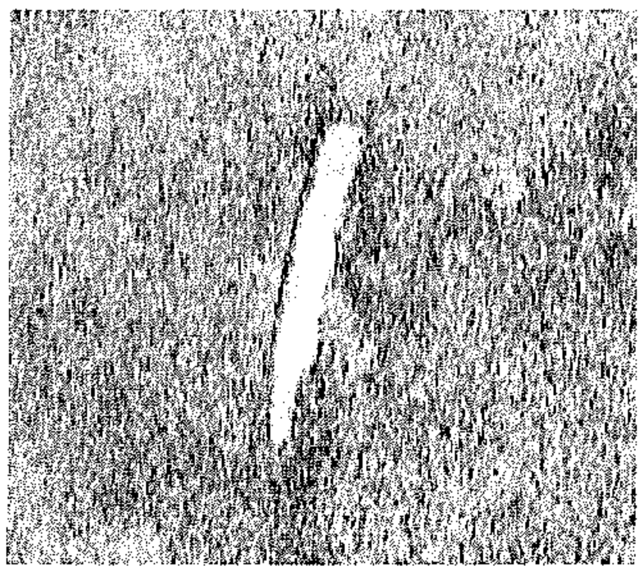


Target # C33-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\33chan-BAC.CMN
File Creation Time: 11/19/02 15:34:26
First Target Ping Num: 1246 at 10/21/2002 15:03:06
Target Location: 41° 38.0824' N 070° 54.7976' W

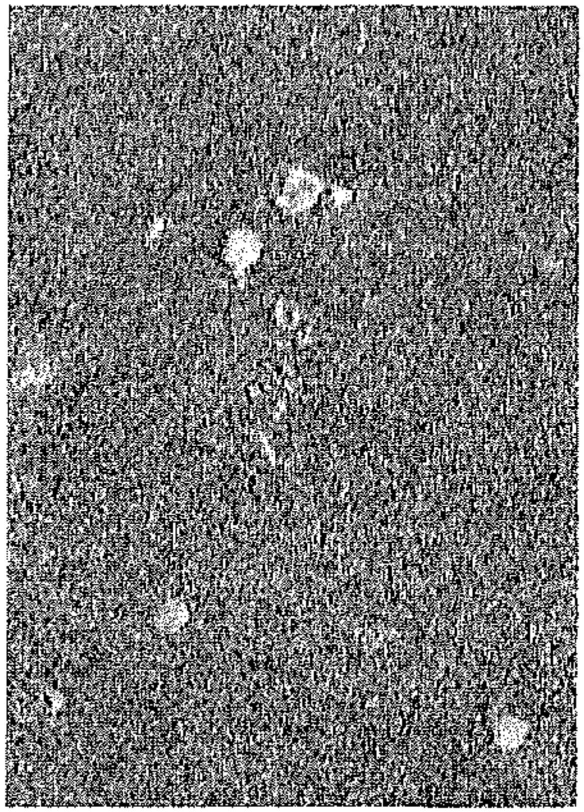


Target # C35-3
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\35chan-BAC.CMN
File Creation Time: 11/19/02 15:37:59
First Target Ping Num: 415 at 10/21/2002 15:11:14
Target Location: 41° 37.7420' N 070° 54.5754' W

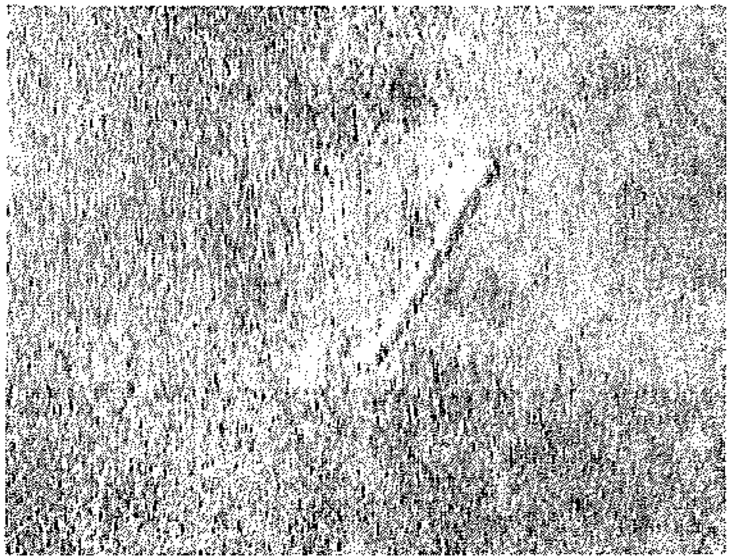


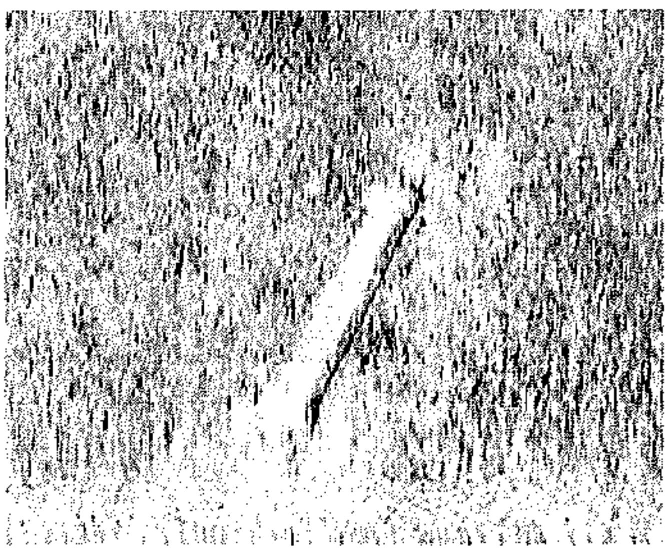


Target # C37-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\37chan-BAC.CMN
File Creation Time: 11/19/02 15:38:25
First Target Ping Num: 3337 at 10/21/2002 15:23:07
Target Location: 41° 38.0097' N 070° 54.7183' W

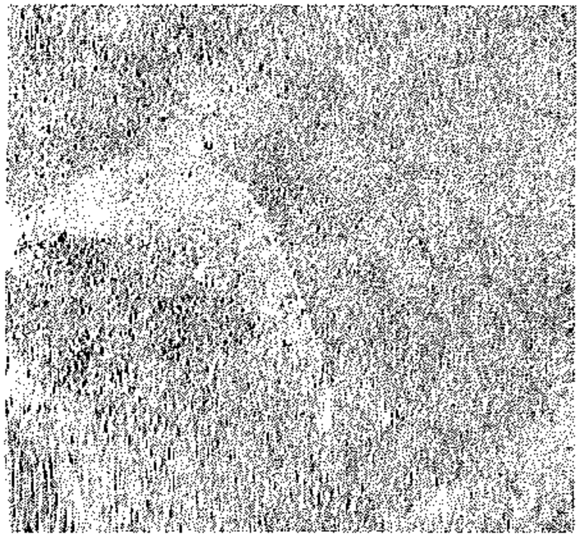


Target # C37-2
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\37chan-BAC.CMN
File Creation Time: 11/19/02 15:40:54
First Target Ping Num: 10851 at 10/21/2002 15:27:49
Target Location: 41° 37.7658' N 070° 54.5651' W

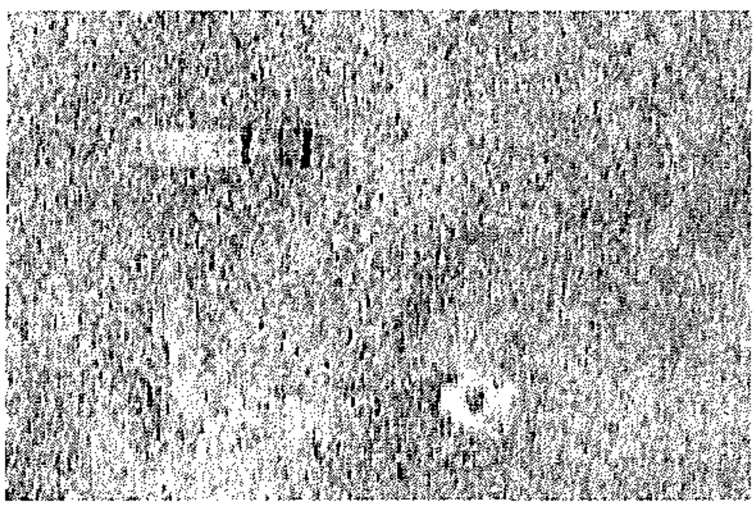




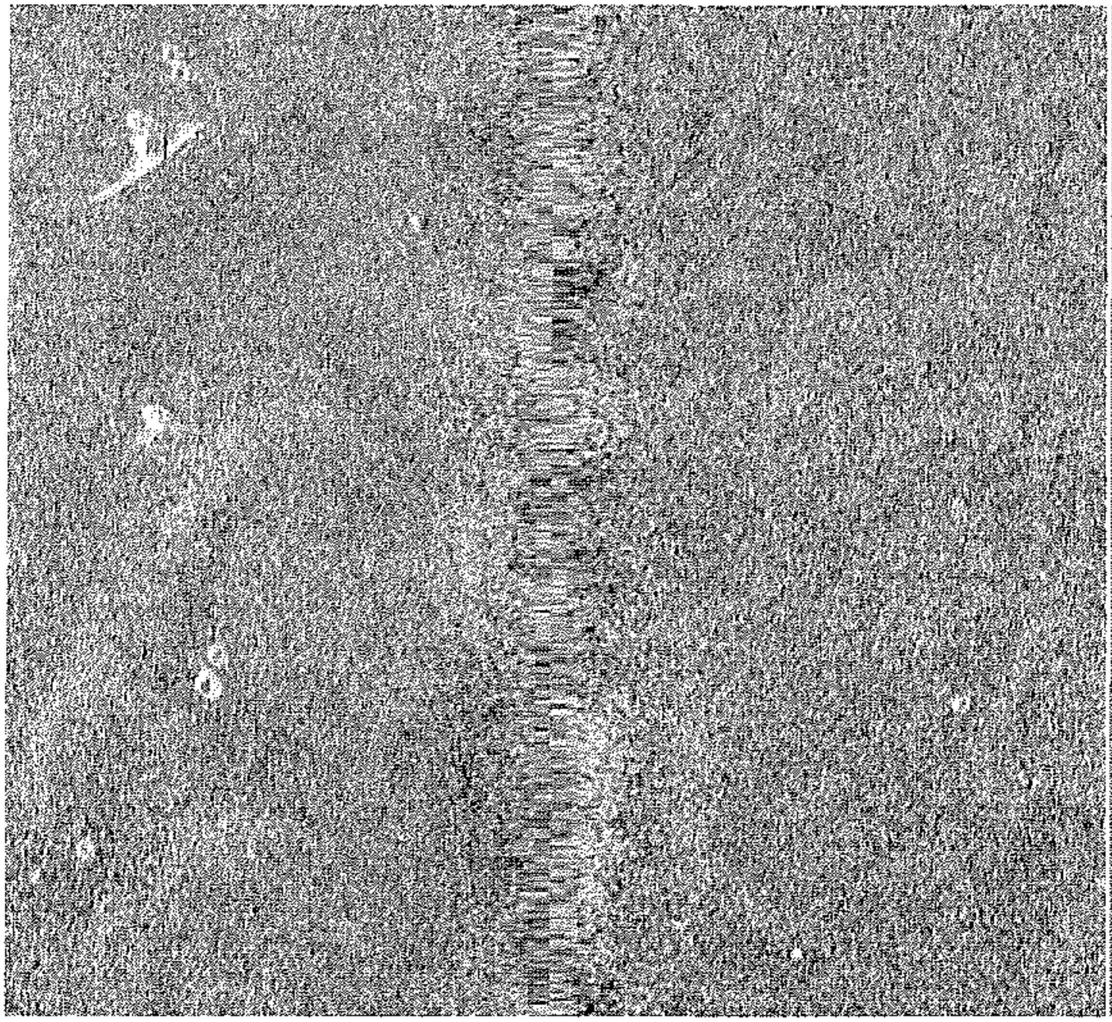
Target # C39-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\39chan-BAC.CMN
File Creation Time: 11/19/02 16:38:07
First Target Ping Num: 12674 at 10/21/2002 15:37:14
Target Location: 41° 38.0526' N 070° 54.7209' W



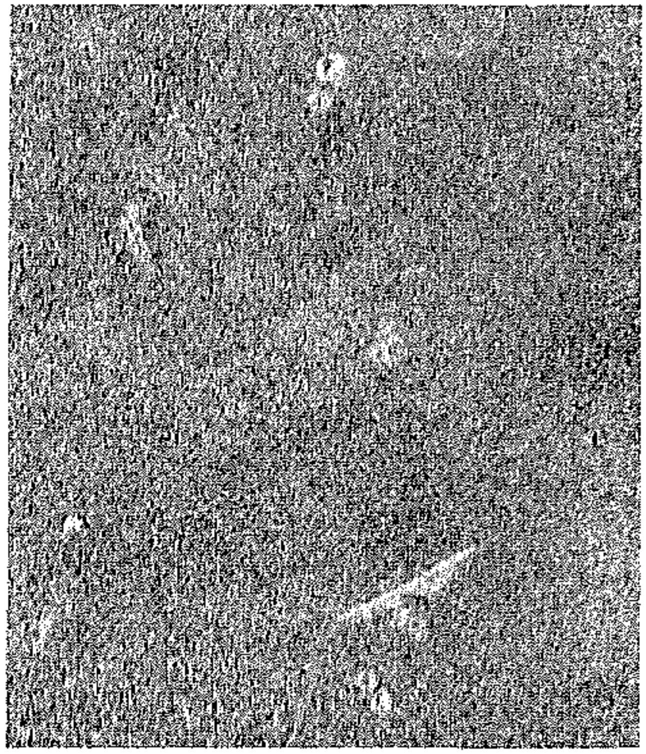
Target # C39-2
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\39chan-BAC.CMN
File Creation Time: 11/19/02 16:38:29
First Target Ping Num: 9321 at 10/21/2002 15:35:08
Target Location: 41° 37.9714' N 070° 54.6694' W



Target # C39-3
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\39chan-BAC.CMN
File Creation Time: 11/19/02 16:38:43
First Target Ping Num: 7943 at 10/21/2002 15:34:17
Target Location: 41° 37.9385' N 070° 54.6510' W



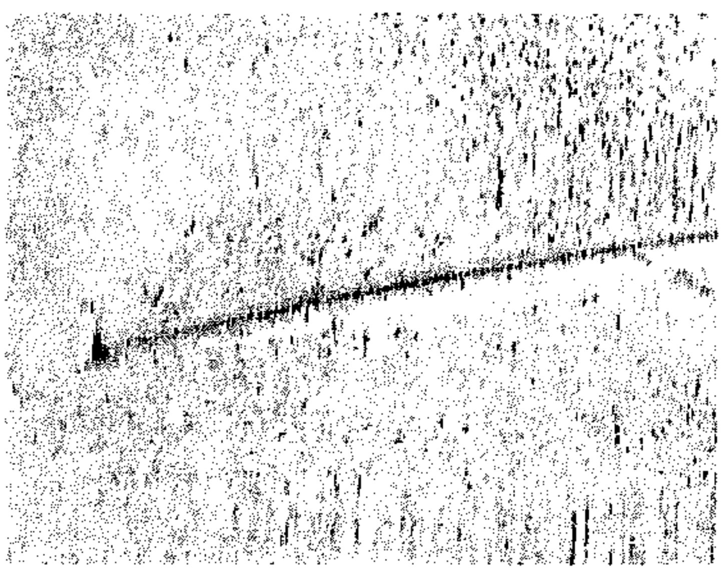
Target # C41-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\41rchan-BAC.CMN
File Creation Time: 11/19/02 16:39:44
First Target Ping Num: 5711 at 10/21/2002 17:02:49
Target Location: 41° 37.7838' N 070° 54.5322' W



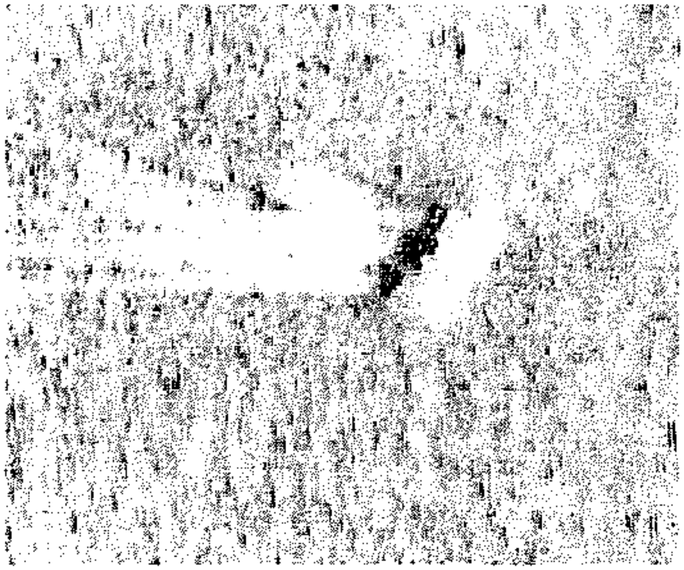
Target # C41-1
SonarWeb V3.13M PRO
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\Channel\SlantRangeCorrected\41rchan-BAC.CMN
File Creation Time: 11/19/02 16:39:44
First Target Ping Num: 5711 at 10/21/2002 17:02:49
Target Location: 41° 37.7838' N 070° 54.5322' W

APPENDIX B
Detail Side Scan Images
Popes Island North Area

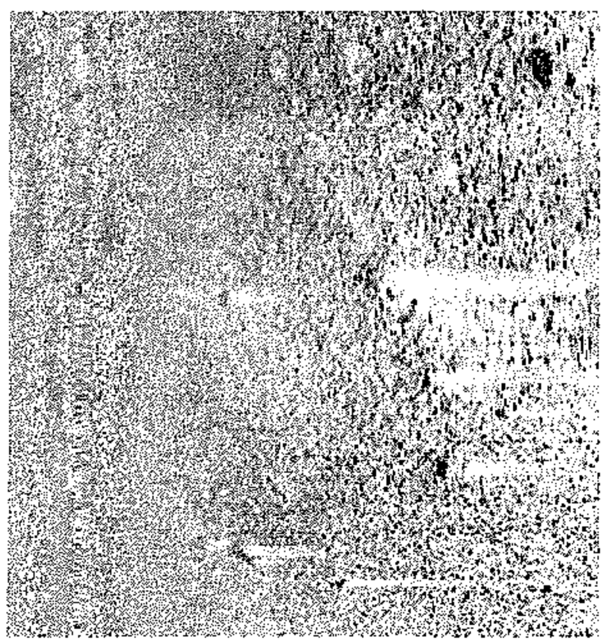
Target # P4-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\04popes-BAC.CMN
First Target Ping Num: 4117 at 10/23/2002 17:59:56
Target Location: 41° 38.5894' N 070° 54.9566' W



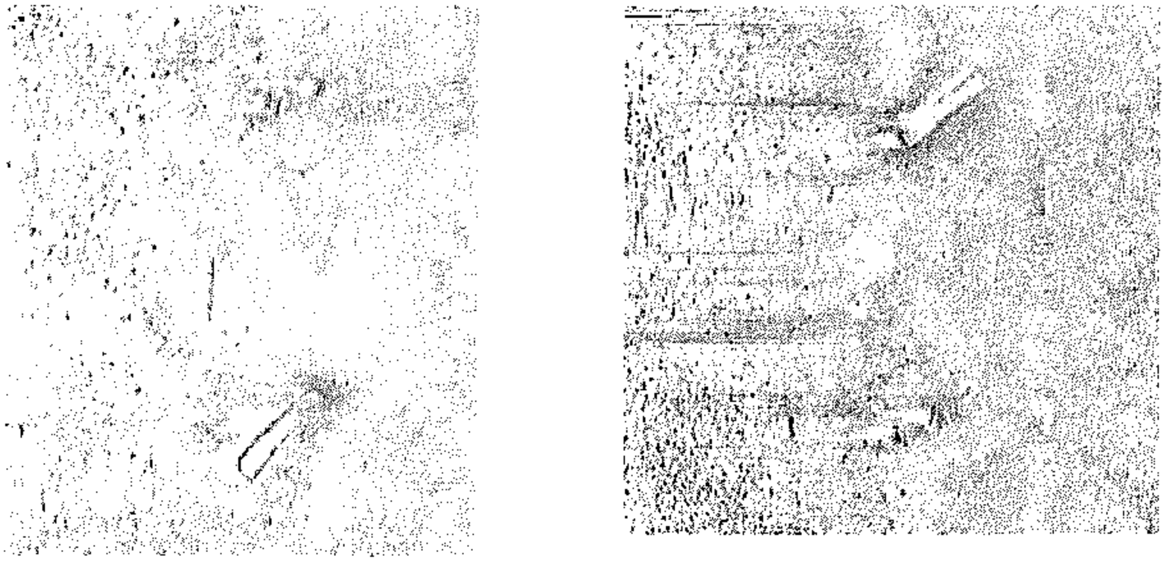
Target # P4-2
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\04popes-BAC.CMN
First Target Ping Num: 3520 at 10/23/2002 17:59:33
Target Location: 41° 38.6064' N 070° 54.9768' W



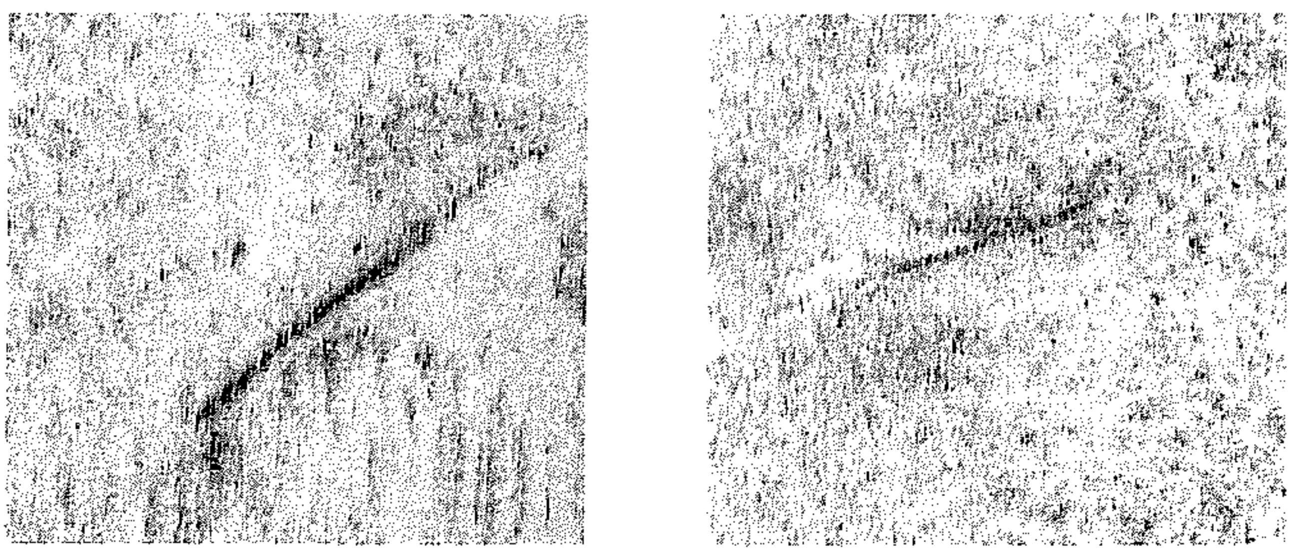
Target # P6-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\06popes-BAC.CMN
First Target Ping Num: 6434 at 10/23/2002 17:54:43
Target Location: 41° 38.6559' N 070° 54.9933' W



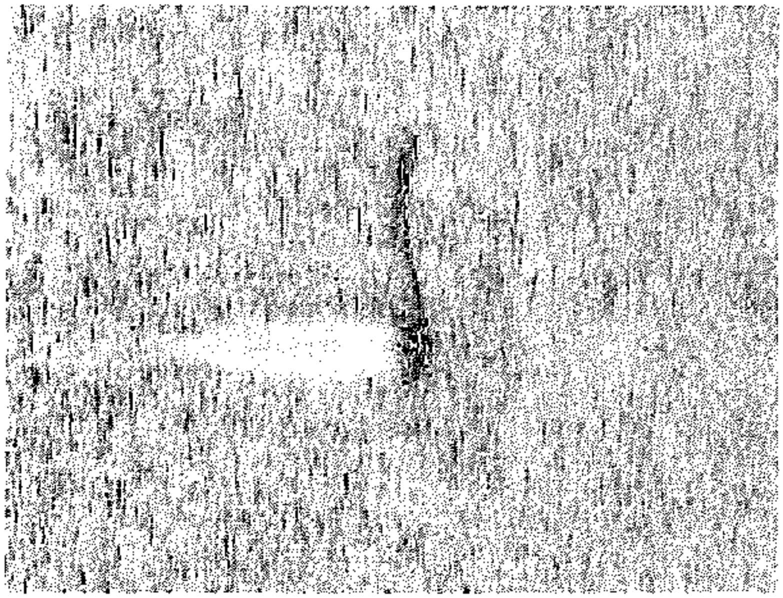
Target # P8-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\08popes-BAC.CMN
First Target Ping Num: 7346 at 10/23/2002 17:48:25
Target Location: 41° 38.5349' N 070° 54.8380' W



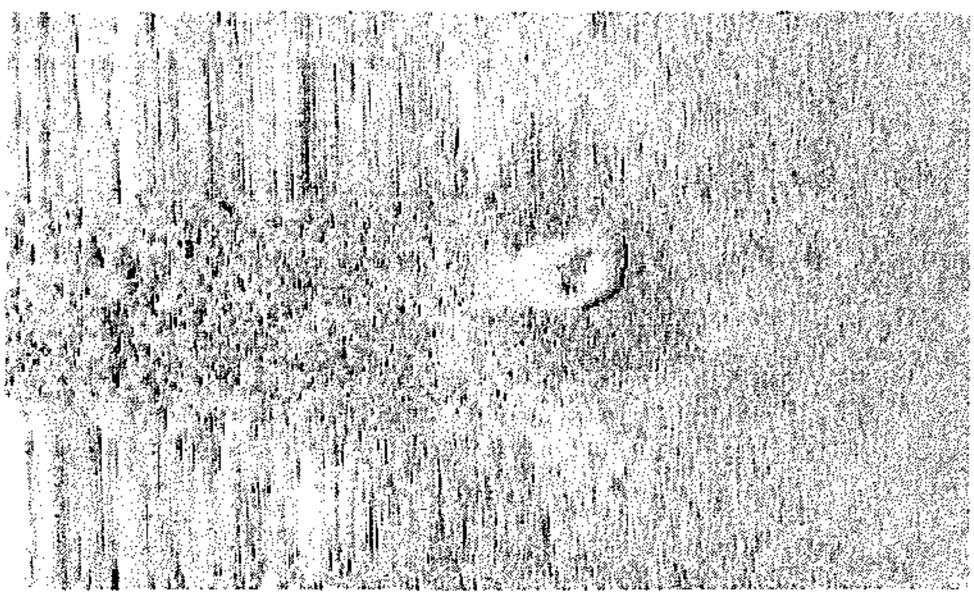
Target # P13-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\13popes-BAC.CMN
First Target Ping Num: 383 at 10/23/2002 12:45:34
Target Location: 41° 38.7706' N 070° 55.0220' W



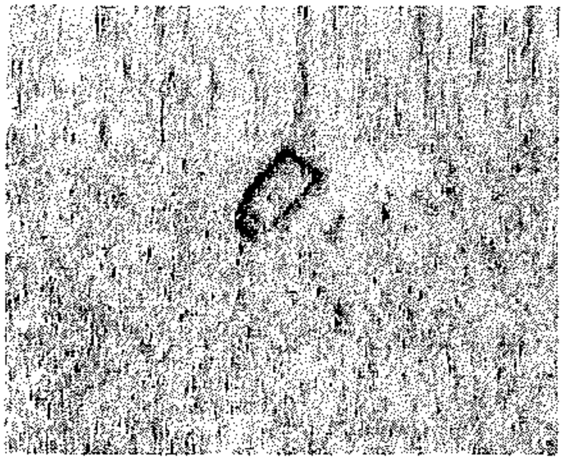
Target # P22-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\22rpopes-BAC.CMN
First Target Ping Num: 6604 at 10/23/2002 15:26:44
Target Location: 41° 38.7015' N 070° 54.8190' W

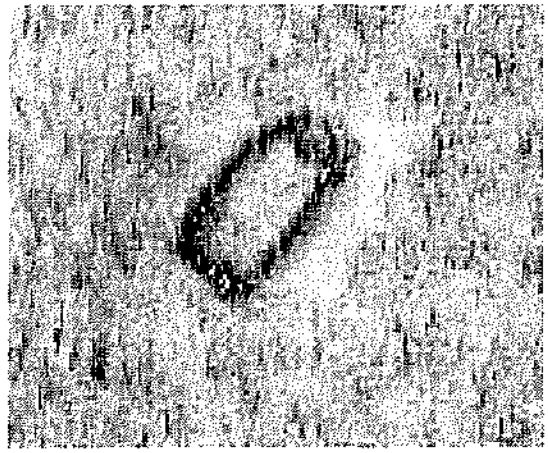


Target # P24-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\24popes-BAC.CMN
First Target Ping Num: 1716 at 10/23/2002 14:58:10
Target Location: 41° 38.5588' N 070° 54.6286' W

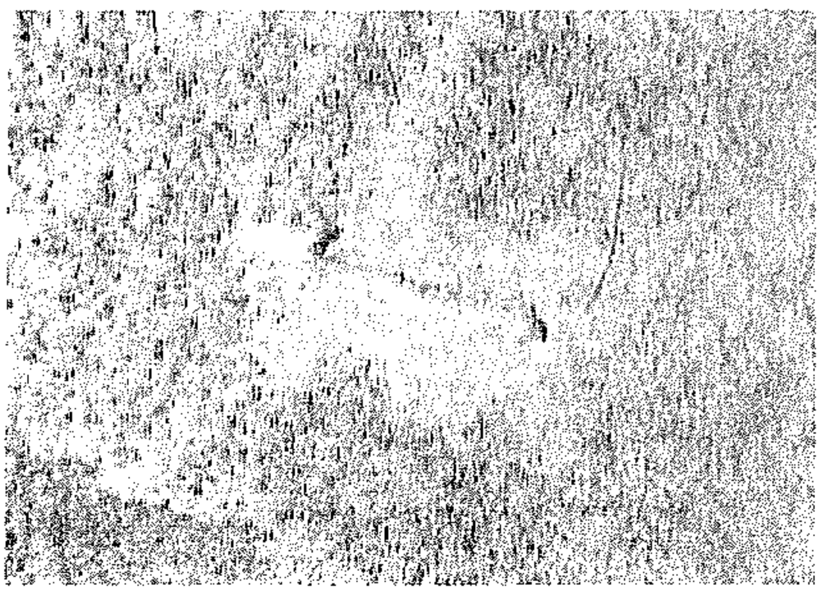


Target # P24-2
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\24popes-BAC.CMN
First Target Ping Num: 2188 at 10/23/2002 14:58:27
Target Location: 41° 38.5723' N 070° 54.6404' W

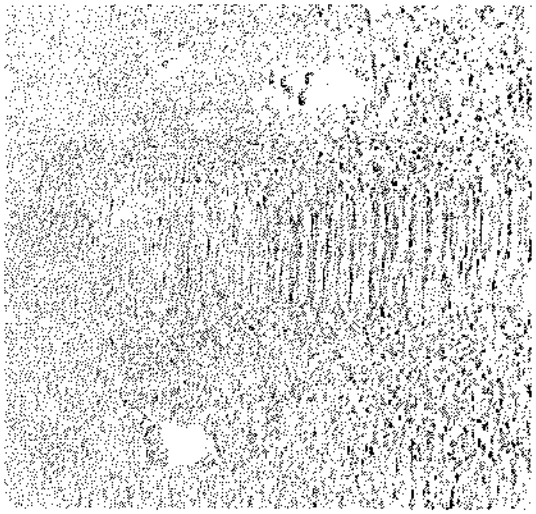
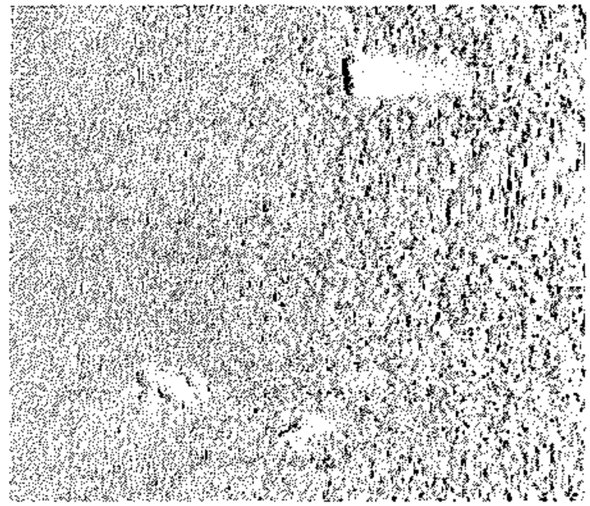




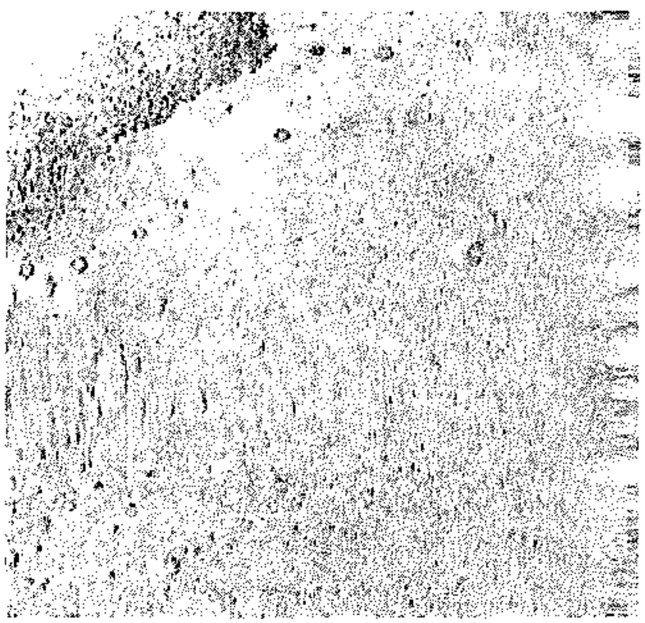
Target # P26-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\26rpopes-BAC.CMN
First Target Ping Num: 4406 at 10/23/2002 14:49:43
Target Location: 41° 38.7815' N 070° 54.8469' W



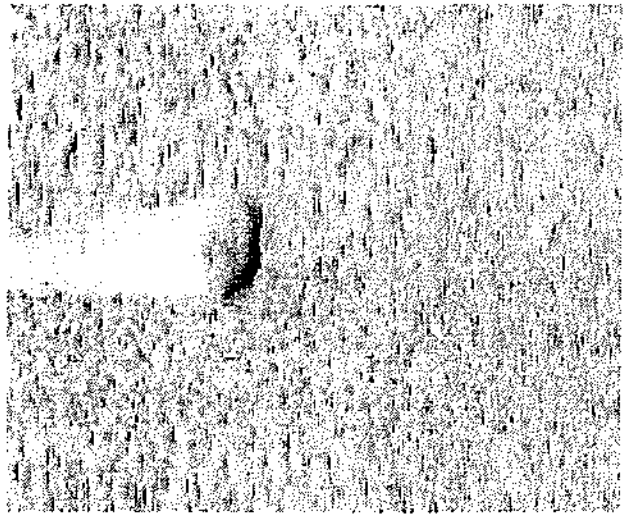
Target # P28-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\28popesd-BAC.CMN
First Target Ping Num: 4679 at 10/23/2002 14:36:39
Target Location: 41° 38.6508' N 070° 54.6768' W

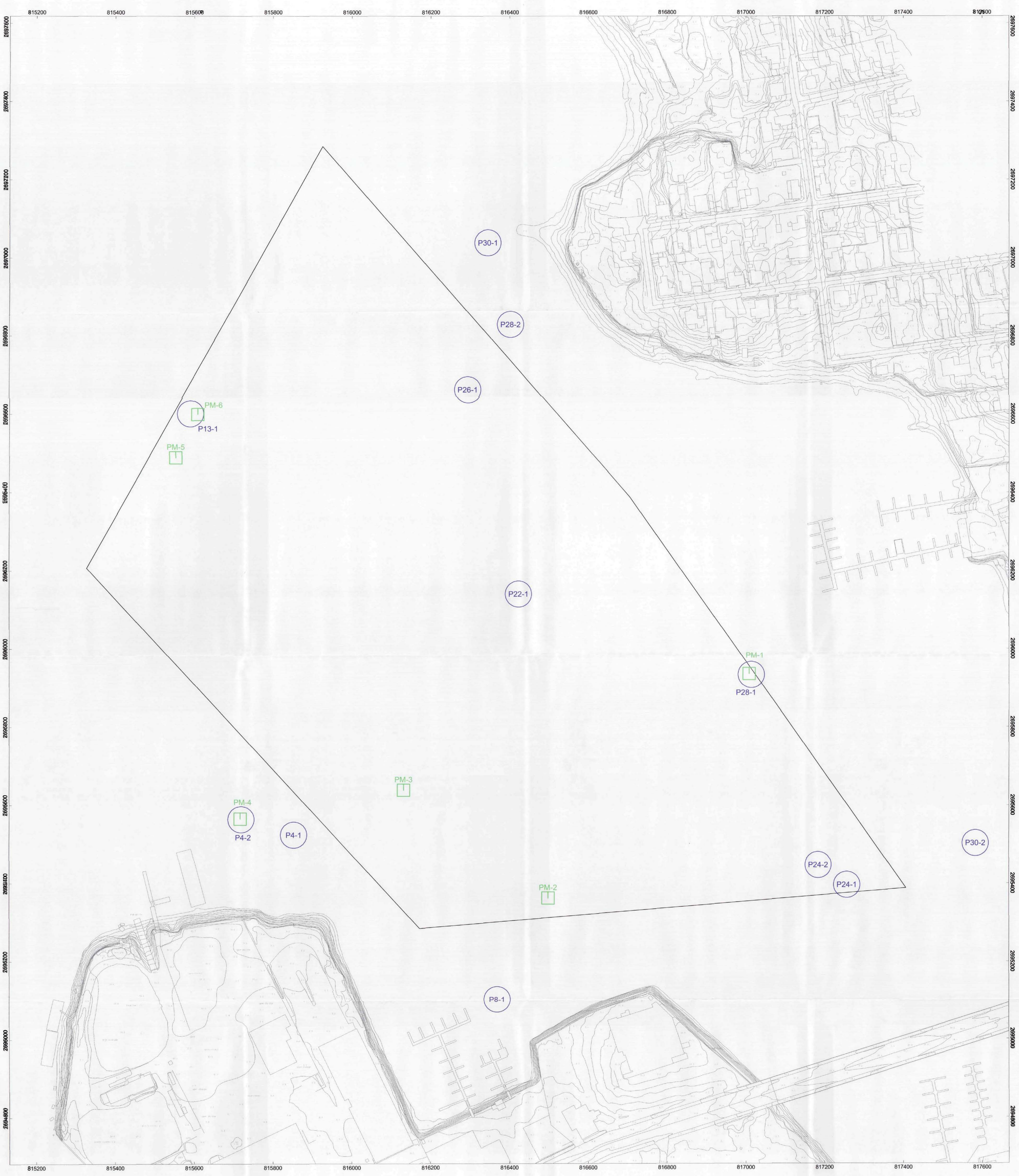
Target # P28-2
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\28popesd-BAC.CMN
First Target Ping Num: 11022 at 10/23/2002 14:40:37
Target Location: 41° 38.7876' N 070° 54.8212' W



Target # P30-1
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\30popes-BAC.CMN
First Target Ping Num: 3634 at 10/23/2002 14:25:16
Target Location: 41° 38.8340' N 070° 54.8502' W



Target # P30-2
Sonar Filename: C:\Program Files\Chesapeake Technology, Inc\SonarWeb\popes\SlantRangeCorrected\30popes-BAC.CMN
First Target Ping Num: 14724 at 10/23/2002 14:32:12
Target Location: 41° 38.5810' N 070° 54.5852' W



NOTES:

1. Base Plan of the New Bedford harbor area obtained from the US Army Corps of Engineers and has not been feild verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Data was collected over a four day period between October 21-24, 2002 using a Geometrics G-881 Cesium magnetometer flown on the water surface. Planned line spacing of 50 feet.

LEGEND:
- AREA OF PROPOSED CAD CELL
- MAGNETIC ANOMALY - TARGET
- SIDE SCAN SONAR ANOMALY

REV.	DESCRIPTION	BY:	DATE:

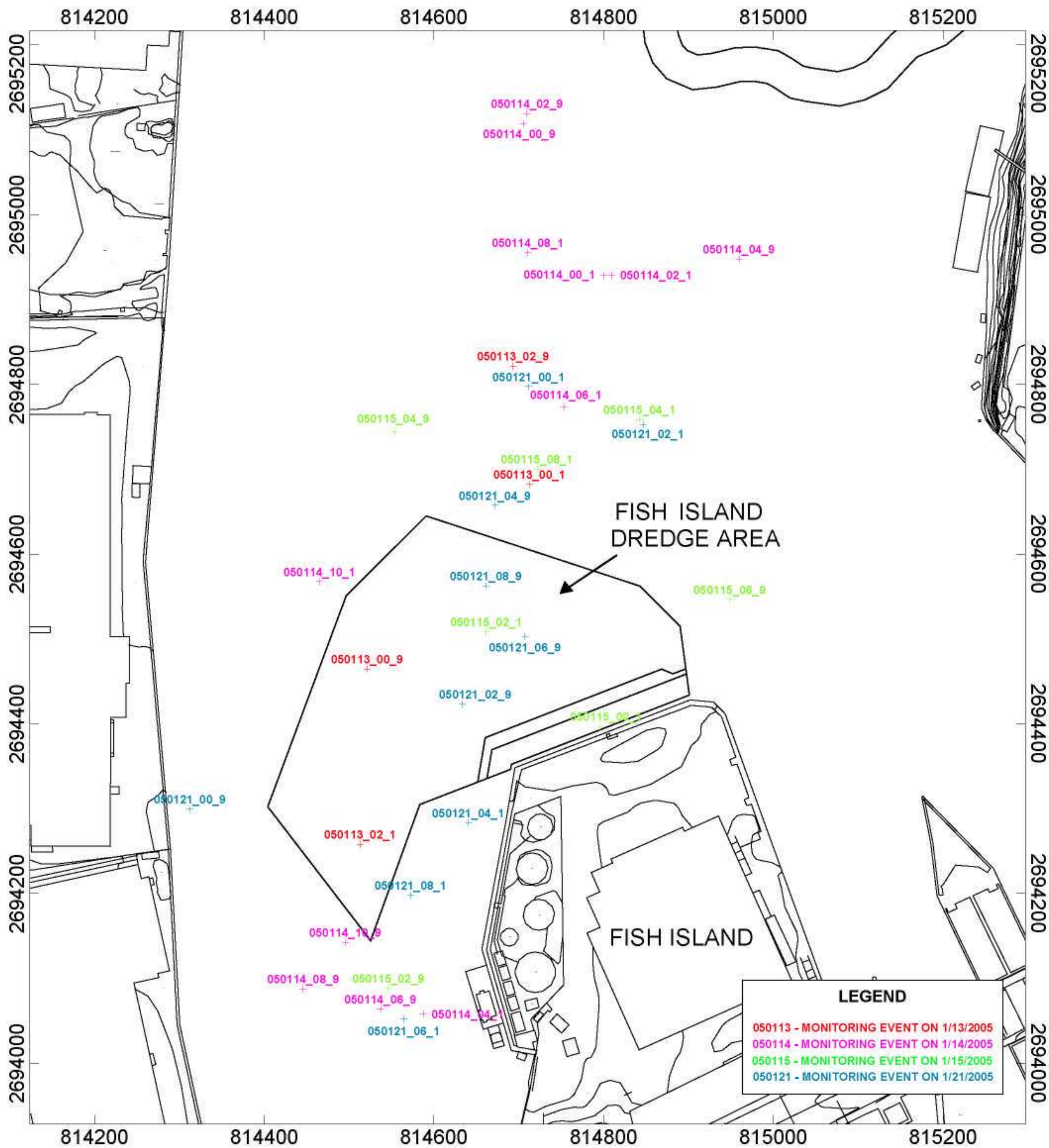
HAZARDS & CULTURAL IDENTIFICATION - SUMMARY

POPES ISLAND NORTH AREA
NEW BEDFORD HARBOR, MA

INTERPRETED TARGETS

Apex environmental, inc.
308 Congress St
Suite 500
Boston MA 02210
(617) 728-0070

SCALE: 1"=100'	DRAWN BY:	DESIGN BY:	CHECKED BY:	PROJECT: 6510.002	ISSUE
DATE: 12-20-02	TM	TM	JAB	SHEET 8 OF 8	0



Scale 1" = 175'

100 0 100

US survey foot

NEW BEDFORD HARBOR DREDGE - PHASE II

WATER QUALITY MONITORING LOCATIONS
1/13/05 - 1/21/05

APEX ENVIRONMENTAL, INC.

1/13/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 10:01									
	13:30	050113_00_1_05	N:2694684.583	Up	5	2.3		Foggy, Cold	None
	13:32	050113_00_1_15	E:814715.222	Up	10	1.9		Light N Wind	None
	13:34	050113_00_1_25		Up	25	1.9			None
					AVERAGE	**2.0**	**22.0**		
	13:42	050113_00_9_05	N:2694464.650	Down	5	2.4		Foggy, Cold	None
	13:45	050113_00_9_12	E:814525.369	Down	12	2.5		Light N Wind	None
	13:47	050113_00_9_20		Down	20	2.3			None
Low 15:56					**AVERAGE**	**2.4**	(19.6 Below Limit)		
	18:44	050113_02_1_05	N:2694258.072	Up	5	2.8		Cloudy, ~40F	None
	18:45	050113_02_1_14	E:814513.105	Up	14	2.7		Light SW Wind	None
	18:50	050113_02_1_22		Up	22	2.4			None
					AVERAGE	**2.6**	**22.6**		
	18:56	050113_02_9_05	N:2694824.140	Down	5	2.8		Cloudy, ~40F	None
	18:58	050113_02_9_14	E:814696.050	Down	14	2.8		Light SW Wind	None
	18:59	050113_02_9_25		Down	25	2.7			None
					AVERAGE	**2.7**	(19.9 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

1/15/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
Low 4:59									
	6:31	050115_00_1_05	Fish Isl.	Up	5	3.8		Partly Cloudy, 30 Degrees	None
	6:31	050115_00_1_15		Up	10	3.5		E Wind ~5 Knots	None
	6:31	050115_00_1_25		Up	25	3.5			None
					AVERAGE	**3.6**	**23.6**		
	8:30	050115_02_1_05	N:2694508.091	Up	5	3.6		Sunny, ~30 Degrees	None
	8:32	050115_02_1_15	E:814661.751	Up	15	3.4		Light Wind	None
	8:33	050114_02_9_25		Up	25	3.1			None
					AVERAGE	**3.4**	**23.4**		
	8:35	050115_02_9_05	N:2694088.242	Down	5	6.0		Sunny, ~30 Degrees	None
	8:36	050115_02_9_15	E:814546.150	Down	15	3.8		Light Wind	None
	8:37	050115_02_9_25		Down	25	3.8			None
					AVERAGE	**4.5**	(18.9 Below Limit)		
	10:48	050115_04_1_05	N:2694758.328	Up	5	4.0		Sunny, ~35 Degrees	None
	10:49	050115_04_1_15	E:814842.285	Up	15	3.6		Light Wind	None
	10:49	050115_04_1_25		Up	25	3.6			None
					AVERAGE	**3.7**	**23.7**		
	10:57	050115_04_9_05	N:2694802.673	Down	5	7.5		Sunny, ~35 Degrees	None
	10:58	050115_04_9_15	E:814217.831	Down	25	4.2		Light Wind	None
	10:59	050115_04_9_25		Down	25	4.0			None
High 11:47					**AVERAGE**	**5.2**	(18.5 Below Limit)		
	12:30	050115_06_1_05	N:2693165.688	Up	5	3.9		Sunny, ~40 Degrees	None
	12:31	050115_06_1_15	E:814634.427	Up	15	4.8		Light Wind	None
	12:32	050115_06_1_25		Up	25	4.0			None
					AVERAGE	**4.2**	**24.2**		
	12:35	050115_06_9_05	N:2694546.483	Down	5	8.8		Sunny, ~40 Degrees	None
	12:36	050115_06_9_15	E:814948.512	Down	15	25.3		Light Wind	None
	12:37	050115_06_9_25		Down	25	25.3			None
					AVERAGE	**19.8**	(4.4 Below Limit)		
	14:30	050115_08_1_05	N:2694702.864	Up	5	3.0		Sunny, ~35 Degrees	None
	14:31	050115_08_1_15	E:814724.210	Up	15	4.0		Light Wind	None
	14:32	050115_08_1_25		Up	25	3.5			None
					AVERAGE	**3.5**	**23.5**		
	14:35	050115_08_9_05	N:2694282.427	Down	5	3.6		Sunny, ~35 Degrees	None
	14:36	050115_08_9_15	E:8145222.051	Down	15	6.0		Light Wind	None
	14:37	050115_08_9_25		Down	25	10.5			None
Low 17:20					**AVERAGE**	**6.7**	(16.8 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

1/14/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring

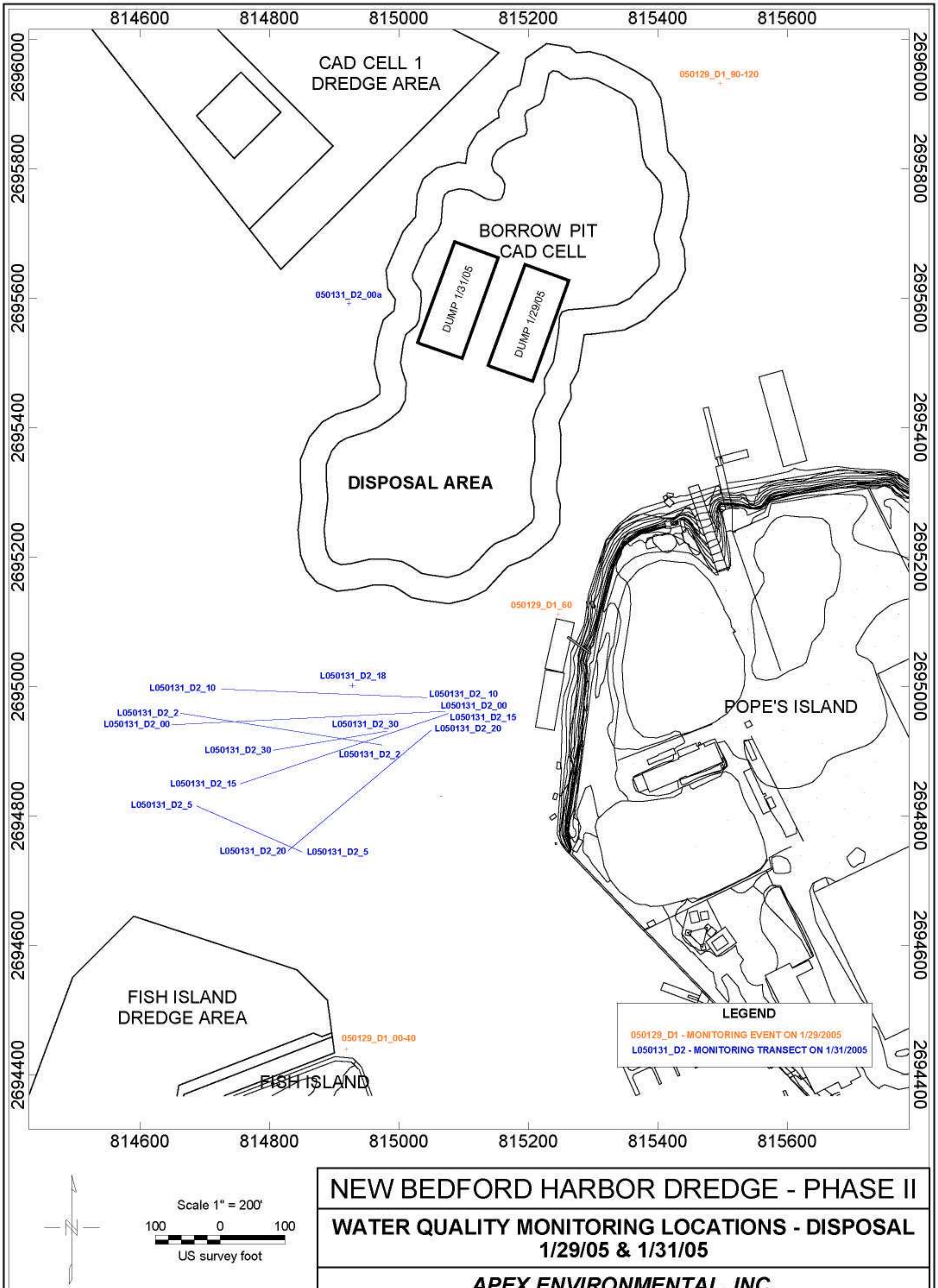
Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
Low 4:03									
	7:02	050114_00_1_05	N:2694928.096	Up	5	2.0		Partly Cloudy, 35 Degrees	None
	7:03	050114_00_1_15	E:814800.127	Up	10	2.1		S Wind ~15 Knots	None
	7:04	050114_00_1_24		Up	24	2.0			None
					AVERAGE	2.0	22.0		
	6:52	050114_00_9_05	N:2695109.669	Down	5	2.5		Partly Cloudy, 35 Degrees	None
	6:53	050114_00_9_10	E:814707.776	Down	10	2.6		S Wind ~15 Knots	None
	6:54	050114_00_9_25		Down	25	2.8			None
					AVERAGE	2.6	(19.4 Below Limit)		
	8:55	050114_02_1_05	N:2694928.158	Up	5	2.4		Cloudy, 25 Degrees	None
	8:55	050114_02_1_15	E:814809.238	Up	15	2.5		Strong S Wind	None
	8:56	050114_02_9_25		Up	25	2.1			None
					AVERAGE	2.3	22.3		
	8:45	050114_02_9_05	N:2695121.846	Down	5	3.5		Cloudy, 25 Degrees	None
	8:46	050114_02_9_15	E:814712.249	Down	15	2.4		Strong S Wind	None
	8:47	050114_02_9_25		Down	25	2.4			None
High 10:54					AVERAGE	2.8	(19.5 Below Limit)		
	11:18	050114_04_1_05	N:2694058.155	Up	5	2.4		Cloudy, 35 Degrees	None
	11:19	050114_04_1_15	E:814587.358	Up	15	2.5		Strong W Wind	None
	11:19	050114_04_1_24		Up	24	2.6			None
					AVERAGE	2.5	22.5		
	11:30	050114_04_9_05	N:2694947.400	Down	5	3.4		Cloudy, 35 Degrees	None
	11:32	050114_04_9_18	E:814959.449	Down	18	3.7		Strong W Wind	None
	11:34	050114_04_9_30		Down	30	2.2			None
					AVERAGE	3.1	(19.4 Below Limit)		
	13:01	050114_06_1_05	N:2694775.958	Up	5	3.0		Rainy, 40 Degrees	None
	13:02	050114_06_1_15	E:814755.603	Up	15	3.1		N Wind ~ 15 Knots	None
	13:02	050114_06_1_25		Up	25	2.9			None
					AVERAGE	3.0	23.0		
	13:08	050114_06_9_05	N:2694063.888	Down	5	0.6		Rainy, 40 Degrees	None
	13:09	050114_06_9_15	E:814537.203	Down	15	4.0		N Wind ~ 15 Knots	None
	13:10	050114_06_9_25		Down	25	8.0			None
					AVERAGE	4.2	(18.8 Below Limit)		
	14:55	050114_08_1_05	N:2694957.872	Up	5	6.5		Rainy, 40 Degrees	None
	14:56	050114_08_1_15	E:814713.364	Up	15	4.0		N Wind ~25 Knots	None
	14:57	050114_08_1_25		Up	25	8.0			None
					AVERAGE	6.2	26.2		
	14:47	050114_08_9_05	N:2694087.562	Down	5	11.0		Rainy, 40 Degrees	None
	14:48	050114_08_9_15	E:814445.923	Down	15	10.0		N Wind ~25 Knots	None
	14:49	050114_08_9_25		Down	25	10.0			None
Low 15:56					AVERAGE	10.3	(15.9 Below Limit)		
	17:00	050114_10_1_05	N:2694567.491	Up	5	3.6		Rainy, 30 Degrees	None
	17:01	050114_10_1_15	E:814465.444	Up	15	5.8		N Wind ~25 Knots	None
	17:03	050114_10_1_25		Up	25	5.0			None
					AVERAGE	4.8	24.8		
	16:55	050114_10_9_05	N:2694142.560	Down	5	7.0		Rainy, 30 Degrees	None
	16:56	050114_10_9_15	E:814495.665	Down	15	7.1		N Wind ~25 Knots	None
	16:56	050114_10_9_25		Down	25	4.0			None
					AVERAGE	6.0	(18.8 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

1/21/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 5:05									
	6:50	050121_00_1_05	N:2694799.971	Up	5	3.1		Clear, ~5 Degrees	None
	6:50	050121_00_1_15	E:814714.437	Up	10	3.3		N Wind ~10 Knots	None
	6:51	050121_00_1_24		Up	24	3.1			None
					AVERAGE	**3.1**	**23.1**		
	7:01	050121_00_9_05	N:2694299.223	Down	5	3.0		Clear, ~5 Degrees	None
	7:02	050121_00_9_10	E:814312.363	Down	10	4.1		N Wind ~10 Knots	None
	7:03	050121_00_9_25		Down	25	3.2			None
					AVERAGE	**3.4**	(19.7 Below Limit)		
	10:08	050121_02_1_05	N:2694752.286	Up	5	1.3		Clear, ~5 Degrees	None
	10:09	050121_02_1_15	E:814846.881	Up	15	1.8		N Wind ~10 Knots	None
	10:10	050121_02_9_25		Up	25	11.5			None
					AVERAGE	**4.8**	**24.8**		
	10:15	050121_02_9_05	N:2694422.975	Down	5	3.7		Clear, ~5 Degrees	None
	10:16	050121_02_9_15	E:814648.662	Down	15	8.4		N Wind ~10 Knots	None
	10:17	050121_02_9_25		Down	25	6.8			None
Low 11:30					**AVERAGE**	**6.3**	(18.5 Below Limit)		
	12:02	050121_04_1_05	N:2694283.231	Up	5	5.5		Clear, ~10 Degrees	None
	12:03	050121_04_1_15	E:814640.500	Up	15	7.5		N Wind ~10 Knots	None
	12:03	050121_04_1_24		Up	24	5.0			None
					AVERAGE	**6.0**	**26.0**		
	12:10	050121_04_9_05	N:2694660.012	Down	5	0.4		Clear, ~10 Degrees	None
	12:11	050121_04_9_18	E:814674.386	Down	18	4.3		N Wind ~10 Knots	None
	12:12	050121_04_9_30		Down	30	9.0			None
					AVERAGE	**4.6**	(21.5 Below Limit)		
	14:27	050121_06_1_05	N:2694051.928	Up	5	0.9		Clear, ~5 Degrees	None
	14:29	050121_06_1_15	E:814564.621	Up	15	9.0		N Wind ~10 Knots	None
	14:30	050121_06_1_25		Up	25	20.0			None
					AVERAGE	**10.0**	**30.0**		
	15:39	050121_06_9_05	N:2694502.328	Down	5	12.5		Clear, ~5 Degrees	None
	15:40	050121_06_9_15	E:814707.350	Down	15	13.0		N Wind ~10 Knots	None
	15:41	050121_06_9_25		Down	25	20.5			None
					AVERAGE	**15.3**	(14.7 Below Limit)		
	16:22	050121_08_9_05	N:2694562.749	Up	5	3.0		Clear, ~5 Degrees	None
	16:22	050121_08_9_15	E:814661.380	Up	15	4.3		N Wind ~10 Knots	None
	16:23	050121_08_9_25		Up	25	4.5			None
					AVERAGE	**3.9**	**23.9**		
	16:14	050121_08_1_05	N:2694197.744	Down	5	7.5		Clear, ~5 Degrees	None
	16:15	050121_08_1_15	E:814572.742	Down	15	9.0		N Wind ~10 Knots	None
	16:16	050121_08_1_25		Down	25	14.0			None
					AVERAGE	**10.2**	(13.7 Below Limit)		
	16:27	050121_08_9a_05	N:2694197.744	Down	5	12.5		Clear, ~5 Degrees	None
	16:28	050121_08_9a_15	E:814572.742	Down	15	50.0		N Wind ~10 Knots	None
	16:29	050121_08_9a_25		Down	25	57.5			None
					AVERAGE	**40.0**	**(16.1 Above Limit)**		
	16:45	050121_08_9b	N:2694197.744	Down	15	20.0	(3.9 Below Limit)		None
High 17:24	17:00	050121_08_9b	E:814572.742	Down	15	15.0	(8.9 Below Limit)		None

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



NEW BEDFORD HARBOR DREDGE - PHASE II

WATER QUALITY MONITORING LOCATIONS - DISPOSAL
1/29/05 & 1/31/05

APEX ENVIRONMENTAL, INC.

1/29/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Disposal Operations

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
10:10 High									
	14:55	050129_D1_00	Fish Island	Down	15	6.5		Clear, ~25 Degrees	None
	14:56	050129_D1_00_1	Fish Island	Down	15	6.8		N Wind ~5 Knots	
	15:10	**DISPOSAL**	**STARTED**						
					AVERAGE	**6.6**	**46.6**		
	15:20	050129_D1_10	Fish Island	Down	15	11.5		Clear, ~25 Degrees	None
								N Wind ~5 Knots	
					AVERAGE	**11.5**	(35.1 Below Limit)		
	15:23	050129_D1_20	Fish Island	Down	15	9.0		Clear, ~25 Degrees	None
								N Wind ~5 Knots	
					AVERAGE	**9.0**	(38.5 Below Limit)		
	15:35	050129_D1_30	Fish Island	Down	15	7.5		Clear, ~25 Degrees	None
								N Wind ~5 Knots	
					AVERAGE	**7.5**	(39.1 Below Limit)		
	15:41	050129_D1_40	Fish Island	Down	15	8.6		Clear, ~25 Degrees	None
								N Wind ~5 Knots	
15:51 Low					**AVERAGE**	**8.6**	(38.0 Below Limit)		
	16:15	050129_D1_60	Pope's Island	Down	10	7.8		Clear, ~20 Degrees	None
								N Wind ~5 Knots	
					AVERAGE	**7.8**	(38.8 Below Limit)		
	16:23	050129_D1_70	Pope's Island	Up	10	7.5		Clear, ~20 Degrees	None
								NW Wind ~10 Knots	
					AVERAGE	**7.5**	**47.5**		
	16:56	050129_D1_90	N:815431.19	Down	6	17.5		Clear, ~15 Degrees	X
			E:2695916.29					NW Wind ~10 Knots	
	17:00	**DISPOSAL**	**STOPPED**						
	17:02				10	17.5			None
	17:04				15	42.5			None
	17:06				18	17.5			None
					AVERAGE	**23.8**	(23.7 Below Limit)		
	17:11	050129_D1_120	N:815431.19	Down	10	22.5		Clear, ~15 Degrees	None
			E:2695916.29					NW Wind ~10 Knots	
	17:15	**DISPOSAL**	**CONTINUED**						
					AVERAGE	**22.5**	(25 Below Limit)		
	17:27	050129_D1_140	N:815431.19	Down	10	15.0		Clear, ~12 Degrees	X
	17:58		E:2695916.29	Down	10	25.0		NW Wind ~10 Knots	
					AVERAGE	**20.0**	(27.5 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

1/31/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Disposal Operations

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
15:51 Low									
	16:08	050131_D2_00	W-E Transect	Down	10	4.0		Clear, ~40 Degrees	None
	16:12				20	4.5		N Wind ~5 Knots	None
	16:16				20	3.9			None
					AVERAGE	**4.1**	**44.1**		
	16:20	050131_D2_00a	GPS Target 1621	Down	5	4.9		Clear, ~40 Degrees	None
					15	4.0		N Wind ~5 Knots	
	16:23	**DUMPING**	**STARTED**		25	3.6			
					AVERAGE	**4.2**	**44.2**		
	16:24	050131_D2_2	W-E Transect	Down	20	4.3		Clear, ~35 Degrees	None
								N Wind ~5 Knots	
					AVERAGE	**4.3**	(39.9 Below Limit)		
	16:28	050131_D2_5	E-W Transect	Down	25	3.8		Clear, ~35 Degrees	None
								N Wind ~5 Knots	
					AVERAGE	**3.8**	(40.4 Below Limit)		
	16:32	050131_D2_10	W-E Transect	Down	15	4.3		Clear, ~30 Degrees	None
								N Wind ~5 Knots	
					AVERAGE	**4.3**	(39.9 Below Limit)		
	16:35	050131_D2_15	E-W Transect	Down	5	3.8		Clear, ~30 Degrees	None
					15	4.1		N Wind ~5 Knots	
					25	3.6			
					AVERAGE	**3.8**	(40.4 Below Limit)		
	16:37	050131_D2_18	W-E Transect	In Sheen	5	5.0		Clear, ~30 Degrees	None
					15	4.2		N Wind ~5 Knots	
					25	3.8			
					AVERAGE	**4.3**	(39.9 Below Limit)		
	16:40	050131_D2_20	W-E Transect	Down	20	4.5		Clear, ~30 Degrees	None
								N Wind ~5 Knots	
					AVERAGE	**4.5**	(39.7 Below Limit)		
	16:47	050131_D2_30	E-W Transect	Down	35	3.8		Clear, ~30 Degrees	None
								N Wind ~5 Knots	
					AVERAGE	**3.8**	(40.4 Below Limit)		

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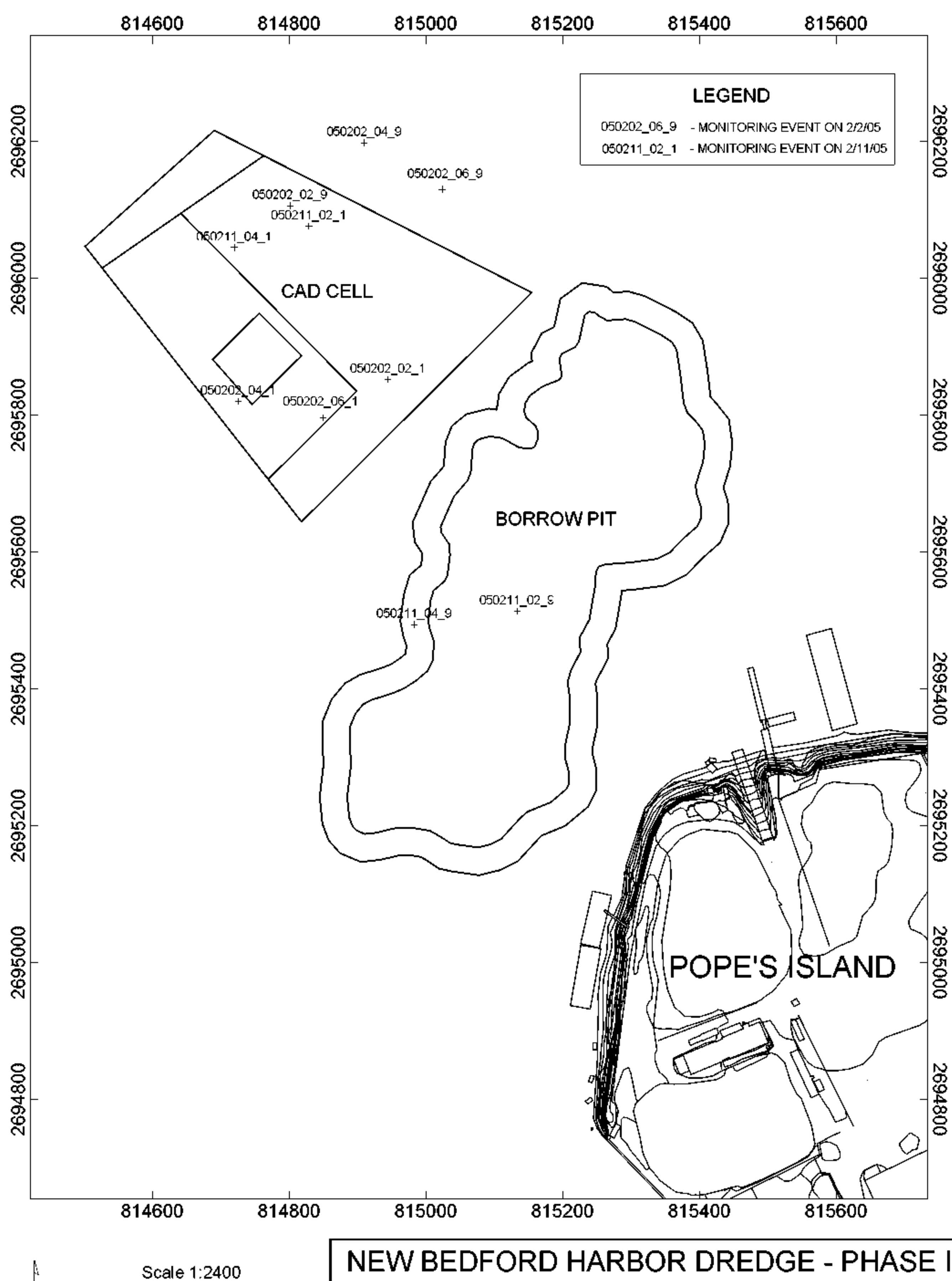


NEW BEDFORD HARBOR DREDGE - PHASE II

WATER QUALITY MONITORING LOCATIONS
2/5/05 & 2/11/05

APEX ENVIRONMENTAL, INC.

2/2/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring

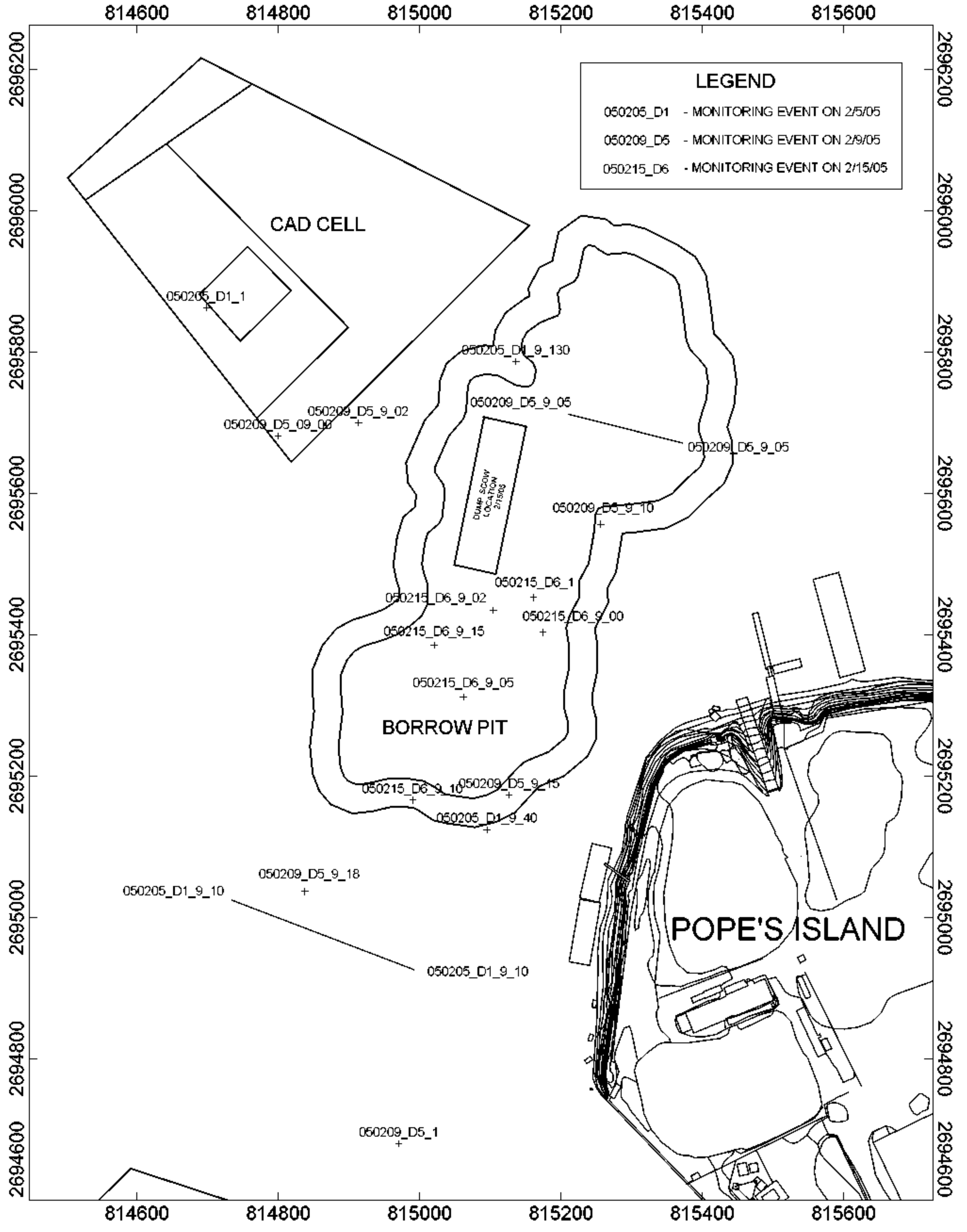
Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 5:41				Current		(NTUs)	Increase (NTUs)		Traffic
	10:27	050202_02_1	2695852.23	Up	5	5.8		Clear, ~38 Degrees	None
			814944.175		10	4.3		NE Wind ~10 Knots	
					25	3.3			
					AVERAGE	**4.4**	**24.4**		
	10:32	050202_02_9	2696106.339	Down	5	7.5		Clear, ~38 Degrees	None
			814801.221		10	11.3		NE Wind ~10 Knots	
					25	50.0			
					AVERAGE	**22.9**	(1.5 Below Limit)		
	12:42	050202_04_1	2695820.376	Up	5	2.0		Clear, ~40 Degrees	None
			814725.721		15	3.4		NE Wind ~10 Knots	
					25	3.0			
					AVERAGE	**2.8**	**22.8**		
	12:47	050202_04_9	2696198.18	Down	5	20.0		Clear, ~40 Degrees	None
			814909.93		15	15.0		NE Wind ~10 Knots	
					25	15.0			
High 13:23					**AVERAGE**	**16.7**	(6.1 Below Limit)		
	14:32	050202_06_1	2694283.231	Up	5	15.0		Clear, ~40 Degrees	None
			814925.126		15	30.0		NE Wind ~10 Knots	
					25	7.5			
					AVERAGE	**17.5**	**32.5**		
	14:27	050202_06_9	2694333.149	Down	5	3.8		Clear, ~40 Degrees	None
			814836.066		15	5.6		NE Wind ~10 Knots	
					25	7.5			
					AVERAGE	**5.6**	(26.9 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

2/11/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 9:38									
	9:39	050211_02_1	2696076.16	Up	5	6.5		Sunny, ~28 Degrees	None
			814828.76		10	11.0		NW Wind ~25 knots	None
					25	12.5			None
					AVERAGE	**10.0**	**30.0**		
	9:46	050211_02_9	2695513.409	Down	5	8.5		Sunny, ~28 Degrees	None
			815133.267		10	6.5		NW Wind ~25 knots	None
					25	14.0			None
					AVERAGE	**9.7**	(20.3 below limit)		
	12:03	050211_04_1	2696045.05	Up	5	5.3		Sunny, ~30 Degrees	None
			814719.637		15	5.5		NW Wind ~20 knots	None
					25	7.0			None
					AVERAGE	**5.9**	**25.9**		
	12:09	050211_04_9	2695494.165	Down	5	16.0		Sunny, ~30Degrees	None
			814983.059		15	19.0		NW Wind ~20 knots	None
					25	7.5			None
Low 15:21					**AVERAGE**	**14.2**	(11.7 below limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



NEW BEDFORD HARBOR DREDGE - PHASE II

WATER QUALITY MONITORING LOCATIONS - DISPOSAL
2/5/05, 2/9/05, 2/15/05

APEX ENVIRONMENTAL, INC.

2/5/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Disposal Operations

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 4:16									
	8:57	050205_D1_1	2695862.702	Up	5	2.7		Sunny, ~40 Deg. F	None
			814698.099		10	2.5		N Wind ~10 knots	
					22	4.0			
					AVERAGE	**3.1**	**43.1**		
	9:29	050205_D1_9_10	2694917.407	Down	5	4.0		Sunny, ~40 Deg. F	None
			815014.323		15	5.0		N Wind ~10 knots	
					25	4.0			
					AVERAGE	**4.3**	(38.8 below limit)		
	10:00	050205_D1_9_40	2695124.451	Down	20	4.0		Sunny, ~40 Deg. F	None
			815094.917		20	6.0		N Wind ~10 knots	
Low 10:41					**AVERAGE**	**5.0**	(38.1 below limit)		
	11:26	050205_D1_9_130	2695786.73	Down	10	35.0		Sunny, ~40 Deg. F	None
			815135.959					N Wind ~10 knots	
					AVERAGE	**35.0**	(8.1 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

2/9/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Disposal Operations

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 8:00									
	7:13	050209_D5_1	2694680.246	Up	5	2.8		Overcast, ~35 Deg.	None
			814970.38		10	2.5		Minimal wind	
					25	2.5			
	7:33	**DISPOSAL**	**STARTED**						
					AVERAGE	**2.6**	**42.6**		
	7:34	050209_D5_09_00	2695681.191	Down	5	3.4		Overcast, ~35 Deg.	None
			814799.558		10	3.3		Minimal wind	
					25	2.6			
					AVERAGE	**3.1**	(39.5 Below Limit)		
	7:36	050209_D5_9_02	2695700.186	Down	15	2.4		Overcast, ~35 Deg.	None
			814913.321		25	2.6		Minimal wind	
					AVERAGE	**2.5**	(40.1 Below Limit)		
	7:39	050209_D5_9_05	2695714.257	Down	15	3.1		Overcast, ~35 Deg.	None
			815195.677		25	3.3		Minimal wind	
					AVERAGE	**3.2**	(39.4 Below Limit)		
	7:42	050209_D5_9_10	2695556.76	Down	15	2.8		Overcast, ~35 Deg.	None
			815255.975		25	3.1		Minimal wind	
					AVERAGE	**2.9**	(39.7 Below Limit)		
	7:45	050209_D5_9_15	2695173.254	Down	5	3.8		Overcast, ~35 Deg.	None
			815126.475		15	7.0		Minimal wind	
					25	13.0			
					AVERAGE	**7.9**	(34.7 Below Limit)		
	7:48	050209_D5_9_18	2692864.793	Down	5	2.9		Overcast, ~35 Deg.	None
			815041.977		15	3.6		Minimal wind	
					25	2.8			
Low 14:03					**AVERAGE**	**3.1**	(39.5 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

2/15/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Disposal Operations

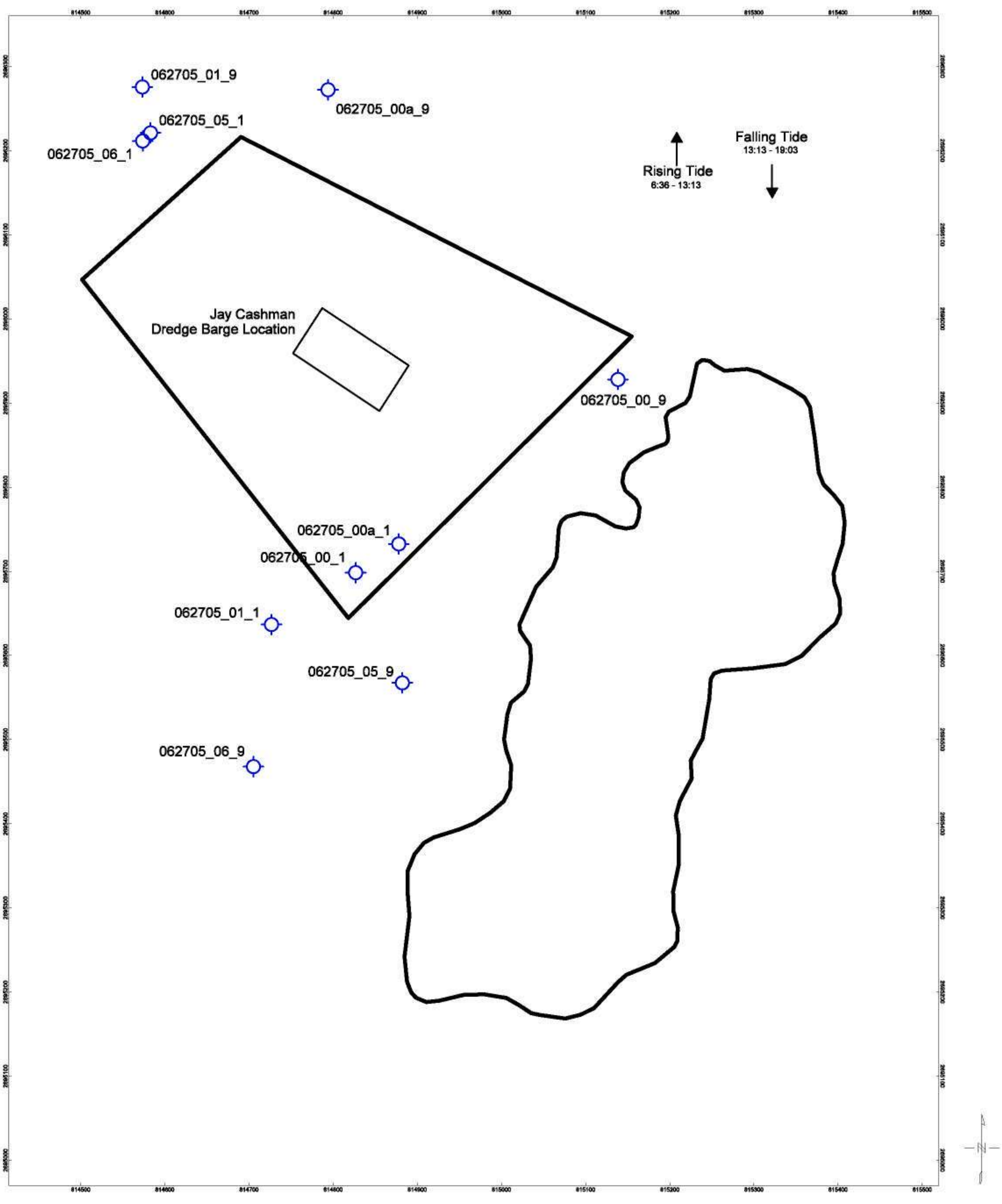
Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
High 13:54				Current		(NTUs)	Increase (NTUs)		Traffic
	15:42	050215_D6_1	2695452.865	Up	5	1.0		Clear, ~45 Degrees	None
			815161.014	Up	15	1.5		W Wind ~10 Knots	
				Up	25	2.8			
					AVERAGE	1.8	41.8		
	15:53	DISPOSAL	STARTED						
	15:53	050215_D6_9_00	2695440.594	Down	5	0.3		Clear, ~45 Degrees	None
			815142.875					W Wind ~10 Knots	
					AVERAGE	0.3	(41.5 Below Limit)		
	15:54	050215_D6_9_02	2695440.346	Down	5	0.7		Clear, ~45 Degrees	None
			815106.431		10	4.0		W Wind ~10 Knots	
					15	2.6			
					20	8.5			
					25	10.0			
					AVERAGE	5.2	(36.6 Below Limit)		
	15:59	050215_D6_9_05	2695312.5	Down	5	6.0		Clear, ~45 Degrees	None
			815061.745		10	8.0		W Wind ~10 Knots	
					15	9.0			
					20	11.5			
					25	10.5			
					30	10.0			
					15	11.5			
					10	9.0			
					5	7.0			
					AVERAGE	9.2	(32.6 Below Limit)		
	16:01	050215_D6_9_10	2695166.249	Down	5	6.5		Clear, ~45 Degrees	None
			814989.849		10	7.3		W Wind ~10 Knots	
					15	10.0			
					20	10.5			
					25	10.0			
					30	8.0			
					20	11.8			
					15	8.5			
					10	7.0			
					5	6.0			
					AVERAGE	8.6	(33.2 Below Limit)		
	16:05	050215_D6_9_15	2695385.098	Down	5	6.8		Clear, ~45 Degrees	None
			815020.248		10	7.0		W Wind ~5 Knots	
					15	7.5			
					20	6.5			
					25	10.5			
					30	11.9			
					25	13.0			
					20	6.5			
					15	27.5			
					10	7.3			
					5	6.3			
Low 18:54					AVERAGE	10.1	(31.7 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity

6/27/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
Low 6:36									
Rising Tide	7:39	062705_00_1	814882.29	Up	5	2.3		Sunny, ~82 Degrees	None
		(Background)	2695567.46		10	2.8		W Wind 0-5 knots	
					15	2.8			
					20	2.3			
					25	2.2			
					30	2.5			
					AVERAGE	2.5	22.5		
	7:47	062705_00_9	814793.96	Down	5	7.0		Sunny, ~82 Degrees	None
			2696272.35		10	4.3		W Wind 0-5 knots	
					15	2.6			
					20	2.5			
					25	2.8			
					30	4.3			
					AVERAGE	3.9	(18.6 Below Limit)		
	12:13	062705_00a_1	814726.76	Up	5	2.8		Sunny, ~85 Degrees	None
		(Background)	2695636.82		10	3.5		W Wind 1-5 knots	
					15	2.4			
					20	2.1			
					25	2.2			
					30	8.5			
					AVERAGE	3.6	23.6		
	12:21	062705_00a_9	814573.74	Down	5	2.6		Sunny, ~85 Degrees	None
			2696211.51		10	2.1		W Wind 1-5 knots	
					15	5.6			
					20	4.9			
					25	5.0			
					30	5.0			
					AVERAGE	4.2	(19.4 Below Limit)		
	12:33	062705_01_1	814878.05	Up	5	2.9		Sunny, ~85 Degrees	None
		(Background)	2695732.56		10	2.8		W Wind 1-5 knots	
					15	2.6			
					20	2.4			
					25	2.6			
					30	4.0			
					AVERAGE	2.9	22.9		
	12:40	062705_01_9	814573.31	Down	5	2.7		Sunny, ~85 Degrees	None
			2696275.65		10	2.8		W Wind 1-5 knots	
					15	3.0			
					20	5.8			
					25	6.3			
					30	5.5			
High 13:13					AVERAGE	4.3	(18.6 Below Limit)		
Falling Tide	14:18	062705_05_1	814583.06	Up	5	3.1		Sunny, ~85 Degrees	None
		(Background)	2696221.14		10	3.3		W Wind 1-5 knots	
					15	3.2			
					20	4.8			
					25	6.8			
					30	6.3			
					AVERAGE	4.6	24.6		
	14:10	062705_05_9	814789.66	Down	5	2.5		Sunny, ~85 Degrees	None
			269578.51		10	5.5		W Wind 1-5 knots	
					15	10.0			
					20	24.0			
					25	6.5			
					30	5.0			
					AVERAGE	8.9	(15.7 Below Limit)		
	15:40	062705_06_1	814782.92	Up	5	3.2		Sunny, ~85 Degrees	None
		(Background)	269618.36		10	2.9		S Wind 5-10 knots	
					15	6.1			
					20	6.5			
					25	15.5			
					30	17.0			
					AVERAGE	8.5	28.5		
	15:48	062705_06_9	814705.34	Down	5	4.2		Sunny, ~85 Degrees	None
			2695467.98		10	6.3		S Wind 5-10 knots	
					15	8.0			
					20	8.5			
					25	7.8			
					30	10.0			
Low 19:03					AVERAGE	7.5	(21.0 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

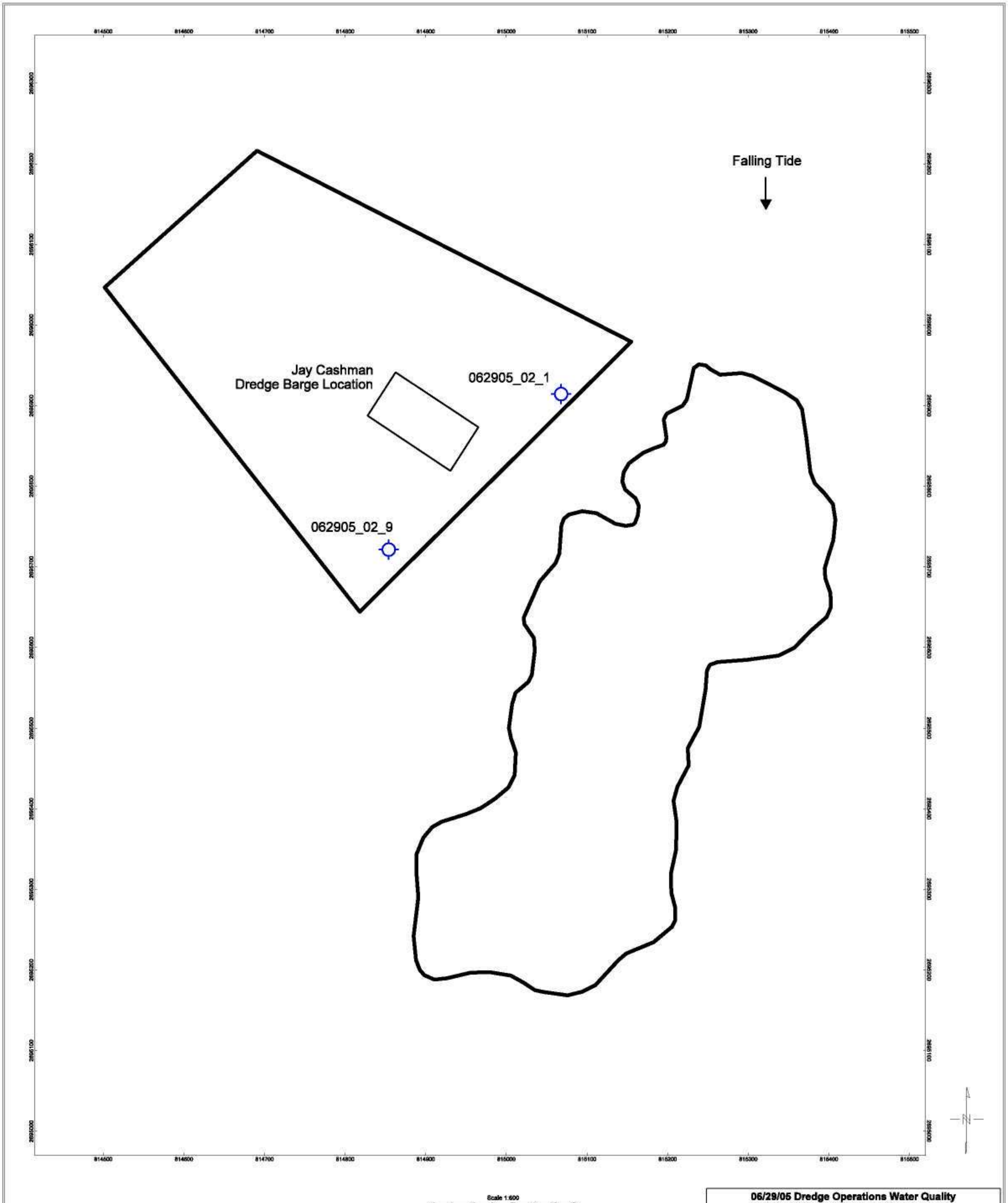


06/27/05 Dredge Operations Water Quality
CAD Cell Area Water Quality Monitoring Locations
Water Quality Stations
Apex Environmental, Inc.

6/29/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 2:33									
Falling Tide	8:16	062905_02_1	814854.04	Up	5	4.9		Sunny, ~80 Degrees	None
		(Background)	2695721.48		10	4.8		W Wind 5-10 knots	
					15	6.3			
					20	11.0			
					25	4.7			
					30	4.3			
					AVERAGE	**6.0**	**26.0**		
	8:22	062905_02_9	815067.86	Down	5	14.0		Sunny, ~80 Degrees	None
			2695914.44		10	24.0		W Wind 5-10 knots	
					15	10.5			
					20	12.5			
					25	13.5			
					30	15.0			
Low 8:26					**AVERAGE**	**14.9**	11.1 NTUs Below Permissible Turbidity Increase Limit		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



06/29/05 Dredge Operations Water Quality
CAD Cell Area Water Quality Monitoring Locations

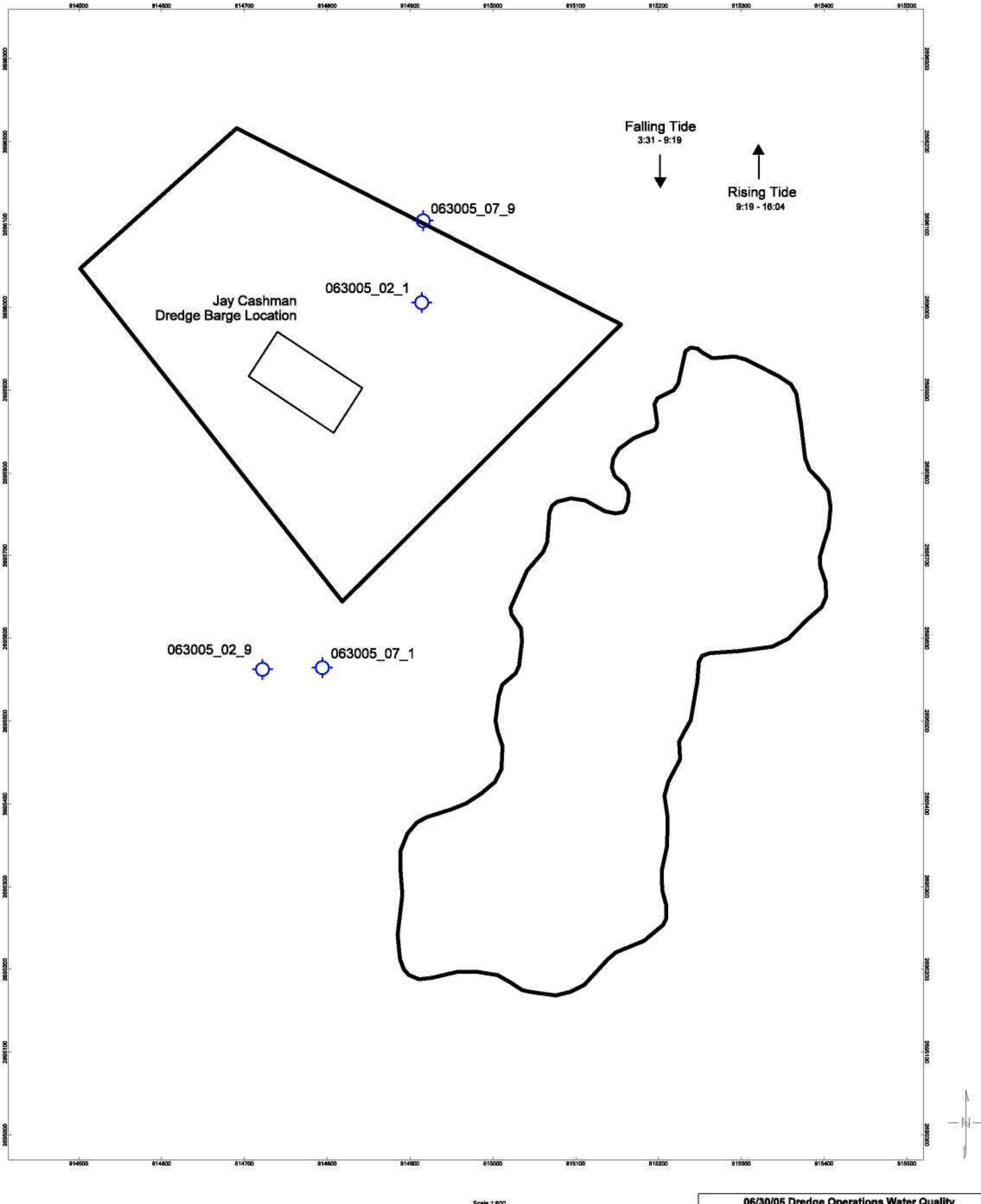
Water Quality Stations

Apex Environmental, Inc.

6/30/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 3:31									
Falling Tide	8:53	063005_02_1	814721.76	Up	5	5.5		Rainy, ~75 Degrees	None
		(Background)	2695562.44		10	10.0		W Wind 5-10 knots	
					15	7.0			
					20	12.0			
					25	12.5			
					30	8.5			
					AVERAGE	**9.3**	**29.3**		
	9:00	063005_02_9	814914.04	Down	5	5.0		Rainy, ~75 Degrees	None
			2696005.58		10	5.1		W Wind 5-10 knots	
					15	3.1			
					20	19.0			
					25	30.0			
					30	42.0			
Low 9:19					**AVERAGE**	**17.4**	11.9 NTUs		
Rising Tide	14:16	063005_07_1	814793.99	Up	5	1.5	Below Permissible	Rainy, ~75 Degrees	None
		(Background)	2695564.51		10	1.7	Turbidity Increase Limit	SW Wind 5-10 knots	
					15	1.6			
					20	1.7			
					25	2.1			
					30	2.0			
					AVERAGE	**1.8**	**21.8**		
	14:07	063005_07_9	814915.86	Down	5	6.0		Rainy, ~75 Degrees	None
			2696104.53		10	11.0		SW Wind 5-10 knots	
					15	9.0			
					20	12.0			
					25	9.5			
					30	9.0			
High 16:04					**AVERAGE**	**9.4**	(12.3 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

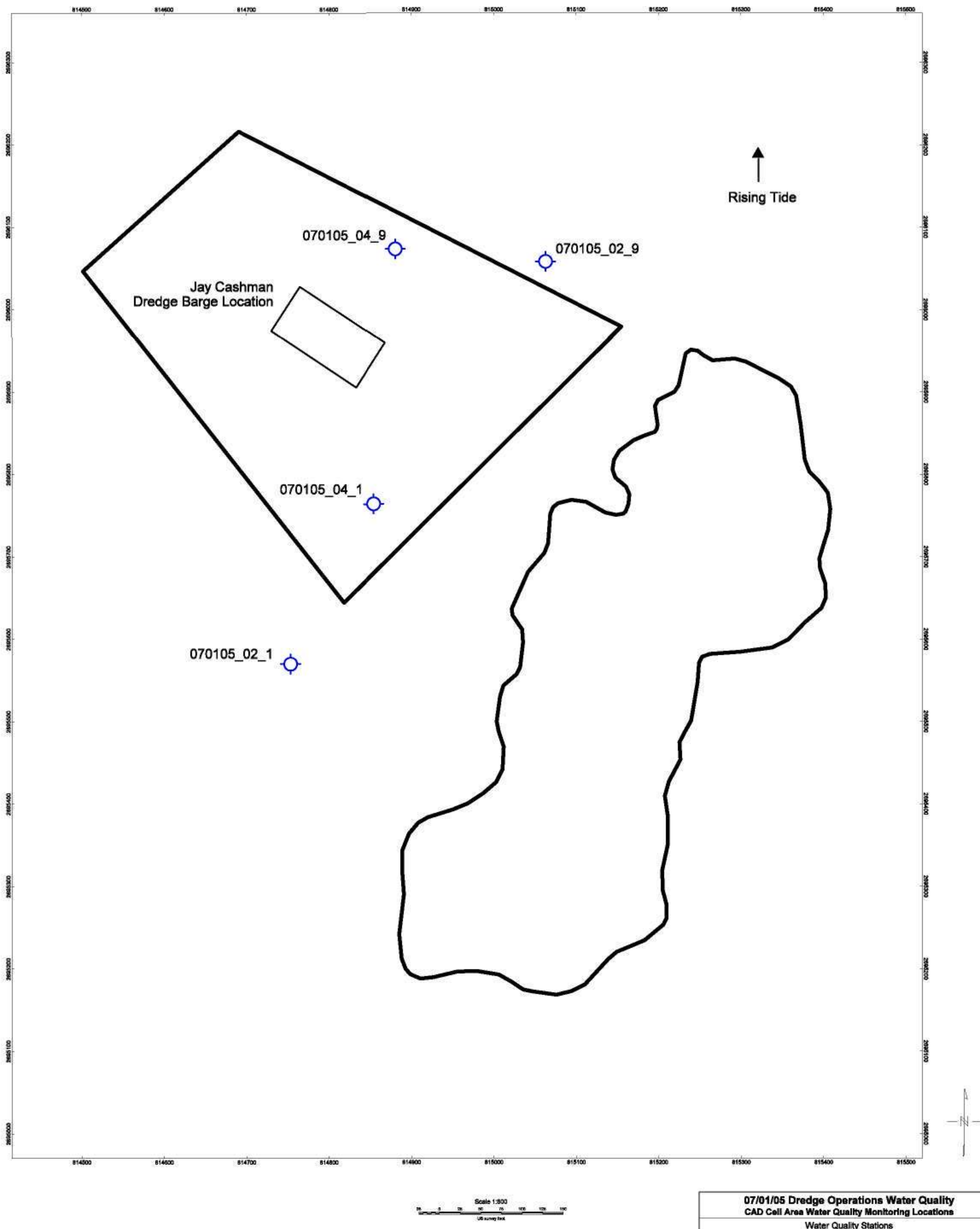


06/30/05 Dredge Operations Water Quality
CAD Cell Area Water Quality Monitoring Locations
Water Quality Stations
Apex Environmental, Inc.

7/1/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
Low 10:04									
Rising Tide	12:19	070105_02_1	814753.16	Up	5	3.8		Cloudy, ~72 Degrees	None
		(Background)	2695570.14		10	5.3		S Wind 5-10 knots	
					15	5.5			
					20	9.0			
					25	10.0			
					30	3.5			
					AVERAGE	**6.2**	**26.2**		
	12:28	070105_02_9	815062.91	Down	5	9.5		Cloudy, ~72 Degrees	None
			2696058.4		10	12.8		S Wind 5-10 knots	
					15	10.0			
					20	11.5			
					25	9.0			
					30	18.0			
					AVERAGE	**11.8**	14.4 NTUs		
	14:35	070105_04_1	814915.86	Up	5	1.9	Below Permissible	Cloudy, ~72 Degrees	None
		(Background)	2696104.53		10	2.0	Turbidity Increase Limit	S Wind 5-10 knots	
					15	2.0			
					20	1.9			
					25	5.5			
					30	12.0			
					AVERAGE	**4.2**	**24.2**		
	14:39	070105_04_9	814793.99	Down	5	22.5		Cloudy, ~72 Degrees	None
			2695564.51		10	5.7		S Wind 5-10 knots	
					15	8.0			
					20	10.2			
					25	10.0			
					30	8.7			
High 17:04					**AVERAGE**	**10.9**	(13.3 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/01/05 Dredge Operations Water Quality
CAD Cell Area Water Quality Monitoring Locations

Water Quality Stations

Apex Environmental, Inc.

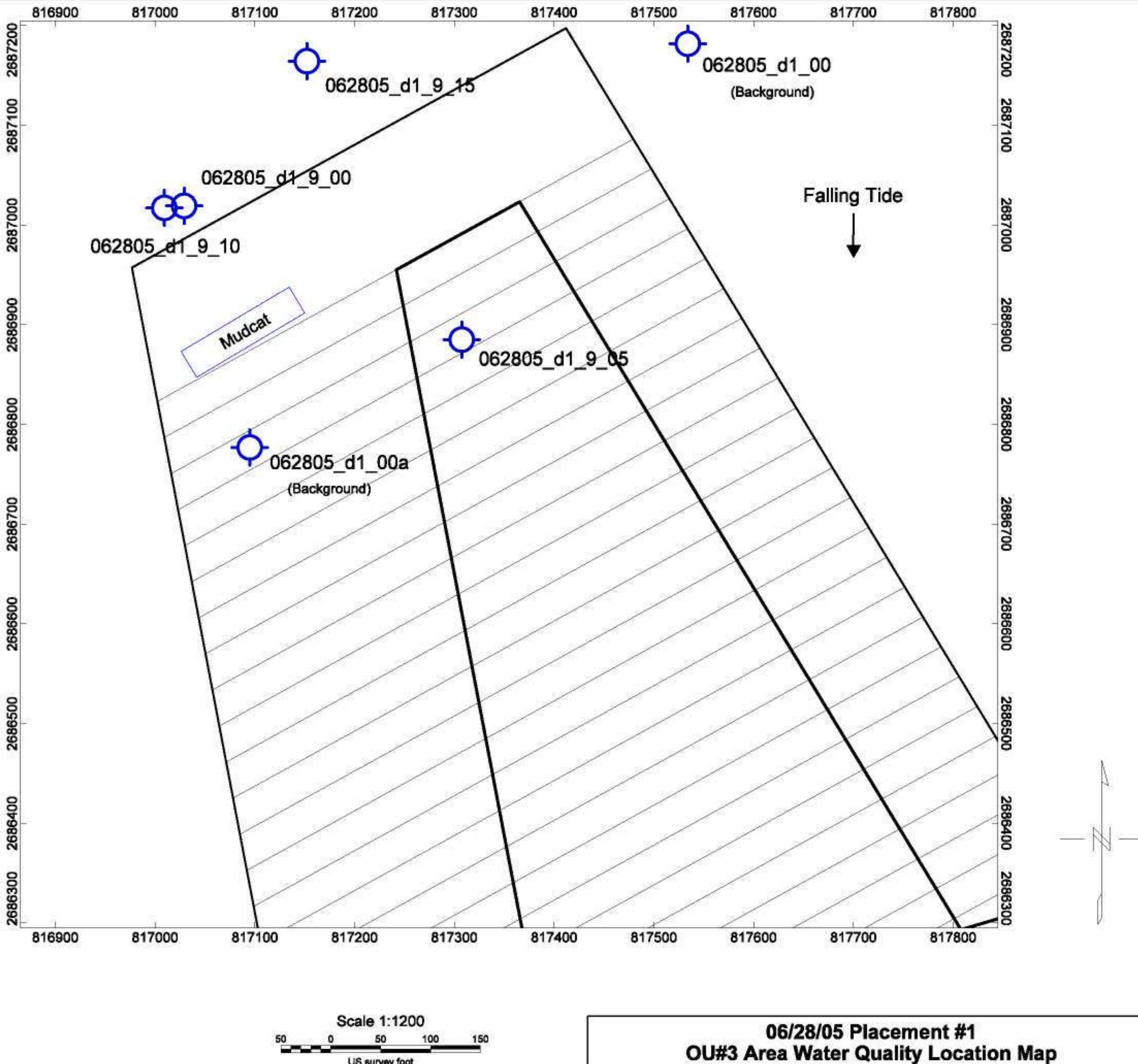
6/28/2005

New Bedford Harbor Dredge Project - Phase II

Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
Low 7:30									
Falling Tide	10:22	062805_d1_00	817780.5	Up	2	4.5		Sunny, ~85 Degrees	None
		(Background)	2687437.15		4	4.0		W Wind ~10 Knots	
					6	3.6			
					8	4.5			
					AVERAGE	**4.1**	**44.1**		
	10:46	062805_d1_00a	817159.23	Down	2	2.3		Sunny, ~85 Degrees	None
		(Background)	2686632.01		4	3.0		W Wind ~10 Knots	
					6	7.5			
					8	9.5			
					AVERAGE	**2.3**	**42.3**		
	11:30	**PLACEMENT 1**	**STARTED**						
	11:30	062805_d1_9_00	817014.81	Down	2	1.7		Sunny, ~85 Degrees	None
			2687052.69		4	3.5		W Wind ~10 Knots	
					6	5.0			
					8	6.0			
					6	4.5			
					8	2.5			
					10	3.8			
					AVERAGE	**4.5**	37.8 NTUs		
	11:35	062805_d1_9_05	817023.65		2	20.0	Below Permissible	Sunny, ~85 Degrees	None
			2687068.38		4	11.0	Turbidity Increase Limit	W Wind ~10 Knots	
					6	7.0			
					8	18.0			
					AVERAGE	**7.3**	(35.0 Below Limit)		
	11:39	062805_d1_9_10	817006.35	Down	10	6.0		Sunny, ~85 Degrees	None
			2687052.69		6	8.0		W Wind ~10 Knots	
					8	9.0			
					10	11.5			
					AVERAGE	**8.6**	(33.7 Below Limit)		
	11:43	062805_d1_9_15	817233.98	Down	10	5.5		Sunny, ~85 Degrees	None
			2687271.84		8	6.5		W Wind ~10 Knots	
					6	4.5			
					4	2.5			
					2	4.0			
High 14:09					**AVERAGE**	**4.6**	(37.7 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity



06/28/05 Placement #1
OU#3 Area Water Quality Location Map

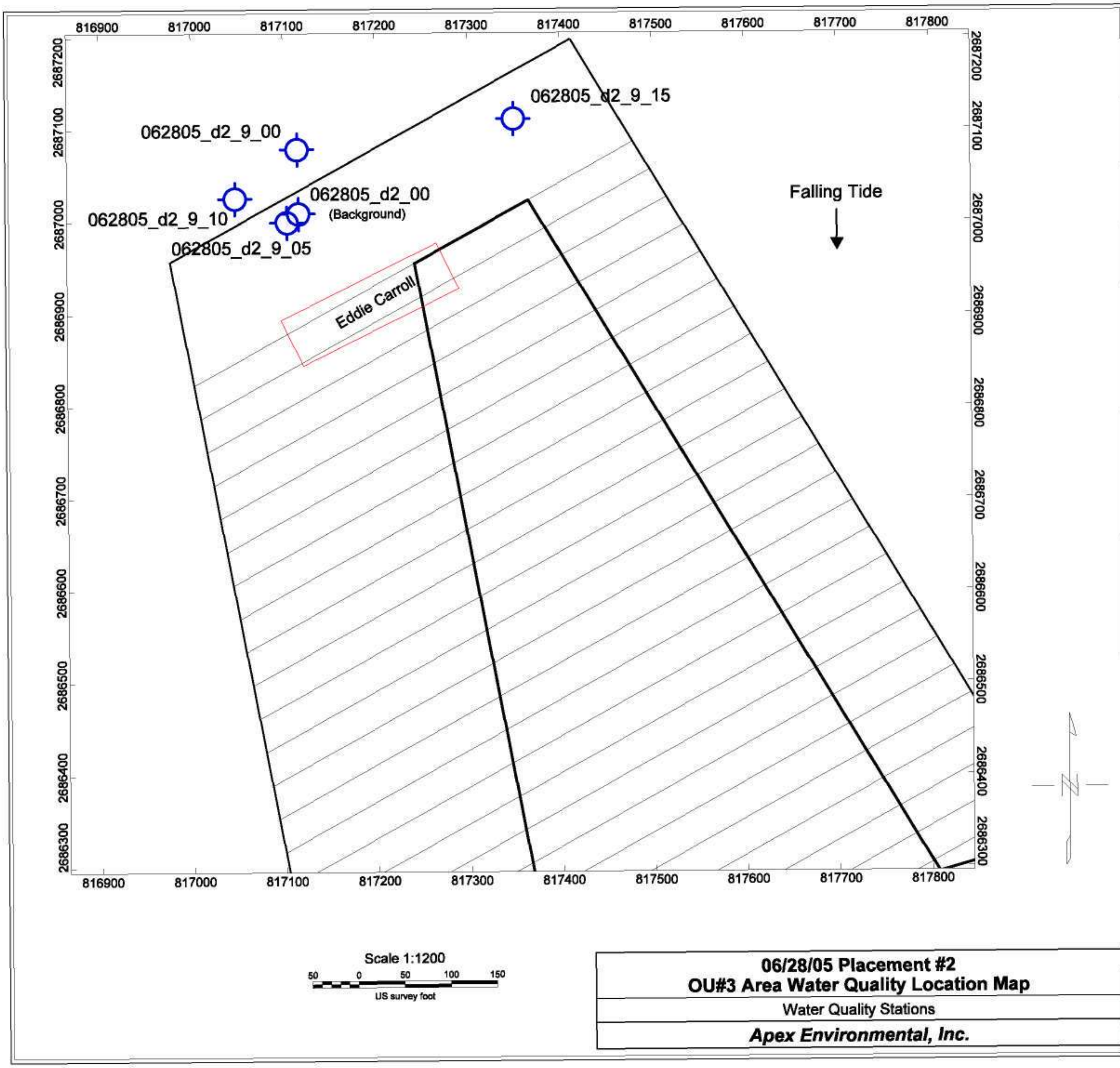
Water Quality Stations

Apex Environmental, Inc.

6/28/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OUI#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 14:09									
Falling Tide	14:42	062805_d2_00	817102.22	Down	2	3.5		Cloudy, ~80 Degrees	None
		(Background)	2687100.03		4	3.8		SW Wind ~10 Knots	
					6	3.9			
					8	3.7			
					AVERAGE	3.7	43.7		
	15:25	PLACEMENT 2	STARTED						
	15:25	062805_d2_9_00	817142.09	Down	2	3.4		Cloudy, ~80 Degrees	None
			2687139.84		4	3.5		SW Wind ~10 Knots	
					6	3.5			
					8	3.8			
					10	12.0			
					12	16.0			
					10	12.5			
					8	7.0			
					AVERAGE	7.7	36.0 NTUs		
	15:30	062805_d2_9_05	817142.2	Down	8	7.5	Below Permissible	Cloudy, ~80 Degrees	None
			2687080.87		6	13.0	Turbidity Increase Limit	SW Wind ~10 Knots	
					4	12.0			
					8	27.0			
					10	34.0			
					8	15.0			
					6	5.0			
					AVERAGE	16.2	(27.5 Below Limit)		
	15:35	062805_d2_9_10	817154.12	Down	10	27.0		Sunny, ~85 Degrees	None
			2687090.14		8	13.0		W Wind ~10 Knots	
					6	4.0			
					4	0.7			
					2	0.3			
					4	0.5			
					6	2.5			
					8	11.5			
					10	25.0			
					AVERAGE	9.4	(34.3 Below Limit)		
	15:40	062805_d2_9_15	817355.87	Down	2	0.4		Sunny, ~85 Degrees	None
			2687144.62		4	0.5		W Wind ~10 Knots	
					6	1.0			
					8	1.8			
					10	2.3			
Low 20:45					AVERAGE	6.0	(37.7 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity



06/28/05 Placement #2
OU#3 Area Water Quality Location Map

Water Quality Stations

Apex Environmental, Inc.

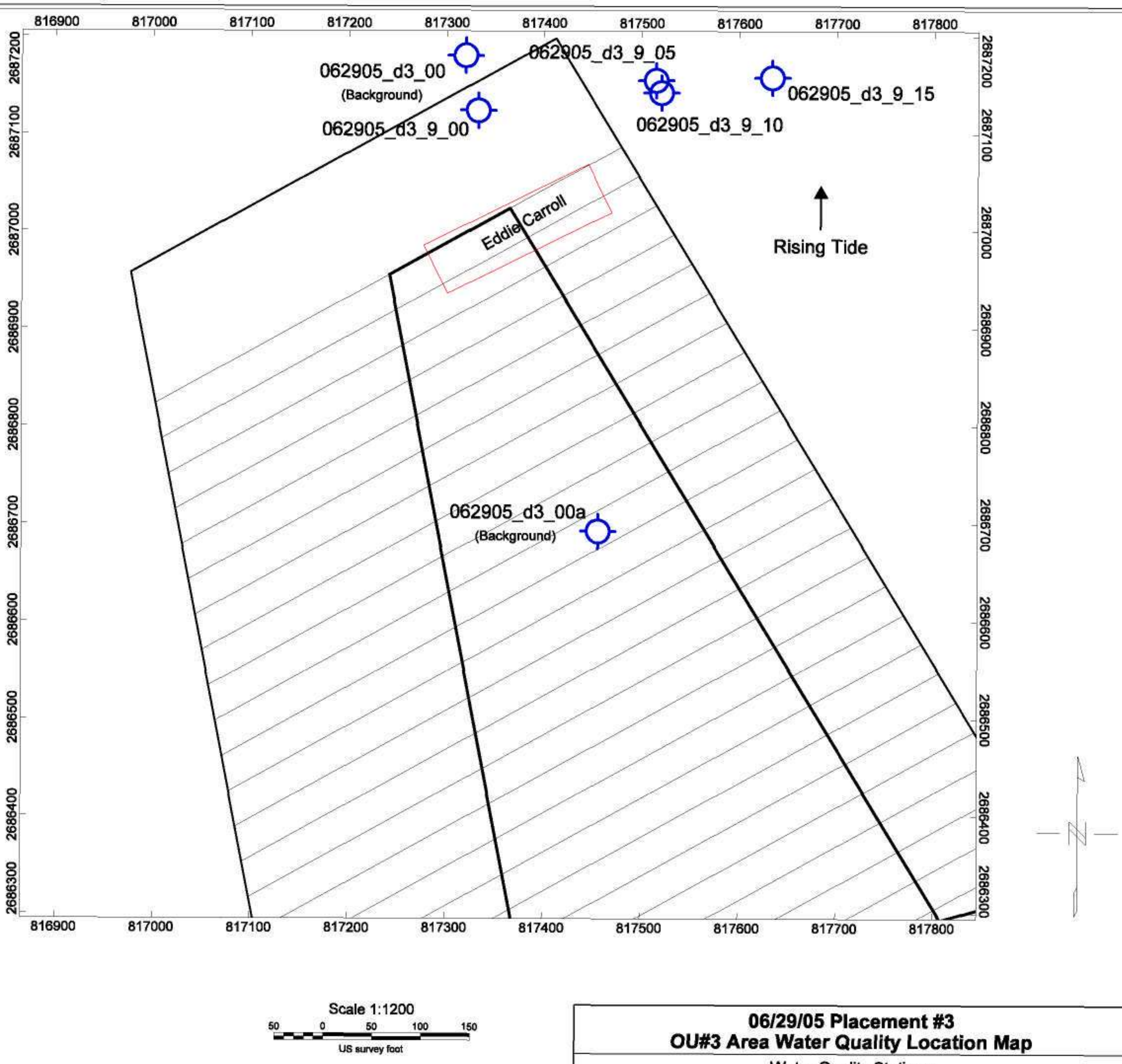
6/29/2005

New Bedford Harbor Dredge Project - Phase II

Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
Low 8:26									
Rising Tide	8:42	062905_d3_00	817378.02	Up	2	2.0		Hazy, ~80 Degrees	None
		(Background)	2687268.54		4	1.9		SW Wind ~10 Knots	
					6	2.0			
					8	2.3			
					AVERAGE	2.0	42.0		
	9:09	062905_d3_00a	817461.49	Down	2	1.8		Hazy, ~80 Degrees	None
		(Background)	2686770.79		4	2.1		SW Wind ~10 Knots	
					6	2.5			
					8	2.5			
					AVERAGE	2.2	42.2		
	9:12	PLACEMENT 3	STARTED						
	9:12	062905_d3_9_00	817382.95	Down	2	7.0		Hazy, ~80 Degrees	None
			2687227.96		4	2.0		SW Wind ~10 Knots	
					6	2.3			
					8	7.0			
					6	6.5			
					AVERAGE	5.0	37.0 NTUs		
	9:17	062905_d3_9_05	817549.98	Down	2	6.0	Below Permissible	Hazy, ~80 Degrees	None
			2687276.36		4	8.5	Turbidity Increase Limit	SW Wind ~10 Knots	
					6	7.0			
					8	10.5			
					6	11.0			
					4	4.5			
					AVERAGE	7.9	(34.1 Below Limit)		
	9:22	062905_d3_9_10	817558.03	Down	2	7.5		Hazy, ~80 Degrees	None
			2687268.82		4	9.0		SW Wind ~10 Knots	
					6	8.0			
					8	10.0			
					AVERAGE	8.5	(33.6 Below Limit)		
	9:26	062905_d3_9_15	817608.51	Down	2	6.0		Hazy, ~80 Degrees	None
			2687283.65		4	8.5		SW Wind ~10 Knots	
					6	9.0			
					8	10.0			
High 4:14					AVERAGE	8.4	(33.7 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity

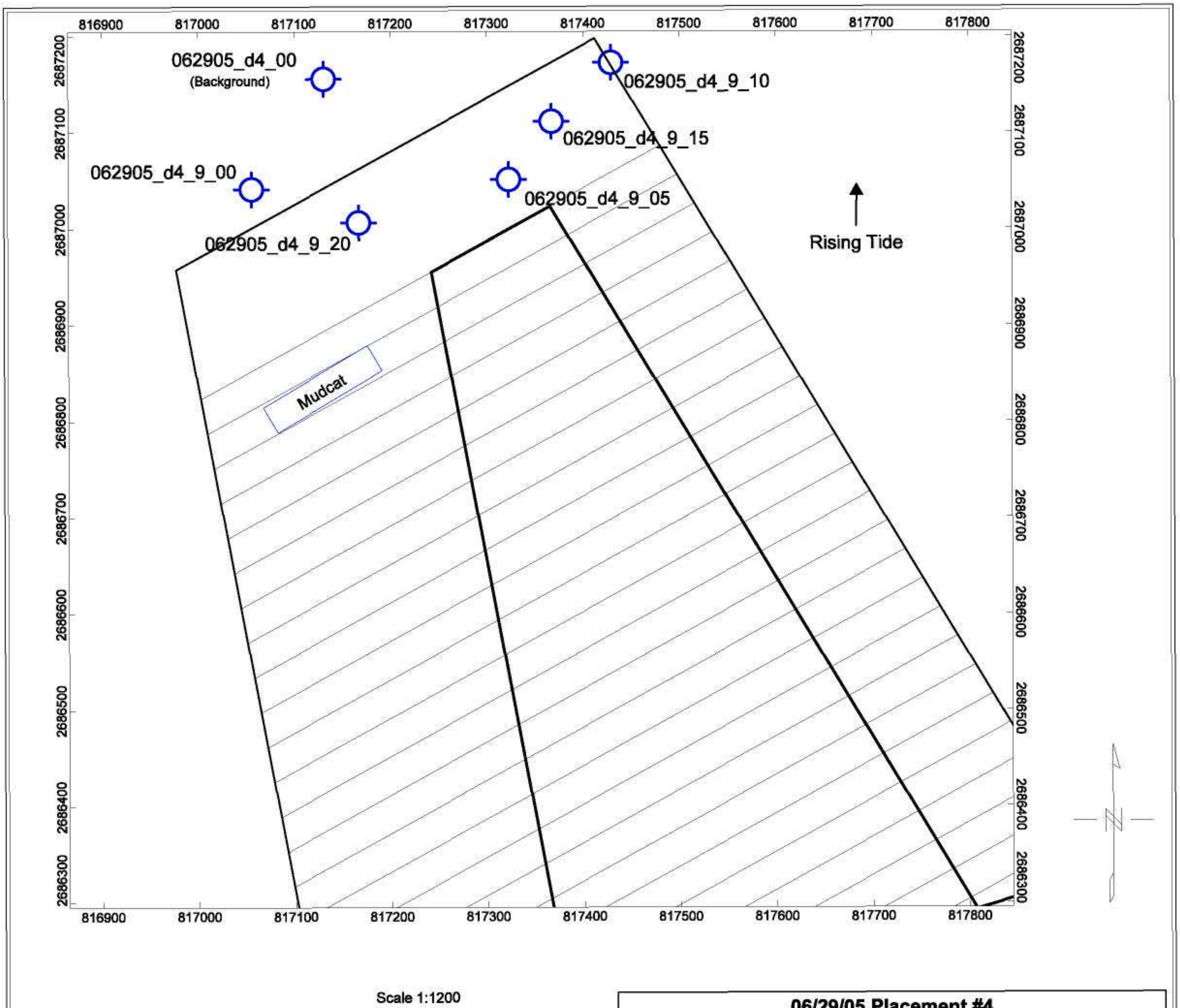


06/29/05 Placement #3 **OU#3 Area Water Quality Location Map**
Water Quality Stations
Apex Environmental, Inc.

6/29/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 8:26				Current		(NTUs)	Increase (NTUs)		Traffic
Rising Tide	11:38	062905_d4_00	817169.09	Up	2	11.0		Sunny, ~80 Degrees	None
		(Background)	2687165.38		4	12.0		SW Wind ~10 Knots	
					6	12.5			
					8	11.9			
					AVERAGE	11.9	51.9		
	12:09	PLACEMENT 4	STARTED						
	12:09	062905_d4_9_00	817196.47	Down	2	1.8		Sunny, ~80 Degrees	None
			2687034.69		4	2.1		SW Wind ~10 Knots	
					6	2.5			
					8	2.5			
					AVERAGE	2.2	49.7 NTUs		
	12:14	062905_d4_9_05	817328.15	Down	2	16.0	Below Permissible	Sunny, ~80 Degrees	None
			2687051.98		4	17.0	Turbidity Increase Limit	SW Wind ~10 Knots	
					6	12.0			
					8	11.0			
					6	7.6			
					8	14.0			
					AVERAGE	12.9	(39.0 Below Limit)		
	12:19	062905_d4_9_10	817441.07	Down	2	14.0		Sunny, ~80 Degrees	None
			2687198.78		4	16.0		SW Wind ~10 Knots	
					6	23.0			
					8	28.0			
					6	30.0			
					AVERAGE	22.2	(29.7 Below Limit)		
	12:24	062905_d4_9_15	817386.58	Down	2	12.5		Sunny, ~80 Degrees	None
			2687114.23		4	8.0		SW Wind ~10 Knots	
					6	7.0			
					8	30.0			
					6	11.0			
					8	35.0			
					AVERAGE	18.0	(33.9 Below Limit)		
	12:29	062905_d4_9_20	817401.1	Down	2	12.0		Sunny, ~80 Degrees	None
			268147.32		4	13.0		SW Wind ~10 Knots	
					6	10.0			
					8	20.0			
					6	16.0			
					4	8.0			
					6	7.5			
					8	5.0			
High 4:14					AVERAGE	12.2	(39.7 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity



06/29/05 Placement #4
OU#3 Area Water Quality Location Map

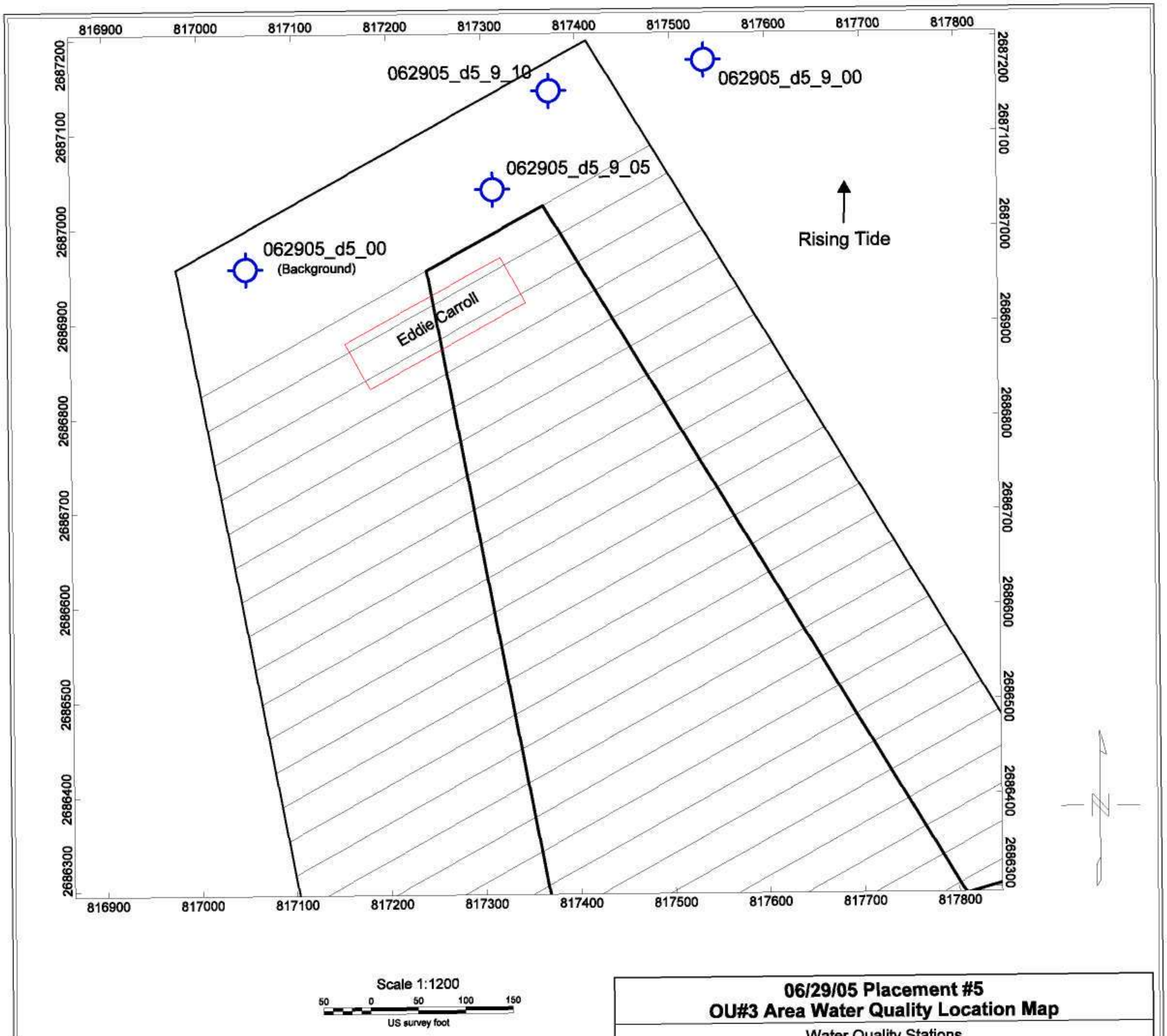
Water Quality Stations

Apex Environmental, Inc.

6/29/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 8:26				Current		(NTUs)	Increase (NTUs)		Traffic
Rising Tide	14:45	062905_d5_00	817088.64	Down	2	2.9		Sunny, ~80 Degrees	None
		(Background)	2687018.04		4	2.8		W Wind ~10 Knots	
					6	3.0			
					8	2.9			
					10	4.0			
					AVERAGE	**3.1**	**43.1**		
	15:13	**PLACEMENT 5**	**STARTED**						
	15:13	062905_d5_9_00	817556.14	Down	2	13.0		Sunny, ~80 Degrees	None
			2687248.75		4	10.0		W Wind ~10 Knots	
					6	11.0			
					8	21.0			
					10	35.0			
					AVERAGE	**18.0**	25.1 NTUs		
	15:18	062905_d5_9_05	817328.15	Down	2	16.0	Below Permissible	Sunny, ~80 Degrees	None
			2687051.98		4	17.0	Turbidity Increase Limit	W Wind ~10 Knots	
					6	12.0			
					8	11.0			
					6	7.6			
					8	14.0			
					AVERAGE	**12.9**	(30.2 Below Limit)		
	15:23	062905_d4_9_10	817441.07	Down	2	9.0		Sunny, ~80 Degrees	None
			2687198.78		4	12.3		W Wind ~10 Knots	
					6	14.0			
					8	55.0			
High 4:14					**AVERAGE**	**22.6**	(20.5 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity



06/29/05 Placement #5
OU#3 Area Water Quality Location Map

Water Quality Stations

Apex Environmental, Inc.

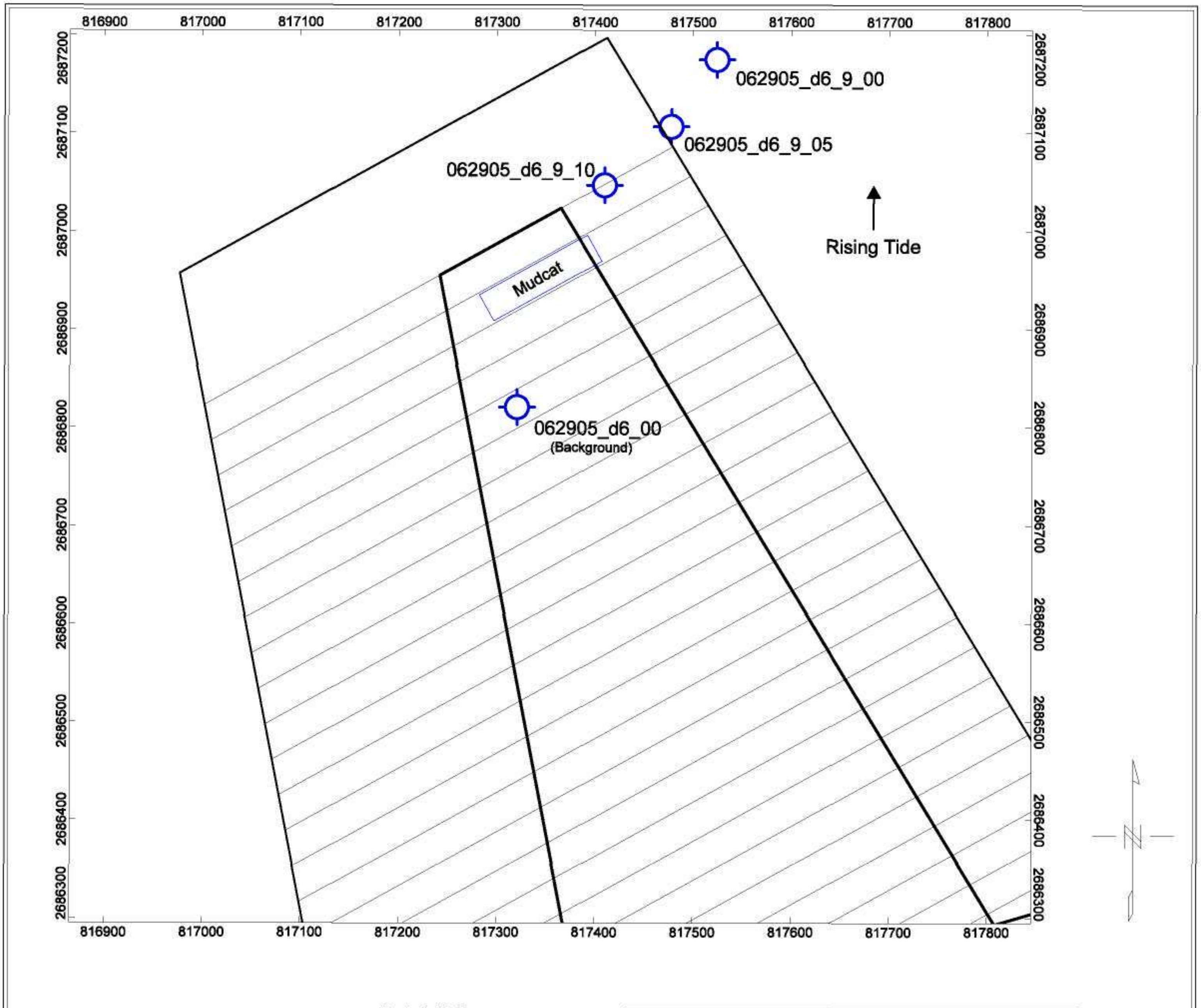
6/29/2005

New Bedford Harbor Dredge Project - Phase II

Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 8:26				Current		(NTUs)	Increase (NTUs)		Traffic
Rising Tide	17:04	062905_d6_00	817140.14	Up	2	4.8		Sunny, ~80 Degrees	None
		(Background)	2682753.9		4	4.5		W Wind ~10 Knots	
					6	5.0			
					8	4.8			
					AVERAGE	4.8	44.8		
	17:09	PLACEMENT 6	STARTED						
	17:09	062905_d6_9_00	817504.71	Down	2	4.1		Sunny, ~80 Degrees	None
			2687251.9		4	6.1		W Wind ~10 Knots	
					6	4.4			
					8	5.8			
					6	5.3			
					4	5.6			
					AVERAGE	5.2	39.6 NTUs		
	17:14	062905_d6_9_05	817498.04	Down	2	16.0	Below Permissible	Sunny, ~80 Degrees	None
			2687155.56		4	17.0	Turbidity Increase Limit	W Wind ~10 Knots	
					6	12.0			
					8	11.0			
					6	7.6			
					4	14.0			
					AVERAGE	12.9	(31.9 Below Limit)		
	15:23	062905_d6_9_10	817402.84	Down	2	5.8		Sunny, ~80 Degrees	None
			2687051.81		4	6.2		W Wind ~10 Knots	
					6	9.5			
					8	10.0			
High 4:14					AVERAGE	7.9	(36.9 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity



06/29/05 Placement #6
OU#3 Area Water Quality Location Map

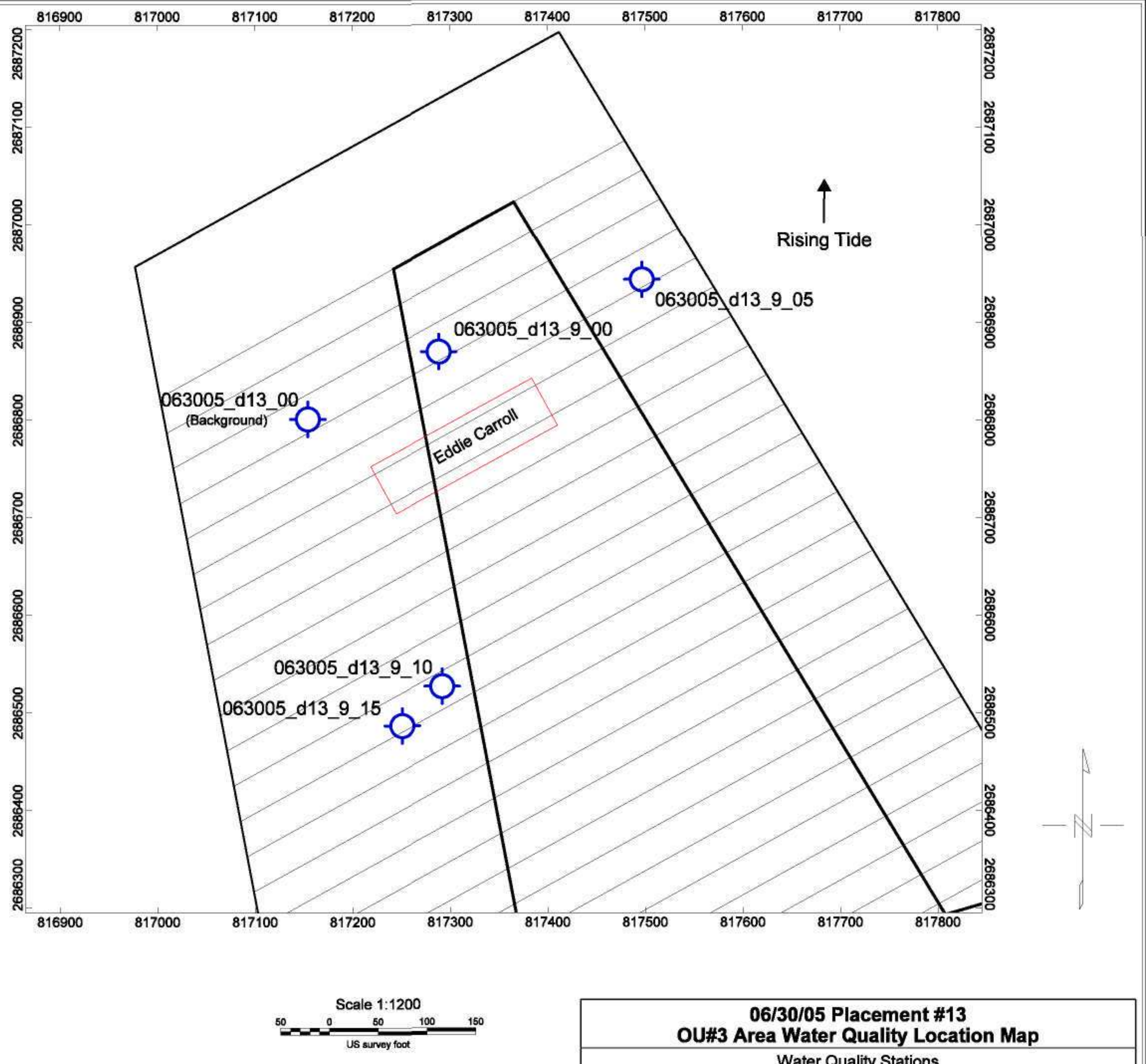
Water Quality Stations

Apex Environmental, Inc.

6/30/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 8:26				Current		(NTUs)	Increase (NTUs)		Traffic
Rising Tide	12:56	063005_d13_00	817140.14	Down	2	3.3		Cloudy, ~70 Degrees	None
		(Background)	2682753.9		4	3.5		W Wind ~10 Knots	
					6	7.5			
					8	8.0			
					AVERAGE	**5.6**	**45.6**		
	13:05	**PLACEMENT 13**	**STARTED**						
	13:05	063005_d13_9_00	817504.71	Down	2	6.5		Cloudy, ~70 Degrees	None
			2687251.9		4	6.9		W Wind ~10 Knots	
					6	8.0			
					8	8.5			
					6	15.0			
					4	9.5			
					2	8.5			
					AVERAGE	**9.0**	36.6 NTUs		
	13:09	063005_d13_9_05	817498.04	Down	2	8.5	Below Permissible	Cloudy, ~70 Degrees	None
			2687155.56		4	7.5	Turbidity Increase Limit	W Wind ~10 Knots	
					6	7.0			
					8	10.1			
					6	13.3			
					4	12.0			
					2	5.0			
					AVERAGE	**9.0**	(36.6 Below Limit)		
	13:20	063005_d13_9_10	817402.84	Up	2	4.0		Cloudy, ~70 Degrees	None
			2687051.81		4	3.8		W Wind ~10 Knots	
					6	4.5			
					8	6.0			
					AVERAGE	**4.6**	(41.0 Below Limit)		
	13:25	063005_d13_9_15		Up	2	10		Cloudy, ~70 Degrees	None
					4	12.5		W Wind ~10 Knots	
					6	16.75			
					8	6.5			
					6	5.9			
					8	5.7			
High 15:06					**AVERAGE**	**8.7**	(36.9 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



06/30/05 Placement #13
OU#3 Area Water Quality Location Map

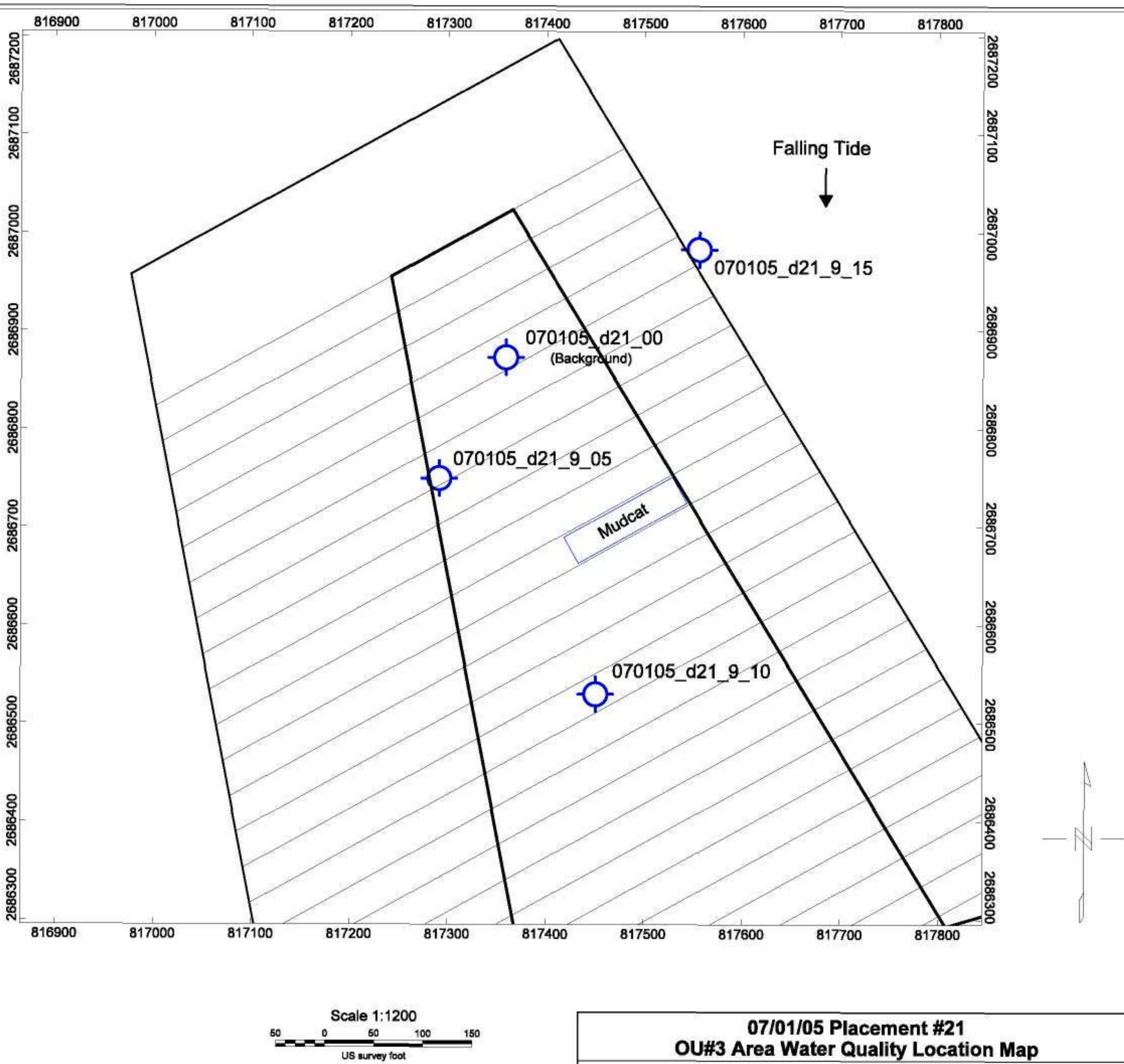
Water Quality Stations

Apex Environmental, Inc.

7/1/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
High 10:04				Current		(NTUs)	Increase (NTUs)		Traffic
Falling Tide	10:36	070105_d21_00	817562.15	Up	2	3.5		Cloudy, ~72 Degrees	None
		(Background)	2686529.48		4	3.0		S Wind ~10 Knots	
					6	3.5			
					8	4.0			
					10	7.5			
					AVERAGE	**4.3**	**44.3**		
	10:37	**PLACEMENT 21**	**STARTED**						
	10:39	070105_d21_9_05	817284.95	Up	2	14.3		Cloudy, ~72 Degrees	None
			2686765.33		4	19.0		S Wind ~10 Knots	
					6	21.0			
					8	6.0			
					AVERAGE	**15.1**	29.2 NTUs		
	10:45	070105_d21_9_10	817348.66	Down	2	22.5	Below Permissible	Cloudy, ~72 Degrees	None
			2686862.68		4	24.5	Turbidity Increase Limit	S Wind ~10 Knots	
					6	8.1			
					7	6.0			
					AVERAGE	**15.3**	(29.0 Below Limit)		
	10:49	070105_d21_9_15	817578.57	Up	2	6.8		Cloudy, ~72 Degrees	None
			2686934.87		4	11.0		S Wind ~10 Knots	
					6	24.0			
					8	30.0			
Low 17:03					**AVERAGE**	**18.0**	(26.3 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/01/05 Placement #21
OU#3 Area Water Quality Location Map

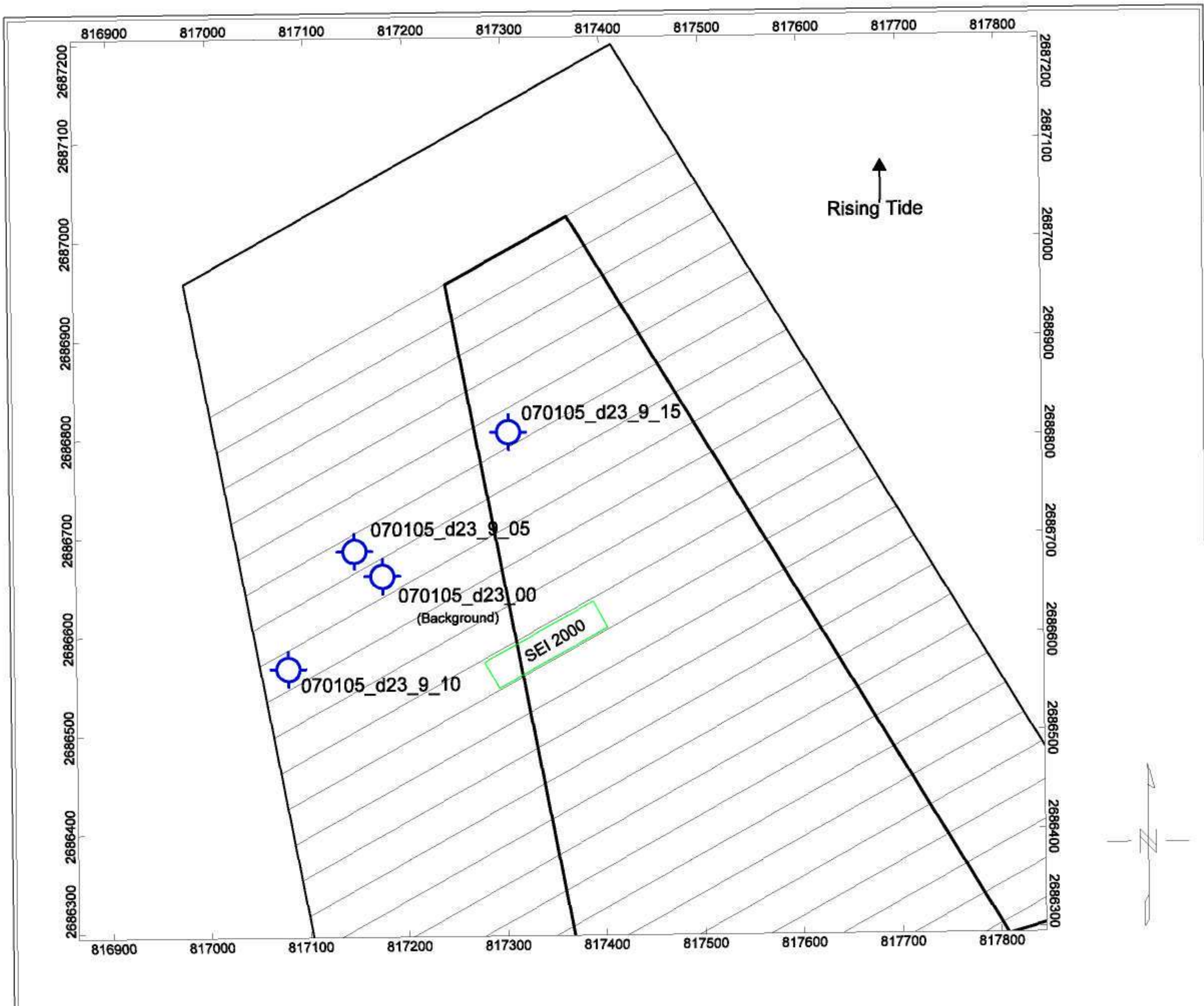
Water Quality Stations

Apex Environmental, Inc.

7/1/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 10:04				Current		(NTUs)	Increase (NTUs)		Traffic
Rising Tide	12:42	070105_d23_00	817329.23	Down	2	3.8		Cloudy, ~75 Degrees	None
		(Background)	2686350.62		4	4.0		S Wind ~10 Knots	
					6	3.5			
					8	4.3			
					AVERAGE	3.9	43.9		
	13:18	PLACEMENT 23	STARTED						
	13:18	070105_d23_9_05	817190.63	Down	2	9.0		Cloudy, ~75 Degrees	None
			2686732.17		4	8.5		S Wind ~10 Knots	
					6	10.0			
					8	7.5			
					AVERAGE	8.8	35.1 NTUs		
	13:22	070105_d23_9_10	817087.58	Down	2	12.0	Below Permissible	Cloudy, ~75 Degrees	None
			2686622.32		4	15.5	Turbidity Increase Limit	S Wind ~10 Knots	
					6	14.0			
					8	16.3			
					AVERAGE	14.4	(29.5 Below Limit)		
	13:32	070105_d23_9_15	817348.05	Down	2	9.3		Cloudy, ~75 Degrees	None
			2686808.55		4	9.8		S Wind ~10 Knots	
					6	10.0			
					8	11.5			
High 17:03					AVERAGE	10.1	(33.8 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/01/05 Placement #23
OU#3 Area Water Quality Location Map

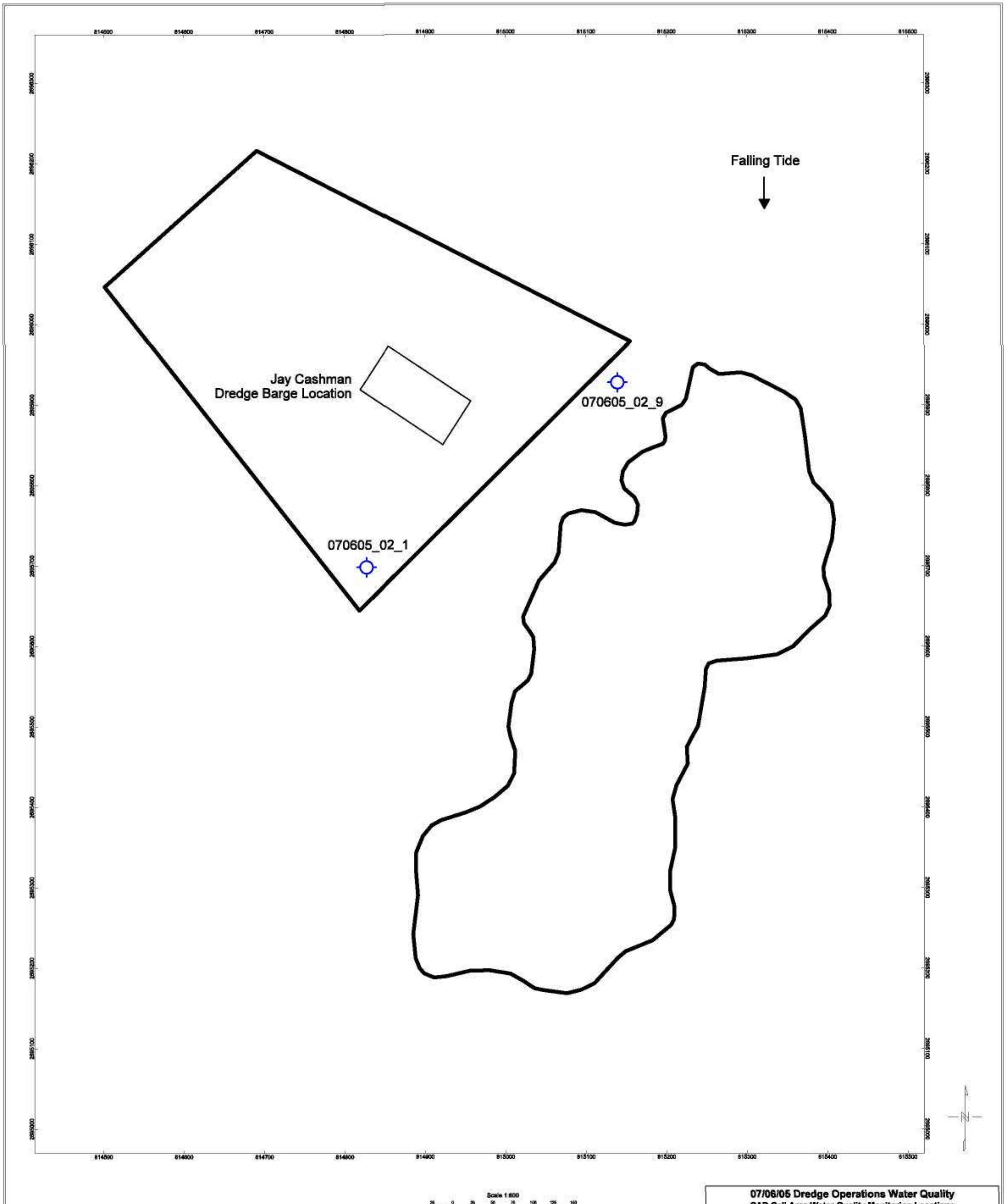
Water Quality Stations

Apex Environmental, Inc.

7/6/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 8:40									
Falling Tide	12:00	070605_02_1	814826.81	Up	5	2.8		Cloudy, ~80 Degrees	None
		(Background)	2695698.48		10	2.5		S Wind 1-5 knots	
					15	4.7			
					20	6.0			
					25	6.0			
					30	3.5			
					AVERAGE	**4.3**	**24.3**		
	11:50	070605_02_9	815138.52	Down	5	9.5		Cloudy, ~80 Degrees	None
			2695928.02		10	10.0		S Wind 1-5 knots	
					15	14.5			
					20	21.5			
					25	10.5			
					30	9.0			
Low 13:40					**AVERAGE**	**12.5**	11.8 NTUs Below Permissible Turbidity Increase Limit		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

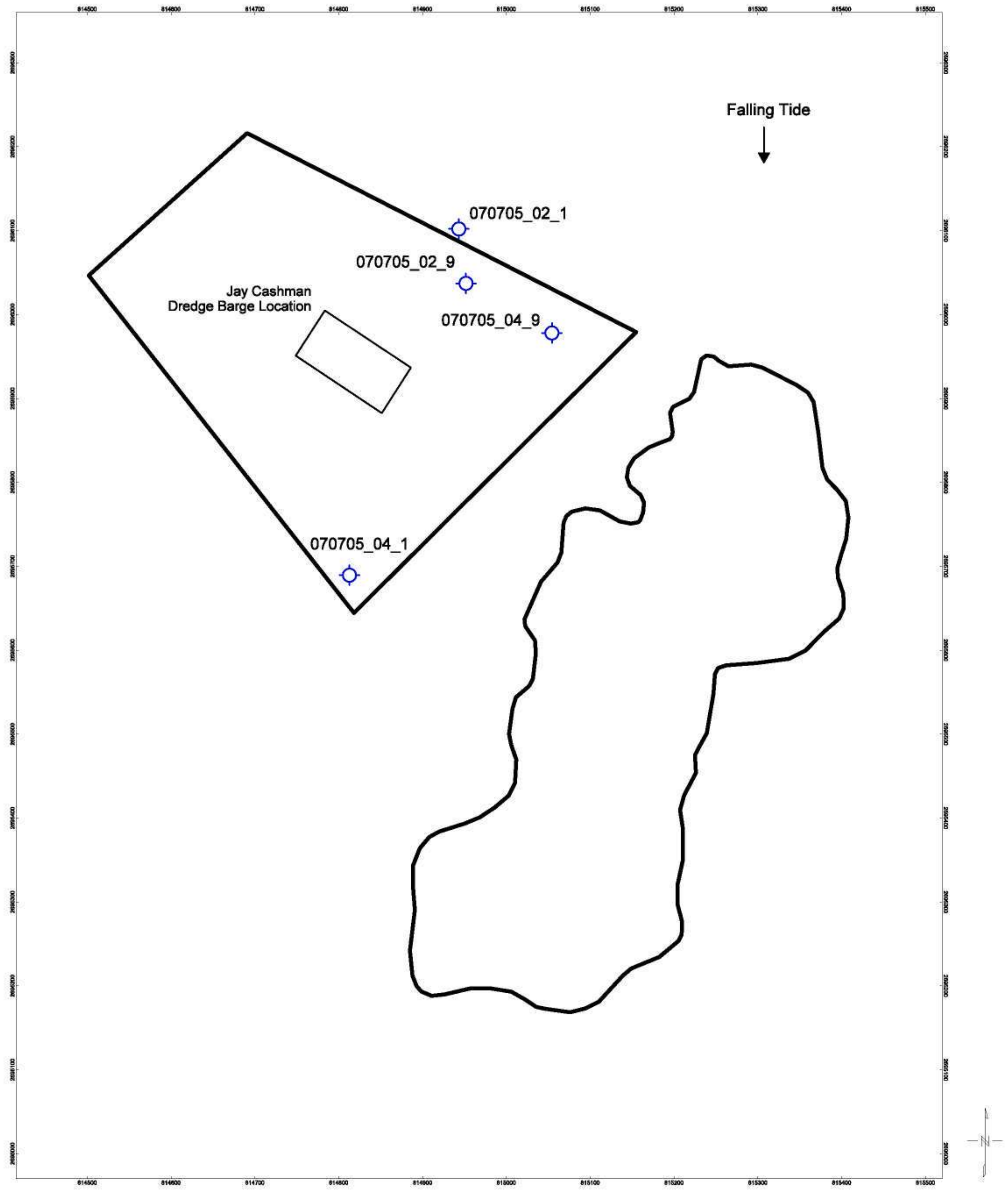


07/06/05 Dredge Operations Water Quality
CAD Cell Area Water Quality Monitoring Locations
Water Quality Stations
Apex Environmental, Inc.

7/7/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down Current	Depth (ft.)	Ave. Turbidity (NTUs)	Permissible Turbidity Increase (NTUs)	Weather Conditions	Vessel Traffic
High 9:21									
Falling Tide	11:56	070705_02_1	814943.23	Up	5	5.5		Cloudy, ~70 Degrees	None
		(Background)	2696102.07		10	6.0		N Wind 5-15 knots	
					15	6.3			
					20	11.0			
					25	17.0			
					30	22.5			
					AVERAGE	**11.4**	**31.4**		
	12:05	070705_02_9	815780.97	Down	5	6.5		Cloudy, ~70 Degrees	None
			2695561.53		10	8.0		N Wind 5-15 knots	
					15	7.5			
					20	9.5			
					25	13.5			
					30	7.5			
					AVERAGE	**8.8**	22.6 NTUs		
	13:17	070705_04_1	814951.76	Up	5	6.5	Below Permissible	Cloudy, ~70 Degrees	None
		(Background)	2696037.2		10	6.5	Turbidity Increase Limit	N Wind 5-15 knots	
					15	22.0			
					20	11.7			
					25	16.0			
					30	16.0			
					AVERAGE	**13.1**	**33.1**		
	13:23	070705_04_9	814812.74	Down	5	2.2		Cloudy, ~70 Degrees	None
			2695689.43		10	2.6		N Wind 5-15 knots	
					15	2.3			
					20	3.6			
					25	4.8			
					30	10			
Low 14:47					**AVERAGE**	**4.3**	(28.8 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/07/05 Dredge Operations Water Quality
CAD Cell Area Water Quality Monitoring Locations

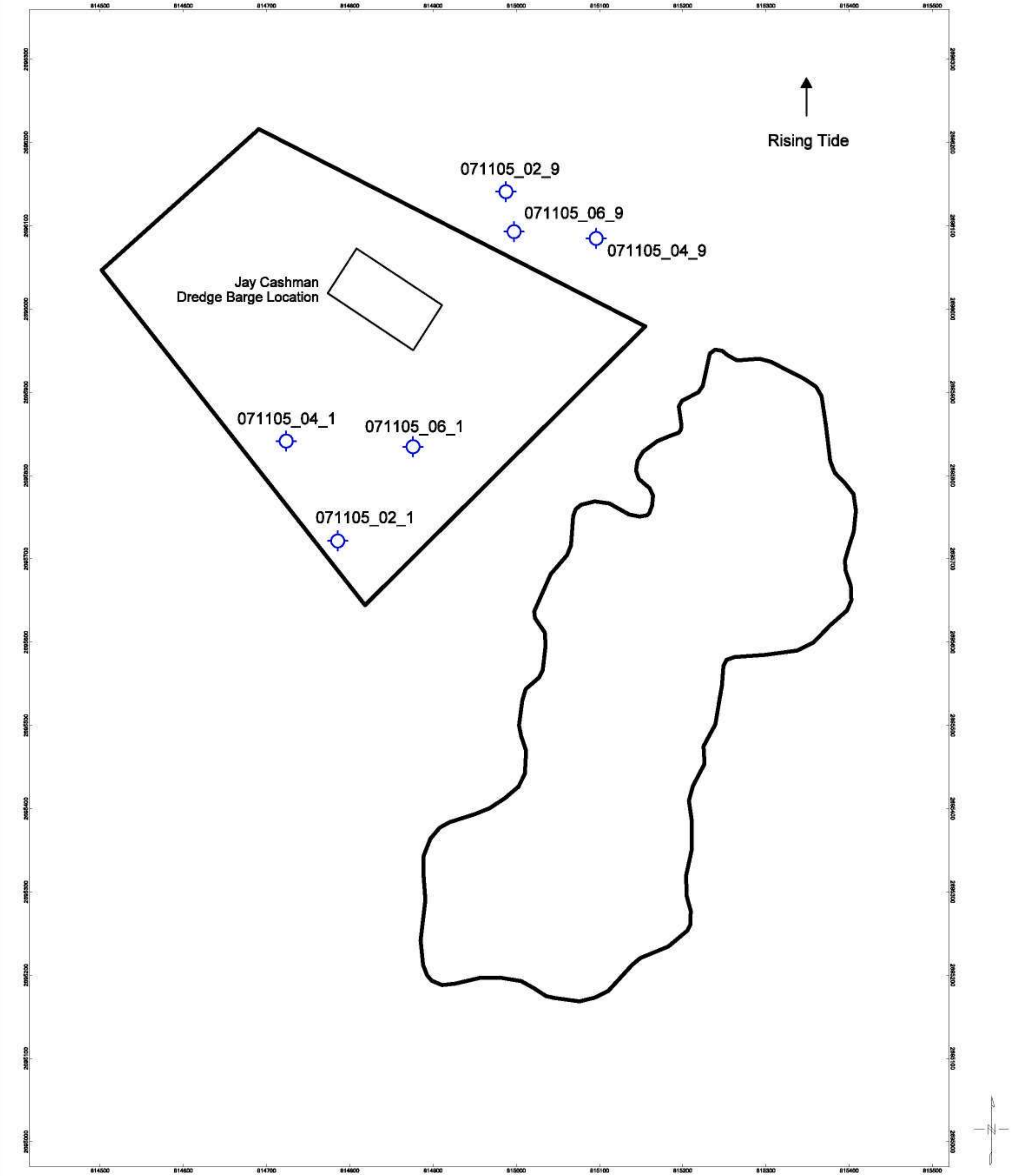
Water Quality Stations

Apex Environmental, Inc.

7/11/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 5:14				Current		(NTUs)	Increase (NTUs)		Traffic
Rising Tide	8:43	071105_02_1	814739.92	Up	5	4.8		Sunny, ~80 Degrees	None
		(Background)	2695456.99		10	4.8		NE Wind 5-10 knots	
					15	5.0			
					20	4.2			
					25	4.4			
					30	5.5			
					AVERAGE	4.8	24.8		
	8:53	071105_02_9	814987.43	Down	5	10.5		Sunny, ~80 Degrees	None
			2696141.02		10	15.0		NE Wind 5-10 knots	
					15	7.1			
					20	35.0			
					25	11.0			
					30	22.0			
					AVERAGE	16.8	8.0 NTUs		
	10:04	071105_04_1	814982.98	Up	5	2.6	Below Permissible	Sunny, ~80 Degrees	None
		(Background)	2695576.6		10	3.0	Turbidity Increase Limit	NE Wind 5-10 knots	
					15	3.0			
					20	2.4			
					25	1.6			
					30	1.8			
					AVERAGE	2.4	22.4		
	10:15	071105_04_9	815095.87	Down	5	5.7		Sunny, ~80 Degrees	None
			2696084.83		10	5.5		NE Wind 5-10 knots	
					15	4.8			
					20	5			
					25	8.5			
					AVERAGE	5.9	(16.5 Below Limit)		
	10:46	071105_06_1	815116.14	Up	5	2.3		Sunny, ~80 Degrees	None
		(Background)	2695747.5		10	3.0		NE Wind 5-10 knots	
					15	6.0			
					20	6.5			
					25	6.5			
					30	3.5			
					AVERAGE	4.6	24.6		
	10:54	071105_06_9	814997.22	Down	5	2.8		Sunny, ~80 Degrees	None
			2696092.99		10	4.3		NE Wind 5-10 knots	
					15	5			
					20	10			
High 12:04					AVERAGE	5.5	(19.1 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

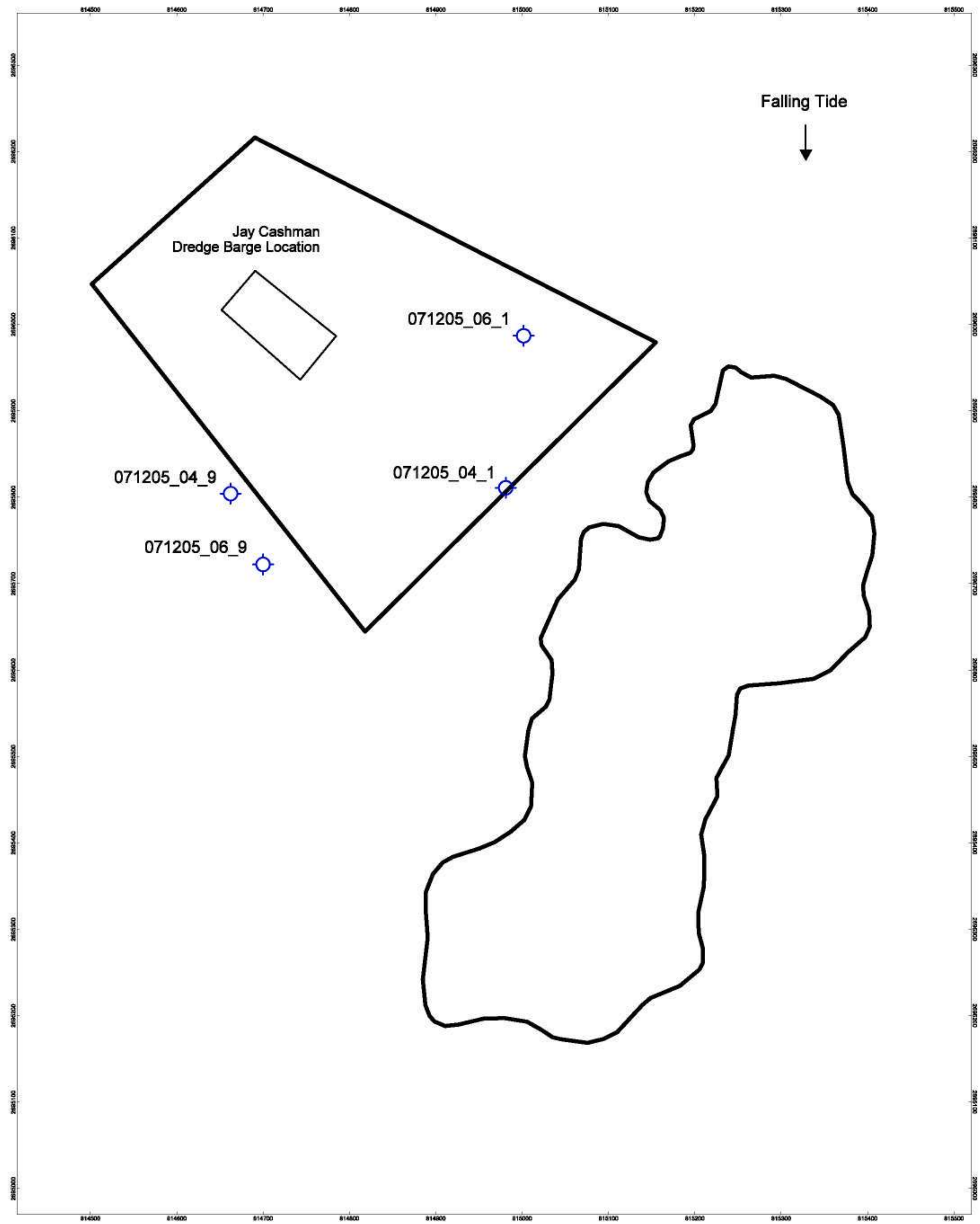


07/11/05 Dredge Operations Water Quality CAD Cell Area Water Quality Monitoring Locations
Water Quality Stations
Apex Environmental, Inc.

7/12/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
High 12:44				Current		(NTUs)	Increase (NTUs)		Traffic
Falling Tide	15:22	071205_04_1	814980..58	Up	5	1.8		Sunny, ~80 Degrees	None
		(Background)	2695810.92		10	1.9		NE Wind 5-10 knots	
					15	3.0			
					20	4.1			
					25	5.5			
					30	12.0			
					AVERAGE	**4.7**	**24.7**		
	15:30	071205_04_9	814662.38	Down	5	1.9		Sunny, ~80 Degrees	None
			2695804.14		10	2.6		NE Wind 5-10 knots	
					15	4.9			
					20	4.8			
					25	5.4			
					30	3.5			
					AVERAGE	**3.9**	20.8 NTUs		
	15:52	071205_06_1	815001.71	Up	5	2.0	Below Permissible	Sunny, ~80 Degrees	None
		(Background)	2695986.79		10	2.8	Turbidity Increase Limit	NE Wind 5-10 knots	
					15	2.1			
					20	3.0			
					25	11.0			
					30	13.5			
					AVERAGE	**5.7**	**25.7**		
	15:58	071205_06_9	814699.98	Down	5	2		Sunny, ~80 Degrees	None
			2695722.2		10	3.3		NE Wind 5-10 knots	
					15	5.5			
					20	2.6			
					25	6.2			
					30	6			
Low 17:47					**AVERAGE**	**4.3**	(21.4 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



Scale 1:600

US survey feet

07/12/05 Dredge Operations Water Quality
CAD Cell Area Water Quality Monitoring Locations

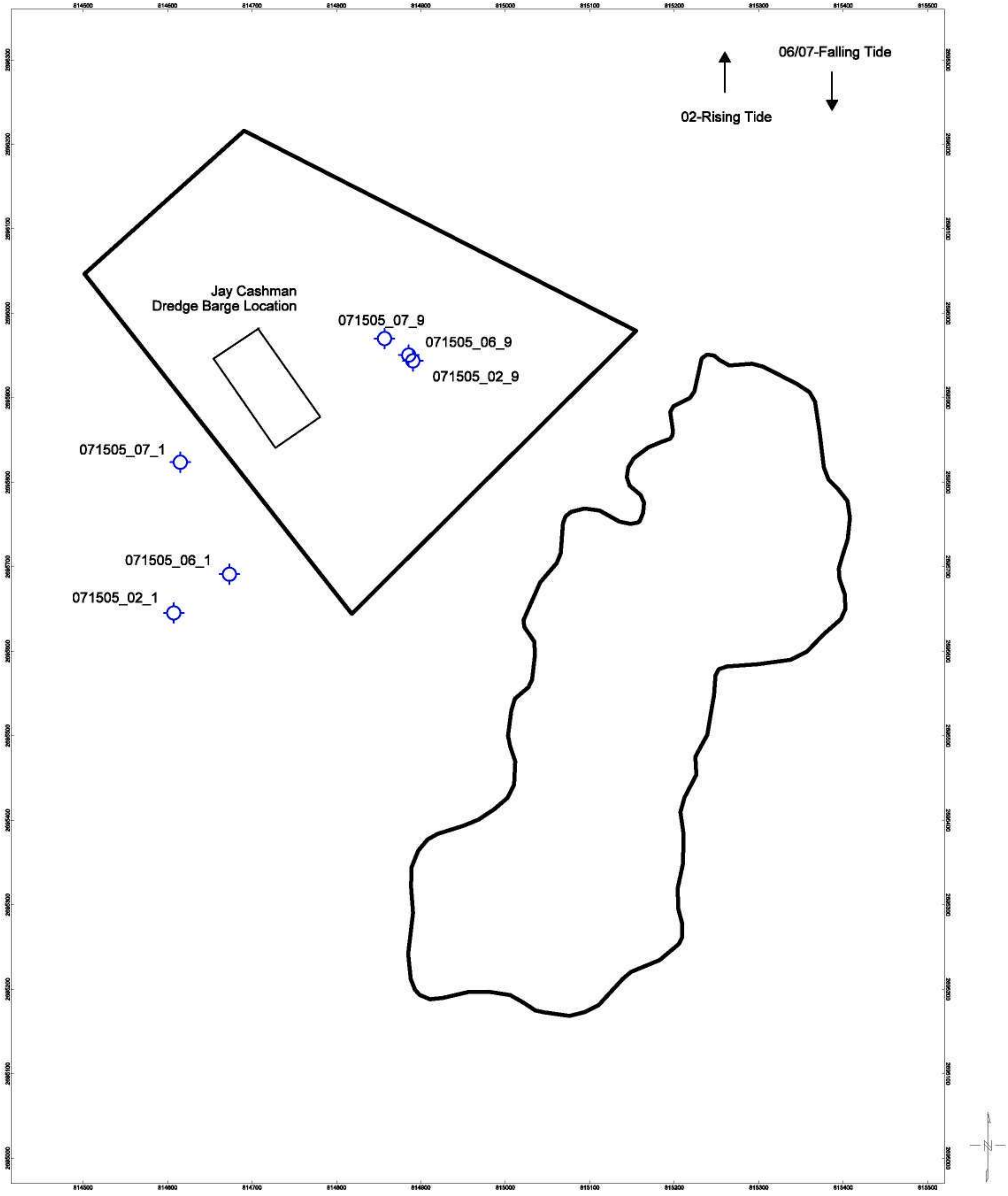
Water Quality Stations

Apex Environmental, Inc.

7/15/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 8:01				Current		(NTUs)	Increase (NTUs)		Traffic
Rising Tide	12:03	071505_02_1	814607.4	Up	5	2.5		Cloudy, ~80 Degrees	None
		(Background)	2695645.46		10	3.2		NE Wind 0-5 knots	
					15	3.2			
					20	3.0			
					25	2.0			
					30	3.5			
					AVERAGE	2.9	22.9		
	12:09	071505_02_9	814890.48	Down	5	3.0		Cloudy, ~80 Degrees	None
			2695943.76		10	2.3		NE Wind 0-5 knots	
					15	1.9			
					20	2.0			
					25	2.1			
					30	3.2			
High 15:08					AVERAGE	2.4	20.5 NTUs		
Falling Tide	17:18	071505_06_1	814673.28	Up	5	2.8	Below Permissible	Sunny, ~85 Degrees	None
		(Background)	2695691.25		10	3.6	Turbidity Increase Limit	NE Wind 0-5 knots	
					15	3.1			
					20	3.4			
					25	2.6			
					30	2.5			
					AVERAGE	3.0	23.0		
	17:23	071505_06_9	814885.59	Down	5	3.8		Sunny, ~85 Degrees	None
			2695950.67		10	6.3		NE Wind 0-5 knots	
					15	9.0			
					20	7.8			
					25	1.3			
					30	1.7			
					AVERAGE	5.0	(18.0 Below Limit)		
	17:33	071505_07_1	814615.08	Up	5	2.9		Sunny, ~85 Degrees	None
		(Background)	2695823.84		10	4.0		NE Wind 0-5 knots	
					15	4.2			
					20	4.6			
					25	5.0			
					30	3.8			
					AVERAGE	4.1	24.1		
	17:38	071505_07_9	814856.96	Down	5	4.8		Sunny, ~85 Degrees	None
			2695970.18		10	5.8		NE Wind 0-5 knots	
					15	6.4			
					20	11.0			
					25	10.0			
					30	14.0			
Low 21:18					AVERAGE	8.7	(15.4 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.

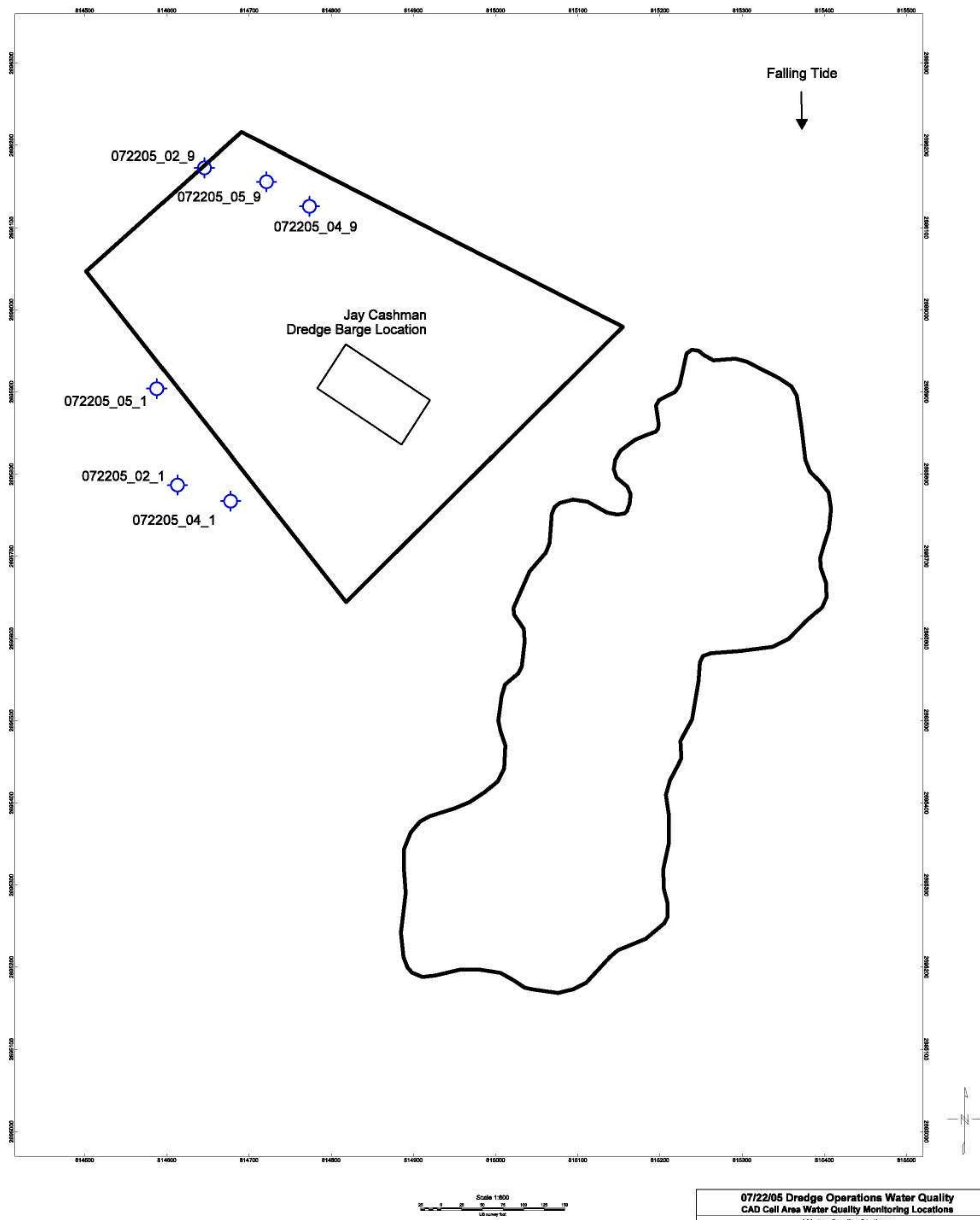


07/15/05 Dredge Operations Water Quality
CAD Cell Area Water Quality Monitoring Locations
Water Quality Stations
Apex Environmental, Inc.

7/22/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - CAD Cell Excavation Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
High 9:13				Current		(NTUs)	Increase (NTUs)		Traffic
Falling Tide	10:10	072205_02_1	814612.57	Up	5	0.2		Sunny, ~80 Degrees	None
		(Background)	2695786.89		10	2.4		SE Wind 5-10 knots	
					15	2.6			
					20	2.6			
					25	2.7			
					30	2.6			
					AVERAGE	2.2	22.2		
	10:17	072205_02_9	814645.5	Down	5	1.1		Sunny, ~80 Degrees	None
			2696172.85		10	1.4		SE Wind 5-10 knots	
					15	2.0			
					20	2.6			
					25	2.2			
					30	8.0			
					AVERAGE	2.9	19.3 NTUs		
	12:43	072205_04_1	814677.39	Up	5	2.6	Below Permissible	Sunny, ~80 Degrees	None
		(Background)	2695767.28		10	2.7	Turbidity Increase Limit	SE Wind 5-10 knots	
					15	2.6			
					20	2.8			
					25	3.4			
					30	5.0			
					AVERAGE	3.2	23.2		
	12:48	072205_04_9	814644.69	Down	5	5.2		Sunny, ~80 Degrees	None
			2696093.75		10	9.5		SE Wind 5-10 knots	
					15	11.0			
					20	12.0			
					25	19.0			
					30	17.0			
					AVERAGE	12.3	(10.9 Below Limit)		
	12:54	072205_05_1	814773.41	Up	5	2.8		Sunny, ~80 Degrees	None
		(Background)	2696126.03		10	2.9		SE Wind 5-10 knots	
					15	2.6			
					20	2.7			
					25	2.6			
					30	2.8			
					AVERAGE	2.7	22.7		
	12:57	072205_05_9	814808	Down	5	3.4		Sunny, ~80 Degrees	None
			2605789.33		10	4.7		SE Wind 5-10 knots	
					15	10.5			
					20	7.4			
					25	16.0			
					30	19.0			
Low 14:47					AVERAGE	10.2	(12.6 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/22/05 Dredge Operations Water Quality
CAD Cell Area Water Quality Monitoring Locations

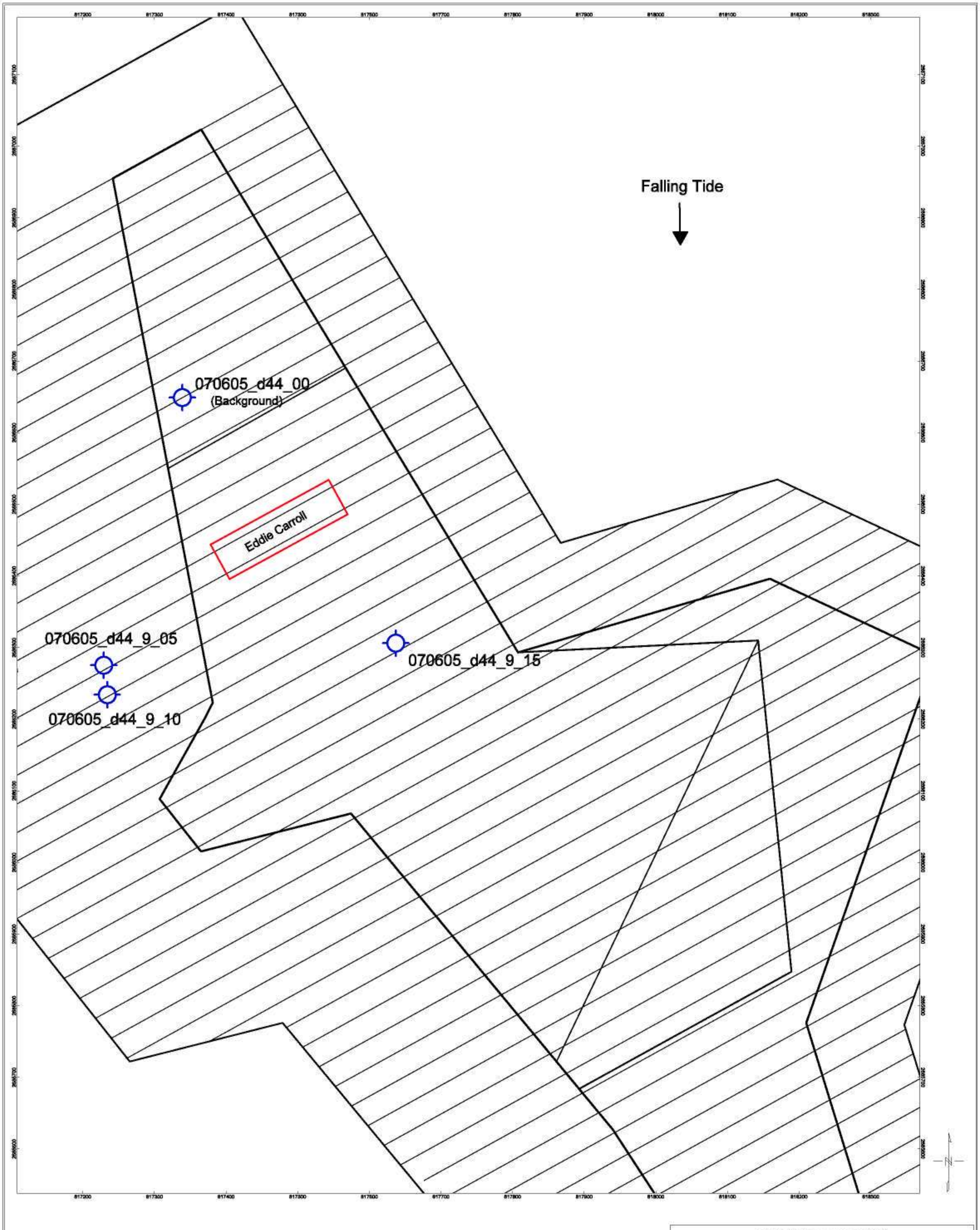
Water Quality Stations

Apex Environmental, Inc.

7/6/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
High 8:40				Current		(NTUs)	Increase (NTUs)		Traffic
Falling Tide	12:33	070605_d44_00	817338.98	Up	2	7.8		Cloudy, ~80 Degrees	None
		(Background)	2686649.09		4	9.5		S Wind 1-5 Knots	
					6	11.5			
					7	9.5			
					AVERAGE	9.6	49.6		
	12:55	PLACEMENT 44	STARTED						
	13:00	070605_d44_9_05	817229.27	Down	2	2.9		Cloudy, ~80 Degrees	None
			2686275.37		4	3.5		S Wind 1-5 Knots	
					6	3.1			
					8	2.8			
					AVERAGE	3.1	46.5 NTUs		
	13:06	070605_d44_9_10	817234.23	Down	2	13.0	Below Permissible	Cloudy, ~80 Degrees	None
			2686234.23		4	12.5	Turbidity Increase Limit	S Wind 1-5 Knots	
					6	10.5			
					8	16.3			
					AVERAGE	13.1	(36.5 Below Limit)		
	13:12	070605_d44_9_15	817636.99	Down	2	8.5		Cloudy, ~80 Degrees	None
			2686306.24		4	6.8		S Wind 1-5 Knots	
					6	7.5			
					8	10.0			
Low 13:40					AVERAGE	8.2	(41.4 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/06/05 Placement #44
OU#3 Area Water Quality Location Map

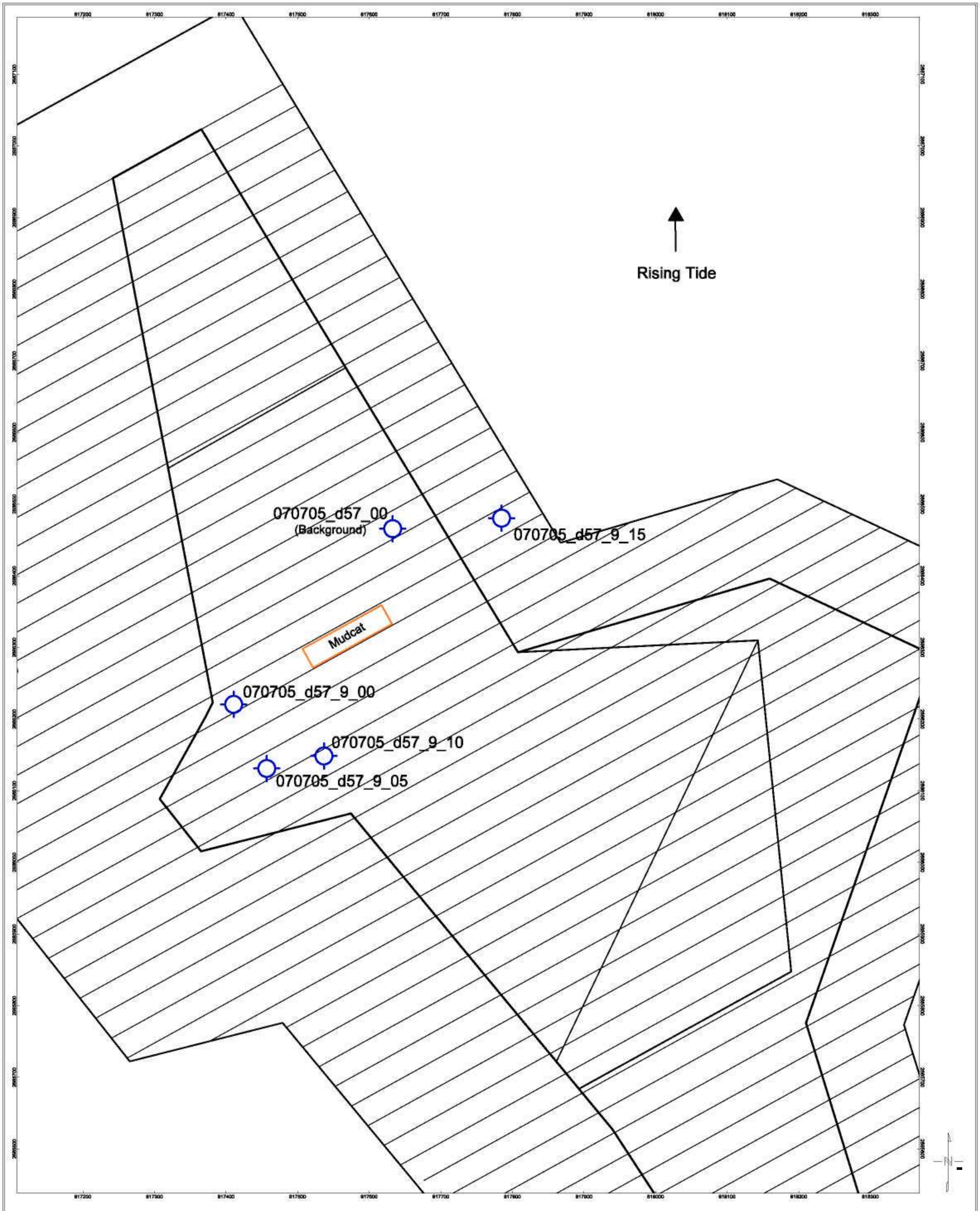
Water Quality Stations

Apex Environmental, Inc.

7/7/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 14:59				Current		(NTUs)	Increase (NTUs)		Traffic
Rising Tide	15:54	070705_d57_00	817632.68	Down	2	6.0		Cloudy, ~70 Degrees	None
		(Background)	2686465.82		4	7.0		N Wind 5-15 Knots	
					6	9.0			
					8	10.0			
					AVERAGE	8.0	48.0		
	15:59	PLACEMENT 57	STARTED						
	16:00	070705_d57_9_00	817410.56	Down	2	7.0		Cloudy, ~70 Degrees	None
			2686220.56		4	9.0		N Wind 5-15 Knots	
					6	13.0			
					8	16.5			
					AVERAGE	11.4	36.6 NTUs		
	16:05	070705_d57_9_05	817456.77	Up	2	11.0	Below Permissible	Cloudy, ~70 Degrees	None
			2686131.07		4	12.0	Turbidity Increase Limit	N Wind 5-15 Knots	
					6	12.0			
					8	18.0			
					AVERAGE	13.3	(34.7 Below Limit)		
	16:08	070705_d57_9_10	817536.68	Up	2	12.0		Cloudy, ~70 Degrees	None
			2686148.56		4	14.0		N Wind 5-15 Knots	
					6	16.0			
					8	17.0			
					AVERAGE	14.8	(33.2 Below Limit)		
	16:15	070705_d57_9_15	817784.8	Up	2	2.0		Cloudy, ~70 Degrees	None
			2686480.46		4	2.1		N Wind 5-15 Knots	
					6	2.2			
					8	2.8			
High 21:36					AVERAGE	2.3	(45.7 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/07/05 Placement #57
OU#3 Area Water Quality Location Map

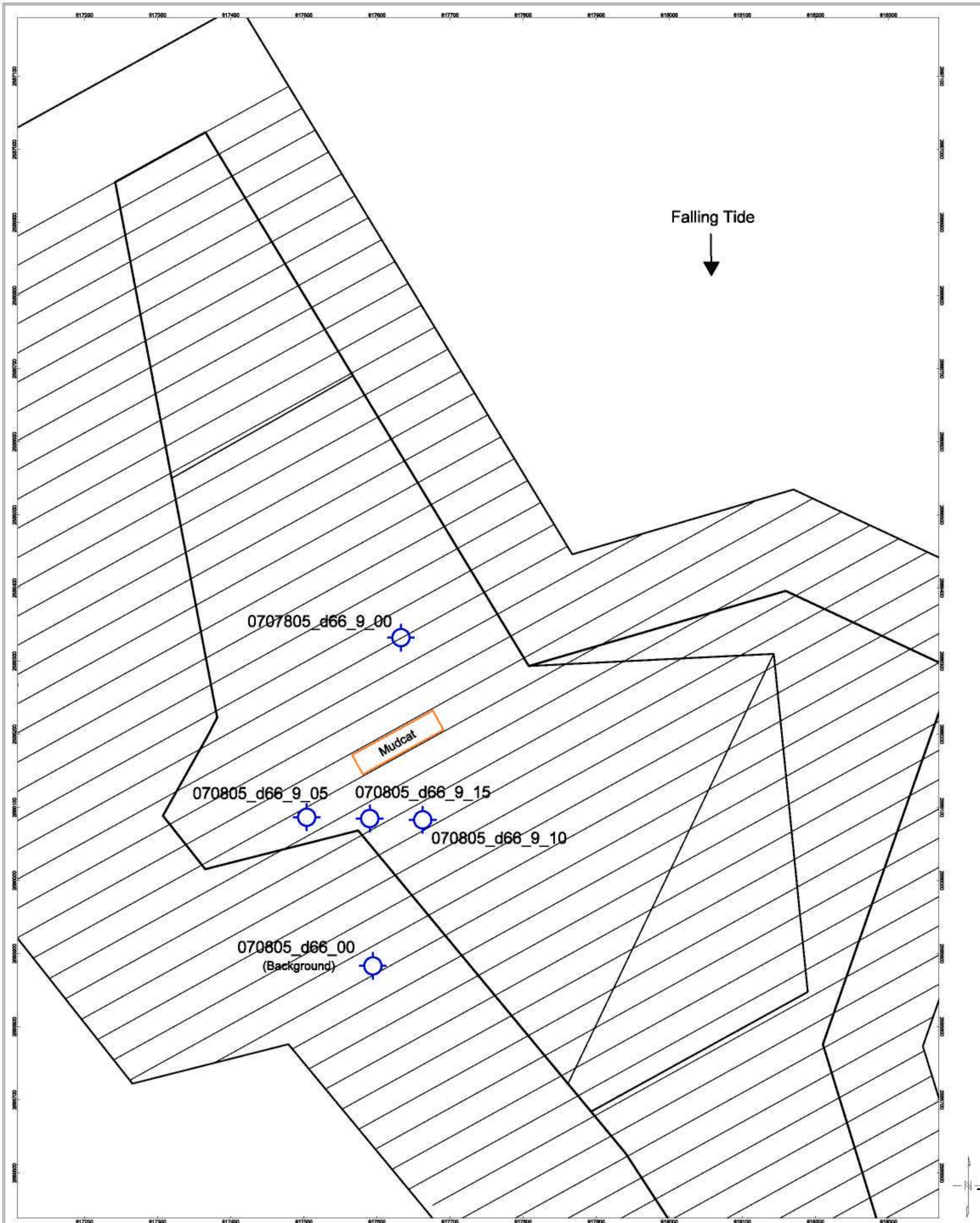
Water Quality Stations

Apex Environmental, Inc.

7/8/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
High10:02				Current		(NTUs)	Increase (NTUs)		Traffic
Falling Tide	9:33	070805_d66_00	817594.42	Down	2	4.0		Cloudy,~65 Degrees	None
		(Background)	2685883.24		4	4.2		E,SE Wind 5-10 Knots	
					6	4.5			
					8	4.5			
					10	4.4			
					AVERAGE	4.3	44.3		
	9:38	PLACEMENT 66	STARTED					Cloudy,~65 Degrees	
	9:39	0707805_d66_9_00	817632.84	Up	2	2.3		E,SE Wind 5-10 Knots	None
			2686332.16		4	2.6			
					6	2.6			
					8	2.7			
					10	2.5			
					AVERAGE	2.5	41.8 NTUs		
	9:44	070805_d66_9_05	817503.9	Down	2	5.0	Below Permissible	Cloudy,~65 Degrees	None
			2686086.51		4	4.4	Tubidity Increase Limit	E,SE Wind 5-10 Knots	
					6	5.0			
					8	4.5			
					AVERAGE	4.7	(37.1 Below Limit)		
	9:49	070805_d66_9_10	817662.58	Down	2	2.6		Cloudy,~65 Degrees	None
			2686082.98		4	2.4		E,SE Wind 5-10 Knots	
					6	2.9			
					8	2.7			
					10	2.7			
					AVERAGE	2.7	(34.4 Below Limit)		
	9:53	070805_d66_9_15	817590.14	Down	2	4.2		Cloudy,~65 Degrees	None
			2686084.76		4	4.4		E,SE Wind 5-10 Knots	
					6	4.5			
					8	4.7			
					10	4.6			
Low 15:13					AVERAGE	4.5	(29.9 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/08/05 Placement #66
OU#3 Area Water Quality Location Map

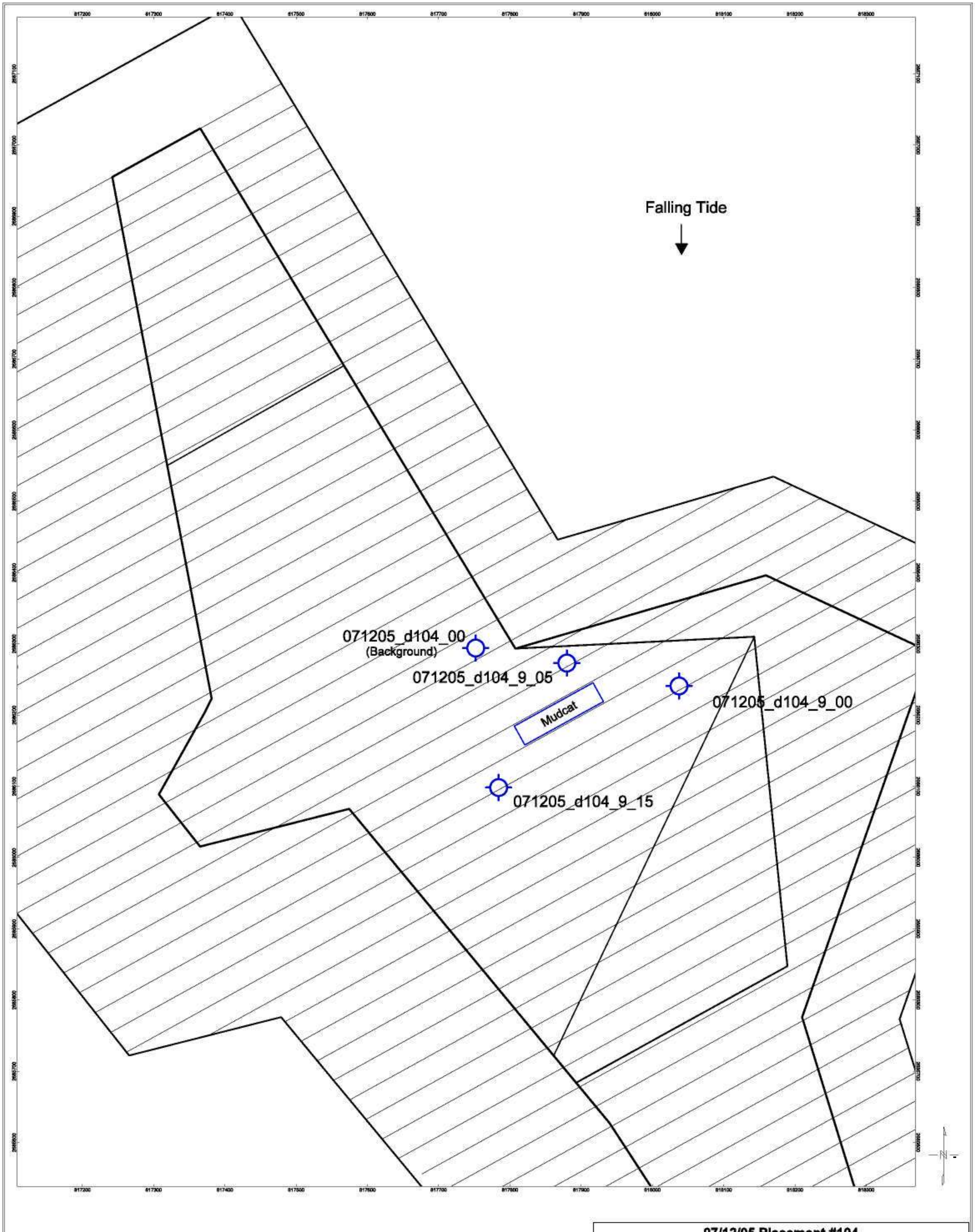
Water Quality Stations

Apex Environmental, Inc.

7/12/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
High 12:44				Current		(NTUs)	Increase (NTUs)		Traffic
Falling Tide	16:10	071205_d104_00	818012.77	Up	2	5.0		Cloudy,~65 Degrees	None
		(Background)	2696359.72		4	4.0		E,SE Wind 5-10 Knots	
					6	4.4			
					8	6.0			
					AVERAGE	**4.9**	**44.9**		
	16:15	**PLACEMENT 104**	**STARTED**					Cloudy,~65 Degrees	
	16:20	071205_d104_9_05	817879.82	Up	2	37.0		E,SE Wind 5-10 Knots	None
			2686272.97		4	36.0			
					6	34.0			
					8	40.0			
					AVERAGE	**36.8**	8.1 NTUs		
	16:25	071205_d104_9_10	817751.93	Down	2	12.0	Below Permissible	Cloudy,~65 Degrees	None
			2686294.06		4	11.8	Turbidity Increase Limit	E,SE Wind 5-10 Knots	
					6	18.0			
					8	4.0			
					AVERAGE	**11.5**	(33.4 Below Limit)		
	16:28	071205_d104_9_15	827729.61	Down	2	12.0		Cloudy,~65 Degrees	None
			2686205.92		4	14.0		E,SE Wind 5-10 Knots	
					6	20.0			
					8	19.5			
Low 17:22					**AVERAGE**	**16.4**	(28.5 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/12/05 Placement #104
OU#3 Area Water Quality Location Map

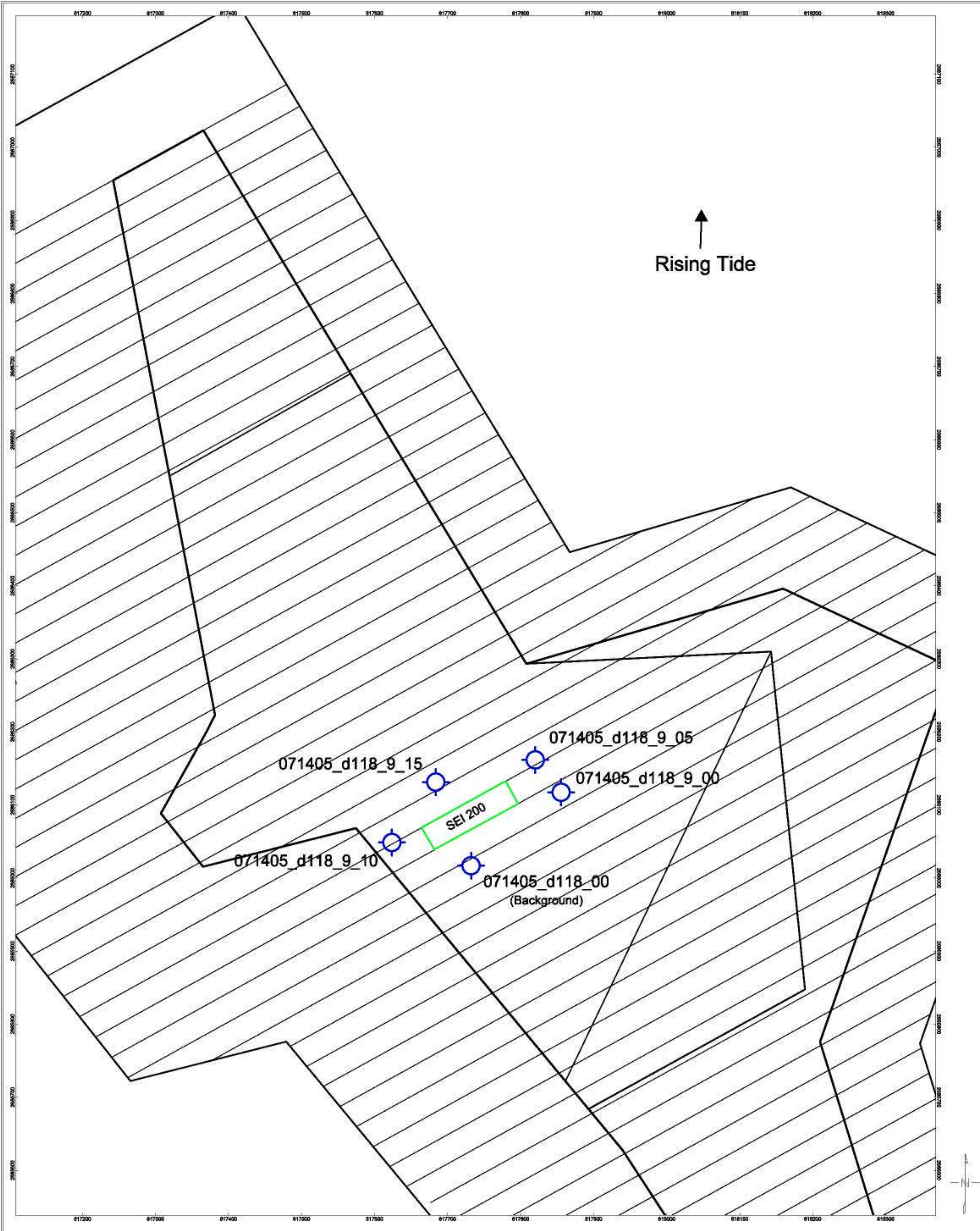
Water Quality Stations

Apex Environmental, Inc.

7/14/2005
New Bedford Harbor Dredge Project - Phase II
Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
Low 7:08				Current		(NTUs)	Increase (NTUs)		Traffic
Rising Tide	9:20	071405_d118_00	817819.92	Up	2	1.3		Cloudy,~75 Degrees	None
		(Background)	2686161.75		4	1.5		SW Wind 5-10 Knots	
					6	1.6			
					8	1.8			
					AVERAGE	1.6	41.6		
	9:42	PLACEMENT 118	STARTED					Cloudy,~75 Degrees	
	9:42	071405_d118_9_00	817855.33	Down	2	1.2		SW Wind 5-10 Knots	None
			2686117.46		4	2.5			
					6	4.2			
					8	5.0			
					AVERAGE	3.2	38.3 NTUs		
	9:46	071405_d118_9_05	817732.02	Down	2	1.4	Below Permissible	Cloudy,~75 Degrees	None
			2686016.99		4	2.5	Turbidity Increase Limit	SW Wind 5-10 Knots	
					6	2.2			
					8	2.1			
					AVERAGE	2.1	(39.5 Below Limit)		
	9:51	071405_d118_9_10	817692.5	Down	2	1.8		Cloudy,~75 Degrees	None
			2685808.39		4	2.5		SW Wind 5-10 Knots	
					6	2.2			
					8	10.0			
					AVERAGE	4.1	(37.4 Below Limit)		
	9:56	071405_d118_9_15	818008.59	Down	2	12.0		Cloudy,~75 Degrees	Yes
			2685744.23		4	14.0		SW Wind 5-10 Knots	
					6	10.0			
					8	11.0			
High 14:11					AVERAGE	11.8	(29.8 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/18/05 Placement #118
OU#3 Area Water Quality Location Map

Water Quality Stations

Apex Environmental, Inc.

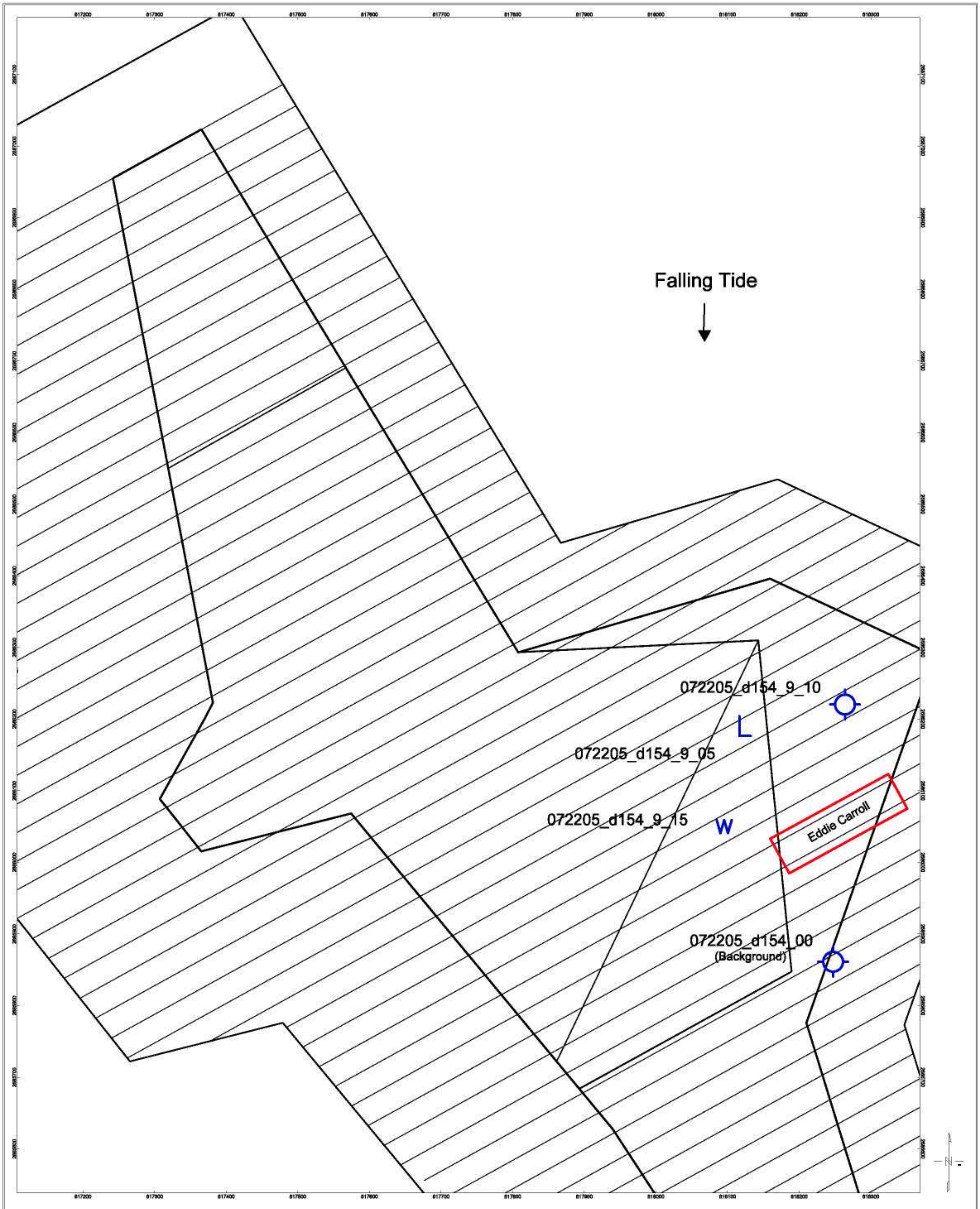
7/22/2005

New Bedford Harbor Dredge Project - Phase II

Water Quality Monitoring - Placement Operations - OU#3 Cap Area

Tide Time	Time	ID	Coordinates	Up/Down	Depth (ft.)	Ave. Turbidity	Permissible Turbidity	Weather Conditions	Vessel
High 9:13				Current		(NTUs)	Increase (NTUs)		Traffic
Falling Tide	11:23	071405_d154_00	818247.33	Down	2	1.2		Sunny,~80 Degrees	None
		(Background)	2685861.26		4	1.0		SE Wind 5-10 Knots	
					6	1.1			
					8	1.0			
					10	1.0			
					AVERAGE	1.1	41.1		
	12:00	PLACEMENT 154	STARTED					Sunny,~80 Degrees	
	12:03	071405_d154_9_05	818111.32	Up	2	14.0		SE Wind 5-10 Knots	Yes
			2686176.54		4	22.0			
					6	24.0			
					8	20.0			
					10	12.0			
					AVERAGE	18.4	22.7 NTUs		
	12:08	071405_d154_9_10	818263.87	Up	2	1.0	Below Permissible	Sunny,~80 Degrees	None
			2686220.39		4	1.5	Turbidity Increase Limit	SE Wind 5-10 Knots	
					6	1.2			
					8	3.9			
					10	5.0			
					12	13.0			
					AVERAGE	4.3	(36.8 Below Limit)		
	12:15	071405_d154_9_15	818080.84	Up	2	1.3		Sunny,~80 Degrees	None
			2686040.82		4	15.0		SE Wind 5-10 Knots	
					6	10.0			
					8	31.0			
					10	18.0			
					12	20.0			
Low 14:47					AVERAGE	15.9	(25.2 Below Limit)		

Notes: An X in the vessel traffic column indicates that either a vessel had passed or there was a movement of spuds that may have had an effect on turbidity.



07/22/05 Placement #154
OU#3 Area Water Quality Location Map

Water Quality Stations

Apex Environmental, Inc.

TABLE 7 - NEW BEDFORD HARBOR DREDGE - PHASE III

Water Quality Monitoring - Turbidity Measurements

June 12, 2008 -- August 25, 2009

Date	Time of Up Current	Average of Up Current	Time of Down Current	Average of Down Current	Difference (Down Current - Up Current)	Time of Disposal Location	Average of Disposal Location	Project Title	Project and/or Location
06/13/08	11:15	0.00	10:45	0.00	0.00	-	-	TOP of CAD II	TOP of CAD II
06/14/08	7:20	0.00	8:25	0.23	0.23	-	-	TOP of CAD II	TOP of CAD II
06/14/08	10:15	0.90	10:35	2.00	1.10	-	-	TOP of CAD II	TOP of CAD II
06/14/08	12:40	0.00	12:50	1.00	1.00	-	-	TOP of CAD II	TOP of CAD II
06/14/08	16:30	2.03	16:55	1.17	-0.87	-	-	TOP of CAD II	TOP of CAD II
06/16/08	16:45	14.63	16:30	0.00	-14.63	17:00	1.29	TOP of CAD II	CAD I (Disposal Only)
06/19/08	8:00	6.07	8:30	2.17	-3.90	-	-	TOP of CAD II	TOP of CAD II
06/19/08	12:00	23.43	12:30	4.23	-19.20	12:05	1.77	TOP of CAD II	CAD I (Disposal Only)
06/24/08	7:50	0.07	8:00	0.20	0.13	-	-	TOP of CAD II	TOP of CAD II
06/24/08	10:00	0.57	10:10	0.23	-0.33	-	-	TOP of CAD II	TOP of CAD II
06/26/08	10:05	1.67	10:10	0.47	-1.20	-	-	TOP of CAD II	TOP of CAD II
06/26/08	11:50	0.67	11:55	3.17	2.50	-	-	TOP of CAD II	TOP of CAD II
06/26/08	18:00	0.00	18:05	6.60	6.60	-	-	TOP of CAD II	TOP of CAD II
06/26/08	16:00	0.00	16:07	5.10	5.10	-	-	TOP of CAD II	TOP of CAD II
06/30/08	7:00	0.00	7:10	0.27	0.27	-	-	TOP of CAD II	TOP of CAD II
06/30/08	16:10	4.33	16:05	0.23	-4.10	-	-	TOP of CAD II	TOP of CAD II
06/30/08	14:25	2.87	14:20	2.73	-0.13	-	-	TOP of CAD II	TOP of CAD II
06/30/08	12:15	6.87	12:20	2.10	-4.77	-	-	TOP of CAD II	TOP of CAD II
06/30/08	10:00	0.63	10:04	1.70	1.07	-	-	TOP of CAD II	TOP of CAD II
07/03/08	15:40	4.17	15:55	6.13	1.97	-	-	TOP of CAD II	TOP of CAD II
07/03/08	13:30	5.50	13:35	4.93	-0.57	-	-	TOP of CAD II	TOP of CAD II
07/03/08	12:20	1.77	12:40	3.60	1.83	12:30	20.97	TOP of CAD II	CAD I (Disposal Only)
07/03/08	10:40	0.00	10:45	4.50	4.50	-	-	TOP of CAD II	TOP of CAD II
07/03/08	8:40	15.03	8:45	6.00	-9.03	-	-	TOP of CAD II	TOP of CAD II
07/03/08	6:46	0.83	6:55	0.97	0.13	6:50	6.77	TOP of CAD II	CAD I (Disposal Only)
07/08/08	12:00	0.30	12:10	1.53	1.23	12:25	7.17	TOP of CAD II	CAD I (Disposal Only)
07/08/08	10:05	14.33	10:23	7.60	-6.73	-	-	TOP of CAD II	TOP of CAD II
07/08/08	7:40	0.93	7:45	0.87	-0.07	-	-	TOP of CAD II	TOP of CAD II
07/08/08	7:05	3.10	7:25	2.10	-1.00	7:32	19.13	TOP of CAD II	CAD I (Disposal Only)
07/31/08	7:10	0.40	7:20	0.20	-0.20	-	-	Steamship	Steamship
07/31/08	9:10	8.86	9:25	0.10	-8.76	-	-	Steamship	Steamship
07/31/08	11:10	1.15	11:17	0.00	-1.15	-	-	Steamship	Steamship
07/31/08	14:18	0.30	14:25	5.26	4.96	-	-	Steamship	Steamship
07/31/08	16:45	2.43	16:35	0.43	-2.00	-	-	Steamship	Steamship
08/04/08	12:00	2.53	12:35	0.53	-2.00	12:25	-	Steamship	CAD I (Disposal Only)
08/05/08	7:40	0.26	7:50	0.00	-0.26	-	-	Steamship	Steamship
08/05/08	9:40	1.33	9:50	1.63	0.30	-	-	Steamship	Steamship

TABLE 7 - NEW BEDFORD HARBOR DREDGE - PHASE III

Water Quality Monitoring - Turbidity Measurements

June 12, 2008 -- August 25, 2009

Date	Time of Up Current	Average of Up Current	Time of Down Current	Average of Down Current	Difference (Down Current - Up Current)	Time of Disposal Location	Average of Disposal Location	Project Title	Project and/or Location
08/05/08	12:00	22.40	12:10	2.53	-19.87	-	-	Steamship	Steamship
08/05/08	14:05	1.17	14:20	16.20	15.03	-	-	Steamship	Steamship
08/05/08	16:46	2.53	16:55	0.66	-1.87	16:45	-	Steamship	CAD I (Disposal Only)
08/07/08	10:00	0.00	10:30	0.00	0.00	-	-	Steamship	Steamship
08/07/08	11:45	0.03	12:00	0.83	0.80	-	-	Steamship	Steamship
08/07/08	14:20	0.00	14:30	0.93	0.93	-	-	Steamship	Steamship
08/07/08	15:30	0.00	15:55	6.70	6.70	0.65	-	Steamship	CAD I (Disposal Only)
08/07/08	17:15	0.00	17:25	0.00	0.00	-	-	Steamship	Steamship
08/08/08	7:15	0.00	7:25	0.00	0.00	-	-	Steamship	Steamship
08/08/08	13:30	0.16	13:40	11.07	10.91	-	-	Steamship	Steamship
08/08/08	15:45	0.30	16:01	0.93	0.63		-	Steamship	Steamship
08/11/08	8:50	4.00	8:40	0.00	-4.00	-	-	Steamship	Steamship
08/11/08	16:30	1.23	16:50	2.00	0.77	-	-	Steamship	Steamship
08/12/08	11:20	0.00	11:30	1.40	1.40	-	-	Steamship	Steamship
08/12/08	13:40	0.00	13:30	2.93	2.93	-	-	Steamship	Steamship
08/12/08	15:30	0.00	15:40	4.26	4.26	-	-	Steamship	Steamship
08/18/08	8:30	0.00	8:40	0.96	0.96	-	-	Steamship	Steamship
08/18/08	10:30	8.53	10:44	0.00	-8.53			Steamship	Steamship
08/18/08	12:30	5.93	12:40	2.97	-2.96	-	-	Steamship	Steamship
08/18/08	15:28	5.90	15:32	2.70	-3.20			Steamship	Steamship
08/18/08	17:34	0.83	17:40	2.97	2.14		-	Steamship	Steamship
08/21/08	9:50	1.03	10:15	0.13	-0.90	-	-	Steamship	Steamship
08/21/08	12:45	3.90	12:50	0.00	-3.90	-	-	Steamship	Steamship
08/21/08	14:59	5.53	14:50	0.63	-4.90	-	-	Steamship	Steamship
08/21/08	17:22	5.60	17:26	0.83	-4.77	-	-	Steamship	Steamship
08/21/08	16:04	2.20	17:04	2.86	0.66	16:00	-	Steamship	CAD I (Disposal Only)
08/26/08	7:00	4.10	7:10	0.50	-3.60	-	-	Steamship	Steamship
08/26/08	8:55	0.30	9:02	18.47	18.17	-	-	Steamship	Steamship
08/26/08	11:05	4.97	11:15	5.43	0.46	-	-	Steamship	Steamship
08/26/08	13:00	2.77	13:12	9.73	6.96	-	-	Steamship	Steamship
08/28/08	7:30	3.77	7:40	3.37	-0.40	-	-	Steamship	Steamship
08/28/08	9:30	5.10	9:35	6.30	1.20	-	-	Steamship	Steamship
08/28/08	11:40	2.67	11:35	6.27	3.60	-	-	Steamship	Steamship
08/28/08	15:35	10.10	15:28	6.50	-3.60	-	-	Steamship	Steamship
08/28/08	8:50	24.10	8:57	9.63	-14.47	-	-	Steamship	Steamship
09/03/08	9:00	1.03	9:11	6.57	5.54	-	-	Steamship	Steamship
09/03/08	11:25	1.00	11:32	16.13	15.13	-	-	Steamship	Steamship

TABLE 7 - NEW BEDFORD HARBOR DREDGE - PHASE III

Water Quality Monitoring - Turbidity Measurements

June 12, 2008 -- August 25, 2009

Date	Time of Up Current	Average of Up Current	Time of Down Current	Average of Down Current	Difference (Down Current - Up Current)	Time of Disposal Location	Average of Disposal Location	Project Title	Project and/or Location
09/03/08	13:52	1.47	13:44	1.27	-0.20	-	-	Steamship	Steamship
08/27/08	13:47	2.83	13:40	8.57	5.74	N/A*2	N/A*2	BOC II	BOC II
08/27/08	15:42	2.10	15:35	4.23	2.13	N/A*2	N/A*2	BOC II	BOC II
08/27/08	17:30	2.23	17:42	3.16	0.93	N/A*2	N/A*2	BOC II	BOC II
08/28/08	8:00	1.90	8:10	1.53	-0.37	N/A*2	N/A*2	BOC II	BOC II
08/28/08	10:30	4.23	10:24	3.17	-1.06	N/A*2	N/A*2	BOC II	BOC II
08/28/08	12:22	3.73	12:27	2.23	-1.50	N/A*2	N/A*2	BOC II	BOC II
08/28/08	14:45	9.00	14:50	1.83	-7.17	N/A*2	N/A*2	BOC II	BOC II
08/28/08	16:40	1.60	16:50	4.13	2.53	N/A*2	N/A*2	BOC II	BOC II
09/03/08	8:10	3.33	8:05	19.23	15.90	N/A*2	N/A*2	BOC II	BOC II
09/03/08	10:54	4.10	11:02	1.93	-2.17	N/A*2	N/A*2	BOC II	BOC II
09/03/08	13:05	1.63	13:17	9.13	7.50	N/A*2	N/A*2	BOC II	BOC II
09/11/08	8:22	1.63	8:49	4.67	3.04	N/A*2	N/A*2	BOC II	BOC II
09/11/08	10:40	1.67	10:32	1.63	-0.04	N/A*2	N/A*2	BOC II	BOC II
09/11/08	13:00	1.30	13:05	1.73	0.43	N/A*2	N/A*2	BOC II	BOC II
09/11/08	16:42	2.33	17:00	3.80	1.47	N/A*2	N/A*2	BOC II	BOC II
09/16/08	9:50	1.50	10:00	2.37	0.87	N/A*2	N/A*2	BOC II	BOC II
09/16/08	11:50	3.50	11:56	1.67	-1.83	N/A*2	N/A*2	BOC II	BOC II
09/16/08	14:41	10.20	14:30	3.60	-6.60	N/A*2	N/A*2	BOC II	BOC II
09/16/08	16:20	5.33	16:16	4.73	-0.60	N/A*2	N/A*2	BOC II	BOC II
09/18/08	11:40	1.13	11:50	2.10	0.97	N/A*2	N/A*2	BOC II	BOC II
09/18/08	15:36	3.20	15:45	3.57	0.37	N/A*2	N/A*2	BOC II	BOC II
03/23/09	*1	1.45	*1	1.85	0.40	-	N/A*3	PH III PART B	NBRF
03/25/09	11:25	1.10	12:25	3.59	2.49	12:15	N/A*3	PH III PART B	NBRF (Disposal Only)
03/27/09	12:20	0.40	12:30	0.30	-0.10	12:14	N/A*3	PH III PART B	NBRF (Disposal Only)
04/05/09	11:40	1.55	13:00	1.73	0.18	11:55	N/A*3	PH III PART B	NBRF (Disposal Only)
04/08/09	13:20	2.94	13:35	2.43	-0.51	13:25	N/A*3	PH III PART B	NBRF (Disposal Only)
04/10/09	14:15	1.10	14:50	1.33	0.23	14:25	N/A*3	PH III PART B	NBRF (Disposal Only)
04/13/09	14:20	1.04	14:45	1.75	0.71	-	N/A*3	PH III PART B	NBRF
04/14/09	17:00	3.63	17:30	2.39	-1.24	17:15	N/A*3	PH III PART B	NBRF (Disposal Only)
04/21/09	10:14	2.21	11:00	5.05	2.84	10:50	N/A*3	PH III PART A	Gifford St.
04/22/09	8:15	1.70	8:28	4.07	2.37	8:20	N/A*3	PH III PART A	Gifford St.
04/22/09	13:50	1.60	14:10	2.17	0.57	-	N/A*3	PH III PART A	Gifford St.

TABLE 7 - NEW BEDFORD HARBOR DREDGE - PHASE III

Water Quality Monitoring - Turbidity Measurements

June 12, 2008 -- August 25, 2009

Date	Time of Up Current	Average of Up Current	Time of Down Current	Average of Down Current	Difference (Down Current - Up Current)	Time of Disposal Location	Average of Disposal Location	Project Title	Project and/or Location
04/23/09	* 1	1.83	* 1	2.00	0.17	7:35	N/A*3	PH III PART A	Gifford St., South Terminal
04/24/09	8:35	1.43	9:35	1.73	0.30	9:25	N/A*3	PH III PART A	CAD II (Disposal only)
04/26/09	12:25	0.85	13:05	1.37	0.52	12:45	N/A*3	PH III PART A	Gifford St., South Terminal
05/04/09	11:30	3.02	* 1	1.22	-1.80	11:45	N/A*3	PH III PART A	CAD II (Disposal only)
05/06/09	11:45	1.70	12:00	1.80	0.10	11:50	N/A*3	PH III PART A	CAD II (Disposal only)
05/06/09	16:45	2.50	16:58	14.30	11.80	-	N/A*3	PH III PART A	Gifford St.
05/07/09	15:00	13.00	15:20	2.73	-10.27	-	N/A*3	PH III PART A	South Terminal
05/13/09	13:30	1.37	13:50	1.47	0.10	13:36	N/A*3	PH III PART A	CAD II (Disposal only)
05/14/09	8:20	0.60	8:45	2.27	1.67	8:35	N/A*3	PH III PART A	CAD II (Disposal only)
05/16/09	12:30	2.09	13:25	0.61	-1.48	-	N/A*3	PH III PART A	Union Wharf
05/20/09	14:00	21.60	14:20	3.19	-18.41	-	N/A*3	PH III PART A	Gifford St.
05/22/09	8:00	0.81	8:15	0.29	-0.52	8:05	N/A*3	PH III PART A	CAD II (Disposal only)
05/28/09	10:13	1.09	10:25	1.85	0.76	-	N/A*3	PH III PART A	Linberg Marine
05/28/09	14:00	1.06	14:45	1.71	0.65	14:20	N/A*3	PH III PART A	CAD II (Disposal only)
06/04/09	14:35	1.60	14:52	3.53	1.93	-	N/A*3	PH III PART A	Linberg Marine
06/04/09	16:20	1.90	16:55	3.13	1.23	16:35	N/A*3	PH III PART A	CAD II (Disposal only)
06/06/09	14:05	1.47	14:30	3.76	2.29	-	N/A*3	PH III PART A	Linberg Marine
06/14/09	8:40	3.07	9:15	3.17	0.10	8:50	N/A*3	PH III PART A	CAD II (Disposal only)
06/17/09	15:25	2.99	15:40	4.05	1.06	-	N/A*3	PH III PART A	WA-S
06/18/09	8:30	0.87	9:00	1.30	0.43	8:45	N/A*3	PH III PART A	CAD II (Disposal only)
06/22/09	11:15	1.66	11:35	1.04	-0.62	-	N/A*3	PH III PART A	ONWF
06/24/09	10:10	4.54	10:25	0.46	-4.08	-	N/A*3	PH III PART A	Gifford St.
07/01/09	14:40	2.88	15:17	3.83	0.95	-	N/A*3	PH III PART A	Gifford St.
07/02/09	16:45	2.28	17:15	5.23	2.95	-	N/A*3	PH III PART A	Gifford St.
07/08/09	11:55	1.93	12:15	1.83	-0.10	-	N/A*3	PH III PART A	NL
07/08/09	14:33	3.60	14:40	18.00	14.40	14:35	N/A*3	PH III PART A	CAD II (Disposal only)
07/10/09	9:30	0.73	10:15	1.05	0.32	-	N/A*3	PH III PART A	Packer Marine

TABLE 7 - NEW BEDFORD HARBOR DREDGE - PHASE III									
Water Quality Monitoring - Turbidity Measurements									
June 12, 2008 -- August 25, 2009									
Date	**Time of Up Current**	**Average of Up Current**	**Time of Down Current**	**Average of Down Current**	**Difference (Down Current - Up Current)**	**Time of Disposal Location**	**Average of Disposal Location**	**Project Title**	**Project and/or Location**
07/15/09	13:58	1.97	14:05	5.57	3.60	-	N/A*3	PH III PART A	Gifford St.
07/17/09	13:48	2.13	14:05	1.59	-0.54	-	N/A*3	PH III PART A	WA-S
07/22/09	13:35	2.59	14:00	3.63	1.04	-	N/A*3	PH III PART A	South Terminal
07/23/09	15:30	4.22	15:40	2.70	-1.52	-	N/A*3	PH III PART A	South Terminal
07/28/09	8:55	4.62	9:10	4.35	-0.27	-	N/A*3	PH III PART A	South Terminal
08/12/09	13:40	2.90	14:10	4.51	1.61	-	N/A*3	PH III PART A	Gifford St.
08/13/09	17:48	1.90	18:05	2.60	0.70	-	N/A*3	PH III PART A	South Terminal
08/17/09	10:10	0.77	10:25	2.07	1.30	-	N/A*3	PH III PART A	Packer Marine
08/20/09	14:25	2.28	14:45	2.79	0.51	-	N/A*3	PH III PART A	Packer Marine
08/25/09	16:46	5.62	17:00	3.23	-2.39	-	N/A*3	PH III PART A	South Terminal

Comments:

- Denotes a non-disposal event

*1 Time field left blank on original field sheet/log-book

*2 Bottom of CAD disposal events were off shore and water quality montitoring was not completed

*3 PH III Part A and Part B Dredging were completed with a silt curtain around CAD II therefore no disposal location readings were taken (up-current and down-current measurements were taken outside the silt curtain.

DREDGED MATERIAL TRANSPORT MODELING ANALYSIS IN NEW BEDFORD HARBOR

ASA Project 01-100

Prepared for:

Massachusetts Coastal Zone Management Agency
251 Causeway Street, Suite 900
Boston, MA 02202

CZM

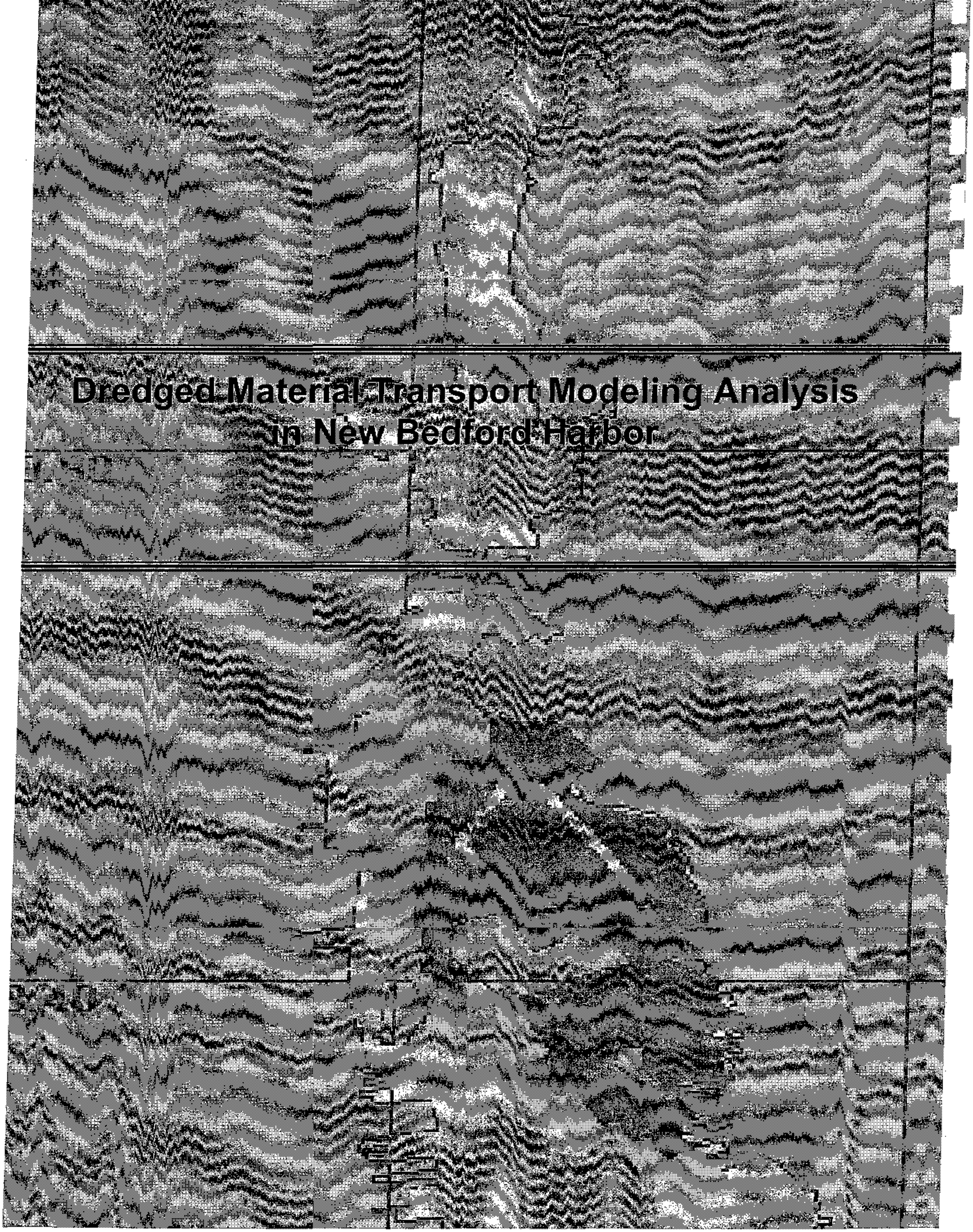
Submitted by:

Maguire Group Inc.

MAGUIRE GROUP

July 2003

Dredged Material Transport Modeling Analysis in New Bedford Harbor



Executive Summary

A series of computer simulations were performed to estimate the water quality from dredging and disposal operations at a proposed Confined Aquatic Disposal (CAD) site in the New Bedford Inner Harbor. The computer models BFHYDRO (Boundary Fitted Hydrodynamic model), SSFATE (Suspended Sediment FATE model), STFATE (Short-Term FATE dredged material disposal model) and BFMASS (Boundary Fitted Mass Transport model), were employed for hydrodynamic, dredging and disposal modeling, respectively.

This study consisted of two parts: 1, a field program to monitor present conditions and 2, extension of previous modeling that characterized the transport and fate of the dredged sediment and associated pollutants during disposal operations. Additional modeling of dredging operations was also conducted.

The physical field data that included surface elevations and velocities at multiple sites were examined to identify primary forces that drive the circulation in New Bedford Harbor, which was found to be winds and tides. Hydrodynamic simulations were conducted to verify the model performance during the period of the field measurement program. A set of simulations were then performed, based on the combination of three tidal ranges (neap, mean and spring) and three wind conditions (calm, southwesterly [SWS] and northwesterly [NWW]). These nine hydrodynamic conditions were used to provide three-dimensional velocity predictions to the pollutant and sediment transport model both before and after excavation of the CAD facility.

The SSFATE model was used to simulate TSS (Total Suspended Solids) concentrations due to excavation of the proposed CAD cells to be located north of Popes Island and disposal operations into the cells. Combinations of the wind-induced circulation and bathymetry were found to play a key role. When the sediment plumes were carried into the deeper sections of the Harbor, the duration and size of sediment cloud were more extensive than the case in which the sediment plumes were carried into shallower sections, where the sediment settled to the bottom more quickly.

A series of pollutant fate and transport simulations were performed to estimate the water quality impacts using BFMASS. Simulations were run using measured pollutant levels found at six representative sites for constituents whose elutriate concentrations exceeded the U. S. EPA water quality criteria. These included metals (aluminum, copper, nickel and silver), and polychlorinated biphenyls (PCBs). The dredged material disposal operation was assumed to last for 6 days with disposal taking place twice a day following the M_2 tidal cycle period of 12.42 hrs. Each release volume of dredged material was assumed to be 1,530 m^3 (2,000 yd^3), a typical barge capacity.

None of pollutant elutriate concentrations exceeded the U. S. EPA water quality acute criteria except copper (4.8 ug/L) at two stations. Al, Cu, Ni, Ag, and PCB exceed chronic levels. The dilution of elutriate concentration for PCB to meet the chronic criteria ranged between 11 and 767, Cu had the next highest required dilutions (1 to 32) followed by Al (2 to 27), Ag (14) and Ni (2). One proposed site, Station NBH-202, located at another proposed CAD site denoted

Channel Inner (CAD-CI), had the highest concentrations for all constituents. Station NBH-207, located north of Fish Island, was second highest.

The BFMASS simulation results indicated that the contaminant distribution patterns in the horizontal and vertical were similar for the three tide ranges. Concentration levels, however, were higher in the near field for neap tides than for spring tides because more energetic currents during the spring tides promote more dispersion and mixing. Different wind conditions resulted in different spatial distribution patterns and coverages. Among the nine environmental scenarios, the largest spatial coverage (area) was predicted for neap tides and calm wind conditions. The smallest coverage occurred for neap tides and northwesterly winds. This finding was consistent among three different release locations in the large PIN-CAD cell.

According to toxicity tests using sediments from the NBH-202 station sampled at CAD-CI, the combination of multiple pollutants was the cause of the observed acute toxicity effects. For example, half the toxicity to mysids was due to PCBs and the other half was due to a combination of copper and ammonia. From these results SAIC concluded a dilution to less than 2.2% of the elutriate concentration would be protective. The model results showed that for any environmental condition, area coverage for a concentration of 2.2% of the elutriate level was always smaller than the PIN-CAD area (1.67×10^5 m^2 [41 ac]). The largest area coverage (1.2×10^5 m^2 [30 ac]) of the 2.2% elutriate concentration occurred for a release during calm conditions while the smallest coverage (1.0×10^4 m^2 [2.5 ac]) occurred for a release during northwesterly winds. Other sediments with lower elutriate concentrations, and presumably lower toxicity, would affect smaller areas.

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1. Introduction

New Bedford Inner Harbor (Figure 1.1) is morphologically complex due to two contractions at the Coggeshall St. and I-95 bridges in the upper estuary and it is semi-enclosed by the Hurricane Barrier at its southern end, connecting to the Outer Harbor with a 46 m (150 ft) wide opening. The hydrodynamics are hence complicated, exhibiting circulation governed by both winds and tides. Winds in the area are distinct by season, northwesterly in winter and southwesterly in summer. The currents in the Inner Harbor are dominated by semi-diurnal tides, on the order of 10 cm/s (0.2 kt). A small tributary at the north end of the Inner Harbor is the Acushnet River. Its annual average flow is 0.54 m^3/s (19.1 ft^3/s) (Abdelrhman and Dettmann, 1995). This discharge is too small to play a role in flushing of disposed materials.

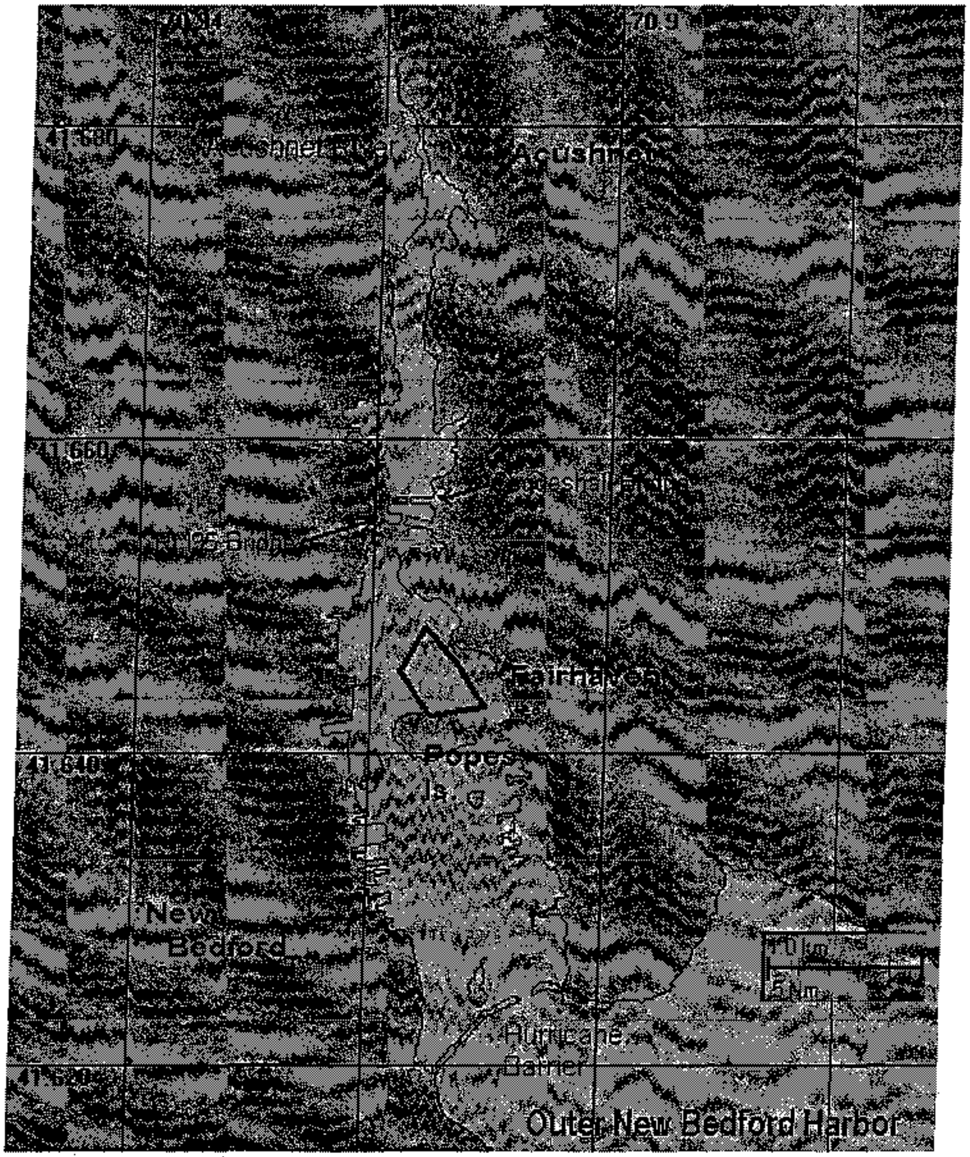


Figure 1-1. New Bedford Inner Harbor.

Applied Science Associates, Inc. (ASA)'s work reported here is part of the final draft environmental impact report for the navigation and operational dredging and disposal in Inner New Bedford Harbor, supported by Massachusetts Coastal Zone Management, and is an extension of the preliminary modeling conducted previously (ASA, 2001) to evaluate Confined Aquatic Disposal (CAD) sites at Popes Island and Channel Inner. This present work included modeling of dredging operations and the fate and transport of dredged material in the Inner Harbor. A two-phase approach was taken; first, a field program to determine present conditions and second, extension of the preliminary modeling to characterize transport and fate of the dredged sediment and associated pollutants during disposal operations.

The main purpose of field observations was to support the calibration of the hydrodynamic, sediment and pollutant transport models. Tide and current data were collected for use in the hydrodynamic calibration, sediment physical samples were obtained for use in the dredging modeling, and elutriate concentrations of sediment contaminants were collected to determine source strengths for the fate and transport modeling. Details of the field observations are presented in section 2.

The modeling phase was composed of three parts: 1. hydrodynamic modeling, 2. dredging operation modeling, and 3. fate and transport modeling of disposed material. Models employed for the individual tasks were ASA's BFHYDRO (Boundary Fitted Hydrodynamic model), SSFATE (Suspended Sediment Fate model), and BFMASS (Boundary Fitted Mass Transport Model). A 3-D BFHYDRO application was used to simulate the vertical structure of horizontal currents. SSFATE was employed to estimate the fate of material released during dredging operations. BFMASS was used to model dissolved fractions of pollutants (metals and PCBs) found in the sediments to be dredged so that comparison of predicted concentrations to water quality criteria could be made. Details of modeling work are documented in sections 3 through 5.

During the course of the study, the dredging modeling was focused on the construction of the Popes Island CAD site and disposal of dredged material into it. There are two types of dredging (and therefore disposal) projects planned in New Bedford Harbor that are classified by dredging volume: 1) small projects run by private, state or local government where dredging volume is on the order of 30,600 m^3 (40,000 yd^3) per project; and 2) a large project by the federal government to dredge substantially more than 30,600 m^3 (40,000 yd^3). Since the large scale dredging operations in the navigation channel are thus far not defined, the next largest dredging operation is the excavation of the CAD cells. The CAD site north of Popes Island is composed of one large and five small cells, with potential storage capacities of 1,408,000 m^3 (1,841,000 yd^3) and 36,800 m^3 (48,100 yd^3), respectively.

2. Field Program and Data

Data considered here derive from a field survey conducted by Science Applications International Corporation (SAIC) in New Bedford Harbor from 23 October through 22 November 2002. Current speed and direction, surface elevation and optical backscatter were measured continuously throughout the study period at two locations in New Bedford Harbor: the Popes Island and Channel Inner stations (Figure 2-1; Table 2-1). This was accomplished through the deployment of Acoustic Doppler Current Profilers (ADCPs) and Acoustic Doppler Current

Meters (ADCMs) at each of these two locations. Surface elevation and optical backscatter were also monitored at the Tide Gauge station, located outside of New Bedford Harbor, using a tide gauge and an Optical Backscatter Sensor (OBS). In addition to the long term instrument deployments, a series of water samples were taken at each of the three stations mentioned above to measure suspended sediment concentrations. A set of surface grab samples were obtained from eleven locations within the study area and analyzed to provide sediment grain size composition. Finally, elutriate analyses were performed on sediment samples from three locations at the proposed Channel Inner CAD site, two locations at the proposed Popes Island CAD site, and one location northwest of Fish Island in the Inner Harbor to determine levels for a number of pollutants.

Table 2-1. Location of stations from field survey.

Station Name	Latitude (°N)	Longitude (°W)	Data Types
Channel Inner	41.6315	70.9134	elevation, currents, OBS
Tide Gauge	41.6232	70.9037	elevation, OBS
Popes Island	41.6447	70.9138	elevation, currents, OBS
NBH-201 (CAD-CI)	41.6305	70.9114	elutriate
NBH-202 (CAD-CI)	41.6320	70.9152	elutriate
NBH-204 (CAD-CI)	41.6430	70.9106	elutriate
NBH-205 (CAD-PI)	41.6462	70.9146	elutriate
NBH-206 (CAD-PI)	41.6447	70.9151	elutriate
NBH-207 (Fish I)	41.6402	70.9210	elutriate

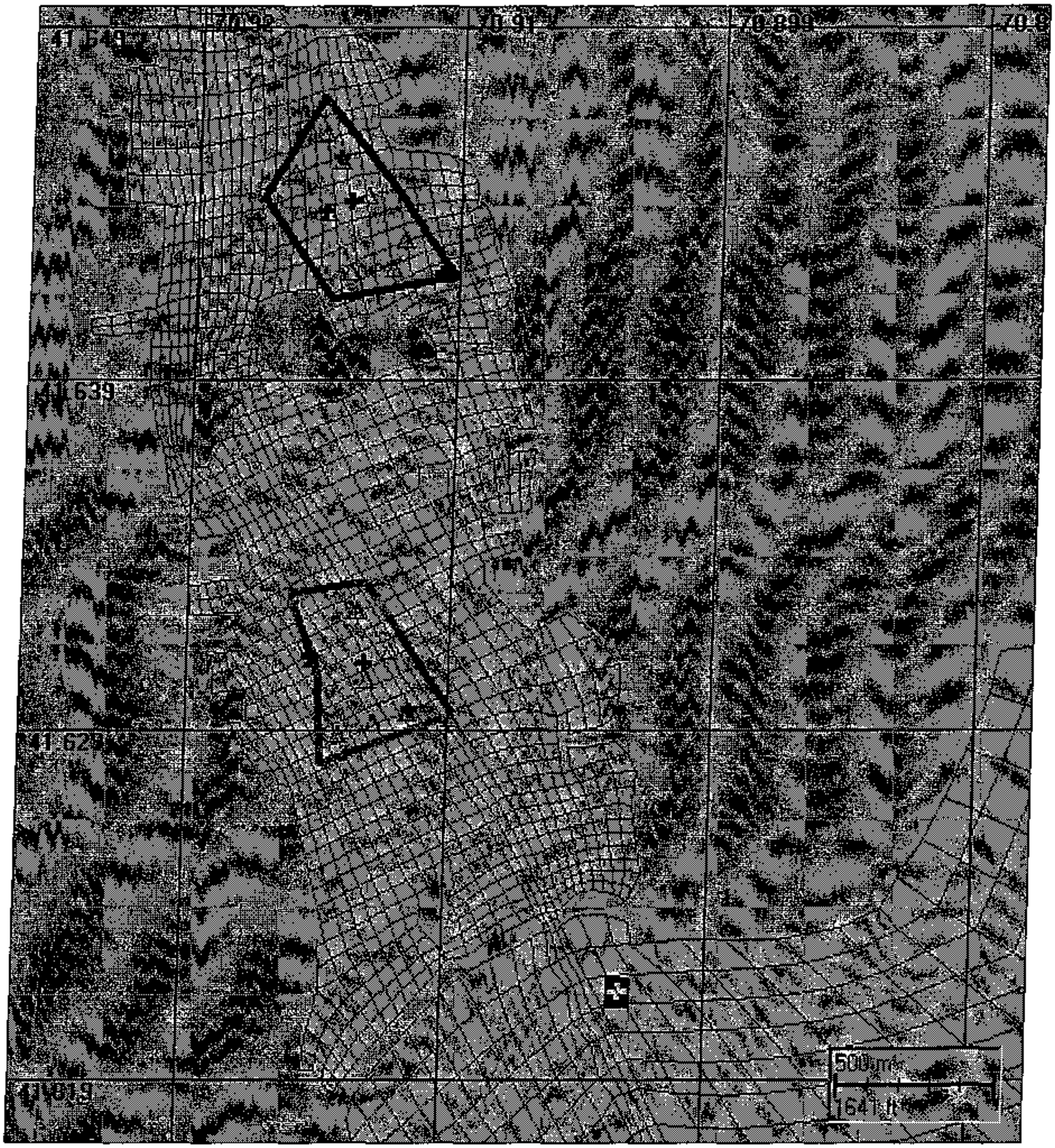


Figure 2-1. Distribution of two long term deployment stations (black crosses), eleven sediment sampling sites (blue triangles), and six elutriate analyses locations (red crosses). Popes Island (blue polygon) and Channel Inner (green polygon) CAD sites are also shown. *Grid of model cells shown is explained in Section 3.*

2.1 Tides

Variations in sea surface elevation were measured at three stations within the study area. For convenience, these time series are shown relative to mean sea level (Figure 2-2). Pressure gauges on the ADCMs deployed at the Popes Island and Channel Inner stations recorded total pressure from the water column and atmosphere at 15 minute intervals. These data were corrected for atmospheric pressure and then demeaned to give variations relative to mean sea level shown in the figure. Sea surface elevation was measured outside of New Bedford Harbor at the Tide Gauge station. A tide gauge was used to record total pressure due to atmospheric pressure and water column height at 15 minute intervals. As with the ADCMs, these data were corrected for atmospheric pressure and demeaned to give variations relative to mean sea level.

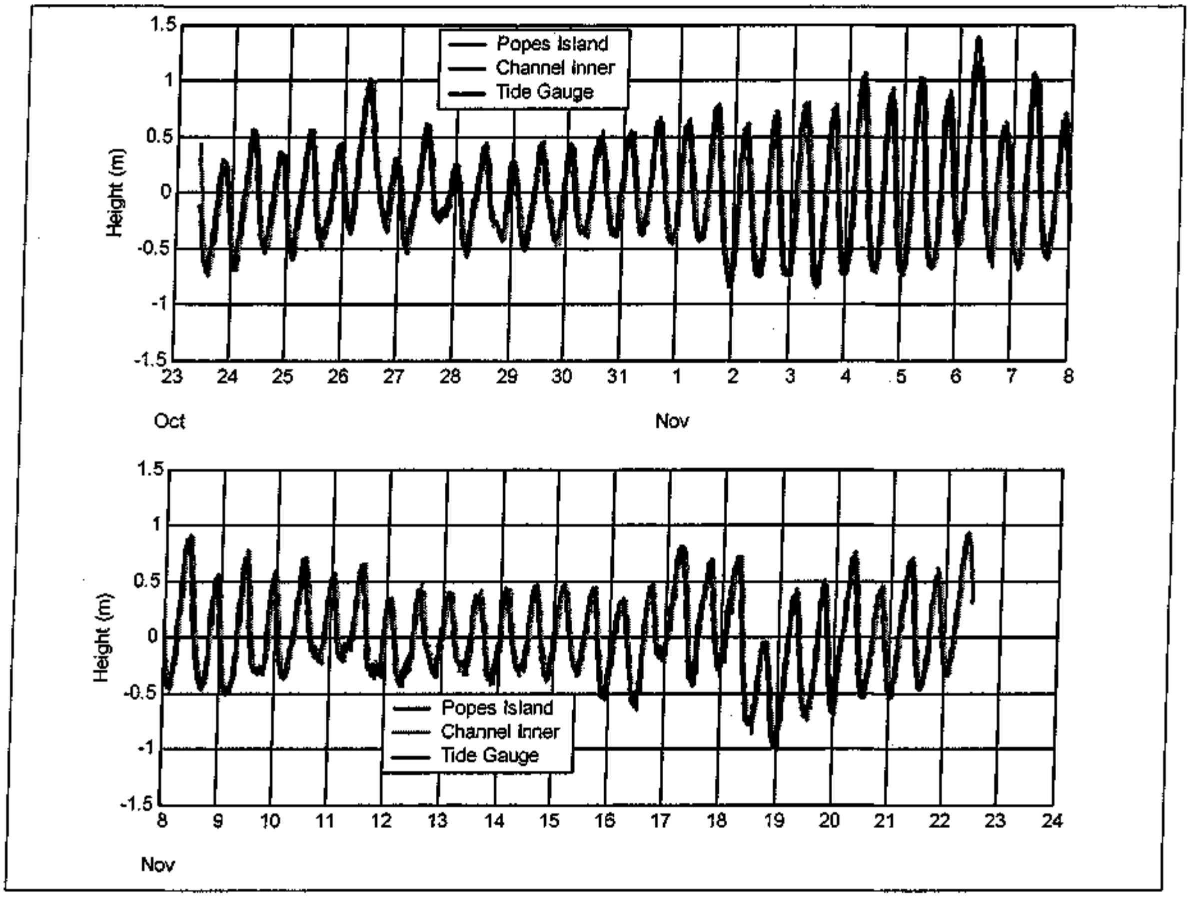


Figure 2-2. Sea surface height relative to mean sea level measured at the Popes Island (blue), Channel Inner (red) and Tide Gauge (black) stations during the study period.

The sea surface height record was dominated by the semi-diurnal tidal signal, which has a period of 12.42 hr and an amplitude of approximately 1 m (3.3 ft) at this location. Periodic low frequency deviations from a simple semi-diurnal signal are due to the spring–neap cycle, while brief excursions from this smooth envelope (e.g., 17-19 November) most likely reflect storm events. The records at all three stations are very strongly correlated, with the signal showing little lag or attenuation between stations.

2.2 Currents

Horizontal currents were measured throughout the water column at the Popes Island and Channel Inner stations using ADCPs from RD Instruments. A 1200 kHz instrument was used at the Popes Island site, with a bin size of 0.25 m (0.8 ft), while a 600 kHz instrument, with a bin size of 0.50 m (1.6 ft), was used in the deeper waters at the Channel Inner site. The ADCPs recorded velocities at 15 minute intervals. The resulting data was subsequently low-pass filtered using a 5-hr window. To better resolve currents near the bottom, an Aquadopp ADCM was deployed in conjunction with each ADCP. Positioned approximately 0.6 m (2 ft) above the seafloor, or about one third of the distance to the first bin of ADCP data, the ADCMs recorded velocities at the bottom of the water column at 15 minute intervals. These data were low pass filtered with a 5-hr window.

The net flow of water at a given location can be estimated by considering the average current velocity over the entire depth of the water column. Depth-averaged currents at the Popes Island site were predominantly to the southeast during the study period, though periods of flow to the north did occur during flood tides (Figure 2-3). Depth-averaged currents had a mean speed of 2.3 cm/s (0.08 ft/s) to southeast, with a maximum value 15.0 cm/s (0.49 ft/s) during this period.

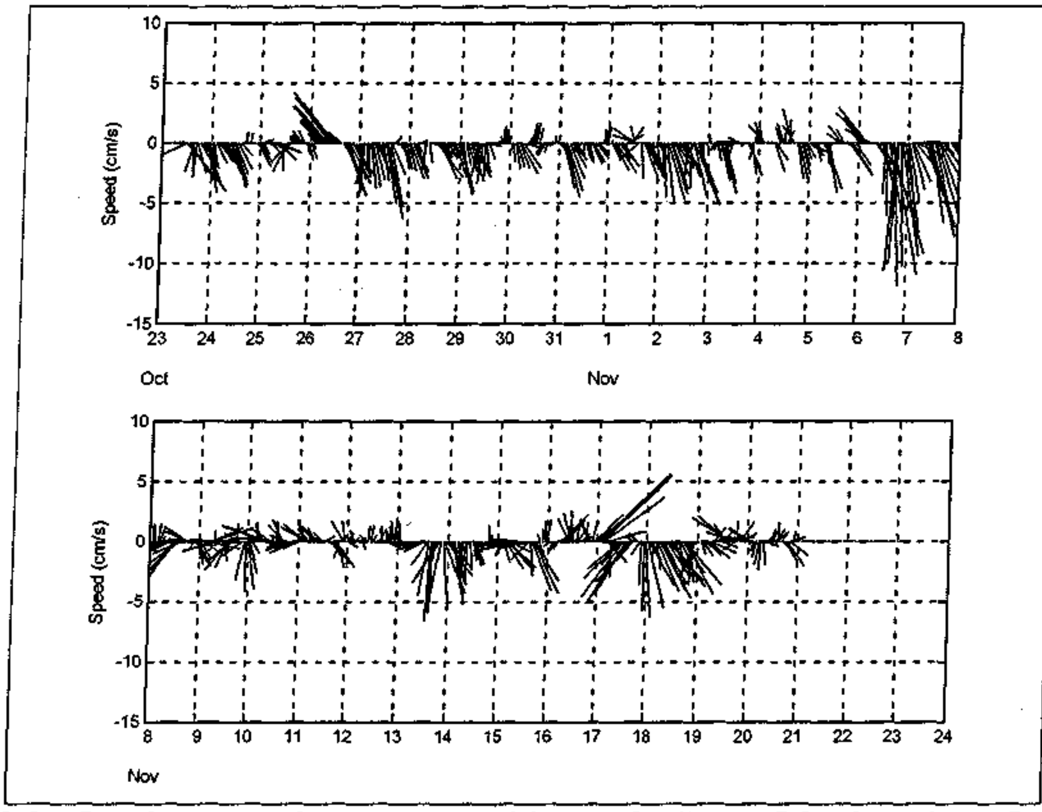


Figure 2-3. Depth averaged current velocities at the Popes Island station. Individual vectors point in the direction the current is moving to (e.g., a vertical line pointing upwards indicates flow from south to north). The length of each vector is proportional to the current speed. The data have been subsampled at hourly intervals for clarity.

Currents at the Popes Island site exhibited little vertical structure during the study period as shown by the vertical bands of color shown in Figures 2-4 and 2-5. The relatively shallow water precluded large variations in currents over the water column. Maximum velocities over the period reached approximately 5 cm/s (0.16 ft/s) to the east, 7 cm/s (0.23 ft/s) to the west, 5 cm/s (0.16 ft/s) to the north and 10 cm/s (0.33 ft/s) to the south.

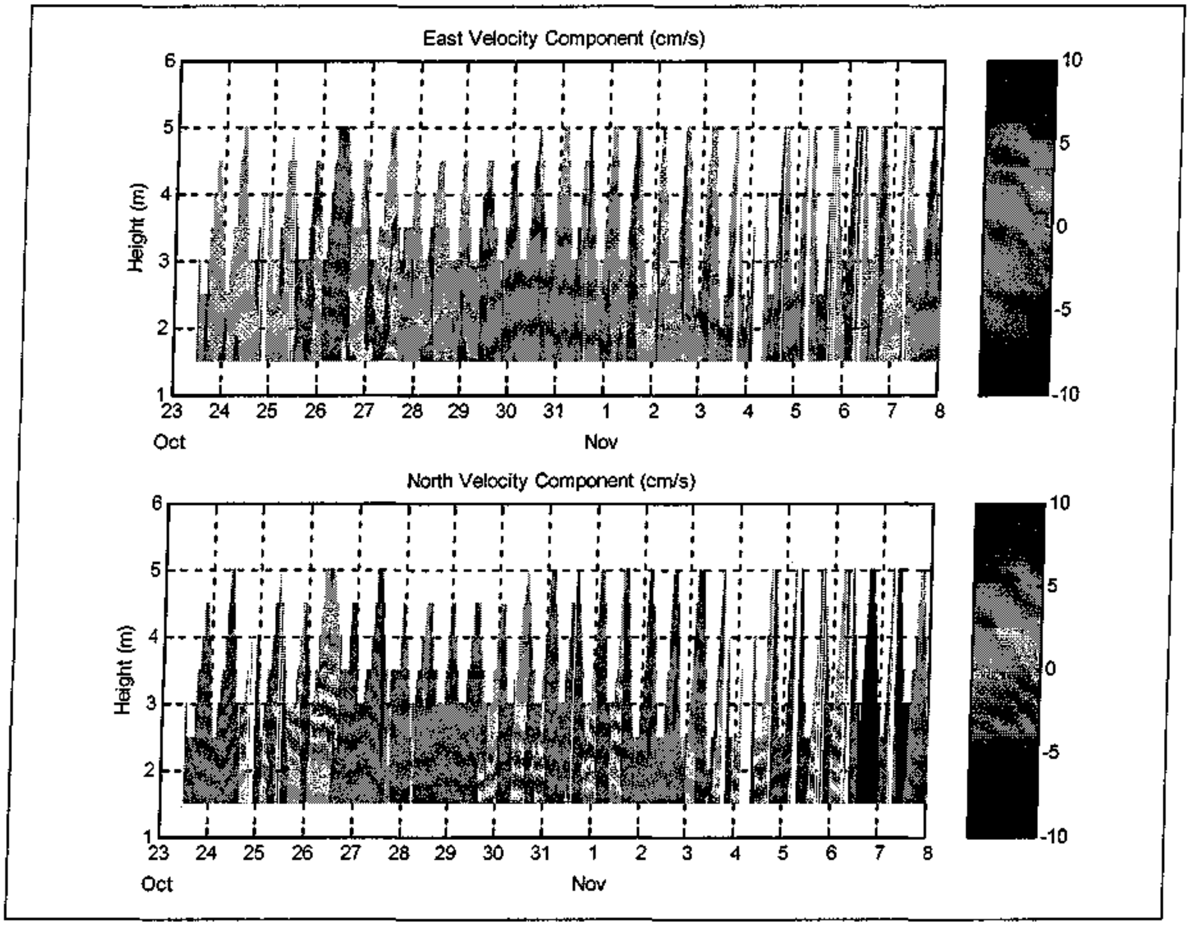


Figure 2-4. Vertical structure of east (top) and north (bottom) components of current velocity at the Popes Island station for the period from 23 October through 8 November 2002.

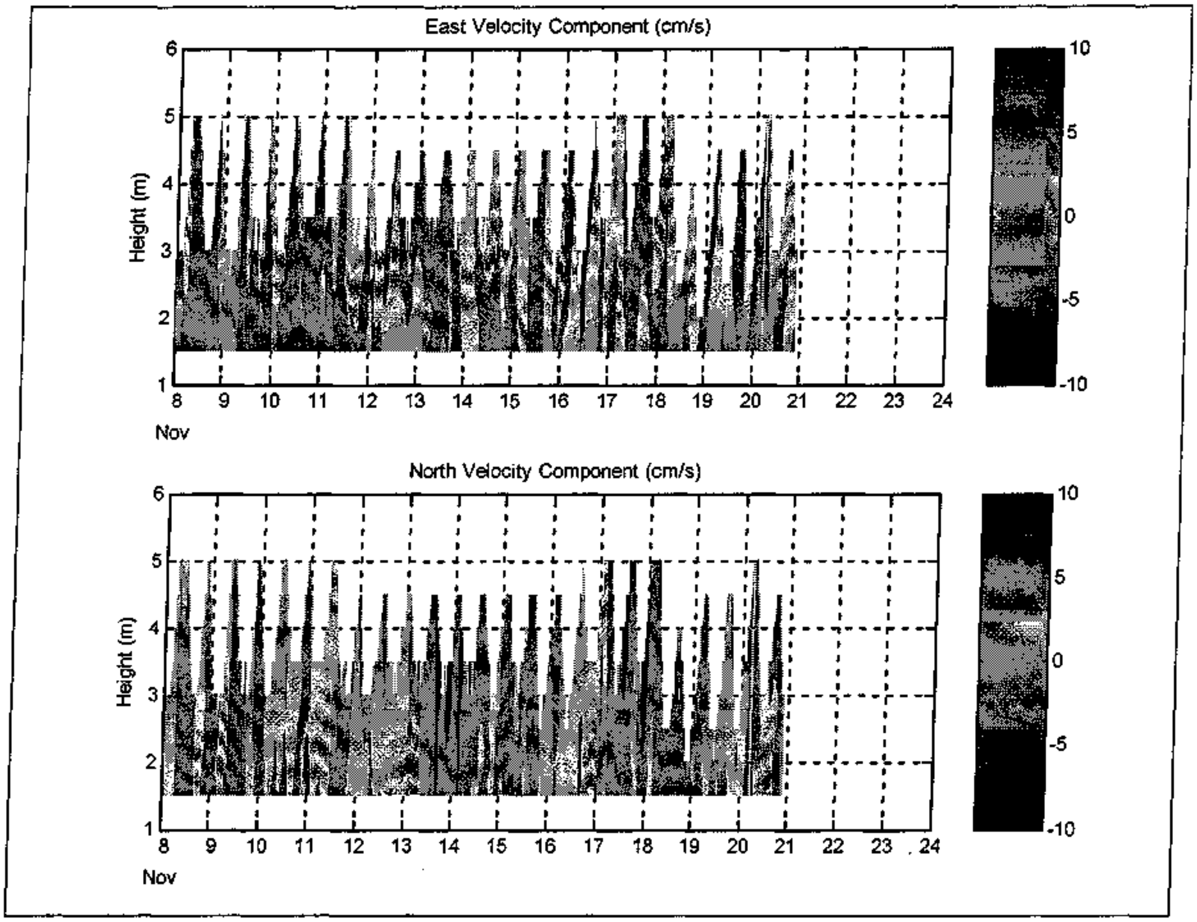


Figure 2-5. Vertical structure of east (top) and north (bottom) components of current velocity at the Popes Island station for the period from 8–24 November 2002.

Currents near the bottom of the water column at Popes Island differed little from those observed in the rest of the water column. A comparison of the currents observed by the ADCM to the deepest currents observed by the ADCP reveals only small differences (Figures 2-6 and 2-7). The average current speed recorded by the ADCM during this period was 2.2 cm/s (0.072 ft/s), with a maximum value of 8.3 cm/s (0.27 ft/s). The average speed for the deepest current measured by the ADCP was 2.3 cm/s (0.75 ft/s), while the maximum was 10.4 cm/s (0.34 ft/s).

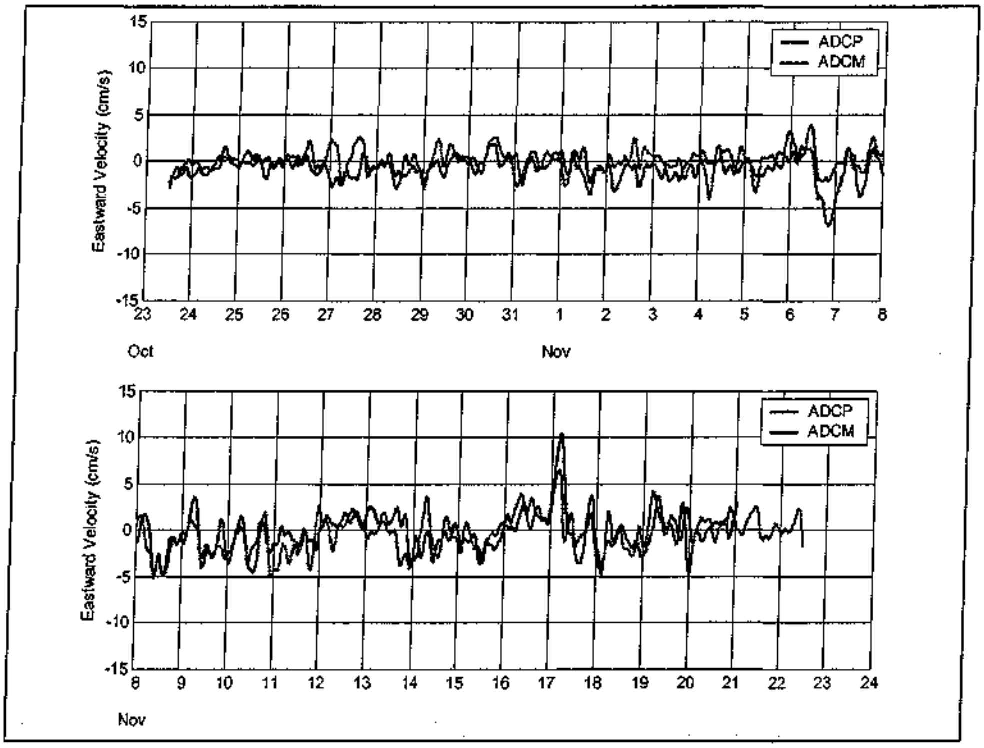


Figure 2-6. A comparison of the eastward component of near bottom current velocity as measured by the ADCP (blue) and the ADCM (red) at the Popes Island station.

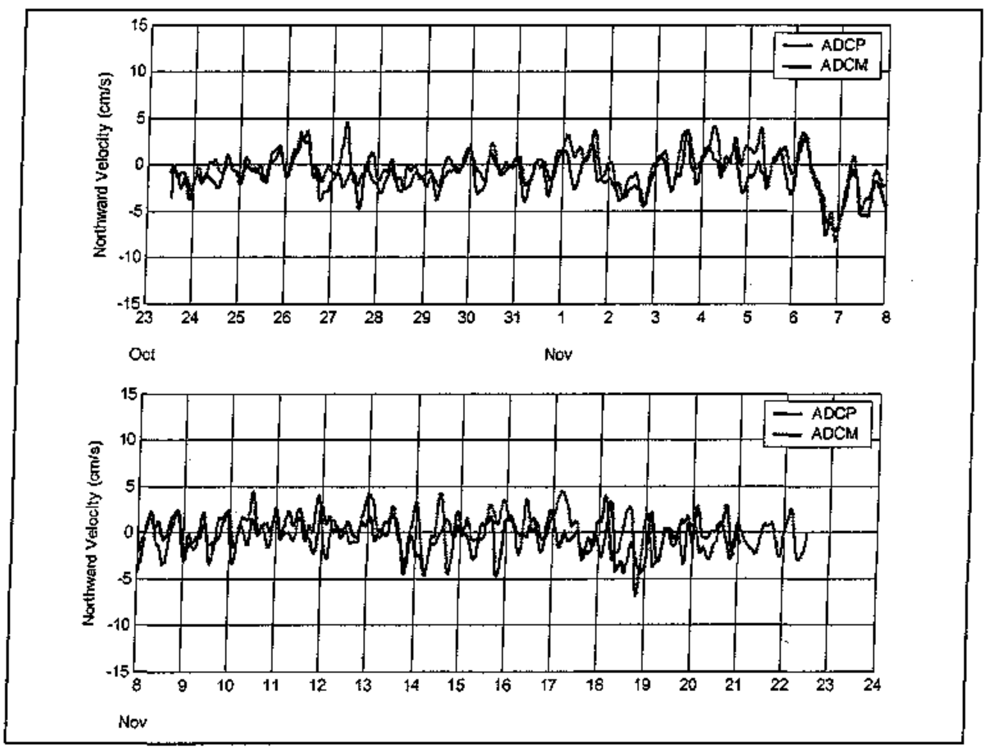


Figure 2-7. A comparison of the northward component of near bottom current velocity as measured by the ADCP (blue) and the ADCM (red) at the Popes Island station.

At the Channel Inner site, depth-averaged currents showed a regular variation in response to the tides (Figure 2-8). Flow to the south during ebb tide appeared slightly stronger and more sustained than the northward flow observed during flood tide. Depth-averaged currents averaged 4.0 cm/s (0.13 ft/s), with a maximum value 16.3 cm/s (0.53 ft/s) during the study period.

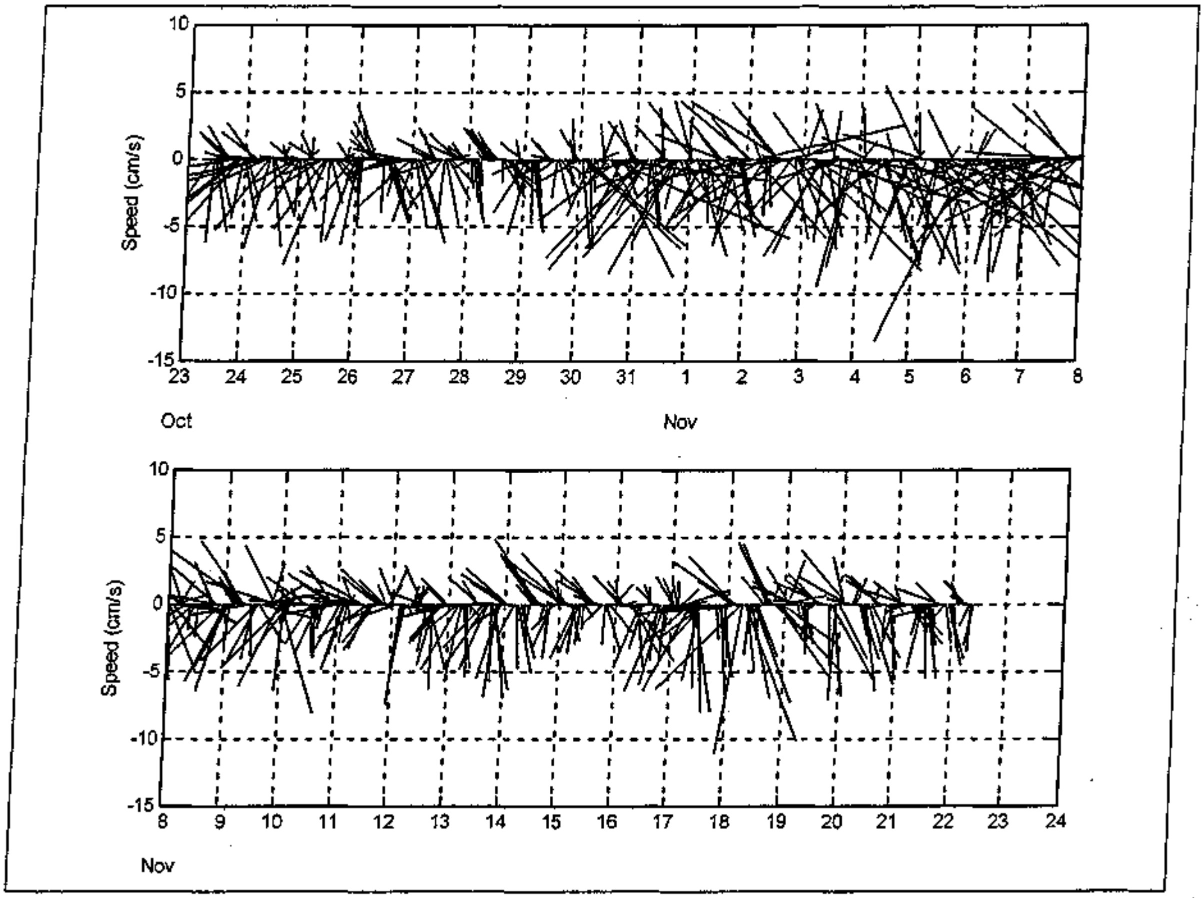


Figure 2-8. Depth averaged current velocities at the Channel Inner station. Individual vectors point in the direction the current is moving to (e.g., a vertical line pointing upwards indicates flow from south to north). The length of each vector is proportional to the current speed. The data have been subsampled at hourly intervals for clarity.

Horizontal currents at the Channel Inner site exhibited substantial vertical structure over the course of the study period (Figures 2-9 and 2-10). This is particularly evident in the north velocity component. At the surface, flow tends toward the south, particularly during ebb tide, while at the same time flow at depth is predominantly toward the north.

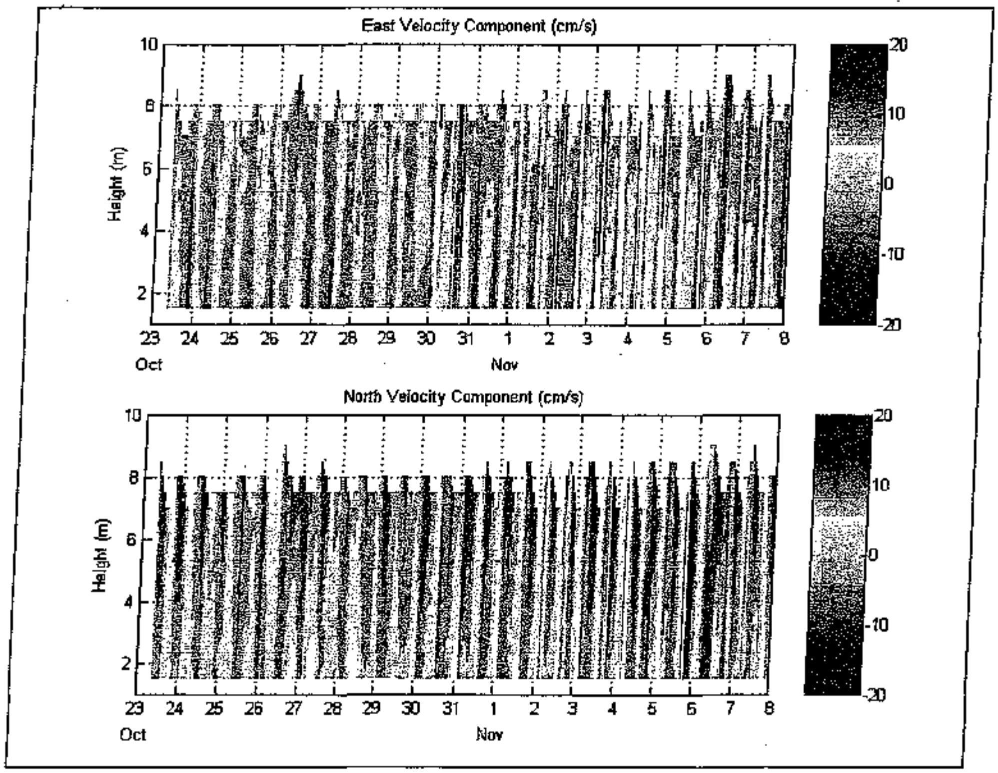


Figure 2-9. Vertical structure of east (top) and north (bottom) components of current velocity at the Channel Inner station for the period from 23 October through 8 November 2002

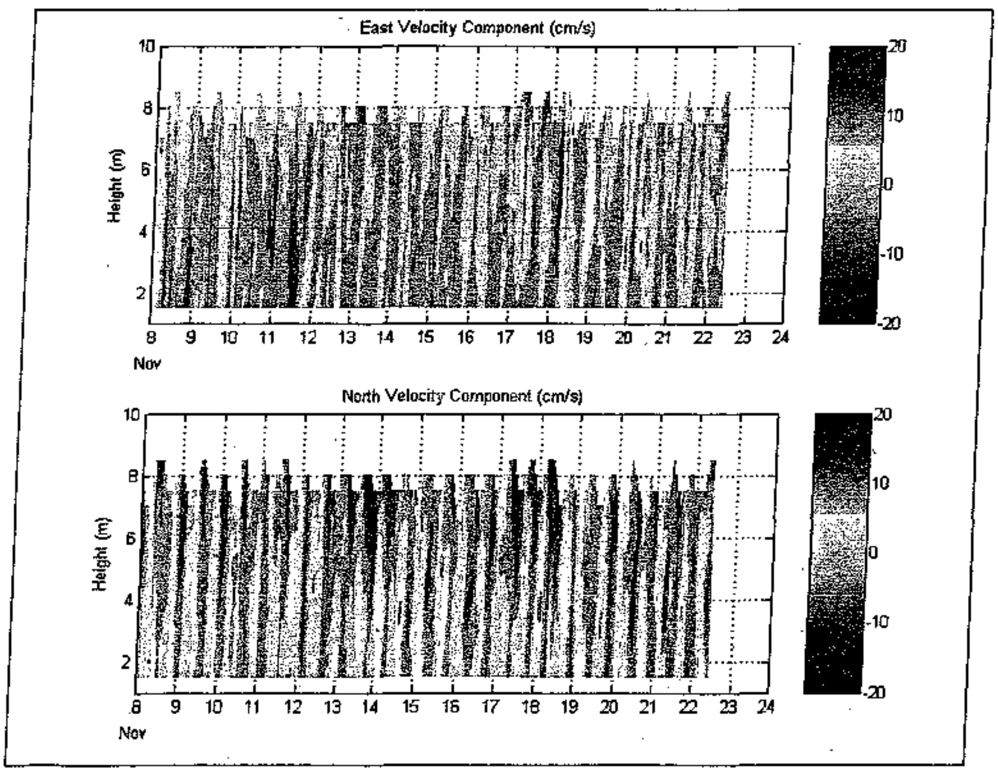


Figure 2-10. Vertical structure of east (top) and north (bottom) components of current velocity at the Channel Inner station for the period from 8–24 November 2002.

A comparison of the currents observed by the ADCM to the deepest currents observed by the ADCP shows the most significant difference to be a slight decrease in current speed near the bottom (Figures 2-11 and 2-12). The average current speed recorded by the ADCM during this period was 3.0 cm/s (0.098 ft/s), with a maximum value of 11.0 cm/s (0.36 ft/s). The average speed for the deepest current measured by the ADCP is 4.0 cm/s (0.13 ft/s), while the maximum was 15.2 cm/s (0.50 ft/s)

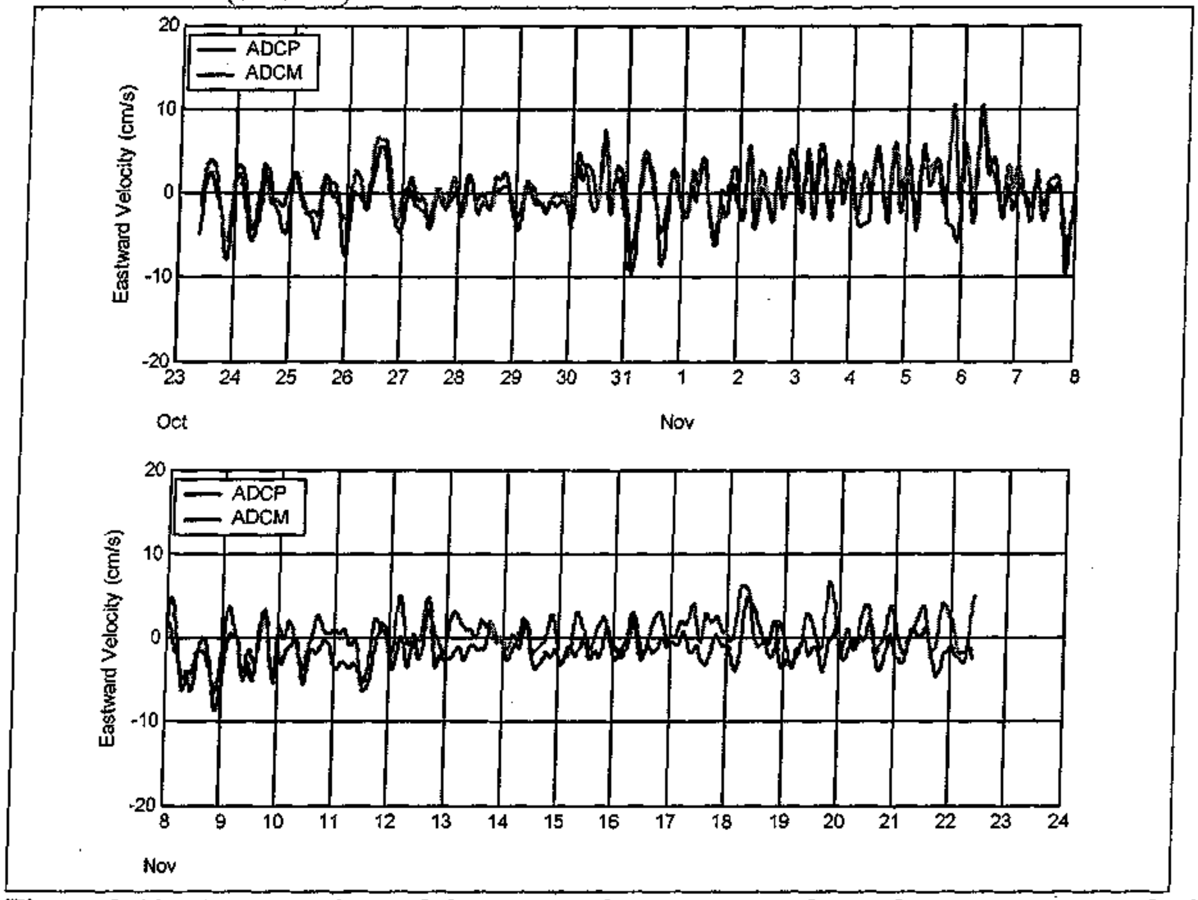


Figure 2-11. A comparison of the eastward component of near bottom current velocity as measured by the ADCP (blue) and the ADCM (red) at the Channel Inner station.

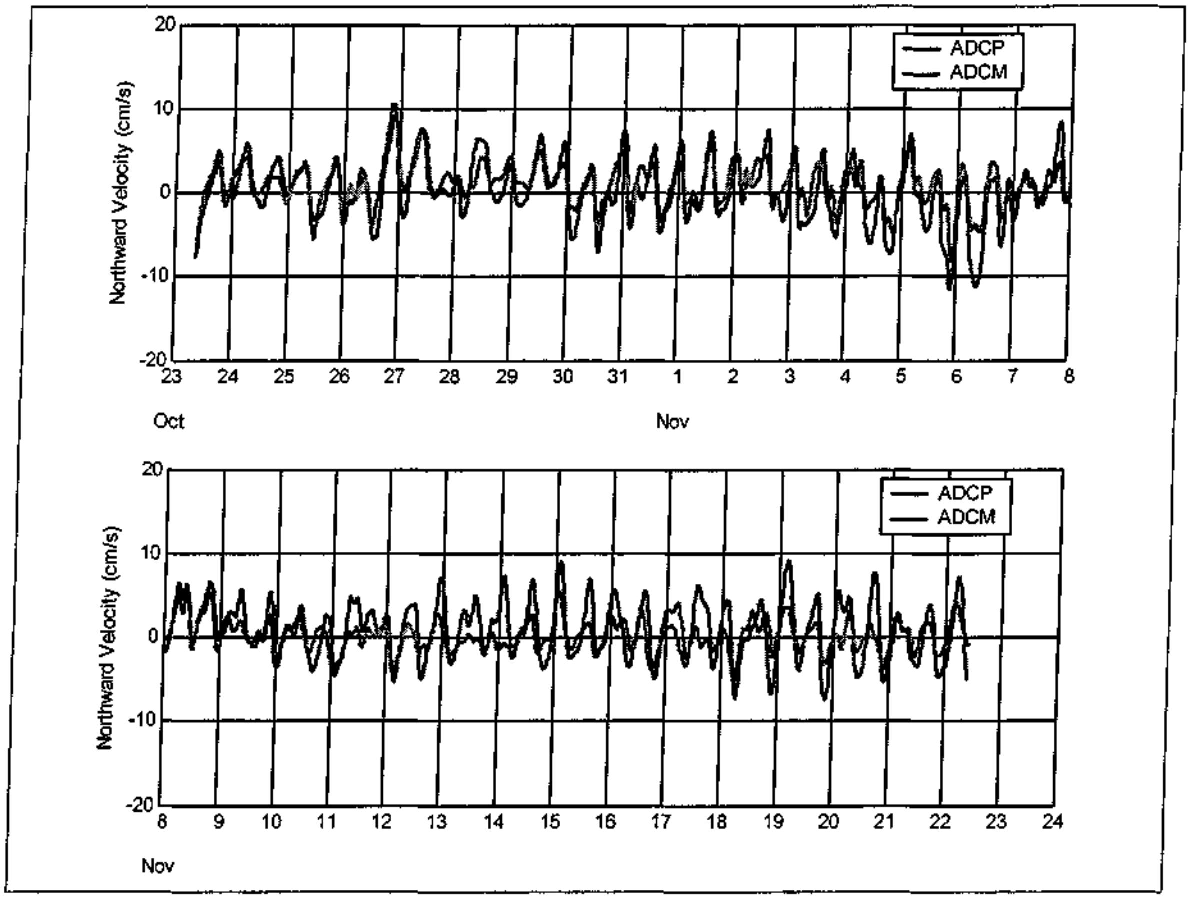


Figure 2-12. A comparison of the northward component of near bottom current velocity as measured by the ADCP (blue) and the ADCM (red) at the Channel Inner station.

2.3 Total Suspended Sediments

Optical backscatter was measured continuously at each of the three long-term deployment stations using D+A Optical Backscatter Sensors (OBSs). At the Popes Island and Channel Inner stations the OBSs were part of the ADCM instrument package, while at the Tide Gauge station it was a separate instrument. Optical backscatter was measured at 15 minute intervals at all three locations. Measurements of optical backscatter were generally low, averaging 2.7 (Nephelometric Turbidity Units (NTU) at Popes Island, 9.1 NTU at Channel Inner and 4.3 NTU at the Tide Gauge station. Deviations from these values were typically sudden spikes to extremely high values, with optical backscatter measurements reaching values of as much as 291.6 NTU (Popes Island), 448.0 (Channel Inner) and 210.0 (Tide Gauge). These excursions were short lived, lasting a few hours at most, except for one event lasting almost a day at Channel Inner. The Channel Inner station also experienced significantly larger and more frequent events than either the Popes Island or the Tide Gauge station.

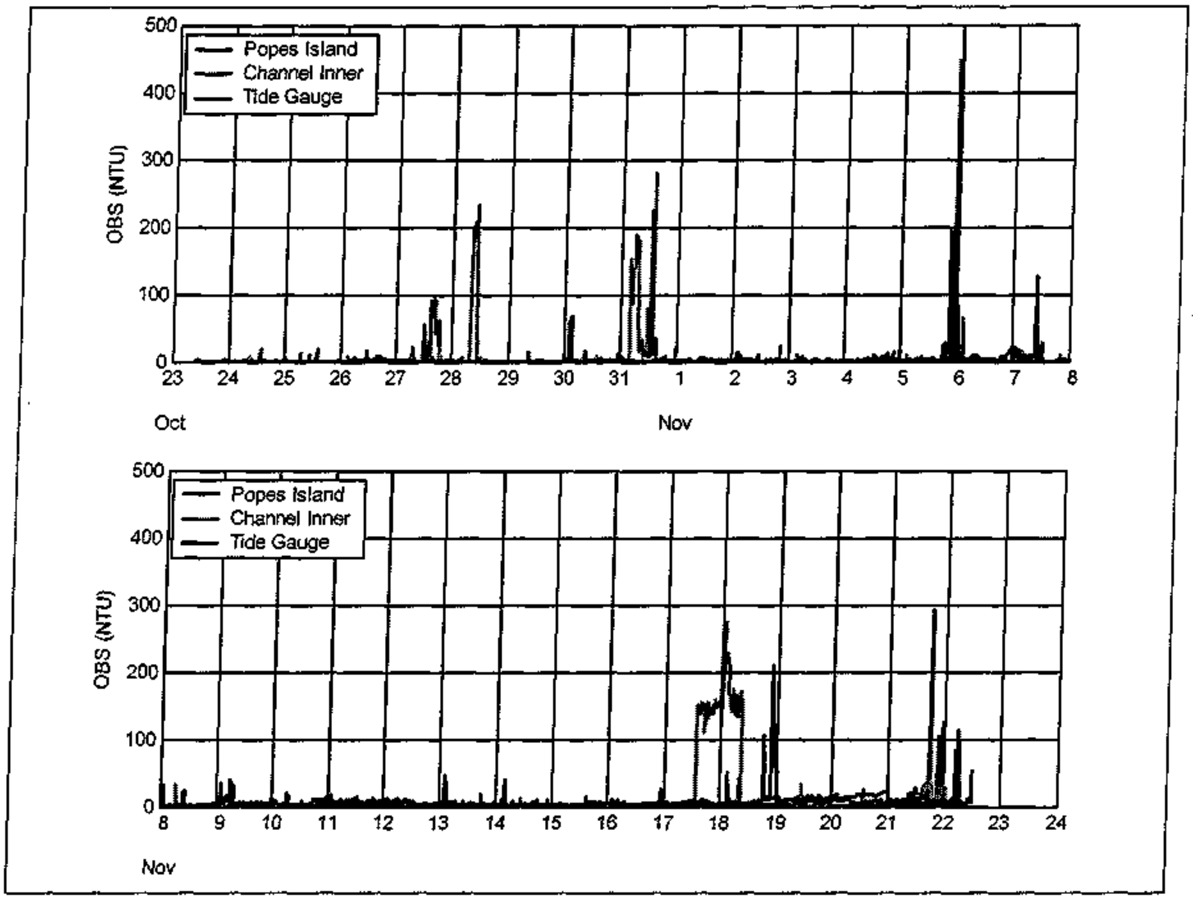


Figure 2-13. Optical backscatter measured at the Popes Island (blue), Channel Inner (red) and Tide Gauge (black) stations during the study period.

In order to relate optical backscatter to sediment levels in the water column, measurements of total suspended sediment (TSS) concentrations were made at the three station locations on five occasions during the study period (Table 2-2). Multiple samples were taken at a height of approximately 1 m (3.3 ft) above the seafloor on each occasion. Mean values of the three samples of TSS are compared to OBS measurements at the corresponding site at the same time in Figure 2-14.

Table 2-2. Total suspended sediment sampling schedule. Times are given as Local Standard Time (LST).

	Date				
Site	**23 Oct**	**1 Nov**	**7 Nov**	**14 Nov**	**22 Nov**
Popes Island	9:50	8:58	13:50	8:50	11:30
Channel Inner	11:50	9:15	13:00	9:10	9:38
Tide Gauge	11:00	9:30	15:00	9:30	8:50

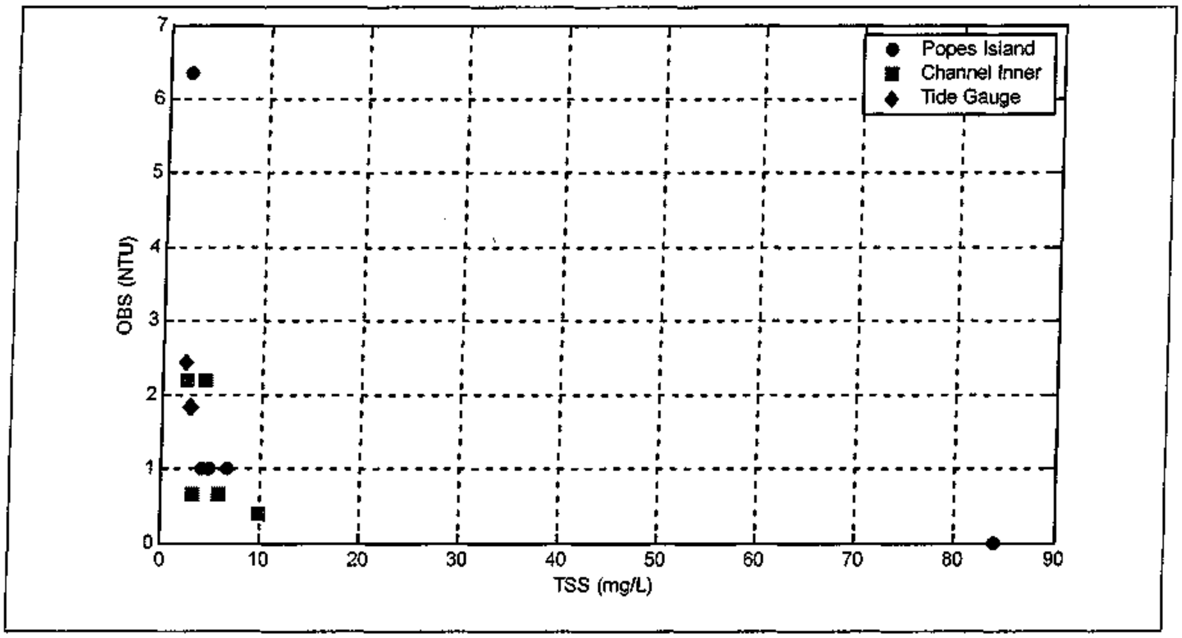


***Figure 2-14.* Optical backscatter plotted against total suspended sediment for the Popes Island (blue), Channel Inner (red) and Tide Gauge (black) stations.**

2.4 Chemistry

Elutriate tests are performed to estimate the release of soluble contaminants during dredging operations. A combination of 20 sediment and 80% site water is mixed and allowed to settle. The liquid is then analyzed for contaminant concentrations. The protocol was designed to mimic the initial concentration levels when sediments are released in the water column (Averett, 1989). Elutriate analyses were performed on samples from six stations within Inner New Bedford Harbor to determine background pollutant levels (Table 2-3 and Figure 2-1) and reported in SAIC (2002). Aluminum, copper, nickel, silver and Total PCBs registered above the chronic exposure levels established by the United States Environmental Protection Agency (EPA) at all sites for which analyses were performed. Lead exceeded chronic exposure levels at the NBH-202 station, Benzo(b)fluoranthene exceeded chronic exposure levels at the NBH-202 and NBH-207 stations, and Benzo(k)fluoranthene exceeded chronic exposure levels at NBH-202, NBH-205, NBH-206 and NBH-207. In addition, acute exposure levels were exceeded for aluminum at NBH-202 and NBH-207, and for copper at NBH-201, NBH-202, NBH-205, NBH-206 and NBH-207. Stations NBH-202, a CAD Channel Inner site, and NBH-207, the Fish Island site, showed generally higher concentrations than the other sites.

Table 2-3. Results of elutriate analyses from the NBH Water Quality Study. Values given in bold red italics exceed chronic exposure levels as established by the EPA (chronic and acute values are listed to the right).

		Station (NBH-)						EPA Criteria	
Class	Analyte	201	202	204	205	206	207	Chronic	Acute
MET	Aluminum	***161*** B	***2320***	***577***	***346***	***216***	***853***	87	750
MET	Antimony	3.50 U	3.50 U	3.50 U	3.50 U	3.50 U	5.80 B		
MET	Arsenic	5.20 B	18	3.80 B	24	13	5.10 B	36	69
MET	Cadmium	0.30 U	0.45 B	0.30 U	0.30 U	0.30 U	0.30 U	9.3	43
MET	Chromium	4.60 U	35	4.60 U	4.60 U	4.60 U	10	50	1100
MET	Copper	***7.10*** B	***98***	***4.00*** B	***11*** B	***7.10*** B	***39***	3.1	4.8
MET	Iron	214	2630	587	218	212	995		
MET	Lead	1.10 U	***13***	1.10 U	1.10 U	1.10 U	1.10 U	8.1	220
MET	Manganese	2.50 U	2.50 U	27	2.50 U	2.50 U	2.50 U		
MET	Mercury								
MET	Nickel	***14*** U	***14*** U	***14*** U	***14*** U	***14*** U	***14*** U	8.2	74
MET	Silver	***1.40*** U	***1.40*** U	***1.40*** U	***1.40*** U	***1.40*** U	***1.40*** U	0.1	1.9
MET	Zinc	6.90 U	40	6.90 U	6.90 U	6.90 U	16 B	81	90
PAH	Benzo(b)fluoranthene	0.02 J	***0.14***	0.02 J	0.03	0.04	***0.11***	0.04	0.38
PAH	Benzo(k)fluoranthene	0.02 J	***0.14***	0.01 J	***0.03***	***0.03***	***0.07***	0.02	0.17
PCB	Total PCBs	***1.72***	***23***	***0.34***	***0.88***	***1.22***	***5.69***	0.03	10

Units: µg/L.

Data Qualifiers: "B" (metals) Contract Detection Limit but > Instrument Detection Limit; "J" = estimated (result is between 1/2 reporting limit (RL) and RL); "U"=not detected above reporting limit.

Total PCBs - Sum PCB congeners (8, 18, 28, 44, 52, 66, 101, 105, 118, 128, 138, 153, 170, 180, 187, 195, 206, 209) x 2; list of congeners analyzed by NOAA Status and Trends Program (listed in NOAA, 1993; revised NOAA, 1998).

3. Hydrodynamic Modeling

3.1 Water Circulation in New Bedford Harbor Estuary

The objective of hydrodynamic simulations was to provide characteristic circulation patterns in New Bedford Harbor for use in the subsequent pollutant and sediment transport modeling. This section documents the following tasks that were conducted:

- Examine the field elevation and velocity data to identify primary forces that drive the circulation in New Bedford Harbor (section 3.2).
- Perform hydrodynamic simulations for the period of the field program to verify model performance (section 3.3).
- Produce typical circulation patterns that reflect various tidal and wind conditions most likely encountered (section 3.4).

3.2 Driving Forces of Water Circulation in New Bedford Harbor

SAIC conducted an extensive hydrographic survey from 23 October to 22 November 2002, as part of the field program described in Section 2. Figure 3.1 shows energy spectrum distributions of the surface elevations collected at the three long-term deployment stations (See Figure 2-1). In general, an energy spectrum distribution reveals the relative significance of the basic driving forces. Each driving force is associated with a particular frequency band or period. There are super tidal (less than 4 hrs), tidal (4 to 24 hrs), and sub-tidal (longer than 30 hrs) periods. Typically the magnitude increases steadily as frequency decreases and sharp spikes in tidal frequency band indicate a particular tidal constituent is present in the data.

Figure 3-1 shows that the semidiurnal tide (M_2) is the primary cause of elevation variation. Secondary components, which are of nearly equal magnitude, are M_4 (shallow tide), K_1 (diurnal tide), and sub-tidal forces. The sub-tidal forces are likely attributed to weather phenomenon (wind stress and atmospheric pressure). All stations (Hurricane Barrier [HB], Channel Inner [CI], and Popes Island [PI]) show almost identical profiles, except that station HB falls off more sharply at periods shorter than ~2 hours. Details of the relative significance among tidal constituents are exhibited in Figure 3-2. Very little difference exists among the three stations. The amplitude of the semidiurnal constituents (M_2, for example) increase by ~1% in the Harbor relative to outside the Hurricane Barrier and their phases lag by ~1 hour. Likewise, phases of diurnal constituents (K_1 for example) lag by ~45 minutes, however their amplitudes reduce by ~2%.

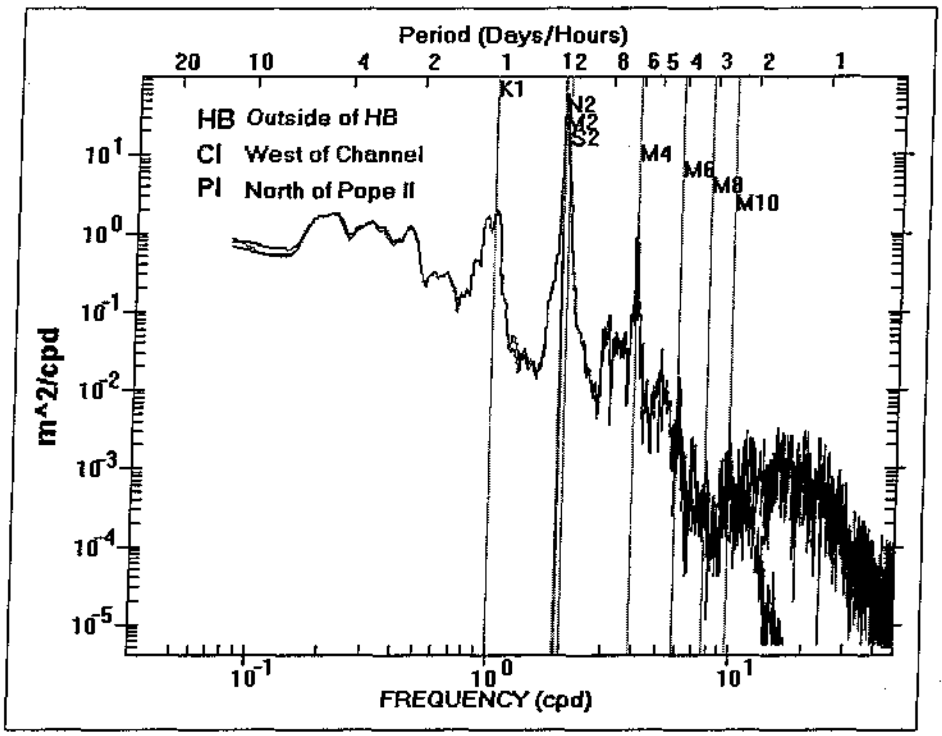


Figure 3-1. Energy spectrum distribution obtained from surface elevations at the long term deployment stations: HB(Hurricane Barrier), PI (Popes Island north), and CI (Channel Inner). Periods and frequencies of selected tidal constituents are shown.

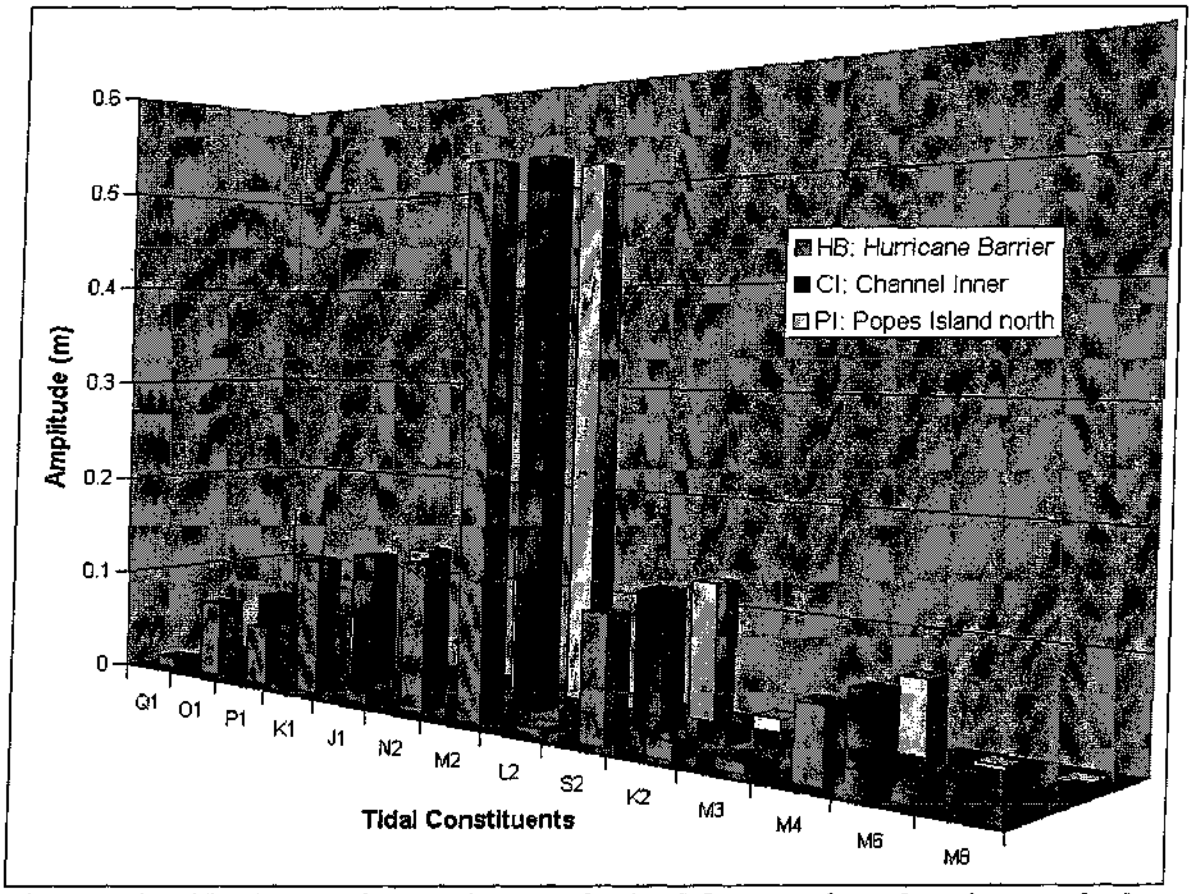


Figure 3-2. Tidal harmonic constituents obtained from surface elevations at the long term deployment stations (positioned in order from south (Hurricane Barrier) to north (Popes Island).

Similar observations can be made for the currents measured at the Channel Inner and Popes Island stations. No current meter was deployed at the Hurricane Barrier station. Figure 3-3 shows the energy spectrum distributions obtained from the vertically averaged velocities. The trend is similar to the one for elevations; with a falloff at higher frequencies and the existence of tidal frequency spikes. The energy in sub-tidal spectrums, however, becomes more prominent at the shallower station, Popes Island with a MLW depth of 2.6 m (8.5 ft) compared to 9.2 m (30 ft) at Channel Inner. Magnitudes of energy at the sub-tidal periods (~2 to 4 days) equal the tidal (M_2) components. Also noticeable is the difference at sub-tidal periods in the east/west versus south/north components. This difference indicates wind forces have significant influence on currents.

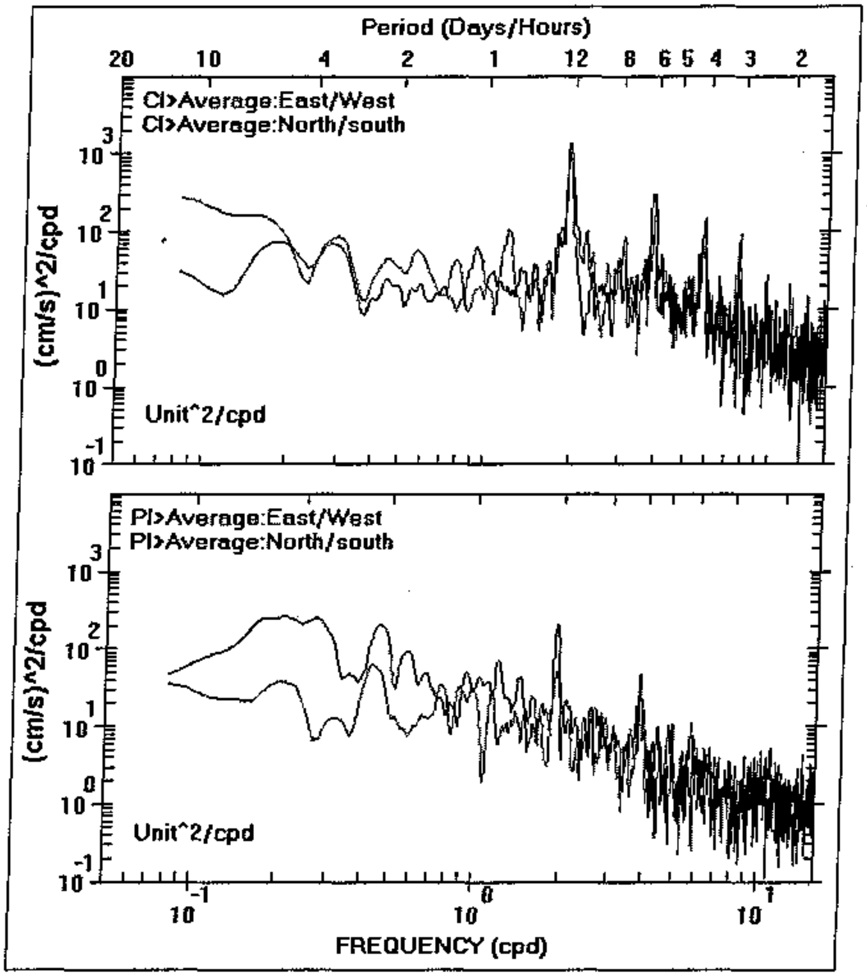


Figure 3-3. Energy spectrum distributions obtained from vertically averaged velocities at the long term deployment stations, Channel Inner (CI) and Popes Island (PI).

There are some differences in elevation versus velocity spectrum distributions, however, due to the inherent differences in these hydrodynamic quantities. Elevations are integrated quantities over the water depth and the region. Velocities are highly variable and dependent on depth of observation and immediate local morphology. This is why the elevation spectrum distributions look very similar for all stations while the velocity spectrum distributions look different.

The elevation and velocity spectrum distributions reveal that tides and winds are the primary causes that drive circulation in the region. This observation can also be inferred by examining the variations of elevation and velocity in time. Figure 3-4 shows observed winds (New Bedford municipal airport), elevation (outside of the Hurricane Barrier) and velocities (Channel Inner and Popes Island North) together on the same time axis. All forces drive the circulation with their own frequencies or random times: half daily tidal cycles, spring-neap fortnightly cycles and episodic wind events. Although the variation of velocities is very complex, the response to wind is particularly noticeable through time. Velocities in Figure 3-4 are shown for surface, vertically averaged, and bottom. At the Channel Inner station, with a 9.2 m (30 ft) water depth, the surface and bottom velocities are quite different. The surface velocities are larger, more variable, and generally flow to the south, while bottom velocities are smaller and show an oscillating north-south direction. Velocities at Popes Island North, with a 2.6 m (8.5 ft) water depth, are more uniform vertically with somewhat higher speeds t the surface than at the bottom.

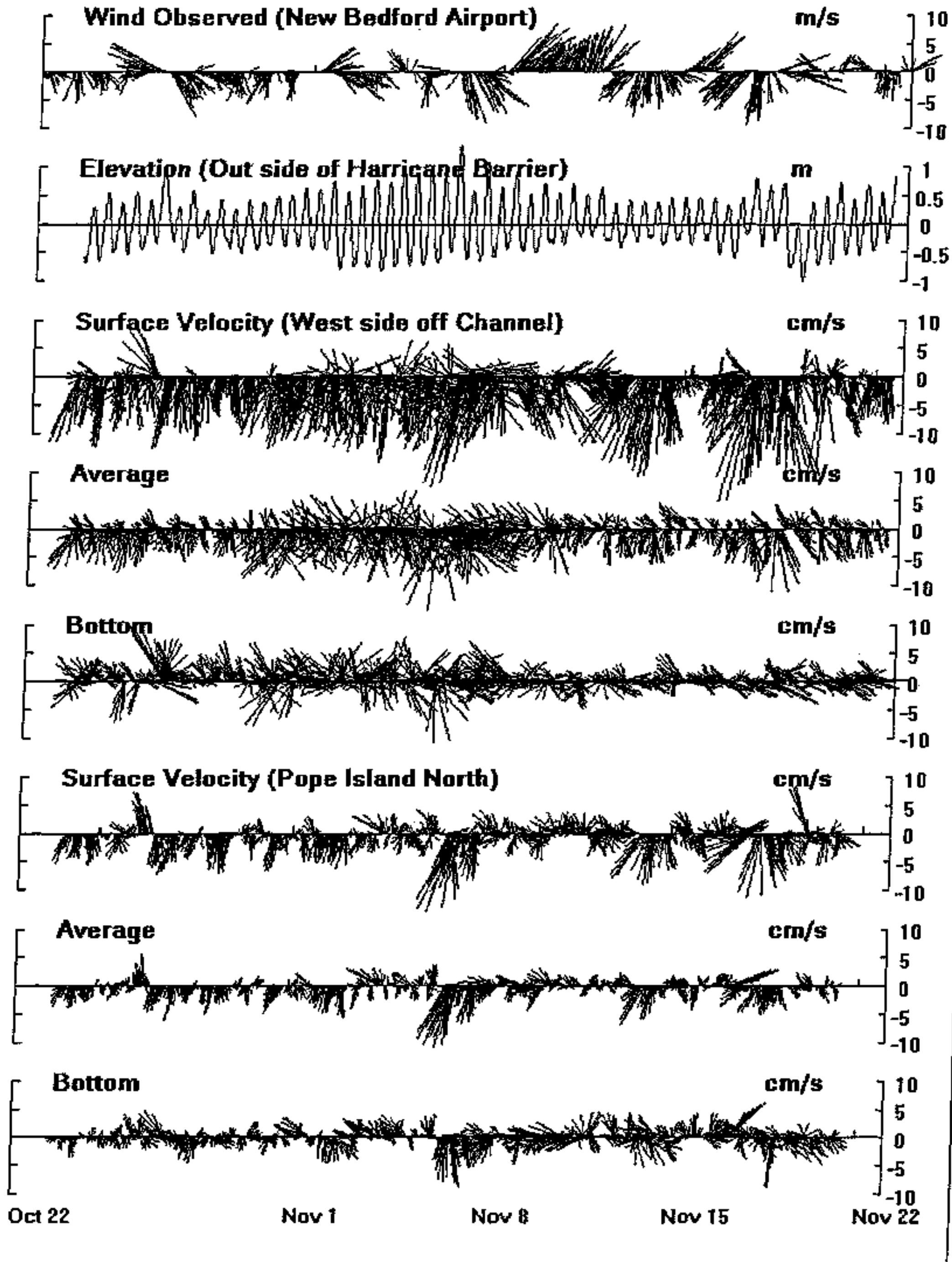


Figure 3-4. Time series stack plot of observed wind, elevation and velocity data.

In general, typical driving forces in normal estuarine circulation are tide, wind, and density gradient. Tide and wind influence are clearly seen in the observations. The significance of the density gradient is based on freshwater inflows. If the amount of freshwater inflow is small relative to the estuary size, the density gradient is not expected to play a significant role. The evidence of density gradients can be seen in the longitudinal salinity. No salinity observation were made for the period of field investigation but other studies concluded the density driven flow would be much less than 1 cm/s (see the discussion in Abdelrhman [2002]) south of Coggeshall St./I-95 Bridge, the lower portion of the Inner Harbor where the dredging and disposal operations are planned.

3.3 Hydrodynamic Model Application

3.3.1 Description of Hydrodynamic Model WQMAP/BFHYDRO

ASA has developed and applied evolving versions of sophisticated model systems (Swanson 1986, Spaulding et al., 1999) for use in studies of coastal waters for more than two decades. WQMAP, as the model system is known, uses a three dimensional boundary fitted finite difference hydrodynamic model (BFHYDRO) developed by Muin and Spaulding (1997a and b). The model has undergone extensive testing against analytical solutions and used for numerous water quality studies. Some applications particular to dredging studies in the northeastern United States are

- Water quality impacts of dredging and disposal operations in Boston Harbor (Swanson and Mendelsohn 1996)
- Dredged material plume for the Providence River and Harbor Maintenance Dredging Project (Swanson et al., 2000)
- Simulations of sediment deposition from jet plow operations in New Haven Harbor (Swanson et al., 2001)
- Simulations of sediment transport and deposition from jet plow and excavation operations in the Hudson River (Galagan et al., 2001)

The grid system used in the boundary-fitted coordinate model system is unique in that grid cells can be aligned to shorelines and bathymetric features (like dredged channels) to best characterize the study area. In addition, grid resolution can be refined to obtain more detail in areas of concern. This gridding flexibility is critical in representing the New Bedford Harbor waters where geometry is highly variable and complex.

3.3.2 New Bedford Harbor Grid

The domain of the hydrodynamic model for this application included the entire New Bedford Harbor, Inner and Outer, and a portion of Buzzards Bay. Figure 3-5 shows the large variation of cell size. The Buzzards Bay portion served as the open boundary condition where a cell size of ~700 m (2300 ft) was employed. The finest grid resolution of ~50 m (165 ft) was located in the immediate study area of Inner New Bedford Harbor where bathymetric and shoreline variations were complex. Special attention was made to resolve the narrow channel that extends from the upper portion of the Inner Harbor to the Outer Harbor. The bathymetry data used in the model was taken from the hydrographic survey data CD-ROM Set (NGDC 1998) and from the Buzzards Bay project web-site http://www.buzzardsbay.org/gisdownload.htm.

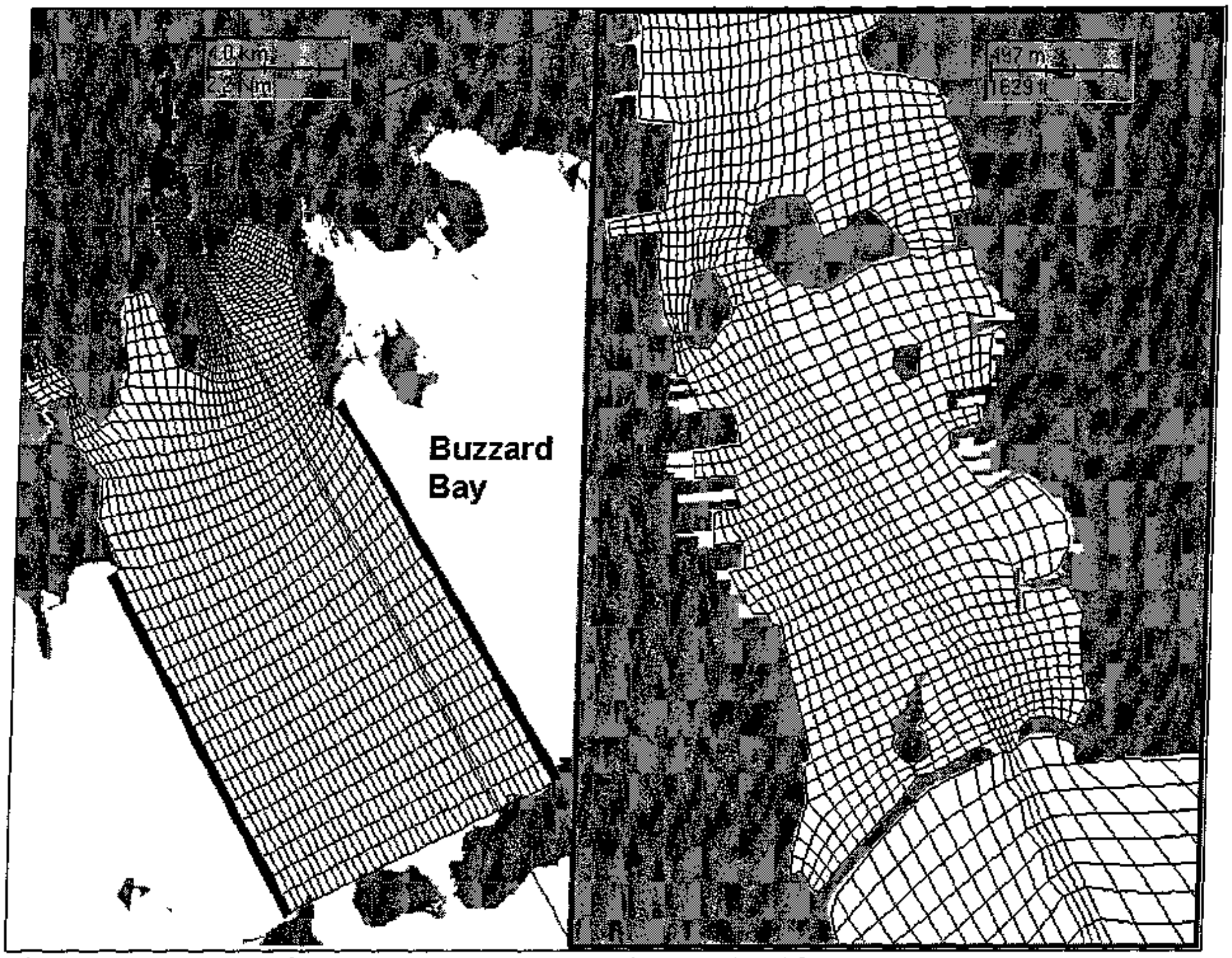


Figure 3-5. New Bedford harbor hydrodynamic model grid

3.3.3 Model Input

3.3.3.1 Open Boundary Condition

Elevation was prescribed at the open boundary. Two sets of boundary lines extend across Buzzards Bay as shown. Since no observations were available there, the elevation observed at Hurricane barrier is used by applying phase offsets of -20 minutes to the western boundary and +20 minutes to the eastern boundary, based on the gravity speed of long wave propagation.

3.3.3.2 Surface Wind Stress

Two wind data sets from New Bedford Municipal Airport (~5.3 km [3.3 mi] north-west of Popes Island) and Buzzards Bay NOAA Buoy (~29 km [18 mi] south-south-west of Popes Island) were considered. During the period of the field program, their directions were nearly identical but speeds at the buoy were substantially larger. Although the NOAA Buzzards Bay Buoy provided a better estimate of the unobstructed wind, the wind record from the airport was selected because of its proximity to the Inner Harbor.

3.3.3.3 Other Model Parameters

The computational time step defined how often the model calculated velocities and was chosen to be 300 sec, the largest allowed without causing model instabilities. The number of vertical layer was chosen as 7, sufficient to resolve the vertical structure of the horizontal currents. The bottom stress coefficient, based on Manning's equation was selected as 0.03, typical for estuaries. The wind stress coefficient was selected as 0.0014. The depth dependent vertical viscosity was chosen as 0.0005 + 0.0001 times the local depth (m) and expressed in m^2/sec.

3.3.4 Simulation Results

The hydrodynamic model simulated the circulation from 20 October to 20 November 2002, the period of the field program, with aforementioned model inputs and parameters. Figure 3.6 shows comparisons of observed versus simulated elevations at the three field stations. The station outside of Hurricane Barrier shows the best match. This is not surprising since the open boundaries were based on this elevation (+/- 20 min phase offset but the same amplitude). There was very little elevation gradient between Buzzards Bay and the Outer Harbor. Simulated elevations at Channel Inner and Popes Island are in good agreement in amplitude but their phases slightly lead the observations.

Figure 3-7 and 3-8 show comparisons of the observed versus simulated velocities at the Channel Inner and Popes Island North stations, respectively. Magnitudes of the velocities agreed well with the observations. The flow directions, however, differed in various degrees during the simulation period. The apparent complexity is due to wind stress. During some periods, the currents strongly correlated with the wind. For example, during the period (Oct 24 – Oct 30), wind blew steadily from the NNW direction. The observed surface currents flowed to the SSE, showing a strong positive wind/current correlation. On other occasions, i.e., from Nov 8 to Nov 12, strong winds blew from the SW~SSW direction but both observed surface currents appeared unaffected. The simulated current showed a contrary response during these periods: weak flow in the first period and strong flow to the later period, although the surface currents were always positively correlated with the wind. This suggests actual winds on the water may be different from the wind observed at the airport. However, simulations using rotated winds were tried but with no significant improvement.

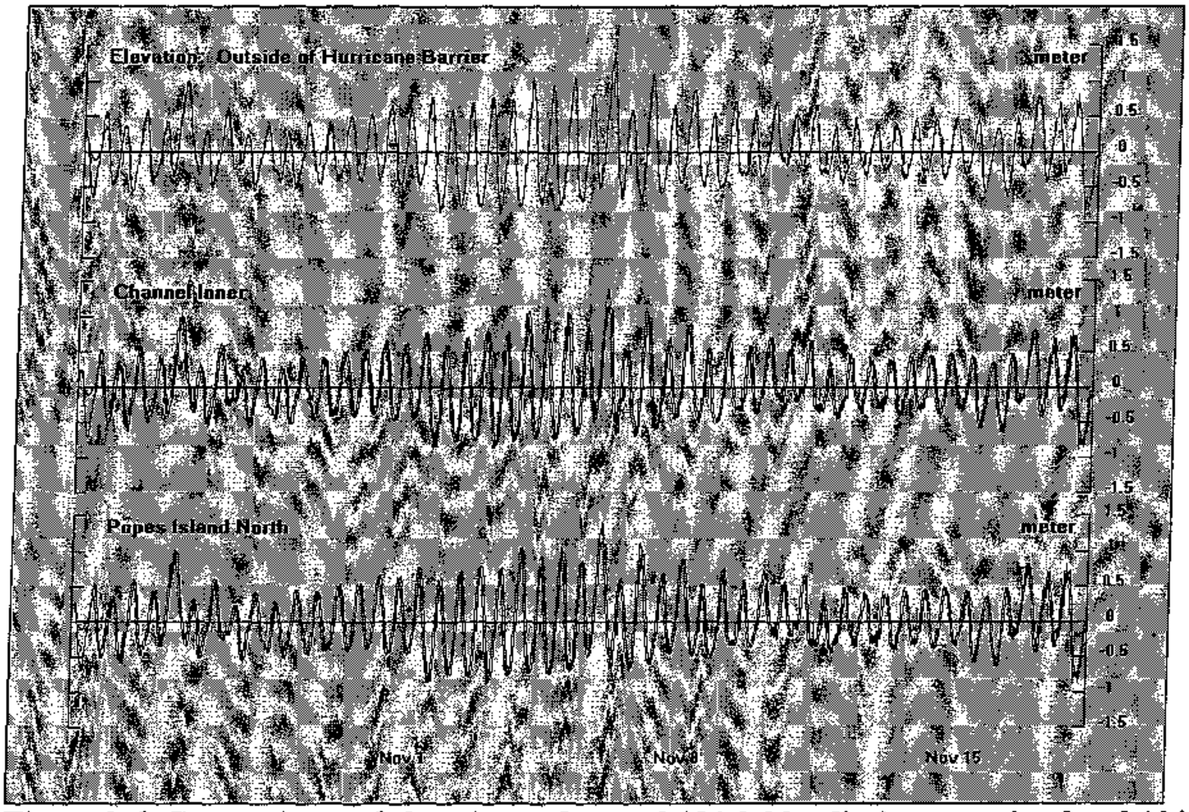


Figure 3-6. Comparisons of elevations: observed (thick blue line) versus simulated (thin red line).

In conclusion, the simulated elevations and velocity magnitudes agree very well with the observations. This assures overall hydrodynamics are consistent. The difference in the flow direction can be attributed to the uncertainty of the actual forcing wind magnitude.

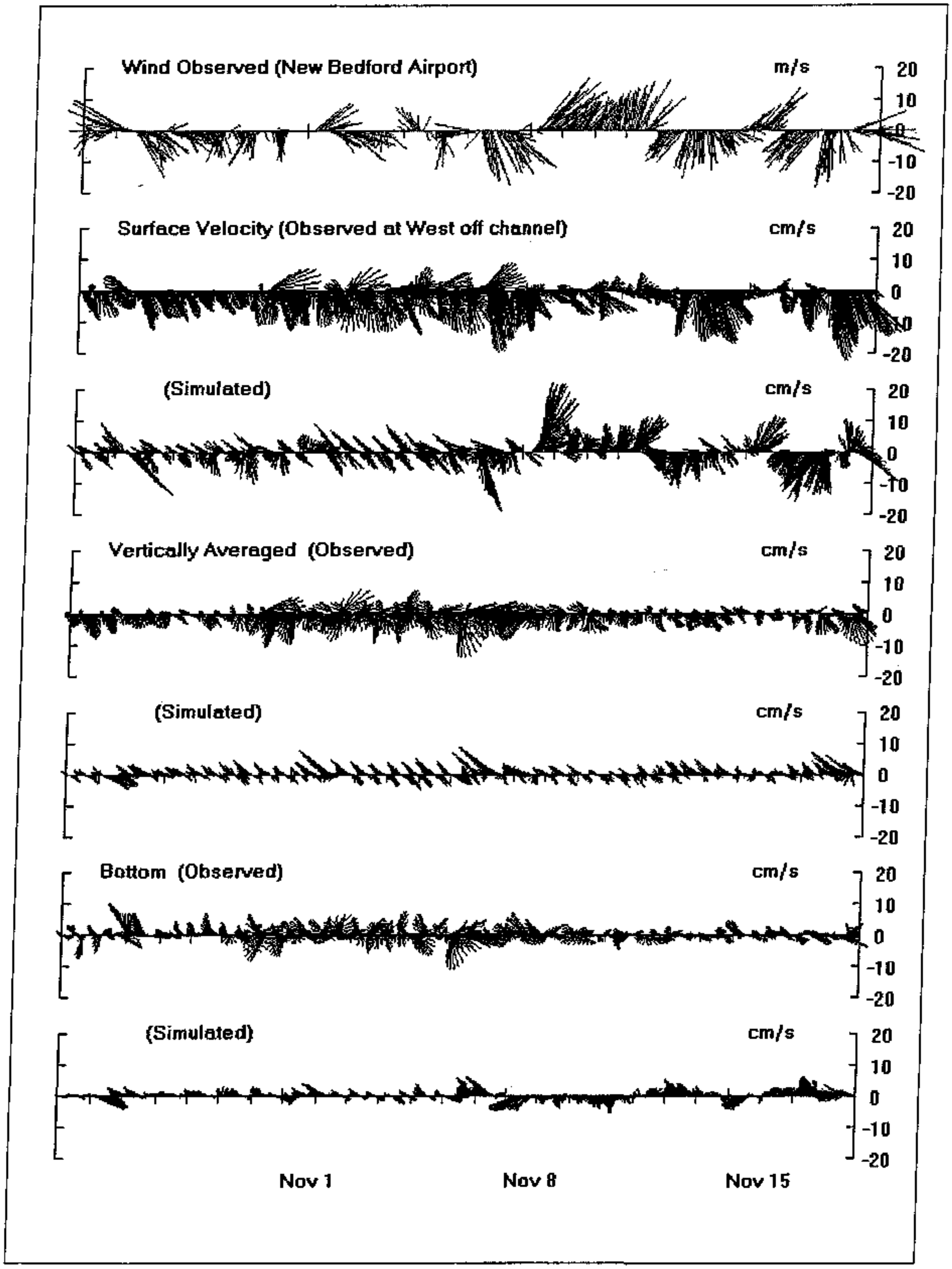


Figure 3-7. Comparison of observed versus simulated velocity at Channel Inner station.

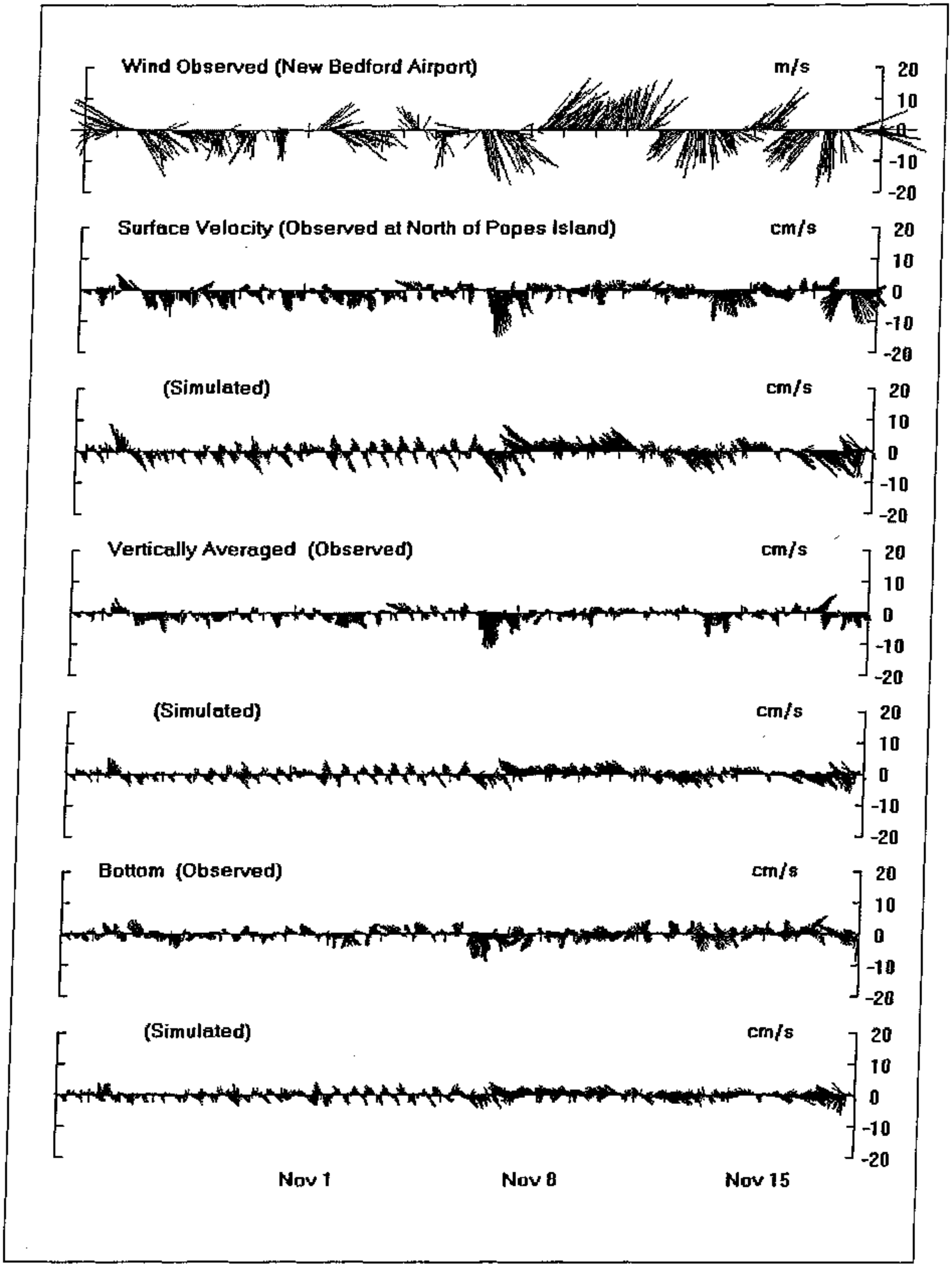


Figure 3-8. Comparison of observed versus simulated velocity at Popes Island north station.

3.4 Characteristic Circulation Scenarios

The analysis of the field observations and hydrodynamic simulations confirmed that the major forces driving the circulation in New Bedford Harbor are astronomic tides and winds. Since the purpose of the mass transport simulations was to predict the distribution of dredged pollutants and sediments under typical wind and tidal conditions, the particular periods (season or date) of such simulations were not determined *a priori*. The approach taken here was to develop a set of circulation scenarios that reflected most likely conditions. These scenarios were comprised of various tidal conditions and most probable wind conditions. Tidal variations considered were spring, mean and neap tides. Unlike the astronomic tide, which is predictable, wind is very episodic and must be approached in a statistical sense.

3.4.1 Wind Climate for Inner New Bedford Harbor

The variability of the wind at the New Bedford Municipal Airport was examined. Figure 3.9 and Table 3.1 shows the seasonal probability of wind direction in 30° increments. Two prominent wind directions found were south-west-south (SWS) and north-west-west (NWW). Nearly 50% of the time wind blew from the SWS direction in summer and the NWW direction in winter. This tendency remained to a lesser degree during spring and autumn. The probability that wind speed was less than 3.0 m/s (6.7 mph), considered as calm wind, is ~10.7% on average.

Table 3.1. Variations of winds at New Bedford Municipal Airport by season.

	Chance wind blows from either SWS or NWW	Calm wind (<3.0 m/s)
Winter	45.5%	8.4 %
Spring	35.4	11.1
Summer	50.9	13.8
Autumn	35.3	10.1

Wind speed was quite variable during the seasons. The average wind speed for both directions (excluding the calm wind period) was calculated to be 8.2 m/s (18.3 mph), equivalent to a wind stress of approximately 1 dyne/cm^2 (0.0021 lbs/ft^2).

3.4.2 Circulation Scenarios

Three tidal conditions (neap, mean, and spring) and three wind conditions (calm, SWS, NWW at 8.2 m/s speed) were combined to make the nine circulation scenarios summarized in Table 3.2.

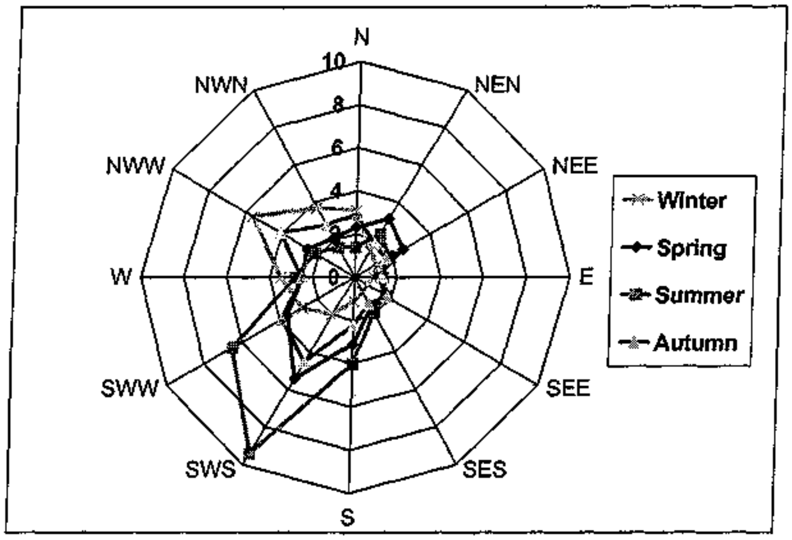


Figure 3-9. Probability of wind direction of the four seasons.

Table 3.2. Circulation scenarios based on tide and wind conditions.

Circulation Scenario	Tide Range	Wind
1	Neap (0.7 m [2.3 ft])	Calm
2	Mean (1.0 m [3.3 ft])	calm
3	Spring (1.4 m [4.6 ft])	calm
4	Neap (0.7 m [2.3 ft])	SWS 8.2 m/s
5	Mean (1.0 m [3.3 ft])	SWS 8.2 m/s
6	Spring (1.4 m [4.6 ft])	SWS 8.2 m/s
7	Neap (0.7 m [2.3 ft])	NWW 8.2 m/s
8	Mean (1.0 m [3.3 ft])	NWW 8.2 m/s
9	Spring (1.4 m [4.6 ft])	NWW 8.2 m/s

To assess the direct effect of tidal conditions and winds, hydrodynamic simulations were run separately for each component. Figures 3-10 and 3-11 show simulated surface flood speed contours and velocity vectors for neap, mean and spring tides under calm wind conditions, respectively. As the tide range doubles from neap to spring conditions, the velocity also approximately doubles throughout the region. Figures 3-12 and 3-13 show simulated surface and bottom flood speed contours and velocity vectors driven by the SWS wind and mean tide, respectively. There is a strong surface flow heading downwind but modulated by the Inner Harbor geometry. The bottom flow is much lower in magnitude. Figures 3-14 and 3-15 show simulation results driven by the NWW wind and mean tide. Here the surface flow is again downwind with a significant upwind flow along the bottom in the channel. In general, surface and shallow waters tend to move with the wind while flows in deeper areas adjust by compensating the flow to balance the direct wind-induced flows.

Nine hydrodynamic simulations using the combination of tide and wind conditions were then executed. Table 3.3 compares the simulated speed (vertically averaged) at the two field stations. The result indicates flows driven only by tides are very weak, varying from 1.4 to 4.3 cm/s (0.046 to 0.14 ft/s). Wind substantially increases flow velocities, the SWS wind generating a range of speeds between 5.1 and 9.6 cm/s (0.17 to 0.32 ft/s) and the NWW wind generating a range of speeds between 6.5 and 15.7 cm/s (0.21 to 0.52 ft/s).

Table 3.3 Vertically averaged simulated speed at two field station locations for the nine circulation scenarios.

Circulation Tide	Scenario Wind	Channel Inner Speed (cm/s)	Popes Island North Speed (cm/s)
Neap	Calm	2.1	1.4
Mean	Calm	3.0	1.9
Spring	Calm	4.3	2.6
Neap	SWS @ 8.2 m/s	5.1	9.6
Mean	SWS @ 8.2 m/s	6.0	9.3
Spring	SWS @ 8.2 m/s	7.1	9.4
Neap	NWW @ 8.2 m/s	13.6	6.5
Mean	NWW @ 8.2 m/s	14.6	7.0
Spring	NWW @ 8.2 m/s	15.7	7.5

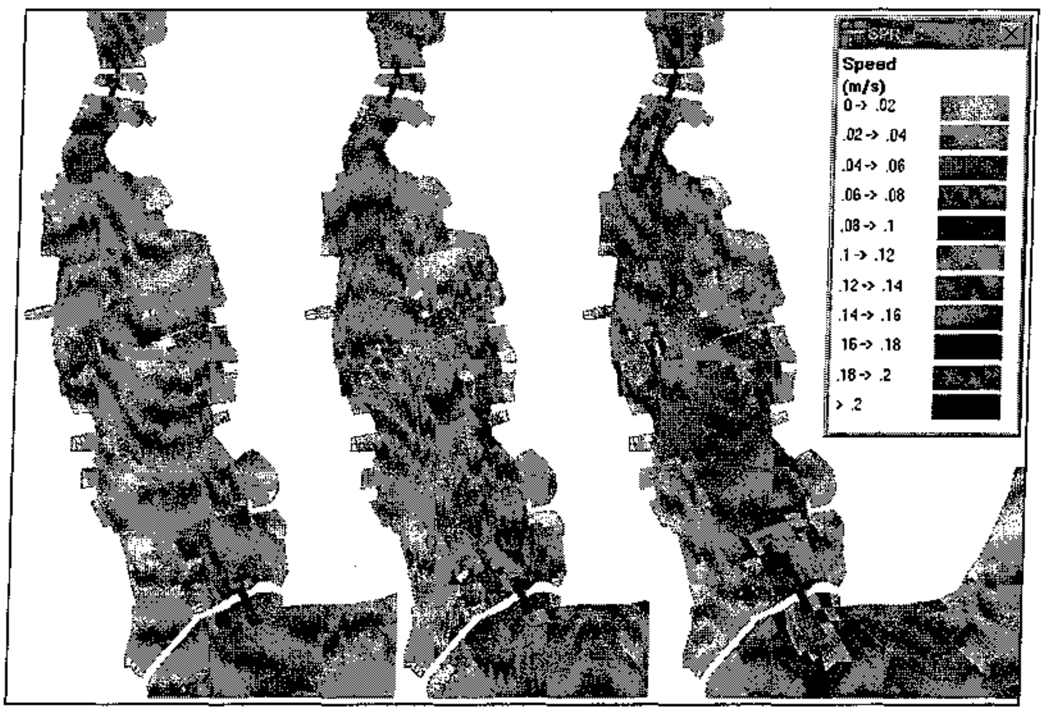


Figure 3-10. Surface flood speed contours for neap, mean and spring (from left to right) tide conditions under calm wind conditions.

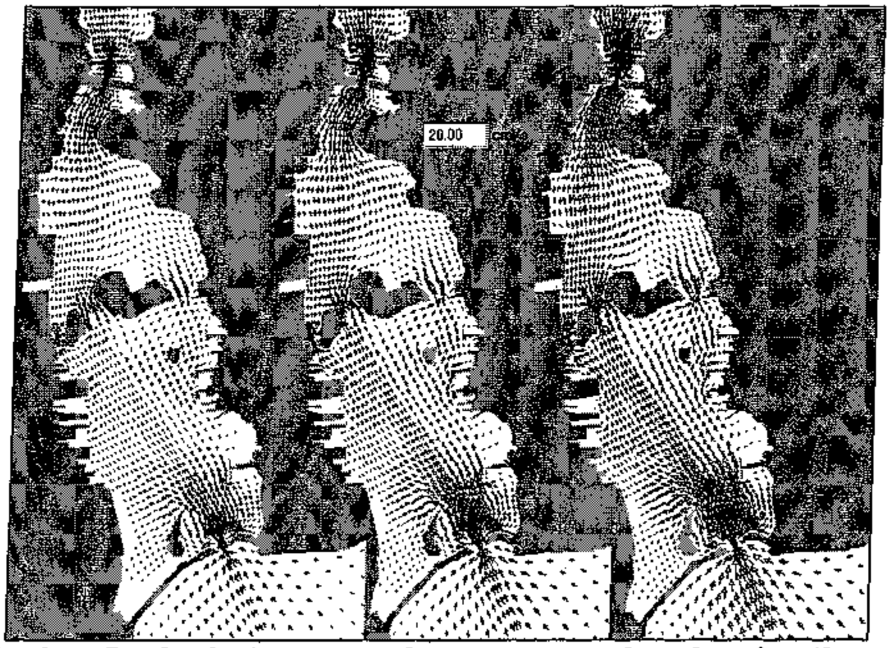


Figure 3-11. Surface flood velocity vectors for neap, normal, and spring (from left to right) tidal conditions under calm wind conditions.

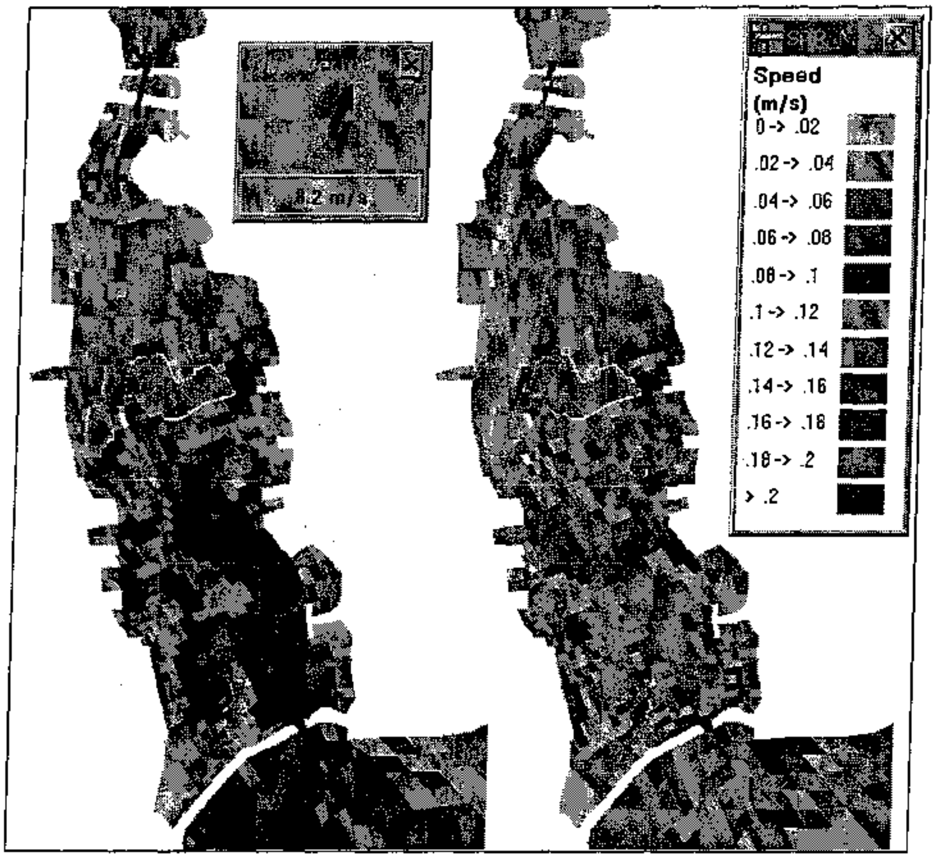


Figure 3-12. Surface (left) and bottom (right) speed contours for SWS wind.

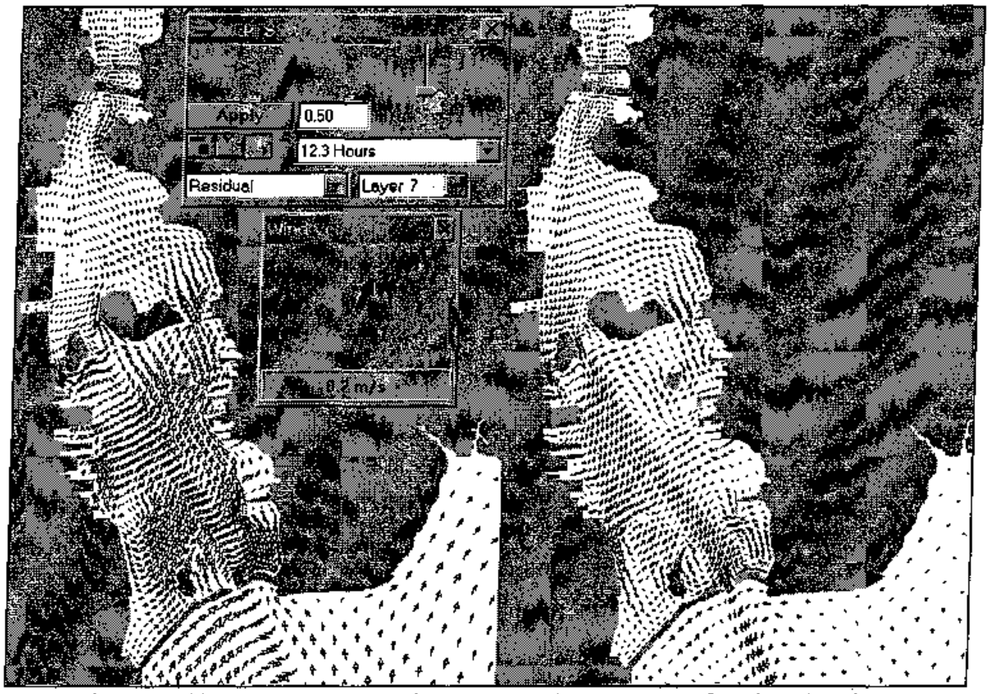


Figure 3-13. Surface (left) and bottom (right) velocity vectors for SWS wind.

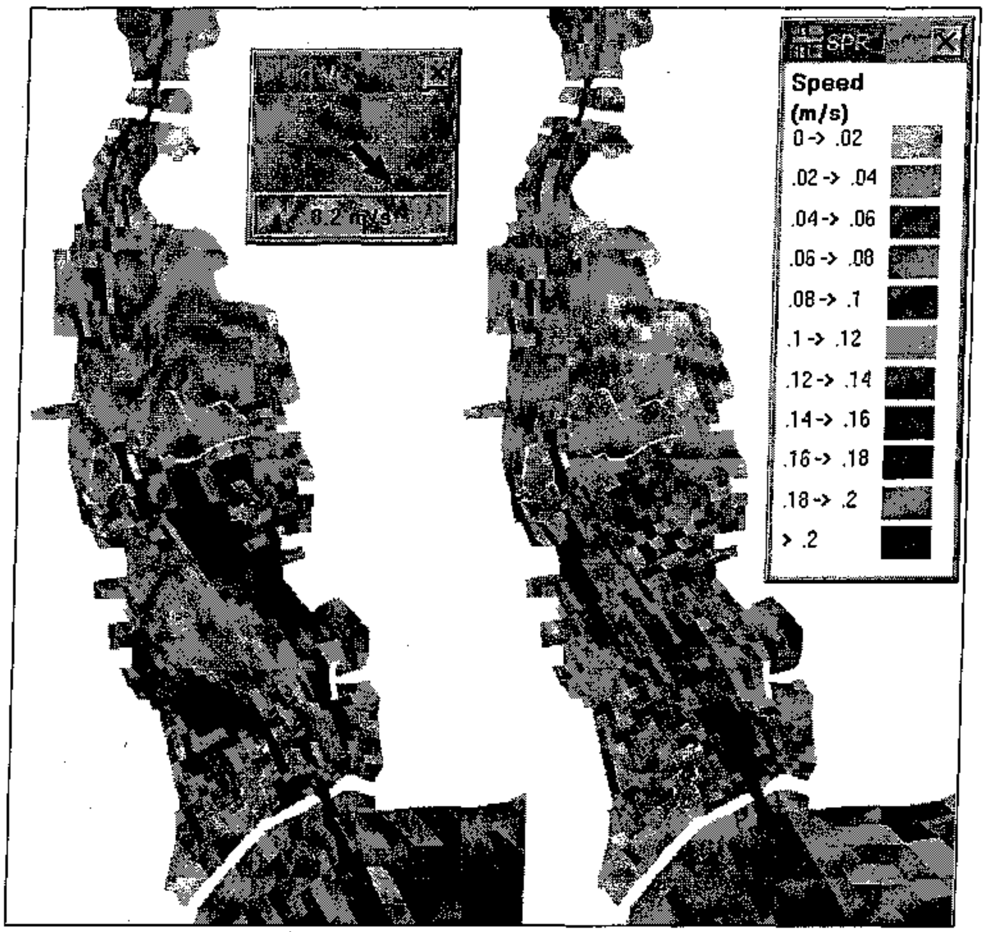


Figure 3-14. Surface (left) and bottom (right) speed contours for NWW wind.

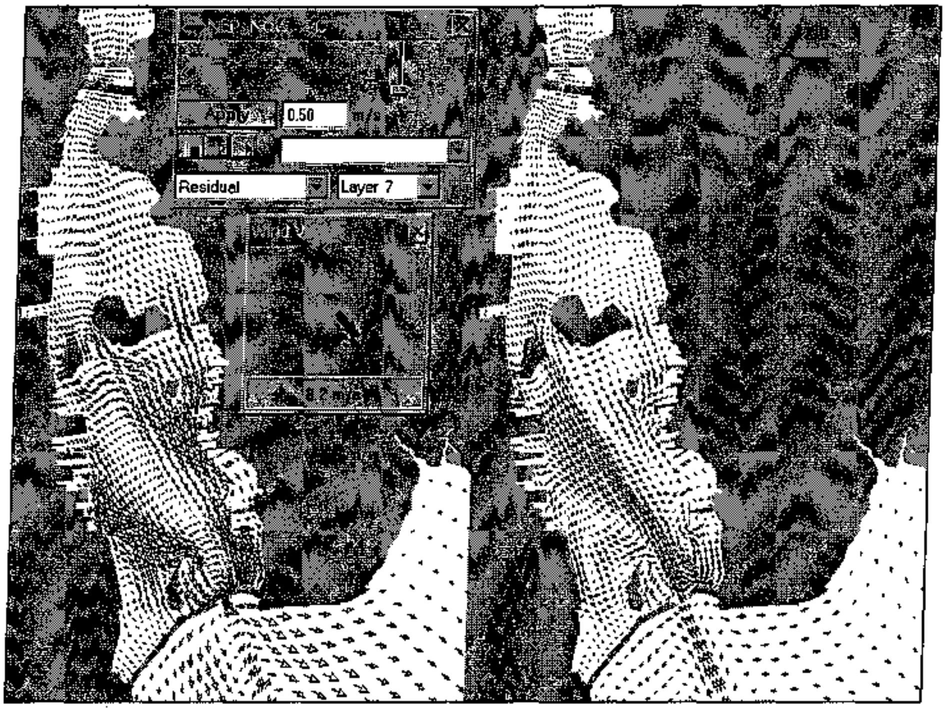


Figure 3-15. Surface (left) and bottom (right) velocity vectors for NWW wind.

The set of scenarios listed in Table 3.3 were rerun with bathymetry that reflects the proposed Popes Island CAD cell excavation, from 2.6 to 17 m (8.5 to 56 ft), to simulate the circulation for dredge material disposal simulations into the cells. The results of these additional hydrodynamic runs were very similar to the present bathymetry runs. Velocities for tide only cases simply showed a reduction in speed (Figure 3-16). The immediate vicinity of the CAD site, however, showed surface water moving in direct response to wind and a reverse flow developed at the bottom for wind driven cases (Figures 3-17 and 3-18).

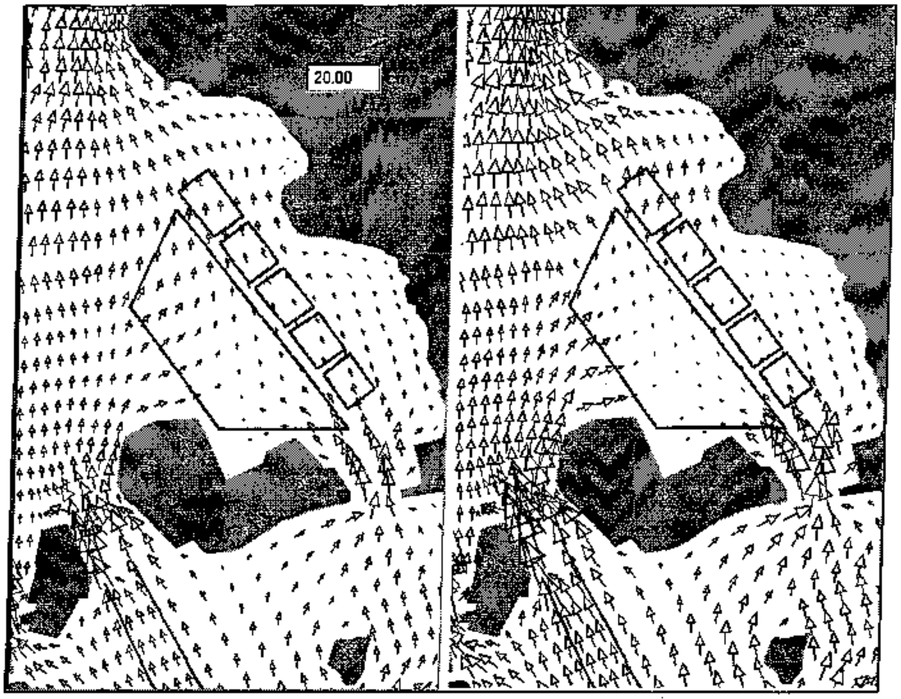


Figure 3-16 Comparison of flood surface velocity vectors for spring tide and calm winds: existing (left) versus excavated (right) bathymetry. Red polygons represent cells in the proposed CAD facility at north of Popes Island.

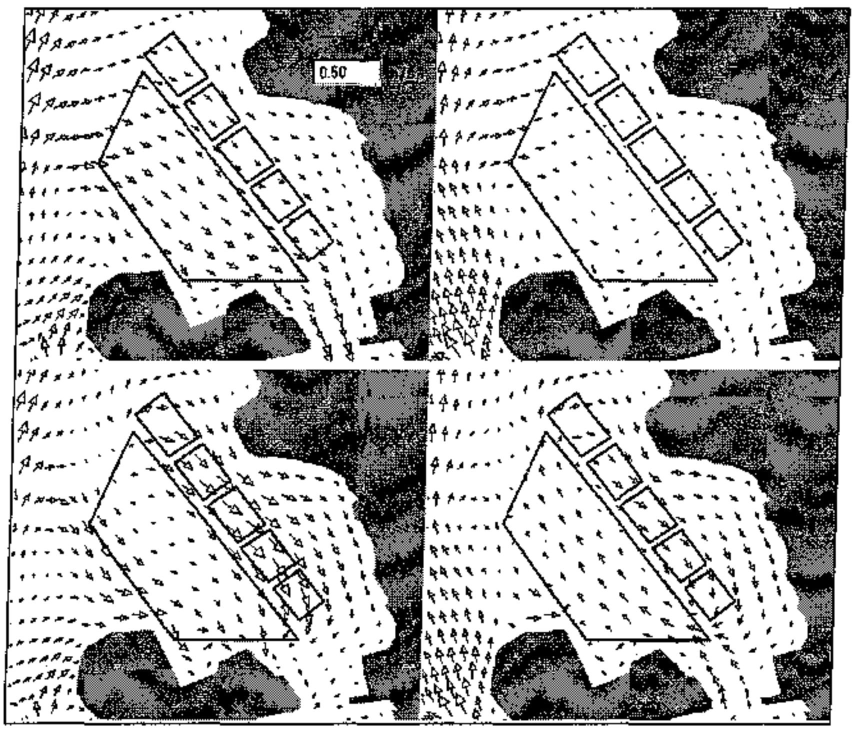


Figure 3-17 Comparison of velocity vectors at surface (left panels) and bottom (right panels) for the NWW wind case, existing (upper panels) versus excavated (lower panels) bathymetry. Red polygons represent cells in the CAD facility at north of Popes Island.

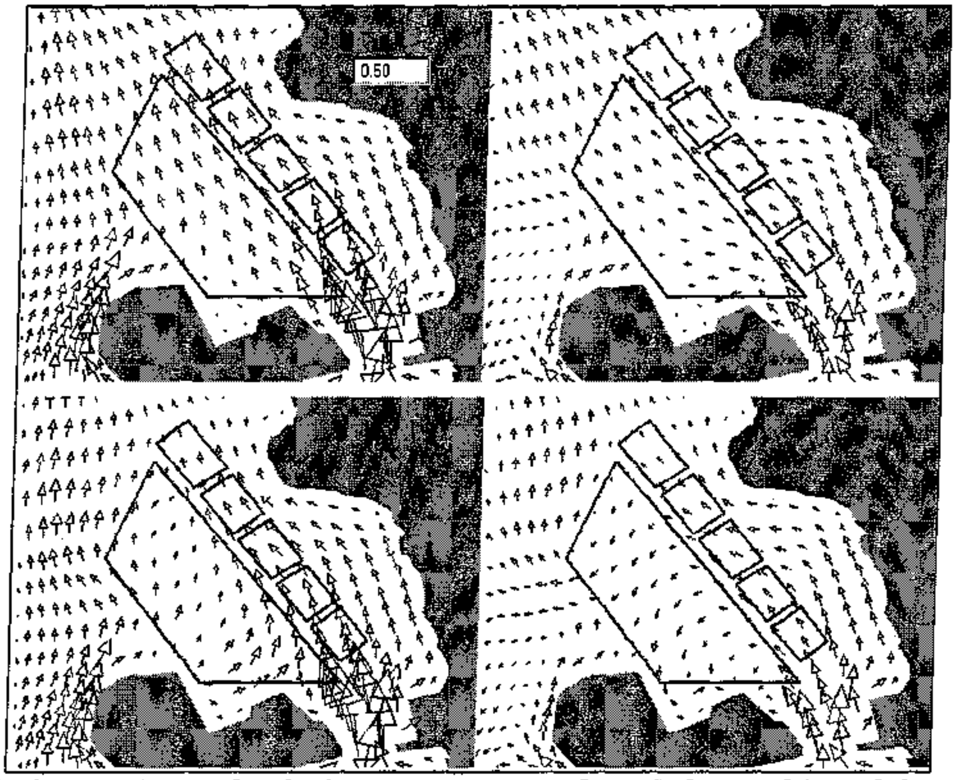


Figure 3-18 Comparison of velocity vectors at surface (left panels) and bottom (right panels) for the SWS wind case, existing (upper panels) versus excavated (lower panels) bathymetry. Red polygons represent cells in the CAD facility at north of Popes Island.

4. Dredged Material Modeling using SSFATE

4.1 Excavation of Popes Island CAD Cell

All of the dredged sediments from the waterways are to be disposed in the PIN-CAD facility. The capacity of the CAD site was designed to accommodate many dredging projects. Six cells are planned at the PIN-CAD site (shown in Figures 3-16 to 3-18). The largest cell volume is 1,739,362 m^3 (2,275,000 yd^3), and the volume for the small cells ranges from 62,980 m^3 (82,375 yd^3) to 65,331 m^3 (85,459 yd^3). Excavation of these CAD cells exceeds the volume from dredging operations from all the waterways projects..

This report section details the analysis of water column TSS concentration increases due to excavation of the PIN-CAD cells. The process of excavation is similar to maintenance dredging; a clamshell bucket (7 yd^3 [5.4 m^3]) is lowered to the bottom (~15 m [50 ft]), grabs the sediment, and the bucket is then raised to the surface, where the sediment is dropped into a barge. This cycle repeats every ~90 sec until the total volume is excavated (lasting up to several months). Water column TSS increases occur if some portions of the sediment become waterborne. Most of the sediment release takes place when the bucket contacts the seafloor. Additional sediment escapes from the bucket while the bucket travels up through water column, particularly if the bucket is not well sealed. Total sediment amount released (source strength of TSS) varies depending on the type of bucket (to be discussed in the next section).

This sediment loss during dredging serves as a TSS source to the water column for the entire period of dredging operation. The distribution of water column concentration of TSS away from the immediate site of operation is governed by how the sediment is transported, settled, and dispersed by ambient currents, in addition to the initial source strength. These processes were simulated by ASA's SSFATE (Suspended Sediment Fate) model.

SSFATE was jointly developed by ASA and the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC). SSFATE is to be one of a family of USACE models that simulate various dredging related activities (e.g., STFATE, dredged material disposal; MDFATE, multiple dump disposals; and LTFATE, long-term mound stability). It has been documented in a series of USACE Dredging Operations and Environmental Research (DOER) Program technical notes (Johnson et al., 2000 and Swanson et al., 2000).

4.1.1 Source Strength Estimation

Dredging operations using a clamshell bucket inevitably disturb the bottom sediments and cause a portion to suspend above the bottom. Sediment losses from the bucket occur during travel through the water column and as the bucket breaks the water surface. There can be additional losses if the excess liquid in the scow is allowed to flow overboard. Typical loss rate ranges 1.5 to 4% for various bucket types shown in Table 4.1.

Table 4.1. Typical loss rates for different bucket types.

Type of bucket	Loss (%)
Conventional bucket with over flow	4
Conventional bucket without over flow	2
Environmental bucket	1.5

From *DOER Technical Notes Collection* (ERDC TN-DOER-E12)

Newer buckets (environmental buckets) are designed to minimize resuspension and loss by using various measures, for example, better venting, rubber sealed bucket and level cut capability which reduces side collapsing. The use of such buckets is planned for this project so a loss rate of 1.5% was assumed.

Total suspended solids (TSS) source strength used in the model is the defined as the mass rate of sediment injected into the water column. It can be determined using the following parameters,

- Production rate = 214 m^3/hr (280 yd^3/hr equivalent to a bucket capacity of 7 yd^3 and a cycle time of 90 s)
- Solid fraction = 60% (average of 65.7% for NHB-202-3 and 53.4% for NHB-202-6)
- Sediment density = 2,600 kg/m^3 (162 lb/ft^3)

The mean release rate of sediment is then the quadruple product,

$$(\text{loss rate}) \times (\text{production rate}) \times (\text{solid fraction}) \times (\text{density}) = 1.8 \text{ kg/s}.$$

4.1.2 Sediment Characteristics Near the CAD Cell Site

One of the major factors that controls TSS concentration is how fast the sediment settles from the water column back to the bottom. In general, coarser materials have higher settling velocities while the finer materials stay in the water column much longer. By examining size fractions of sediment for the site, basic settling characteristics can be determined. The SSFATE model treats sediments as having five distinct size classes (Johnson, et. Al., 2000),

Table 4.2 SSFATE sediment size classes.

Class	Size (micron)	Description
1	0 – 7 micron	Clay
2	8-35	fine silt
3	36-74	medium fine silt
4	75-130	fine sand
5	>130	coarse sand

Figure 4-1 shows the distribution of sediment size classes obtained from samples from the proposed PIN-CAD cell site (see Figure 4-2 for locations of the sediment samples). Values of the all sampling stations were averaged (Table 4.3) and used in the SSFATE model.

Table 4.3 Average sediment size composition of samples from the PIN-CAD site.

Class	Description	Distribution (%)
1	Clay	25.1
2	find silt	19.0
3	medium fine silt	19.0
4	fine sand	16.5
5	coarse sand	20.5

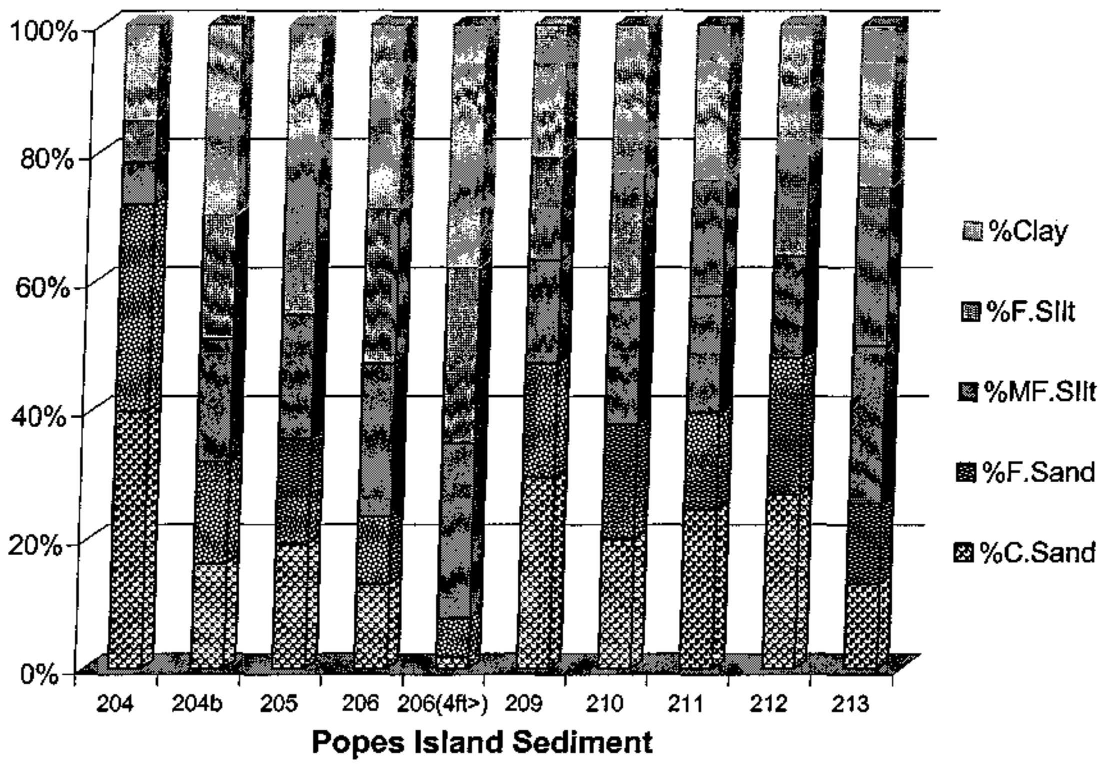


Figure 4-1 Sediment type distributions near the PIN-CAD cell site.

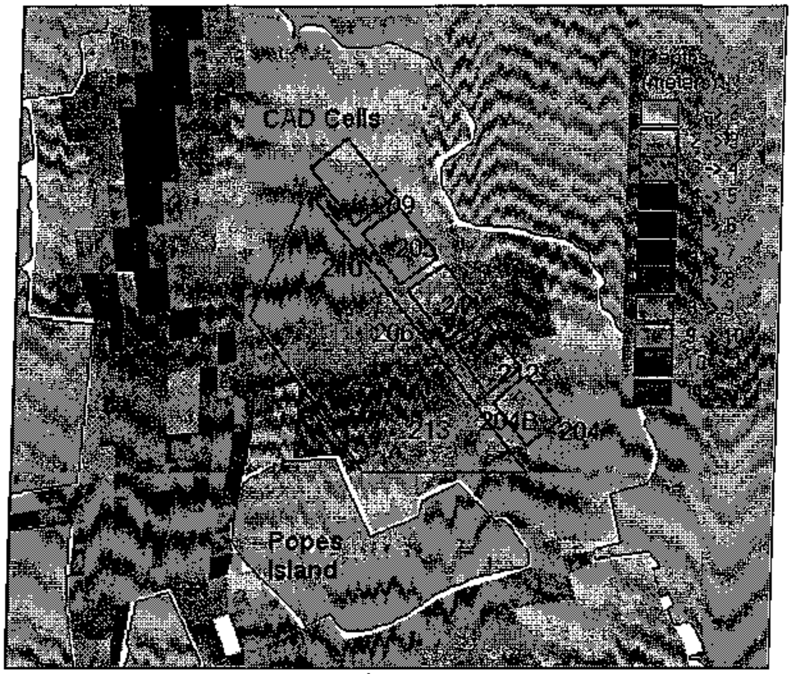


Figure 4-2 Map showing the PIN-CAD cells and sediment sampling stations.

4.1.3 Predicted TSS Concentrations

SSFATE simulations that represent CAD cell excavations using clamshell bucket dredging were performed for the nine typical hydrodynamic conditions described above. The center coordinate of the largest CAD cell was designated as a representative dredging operation location, which was fixed for the duration of the simulation. TSS concentration distributions due to the clamshell dredging reached a quasi-steady state within two tidal cycles (~1 day). All simulations were run for 3 days.

Presentation of simulation results are shown by:

- Horizontal and vertical views of TSS concentration distribution
- Acreage of the area exceeding various concentration levels
- Sediment mass balance

Figure 4-3 shows contours of the maximum TSS concentrations throughout the water column over the 3-day simulation period. A vertical section of the concentration distribution was inserted at the base of each plan view. Frames in the figure are organized such that rows display simulations for the three wind conditions and columns for the three different tides.

For the neap only condition (1st row), all TSS distributions appeared to be centered in the dredge site. Overall sediment plume sizes correspond to the tide strength. For the NWW wind cases, all sediment plumes trail to the lee side of the wind direction, whereas the opposite is found for the SWS wind cases. Similar results are obtained for mean and spring tidal conditions, except the size of plume increases with increasing tide range.

It is important to note that the instantaneous concentrations, which vary widely in time, are significantly smaller than the maximum TSS concentrations presented here.

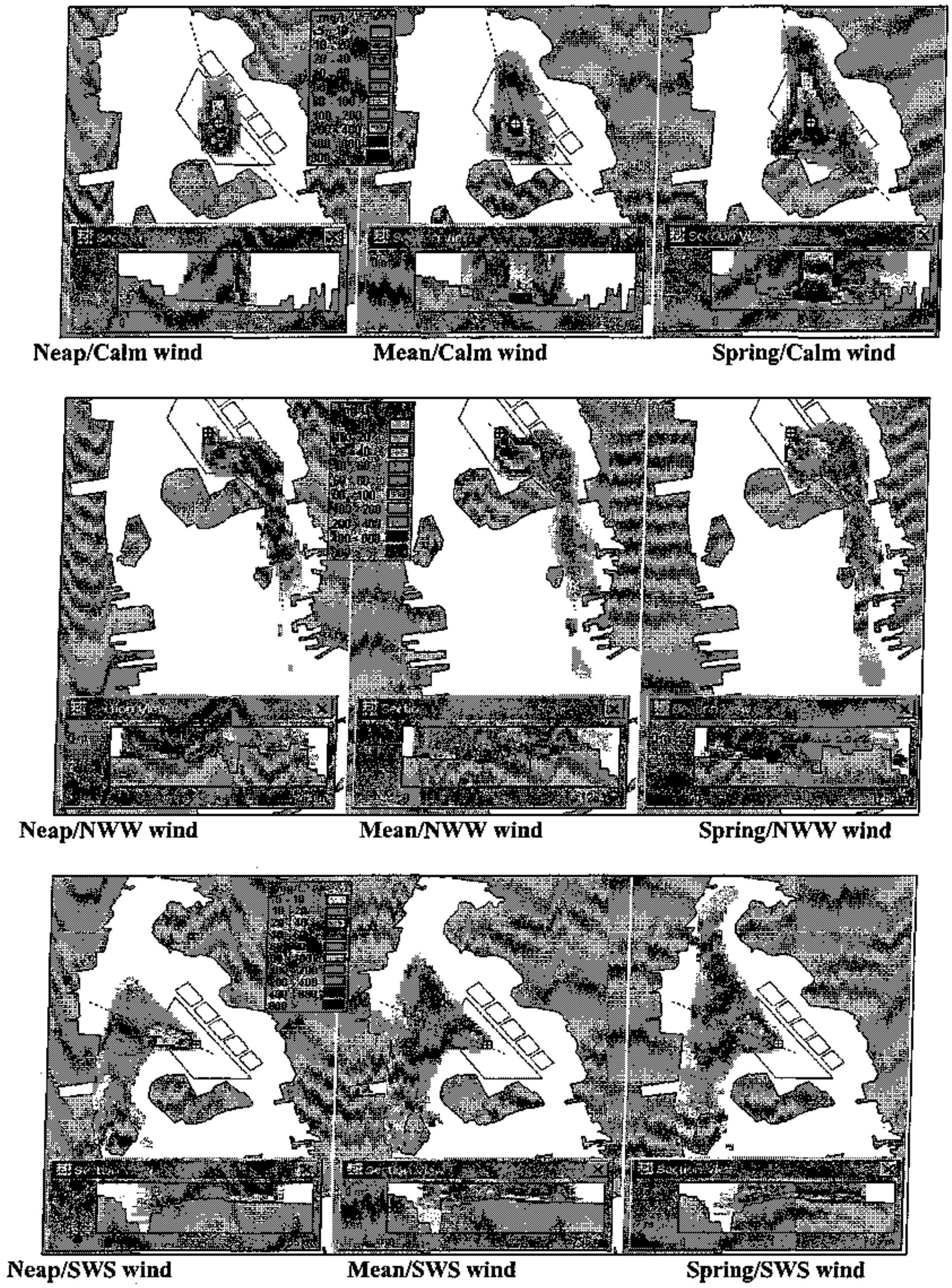


Figure 4.3 Maximum TSS concentrations for the nine circulation scenarios. Inserted in each plan view is a vertical section view along the dashed line.

Figures 4-4 through 4-6 shows the area coverage (acres) exceeding fixed TSS concentration levels in the same order as Figure 4-3. This is essentially the same information as contained in Figure 4-3, except it more direct area comparisons in a quantitative manner. Neap tide also results in smaller areas and spring tide results in larger areas than the mean tide. The analysis presented here did not include the ambient or background TSS concentrations which were sampled during the field program and typically ranged from 3 to 10 mg/L.

Figure 4-7 presents the mass of the fine fractions of sediment remaining in the water column after all settling has occurred. When the system reaches a quasi-steady state, the sediment mass introduced by dredging balances the mass that settles out, so the fraction of sediment that remains waterborne becomes constant. This water column sediment fraction is uniquely distributed by overall size and concentration among the hydrodynamic conditions.

For example, the water column sediment fractions in the NWW case and SWS case are ~2% and ~3%, respectively. This number indicates that the SWS case produces a larger sediment plume and a higher sediment fraction remaining in the water column, compared to the NWW case. This is caused by advection carrying sediments to the deeper waters, in contrast to the NWW case, in which sediments are transported to shallow water where more settling take place. In the case of calm wind conditions, the higher tide conditions have the higher water column sediment fraction. The reason is not obvious. However, there are two possible explanations: 1) the smaller tide range tends to form higher sediment concentrations, which in turn enhance the aggregative settling, 2) the lower tide (lower velocity) provides higher deposition probability (sediments can not be deposited if bottom velocity exceeds a certain threshold).

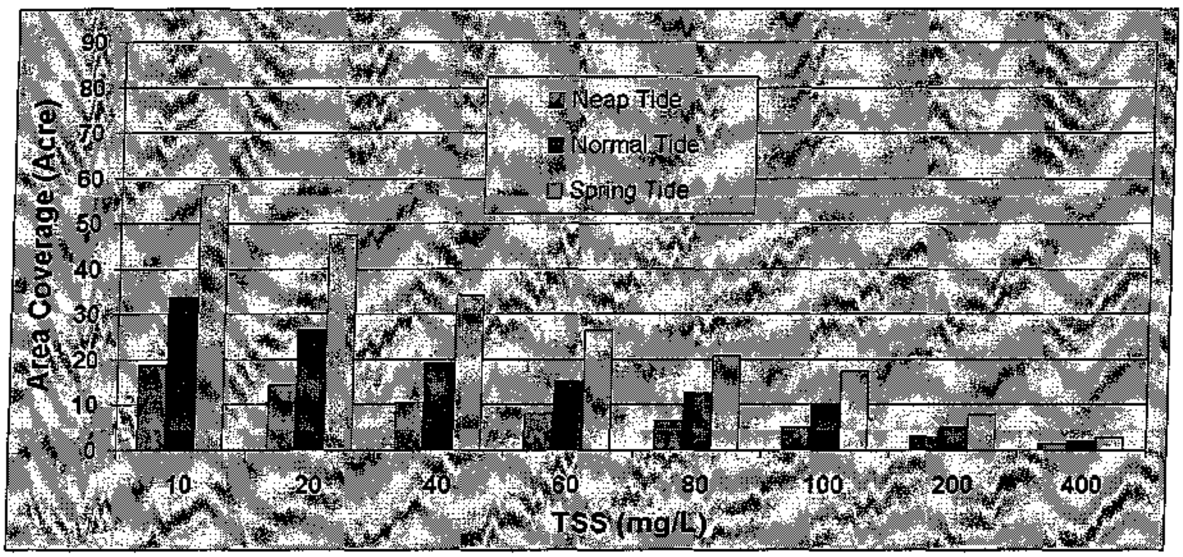


Figure 4-4 Area coverage (acres) of exceeding specified TSS concentration levels for the calm wind (tide only) condition.

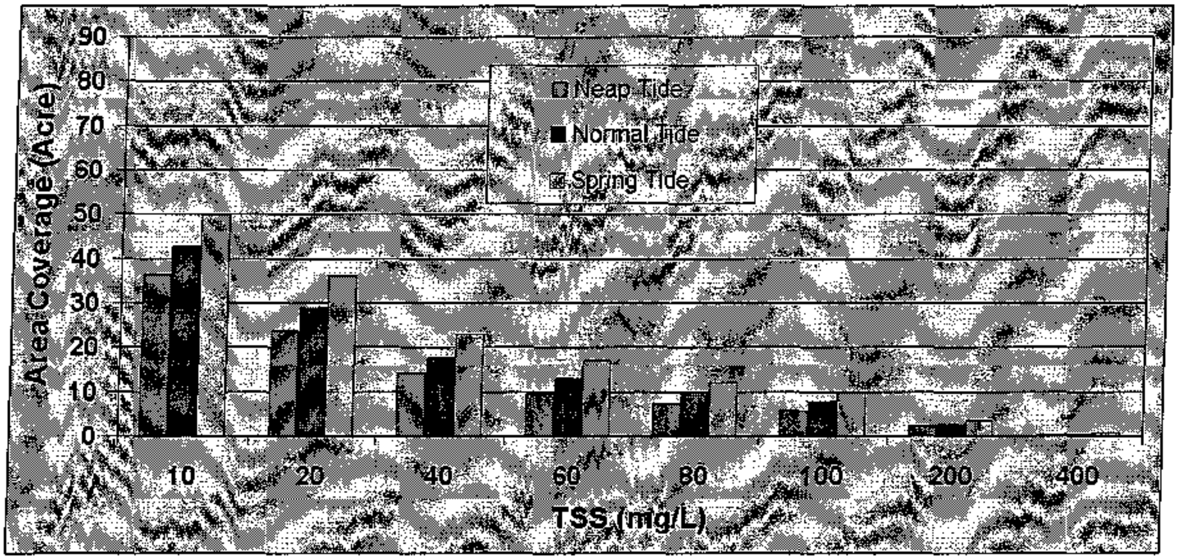


Figure 4-5 Area coverage (acres) of exceeding specified TSS concentration levels for the NWW wind case.

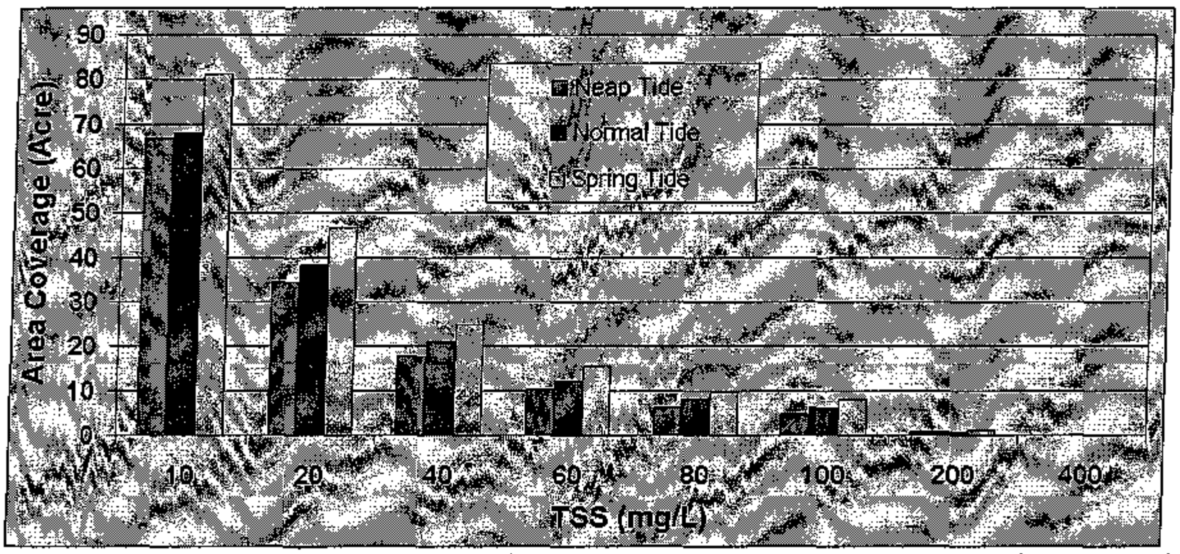


Figure 4-6 Area coverage (acres) of exceeding specified TSS concentration levels for the SWS wind case.

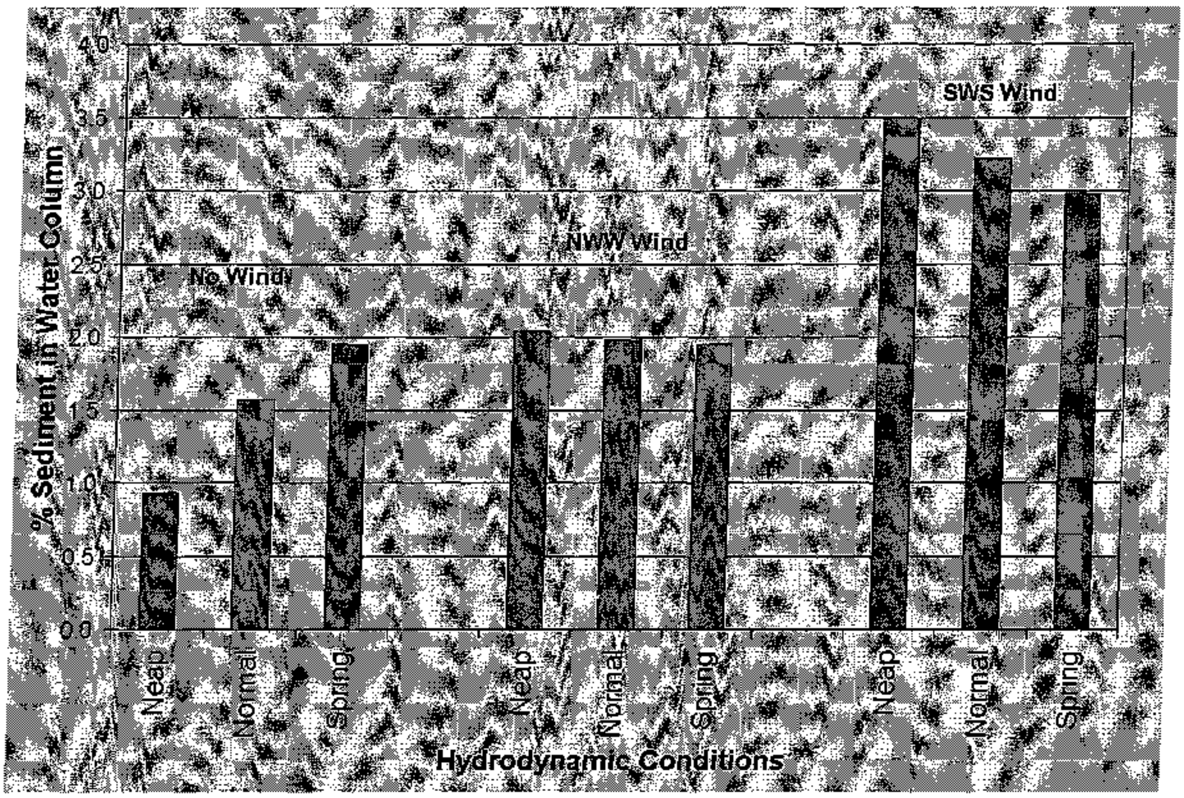


Figure 4-7 Sediment fractions in water column for various hydrodynamic conditions.

4.2 Single Event Disposal into Popes Island CAD Cell

In the previous section, simulations of the TSS increases in the water column due to CAD cell excavation were presented, in which a clamshell bucket operation continuously releases sediments. In this section, TSS concentration increases due to sediment disposal from a scow into the CAD cell is presented. Sediments dredged for channel maintenance and improvement are planned to be stored in a scow as the clamshell bucket removes sediments from the seafloor. When the scow becomes full, it will be moved from the dredging site to a location above the designated CAD cell. Then the scow bottom is opened and the entire contents released. As the sediment descends to the CAD cell floor, some portion of sediment is stripped and remains in the water column. The occurrence of those disposal events is controlled by the clamshell dredging speed of 214 m^3/hr (280 yd^3/hr) and the scow capacity of 1,530 m^3 (2,000 yd^3). At this rate, a disposal event will occur every ~12 hours. The approach to simulate TSS concentrations caused by a single scow disposal follows the same procedure employed in the previous section.

4.2.1 Source Strength Estimation due to Scow Disposal Events

Although excavated CAD cells have much deeper water depths (~17 m [56 ft]) than the original undisturbed depth (~2.6 m), the time for most of the sediment to reach the bottom is still very short (< 120 sec). This short time span cannot be directly simulated by SSFATE. Instead, the USACE model STFATE (Short-Term Fate dredged material disposal model) was used with equivalent input and environmental conditions. STFATE has various operational modes. One option is to simulate convective descent and sediment cloud collapse phase. This output was used to estimate initial source strengths and vertical distribution of waterborne sediment mass.

The estimated portion of the sediment that is stripped during descent has been estimated to be 1% of total sediment in the bucket (ENSR, 2002). Clamshell-dredged, cohesive material has a high proportion of clump content that tends to reach the bottom intact. This stripped loss estimate is comparable to those used in similar projects in Providence and Boston. The vertical distribution of waterborne sediment mass predicted from the STFATE model is given in Table 4.4. Most (85%) of the material immediately falls to the bottom and only 1% remains in the surface less immediately following disposal.

Table 4.4 The vertical distribution of waterborne sediment mass.

Percent of water column	Percent of sediment mass
90 (near surface)	1
70	2
50	4
30	8
10 (near bottom)	85

4.2.2 Sediment Characteristics of Dredged Materials

Figure 4-8 shows the distribution of sediment classes obtained from the Channel Inner CAD cell site (see Figure 4-9 for locations of the sediment samples). Some of the dredging is expected to take place at this location.. Averaged values of size distributions from these sampling stations were considered to be representative (Table 4.5). The distribution is very similar to the Popes Island one (Table 4.3).

Table 4.5. Representative sediment size class distribution.

Class	Description	Distribution %
1	Clay	20.1
2	Fine silt	17.7
3	Medium fine silt	17.7
4	Fine sand	20.1
5	Coarse sand	24.5

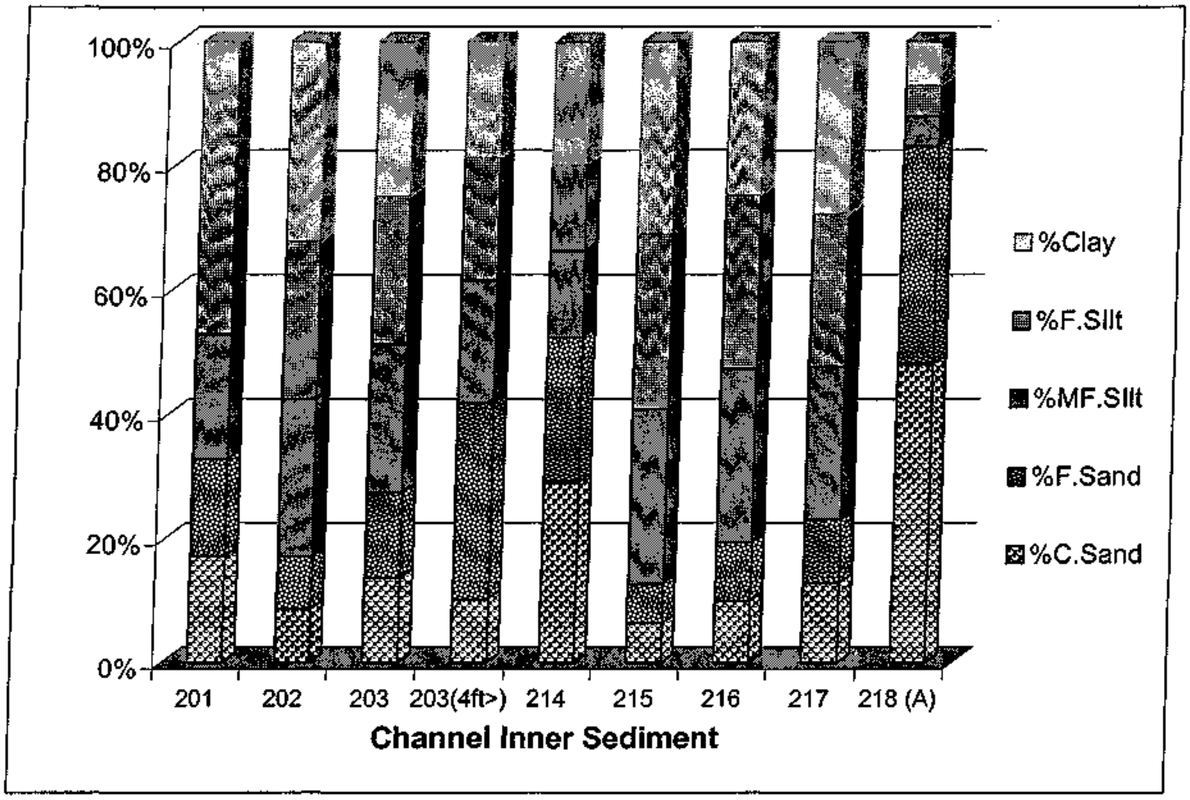


Figure 4-8 Sediment type distributions near Channel Inner dredging site.

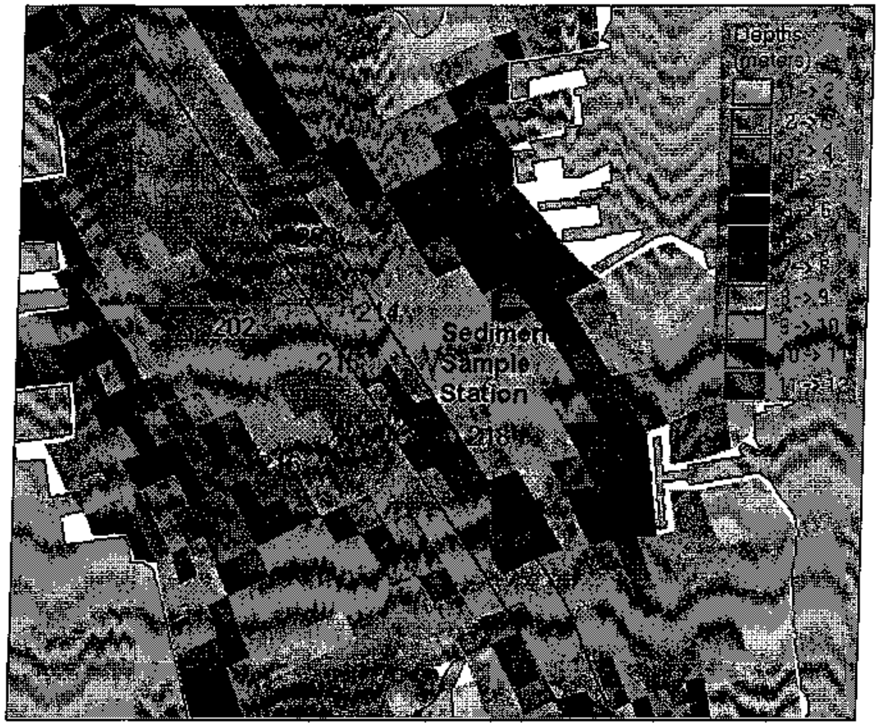


Figure 4-9. Map showing sediment sampling stations near Channel Inner dredge site.

4.2.3 Model Results for Dredged Material Disposal Operation

SSFATE simulations that represented the fate of the dredged material from disposal operations were performed for the nine hydrodynamic conditions. The bathymetry in which the circulation field was created is substantially deeper (~17 m [50 ft]) at the disposal site than the one used (~2.6 m [8.5 ft]) in the previous PIN-CAD cell excavation simulation. The center coordinate of the largest CAD cell was used as the representative disposal site. Unlike dredging operations, sediment disposal is much quicker. The simulation period was 12 hours.

The simulation results presented in this section include:

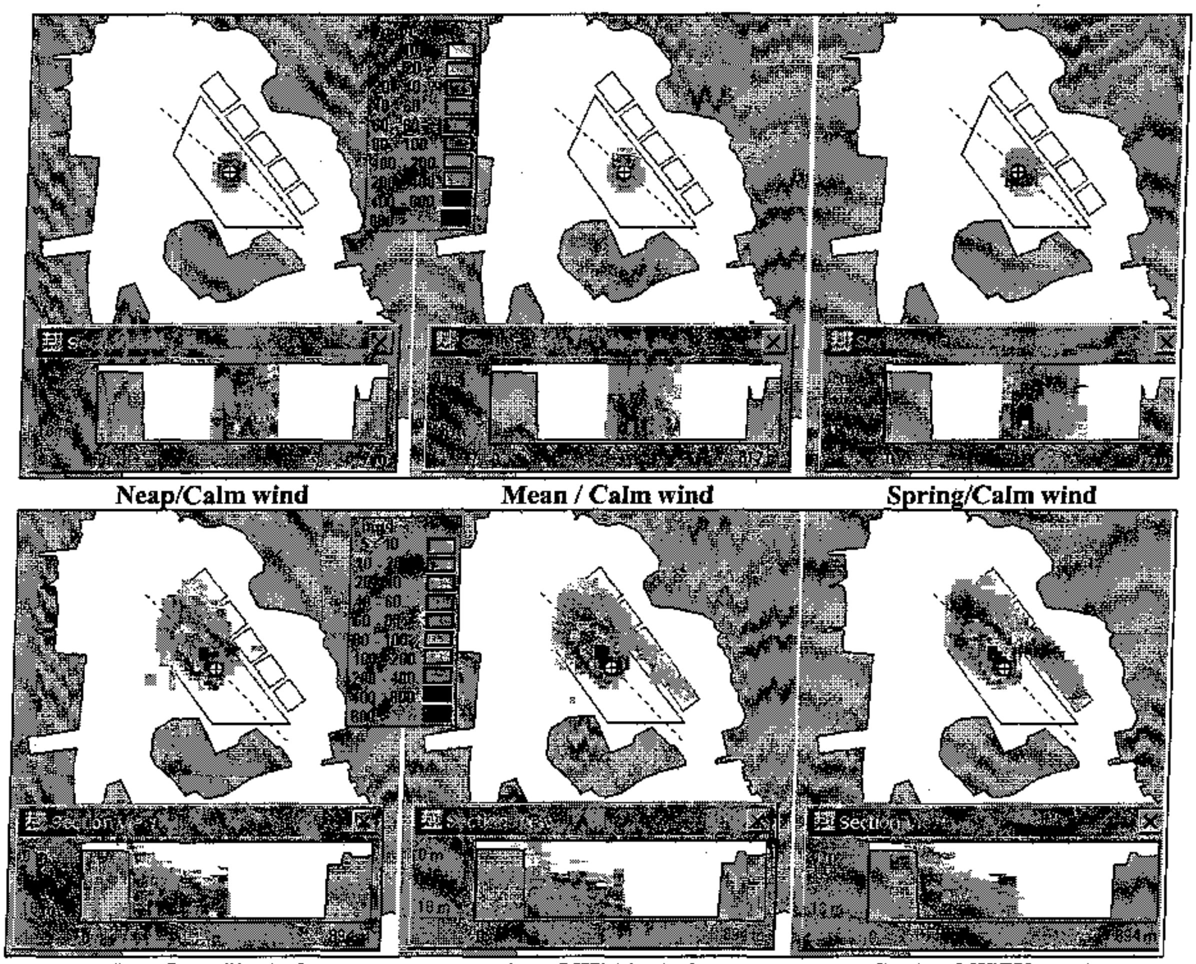
- Horizontal and vertical view of TSS distribution
- Time series of acreage of exceeding 10 mg/L concentration levels

Figure 4-10 shows a plan view of the maximum predicted TSS concentrations throughout the water column during the 12-hour simulation period. Inserted is a vertical section view of the concentration. The frames in the figure are organized by row (wind conditions) and columns (tide conditions). The rows correspond to calm wind, NWW wind and SWS wind from top to bottom, and the columns correspond to neap, mean, and spring tide from left to right.

All TSS concentration distributions for the tide only scenarios were confined within the PIN-CAD cell since the circulation is too weak (see Figure 3-16) to transport material very far. For the NWW and SWW wind cases, sediment clouds reach the edge of the CAD cells, although most of the sediment remained in the cell. The direction of sediment drift corresponded to the flow guided by a combination of the surface wind stress and the bathymetry of the CAD cell.

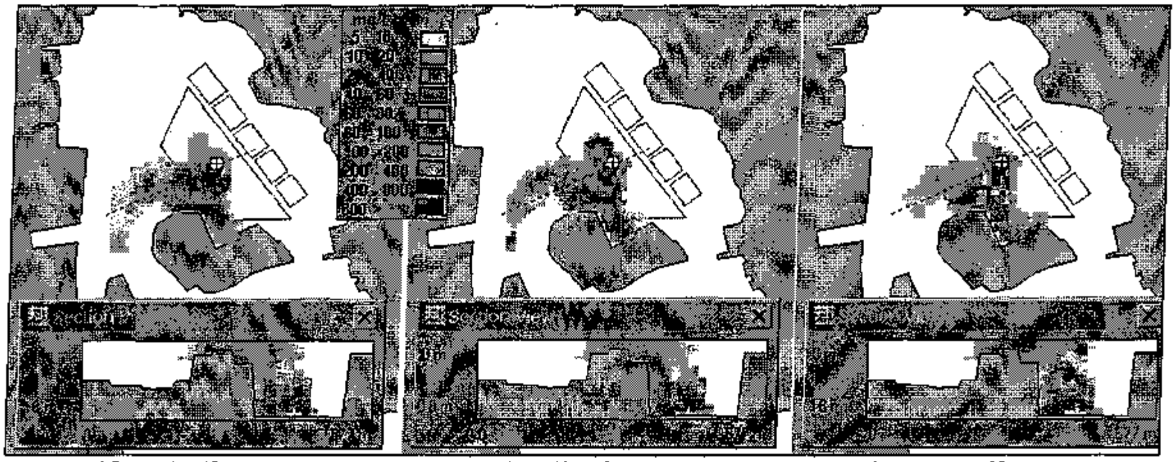
The NWW wind case transported the bottom sediment to the northwest and the SWS wind case transported the sediment to the southwest. It is important to note that the instantaneous concentrations, which varied widely in time, was significantly smaller than the maximum TSS concentrations presented here.

Figure 4-11 shows the area coverage that exceeds a TSS concentration of 10 mg/L (approximately the background threshold) in time. For the case of wind driven circulation, the sediment cloud dissipates within ~ 3 hours. The calm wind tide cases take much longer to settle as most sediment stays in the deep area (~17 m) and so the vertical travel time is increased.



Neap/Calm wind **Mean / Calm wind** **Spring/Calm wind**

Neap/NWW wind **Mean/NWW wind** **Spring/NWW wind**



Neap/SWS wind Mean/SWS wind Spring/SWS wind

Figure 4-10 Maximum TSS concentrations throughout water column and duration of simulation for the nine hydrodynamic scenarios.

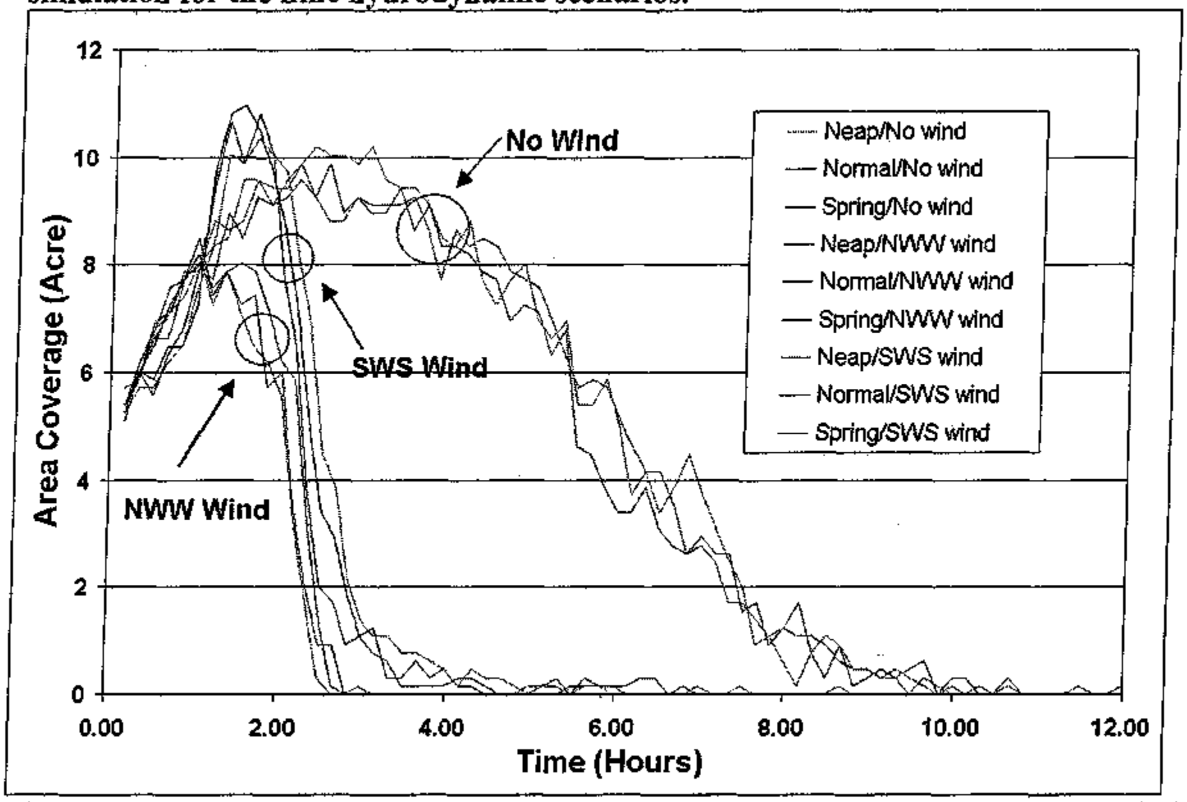


Figure 4-11. Time series of area coverage (acre) that exceeds TSS concentration of 10mg/L for the nine hydrodynamic scenarios.

5. Pollutant Transport Modeling

5.1 BFMASS Model

The BFMASS model, a component of the WQMAP pollutant transport model system, is a single constituent transport model, which includes first order reaction terms. This model is suitable for a single constituent contaminant that is conservative, settles, decays, or grows. This model was used in this application to predict the temporally and spatially varying concentrations associated with transport of equilibrated sediment contaminants (e.g. hydrocarbons and metals) in dissolved phase (i.e. a conservative constituent).

In BFMASS the two- or three-dimensional advection-diffusion equation is solved on the same boundary conforming grid as the hydrodynamic model, BFHYDRO. The model obtains the face-centered, contra-variant velocity vector components from the hydrodynamic model. This procedure eliminates the need for aggregation or spatial interpolation of the flows from the hydrodynamic model and assures mass conservation. The transport model is solved using a simple explicit finite difference technique on the boundary conforming grid (ASA, 1997). The vertical diffusion, however, is represented implicitly to ease the time step restriction caused by the normally small vertical length scale that characterizes many coastal applications. The horizontal diffusion term is solved by a centered-in-space, explicit technique. The solution to the advection-diffusion equation has been validated by comparison to one- and two-dimensional analytic solutions for constant plane and line source loads in a uniform flow field and for a constant step function at the upstream boundary. The model has also been tested for salinity intrusion in a channel (Muin, 1993).

5.2 Model Application

5.2.1 Disposal Operations

Contaminated dredged material will be buried in the confined aquatic disposal (CAD) facility that is proposed north of Popes Island (PIN). There are two types of dredging operations that will use the facility that are classified large and small volume projects. Since the extent or likelihood of large projects are uncertain at this time, pollutant transport and fate simulations were focused on disposal activity for a small project whose volume is on the order of 30,600 m^3 (40,000 yd^3). Table 5-1 lists the details of a likely disposal activity in addition to the associated dredging operation. These details were developed jointly with Maguire personnel. The use of two split-hull scows were assumed, alternating to carry and dispose dredged material during two 12-hr shifts per day. Dimensions of each barge were 3 m (10 ft) wide by 76 m (250 ft) long with a holding capacity of 1,530 m^3 (2,000 yd^3).

Table 5-1. Assumed details for dredging and disposal operations in New Bedford Harbor.

Operation	Parameter		Detail
Dredging	Dredging Sites		Maneuvering channel, berth, wharf, inner federal navigation channel
	Dredging Project Volume		30,600 m (40,000 yd^3)
	Composition of dredged material (%)	Contaminated material	90
	Types of dredging operation for	Contaminated material	Continuous
	Dredging equipment used for	Contaminated material	Environmental bucket

	Bucket capacity	Environmental bucket	5.4 m^3 (7 yd^3)
	Dredging rate (min/grab)		1.5
	Duration of dredging operation (day)		6
	Number of concurrent dredging operations		One
	Time of dredge operations		1 June 2003 ~ 1 January 2004
	Loss rate during dredging operation		1.5%
Disposal	Disposal Site Location		Popes Island North
	Number of scows		2
	Scow Capacity (yd^3)		1,530 m^3 (2,000 yd^3)
	Dimension of scow		3 m (10 ft) wide × 76 m (250 ft) long
	Type of scow		Split-hull
	Duration of disposal operation (sec)		5
	Typical cycle from barge loading to disposal (hour)		12

5.2.2 Source Strength

The source strength is the mass of pollutant entering the system on a rate basis. Three types of source strengths can be specified in BFMASS: 1), an instantaneous release; 2), a constant release over time; and 3), variable release over time. An instantaneous source release is the mass of material released to the water column from an entire split-hull barge load in a second. A constant source is defined as the mean loading to the water column from multiple barge releases over time. A variable source is the time varying loading to the water column as individual barge releases occur according to a time schedule.

The disposal operation of dredged material in New Bedford Harbor is assumed to take place twice a day over a 6-day period for a typical small project (Table 5-1). To simulate the operation, a series of 12 instantaneous releases of a volume of 1,529 m^3 (2,000 yd^3) occurred once every 12 hours.

A conservative estimate of the mass of pollutant released from the disposal of dredged material can be determined from the elutriate analysis data (EPA, 1991). Elutriate pollutant concentration data are reported on a mass of pollutant to volume of water basis (i.e. mg/L) based on an initial 200 g of wet sediment mixed with 800 g of site water. (SAIC, 2003). Since the elutriate test is designed to measure the dissolved fraction of pollutant in liquid portion, the mass of pollutant can be approximated as the product of the elutriate concentration E and the volume of water V. Assuming the wet sediment is composed of 50% water and 50% sediment particles the total volume of water is its mass, 900 g, divided by its approximate density, 1000 g/L, to give V = 0.9 L. Thus a pollutant mass, m, is

$$
\begin{aligned}
m\ (\mu g) &= EV \\
&= E\ (\mu g/L) \times 0.9\ (L) \qquad (1) \\
&= 0.9\ E\ (\mu g)
\end{aligned}
$$

is generated from every 200 g of wet sediment. The total amount of pollutant released from the total sediment volume released from a 1,530 m^3 (2,000 yd^3) barge, M (g), is

$$M\ (g) = m\ (\mu g) / 200\ (g) \times D\ (m^3) \times C\ (gL/10^3 m^3 \mu g), \qquad (2)$$

where D is the total sediment volume released in m^3, and C is a unit conversion factor, (10^3 L/m^3) × (g/10^6μg).

5.2.3 Settling Velocity

The settling velocity acts as a mechanism to remove suspended sediment from the water column. It varies with the type (cohesive or non-cohesive) of material and particle size. Since we are considering dissolved phase contaminants in these disposal simulations, no settling velocity was applied.

5.2.4 Release Location

The PIN-CAD facility is excavated to an average depth between 11.6 m (38 ft) and 17.4 m (57 ft), to accommodate 734,000 m^3 (960,000 yd^3) of dredged material in a total of 6 cells generated from projects over the next 10 years. Except for cell 1 that is the largest, potentially storing 1,408,000 m^3 (1,841,000 yd^3) of sediment, cells 2 through 6 are similar in size and each can hold approximately 39,000 m^3 (51,000 yd^3) volume (Figure 5-1). Since the estimated size of a small cell (86 m long by 65 m wide) is slightly larger than a typical model grid cell at the PIN-CAD facility, the cell size is too small to accurately simulate. Therefore, simulations of disposal operations will focus on the much larger cell 1.

Since cell 1 will be filled in progressively, we simulated disposal operations as three separate operations as representative of the continuous activity, having release locations at the center, the northwest and southeast corners of the CAD-site (Figure 5-1).

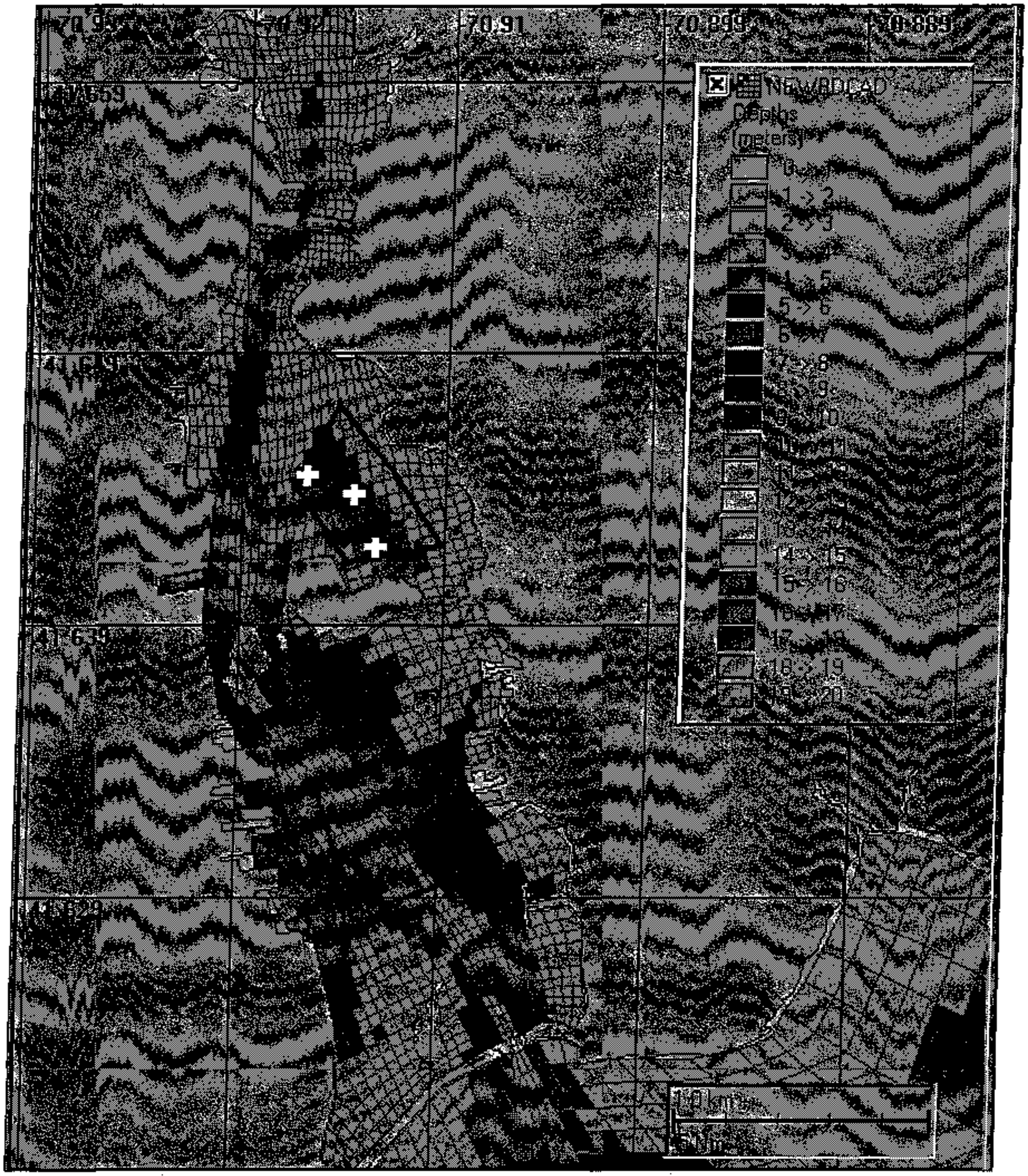


Figure 5-1. Modeled mass load locations (white crosses) used to simulate disposal operations in PIN-CAD site (black polygon), superimposed on bathymetry.

5.2.5 Toxic Pollutants

Simulations of the fate and transport of pollutants were performed on constituents whose elutriate concentrations exceeded U. S. EPA water quality chronic levels. Analysis of elutriate samples in New Bedford Harbor (SAIC, 2003) showed that most of the stations located at dredging and disposal sites contained elevated concentrations of Aluminum (Al), Copper (Cu), Nickel (Ni), Silver (Ag) and Polychlorinated Biphenyls (PCB). Benzo(a)fluoranthene and Benzo(k)fluoranthene, part of high molecular weight (HMW) (Petroleum Aromatic Hydrocarbon), also exceeded the USEPA chronic levels at some stations.

As part of modeling input, the mass of the pollutant source is required for each contaminant. Table 5-2 lists the source strengths calculated from equations (1) and (2). Also shown are U. S. EPA water quality chronic criteria and the dilution required to lower elutriate concentrations to meet the criteria.

None of pollutants exceed the U. S. EPA water quality acute level except copper (4.8 ug/L) at NBH-202 and NBH-207 stations. Only Al, Cu, Ag and PCB exceed the chronic levels. The dilution of elutriate concentration for PCB to meet the chronic level ranges between 11 and 67. Copper has the next highest required dilutions (1 to 32) followed by silver (14). Station NBH-202, located at the Channel Inner CAD site, has the highest concentrations for all constituents shown in the table. The next highest concentrations are from station NBH-207, located at Fish Island.

5.2.6 Other Model Parameters

Primary physical processes governing the fate and transport of disposed material are advection and diffusion. The former is due to the currents that are predicted from the hydrodynamic modeling. The latter includes horizontal and vertical diffusion which are specified as model inputs. The vertical diffusion coefficient used was 50 cm^2/sec (0.05 ft^2/s), typical of estuary systems (Officer, 1976), and the horizontal diffusion was 1000 cm^2/sec (1.09 ft^2/s), determined from a dye study in the lower Acushnet estuary (ASA, 2003).

Table 5-2. Pollutant constituents, elutriate concentrations, source strengths and dilutions for disposal operations at the PIN-CAD site. Dilution is the ratio of elutriate concentration and chronic criteria concentration.

Station	Pollutant	Elutriate Conc* (μg/L)	Source Strength (g)	WQ Chronic (μg/L)	Dilution
NBH-201	Al	161	2021.7	87	2
	Cu	7.1	89.2	3.1	2
	Ni	13.5	169.5	8.2	2
	Ag	1.4	17.6	0.1	14
	PCB	1.72	21.6	0.03	57
NBH-202	Al	2320	29132.0	87	27
	Cu	97.8	1228.1	3.1	32
	Pb	13.4	168.3	8.1	2
	Ni	13.5	169.5	8.2	2
	Ag	1.4	17.6	0.1	14
	PCB	23	288.8	0.03	767
NBH-204	Al	577	7245.3	87	7
	Cu	4	50.2	3.1	1
	Ni	13.5	169.5	8.2	2
	Ag	1.4	17.6	0.1	14
	PCB	0.34	4.3	0.03	11
NBH-205	Al	346	4344.7	87	4
	Cu	10.8	135.6	3.1	4
	Ni	13.5	169.5	8.2	2
	Ag	1.4	17.6	0.1	14
	PCB	0.88	11.1	0.03	29
NBH-206	Al	216	2712.3	87	3
	Cu	7.1	89.2	3.1	2
	Ni	13.5	169.5	8.2	2
	Ag	1.4	17.6	0.1	14
	PCB	1.22	15.3	0.03	41
NBH-207	Al	853	10711.0	87	10
	Cu	39	489.7	3.1	13
	Ni	13.5	169.5	8.2	2
	Ag	1.4	17.6	0.1	14
	PCB	5.69	71.4	0.03	190

5.3 BFMASS Modeling Results

This section documents the results of the fate and transport simulations of contaminants disposed at the PIN-CAD site in Inner New Bedford Harbor. Simulations were performed using a three-dimensional (7-layer) application of BFMASS. Three different tides (spring, neap and mean tides), and three wind conditions (calm, northwesterly and southwesterly winds) were chosen as representative of the range of likely environmental conditions.

All modeled constituents were released at the end of flood portion of the M_2 tidal cycle, so that the subsequent ebb currents transported the constituents in the water column south toward the Hurricane Barrier.

Elutriate concentration data (Table 5-2) shows that dredged material from station NBH-202 (located at the proposed CAD-CI) was more highly contaminated compared to the other stations. For example, the PCB elutriate concentration was 767 times the U.S. EPA chronic level (U. S. EPA, 2002). This is four times higher than the next highest PCB concentration found at station NBH-207 (located at Fish Island) and 70 times higher than the lowest at station NBH-204 (also located at CAD-CI). This section documents model results in detail for the worst contaminant case, NBH-202 PCBs, and then presents the results in more generalized format for the rest of contaminants and stations.

The BFMASS simulation results indicated that the contaminant distribution patterns in the horizontal and vertical were similar for the three tide ranges. Concentration levels, however, were higher in the near field for neap tides than for spring tides because more energetic currents during the spring tides promote more dispersion and mixing. Different wind conditions resulted in different spatial distribution patterns and coverages. For example, Figure 5-2 PCB shows concentration levels 1 hour after the final disposal event for calm, southwesterly and northwesterly winds. Background hydrodynamics were driven by neap tides. During calm conditions (Figure 5-2a), the simulated plume is more concentric, exhibiting the highest concentration at the release site, whereas the plume is oriented in the down-wind direction forming an elliptic shape (Figures 5-2b and 5-2c). The vertical distribution of contaminant confirms the plume pattern, exhibiting a larger shift toward the down-wind direction at the surface layer than in the lower layers.

Among the three wind conditions, spatial coverage (area exceeding a specified concentration) for the PCB WQ chronic concentration (0.03 ug/L) is the largest for calm wind and the smallest for northwesterly winds. Area coverages appear to have a distinct pattern for different ranges of concentration. Comparing between calm and southwesterly winds, the coverages without wind are larger for concentrations greater than 0.03 μg/L but smaller for lower concentrations. However, for calm conditions, the coverage is larger than for northwesterly winds. Although the same wind speed is applied to Figures 5-5b and 5-5c, smaller area coverages for concentrations larger than 0.05 μg/L and larger coverages for low concentrations ($\leq$ 0.05 μg/L) are predicted for southwesterly winds (Figure 5-2b). This is due to both tides and southwesterly winds, of which the latter advects contaminants to relatively open and deep areas where the former is also strong.

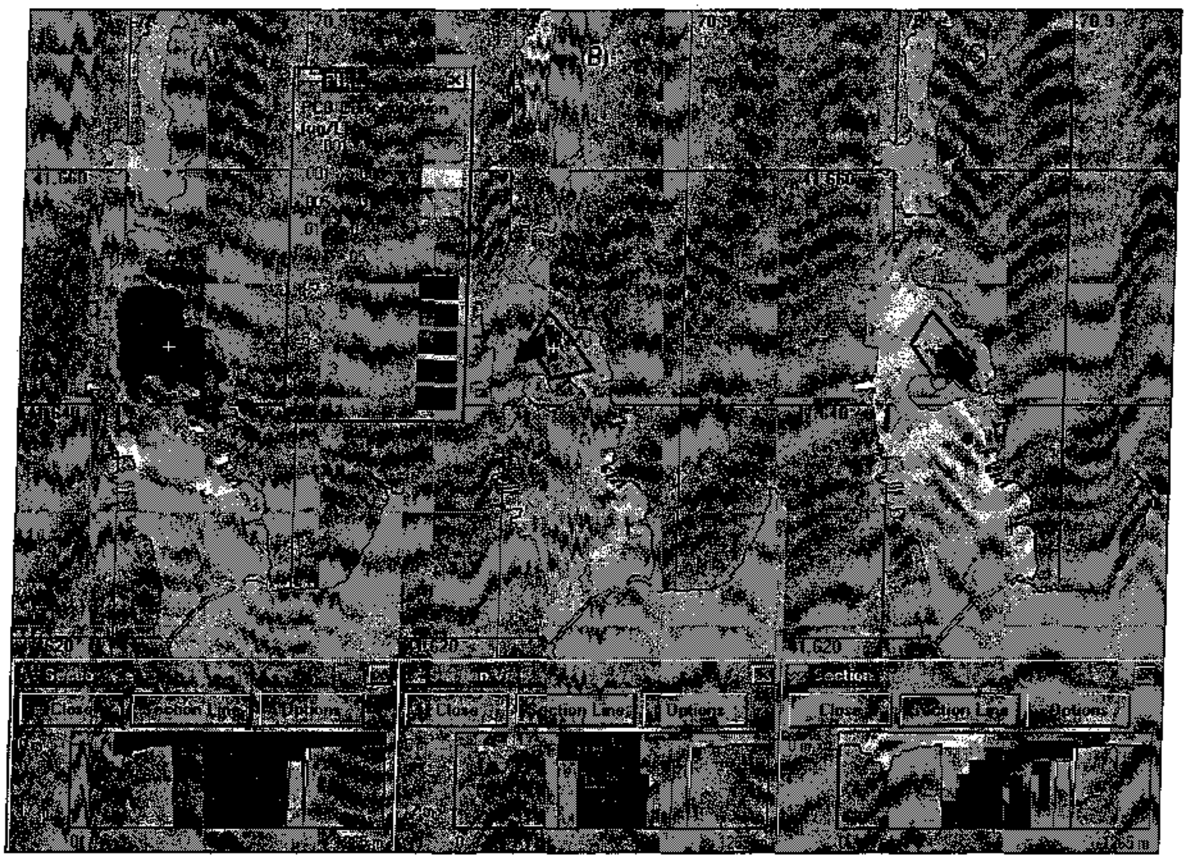


Figure 5-2. Simulated PCB distributions for calm wind (a), southwesterly (b) and northwesterly winds (c). Distributions are shown 1 hour after the final disposal event.

Among the nine environmental scenarios, the largest spatial coverage was predicted for neap tides and calm wind conditions. On the other hand, the smallest coverage occurred for neap tides and northwesterly winds. This finding was consistent among the three different release locations in the PIN-Cad cell. Figures 5-3 and 5-4 show the maximum area affected (coverage) due to released NBH-202 PCB as a function of concentration for the neap tide and no wind condition and the neap tide and northwesterly wind condition, respectively. The area of the PIN-CAD is shown for reference as is the U. S. EPA chronic water quality (WQ) concentration for PCB.

Under calm winds (Figure 5-3), the area coverage is always larger than the CAD area for concentrations less than 0.4 μg/L. The coverages at the PCB chronic level (0.03 μg/L) are 1×10^6 m^2 (southeast corner release) and 1.2×10^6 m^2 (center and northwest corner releases), which are between 6 and 7 times larger than the CAD cell area, respectively. The concentrations for an area the same as the CAD site area are 0.42 μg/L, 0.44 μg/L and 0.35 μg/L for a center, northwest and southeast release, respectively. While the calm wind condition simulates very similar coverages for the three release locations (Figure 5-3), a northwest release with northwesterly winds generates the largest coverage and a southeast release yields the smallest coverage (Figure 5-4). Spatial coverage for the 0.03

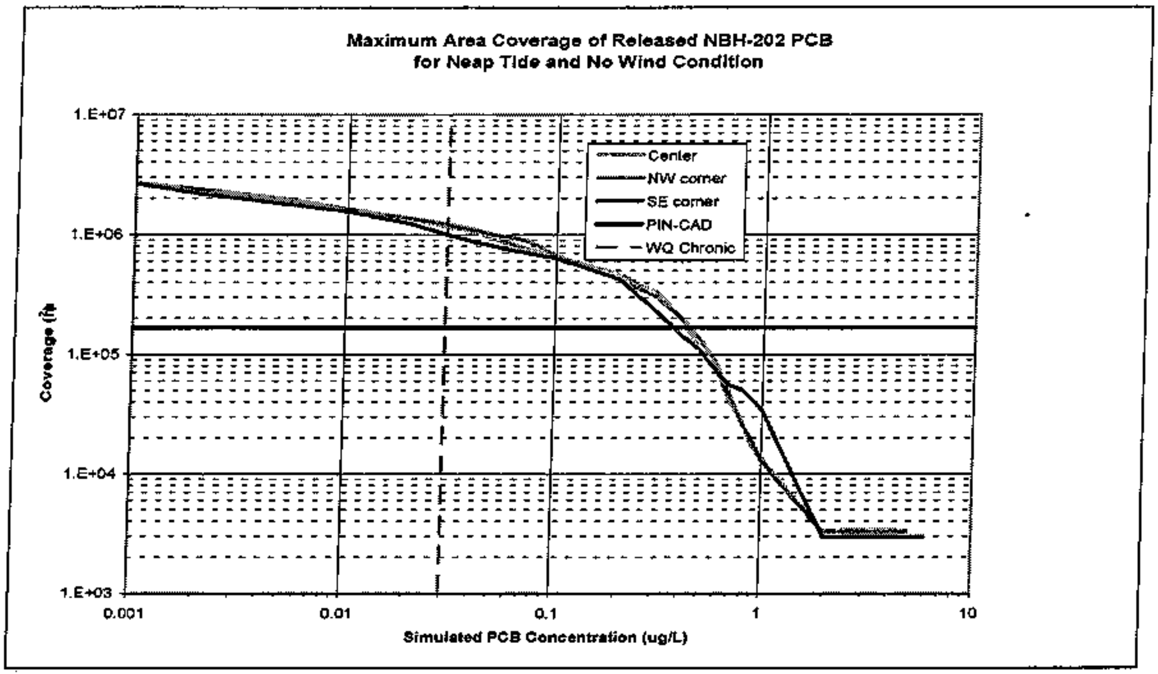


Figure 5-3. Maximum area coverages (y-axis) of PCBs vs. concentrations for neap tides and calm winds for three release sites using the NBH-202 station source strength. Both x- and y-axes are logarithmic scales. The PIN-CAD cell area (1.67×10^5 m^2) is shown with a black horizontal line and the U. S. EPA WQ chronic value for PCB (0.03 µg/L) is shown with a dashed vertical line.

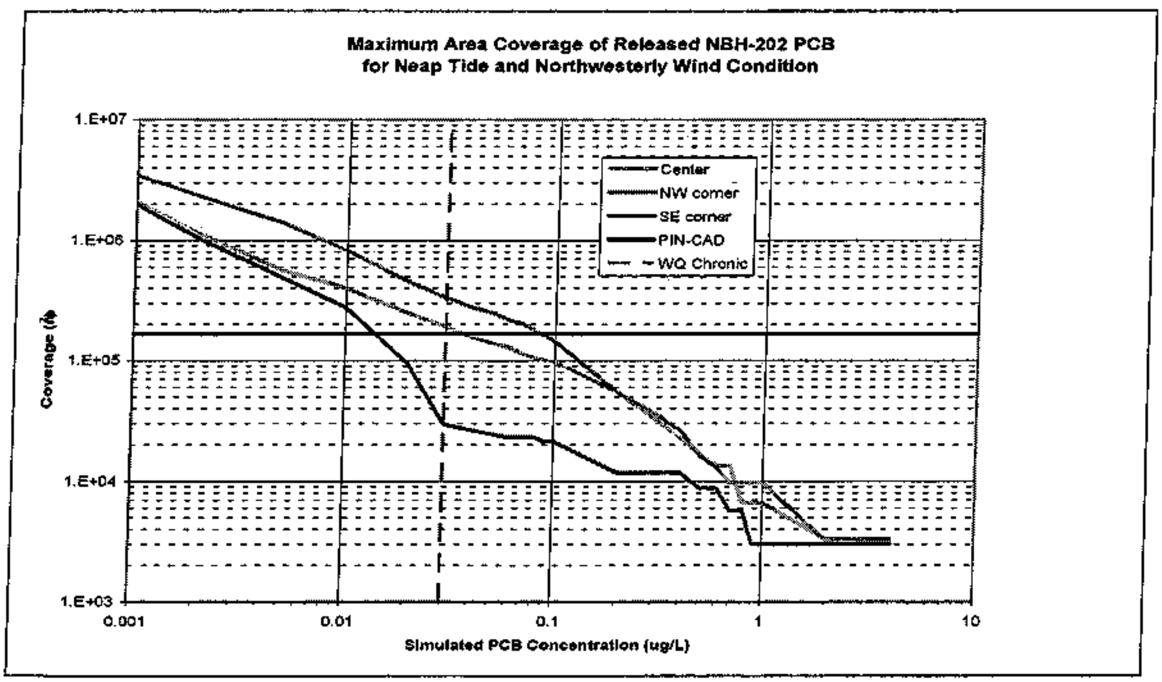


Figure 5-4. Maximum area coverages (y-axis) of PCBs vs. concentrations for neap tides and northwesterly winds for three release sites using the NBH-202 station source strength. Both x- and y-axis are logarithmic scale. The PIN-CAD cell area (1.67×10^5 m^2) is shown with a black horizontal line and the U. S. EPA WQ chronic value for PCB (0.03 µg/L) is shown with a dashed vertical line.

μg/L chronic concentration with wind is 0.3×10^6 m^2, 1.9×10^5 m^2, and 3.3×10^6 m^2 with southeast, center and northwest releases, respectively. The concentrations for areas equivalent to the CAD site area are 0.015 μg/L for a southeast release, 0.035 μg/L for a center release and 0.08 μg/L for a northwest release.

Figure 5-5a presents the same area coverages as Figure 5-3, except concentrations are shown relative to a unit input mass (g). In other words, Figure 5-3 can be obtained by multiplying the concentrations in Figure 5-5a by 288.8 (PCB source strength for NBH-202). The advantage of presenting the results in this way is that the simulated coverage is not pollutant- or site-specific. Hence, the results can be applied to any pollutant and any station by multiplying by the corresponding source strength listed in Table 5-2. Ni and Pb chronic criteria are almost identical so the Pb is not presented in the figure.

For example, using aluminum (Al) originating from station NBH-201, the concentration having the same size as the CAD cell is 3 μg/L (0.00158 μg/L × 2021.7) with the southeast corner release (red curve in Figure 5-5a). Areas for concentrations greater than 3 μg/L are smaller than the CAD cell. The coverage for the Al WQ chronic concentration (87 μg/L) is 5.5×10^4 m^2. Similarly for the center (blue in Figure 5-5a) and northwest releases (green in Figure 5-5a), the concentration covering the same size as the CAD cell is 2.5 μg/L (0.00126 μg/L × 2021.7) and spatial coverage for the chronic concentration is 2.2×10^4 m^2.

Overall, for neap tide and calm wind conditions both Al and Cu exhibit smaller area coverages than the CAD cell. Area coverage for Ag is either the same as or slightly larger than the area of the release cell (shown as the horizontal tail end of each curve). For Pb and Ni, predicted concentrations in the release cell are below the chronic level.

Figures 5-b and 5-c are the same as Figure 5-a, except for different wind directions, southwesterly and northwesterly, respectively. The difference between the two wind conditions is that the area coverage for southwesterly winds is almost constant for low concentrations and gradually decreases for high concentrations, whereas the coverage for northwesterly winds linearly decreases with concentrations. The coverages for Al, Cu and Ag chronic concentrations are smaller than the CAD cell size for both wind conditions. Predicted concentrations of Pb and Ni are always smaller than their chronic concentrations while PCB concentrations are larger.

During neap tides and calm winds (Figure 5-5a), the coverage is almost same regardless of release site. With winds (Figures 5-5b and 5-5c), the southeast corner release exhibits the largest coverage for southwesterly winds and the smallest coverage for northwesterly winds. The opposite exists for a northwest corner release, with a large coverage for southwesterly winds and small coverage for northwesterly winds.

Figure 5-6 shows maximum area coverages for spring tides and the three different wind conditions. Individual spatial coverage curves for spring tides appear very similar to those for neap tides (Figure 5-5). However, a comparison between Figures 5-5b and 5-6b for southwesterly winds shows that smaller coverages for spring tides are found with a southeast release, and relatively larger coverages for spring tides are predicted with a

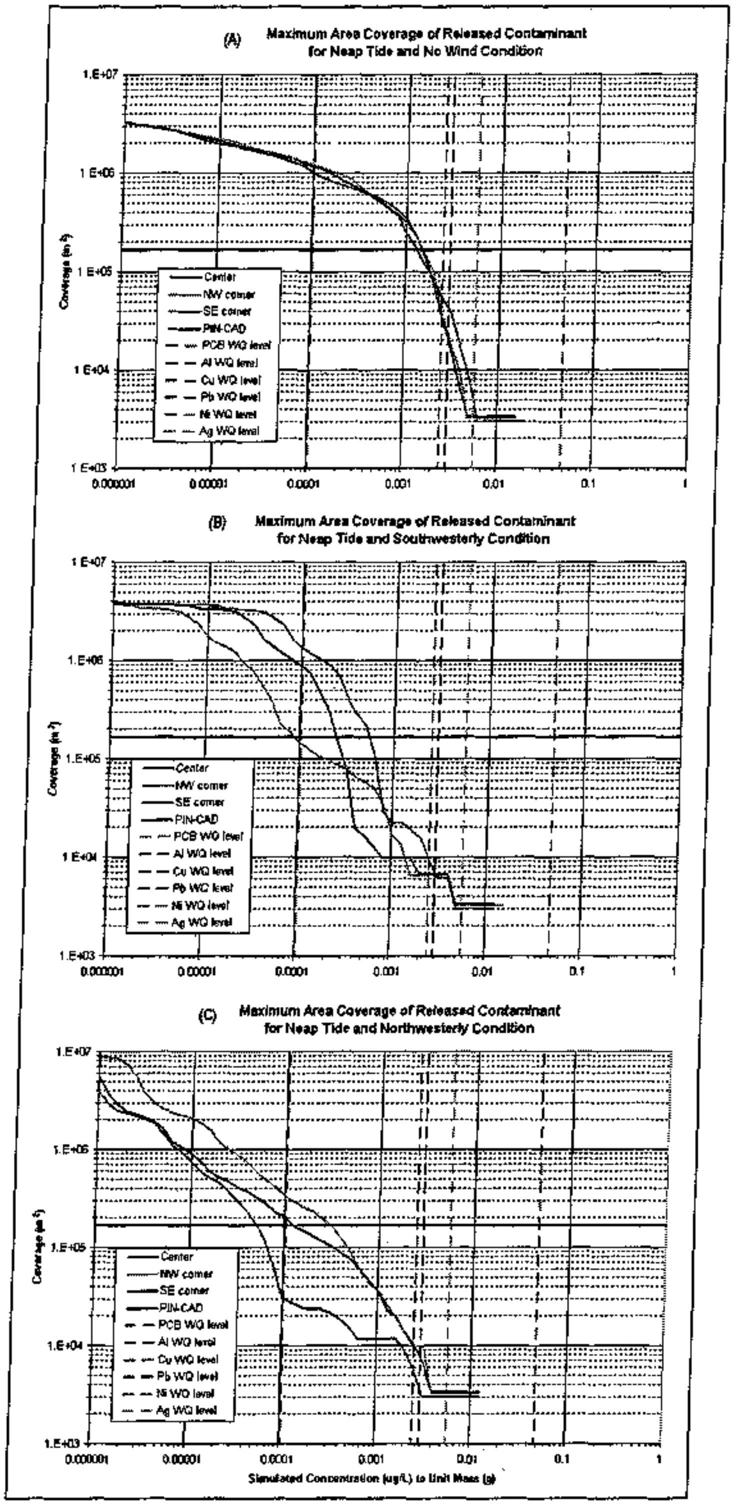


Figure 5-5. Maximum area coverages (solid lines) for neap tides and calm (a), southwesterly (b) and northwesterly winds (c). Dashed lines denote U. S. EPA WQ chronic concentrations normalized to input mass.

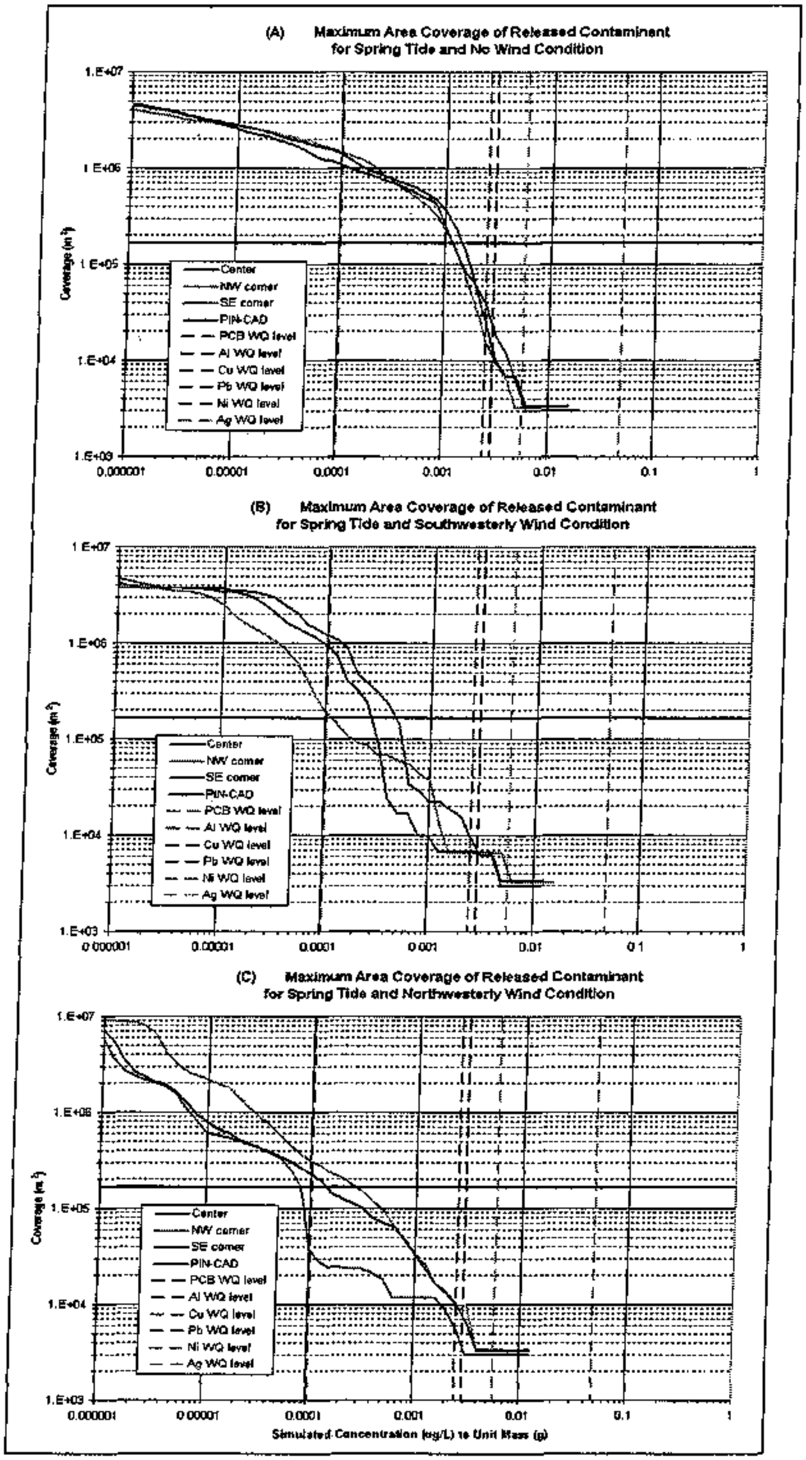


Figure 5-6. Maximum area coverages (solid lines) for spring tides and calm (a), southwesterly (b) and northwesterly winds (c). Dashed lines denote U. S. EPA WQ chronic concentrations normalized to input mass.

northwest release. For northwesterly winds between neap (Figure 5-5c) and spring (Figure 5-6c) tides, the coverage with a northwest release was the same for both tides but relatively larger coverage occurs for spring tides than neap tides with a southeast release.

Figure 5-7 shows maximum spatial coverages for mean tides and the three wind conditions. Variations in area coverage consistently lie between neap and spring tides, as expected.

According to toxicity tests using sediments from the stations listed in Table 5-2 with mysids and sea urchins reported by SAIC (2003), the cause of acute toxicity was the combination of multiple pollutants. For example, half the toxicity to mysids was due to PCBs and the other half was due to a combination of copper and ammonia. From these results, SAIC suggested that a dilution to at least 2.2% of the elutriate concentration would be protective.

Figure 5-8 shows maximum area coverages for a release of 1g of a combination of toxic pollutants. Presented are the coverages for the worst conditions (neap tide and calm wind) and the most favorable conditions (neap tide and northwesterly wind). For both conditions, area coverage for a concentration of 2.2% of the elutriate level was always smaller than the PIN-CAD area. The largest area coverage for the 2.2% elutriate concentration occurred for a northwest release during calm winds, 1.2×10^5 m^2. The smallest coverage for the protective dilution level occurred for a southeast release during northwesterly winds, 1.0×10^4 m^2.

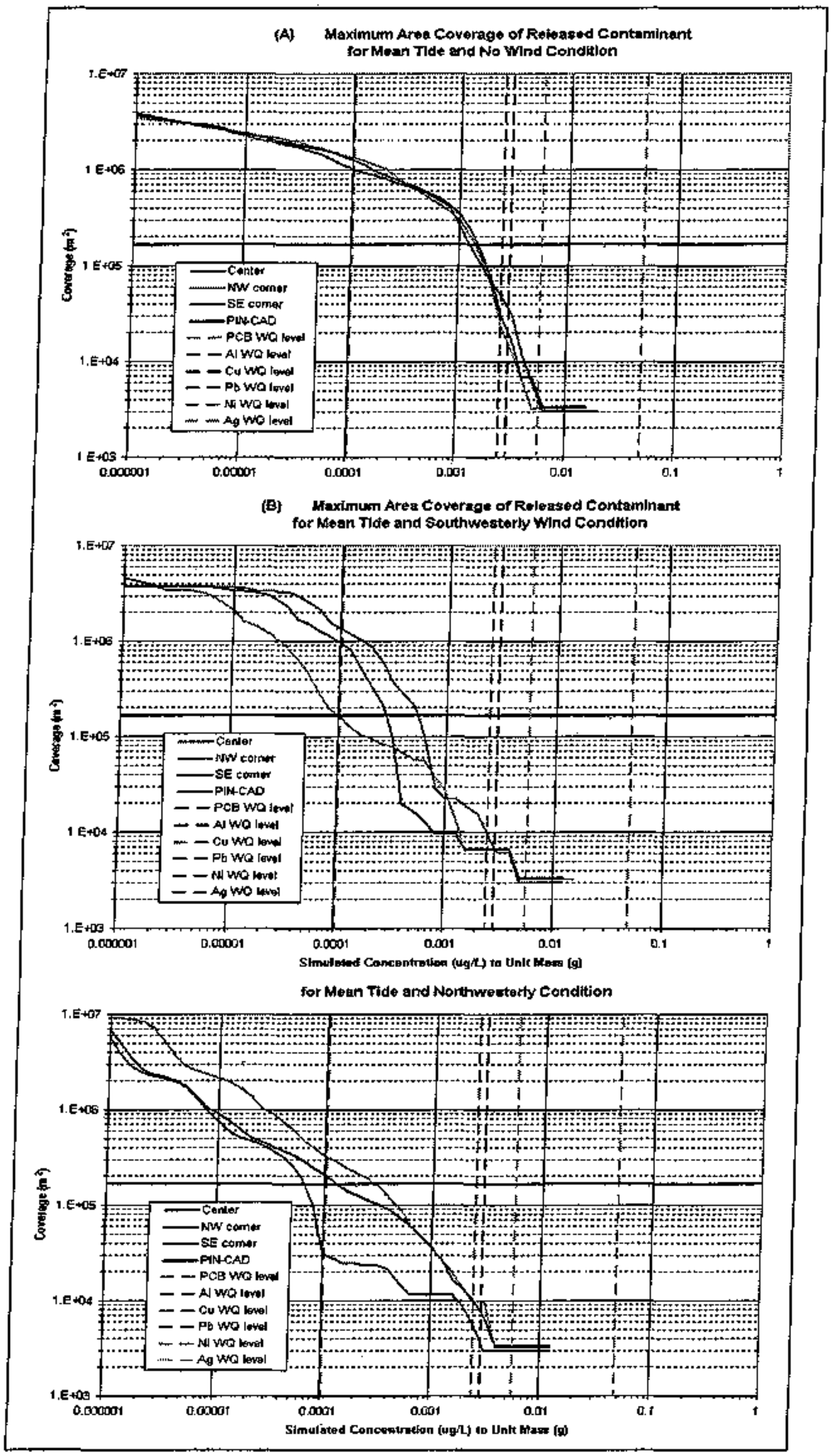


Figure 5-7. Maximum area coverages (solid lines) for mean tides and calm (a), southwesterly (b) and northwesterly winds (c). Dashed lines denote U. S. EPA WQ chronic concentrations normalized to input mass.

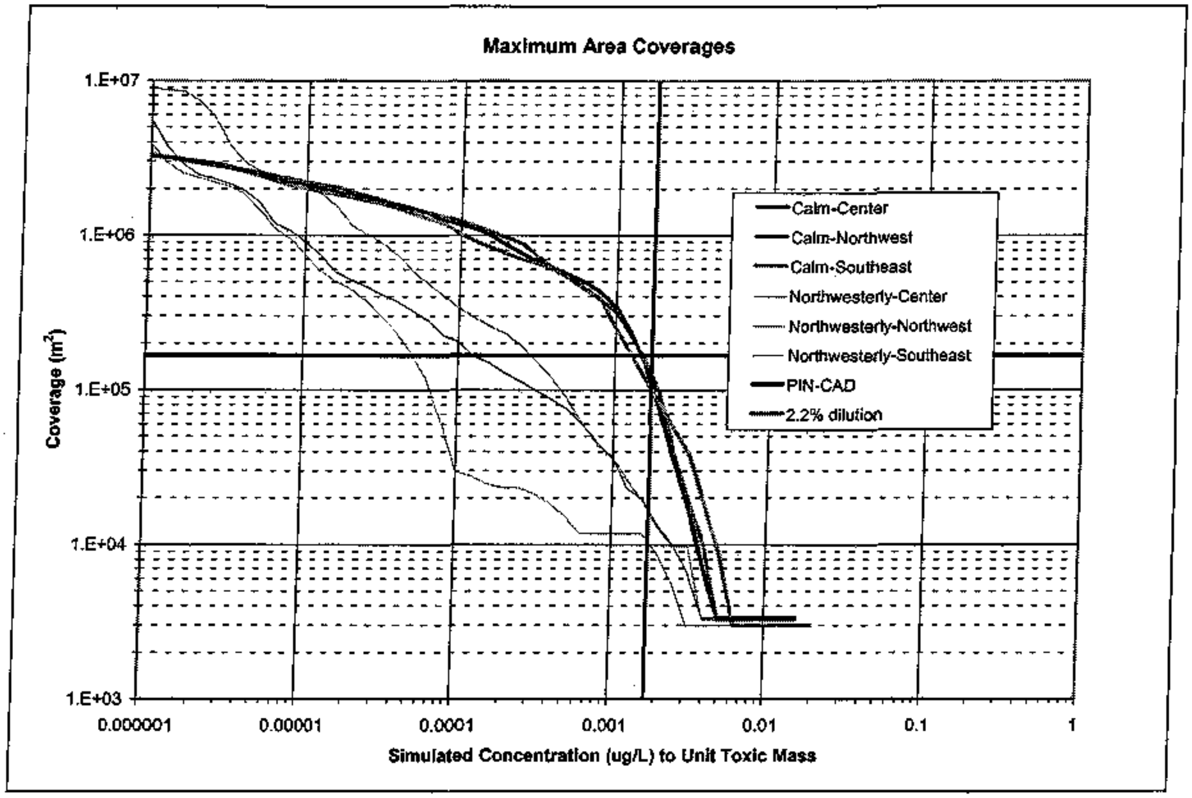


Figure 5-8. Maximum area coverage for released toxic material for calm and northwesterly winds.

6. Summary and Conclusions

The field-obtained elevations and velocities were examined to determine that tides and wind were the primary forces that drove the circulation in New Bedford Harbor. Hydrodynamic simulations were successfully conducted to verify model performance for the period of the field measurement program. Nine basic hydrodynamic conditions were prepared to provide the advection data to the pollutant and sediment transport models based on the combination of three tidal ranges (neap, mean and spring) and three most likely wind conditions (calm, southwesterly and northwesterly directions).

The SSFATE (Suspended Sediment Fate) model was used to simulate TSS (Total Suspended Solid) concentrations due to the proposed excavation of the CAD (Confined Aquatic Disposal) cells and the disposal of dredged material into one of the cells. Resultant TSS distributions showed that combinations of the wind induced circulation and bathymetry played a key role. When the sediment plumes were carried into the deeper sections of the harbor, the duration and size of sediment cloud were more extensive than when the sediment plumes were carried into the shallower sections, where the sediment settled out more quickly.

A series of dissolved phase pollutant fate and transport simulations were performed to estimate the water quality impacts in the water column at north of Popes Island, using BFMASS (Boundary Fitted Mass Transport Model). Simulations were performed for various pollutant constituents whose elutriate concentrations exceeded the U. S. EPA water quality guidance levels: metals (aluminum, copper, nickel and silver), and polychlorinated biphenyls (PCBs). The model simulated the fate and transport of disposal of dredged material at the PIN-CAD site (north of Popes Island). Disposal operations were assumed to last for 6 days and disposal taking place twice a day following the M_2 tidal cycle. Each release volume of dredged material was assumed to be 1,530 m^3 (2,000 yd^3).

None of pollutant elutriate concentrations exceeded the U. S. EPA water quality acute criteria except copper (4.8 ug/L) at two stations. Al, Cu, Ni, Ag, and PCB exceed chronic levels. The dilution of elutriate concentration for PCB to meet the chronic criteria ranged between 11 and 767, Cu had the next highest required dilutions (1 to 32) followed by Al (2 to 27), Ag (14) and Ni (2). One proposed site, Station NBH-202, located at another proposed CAD site denoted Channel Inner (CAD-CI), had the highest concentrations for all constituents. Station NBH-207, located north of Fish Island, was second highest.

The BFMASS simulation results indicated that the contaminant distribution patterns in the horizontal and vertical were similar for the three tide ranges. Concentration levels, however, were higher in the near field for neap tides than for spring tides because more energetic currents during the spring tides promote more dispersion and mixing. Different wind conditions resulted in different spatial distribution patterns and coverages. Among the nine environmental scenarios, the largest spatial coverage (area) was predicted for neap tides and calm wind conditions. The smallest coverage occurred for neap tides and northwesterly winds. This finding was consistent among three different release locations in the large PIN-CAD cell.

According to toxicity tests using sediments from the NBH-202 station sampled at CAD-CI, the combination of multiple pollutants was the cause of the observed acute toxicity effects. For example, half the toxicity to mysids was due to PCBs and the other half was due to a combination of copper and ammonia. From these results SAIC concluded a dilution to less than 2.2% of the elutriate concentration would be protective. The model results showed that for any environmental condition, area coverage for a concentration of 2.2% of the elutriate level was always smaller than the PIN-CAD area (1.67×105 m2 [41 ac]). The largest area coverage (1.2×105 m2 [30 ac]) of the 2.2% elutriate concentration occurred for a release during calm conditions while the smallest coverage (1.0×104 m2 [2.5 ac]) occurred for a release during northwesterly winds. Other sediments with lower elutriate concentrations, and presumably lower toxicity, would affect smaller areas.

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NEW BEDFORD HARBOR PCB FLUX STUDY

Contract No. W912WJ-09-D-0001-0005-02

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August 2010

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New Bedford Harbor PCB Flux Study

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List of Acronyms

ADCP – Acoustic Doppler Current Profiler
COC – Chain–Of-Custody
CSM – Conceptual Site Model
EMC – Event Mean Concentration
HADCP – Horizontal Acoustic Doppler Current Profiler
NOAA – National Oceanic and Atmospheric Administration
OU#3 – Operable Unit # 3, New Bedford Harbor Superfund Site
PCB – Polychlorinated Biphenyls
QAPP – Quality Assurance Project Plan
RI/FS – Remedial Investigation/Feasibility Study
SNR – Signal-to-Noise Ratio
SOW – Statement of Work
TRDI – Teledyne RD Instruments
USGS – US Geological Survey
USACE – US Army Corps of Engineers
WHG – Woods Hole Group Inc.

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EXECUTIVE SUMMARY

This report summarizes the results from a flux study completed to quantify the transport of PCBs through the hurricane barrier at New Bedford Harbor. Flow-proportioned, composite water samples were collected and analyzed for PCBs in total and dissolved fractions. Samples were collected every half-hour at two stations, over three depths, throughout six separate tidal cycles. The six events included spring, neap, and abnormal weather conditions in April and May, 2010. The net rate of the total PCB mass flux ranged from -24.7g[1] per tidal cycle (neap tide on April 21) to -82.8g per tidal cycle (weather event on April 28 coinciding with spring tide). The mean net PCB mass flux for the six (6) sampling events was approximately -61g per tidal cycle, which translates to approximately -118g per day.

These results indicate that the New Bedford Harbor area serves as an ongoing source of PCBs to Operable Unit #3, the 17,000 acre area outside of the hurricane barrier. The methods established herein provide the basis for ongoing investigation of OU#3, and provide the basis for future surveys if appropriate.

[1] The negative value indicates flux outward from the harbor to Upper Buzzard's Bay.

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1.0 INTRODUCTION

The New Bedford Harbor Superfund Site (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 acres of Buzzards Bay. See the Statement of Work for RI/FS Report Field Work, Operable Unit No. 3 (OU3), New Bedford Harbor Superfund Site, New Bedford, MA, 14 August 2009 (SOW) for further information on site background and history. This report describes results from the sub-set of activities for Task 3 – Harbor Flux Study taken in Operable Unit III (OU#3) located at, inside, and outside of the hurricane barrier. The study area is shown in Figure 1.

Figure 1. New Bedford OU#3 Harbor Flux Study area.

The purpose of Task 3, Harbor Flux Study of OU#3 is to quantify the transport of PCBs through the hurricane barrier. The Conceptual Site Model (CSM) and Data Gaps Analysis Report (Woods Hole Group, 2009a) recognized that although there may be multiple potential ongoing sources of PCBs to OU#3, it is anticipated based on consultations with EPA and the project team that the primary ongoing source is from New Bedford Harbor via net flux of PCBs out through the hurricane barrier. PCB flux may be either in aqueous phase or attached to sediments, primarily suspended fine sediments. The ongoing remediation of New Bedford Harbor is intended to substantially reduce the PCB contamination within the Harbor, which also has the intended effect of reducing the export of PCBs throughout the system over time, including into OU#3. Extensive ongoing studies and models by the EPA and USACE are being conducted to quantify the anticipated long-term, time-varying reduction in pollutant loading and health risk reduction (i.e., reduction of contaminant of concern (COC) concentrations in fish tissue and resultant health risk reduction).

The current export of PCBs from the Harbor to OU#3 poses a potential ecological risk (yet to be estimated). However, the estimates of the magnitude of this export are not well-understood. The objective of the Harbor Flux Study is to improve the estimates of present-day PCB flux from the Harbor to OU#3, and establish a methodology that could be repeated in the future, if required, to evaluate the efficacy of remediation.

The approach to quantifying this export of PCBs through the hurricane barrier includes a combination of:

- long-term velocity measurements to capture the time variations of water flow
- short-term current measurements over six (6) tidal cycles to capture the spatial variations in flow as well as water fluxes through the barrier, and
- short-term water sampling and analysis over six (6) tidal cycles to measure the water- and sediment-borne PCB concentrations under various tidal and weather conditions.

This report focuses on developing estimates of the net export of PCBs through the hurricane barrier from the Harbor to OU#3 using these three data sets.

The Harbor Flux Study was performed in consecutive sub-tasks, as outlined below. Water current data were collected from December 09 through March 10 to help select locations for water column sampling and analysis.

The sequence of the Harbor Flux Study sub-tasks for the 2009-2010 sampling is listed in Table 1 below.

Table 1. Sampling tasks/events for OU#3 Harbor Flux Study field reconnaissance

Event	Time
Mobilization	November 2009
Sub-Task 1. Installation of HADCP	December 2009
Sub-Task 2. Perform Real Time ADCP surveys – Qty 2	January - February 2010
Sub-Task 3. Interim Service and Data Retrieval from HADCP	February 2010
Sub-Task 4. Data Analysis to Determine Water Column Sample locations	February - March 2010
Sub-Task 5. Water Column Sampling – Qty 6	April-May 2010
Sub-Task 6. Final Retrieval of HADCP	June 2010
Sub-Task 7. Data Analysis and Reporting	July 2010

This report is organized as follows. Section 2 of the report describes sampling methods used during this study. The results are discussed in Section 3 and summarized in Section 4.

2.0 FIELD SAMPLING METHODS

The flow rate through the Hurricane Barrier Gate varies widely; therefore, water sampling was scheduled to characterize major conditions that contribute to flow variability. These conditions are associated with the fortnightly spring/neap tidal cycle, as well as weather patterns, including abnormal freshwater runoff and/or strong winds that can block or accelerate water exchange through the Hurricane Barrier. Therefore, six sampling events were planned to cover this range of conditions: two (2) surveys during neap tide, two (2) surveys during spring tide, and two (2) surveys during wet weather conditions. One of the wet weather sampling events took place on a windy day when the outflow from the inner harbor was accelerated due to strong northwesterly winds.

Two types of current data were collected during each sampling event. The horizontal ADCP (TRDI 300kHz Workhorse Horizontal ADCP) deployed on the western wall of the Gate continuously recorded two-minute averages of long-channel and cross-channel velocities from 2-m horizontal bins across the channel at a depth of about 7m+/-1m or 4m above the bottom. Current velocity data also were collected during each sampling event from the survey boat using a broadband 1200kHz ADCP (TRDI 1200kHz Workhorse Sentinel ADCP). This ADCP was configured to collect data from 1m vertical bins every second to accurately describe the vertical velocity shear, if present. Bottom tracking was used to correct for boat movements in the raw velocity data.

Post-survey data processing and interpretation of the ADCP data collected on the survey boat revealed frequent occurrence of a sheared velocity profile (i.e., current speed and direction varied considerably over depth). The data revealed that the velocity shears developed as the density stratification of the water column increased in spring due to heating at the surface and increased freshwater runoff. Therefore, while data from the HADCP (mounted on the Hurricane Barrier) were valuable to select measurement locations and understand longer-term flow variability at the Hurricane Barrier, the HADCP data were not used for water flux calculations. Data from the vessel-based ADCP data collected during each survey event were used instead.

The mean current profile, $U(z)$, was calculated for each round of water sampling within the Gate. These discrete current profiles were used to calculate integrated volumes of water transported through the Gate during ebb and flood for each sampling event:

$$Vol_{tide} = S * \sum_{i=1}^{i=n}(\overline{U}_i * \Delta t_i), \qquad (1)$$

where S is the channel cross-section area The estimates of the water (volume) flux for ebb and flood were then multiplied by the mean concentrations of PCBs for each tidal phase to calculate fluxes of PCBs for each tidal phase. Total net PCB flux through the Gate was then calculated as the sum of: 1) the net flow PCB flux (i.e., estimated freshwater inflow rate times the ebb tidal PCB concentration), and; 2) the tide-corrected tidal pumping flux (i.e., mean tidal volume times the difference between the ebb and flood PCB concentration):

$$Total_{flux} = Vol_{fresh} * C_{ebb} + \overline{Vol_{tide}} * (C_{ebb} - C_{flood}), \qquad (2)$$

where C_{ebb} and C_{flood} are the concentrations of PCBs during ebb and flood tidal phases.

This method is consistent with that of a previous PCB flux study performed for New Bedford Harbor (see Teeter, 1988, page 25, section 53). Note that estimating the net-flow flux and tide-corrected tidal pumping flux would not be necessary if there were symmetry in the ebb and flood flows. In reality, although the mass flux of PCBs estimated for each tidal phase may be quite accurate, the estimate of the net flux of PCBs calculated as the difference between the ebb and flood fluxes contains an uncertainty related to tidal asymmetry and other factors. This uncertainty cannot be averaged out using data from just six surveys. A more extended sampling program would be required.

Each survey was conducted throughout a full tidal cycle to estimate the flux in and out of the harbor, during flood and ebb tide, respectively. Two sets of water samples were collected during each sampling round, which typically lasted somewhere between 7 and 20 minutes. Each set included water samples taken from near the surface (approximately 1m deep), mid-water column (approximately 5m deep), and from near the bottom (approximately 10m deep). The samples were taken using a Niskin bottle lowered on a rope using a small davit. The first sample was collected from the near-bottom layer. This sampling depth was determined using a lead weight hanging approximately 1m below the Niskin bottle. At the time the Niskin bottle was lowered, a slack in the rope indicated when the weight hit the seabed. The rope was then pulled back to eliminate the slack and the messenger was sent to close the bottle about 10 seconds later to assure that any sediment suspended when the weight hit the seabed had cleared before the bottom sample was collected. After the first sample was drained into a measuring glass, the bottle was lowered to half of the total depth and the mid-water sample was collected. The depth of the bottle was evaluated visually when the surface sample was collected.

2.1 SAMPLING LOCATIONS

Two (2) preliminary full-tidal-cycle ADCP surveys of the area were conducted to select appropriate sampling locations for the subsequent six (6) flux sampling events. The two (2) preliminary (or reconnaissance) surveys provided data to guide the decision on the locations at which water samples had to be taken during the flux sampling events to exclude possible bias if quasi-stationary circulation patterns were observed in the OU#3 area (e.g., eddies or other turbulence). The data from the two (2) preliminary events were analyzed together with data from the horizontal ADCP. The purpose of this analysis was to determine the extent of horizontal flow variability within (across or at depth) the channel.

Both types of current data revealed a rather homogeneous long-channel flow (Figures 2 and 3). The upper panel of Figure 2 shows a time series of the along-channel flow velocity (i.e., parallel to the Hurricane Barrier walls) during the time of the second reconnaissance survey. Time is represented along the horizontal axis and distance across the Hurricane Barrier is represented on the vertical axis (the 0 point is on the west side of the channel). The color bar represents the current speed (in cm/s) and direction (red represents flow out of New Bedford Harbor and blue represents flow into the Harbor). Moving from left to right across the top panel of Figure 2, each "stripe" represents a snapshot in time of the along channel currents. Although the data show the expected ebb and flood of the tidal currents over the 12 hour period, there is little evidence of cross-channel variation in the along-channel currents.

The lower panel of Figure 2 illustrates a slightly different perspective, however. It represents the small component of the current directed across the channel (i.e., perpendicular to the Hurricane

Barrier walls). At certain times (e.g., after 06:00 on February 2), the data show the cross-channel currents can be directed in different directions depending upon location across the channel. Although these cross-channel currents (0-10cm/s) are small as compared to the along-channel currents (0-100cm/s), these observations were used to select the sampling locations for the flux sampling events. The initial plan was to sample near each wall and in the middle of the channel. Based on reviewing the reconnaissance velocity data with the project team, samples were not collected in the near vicinity of the Hurricane Barrier walls. Instead, the flux event sampling scheme was refined to include one set of samples approximately one-third of the channel width distance off of each wall to avoid possible bias.

Figure 3 shows a plan view of the depth-averaged velocity vectors during ebb tide on the same day. The direction of the vector represents the flow direction, and the vector length is proportional to current speed. This plot is typical, and shows a relatively organized flow field draining from New Bedford Harbor out through the Hurricane Barrier.

The actual practice of holding the boat on-station during each round of sample collection at a fixed position was challenging due to currents, wind and vessel traffic, but a good faith effort was devoted to occupying the intended sampling stations. The boat drift introduced an element of randomness to the sampling location rather sampling strictly at two fixed locations. In view of the conclusion about the homogeneity of the long-channel flow, this random sampling did not compromise the quality of the composite sample. Two sets of samples were collected every 30 minutes.

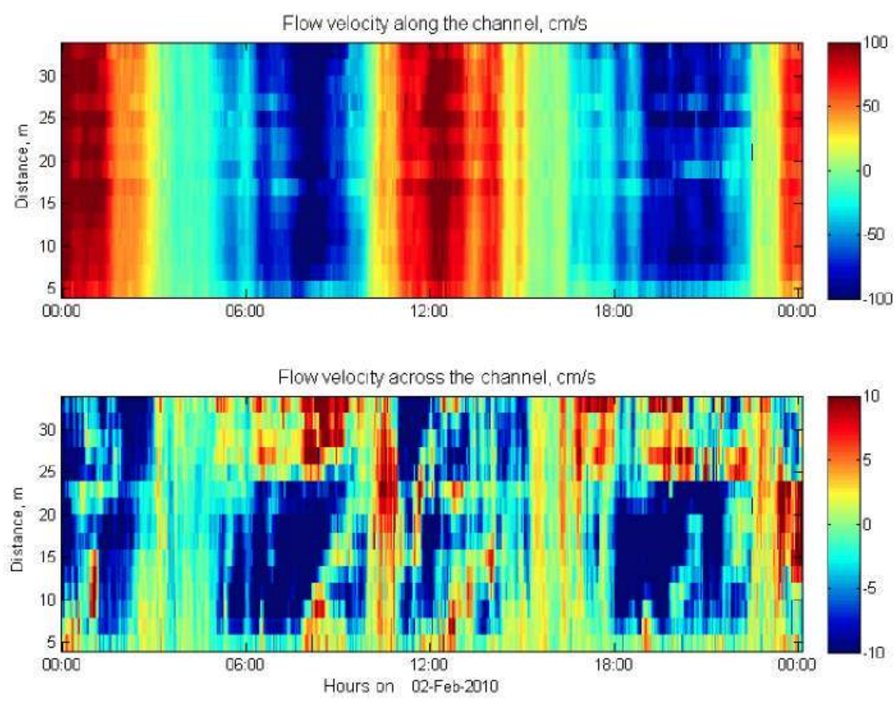

Figure 2. Color-coded time series of long-channel and cross-channel current velocities from the HADCP during the spring tide reconnaissance survey (y-axis shows distance from the instrument, deployed on the western wall, across the channel).

Figure 3. Depth-averaged flow vectors: ebb tide

2.2 WATER SAMPLE COLLECTION AND PROCESSING

All samples collected during a certain tidal phase (ebb or flood) were mixed together to form a composite sample for the particular tidal phase. A flow-proportional sampling scheme was implemented. A flow-proportional composite is comprised of multiple water samples each representative of an equal flow volume through the Hurricane Barrier. During neap tide, a 100ml sample of water was collected per 10cm/s flow velocity and a 50ml water sample was collected per 10cm/s flow velocity during spring tide (to ensure appropriate water volume in the sample). Appendix A shows the volume of water collected during each sampling event. The principal advantage of flow-proportional composites is that flow-proportional composites are not biased by over- or under-sampling any part of the tidal cycle. Flow-proportional sampling allows for direct estimation of Event Mean Concentration (EMC) without making assumptions about the relationship between pollutant concentrations and flow rates. By collecting greater sample volumes at higher flow rates (and smaller volume at low flow rates), a flow-proportional composite water sample allows direct analysis of the composite sample to estimate the EMC, which is defined as the arithmetic average concentration of the pollutant in the total volume. This flow-proportional sampling was implemented in a manner consistent with other EPA and USACE studies (Teeter, 1988).

The method applied to sample surface water using a discrete sampler (Niskin bottle) onboard a boat to obtain a composite surface water sample is described below. More details are provided in the Field Sampling Plan.

- Have a set of six pre-cleaned intermediate sampling containers (clean, inert graduated cylinder).
- Approach the western side of the entrance to the Hurricane Barrier Gate, and start the ADCP.

- Lower Niskin bottle to the appropriate depth and trigger discrete bottom sample.
- Raise Niskin bottle using winch and davit.
- Open Niskin bottle and drain sample in a clean inert graduated cylinder.
- Repeat sampling for mid-water depth.
- Repeat sampling for surface water sample.
- Repeat sampling on the eastern side of the channel.
- End ADCP data collection.
- Open ADCP data file and evaluate the ADCP data to determine the appropriate flow-proportioned sample volume.
- Decant the graduated cylinder for each sample to the appropriate flow-proportioned sample volume.
- Dump the sample(s) into the clean compositing container.
- Repeat above steps until a composite sample from all the depths, locations, and times are obtained.
- Mechanically mix the composite sample and remove a sub-sample using the appropriate new, labeled, pre-cleaned container with screw top provided by the laboratory – specific for each chemical analysis. Transfer the sample into a cooler with ice.
- Decontaminate sampling device and compositing basins between sampling rounds.

2.3 SAMPLE HANDLING AND CUSTODY

The following provides a brief description of sample handling and custody procedures. For details, please refer to the Woods Hole Group QAPP (Woods Hole Group, 2009b).

Samples were placed in coolers with the appropriate documentation and picked-up daily by a courier for Alpha Analytical. The temperature in the cooler was measured and recorded upon receipt at the laboratory.

Additional details regarding sample handling and custody include:

- Sample labels were hand-written at the time of sample collection and were affixed to the individual samples. Chain–Of-Custody (COC) forms were initiated in the field.
- Samples were in the custody of the survey Chief Scientist until relinquished to the laboratory.
- Custody forms accompanied the samples when transferred from the field to the laboratory.
- Each shipment included the original, signed custody forms. Copies of the custody forms were kept in the project files at WHG.
- When the samples arrived at the laboratory, custody was relinquished to the receiving Laboratory Sample Custodian. The Laboratory Sample Custodian examined the samples, verified that the COC forms were accurate and that the samples were intact, logged the samples into the laboratory tracking system, and completed and signed the custody forms.
- Copies of the original COC forms along with the comments and signature of the receiving Laboratory Sample Custodian were transferred to the WHG Task Manager.

2.4 ANCILLARY DATA

Multiple other sources of data were utilized for the flux study, including:

- Current data from the HADCP were used in post-processing to evaluate the accuracy of decisions made in the field regarding volumes of individual samples.
- Data from the USGS Paskamanset River flow gage were used to evaluate freshwater discharge into the upper harbor since direct freshwater discharge measurements are not available for New Bedford Harbor.
- Weather forecasts from NOAA were used to guide decisions on the timing of sampling events.
- Wind data from the Hurricane Barrier meteorological station were used to help interpret study results on inflow and outflow volumes.

3.0 RESULTS

This section reviews flow and sea level variability in the OU#3 study area (Section 3.1) and provides estimates of water and PCB fluxes through the Hurricane Barrier during the six sampling events (Section 3.2).

3.1 FLOW AND SEA LEVEL VARIABILITY AT THE GATE OF THE HURRICANE BARRIER

The data recorded by the pressure sensor of the HADCP were used to calculate parameters of major tidal constituents that describe about 92% of the total energy associated with tidal-driven sea level variability at the location of the sensor; that is, at the western wall of the Gate. A portion of the total record was selected for tidal harmonic analysis that did not have gaps that sometimes occurred due to gate closing. There were no gate closings after April 27th 2010, so the 51.5-day time series beginning on April 27th was used to calculate the water surface tidal constituents, as well as tidal constituents derived from current time series. The results are presented in Tables 2 and 3.

The tables list the names of tidal harmonics that were reliably resolved by the tidal harmonic analysis; that is, the harmonics for which the signal-to-noise ratio (SNR), shown in the last column, is greater than 2. All tidal harmonics characterized by a lower SNR had negligible amplitudes. Other parameters listed in the tables are the period of a harmonic, its amplitude and phase. Both amplitude and phase are shown with 95% confidence limits (indicated as Amplitude error and Phase error in Table 2). The superposition of these harmonics describes tidal oscillation of the water level and of the flow at any time. Thus, the parameters shown in the tables do not only reveal the range of tidal variability but also they can be used for prediction of water level and current at the Gate at any time. The 95% confidence intervals provided in the table for the amplitude and phase of each harmonic indicate how accurate such a prediction may be.

The major harmonics have amplitudes that exceed the noise level by an order of two or three, as for M2 harmonic, for example, indicating the results are accurate. As expected, the major tidal harmonic is M2, which is the primary semi-diurnal (twice daily) tidal constituent resulting from the interaction between the moon and the earth's oceans. Its amplitude is 52cm. The amplitude of the primary semi-diurnal solar constituent, S2, is only 8cm. Since M2 (12.42 hrs) and S2 (12 hrs) have slightly different periods, the spring/neap tidal cycle is typically a result of the interaction between M2 and S2. Because S2 is only a minor contributor at this site, tidal variations within the usual spring/neap tide cycle are relatively small. The amplitude of N2 harmonic, which is due to the non-circularity of the moon's orbit, is 12cm. The combination of M2 and N2 harmonics causes variations of the tide with a 27.5-day period. The role of the diurnal (once-daily) harmonics (which take into account the earth's equatorial plane with respect to the plane of the moon's orbit) is relatively small at this site. The amplitude of K1 is 8cm and the amplitude of O1 is 5cm. Among high-frequency harmonics, M4 (created primarily by non-linear interactions of the tide within the system) is the most energetic with an amplitude about 8cm.

Table 2. Amplitudes and phases of major tidal constituents: Water Level

Tidal harmonic	Period (hours)	Amplitude (m)	Amplitude error* (m)	Phase (degrees)	Phase error* (degrees)	SNR**
*O_1	25.82	0.05	0.009	135	10	33
*NO_1	24.83	0.01	0.007	173	30	4
*K_1	23.94	0.08	0.009	78	7	67
*N_2	12.66	0.12	0.010	214	4	150
*M_2	12.42	0.52	0.009	223	1	3700
*S_2	12.00	0.08	0.010	236	6	75
*MO_3	8.39	0.02	0.006	144	18	7
*MK_3	8.18	0.02	0.005	153	18	11
*MN_4	6.27	0.03	0.007	65	14	16
*M_4	6.21	0.08	0.008	111	5	100
*MS_4	6.10	0.01	0.007	166	31	4
*$2MK_5$	4.93	0.01	0.005	289	28	4

* 95% confidence interval
** Signal-to-Noise Ratio (only constituents with SNR > 2 are shown)

Current data from the HADCP were used to examine tidal variations of the mid-depth through-channel flow, which describe about 80-85% of the total flow variability, depending on the time period used to calculated tidal constituents. The major tidal harmonic of the current regime at the Hurricane Barrier is M2. Its amplitude is 50cm/s, and it accounts for approximately 50% of the total flow variability. The amplitude of S2 is 8cm/s, and the amplitude of N2 is 11cm/s. The amplitude of M4 is 15cm/s. The role of diurnal harmonics in the currents is small. The combined amplitude of O1 and K1 is 7cm/s only. It is common for currents to have a different tidal constituent variability than the water surface.

In addition to tidal-driven circulation, there can be substantial non-tidal, residual motions resulting from climatological conditions, interaction of flow within the system, and other forcings and responses. At the New Bedford Hurricane Barrier, there are occasional unique residual events. Analysis of the residual variations of the flow revealed the occurrence of transient high-amplitude (up to 150cm/s) oscillations with a period of about 80 minutes. The most significant events resulted in currents through the Barrier that were swifter than the tidal currents. With a period of 80 minutes, there were occasions when these residual currents actually caused a reversal in the tidal current direction – a unique circumstance. An example of such variations in the long-channel flow is shown in Figure 4. The alternating red and blue stripes around 1800 hrs on January 25 and after 0600 hrs on January 26 show reversing current directions with speeds approaching 150 cm/sec (~3 kts).

Using current data from the HADCP and meteorological data from the Hurricane Barrier, Woods Hole Group conducted a process-oriented analysis to better understand the importance of these observed residual motions. The analysis was focused on the following questions:

- Can these strong transient currents play a role in transport of PCBs?
- Can the occurrence of such an event be predicted using meteorological data?

The analysis of the data did not reveal any meaningful correlation between the occurrence of such high-frequency high-amplitude current oscillations and specific wind events. For example, these transient flow oscillations were observed to occur over a wide range of wind conditions. However, the residual motions did not consistently occur during any particular wind direction or speed. Wind conditions during the observed residual events occur quite frequently at other times, but the occurrence of high-amplitude flow oscillations was rare. Furthermore, the amplitude of this non-tidal motion exceeded 50cm/s approximately only 1% of the time (Figure 5). Therefore, it is logical to suggest that the role of such flow oscillations in the total flux of PCBs through the Hurricane Barrier is episodic, and small as compared to the ongoing tidal circulation. Based on the lack of a correlation with specific wind conditions, the events also could not be readily predicted based on the available information. Thus, the field sampling scheme was not modified. It was assumed that the major contributors to the flux of PCBs through the Hurricane Barrier may be semi-diurnal tidal oscillations, wind-driven flows, and freshwater runoff.

Table 3. Amplitudes and phases of major tidal constituents: Currents

Tidal harmonic	Period (hours)	Amplitude, cm/s	Amplitude error* (cm/s)	Phase, deg	Phase error* (deg)	SNR**
*O_1	25.82	3	0.6	221	15	16
*K_1	23.94	4	0.7	172	10	32
*N_2	12.66	11	1.1	300	6	100
*M_2	12.42	50	1.1	315	1	2100
*L_2	12.19	3	1.2	279	28	5
*S_2	12.00	8	1.0	326	7	62
*MO_3	8.39	2	0.8	228	25	6
*MK_3	8.18	2	0.9	226	30	3
*MN_4	6.27	6	1.8	15	17	9
*M_4	6.21	15	1.3	207	6	130
*MS_4	6.10	3	1.5	267	31	3
*$2MK_5$	4.93	3	1.6	14	35	3

* 95% confidence interval

** Signal-to-Noise Ratio (only constituents with SNR > 2 are shown)

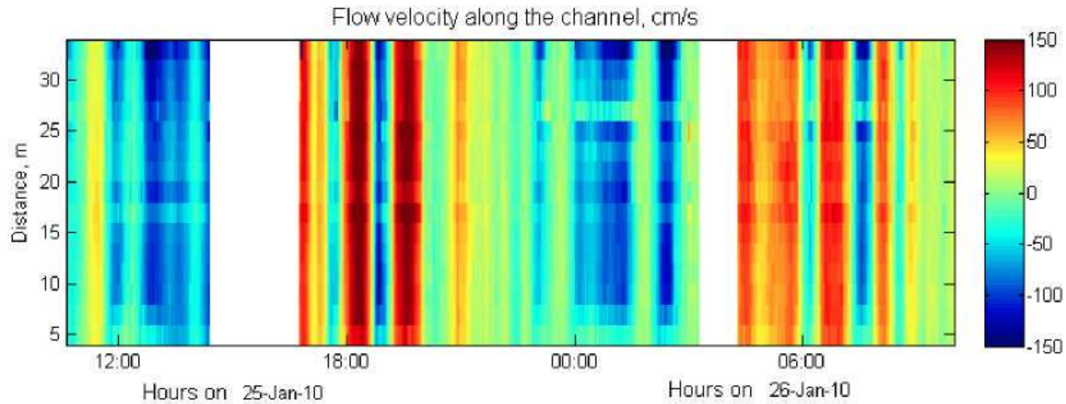

Figure 4. Color-coded time series of long-channel velocity for January 25th and 26th 2010 (y-axis shows distance from the instrument, deployed on the western wall, across the channel).

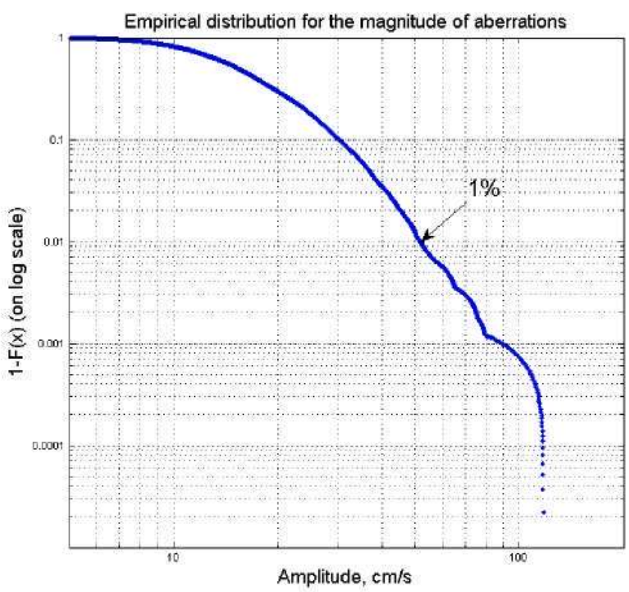

Figure 5. Empirical distribution of the magnitude of high-frequency current oscillations. The amplitude of such oscillations exceeds 50cm/s 1% of the time.

3.2 WATER AND PCB FLUXES DURING SAMPLING EVENTS

This section focuses on the discussion of tidal volumes (Table 4) and PCB fluxes (Table 5) through the Hurricane Barrier during each sampling event. Table 4 shows tidal volumes and water flux for the six sampling events. Table 5 summarizes measured PCB flux for each ebb and flood tide during each survey. All PCB data (209 congeners and homologues) are provided in Appendix B.

Measured flux was calculated based upon the measured PCB concentration and the measured flow volume for the particular tide based on the ADCP data. The difference between the measured flood and ebb PCB flux is not representative of the net flux, however, because of the tidal asymmetry (i.e., there are higher high and lower low tides each day). Therefore, Table 5 also lists estimated net PCB flux for each event due to tidal pumping and net freshwater inflow, as described in Section 2.0 [total net PCB flux (last column of Table 5) is the sum of these two parameters]. PCB concentrations measured in the flow-proportional composite samples for ebb and flood tides for the six sampling events are shown in Figure 6. Sections 3.2.1 through 3.2.6 describe conditions and detailed results for each sampling event.

Table 4. Tidal volumes and water fluxes for the six sampling events.

Event	Flood volume, 10^6 m^3	Ebb volume, 10^6 m^3	Mean tidal volume, 10^6 m^3	Freshwater flux, m^3/s
001-weather (04/02)	3.27	3.97	3.3	14
002-neap (04/21)	3.02	2.73	2.8	0.8
003-weather (04/28)	3.66	4.98	4.3	0.8
004-neap (05/07)	2.48	2.08	2.3	0.5
005-spring (05/13)	3.39	3.74	3.6	0.4
006-spring (05/26)	4.97	3.71	4.3	0.5

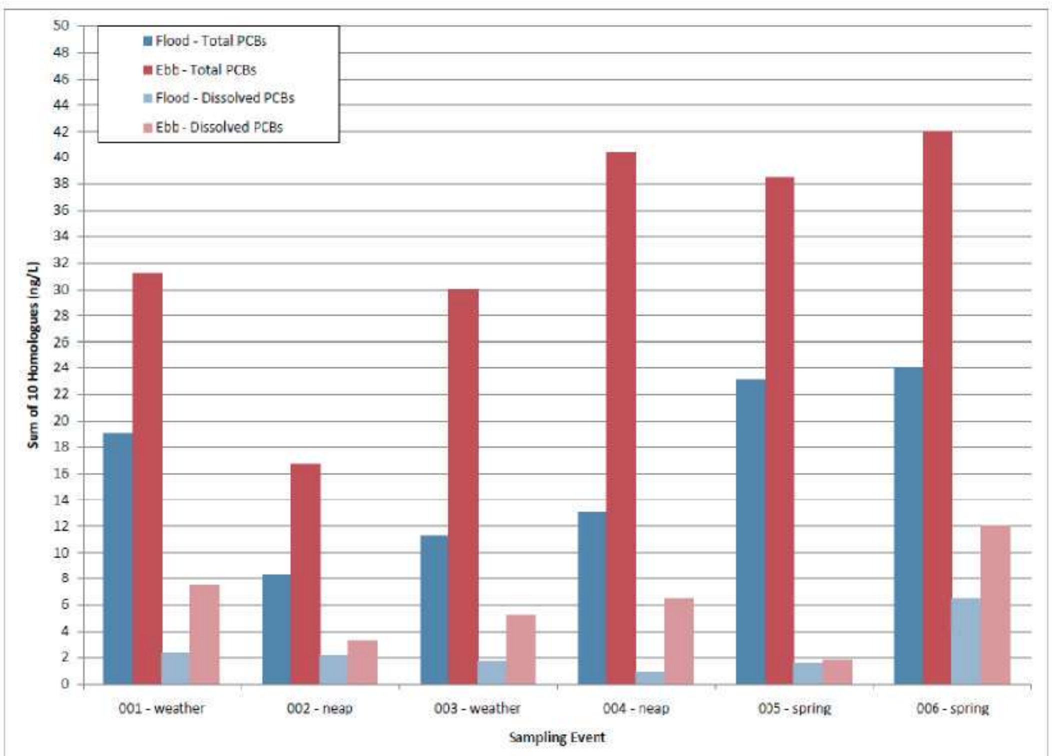

Figure 6. PCB concentration in composite samples for ebb and flood for the six sampling events.

Table 5. PCB fluxes

Event	Measured PCB Mass Flux		Estimated Net PCB Mass Flux		
	Total mass flux of PCBs: flood, g	Total mass flux of PCBs: ebb, g	Tidal-pumping PCB mass flux, g per tidal cycle	Net-flow PCB mass flux, g per tidal cycle	Total PCB mass flux, g per tidal cycle
001-weather	62.1	-123.1	-39.6	-19.4	-59.0
002-neap	25.4	-46.4	-24.1	-0.6	-24.7
003-weather	39.6	-149.4	-81.7	-1.1	-82.8
004-neap	32.2	-83.2	-62.1	-0.9	-63.0
005-spring	78.0	-145.9	-57.6	-0.8	-58.4
006-spring	119.3	-155.8	-77.4	-0.9	-78.3

3.2.1 Sampling event #1: April 2nd 2010 (wet weather event)

Sampling on April 2nd 2010 was conducted after a prolonged period of torrential rains and was selected to represent a wet weather event. The sampling started at low water, approximately at 05:30, and ended around 16:20 when the tide turned to flood again (Figure 7). High water was observed at about 11:00 this day. The range of tidal variability was about 110cm. Wind conditions (Figure 8) were characterized by weak northerly winds during the first half of the day (flood) followed by a persistent southwesterly breeze, with wind speeds around 4m/s, during the ebb. Figure 9 compares long-channel current velocities recorded by the HADCP mounted on the Hurricane Barrier with the velocity estimates measured using the ADCP on the boat to determine the volume of each individual sample. This comparison shows good agreement between these data, which helps confirm the validity of the flow-proportional sampling for this sampling event.

Freshwater discharge data are not available for the Acushnet River, which flows into New Bedford Harbor. To estimate the volume of freshwater runoff for the period of the sampling, flow data from the USGS Paskamanset River gage were used. This is the nearest watershed basin to the Acushnet River basin, located to the west from the Aushnet River. The approach was dependent upon the major assumption that inflow from the Acushnet River could be scaled in proportion to inflow in the Paskamanset River given their close proximity. The Acushnet River and Paskamanset River watersheds cover areas approximately of the same size and shape, though land use may be slightly different in these areas since the Acushnet River includes the city of New Bedford while the Paskamanset River area includes the smaller city of Dartmouth.

The daily data for the Paskamanset River reveal that, in the beginning of April, the discharge of that river was approximately 14 times the mean annual discharge. Based on work by Jason M. Cortell and Associates (Jason M. Cortell and Associates 1982, in Teeter et al. 1988), the mean annual Acushnet River discharge can be estimated as approximately $1m^3/s$. Assuming linear proportionality between the flow in the two rivers, the freshwater discharge of the Acushnet River in the beginning of April was estimated to be $14m^3/s$. This value of freshwater inflow and the mean concentration of PCBs during the ebb were used to calculate net-flow PCB flux [per methods outlined in Section 2.0, equations (1), (2)] through the Hurricane Barrier on April 2nd 2010. This net-flow PCB flux was equal to -19.4g per tidal cycle, or approximately -37g per day. The minus sign defines a flux out of the harbor. At the same time, the difference in the PCB concentrations reported by the laboratory for the ebb and flood (12ng/l) resulted in the outflow of PCBs due to tidal pumping at a rate of -39.6g per tidal cycle. The total flux of PCBs was about -59g per tidal cycle during this period.

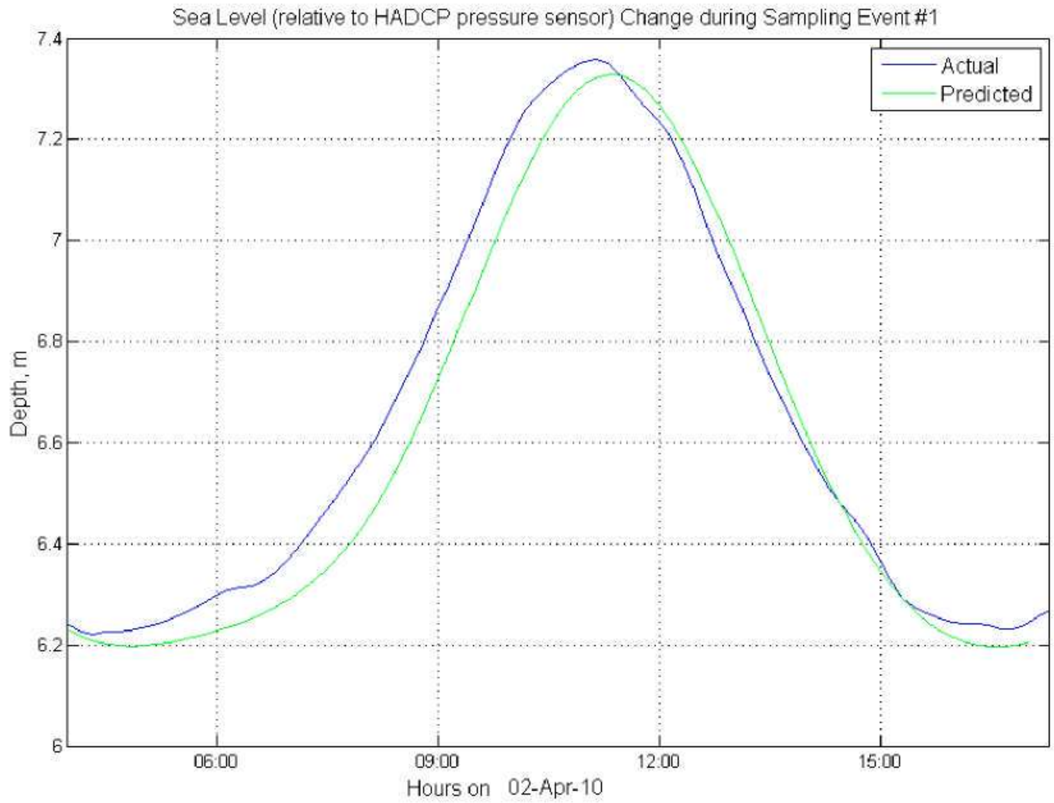

Figure 7. Time series of the actual water level (blue) and predicted water level (green) during the first sampling event (02-Apr-10).

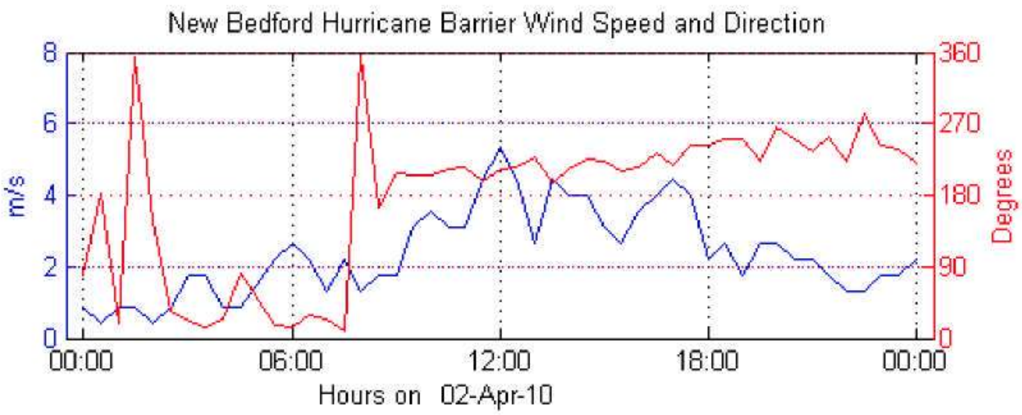

Figure 8. Time series of wind speed and direction at the Hurricane Barrier for 02-Apr-10.

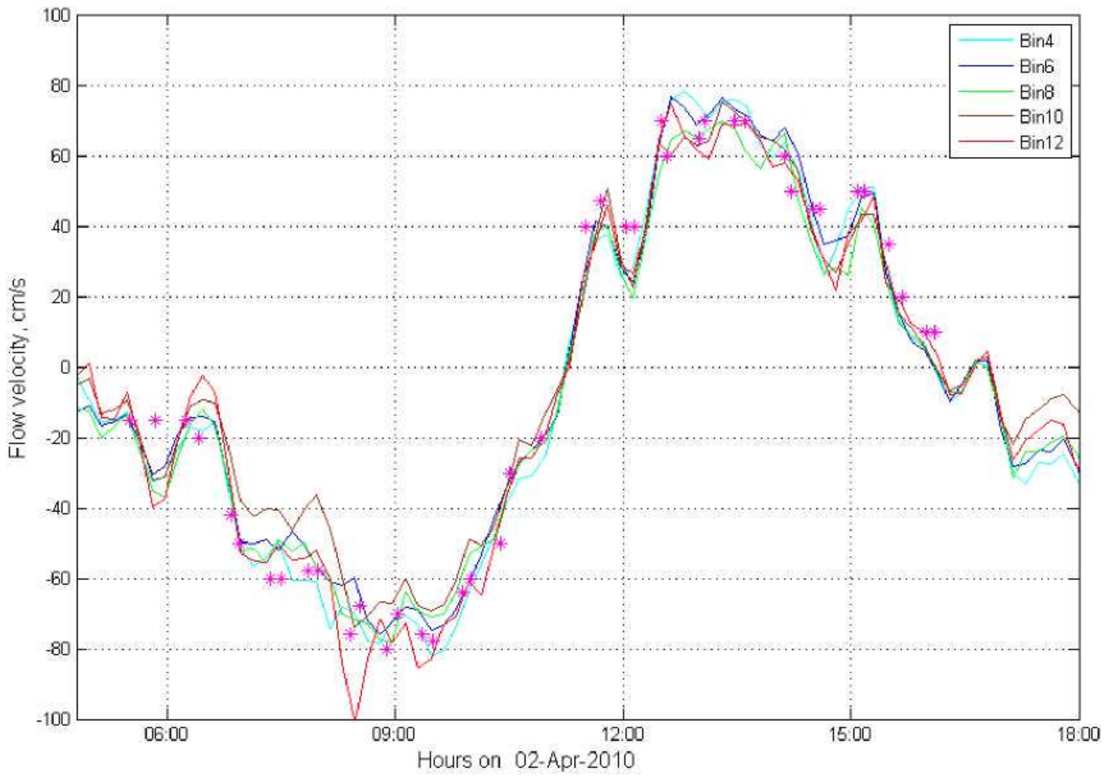

Figure 9. Long-channel flow velocity from selected HADCP bins for 02-Apr-10. Magenta stars (*) show flow velocities (measured from the ADCP on the boat) used for estimation of sample volumes in the field during April 2nd sampling.

3.2.2 Sampling event #2: April 21st 2010 (neap tide)

Sampling on April 21 2010, which was a neap tide sampling event, started at low water, approximately at 09:00, and ended around 19:15 when the tide turned to flood (Figure 10). High water was observed at about 14:00. The range of tidal variability was equal to 90cm. The sea level change during ebb was slightly less than sea level change during flood. This tidal asymmetry may offer an explanation to why the flood tidal volume was slightly greater than the ebb tidal volume during this sampling period. Wind conditions (Figure 11) were characterized by weak northerly winds in the morning, and a persistent southwesterly breeze (wind speeds around 5m/s) during most of the day. The comparison between long-channel current velocities with the velocity estimates made in the field to determine the volume of each individual sample (Figure 12) shows good agreement between these data, which is a confirmation of the validity of flow-proportional sampling for this sampling event.

Freshwater discharge into the harbor for April 21st was estimated under the assumption of similarity between the hydrographs of the Acushnet River and Paskamanset River. The discharge for the Acushnet River was estimated to be around $0.8m^3/s$, which is small compared with the tidal flow rates. This value of freshwater runoff was used to calculate net-flow PCB flux through the

Hurricane Barrier on April 21st 2010. This net-flow PCB flux was equal to -0.6g per tidal cycle. The difference in the PCB concentrations during ebb and flood (8.6ng/l) resulted in the tide-corrected outflow of PCBs at a rate of -24.1g per tidal cycle. The total flux of PCBs was about -24.7g per tidal cycle during this period.

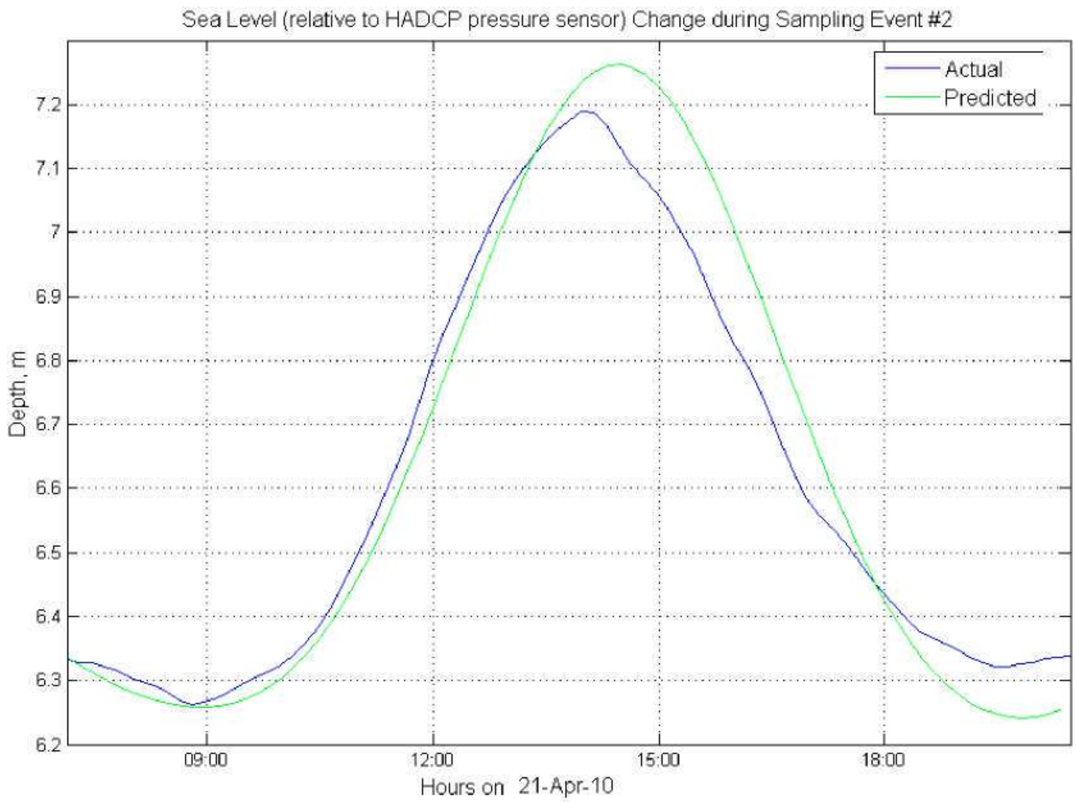

Figure 10. Time series of the actual water level (blue) and predicted water level (green) during the second sampling event (21-Apr-10).

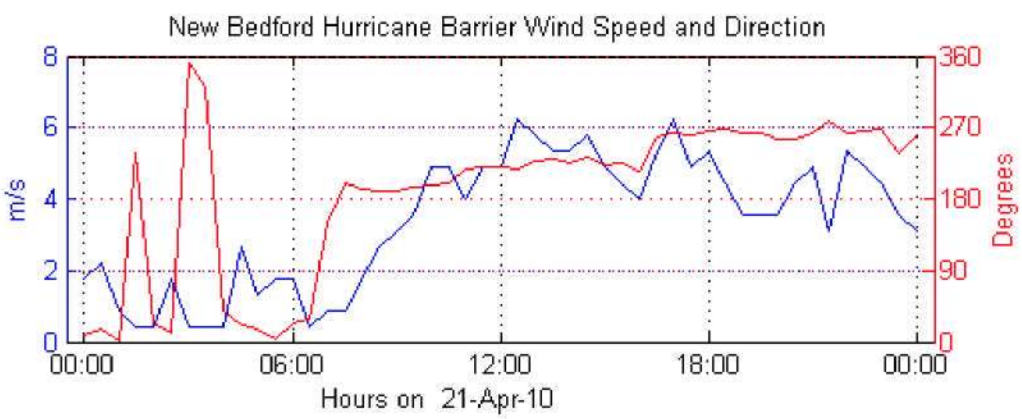

Figure 11. Time series of wind speed and direction at the Hurricane Barrier for 21-Apr-10.

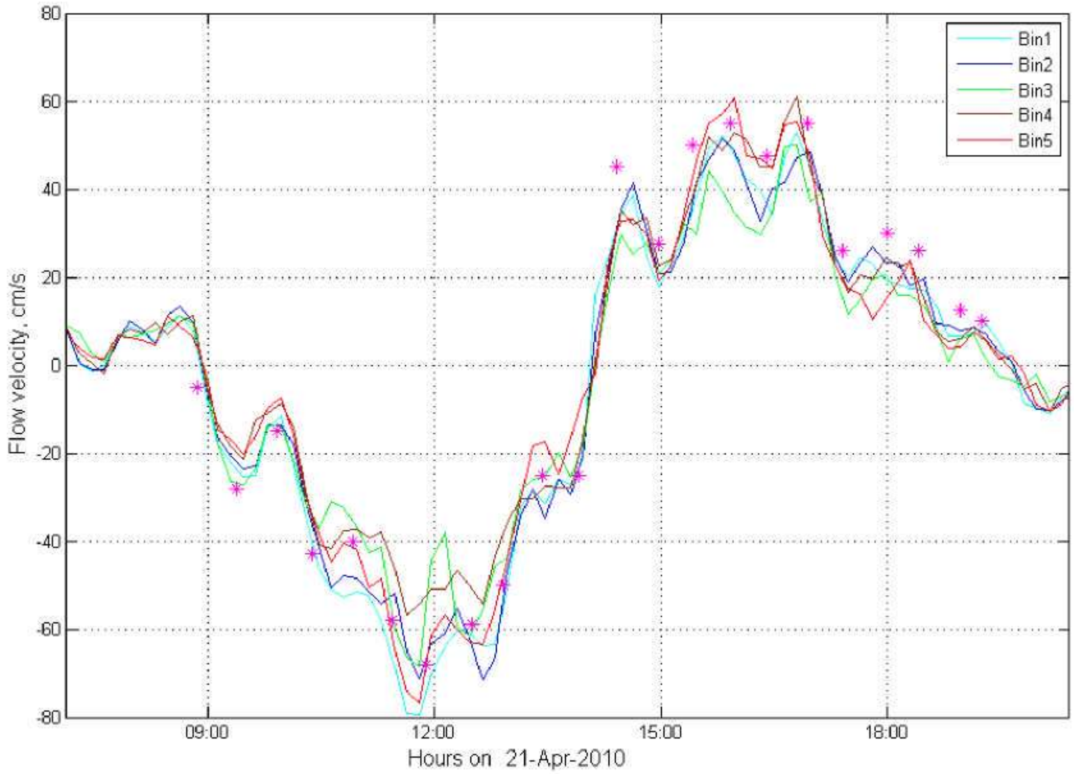

Figure 12. Long-channel flow velocity from selected HADCP bins for 21-Apr-10. Magenta stars (*) show flow velocities (measured from the ADCP on the boat) used for estimation of sample volumes in the field during April 21st sampling.

3.2.3 Sampling event #3: April 28th 2010 (weather event)

Sampling on April 28th 2010 was conducted after a day of heavy rainfall, so it was planned as a wet weather sampling event. However, the discharge of the Paskamanset River did not show any notable increase during this time, but the sampling period was characterized by strong northwesterly winds, so this sampling event was characteristic of an abnormal weather condition. The sampling started at high water, approximately at 09:00, and ended around 20:15 when the tide turned to ebb (Figure 13). Low water was observed at about 14:00. The range of tidal variability was equal to 150cm, which is characteristic of spring tide. The sea level change during ebb was approximately the same as sea level change during flood. However, even without a notable tidal asymmetry, the volume of the outflow exceeded the volume of the inflow by about 26% during the sampling period. This asymmetry in the volumes of the inflow and outflow that day may be attributed to the strong northwesterly winds that were driving the water out of the harbor during ebb tide and blocking the inflow during flood. Wind conditions (Figure 14) were characterized by strong, up to 15m/s, gusty northwesterly winds. The comparison between long-channel current velocities with the velocity estimates made in the field to determine the volume of each individual sample (Figure 15) shows good agreement between these data, which is a confirmation of the validity of flow-proportional sampling for this sampling event.

Freshwater discharge into the harbor for April 28st was estimated under the assumption of similarity between the hydrographs of the Acushnet River and Paskamanset River. The discharge for the Acushnet River was estimated to be around 0.8m^3/s, which is small compared with the tidal flow rates. This value of freshwater runoff was used to calculate net-flow PCB flux through the Hurricane Barrier on April 28th 2010. This net-flow PCB flux was equal to -1.1g per tidal cycle. The difference in the PCB concentrations during ebb and flood (19ng/l) resulted in the tide-corrected outflow of PCBs at a rate of -81.7g per tidal cycle. The total flux of PCBs was about -82.8g per tidal cycle during this period.

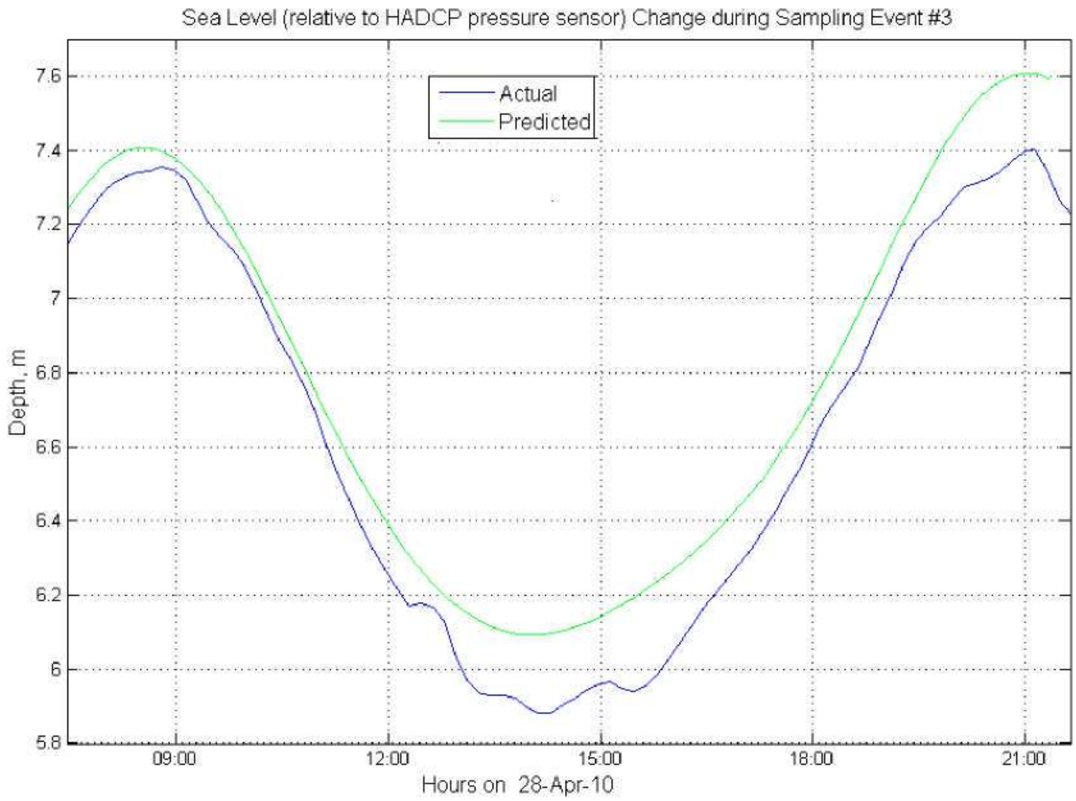

Figure 13. Time series of the actual water level (blue) and predicted water level (green) during the first sampling event (28-Apr-10).

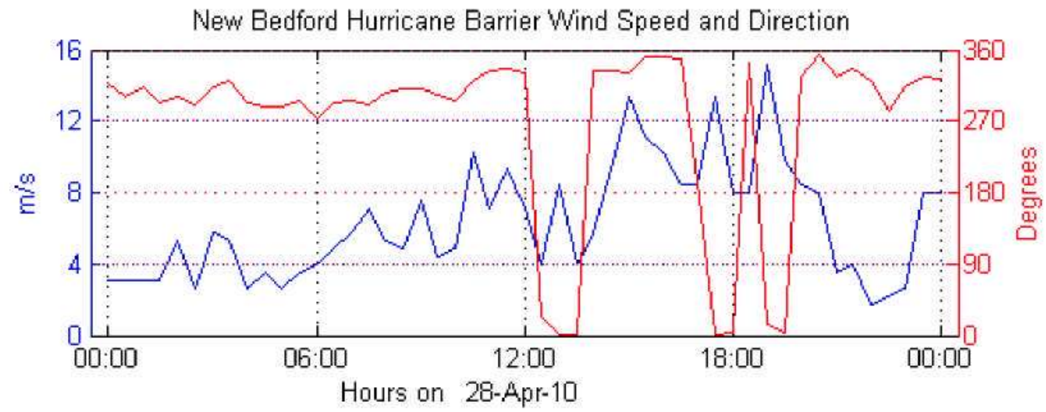

Figure 14. Time series of wind speed and direction at the Hurricane Barrier for 28-Apr-10.

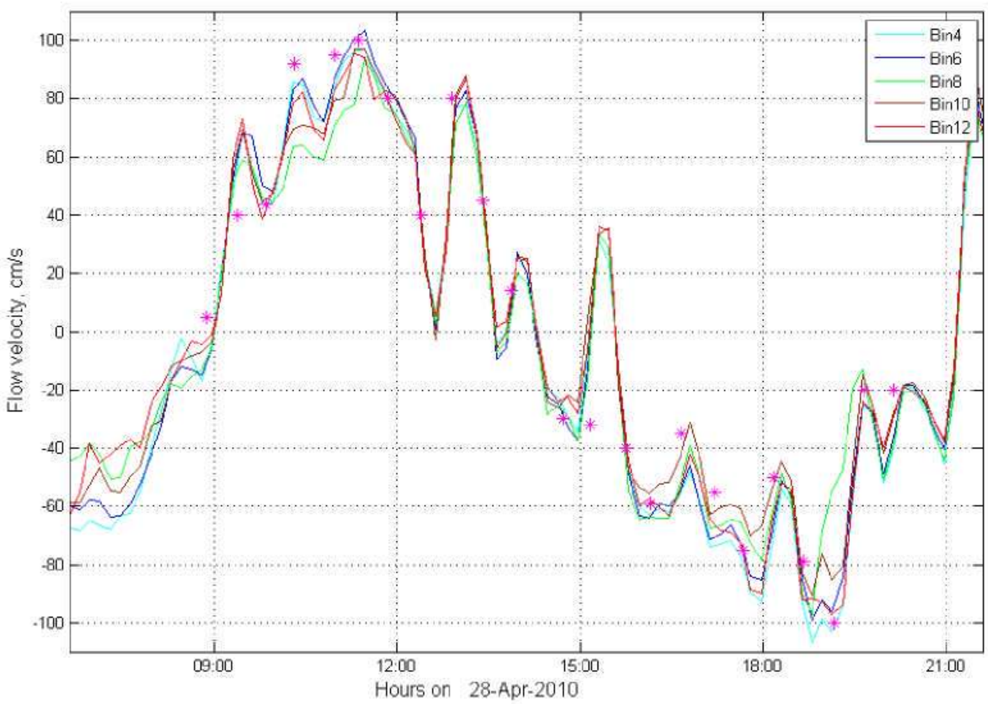

Figure 15. Long-channel flow velocity from selected HADCP bins for 28-Apr-10. Magenta stars (*) show flow velocities (measured from the ADCP on the boat) used for estimation of sample volumes in the field during April 28th sampling.

3.2.4 Sampling event #4: May 7th 2010 (neap tide)

Sampling on May 7th 2010, which was a neap tide sampling event, started at low water, approximately at 09:15, and ended around 21:15 when the tide turned to flood (Figure 16). High water was observed at about 15:50. The range of tidal variability was equal to 80cm. The sea level change during ebb was slightly less than sea level change during flood. This tidal asymmetry may explain why the flood tidal volume was slightly greater than the ebb tidal volume. Wind conditions (Figure 17) were characterized by northwesterly winds during flood. The wind direction changed at about 14:00. During ebb, the wind was from the west. The comparison between long-channel current velocities with the velocity estimates made in the field to determine the volume of each individual sample (Figure 18) shows good agreement between these data, which is a confirmation of the validity of flow-proportional sampling for this sampling event.

The freshwater discharge into the harbor for May 7th was estimated under the assumption of similarity between the hydrographs of the Acushnet River and Paskamanset River. The discharge for the Acushnet River was estimated to be around $0.5m^3/s$, which is small compared with the tidal flow rates. This value of freshwater runoff was used to calculate net-flow PCB flux through the Hurricane Barrier on May 7th 2010. This net-flow PCB flux was equal to -0.9g per tidal cycle. The difference in the PCB concentrations during ebb and flood (27ng/l) resulted in the tide-corrected outflow of PCBs at a rate of -62.1g per tidal cycle. The total flux of PCBs was about -63g per tidal cycle during this period.

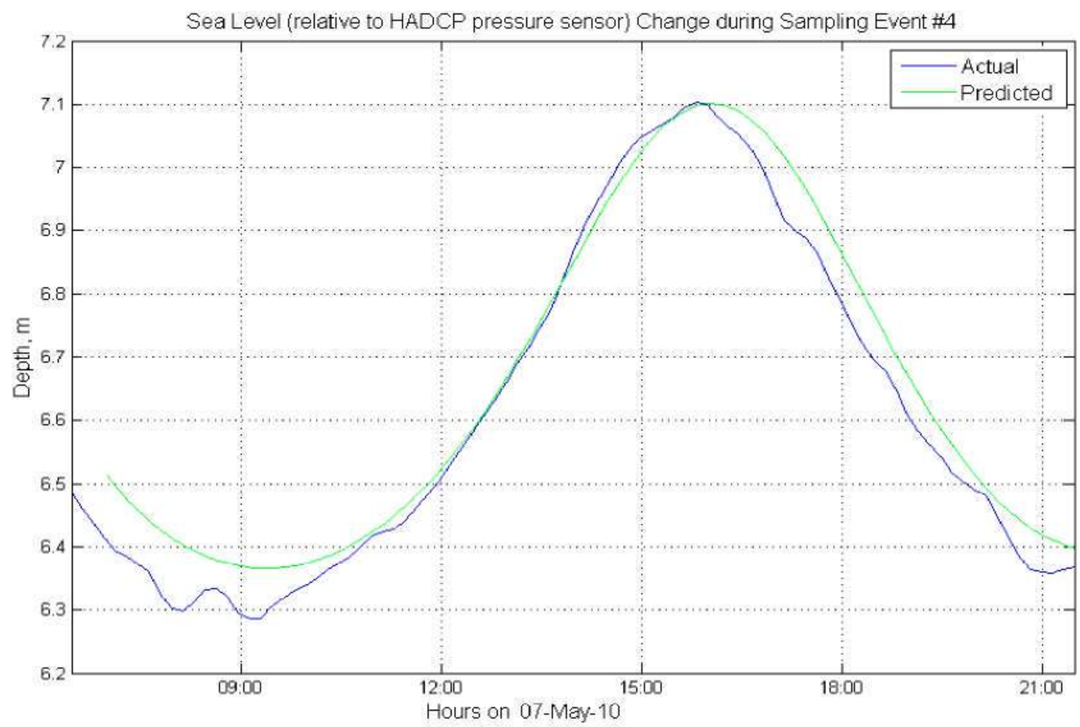

Figure 16. Time series of the actual water level (blue) and predicted water level (green) during the first sampling event (07-May-10).

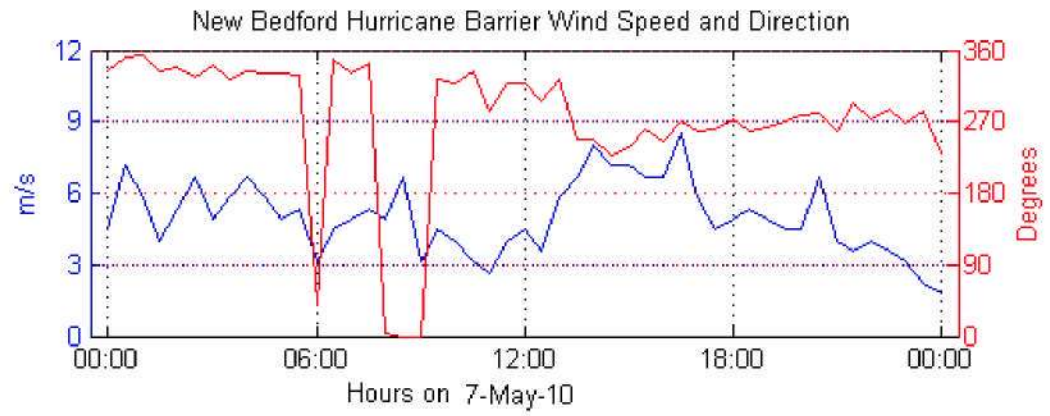

Figure 17. Time series of wind speed and direction at the Hurricane Barrier for 07-May-10.

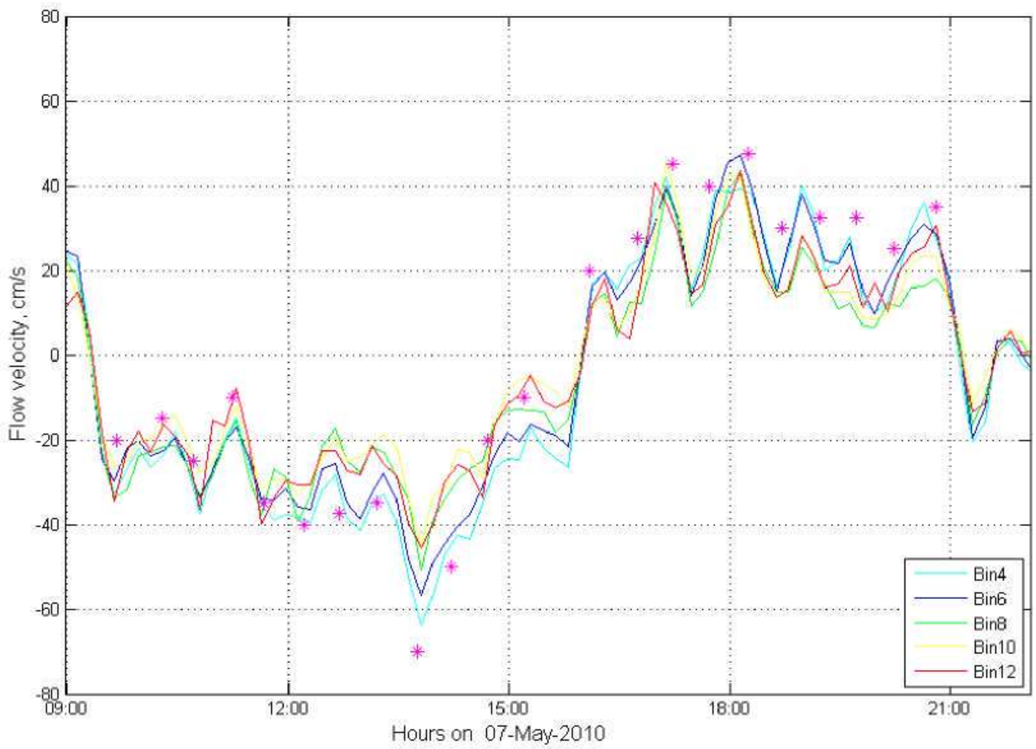

Figure 18. Long-channel flow velocity from selected HADCP bins for 07-May-10. Magenta stars show flow velocities (measured from the ADCP on the boat) used for estimation of sample volumes in the field May 7th sampling.

3.2.5 Sampling event #5: May 13th 2010 (spring tide)

Sampling on May 13th 2010, which was a spring tide sampling event, started at high water, approximately at 08:15, and ended around 19:30 (Figure 19). Low water was observed at about 13:00. The range of tidal variability was equal to 110cm during ebb and 130cm during flood. The tidal asymmetry suggested that the flood tidal volume would be greater than the ebb tidal volume. This was not the case however, perhaps due to northwesterly winds that were driving surface water out of the harbor during ebb. Wind conditions (Figure 20) were characterized by northerly winds during the ebb and southwesterly and westerly winds during the flood. The comparison between long-channel current velocities with the velocity estimates made in the field to determine the volume of each individual sample (Figure 21) shows good agreement between these data, which is a confirmation of the validity of flow-proportional sampling for this sampling event.

Freshwater discharge into the harbor for May 13th was estimated under the assumption of similarity between the hydrographs of the Acushnet River and Paskamanset River. The discharge for the Acushnet River was estimated to be around $0.4 m^3/s$, which is small compared with the tidal flow rates. The net-flow PCB flux was equal to -0.8g per tidal cycle. The difference in the PCB concentrations during ebb and flood (16ng/l) resulted in the tide-corrected outflow of PCBs at a rate of -57.6g per tidal cycle. The total flux of PCBs was about -58.4g per tidal cycle during this period.

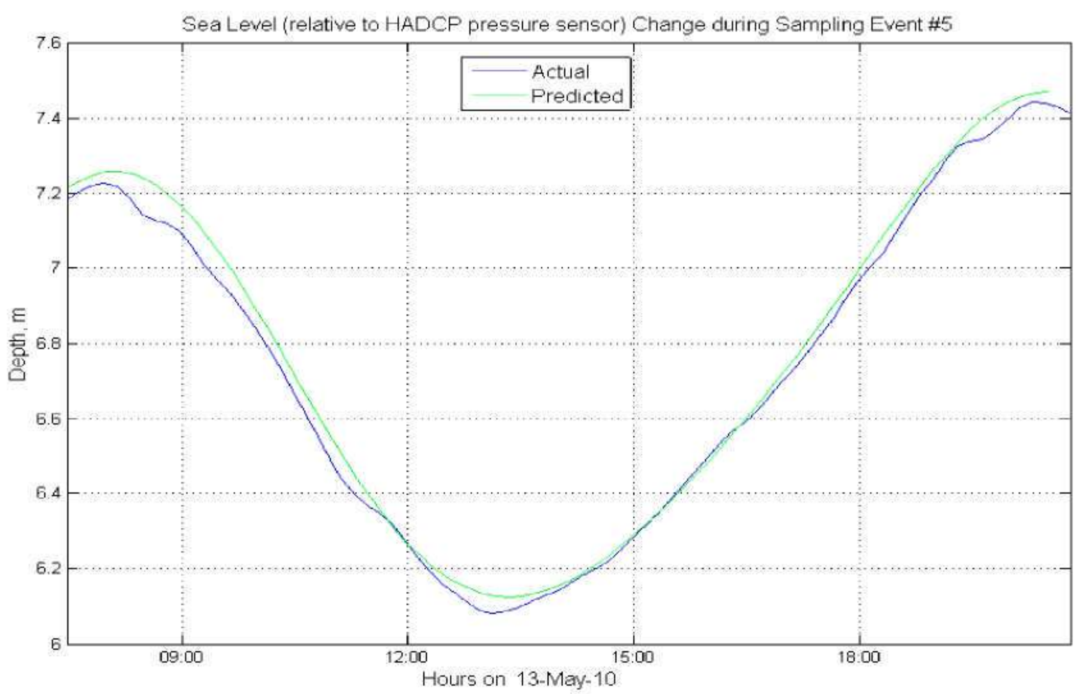

Figure 19. Time series of the actual water level (blue) and predicted water level (green) during the first sampling event (13-May-10).

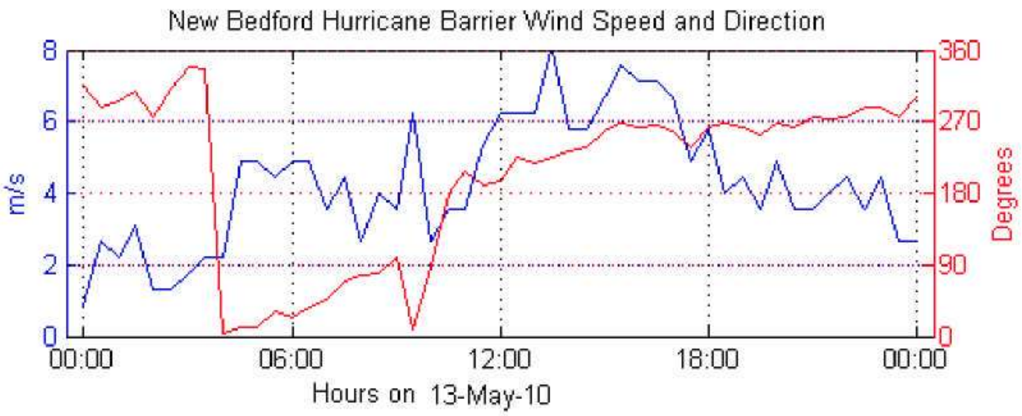

Figure 20. Time series of wind speed and direction at the Hurricane Barrier for 13-May-10.

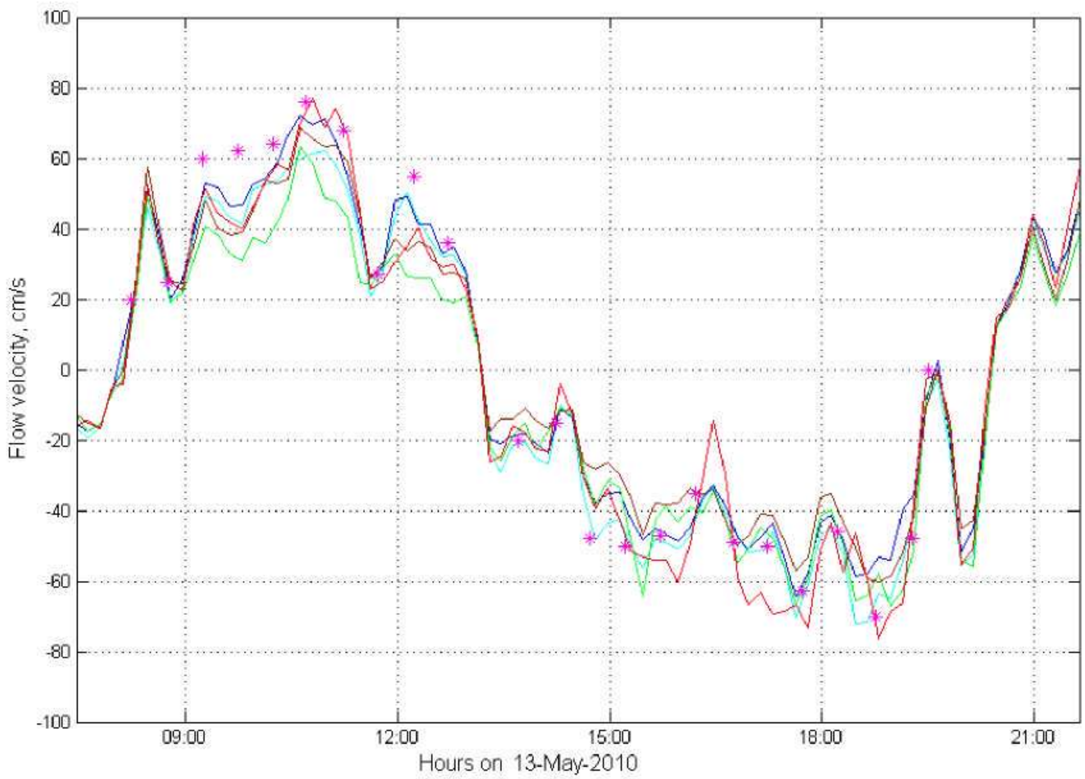

Figure 21. Long-channel flow velocity from selected HADCP bins for 13-May-10. Magenta stars show flow velocities (measured from the ADCP on the boat) used for estimation of sample volumes in the field May 13 sampling.

3.2.6 Sampling event #6: May 26th 2010 (spring tide)

Sampling on May 16th 2010, which was a spring tide sampling event, started at high water, approximately at 07:30, and ended around 19:15. Low water was observed at about 13:15 (Figure 22). The range of tidal variability was equal to 120cm during ebb and 150cm during flood. The tidal asymmetry suggested that the flood volume would be greater than the ebb volume. Indeed, the flood volume exceeded ebb volume by about 25%. Wind conditions (Figure 23) were characterized variable and light winds during the ebb and mostly southerly winds, with speeds around 4m/s, during the flood. The comparison between long-channel current velocities with the velocity estimates made in the field to determine the volume of each individual sample (Figure 24) shows good agreement between these data, which is a confirmation of the validity of flow-proportional sampling for this sampling event.

The freshwater discharge into the harbor for May 26th was estimated under the assumption of similarity between the hydrographs of the Acushnet River and Paskamanset River. The discharge for the Acushnet River was estimated to be around 0.5m^3/s, which is small compared with the tidal flow rates. The net-flow PCB flux was equal to -0.9g per tidal cycle. The difference in the PCB concentrations during ebb and flood (18ng/l) resulted in the tide-corrected outflow of PCBs at a rate of -77.4g per tidal cycle. The total flux of PCBs was about -78.3g per tidal cycle during this period.

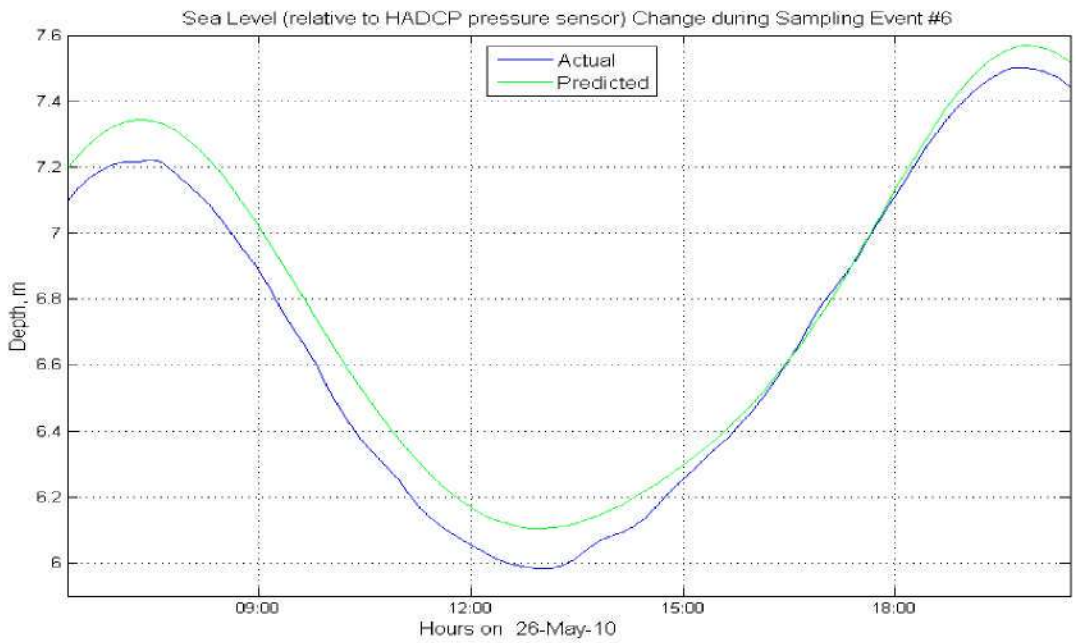

Figure 22. Time series of the actual water level (blue) and predicted water level (green) during the first sampling event (26-May-10).

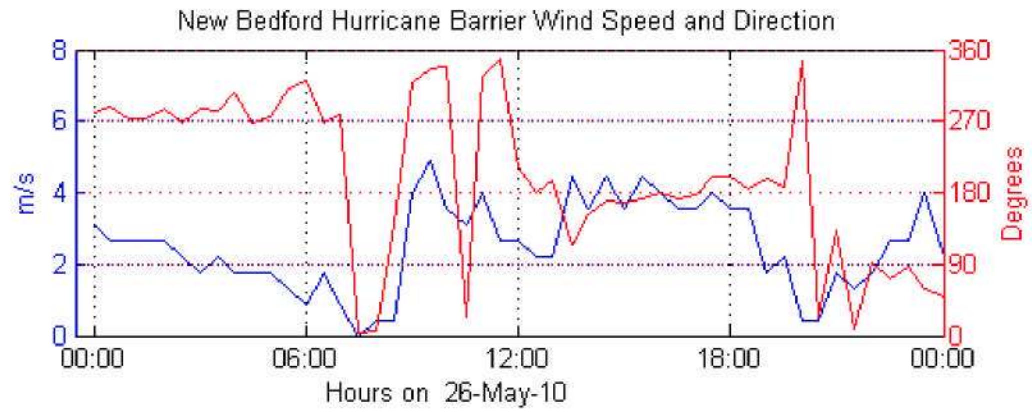

Figure 23. Time series of wind speed and direction at the Hurricane Barrier for 26-May-10.

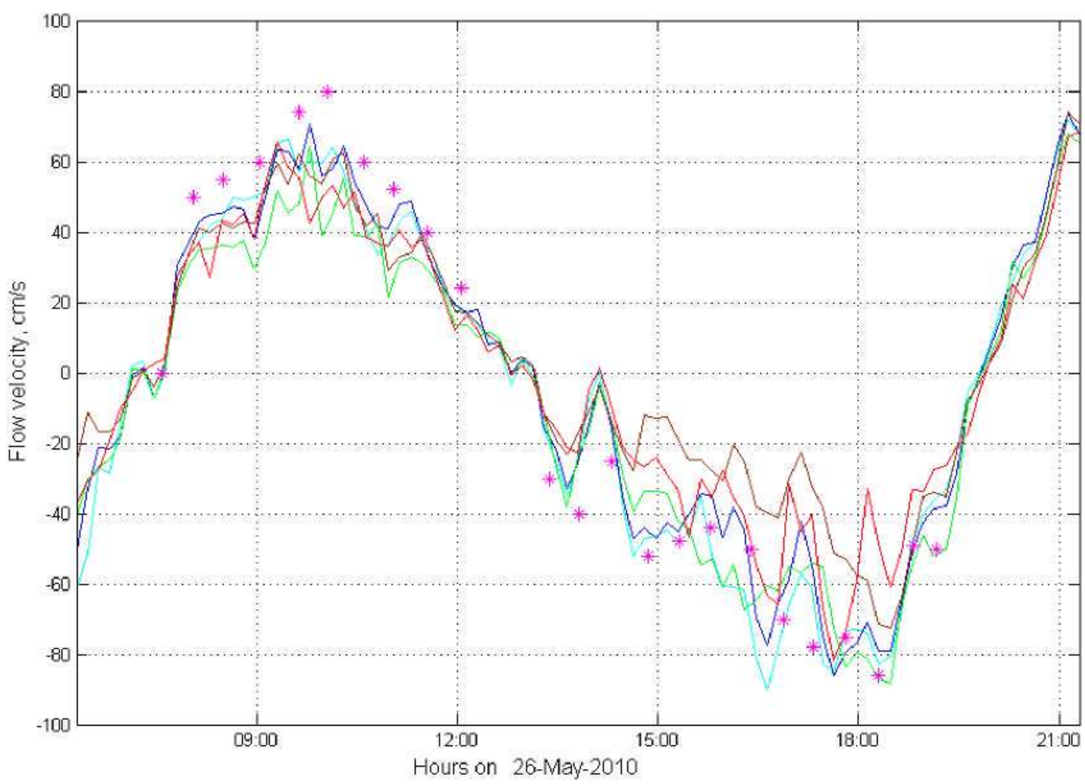

Figure 24. Long-channel flow velocity from selected HADCP bins for 26-May-10. Magenta stars show flow velocities (measured from the ADCP on the boat) used for estimation of sample volumes in the field during May 26th sampling.

4.0 SUMMARY

The results of the six sampling surveys intended to estimate the PCB flux to the OU#3 area show a persistent flux of PCBs through the Hurricane Barrier out from New Bedford Harbor. In the spring of 2010, the net rate of the total PCB mass flux ranged from -24.7g per tidal cycle (neap tide on April 21) to -82.8g per tidal cycle (weather event on April 28 coinciding with spring tide). The mean net PCB mass flux for the six (6) sampling events was approximately -61g per tidal cycle, which translates to approximately -118g per day.

The prevailing mechanism for PCB net flux through the Hurricane Barrier is tidal pumping, with net freshwater discharge providing small contributions during five (5) of the six (6) events. PCB concentrations were always lower on the flood tide than on the ebb tide, and it is the magnitude of this concentration difference that contributed most to the rate of the net PCB outflow from New Bedford Harbor to OU#3. Average tidal pumping PCB net mass flux was 57.1g per tidal cycle (range: -24.1 to -81.7), whereas average net PCB mass flux due to freshwater inflow [for the five (5) events when freshwater inflow was low] was -0.9g per tidal cycle (range: -0.6 to -1.1). The estimated net PCB mass flux for the high freshwater inflow event (April 2 flood) was -19.4g per tidal cycle, which was less than half of the tidal pumping PCB mass flux for that particularly rare event. No meaningful correlation was established between PCB concentrations in the flood and ebb composite samples and such parameters as flow velocities, sea conditions, and freshwater runoff.

PCB flux varied considerably over the six sampling events. On the flood tides, flux varied by a factor of almost 5 (range 25.4 to 119.3g). On ebb tides, flux varied by a factor of about 3 (range 46.4 to 155.8g). Similarly, the fraction of dissolved to total (dissolved plus particulate) PCBs varied by approximately a factor of more than 3. The total PCB concentration, as well as partitioning in the dissolved vs. particulate phase in the water at any given time are affected by a number of variables. These include the amount of particulate and dissolved organic carbon in water, differences in solubility of various PCB compounds (Adzeel et al. 1997; Garton et al. 1996), and suspended sediment concentrations in water column. These in turn depend on a variety of physical, biological, and chemical processes including seawater mixing, sediment scour, microbial and other biological activity, input of dissolved organic matter from surface- or groundwater inflow; and other factors. These issues, as they relate to fate, transport, and bioavailability of PCBs will be further investigated as part of the Remedial Investigation/Feasibility Study for OU#3.

This study indicates that the New Bedford Harbor sediments and water serve as a source of PCBs to OU#3, the 17,000 acre area outside the hurricane barrier. The measured flux rate compares with earlier modeled estimates of PCB flux through the barrier (Battelle, 1990), which estimated an out-flux of PCBs through the barrier of 150g per tidal cycle in 1990 and forecasted an out flux of 110g per tidal cycle for simulation year 10 (this would have been 2000, as the model was completed in 1990). The net PCB mass flux export values from the 2010 campaign outlined in this report are in a similar range, but lower on average. The average calculated net PCB mass flux in 2010 is slightly more than half (55%) of the Battelle modeled value for year 2000. Note that the PCB flux estimates from (Battelle, 1990) were based on field and laboratory studies that provided input to a physical/chemical model interfaced with a food chain model, while the estimates of the fluxes provided in this report are entirely empirical.

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5.0 REFERENCES

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APPENDIX A. TABLES SHOWING SAMPLE VOLUME FOR EACH COMPOSITE SAMPLE (6 TABLES)

[illegible] Study 209 PCB Congeners and Total PCBs (Sum of Congeners, non-detects considered 0)

PCB Congener	Sample ID	SW-LDH-03ED-0.0-40.0			SW-LDH-01E1-0.0-40.0			SW-LDH-01FD-0.0-40.0			SW-LDH-03FF-0.0-40.0		
	CAS Code	Result	Unit	PrnQ	Result	Unit	PrnQ	Result	Unit	PrnQ	Result	Unit	PrnQ
2-Monochlorobiphenyl	2051-60-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
3-Monochlorobiphenyl	2051-61-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
4-Monochlorobiphenyl	2051-62-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2'-Dichlorobiphenyl	13029-08-8	0	NG/L	C10	0	NG/L	C10	0	NG/L	C10	0	NG/L	C10
2,3-Dichlorobiphenyl	16605-91-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3'-Dichlorobiphenyl	25569-80-6	0.306	NG/L		1.29	NG/L		0.306	NG/L	J	0.804	NG/L	
2,4-Dichlorobiphenyl	33284-50-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,4'-Dichlorobiphenyl	34883-43-7	0.593	NG/L		3.21	NG/L		0	NG/L	U	0.765	NG/L	
2,5-Dichlorobiphenyl	34883-39-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,6-Dichlorobiphenyl	33146-45-1	1.01	NG/L	CJ	1.29	NG/L	C	0.552	NG/L	CJ	0.732	NG/L	CJ
3,3'-Dichlorobiphenyl	2050-67-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
3,4-Dichlorobiphenyl	2974-92-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
3,4'-Dichlorobiphenyl	2974-90-5	0	NG/L	U	0.505	NG/L	J	0	NG/L	U	0.268	NG/L	J
3,5-Dichlorobiphenyl	34883-41-5	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
4,4'-Dichlorobiphenyl	2050-68-2	0	NG/L	U	0.413	NG/L	J	0	NG/L	U	0.279	NG/L	J
2,2',3-Trichlorobiphenyl	38444-78-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',4-Trichlorobiphenyl	37680-66-3	0.533	NG/L	J	3.01	NG/L		0	NG/L	U	0.638	NG/L	
2,2',5-Trichlorobiphenyl	37680-65-2	1.46	NG/L		2.66	NG/L		0.73	NG/L		1.57	NG/L	
2,2',6-Trichlorobiphenyl	38444-73-4	0.399	NG/L	J	0.484	NG/L	J	0	NG/L	U	0.299	NG/L	J
2,3,3'-Trichlorobiphenyl	38444-84-7	0	NG/L	C20	0	NG/L	C20	0	NG/L	C20	0	NG/L	C20
2,3,4-Trichlorobiphenyl	55702-46-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,4'-Trichlorobiphenyl	38444-85-8	0	NG/L	U	0.268	NG/L	J	0	NG/L	U	0	NG/L	U
2,3,5-Trichlorobiphenyl	55720-44-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,6-Trichlorobiphenyl	55702-45-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3',4-Trichlorobiphenyl	55712-37-3	0	NG/L	U	1.23	NG/L		0	NG/L	U	0.825	NG/L	

PCB Congener	Sample ID	SW-10H-01EC-0.0-30.0			SW-10H-01ET-0.0-30.0			SW-10H-01ED-0.0-40.0			SW-10H-01FT-0.0-40.0			SW-10H-02EC-0.0-30.0			SW-10H-02ET-0.0-30.0		
	CAS Code	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag
2,2',3,3',5,6,6'-Heptachlorobiphenyl	52663-64-6	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,5'-Heptachlorobiphenyl	35065-29-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6-Heptachlorobiphenyl	74472-47-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6'-Heptachlorobiphenyl	60145-23-5	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5',6-Heptachlorobiphenyl	52663-69-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',6,6'-Heptachlorobiphenyl	74472-48-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,5,5',6-Heptachlorobiphenyl	52712-05-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,5,6,6'-Heptachlorobiphenyl	74472-49-4	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4',5,5',6-Heptachlorobiphenyl	52663-68-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4',5,6,6'-Heptachlorobiphenyl	74487-85-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,5'-Heptachlorobiphenyl	39635-31-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,6-Heptachlorobiphenyl	41411-64-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5',6-Heptachlorobiphenyl	74472-50-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,5,5',6-Heptachlorobiphenyl	74472-51-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4',5,5',6-Heptachlorobiphenyl	69782-91-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,5'-Octachlorobiphenyl	35694-08-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6-Octachlorobiphenyl	52663-78-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6'-Octachlorobiphenyl	42740-50-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',6,6'-Octachlorobiphenyl	33091-17-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,5',6-Octachlorobiphenyl	68194-17-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,5',6'-Octachlorobiphenyl	52663-75-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,6,6'-Octachlorobiphenyl	52663-73-7	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204
2,2',3,3',4,5',6,6'-Octachlorobiphenyl	40186-71-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',5,5',6,6'-Octachlorobiphenyl	2136-99-4	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,5',6-Octachlorobiphenyl	52663-76-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6,6'-Octachlorobiphenyl	74472-52-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,5',6-Octachlorobiphenyl	74472-53-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	40186-72-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl	52663-79-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
Total PCBs (sum of congeners, non-detects are considered 0, J values included as reported value)		7.492			33.211			3			19.113			3.369			16.723		

PCB Congener	Sample ID	SW-10H-02RC-0.0-30.0			SW-10H-02FT-0.0-30.0			SW-10H-03ED-0.0-40.0			SW-10H-03ET-0.0-30.0			SW-10H-03RC-0.0-30.0			SW-10H-03FT-0.0-30.0		
	CAS Code	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag
2,2',3,3',5,6,6'-Heptachlorobiphenyl	52663-64-6	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,5'-Heptachlorobiphenyl	35065-29-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6-Heptachlorobiphenyl	74472-47-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6'-Heptachlorobiphenyl	60145-23-5	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5',6-Heptachlorobiphenyl	52663-69-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',6,6'-Heptachlorobiphenyl	74472-48-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,5,5',6-Heptachlorobiphenyl	52712-05-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,5,6,6'-Heptachlorobiphenyl	74472-49-4	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4',5,5',6-Heptachlorobiphenyl	52663-68-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4',5,6,6'-Heptachlorobiphenyl	74487-85-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,5'-Heptachlorobiphenyl	39635-31-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,6-Heptachlorobiphenyl	41411-64-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5',6-Heptachlorobiphenyl	74472-50-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,5,5',6-Heptachlorobiphenyl	74472-51-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4',5,5',6-Heptachlorobiphenyl	69782-91-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,5'-Octachlorobiphenyl	35694-08-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6-Octachlorobiphenyl	52663-78-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6'-Octachlorobiphenyl	42740-50-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',6,6'-Octachlorobiphenyl	33091-17-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,5',6-Octachlorobiphenyl	68194-17-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,5',6'-Octachlorobiphenyl	52663-75-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,6,6'-Octachlorobiphenyl	52663-73-7	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204
2,2',3,3',4,5',6,6'-Octachlorobiphenyl	40186-71-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',5,5',6,6'-Octachlorobiphenyl	2136-99-4	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,5',6-Octachlorobiphenyl	52663-76-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6,6'-Octachlorobiphenyl	74472-52-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,5',6-Octachlorobiphenyl	74472-53-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	40186-72-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl	52663-79-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
Total PCBs (sum of congeners, non-detects are considered 0, J values included as reported value)		2.324			7.947			5.72			33.388			1.24			33.83		

PCB Congener	Sample ID	SW-10H-04ED-0.0-40.0			SW-10H-04ET-0.0-30.0			SW-10H-04RC-0.0-30.0			SW-10H-04FT-0.0-30.0			SW-10H-05ED-0.0-40.0			SW-10H-05ET-0.0-30.0		
	CAS Code	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag
2,2',3,3',5,6,6'-Heptachlorobiphenyl	52663-64-6	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,5'-Heptachlorobiphenyl	35065-29-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6-Heptachlorobiphenyl	74472-47-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6'-Heptachlorobiphenyl	60145-23-5	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5',6-Heptachlorobiphenyl	52663-69-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',6,6'-Heptachlorobiphenyl	74472-48-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,5,5',6-Heptachlorobiphenyl	52712-05-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,5,6,6'-Heptachlorobiphenyl	74472-49-4	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4',5,5',6-Heptachlorobiphenyl	52663-68-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4',5,6,6'-Heptachlorobiphenyl	74487-85-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,5'-Heptachlorobiphenyl	39635-31-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,6-Heptachlorobiphenyl	41411-64-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5',6-Heptachlorobiphenyl	74472-50-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,5,5',6-Heptachlorobiphenyl	74472-51-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4',5,5',6-Heptachlorobiphenyl	69782-91-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,5'-Octachlorobiphenyl	35694-08-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6-Octachlorobiphenyl	52663-78-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6'-Octachlorobiphenyl	42740-50-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',6,6'-Octachlorobiphenyl	33091-17-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,5',6-Octachlorobiphenyl	68194-17-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,5',6'-Octachlorobiphenyl	52663-75-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,6,6'-Octachlorobiphenyl	52663-73-7	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204
2,2',3,3',4,5',6,6'-Octachlorobiphenyl	40186-71-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',5,5',6,6'-Octachlorobiphenyl	2136-99-4	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,5',6-Octachlorobiphenyl	52663-76-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6,6'-Octachlorobiphenyl	74472-52-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,5',6-Octachlorobiphenyl	74472-53-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	40186-72-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl	52663-79-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
Total PCBs (sum of congeners, non-detects are considered 0, J values included as reported value)		8.494			40.437			0.55			1.5			1.73			38.45		

PCB Congener	Sample ID	SW-10H-05RC-0.0-30.0			SW-10H-05FT-0.0-30.0			SW-10H-06ED-0.0-40.0			SW-10H-06ET-0.0-30.0			SW-10H-06RC-0.0-30.0			SW-10H-06FT-0.0-30.0		
	CAS Code	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag	Result	Units	Flag
2,2',3,3',5,6,6'-Heptachlorobiphenyl	52663-64-6	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,5'-Heptachlorobiphenyl	35065-29-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6-Heptachlorobiphenyl	74472-47-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6'-Heptachlorobiphenyl	60145-23-5	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5',6-Heptachlorobiphenyl	52663-69-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',6,6'-Heptachlorobiphenyl	74472-48-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,5,5',6-Heptachlorobiphenyl	52712-05-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,5,6,6'-Heptachlorobiphenyl	74472-49-4	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4',5,5',6-Heptachlorobiphenyl	52663-68-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4',5,6,6'-Heptachlorobiphenyl	74487-85-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,5'-Heptachlorobiphenyl	39635-31-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,6-Heptachlorobiphenyl	41411-64-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5',6-Heptachlorobiphenyl	74472-50-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,5,5',6-Heptachlorobiphenyl	74472-51-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4',5,5',6-Heptachlorobiphenyl	69782-91-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,5'-Octachlorobiphenyl	35694-08-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6-Octachlorobiphenyl	52663-78-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6'-Octachlorobiphenyl	42740-50-1	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',6,6'-Octachlorobiphenyl	33091-17-7	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,5',6-Octachlorobiphenyl	68194-17-2	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,5',6'-Octachlorobiphenyl	52663-75-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,5,6,6'-Octachlorobiphenyl	52663-73-7	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204	0	NG/L	C204
2,2',3,3',4,5',6,6'-Octachlorobiphenyl	40186-71-8	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',5,5',6,6'-Octachlorobiphenyl	2136-99-4	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,5',6-Octachlorobiphenyl	52663-76-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,4,4',5,6,6'-Octachlorobiphenyl	74472-52-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,3,3',4,4',5,5',6-Octachlorobiphenyl	74472-53-0	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	40186-72-9	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl	52663-79-3	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U	0	NG/L	U
Total PCBs (sum of congeners, non-detects are considered 0, J values included as reported value)		1.59			23.1			11.555			43.561			8.54			34		

NEW BEDFORD SUPERFUND
Data View: nbh_basic_results_view
Unnamed Fields
Created: 01-Jul-2010 11:36:49
Results for

STUDY_ID IN ('NBH OU3 2010')
CLASS IN ('HOM')

	Station ID	Ebb-1			Ebb-1			Flood-1			Flood-1			Ebb-1			Ebb-1		
	Collected		4/2/2010			4/2/2010			4/2/2010			4/2/2010			4/21/2010			4/21/2010	
	Fraction	DISS			TOTAL			DISS			TOTAL			DISS			TOTAL		
	Sample ID	SW-10H-01ED-0.0-40.0			SW-10H-01ET-0.0-40.0			SW-10H-01FD-0.0-40.0			SW-10H-01FT-0.0-40.0			SW-10H-02ED-0.0-40.0			SW-10H-02ET-0.0-40.0		
Param Name	CAS Code	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ
Total MonoCB	27323-18-8	0.543	NG/L	U	0.515	NG/L	U	0.521	NG/L	U	0.515	NG/L	U	0.588	NG/L	U	0.51	NG/L	U
Total DiCB	25512-42-9	2.31	NG/L		4.66	NG/L		0.958	NG/L		2.85	NG/L		0.318	NG/L	J	0.898	NG/L	
Total TriCB	25323-68-6	4.29	NG/L		13.2	NG/L		1	NG/L		8.28	NG/L		2.42	NG/L		7.52	NG/L	
Total TetraCB	26914-33-0	0.945	NG/L		8.69	NG/L		0.302	NG/L	J	5.45	NG/L		0.588	NG/L	U	5.2	NG/L	
Total PentaCB	25429-29-2	0.543	NG/L	U	3.01	NG/L		0.521	NG/L	U	1.74	NG/L		0.588	NG/L	U	2.65	NG/L	
Total HexaCB	26601-64-9	0.543	NG/L	U	1.66	NG/L		0.521	NG/L	U	0.794	NG/L		0.588	NG/L	U	0.449	NG/L	J
Total HeptaCB	28655-71-2	0.543	NG/L	U	0.515	NG/L	U	0.521	NG/L	U	0.515	NG/L	U	0.588	NG/L	U	0.51	NG/L	U
Total OctaCB	55722-26-4	0.543	NG/L	U	0.515	NG/L	U	0.521	NG/L	U	0.515	NG/L	U	0.588	NG/L	U	0.51	NG/L	U
Total NonaCB	53742-07-7	0.543	NG/L	U	0.515	NG/L	U	0.521	NG/L	U	0.515	NG/L	U	0.588	NG/L	U	0.51	NG/L	U
Total DecaCB, Concentration	H-2051-24-3_CONC	0.543	NG/L	U	0.515	NG/L	U	0.521	NG/L	U	0.515	NG/L	U	0.588	NG/L	U	0.51	NG/L	U
Total Sum Homologues		7.485			31.22			2.26			19.114			2.738			16.717		
Total Sum Homologues (2 sig figs)		7.5			31			2.3			19			2.7			17		
Calculations for Total of Homologues																			
Param Name	CAS Code	0			0			0			0			0			0		
Total MonoCB	27323-18-8	2.31			4.66			0.958			2.85			0.318			0.898		
Total DiCB	25512-42-9	4.29			13.2			1			8.28			2.42			7.52		
Total TriCB	25323-68-6	0.945			8.69			0.302			5.45			0			5.2		
Total TetraCB	26914-33-0	0			3.01			0			1.74			0			2.65		
Total PentaCB	25429-29-2	0			1.66			0			0.794			0			0.449		
Total HexaCB	26601-64-9	0			0			0			0			0			0		
Total HeptaCB	28655-71-2	0			0			0			0			0			0		
Total OctaCB	55722-26-4	0			0			0			0			0			0		
Total NonaCB	53742-07-7	0			0			0			0			0			0		
Total DecaCB, Concentration	H-2051-24-3_CONC	0			0			0			0			0			0		
Sum of Homologues	SUM	7.485			31.22			2.26			19.114			2.738			16.717		
	SIG DIGITS	7.5			31			2.3			19			2.7			17		

	Station ID	Flood-1			Flood-1			Ebb-1			Ebb-1			Flood-1			Flood-1		
	Collected		4/21/2010			4/21/2010			4/28/2010			4/28/2010			4/28/2010			4/28/2010	
	Fraction	DISS			TOTAL			DISS			TOTAL			DISS			TOTAL		
	Sample ID	SW-10H-02FD-0.0-40.0			SW-10H-02FT-0.0-40.0			SW-10H-03ED-0.0-40.0			SW-10H-03ET-0.0-40.0			SW-10H-03FD-0.0-40.0			SW-10H-03FT-0.0-40.0		
Param Name	CAS Code	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ
Total MonoCB	27323-18-8	0.565	NG/L	U	0.521	NG/L	U	0.5	NG/L	U	0.526	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total DiCB	25512-42-9	0.565	NG/L	U	0.271	NG/L	J	1.2	NG/L		2.54	NG/L		0.5	NG/L	U	0.58	NG/L	
Total TriCB	25323-68-6	1.71	NG/L		3.89	NG/L		3.13	NG/L		12.2	NG/L		0.47	NG/L	J	4.62	NG/L	
Total TetraCB	26914-33-0	0.418	NG/L	J	2.14	NG/L		0.89	NG/L		8.95	NG/L		0.27	NG/L	J	3.14	NG/L	
Total PentaCB	25429-29-2	0.565	NG/L	U	1.3	NG/L		0.5	NG/L	U	4.34	NG/L		0.5	NG/L	U	2.05	NG/L	
Total HexaCB	26601-64-9	0.565	NG/L	U	0.344	NG/L	J	0.5	NG/L	U	1.88	NG/L		0.5	NG/L	U	0.93	NG/L	
Total HeptaCB	28655-71-2	0.565	NG/L	U	0.521	NG/L	U	0.5	NG/L	U	0.526	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total OctaCB	55722-26-4	0.565	NG/L	U	0.521	NG/L	U	0.5	NG/L	U	0.526	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total NonaCB	53742-07-7	0.565	NG/L	U	0.521	NG/L	U	0.5	NG/L	U	0.526	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total DecaCB, Concentration	H-2051-24-3_CONC	0.565	NG/L	U	0.417	NG/L	J	0.5	NG/L	U	0.526	NG/L	U	0.97	NG/L		0.5	NG/L	U
Total Sum Homologues		2.128			8.362			5.22			29.95			1.71			11.32		
Total Sum Homologues (2 sig figs)		2.1			8.4			5.2			30			1.7			11		
Calculations for Total of Homologues																			
Param Name	CAS Code	0			0			0			0			0			0		
Total MonoCB	27323-18-8	0			0.271			1.2			2.54			0			0.58		
Total DiCB	25512-42-9	1.71			3.89			3.13			12.2			0.47			4.62		
Total TriCB	25323-68-6	0.418			2.14			0.89			8.95			0.27			3.14		
Total TetraCB	26914-33-0	0			1.3			0			4.34			0			2.05		
Total PentaCB	25429-29-2	0			0.344			0			1.88			0			0.93		
Total HexaCB	26601-64-9	0			0			0			0			0			0		
Total HeptaCB	28655-71-2	0			0			0			0			0			0		
Total OctaCB	55722-26-4	0			0			0			0			0			0		
Total NonaCB	53742-07-7	0			0.417			0			0			0.97			0		
Total DecaCB, Concentration	H-2051-24-3_CONC	0			0			0			0			0			0		
Sum of Homologues	SUM	2.128			8.362			5.22			29.95			1.71			11.32		
	SIG DIGITS	2.1			8.4			5.2			30			1.7			11		

	Station ID	Ebb-1			Ebb-1			Flood-1			Flood-1			Ebb-1			Ebb-1		
	Collected		5/7/2010			5/7/2010			5/7/2010			5/7/2010			5/13/2010			5/13/2010	
	Fraction	DISS			TOTAL			DISS			TOTAL			DISS			TOTAL		
	Sample ID	SW-10H-04ED-0.0-40.0			SW-10H-04ET-0.0-40.0			SW-10H-04FD-0.0-40.0			SW-10H-04FT-0.0-40.0			SW-10H-05ED-0.0-40.0			SW-10H-05ET-0.0-40.0		
Param Name	CAS Code	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ
Total MonoCB	27323-18-8	0.549	NG/L	U	0.524	NG/L	U	0.549	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total DiCB	25512-42-9	0.994	NG/L		2.46	NG/L		0.549	NG/L	U	0.25	NG/L	J	0.66	NG/L		3.59	NG/L	
Total TriCB	25323-68-6	4.27	NG/L		13.7	NG/L		0.484	NG/L	J	4.49	NG/L		1.12	NG/L		15.4	NG/L	
Total TetraCB	26914-33-0	1.29	NG/L		12	NG/L		0.396	NG/L	J	3.83	NG/L		0.5	NG/L	U	10.9	NG/L	
Total PentaCB	25429-29-2	0.549	NG/L	U	8.52	NG/L		0.549	NG/L	U	3.03	NG/L		0.5	NG/L	U	6.53	NG/L	
Total HexaCB	26601-64-9	0.549	NG/L	U	3.7	NG/L		0.549	NG/L	U	1.4	NG/L		0.5	NG/L	U	2.08	NG/L	
Total HeptaCB	28655-71-2	0.549	NG/L	U	0.524	NG/L	U	0.549	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total OctaCB	55722-26-4	0.549	NG/L	U	0.524	NG/L	U	0.549	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total NonaCB	53742-07-7	0.549	NG/L	U	0.524	NG/L	U	0.549	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total DecaCB, Concentration	H-2051-24-3_CONC	0.549	NG/L	U	0.524	NG/L	U	0.549	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total Sum Homologues		6.494			40.38			0.88			13			1.78			38.5		
Total Sum Homologues (2 sig figs)		6.5			40			0.88			13			1.8			39		
Calculations for Total of Homologues																			
Param Name	CAS Code	0			0			0			0			0			0		
Total MonoCB	27323-18-8	0.994			2.46			0			0.25			0.66			3.59		
Total DiCB	25512-42-9	4.27			13.7			0.484			4.49			1.12			15.4		
Total TriCB	25323-68-6	1.29			12			0.396			3.83			0			10.9		
Total TetraCB	26914-33-0	0			8.52			0			3.03			0			6.53		
Total PentaCB	25429-29-2	0			3.7			0			1.4			0			2.08		
Total HexaCB	26601-64-9	0			0			0			0			0			0		
Total HeptaCB	28655-71-2	0			0			0			0			0			0		
Total OctaCB	55722-26-4	0			0			0			0			0			0		
Total NonaCB	53742-07-7	0			0			0			0			0			0		
Total DecaCB, Concentration	H-2051-24-3_CONC	0			0			0			0			0			0		
Sum of Homologues	SUM	6.494			40.38			0.88			13			1.78			38.5		
	SIG DIGITS	6.5			40			0.88			13			1.8			39		

	Station ID	Flood-1			Flood-1			Ebb-1			Ebb-1			Flood-1			Flood-1		
	Collected		5/13/2010			5/13/2010			5/26/2010			5/26/2010			5/26/2010			5/26/2010	
	Fraction	DISS			TOTAL			DISS			TOTAL			DISS			TOTAL		
	Sample ID	SW-10H-05FD-0.0-40.0			SW-10H-05FT-0.0-40.0			SW-10H-06ED-0.0-40.0			SW-10H-06ET-0.0-40.0			SW-10H-06FD-0.0-40.0			SW-10H-06FT-0.0-40.0		
Param Name	CAS Code	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ	Result	Unit	FinQ
Total MonoCB	27323-18-8	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total DiCB	25512-42-9	0.53	NG/L		2.16	NG/L		3.31	NG/L		4.65	NG/L		1.37	NG/L		9	NG/L	
Total TriCB	25323-68-6	0.76	NG/L		9.16	NG/L		6.34	NG/L		17.7	NG/L		2.38	NG/L		9.38	NG/L	
Total TetraCB	26914-33-0	0.3	NG/L	J	6.59	NG/L		1.81	NG/L		11.7	NG/L		0.76	NG/L		6.99	NG/L	
Total PentaCB	25429-29-2	0.5	NG/L	U	3.66	NG/L		0.394	NG/L	J	5.36	NG/L		0.99	NG/L		3.13	NG/L	
Total HexaCB	26601-64-9	0.5	NG/L	U	1.53	NG/L		0.5	NG/L	U	2.23	NG/L		1.04	NG/L		1.5	NG/L	
Total HeptaCB	28655-71-2	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total OctaCB	55722-26-4	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total NonaCB	53742-07-7	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total DecaCB, Concentration	H-2051-24-3_CONC	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U	0.5	NG/L	U
Total Sum Homologues		1.59			23.1			11.854			41.64			6.54			24		
Total Sum Homologues (2 sig figs)		1.6			23			12			42			6.5			24		
Calculations for Total of Homologues																			
Param Name	CAS Code	0			0			0			0			0			0		
Total MonoCB	27323-18-8	0.53			2.16			3.31			4.65			1.37			3		
Total DiCB	25512-42-9	0.76			9.16			6.34			17.7			2.38			9.38		
Total TriCB	25323-68-6	0.3			6.59			1.81			11.7			0.76			6.99		
Total TetraCB	26914-33-0	0			3.66			0.394			5.36			0.99			3.13		
Total PentaCB	25429-29-2	0			1.53			0			2.23			1.04			1.5		
Total HexaCB	26601-64-9	0			0			0			0			0			0		
Total HeptaCB	28655-71-2	0			0			0			0			0			0		
Total OctaCB	55722-26-4	0			0			0			0			0			0		
Total NonaCB	53742-07-7	0			0			0			0			0			0		
Total DecaCB, Concentration	H-2051-24-3_CONC	0			0			0			0			0			0		
Sum of Homologues	SUM	1.59			23.1			11.854			41.64			6.54			24		
	SIG DIGITS	1.6			23			12			42			6.5			24		

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APPENDIX B. SPREADSHEETS SHOWING VALUES FOR TOTAL PCB (SUM OF 209 CONGENERS AND SUM OF HOMOLOGUES)

Location: Hurricane Barrier in New Bedford Harbor

Date: 02-Apr-2010

Sample volume = 50ml per 10cm/s velocity

	Sample Volume (ml) - Flood				Sample Volume (ml) - Ebb		
Time	Surface	Midwater	Bottom	Time	Surface	Midwater	Bottom
5:30	0	75	75	11:30	200	200	200
5:50	0	75	75	11:42	200	250	200
6:15	0	75	100	12:02	225	200	200
6:25	0	100	100	12:09	200	200	200
6:50	0	200	250	12:30	350	350	350
6:57	0	250	250	12:35	300	300	300
7:21	50	300	300	13:00	325	325	325
7:30	100	300	300	13:05	300	350	350
7:51	50	300	250	13:28	350	350	350
7:59	50	300	250	13:36	350	350	350
8:24	100	400	350	14:08	300	300	300
8:32	100	350	300	14:13	300	250	250
8:53	100	400	400	14:30	225	225	225
9:02	50	350	350	14:35	225	225	225
9:21	300	400	350	15:05	250	250	250
9:30	400	400	350	15:11	250	250	250
9:53	250	350	250	15:30	175	175	175
10:00	200	300	300	15:40	100	100	100
10:23	150	250	250	16:00	100	50	50
10:31	150	150	150	16:06	75	50	50
10:55	100	100	100				

Location: Hurricane Barrier in New Bedford Harbor									
Date: 21-Apr-2010									
Sample volume = 100ml per 10cm/s velocity									
		Sample Volume (ml) - Flood					Sample Volume (ml) - Ebb		
	Time	Surface	Midwater	Bottom		Time	Surface	Midwater	Bottom
	8:47	0	50	50		14:21	400	400	400
	8:52	0	50	50		14:25	500	500	500
	9:20	50	300	250		14:55	275	275	275
	9:23	50	300	250		14:58	275	275	275
	9:52	50	150	150		15:20	500	500	500
	9:55	50	150	150		15:25	500	500	500
	10:20	350	450	350		15:50	550	550	550
	10:23	350	450	350		15:55	550	550	550
	10:50	500	400	300		16:20	475	475	475
	10:55	500	400	300		16:24	475	475	475
	11:22	650	600	500		16:52	550	550	550
	11:26	650	600	500		16:56	550	550	550
	11:50	800	700	600		17:20	260	260	260
	11:53	800	700	600		17:24	260	260	260
	12:23	600	600	550		17:52	300	300	300
	12:34	600	600	550		18:00	300	300	300
	12:50	500	500	500		18:20	260	260	260
	12:54	500	500	500		18:24	260	260	260
	13:22	250	250	250		18:55	125	125	125
	13:26	250	250	250		18:58	125	125	125
	13:50	250	250	250		19:12	100	100	100
	13:55	250	250	250		19:15	100	100	100

Location: Hurricane Barrier in New Bedford Harbor
Date: 28-Apr-2010
Sample volume = 50ml per 10cm/s velocity, double size sample beginning 16:10 (due to rough weather)

	Sample Volume (ml) - Ebb				Sample Volume (ml) - Flood		
Time	Surface	Midwater	Bottom	Time	Surface	Midwater	Bottom
8:50	50	0	0	14:40	150	150	150
8:53	50	50	0	14:43	150	150	150
9:20	200	200	200	15:12	175	175	125
9:23	200	200	200	15:15	175	175	125
9:48	250	250	150	15:40	200	200	200
9:51	250	250	150	15:45	200	200	200
10:19	475	475	425	16:10	600	600	550
10:22	475	475	425	16:40	350	350	350
10:49	475	475	475	17:12	550	550	550
11:00	475	475	475	17:40	750	750	750
11:18	500	500	500	18:10	500	500	500
11:22	500	500	500	18:40	800	800	750
11:49	400	400	400	19:10	1000	1000	1000
11:51	400	400	400	19:39	200	200	200
12:20	200	200	200	20:08	200	200	200
12:24	200	200	200				
12:50	375	375	375				
12:54	425	425	425				
13:20	225	225	225				
13:24	225	225	225				
13:50	100	75	50				
13:53	100	75	50				

Location: Hurricane Barrier in New Bedford Harbor
Date: 07-May-2010
Sample volume = 100ml per 10cm/s velocity

	Sample Volume (ml) - Flood				Sample Volume (ml) - Ebb		
Time	Surface	Midwater	Bottom	Time	Surface	Midwater	Bottom
9:37	200	200	200	16:02	250	200	100
9:40	200	200	200	16:05	350	200	100
10:13	0	150	150	16:38	275	275	275
10:17	0	150	150	16:45	275	275	275
10:40	50	250	300	17:10	450	450	450
10:43	50	250	300	17:13	450	450	450
11:11	0	100	100	17:40	400	400	400
11:14	0	100	100	17:43	400	400	400
11:36	200	350	350	18:10	475	475	475
11:40	200	350	350	18:15	475	475	475
12:10	300	400	350	18:40	300	300	300
12:13	300	400	350	18:43	300	300	300
12:40	250	375	375	19:11	325	325	325
12:42	250	375	375	19:13	325	325	325
13:10	325	350	325	19:40	325	325	325
13:12	325	350	325	19:43	325	325	325
13:41	700	750	650	20:10	250	250	250
13:49	700	750	650	20:14	250	250	250
14:09	500	500	500	20:41	325	325	325
14:13	500	500	500	20:48	375	375	375
14:40	200	200	200				
14:43	200	200	200				
15:10	100	100	100				
15:12	100	100	100				

Location: Hurricane Barrier in New Bedford Harbor
Date: 13-May-2010
Sample volume = 50ml per 10cm/s velocity

	Sample Volume (ml) - Ebb				Sample Volume (ml) - Flood		
Time	Surface	Midwater	Bottom	Time	Surface	Midwater	Bottom
8:10	100	100	50	13:40	100	100	100
8:15	150	100	50	13:43	100	100	100
8:40	125	125	125	14:11	75	75	75
8:45	125	125	125	14:15	75	75	75
9:10	300	300	300	14:40	250	250	220
9:15	300	300	300	14:43	250	250	220
9:40	310	310	310	15:10	250	250	250
9:45	310	310	310	15:13	250	250	250
10:10	300	300	300	15:40	260	240	200
10:15	340	340	340	15:43	260	240	200
10:40	380	380	380	16:10	200	180	150
10:43	380	380	380	16:13	200	180	150
11:11	325	325	325	16:40	250	250	230
11:15	350	350	350	16:45	250	250	230
11:40	125	125	140	17:12	260	260	230
11:43	140	140	140	17:15	260	260	230
12:10	275	275	275	17:40	360	320	270
12:14	275	275	275	17:43	360	320	270
12:40	180	180	180	18:10	250	250	170
12:43	180	180	180	18:13	250	250	170
				18:40	375	375	275
				18:45	375	375	275
				19:12	300	300	200
				19:16	250	250	150

Location: Hurricane Barrier in New Bedford Harbor

Date: 26-May-2010

Sample volume = 50ml per 10cm/s velocity

	Sample Volume (ml) - Ebb				Sample Volume (ml) - Flood		
Time	Surface	Midwater	Bottom	Time	Surface	Midwater	Bottom
7:30	50	0	0	13:20	150	150	150
7:35	50	0	0	13:22	150	150	150
8:00	250	250	300	13:44	200	200	200
8:03	250	250	300	13:49	200	200	200
8:29	250	275	300	14:16	125	125	125
8:32	250	275	300	14:18	125	125	125
9:00	300	300	300	14:45	260	260	260
9:03	300	300	300	14:51	260	260	260
9:31	370	370	370	15:15	240	240	240
9:38	370	370	370	15:19	240	240	240
10:00	375	375	375	15:44	240	220	220
10:03	420	420	420	15:47	240	220	220
10:30	300	300	300	16:16	250	250	240
10:36	300	300	300	16:23	250	250	240
11:00	250	250	250	16:46	350	350	350
11:03	275	275	275	16:53	350	350	350
11:30	200	200	200	17:15	390	390	390
11:33	200	200	200	17:19	390	390	390
12:00	120	120	120	17:44	390	390	390
12:04	120	120	120	17:49	360	360	360
				18:14	420	420	420
				18:18	440	440	440
				18:45	270	270	240
				18:49	240	240	200
				19:07	250	250	200
				19:10	250	250	200

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Laboratory Testing In Support of *Site Specific Water Quality Criteria Assessment and Hydrographic Data Collection for New Bedford Harbor*

TASK 2A
SUSPENDED PARTICULATE PHASE
ACUTE TOXICITY TESTING WITH MYSIDS

Data Report

Prepared for:

Massachusetts Coastal Zone Management Agency
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CZM

Submitted by:

Maguire Group Inc.

MAGUIRE GROUP

July 2003

Laboratory Testing In Support of *Site Specific Water Quality Criteria Assessment and Hydrographic Data Collection for New Bedford Harbor*

TASK 2A
SUSPENDED PARTICULATE PHASE
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Data Report

Prepared for:

Maguire Group Inc.

Prepared by:

Science Applications International Corporation
221 Third Street
Newport, RI 02840

December 12, 2002

Introduction

Task 2 of SAIC's Site Specific Water Quality Assessment Study involves toxicity testing and chemical analyses to determine risks to aquatic organisms from potential resuspension of sediments during dredging operations in New Bedford Harbor. These data will provide site-specific measures of the allowable chemical concentrations in water associated with the sediment resuspension during dredging. To date these concentrations have been derived through modeling exercises (ASA, 2001; 2002), and thus represents a data gap.

In Task 2A, toxicity testing of Suspended Particulate Phase (SPP) mixtures is performed to document the occurrence and magnitude of toxicity, as well as to select samples for further evaluation of the cause of toxicity using Toxicity Identification Evaluations (TIE, Task 2B). Also, the chemical exposure concentrations corresponding to non-toxic SPP samples are used to as a precursor to the derivation of Water Effect Ratios (Task 2C), which, when applied to the default water quality criteria values, represents an adjusted criteria for site specific conditions.

This document reports on Task 2A, including SPP testing, and data obtained from chemical analyses of SPP and elutriates. Minimal interpretation of the chemistry data is provided here, as this aspect of the Water Quality Criteria Assessment will be further addressed in Task 2B and Task 2C.

Approach

SPP testing is a standard and generally required activity for evaluation of dredged materials to determine the potential impact of dissolved and suspended contaminants on water column organisms (USEPA and USACE, 1991; 1998). For New Bedford Harbor, the SPP testing was conducted with six sediment samples collected from candidate CAD cell areas and navigation dredging areas with the intention of representing the most highly contaminated sediments that would be involved in navigation dredging operations. Background data on these locations were obtained from the draft EIS (Office of Coastal Zone Management, 2002). An SPP consisting of reference sediment was tested for toxicity, resulting in a total of seven toxicity evaluations; the chemical composition of the reference sample was not analyzed.

Methods

Sample Collection and Transport
Samples were collected by Maguire Group as part of an ongoing 'Nature and Extent' study. Three sediments from the Pope's Island CAD cell (PI-CAD; NBH-204, NBH-205 and NBH-206) and two from the more southerly CAD cell area (LH--CAD; NBH-201 and NBH-202) were selected for testing, along with one station (NBH-207) to the west of Pope's Island, a near-shore site that had been identified as a PCB hot-spot (Figure 1). The samples were collected on 10 October 2002, and were shipped in one-gallon polyethylene buckets, filled with no head space, on 11 October, arriving at the toxicity testing laboratory (SAIC's subcontractor, Aquatec Biological in Williston, VT) on 12 October. Standard chain-of-custody procedures were followed. Chain-of custody (CoC) forms were signed and copied. SAIC retains copies of the CoCs, along with test data in experiment binders and project files. Upon arrival, samples were inspected to determine

their temperature and condition (e.g., caps in place or leakage). When coolers were received on 12 October, temperatures slightly exceeded recommended storage conditions (4 $\pm$ 2°C) to varying degrees. However, because the transit time was < 24 hrs and the exceedences were generally small, we believe that results from toxicity tests with the samples are valid.
Samples were stored at 4 ± 2°C in the dark until testing.

Organism Selection and Source
The test species chosen for SPP testing was the saltwater mysid, *Americamysis bahia*. This species has been shown to be sensitive to New Bedford Harbor sediments in previous studies (Nelson et al. 1991; Ho et al., 1997). The mysid was also selected for its relatively high sensitivity to PCBs, and because their sensitivity to a wide variety of other toxicants has also been documented (USEPA AQUIRE). Mysids for testing were supplied by Aquatic Biosystems in Fort Collins Colorado. They were hatched14 October, received at Aquatec on 16 October and the test was initiated on 17 October. Newly hatched *Artemia* were fed to mysids on each day prior to test initiation, and daily feeding continued during the test.

Mysids were evaluated using a standard reference toxicant water-only test with potassium chloride. In this test, survival is determined in each of two replicate chambers to which ten animals have been added. The reference test uses a six dilution series with concentrations ranging between 0.1 and 1.0 g/L, and is used to determine LC50 values for comparison with Control Chart values. Aquatec's Control Chart for the mysid *(A. bahia)* includes > 20 tests from mysid tests conducted since 1999.

Suspended Particulate Phase Preparation and Testing
Suspended Particulate Phase samples were prepared by adding homogenized sediment to site water in a 1:4 volumetric ratio. The solution was stirred with a mixer for 30 minutes, and every 10 minutes by hand, and then allowed to settle for one hour. The supernatant was siphoned off for toxicity testing as well as for total suspended solids (TSS) and total organic carbon (TOC) analyses. For other chemical analyses (TAL metals, PAHs and PCBs), the supernatant (SPP) was centrifuged for approximately 10 minutes at 6000 rpm. Samples were preserved, as appropriate and were air-freighted to SAIC's subcontractor for chemical Analyses, Severn Trent Laboratories in Burlington, VT. The following EPA-recommended analytical methods (U.S. EPA, 1997) were employed: TOC (9060); TSS (160.2); PCB congeners (8082); TAL metals (6010B). PAHs were measured using NOAA Status and Trends methods (NOAA, 1998).

Dilutions of the SPP for toxicity testing were prepared by mixing the centrifuged supernatant with Forty Fathoms@ artificial seawater. Elutriate dilutions (1%, 10%, 25%, 50%, and 100%) as well as Control Water (artificial seawater) and a Long Island Sound Reference Site SPP were tested using mysid exposures.

Ninety-six hour tests using the mysid *(A. bahia)* were conducted according to the accepted proposal. The test chambers were glass jars. Two hundred milliliters of full strength or diluted elutriate was added to each of five replicate chambers per concentration. In addition, a Forty Fathoms® seawater performance control was tested. The performance control and the LIS reference SPP were tested using 100% SPP only. All other SPP samples were tested using the 1%, 10%, 25%, 50% and 100% dilution series. Test temperature ranged from 24 to 25 °C.

At the beginning of each test series, mysids were transferred from acclimating chambers into test chambers using a wide-bore pipette. Ten mysids were randomly distributed into each chamber. Animals were fed during testing. Test chambers were monitored daily and dead mysids were recorded and removed.

Acceptable dissolved oxygen concentrations were documented to be in the range of 7.8 to 8.2 mg/L at the start of the test, and 5.3 to 6.6 mg/L at the end of the test. Salinity increased by ≤3 mg/Kg, from 31 mg/Kg at test initiation, pH ranged between 7.8 and 8.2, across samples, with no apparent temporal trend. All water quality parameters were acceptable (U.S. EPA/U.S. ACE, 1998; U.S. ACE, 1991). Ambient laboratory lighting was set for a 16 hr light and 8 hr dark photoperiod. Full strength SPP solutions were analyzed for ammonia on day 0. Samples were diluted 1 to 10 with deionized water. Total ammonia was measured spectrophotometrically.

Data Analysis

Data analysis was performed with SPP results using a one-way heteroscedastic t-test (alpha=0.05) assuming normal distribution of the data. In addition, for each of the samples with statistically significant reductions in survival, estimated effect concentrations ("LC" values) were calculated using data from the dilution series. Values were calculated using linear interpolation, with bootstrapping to generate confidence intervals. Statistics were generated with the ToxCalc® statistical package from Tidepool Software. Results of the analyses were interpreted within the context of the following decision points, as follows (also see Fig. 1 of the proposal for this project):

- A finding of no toxicity and chemical measures below water quality criteria (WQC) values indicates that default WQC criteria may be used in monitoring and that no further testing is required.
- A finding of toxicity and chemical concentrations above WQC indicates that a specific chemical is causing toxicity or several chemicals are causing toxicity, or that confounding factors (e.g., ammonia toxicity) are contributing, such that a TIE (Task 2B) should be conducted to resolve the toxicity sources.
- A finding of toxicity but chemical concentrations below WQC will indicate that site-specific toxicity of chemicals is greater than presumed by default WQC. This result, generally indicative of confounding factors such as ammonia, and will also be further evaluated through the Task 2B TIE study.

Results

Quality Assurance/Quality Control

The summary report for reference toxicant (potassium chloride) testing conducted by Aquatec is presented in Appendix A. The LC50 was 0.373 g/L, well within the Control Chart lower and upper boundaries of 0.11 and 0.56 g/L, established the normal response of these organisms (Appendix A). During the SPP testing, water quality measurements of temperature, salinity, pH and dissolved oxygen were within normal the normal range for mysid exposures (U.S. EPA, 1991). All QA/QC parameters measured for chemical analyses were within acceptable ranges. SAIC maintains a copy of the full Toxicity Test Data Report provided by Aquatec and the analytical chemistry data report provided by Severn Trent Laboratories.

Site Sample SPP Toxicity Test Results

Mean survival for mysids was greater than 95% in all but one of the six SPP samples (Table 1). For NBH-202, toxicity was observed in the 100% SPP, but not in any of the dilution series. The calculated LC50 value was 76%; the ToxCalc summary report for the statistical analysis is presented at the end of Appendix B. Time series mortality in the NBH-202 100% SPP over each day of the four day test were as follows: No mortality had occurred by Day 1, while exposures through Day 2, Day 3 and Day 4 resulted in mean survival of 42%, 20% and 2%, respectively. Ammonia concentrations (Table 1) measured as a routine practice at the start of SPP testing indicate that NPH-202 had the highest concentration of total and unionized ammonia (37.9 and 1.6 mg/L, respectively), with the unionized concentration approaching the LC50 value for this species (1.94 mg/L). Relationships between toxicity and chemical exposure concentrations are discussed in the following section.

Analytical Chemistry Results and Exposure Characterization

Comparisons with Aquatic Life Criteria and Species-specific Benchmarks.

Results from chemical analyses of elutriates derived from SPP are presented in Appendix C. Hazard Quotients (HQ) derived from Chronic and Acute Water Quality Criteria values or equivalent are presented in Table 2 and Table 3, respectively. The values presented are simply the quotient of measured chemical concentrations (from Appendix C-1; Metals and PAHs and C-2; PCBs), divided by the respective Water Quality screening value.

In Table 2, chronic HQs for aluminum, copper, nickel, silver, benzo(k)fluoranthene and Total PCBs are > 1 for all stations (except NBH-204 for benzo(k) fluoranthene). Among these, the copper and PCB concentrations are likely to be the most toxicologically relevant; as aluminum, is likely biased by the solids component while nickel and silver concentrations were non-detect. Station NBH-202 had the highest chronic HQs.

Using Acute Water Quality Criteria as benchmarks (Table 3), proportionately lower exceedences (HQs> 1) are calculated to represent risks associated with short duration exposures. Because dilution will occur during dredging operations, these Acute HQs are more appropriate than chronic criteria values for interpretation of elutriate concentrations. Acute HQs for PAHs and Total PCBs are less than unity at all stations other than NBH-202. For NBH-202, the sum PAH HQ is 1.33 and the Total PCBs HQ is 2.31, suggesting probable toxicity. The highest HQ for NBH-202 is for copper (HQ=20). Four of the other five stations also exceeded the acute criteria for copper, with (HQ range 1.48 to 8.13). Only NBH-204 had an elutriate copper concentration less than the Acute Criteria value.

Hazard Quotients based on the known sensitivity of mysids *(A. bahia)* to metals, including copper, as well as PCBs and ammonia, are presented in Table 4. Based on available information (i.e., published LC50 values), the major contributors to toxicity in NHB-202 appear to be PCBs (HQ= 1.36), unionized ammonia (HQ=0.82), and copper (HQ=0.64). The sum HQ was less than unity for the remaining stations, suggesting that acute toxicity is not likely to occur.

The sum HQ for NBH-202 mysid exposures, based on measured concentrations of PCBs, ammonia and metals is 2.9 (Table 4), with PCBs being the largest contributor. There is relatively high uncertainty associated with the HQ for PCBs, given that it is based on exposures to Aroclor 1242 (Ho et al., 1997). While Aroclor 1242 and Aroclor 1254 are believed to be the major PCB mixtures present in New Bedford Harbor sediments, mixtures of congeners changes over time due to natural physical and biological processes. Toxicity of PCB mixtures is also expected to change somewhat over time, but parent compound toxicity is generally used to estimate potential toxicity in field samples because no other approach is practical. The mysid LC50 for Aroclor 1242 was used as a conservative value to derive species-specific HQs, and it is about three times more toxic to mysids than Aroclor 1254 (Ho et al., 1997). The value used is particularly conservative because it was derived from a 96 hr test that was renewed with freshly prepared solution at 48 hrs, while the SPP tests for the present study were not renewed, and reduction in exposure concentrations are expected over time. The estimate of total PCBs (Appendix C-2) used in the HQ calculations was calculated from individual congeners using NOAA Status and Trends protocol (1998).

With regard to ammonia, reported LC50s from a single study range over a factor of two-three, based on total and unionized values, respectively. Therefore, the HQ for ammonia for NBH-202 could be as low as 0.5 or as high as 1.6. For copper, the range between two reported LC50s is relatively narrow (141 μg/L, Bay et al. 1993; 164 μ/L, SAIC 1993). In summary, toxicity and chemical concentrations above WQC indicated a likelihood that toxicity could be attributable to metals, PCBs and confounding factors (e.g., ammonia toxicity), but the relative roles of each in toxicity associated with the NBH-202 sample remains uncertain. Task 2B involving the conduct of a Toxicity Identification Evaluation is directed at resolving the relative sources of toxicity. It is also important to consider that the three most likely sources of toxicity may contribute synergistically to observed effects.

Elutriate Concentrations Relative to Predicted Values

Table 5 presents measured concentrations of metals, PCBs and PAHs for each elutriate tested compared with predictions of elutriate concentrations that used equilibrium partitioning and sediment concentrations to derive computed estimates (ASA, 2001 ;U.S. EPA, 1991). Only one elutriate concentration is reported by ASA, representing the highest sediment loading (Fish Island Area; mean of 16 stations) found in the bulk sediment survey conducted by Lecco (1998). Only metals with measured concentrations above detection limits are presented.

For metals, measured values for copper in FI-A (near NBH-207) were a factor of 4.4 less than the estimated elutriate value. For Total PCBs the measured value was three orders of magnitude higher than the elutriate value based on ASA's reported estimate. A review of the ASA result is underway to evaluate potential causes for this large difference. The sum of measured PAH values (used as a surrogate for TPH) were all much lower than estimated values, and represent lower acute and chronic limits than measured PCBs. Massachusetts currently does not apply a standard for TPH.

Summary of Findings for Site Specific Water Quality Study

Results for the SPP tests determined that only NBH-202 was toxic to mysids. In this sample, the absence of toxicity in any of the dilutions indicates a relatively low level of acute toxicity. None of the other samples were acutely toxic. Given the close range of species-specific HQs (0.6-1.4) for the three predominant toxicants in NBH-202, attendant uncertainties associated with each, and the effects of ambient (site-specific) water quality on each, it is not possible to determine if one, two, or all three of the constituents (copper, Total PCBs, ammonia) are important contributors to toxicity. As described in SAIC's "Proposal for Site Specific Water Quality Criteria Assessment and Hydrographic Data Collection for New Bedford Harbor," sample NBH-202 is in the process of further evaluation, using Toxicity Identification Evaluation (TIE) methods as an effort to resolve the potential sources of the observed toxicity.

In addition, it would be useful to obtain estimates of elutriate concentrations derived from sediments representing areas other than Fish Island, and including the sediment chemistry data recently produced for characterization of sediment cores.

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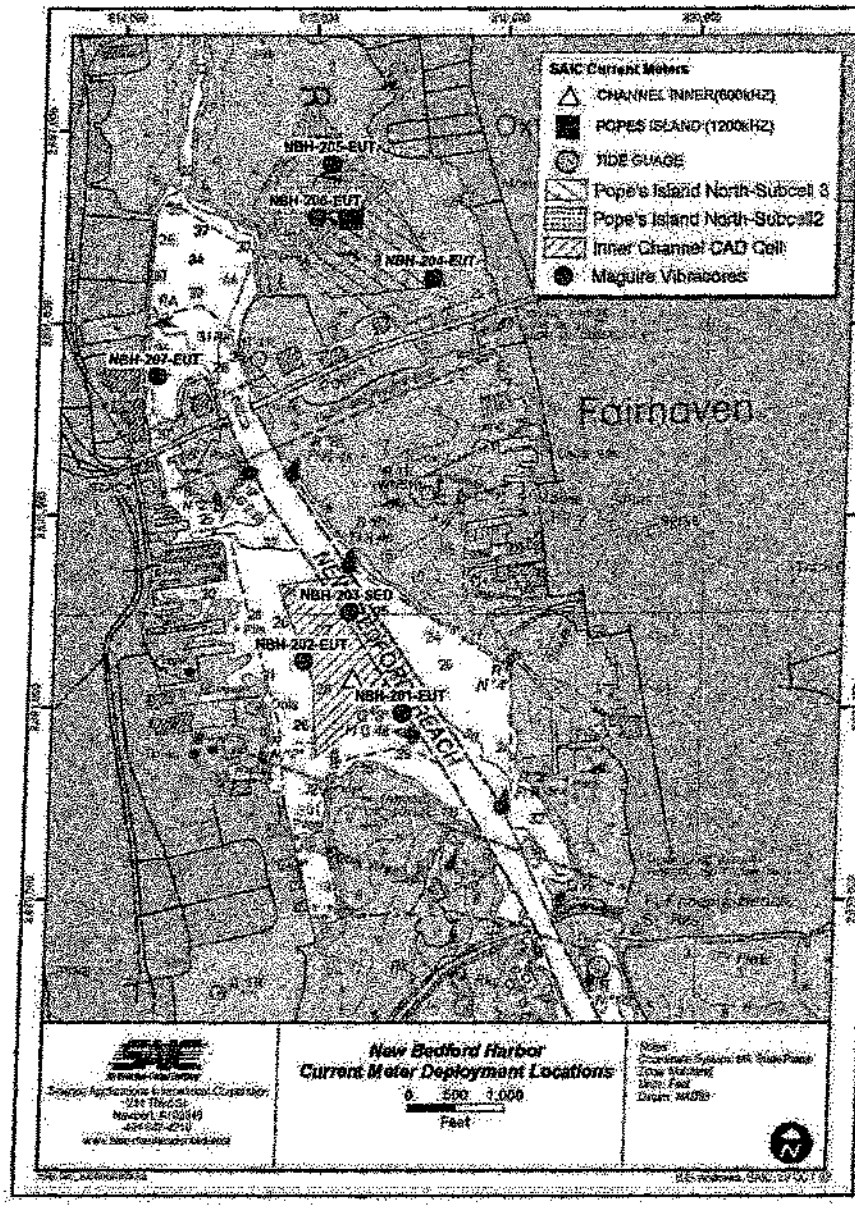


Figure 1. New Bedford Harbor stations selected for the Site Specific Water Quality Criteria Assessment Study (denoted as stations sampled synoptically for sediment core characterization- 'Maguire Vibracores').

Table 1. Results and Test Parameters for 96 hr Acute Suspended Particulate Phase Test using the mysid *Americamysis bahia*, exposed to New Bedford Harbor water and Suspended Particulate Phase samples.

Sample	% Survival[a] (Water only)	% Survival[b] (100% SPP)	% Survival[b] (50% SPP)	Total Ammonia (NH_4, mg/L)	Unionized Ammonia (NH_3, mg/L)
NBH-201	97	96	100	11.3	0.5
NBH-202	100	2	96	37.9	1.6
NBH-204	100	100	100	1.3	0.0
NBH-205	100	98	100	9.1	0.4
NBH-206	100	98	100	6.2	0.3
NBH-207	100	100	100	13.8	0.5
Control[c]	96				
Control[d]		100		1.38	ND

Temperature = 24-25°C ; Salinity = 31-34 mg/Kg; pH = 8.0-8.4; D.O. = 7.8-8.4 mg/L

a = 3 replicates of 10 mysids each per sample

b = 5 replicates of 10 mysids each per sample

c- Control water = Forty Fathoms mix.

d = Control sediment collected from Central Long Island Sound in 2000

Table 2. Hazard Quotients.[1] for CoCs in sediment elutriates for the NBH Water Quality Study

Benchmark = Chronic WQC [2]

Class	Analyte	WQSV Source[2]	NBH-201-ELUT	NBH-202-ELUT	NBH-204-ELUT	NBH-205-ELUT	NBH-206-ELUT	NBH-207-ELUT
MET	Aluminum	87.0	1.85	27	6.63	3.98	2.48	9.80
MET	Antimony							
MET	Arsenic	36.0	0.14	0.50	0.11	0.65	0.37	0.14
MET	Cadmium	9.3	0.03	0.05	0.03	0.03	0.03	0.03
MET	Chromium	50.0	0.09	0.71	0.09	0.09	0.09	0.21
MET	Copper	3.1	2.29	32	1.29	3.48	2.29	13
MET	Iron							
MET	Lead	8.1	0.14	1.65	0.14	0.14	0.14	0.14
MET	Manganese							
MET	Nickel	8.2	1.65	1.65	1.65	1.65	1.65	1.65
MET	Silver	0.1	12	12	12	12	12	12
MET	Zinc	81.0	0.09	0.50	0.09	0.09	0.09	0.20
PAH	1-Methylnaphthalene							
PAH	1-Methylphenanthrene							
PAH	2,3,5-Trimethylnaphthalene							
PAH	2,6- Dimethylnaphthalene							
PAH	2-Methylnaphthalene (L)							
PAH	Acenaphthene (L)	97.00	2.8E-4	1.9E-3	2.2E-4	2.1E-4	2.1E-4	3.6E-4
PAH	Acenaphthylene (L)	49.00	5.5E-4	4.3E-4	4.3E-4	4.1E-4	4.1E-4	4.3E-4
PAH	Anthracene (L)	18.00	1.5E-3	1.8E-3	1.2E-3	1.4E-3	1.3E-3	1.8E-3
PAH	Benzo(a)anthracene (H)	0.66	0.03	0.23	0.02	0.05	0.04	0.14
PAH	Benzo(a)pyrene (H)	0.19	0.11	0.63	0.07	0.22	0.18	0.35
PAH	Benzo(b)fluoranthene	0.04	0.50	3.68	0.42	0.82	0.95	2.89
PAH	Benzo(e)pyrene							
PAH	Benzo(g,h,i)perylene							
PAH	Benzo(k)fluoranthene	0.02	1.24	8.24	0.65	1.76	1.47	4.18
PAH	Biphenyl							
PAH	Chrysene (H)	0.66	0.04	0.27	0.03	0.07	0.06	0.15
PAH	Dibenz(a,h)anthracene (H)							
PAH	Fluoranthene (H)	2.90	0.02	0.04	4.5E-3	0.02	0.02	0.07
PAH	Fluorene (L)	27.00	1.0E-3	1.6E-3	7.8E-4	4.4E-4	4.8E-4	8.9E-4
PAH	Indeno(1,2,3-cd)pyrene							
PAH	Naphthalene (L)	350.00	4.6E-5	9.1E-5	6.0E-5	5.7E-5	5.7E-5	6.3E-5
PAH	Perylene							
PAH	Phenanthrene (L)	24.00	1.0E-3	1.5E-3	8.8E-4	2.0E-3	1.8E-3	2.2E-3
PAH	Pyrene (H)	1.40	0.07	0.16	0.03	0.15	0.12	0.22
PAH	Sum PAH LD_{50}-based TUs[3]		2.01	13	1.22	3.09	2.84	8.01
PCB	Total PCBs	0.03	57	770	11	29	41	190

1 - Hazard Quotient = concentration(Appendix C)/Chronic Water Quality Criteria Value; Benchmark is for Chromium (6). Measured concentration is for total Chromium.

2 - Chronic Water Quality Criteria or Screening Values

3 - Sum PAH-HQ represents the additive toxic effects of PAHs, and equals sum of Toxic Units (PAH conc./LD50) of 13 PAHs (WQSV="F"); Swartz et.al., 1995.

Table 3. Acute Hazard[1] Quotients for CoCs in sediment elutriates for the NBH Water Quality Study.[1]

Benchmark = Acute WQC [2]

Class	Analyte	WQSV Source[2]	NBH-201-ELUT	NBH-202-ELUT	NBH-204-ELUT	NBH-205-ELUT	NBH-206-ELUT	NBH-207-ELUT
MET	Aluminum	750.0	0.21	3.09	0.77	0.46	0.29	1.14
MET	Antimony							
MET	Arsenic	69.0	0.08	0.26	0.06	0.34	0.19	0.07
MET	Cadmium	43.0	7.0E-3	0.01	7.0E-3	7.0E-3	7.0E-3	7.0E-3
MET	Chromium	1100.0	4.2E-3	0.03	4.2E-3	4.2E-3	4.2E-3	9.4E-3
MET	Copper	4.8	1.48	20	0.83	2.25	1.48	8.13
MET	Iron							
MET	Lead	220.0	5.0E-3	0.06	5.0E-3	5.0E-3	5.0E-3	5.0E-3
MET	Manganese							
MET	Nickel	75.0	0.18	0.18	0.18	0.18	0.18	0.18
MET	Silver	1.9	0.74	0.74	0.74	0.74	0.74	0.74
MET	Zinc	90.0	0.08	0.45	0.08	0.08	0.08	0.18
SEM	SEM-AVS	#REF!						
PAH	1-Methylnaphthalene							
PAH	1-Methylphenanthrene							
PAH	2,3,5-Trimethylnaphthalene							
PAH	2,6- Dimethylnaphthalene							
PAH	2-Methylnaphthalene (L)							
PAH	Acenaphthene (L)	970.000	2.8E-5	1.9E-4	2.2E-5	2.1E-5	2.1E-5	3.6E-5
PAH	Acenaphthylene (L)	490.000	5.5E-5	4.3E-5	4.3E-5	4.1E-5	4.1E-5	4.3E-5
PAH	Anthracene (L)	180.000	1.5E-4	1.8E-4	1.2E-4	1.4E-4	1.3E-4	1.8E-4
PAH	Benzo(a)anthracene (H)	6.600	2.7E-3	0.02	2.0E-3	5.0E-3	3.9E-3	0.01
PAH	Benzo(a)pyrene (H)	1.900	0.01	0.06	7.4E-3	0.02	0.02	0.03
PAH	Benzo(b)fluoranthene	0.380	0.05	0.37	0.04	0.08	0.09	0.29
PAH	Benzo(e)pyrene							
PAH	Benzo(g,h,i)perylene							
PAH	Benzo(k)fluoranthene	0.170	0.12	0.82	0.06	0.18	0.15	0.42
PAH	Biphenyl							
PAH	Chrysene (H)	6.600	4.4E-3	0.03	2.6E-3	6.5E-3	5.8E-3	0.02
PAH	Dibenz(a,h)anthracene (H)							
PAH	Fluoranthene (H)	29.000	1.7E-3	4.5E-3	4.5E-4	2.0E-3	1.7E-3	6.6E-3
PAH	Fluorene (L)	270.000	1.0E-4	1.6E-4	7.8E-5	4.4E-5	4.8E-5	8.9E-5
PAH	Indeno(1,2,3-cd)pyrene							
PAH	Naphthalene (L)	3500.000	4.6E-6	9.1E-6	6.0E-6	5.7E-6	5.7E-6	6.3E-6
PAH	Perylene							
PAH	Phenanthrene (L)	240.000	1.0E-4	1.5E-4	8.8E-5	2.0E-4	1.8E-4	2.2E-4
PAH	Pyrene (H)	14.000	7.1E-3	0.02	2.9E-3	0.02	0.01	0.02
PAH	Sum PAH LD_{50}-based TUs[3]		0.20	1.33	0.12	0.31	0.28	0.80
PCB	Total PCBs	10.00	0.17	2.31	0.03	0.09	0.12	0.57

1 - *Hazard Quotient = concentration(Appendix C)/Acute Water Quality Criteria Value; Benchmark is for Chromium (6). Measured concentration is for total Chromium.*

2 - *Acute Water Quality Criteria or Screening Values*

3 - Sum PAH-HQ represents the additive toxic effects of PAHs, and equals sum of Toxic Units (PAH conc./LD50) of 13 PAHs (WQSV="F"); Swartz et.al., 1995.

Table 4. Species-specific elutriate Hazard Quotients for chemical exposures to *Americamysis bahia* exposed to New Bedford Harbor Suspended Particulate Phase samples.

		Americamysis bahia[1]					
Analyte	Acute LC_{50}[2]	NBH-201-Elutriate	NBH-202-Elutriate	NBH-204-Elutriate	NBH-205-Elutriate	NBH-206-Elutriate	NBH-207-Elutriate
Cadmium	63	0.00	0.01	0.00	0.00	0.00	0.00
Chromium	2030	0.00	0.02	0.00	0.00	0.00	0.01
Copper	153	0.05	0.64	0.03	0.07	0.05	0.25
Lead	3000	0.00	0.00	0.00	0.00	0.00	0.00
Zinc	498	0.01	0.08	0.01	0.01	0.01	0.03
PCB	17	0.10	1.36	0.02	0.05	0.07	0.33
NH_3	1.94	0.25	0.82	0.02	0.20	0.14	0.00
sum HQs		0.17	2.93	0.07	0.14	0.14	0.63

1 - Hazard Quotient = elutriate concentration (Appendix A-3)/species LC_{50}.

2 - LC_{50} values from Schubauer-Berigan et al (1993) except chromium (U.S. EPA, 1984b) and

3- Spike exposures not performed for mysids.

Table 5. Comparison of measured vs. predicted elutriate concentrations for New Bedford Harbor CAD and navigation channel locations.

	Fish Island (FI-A)		
Analyte[1]	NBH-207-Elutriate[2]	Predicted interstitial FIA-CAD[3]	Predicted Elutriate F1A-CAD[4]
Arsenic	5.1	6.7	1.34
Cadmium	0.3	5.5	1.1
Chromium	10.3	335	67
Copper	39	**866**	**173.2**
Lead	1.1	162	32.4
Zinc	15.8	**444**	88.8
			0
Total PCBs	*5.69*	0.0276	0.00552
Sum PAH or TPH	0.979	3795	759

1- units: ug/L.

2- Elutriate represents supernatant from centrifuged Suspended Particulate Phase.

2- interstitial water concentrations reported as 'elutriate' in ASA 2002

3- Predicted elutriate concentration estimated to approximate toxicity test elutriate (sediment to water mixture = 1:4). 20% factor applied is slight over-estimate of dilution.

Italicized value indicates that measured concentrations were greater than predicted

Bold values indicate concentrations higher than Acute Water Quality Criteria.

Appendix A
Reference Toxicant (potassium chloride) Test Results

Appendix B
Summary Report for SPP Tests

Appendix B. Acute Mysid Test-96 Hr: ToxCalc Results

Start Date:	10/17/02	Test ID:	MYS_101702	Sample ID:	NBH
End Date:	10/21/02	Lab ID:		Sample Type:	AMB1-Ambient water
Sample Date:		Protocol:	EPAA 91-EPA Acute	Test Species:	MY-Mysidopsis bahia

Comments: S-Control = Forty Fathoms Lab Water, I-Control = REF (CLIS) 100% SPP

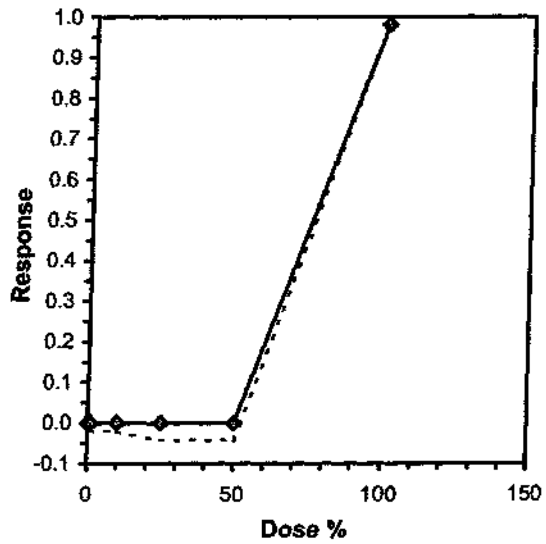
Conc-%	1	2	3	4	5
S-Control	10.000	10.000	9.000	9.000	10.000
I-Control	10.000	10.000	10.000	10.000	10.000
1	9.000	10.000	10.000	10.000	10.000
10	10.000	10.000	10.000	10.000	9.000
25	10.000	10.000	10.000	10.000	10.000
50	10.000	10.000	10.000	10.000	10.000
100	0.000	0.000	1.000	0.000	0.000

			Transform: Untransformed					Isot
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Mean
S-Control	9.600	0.9600	9.600	9.000	10.000	5.705	5	9.600
I-Control	10.000	1.0000	10.000	10.000	10.000	0.000	5	9.840
1	9.800	0.9800	9.800	9.000	10.000	4.563	5	9.840
10	9.800	0.9800	9.800	9.000	10.000	4.563	5	9.840
25	10.000	1.0000	10.000	10.000	10.000	0.000	5	9.840
50	10.000	1.0000	10.000	10.000	10.000	0.000	5	9.840
100	0.200	0.0200	0.200	0.000	1.000	223.607	5	0.200

Auxiliary Tests	Statistic	Critical	Skew
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.881041	0.91	-0.65189
Equality of variance cannot be confirmed			
The control means are not significantly different (p = 0.14)	1.632993	2.306006	

Linear Interpolation (200 Resamples)

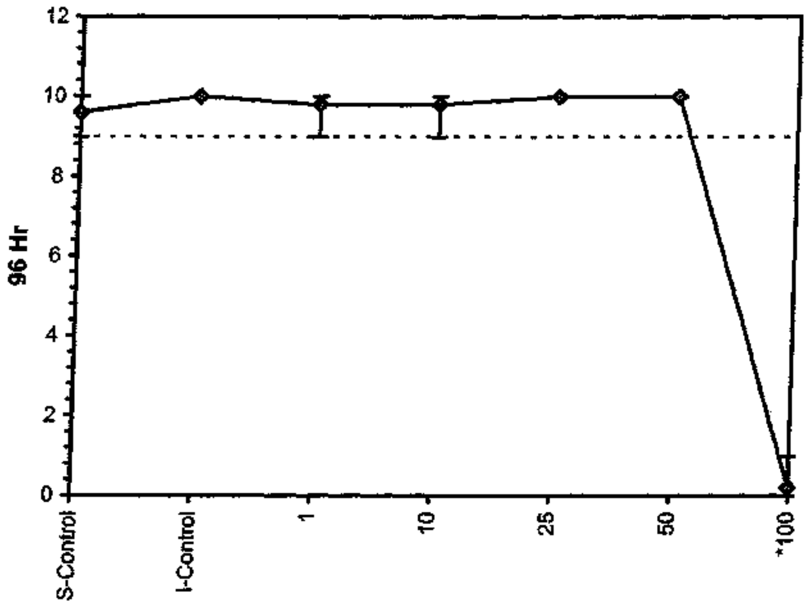
Point	%	SD	95% CL(Exp)		Skew
IC01	50.510	22.216	0.000	50.510	-0.8463
IC05	52.552	0.284	51.224	52.552	-0.3090
IC10	55.104	0.279	53.775	55.105	-0.2784
IC15	57.656	0.284	56.326	57.785	-0.1967
IC20	60.207	0.299	58.877	60.479	-0.0699
IC25	62.759	0.321	61.427	63.119	0.0757
IC40	70.415	0.422	69.080	71.268	0.4239
IC50	75.519	0.505	74.181	76.702	0.5483
IC60	80.622	0.595	79.283	82.135	0.6184
IC75	88.278	0.738	86.935	90.284	0.6713
IC80	90.830	0.787	89.486	93.001	0.6813
IC85	93.382	0.836	92.036	95.718	0.6891
IC90	95.934	0.886	94.587	98.434	0.6950
IC95	98.485				
IC99	>100				



Appendix B. Acute Mysid Test-96 Hr: ToxCalc Results

Start Date:	10/17/02	Test ID:	MYS_101702	Sample ID:	NBH
End Date:	10/21/02	Lab ID:		Sample Type:	AMB1-Ambient water
Sample Date:		Protocol:	EPAA 91-EPA Acute	Test Species:	MY-Mysidopsis bahia
Comments:	S-Control = Forty Fathoms Lab Water, I-Control = REF (CLIS) 100% SPP				

Dose-Response Plot



Appendix C
Chemistry Data

Appendix C-1. Results of elutriate chemical analyses for the NBH Water Quality Study: Metals and PAHs.

Class	Analyte	NBH-201-ELUT	NBH-202-ELUT	NBH-204-ELUT	NBH-205-ELUT	NBH-206-ELUT	NBH-207-ELUT
MET	Aluminum	161 B	2320	577	346	216	853
MET	Antimony	3.50 U	3.50 U	3.50 U	3.50 U	3.50 U	5.80 B
MET	Arsenic	5.20 B	18	3.80 B	24	13	5.10 B
MET	Cadmium	0.30 U	0.45 B	0.30 U	0.30 U	0.30 U	0.30 U
MET	Chromium	4.60 U	35	4.60 U	4.60 U	4.60 U	10
MET	Copper	7.10 B	98	4.00 B	11 B	7.10 B	39
MET	Iron	214	2630	587	218	212	995
MET	Lead	1.10 U	13	1.10 U	1.10 U	1.10 U	1.10 U
MET	Manganese	2.50 U	2.50 U	27	2.50 U	2.50 U	2.50 U
MET	Mercury						
MET	Nickel	14 U	14 U	14 U	14 U	14 U	14 U
MET	Silver	1.40 U	1.40 U	1.40 U	1.40 U	1.40 U	1.40 U
MET	Zinc	6.90 U	40	6.90 U	6.90 U	6.90 U	16 B
PAH	1-Methylnaphthalene	0.03 U	0.01 J	0.02 U	0.02 U	0.02 U	0.01 J
PAH	1-Methylphenanthrene	0.03 U	0.05	0.02 U	0.01 J	0.01 J	0.02
PAH	2,3,5-Trimethylnaphthalene	0.03 U	0.07	0.02 U	0.02 U	0.02 U	0.02 J
PAH	2,6- Dimethylnaphthalene	0.03 U	0.01 J	0.02 U	0.02 J	0.02 J	0.02
PAH	2-Methylnaphthalene (L)	0.03 U	0.02 J	0.02 U	0.02 J	0.01 J	0.02 J
PAH	Acenaphthene (L)	0.03 U	0.18	0.02 U	0.02 U	0.02 U	0.04
PAH	Acenaphthylene (L)	0.03 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
PAH	Anthracene (L)	0.03 U	0.03	0.02 U	0.03	0.02	0.03
PAH	Benzo(a)anthracene (H)	0.02 J	0.15	0.01 J	0.03	0.03	0.10
PAH	Benzo(a)pyrene (H)	0.02 J	0.12	0.01 J	0.04	0.04	0.07
PAH	Benzo(b)fluoranthene	0.02 J	0.14	0.02 J	0.03	0.04	0.11
PAH	Benzo(e)pyrene	0.02 J	0.08	0.02 U	0.04	0.03	0.07
PAH	Benzo(g,h,i)perylene	0.02 J	0.09	0.01 J	0.04	0.03	0.06
PAH	Benzo(k)fluoranthene	0.02 J	0.14	0.01 J	0.03	0.03	0.07
PAH	Biphenyl	0.03 U	0.01 J	0.02 U	0.01 J	0.01 J	0.02 J
PAH	Chrysene (H)	0.03	0.18	0.02 J	0.04	0.04	0.10
PAH	Dibenz(a,h)anthracene (H)	0.03 U	0.03	0.02 U	0.02 U	0.02 U	0.01 J
PAH	Fluoranthene (H)	0.05	0.13	0.01 J	0.06	0.05	0.19
PAH	Fluorene (L)	0.03 U	0.04	0.02 U	0.01 J	0.01 J	0.02
PAH	Indeno(1,2,3-cd)pyrene	0.02 J	0.07	0.02 U	0.03	0.02 J	0.05
PAH	Naphthalene (L)	0.02 J	0.03	0.02 U	0.02 U	0.02 J	0.02
PAH	Perylene	0.03 U	0.02	0.02 U	0.02 U	0.02 U	0.02 J
PAH	Phenanthrene (L)	0.02 J	0.04	0.02 U	0.05	0.04	0.05
PAH	Pyrene (H)	0.10	0.22	0.04	0.21	0.17	0.31
PAH	Total LMW (L) PAHs	0.18	0.36	0.15	0.16	0.15	0.21
PAH	Total HMW (H) PAHs	0.24	0.83	0.12	0.41	0.34	0.77
PAH	Total LMW+HMW PAHs	0.42	1.19	0.27	0.57	0.49	0.98

Units: µg/L.
LMW PAH = sum of 7 2-ring & 3-ring PAHs included in NOAA ER-L/ER-M benchmarks (Long et al. 1995);
(methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene)
HMW PAH = sum of 6 4-ring and 5-ring PAHs included in NOAA ER-L/ER-M benchmarks (Long et al. 1995);
(benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, pyrene)
Total PAHs - *sum of LMW & HMW PAHs;*
Data Qualifiers: "B" (metals)=< Contract Detection Limit but >Instrument Detection Limit;
"J"=estimated (result between 1/2 reporting limit (RL) and RL); "U"=not detected above reporting limit.

Appendix C-2. Results of elutriate chemical analyses for the NBH Water Quality Study: PCBs, TOC and Total Suspended Solids.

Class	Analyte	NBH-201-ELUT	NBH-202-ELUT	NBH-204-ELUT	NBH-205-ELUT	NBH-206-ELUT	NBH-207-ELUT
PCB	PCB 101	0.12	0.90	0.01	0.05	0.08	0.40
PCB	PCB 105	0.04	0.04 U	5.9E-3	0.01	0.02	0.10
PCB	PCB 118	0.09	0.54	0.01	0.04	0.07	0.34
PCB	PCB 126	4.4E-3 U	0.04 U	4.1E-3 U	4.0E-3 U	4.1E-3 U	8.1E-3 U
PCB	PCB 128	0.03	0.23	4.1E-3 U	6.7E-3	0.01	0.05
PCB	PCB 138	0.10	0.92	7.6E-3	0.03 P	0.04 P	0.24
PCB	PCB 153	0.08 P	0.93 P	8.5E-3 P	0.03 P	0.05 P	0.27 P
PCB	PCB 156	0.01	0.11	4.1E-3 U	5.5E-3	7.5E-3	0.03 P
PCB	PCB 169	4.4E-3 U	0.04 U	4.1E-3 U	4.0E-3 U	4.1E-3 U	8.1E-3 U
PCB	PCB 170	0.01	0.15	4.1E-3 U	4.2E-3	6.5E-3	0.04
PCB	PCB 18	0.04	0.96	0.02	0.03	0.04	0.14
PCB	PCB 180	0.01	0.21	4.1E-3 U	5.9E-3	8.4E-3	0.05
PCB	PCB 183	4.9E-3	0.07	4.1E-3 U	4.0E-3 U	4.1E-3 U	0.01
PCB	PCB 184	4.4E-3 U	0.04 U	4.1E-3 U	4.0E-3 U	4.1E-3 U	8.1E-3 U
PCB	PCB 187	8.7E-3 P	0.15 P	4.1E-3 U	4.0E-3 U	4.9E-3 P	0.03 P
PCB	PCB 195	4.4E-3 U	0.04 U	4.1E-3 U	4.0E-3 U	4.1E-3 U	8.1E-3 U
PCB	PCB 206	4.4E-3 U	0.04 U	4.1E-3 U	4.0E-3 U	4.1E-3 U	8.1E-3 U
PCB	PCB 209	4.4E-3 U	0.04 U	4.1E-3 U	4.0E-3 U	4.1E-3 U	8.1E-3 U
PCB	PCB 28	0.05	1.52	0.02	0.06	0.07	0.31
PCB	PCB 44	0.05	1.06	0.01	0.03	0.04	0.17
PCB	PCB 49	0.07	1.92	0.02	0.05	0.06	0.31
PCB	PCB 52	0.10	2.41 E	0.02	0.06	0.07	0.30
PCB	PCB 66	0.09	1.13	0.02	0.05	0.08	0.35
PCB	PCB 77	4.4E-3 U	0.04 EU	4.1E-3 U	4.0E-3 U	4.1E-3 U	8.1E-3 EU
PCB	PCB 8	0.01	0.28	4.1E-3 U	8.0E-3	8.2E-3	0.04
PCB	PCB 87	0.08	0.68	7.9E-3	0.02	0.03	0.13
PCB	PCB 114	5.8E-3 P	0.06 P	4.1E-3 U	4.0E-3 U	4.7E-3 P	0.02 P
PCB	PCB 123	0.07	0.93	9.1E-3	0.03	0.04	0.20
PCB	PCB 157	4.5E-3	0.04 U	4.1E-3 U	4.0E-3 U	4.1E-3 U	0.01
PCB	PCB 167	6.7E-3	0.07	4.1E-3 U	4.0E-3 U	4.5E-3	0.02
PCB	PCB 189	4.4E-3 U	0.04 U	4.1E-3 U	4.0E-3 U	4.1E-3 U	8.1E-3 U
PCB	PCB 81	0.08	0.68	7.9E-3	0.02	0.03	0.13
PCB	Total PCBs	1.72	23	0.34	0.88	1.22	5.69
TOC	TOC - Elutriate, mg/L	4.6	12	2.3	7.3	5.4	6.8
TOC	TOC - SPP, mg/L	6.0	8.8	2.6	6.1	4.8	6.8
TSS	Total Susp. Solids, mg/L	525	1020	384	240	610	506

Units: µg/L (except where noted).
Total PCBs - Sum PCB congeners (8, 18, 28, 44, 52, 66, 101, 105, 118, 128, 138, 153, 170, 180, 187, 195, 206, 209) x 2 list of congeners analyzed by NOAA Status and Trends Program (listed in NOAA, 1993; revised NOAA, 1998).
~~Data Qualifiers: "E" = exceeds calibration range;~~
"P"=>25% difference between 2 analytical columns (lower value reported); "U"=not detected above reporting limit.
TOC - Elutriate: TOC of supernatant measured after centrifugation;
TOC - SPP (Suspended Particulate Phase): TOC of sediment/water mixture measured prior to centrifugation.

Appendix C-3. Results of elutriate particulate metals analysis for the NBH Water Quality Study.[1]

Class	Analyte	NBH-201-ELUT	NBH-202-ELUT	NBH-204-ELUT	NBH-205-ELUT	NBH-206-ELUT	NBH-207-ELUT
MET	Aluminum	6530	12400	3630	10900	11600	8400
MET	Antimony	0.56 B	1.1 B	0.31 B	0.57 B	0.61 B	1.1 B
MET	Arsenic	4.7	9.8	2.8	5.7	6	7.3
MET	Cadmium	1	3.7	0.16	0.29	0.23	2.6
MET	Chromium	85.2	276	31.5	55.6	54.8	236
MET	Copper	198	621	74.3	138	117	623
MET	Iron	11600	21300	6300	16800	18200	15100
MET	Lead	64.1	155	21.9	55.4	40.3	159
MET	Manganese	142	194	71.9	154	163	129
MET	Nickel	11.4	25.6	5.2	13	13.6	25
MET	Silver	1.6	4.3	0.19 B	0.25 B	0.25 B	2.3
MET	Zinc	129	289	44.3	92.7	72.4	409

1 - Elutriate particulate sample consisted of sediment pellet remaining after elutriate centrifugation.
Units: µg/g.
Data Qualifiers (assigned by laboratory): "B" = < Contract Detection Limit but >Instrument Detection Limit.

Laboratory Testing In Support of *Site Specific Water Quality Criteria Assessment and Hydrographic Data Collection for New Bedford Harbor*

TASK 2B
TOXICITY IDENTIFICATION EVALUATION TESTING WITH MYSIDS AND SEA URCHINS

Data Report

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MAGUIRE GROUP

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Laboratory Testing In Support of *Site Specific Water Quality Criteria Assessment and Hydrographic Data Collection for New Bedford Harbor*

TASK 2B
TOXICITY IDENTIFICATION EVALUATION TESTING WITH MYSIDS AND SEA URCHINS

Data Report

Prepared for:

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January 13, 2003

NEW BEDFORD HARBOR TOXICITY IDENTIFICATION EVALUATION

Introduction and Background

Task 2B of SAIC's Site Specific Water Quality Assessment Study is a follow-on study conducted to resolve cause(s) of toxicity observed in Suspended Particulate Phase testing (SPP; Task 2A). Task 2A found that only one of six site samples, NBH-202, was found to be toxic to *Americamysis bahia,* the species chosen for SPP testing. Hence, SPP from NBH-202 was further evaluated using a sequential toxicity identification evaluation (TIE) testing approach (SAIC, 2002). TIEs are used to identify cause and affect relationships between toxicity observed in toxicity tests and factors that have contributed to the observed effects. These relationships are revealed through manipulations that remove the toxicity of individual toxicant classes (e.g., metals, organics, or ammonia) from (e.g., SPP and elutriates). Associated reductions in toxicity are used to characterize causative factors. It was expected that the cause of acute toxicity in the NBH-202 sample would be due principally to copper, PCBs, confounding factors, or a combination of factors. Per EPA Marine TIE methodology (EPA, 1994) two species were tested, as differential sensitivity to specific toxicants provide additional evidence regarding the factors causing toxicity. For this study, the mysid *(A. bahia)* survival test and the sea urchin *(Arbacia punctulata)* larval development test were selected because they were previously used in monitoring of potential dredging-related water column impacts in Upper New Bedford Harbor (Nelson, 1991), and because they are relatively sensitive to PCBs and copper, respectively. Results from the TIE tests will contribute to the basis for an approach to derive Water Effect Ratios (Task 2C) and site specific protective exposure limits for New Bedford Harbor aquatic life.

Methods

Sample Collection, Preparation and Transport

Sediment and water collection for the TIE conducted with NBH-202 were described in the Task 2A report, "Suspended Particulate Phase Acute Toxicity Tests with Myids" (SAIC, 2002). The samples were stored ($4 \pm 2^{\circ}$ C) at the toxicity testing laboratory (SAIC's subcontractor, Aquatec Biological in Williston, VT) from 12 October to 28 October 2002. On 28 October 2002, new SPP was prepared for TIE manipulations and testing. Suspended Particulate Phase samples were prepared as described in the Task 2A report (SAIC, 2002) except that GP-2 artificial sea salts were substituted for the commercial Forty Fathoms® artificial seasalt mixture because GP-2 may be more reliable with the sea urchin larval development test used in the TIE (Aquatec, personal communication). The volume of prepared SPP required for mysid testing was sub-sampled, and the remaining SPP was prepared for the sea urchin larval development tests with *Arbacia punctulata* by centrifuging for approximately10 minutes at 6000 rpm to remove fine particulates that may inhibit larval development. SPP was shipped overnight to SAIC's Newport, RI laboratory for TIE manipulations (see below), and TIE samples were subsequently shipped back to Aquatec for toxicity testing to commence on 30 October 2002.

To serve as a positive control for the TIE tests, SAIC prepared a spiked solution using GP-2 artificial seawater, neat copper chloride (Sigma Chemical) and neat Arochlor 1242 (PP-310) standard from Ultra Scientific, North Kingstown, RI. The copper was spiked from a 10 mg/L stock solution prepared in deionized water manipulated to a pH of 2.0 with nitric acid to result in a test concentration of 120 ug copper/L. Aliquots of 100 mg Aroclor 1242/L in methanol were added to the copper-spiked sample to result in a nominal concentration of 200 μg/L. The copper spike is expected to be largely dissolved and stable (Lussier et al., 1999), while the nominal Aroclor concentration would be expected to be approximately an order of magnitude higher than the actual exposure concentration (Ho et al., 1997). Concentrations were chosen to approximate those that would affect approximately 50% of at least on of the test species (based on known LCs0 or ECs0). While copper and PCBs were the only constituents in the spiked sample for sequential TIE treatments (see TIE Manipulations and Testing, below), ammonia was added from a 1,000 mg/L standard solution (Orlon) to produce a 14 mg/L concentration in the spike prior to the final individual TIE treatments. The ammonia was added immediately prior to the TIE treatments that affect ammonia so that that the effects of treatments to reduce copper and PBC toxicity would not be obscured by ammonia toxicity.

Upon arrival at each laboratory, samples were inspected to determine their temperature and condition (e.g., caps in place or leakage). All samples met transit protocols. Standard chain-of-custody procedures were followed. Chain-of custody (CoC) forms were signed and copied. SAIC retains copies of the CoCs, along with test data in experiment binders and project files.

Organism Selection and Source

Mysids for testing were supplied by Aquatic Biosystems in Fort Collins Colorado. They were hatched on 28 October, received at Aquatec on 30 October, and the test was initiated on the same day. Newly hatched Artemia were fed to mysids on each day prior to test initiation, and daily feeding continued during the test.

Mysids were evaluated using a standard reference toxicant water-only test with potassium chloride. In this test, survival is determined in each of two replicate chambers to which ten animals have been added. The reference test uses a six dilution series with concentrations ranging between 0.1 and 1.0 g/L, and is used to determine LCs0 values for comparison with Control Chart values. Aquatec's Control Chart for the mysid *(A. bahia)* includes > 20 tests from mysid tests conducted since 1999. Sea Urchins used in TIE tests were from Aquatec's in-house cultures. Along with the TIE tests, sea urchin larval development was tested in a standard reference toxicant series with copper sulfate as the toxicant.

Toxicity Identification Evaluation Manipulations and Testing

In all, four samples, GP-2 control water, spiked water, SPP site sample, and centrifuged SPP site sample were used in TIE testing. The GP-2 control water served as a negative control to monitor for potential ancillary effects associated with the TIE manipulations described below. The spiked water served as a positive control to document the effectiveness of the manipulations in reducing toxicity as intended, and the two site samples were prepared to resolved contributors to toxicity in mysids and sea urchins respectively. For the spiked sample, in addition to the 100% undiluted samples, the untreated samples and sodium thiosulfate-treated samples were diluted in a series to include 50%, 25% and 10% dilutions. These extra samples served to discriminate the expected reduction in toxicity that would occur with the first TIE treatment, and to characterize the over-all sensitivity of the organisms to the untreated sample (e.g., to demonstrate differences in sensitivity between the two test species). Centrifuged samples were used for the sea urchin test because physical damage to these organisms may occur when exposed to high concentrations of particulate matter.

Sample Manipulations

As illustrated in Figure 1, the TIE manipulations involved a series of sequential manipulations followed by two independent treatments. The principle of the sequential approach is that as each sample is treated and tested for toxicity, a potential source of toxicity can be identified or eliminated. The procedure begins with untreated samples, followed by the most specific treatments and ends with the most general. For SPP constituents, STS and EDTA act quite specifically on certain groups of common heavy metal contaminants. By treating the metals first, and then applying filtration and Solid Phase Extraction (SPE) to remove organic contaminants, reductions in toxicity following each individual treatment can be associated with specific toxicant groups.

By applying the independent *Ulva* treatment and associated pH adjustments at the end of the sequential treatments, the role of ammonia as a contributor to toxicity can be more clearly discerned. The *Ulva* addition is best suited as a final treatment because it could also remove metals and organics to varying degrees. Its application as final treatment limits uncertainty in the interpretation of results. Similarly, pH adjustments can affect the toxicity of multiple potential contaminants, including certain metals and potentially toxic organic compounds. The elimination or reduction of toxicity due to these groups prior to pH adjustment facilitates the direct association between pH change and commensurate changes in the relative toxicity of both ammonia and sulfides due to ionic shift.

Untreated SPP is sub-sampled to determine baseline toxicity for the SPP, provide a starting point to assess relative changes in toxicity associated with each subsequent treatment. Likewise, sub-sampling occurs after each treatment for TIE toxicity testing. The objective of each treatment step is described below.

Sequential Treatments

Establish Baseline Toxicity with Untreated sample: For this step, sub-samples of untreated SPP are tested to assess toxicity relative to TIE-manipulated sub-samples. Even though SPP tests was performed during toxicity screening (Task 2A) new baseline samples should still be collected and tested to correspond temporally with the manipulated treatments for each sample.

Reduce Metals Concentrations with STS and EDTA: Two treatments are conducted in sequence to reduce bioavailability of metals, specifically by rendering them unavailable for direct uptake into cell tissues. First is the addition of sodium thiosulfate (STS; Na2S203) and second is the addition of ethylenediaminetetraacetic acid (EDTA). Reduction in toxicity of the sample after either or both treatments indicates the presence of metals in toxic concentrations.

a. Reduce Cationic Metals and Oxidants with STS: Sodium thiosulfate addition was performed as the first metals reduction step because it is generally effective with a smaller subset of metal contaminants relative to EDTA. It is reported by EPA to be most effective in reducing toxicity due to Cd^{2+}, Cu^{2+}, Ag^{1+} and Hg (with lesser affinity for Ni^{2+}, Zn^{2+}, Pb^{2+} and Mn^{2+} (U.S. EPA 1994)). Reduction in toxicity of the sample after STS treatment indicates the above metals are present in toxic concentrations. Sodium thiosulfate is added at the rate of 50 mg/L with no apparent effects on test species (U.S. EPA, 1996).

b. Chelate Cationic Metals with EDTA: This reducing agent chelates divalent cationic metals (i.e., Al^{2+}, Ba^{2+}, Fe^{2+}, Mn^{2+}, Sr^{2+}, Cu^{2+}, Ni^{2+}, Pb^{2+}, Cd^{2+}, 002+, and Zn^{2+}) (U.S. EPA., 1996). Reduction in toxicity of the sample after EDTA treatment indicates that members of the above listed group of metals are present in toxic concentrations. If reduction in toxicity does not occur with STS, but does occur with EDTA addition, there are two potential explanations. One possibility is that the metals causing toxicity are amongst the group that is less reactive with STS (NI , Zn , Pb and Mn) and the other is that the magnitude of toxicity was high enough that the addition of both reducing agents was required to affect toxicity. Generally, a fully or partially toxic response following the sequential EDTA treatment indicates that something other than divalent cationic metallic compounds are a major contributor to sediment toxicity. In other words, either metals are not toxic, or alternatively, if the samples remain fully toxic (i.e., no normal response is observed), other toxic agents may be masking the reductions in toxicity associated with metals. EDTA is added at the rate of 60 mg/L with no apparent effects on test species. According to the marine TIE guide (1996) this could potentially chelate 26 mg of divalent metal per liter.

The absence of reduction in toxicity indicates that metals are not toxic in the sample, and/or that remaining constituents are present at levels that still influence toxicity and/or that the toxic load of metals in the sample exceeded the binding capacity of the TIE agents.

Extract Particulate-associated Contaminants with Filtration: Because filtration may remove metals and organics, the placement of the filtration step after the treatments for metals (STS and EDTA) reduces ambiguity of interpretations associated with filtration effects. Filtration is operationally defined by filter type and the filtration procedure used. To assure the removal of all suspended particles that could clog or compromise the integrity of the SPE column used in the following procedure, samples were filtered with 0.45 mm membrane filter (i.e., polyvinylidene fluoride to minimize sorption of organics). Toxicity tests conducted on the pre- and post-filtered fraction permit elucidation of potential toxicity associated with large colloids or particulates in the SPP. Filtration has not been found to affect the concentrations of sample ammonia. Filters used in this step were retained for any subsequent analyses that would be helpful if reduction in toxicity occurred due to filtration.

Extract Organics with a Solid-phase Extraction (SPE) Column: In this step, filtered SPP samples were eluted through a SPE column (Waters C18) to remove organic compounds (Waters, 2001). According to general recommended manufacturer's procedures, the samples were eluted through the column at a rate of 10 ml/min. For each sample, the column was exchanged after 500 ml was eluted. The column was monitored visually to limit the possibility that its capacity would be exhausted prior to elution of 500 ml. Nevertheless, prevention of column break-through cannot be assured for samples with unknown constituents, and removal of toxic organic toxicants may be incomplete.

Independent Treatments

Remove Ammonia with Ulva: For saltwater samples, treatment with the green seaweed *(Ulva lactuca)* is generally more effective than zeolite in removing ammonia. However, this treatment may also remove other residual sources of toxicity to varying degrees, including metals and organics. *Ulva* is a cosmopolitan macroalgae, and is generally found in estuarine lagoons, often floating on mudflats. It inhabits the upper to mid-intertidal, and in some locations may be found up to the subtidal zone and is associated with nutrient-enriched conditions. For this study, the algae was collected on the day prior to test treatments and held in aerated seawater at 15°C. Batches of *Ulva* to be added to each sample were prepared by weighing out lg of *Ulva* per 15 ml sample. Whole leaves of *Ulva* were used to treatment each sample. The pre-weighed batches were held together with skewer sticks and stored in seawater until addition. After addition, the samples were incubated for 5 hours at 15°C (Ho et al., 1997; 1999).

Manipulate Ammonia and Sulfide with Adjusted pH: As noted above, methods to remove ammonia, while generally effective, may provide inconclusive evidence to deduce ammonia toxicity. Hence, it is useful to conduct pH manipulations to provide additional evidence of ammonia toxicity, as well as discriminate between ammonia and hydrogen sulfide as potential toxicants. To achieve a reduction in pH, dilute hydrochloric acid (e.g. 1N) is added in small increments (μLs), followed by mixing, and measurement, repeating the procedure until the target (pH= 7.0 to 7.5) is achieved. If toxicity decreases with decreased sample pH, ammonia is suspected, while an increase in toxicity with lower pH would implicate hydrogen sulfide or residual metals.

TIE Exposures

Mysids were exposed with ten animals in each of three replicates. In all other respects, the mysid tests with each treatment were conducted as described in the report for Task 2A.

Tests with the sea urchin, *Arbacia punctulata,* were conducted according to methods developed by SAIC, as reported in "Laboratory Testing In Support of Environmental Assessment NAE O&M Projects" (U.S. EPA and U.S. ACE, 2002). The test chambers were 20 mL polyethylene scintillation vials. Ten milliliter aliquots of elutriate were added to each of three replicate chambers per sample. Tests were conducted in a temperature-controlled chamber at 20 ± 1°C. Gametes for the test were collected and mixed as follows:

> Four male urchins were placed in seawater in shallow bowls. Males were stimulated to release sperm by touching the shell for about 30 seconds with the steel electrodes of a 12 V transformer. Sperm were collected using a 1 mL disposable syringe fitted with an 18-gauge, blunt tipped needle. The sperm were diluted with seawater to achieve approximately 1 X 10^8 sperm/ml, held on ice and used within 1 hr of release.
>
> Four female urchins were placed in seawater in shallow bowls. Females were stimulated to release eggs by touching the shell as described above. Eggs were collected and held at room temperature for up to two hours with aeration. The eggs were washed two times with seawater by gentle centrifugation (500xg) for two minutes in a conical centrifuge tube. The eggs were diluted with seawater to a concentration of 2,000 eggs/mL and were aerated until used. Sperm and egg suspensions were mixed to a final concentration of 1:500 egg: sperm ratio.

After 60 minutes, fertilization was confirmed (100% in this case) and 1 mL of fertilized egg suspension was added to 10 mL of sample in each of three replicates and was incubated for 72 hours at 20 ± 1EC. The test was terminated by adding 2 mL of preservative to each vial.

One mL of suspension from each of the three replicates was transferred to a Sedgwick-Rafter counting chamber. Embryos were examined using a compound microscope (100X). One hundred embryos were examined for normal (i.e., not delayed) development as indicated by the presence of the pluteus larva.

The number of normal pluteii larvae and the number of abnormal pluteii larvae per 100 organisms were counted, as well as the total number of surviving organisms per ml.

For both tests, acceptable dissolved oxygen concentrations were documented to be in the range of 7.8 to 8.2 mg/L at the start of the test, and 5.3 to 6.6 mg/L at the end of the test. Salinity increased by ≈ 3 mg/Kg, from 31 mg/Kg at test initiation, pH ranged between 7.8 and

8.2, across samples, with no apparent temporal trend. All water quality parameters were acceptable (U.S. EPA/U.S. ACE, 1998; U.S. ACE, 1991). Ambient laboratory lighting was set for constant light during the test exposure period.

Full strength SPP solutions were analyzed for ammonia on day 0. Samples were diluted 1 to 10 with deionized water. Total ammonia was measured spectrophotometrically.

Data Analysis

Mean responses to baseline and TIE treatments were calculated, for mysids and sea urchins. Responses are presented for performance control, the spiked sample and NBH-202 samples. For mysids, results are expressed for both 48 hr and 96 hr responses. For sea urchins, results are expressed as percent normal development and survival relative to controls.

Results

Quality Assurance/Quality Control

Up to 96 hrs, control responses for mysids through all treatments remained > 90%. For sea urchins, control responses, normal development ranged from 98 to 100% and survival counts ranged from 83 to 92 per ml. These results, along with documentation of acceptable water quality, confers validity of test results.

The summary report for reference toxicant testing with mysids and sea urchins using potassium chloride and copper sulfate is presented at the end of the Toxicity Test Data Report provided by Aquatec (Appendix A). The LC_{50} for *A. bahia* was 0.360 g/L (as potassium), well within the Control Chart lower and upper boundaries of 0.11 and 0.83 g/L, established the normal response of these organisms. The EC_{50} calculated for *A punctulata* was 30.9 µL (as copper) is equivalent to the value reported previously reported for this test (SAIC, 1994).

Chemical Exposure Concentrations

Results from the toxicity testing component of the TIE study are best interpreted in the context of the chemical exposure levels present in the untreated toxic sample under investigation. This is accomplished by using hazard Quotients (HQ= measured chemical concentrations divided by species-specific LC_{50}s or EC_{50}s) to represent expected sensitivity of the test species to the chemical exposure. In a single toxicant exposure, HQs less than 1 would result in less than 50% adverse affect while HQs > 1 would generally result in higher percentage of exposed organisms affected; the higher the HQ, the greater and more likely the observation of high percentage effects. For the current study, HQs were derived using chemical concentrations presented in the Task 2A report, Appendix C, and literature values that to represent effect concentrations for each of the toxicants of concern.

Table 1 presents HQs for the spike sample and the site sample (NBH-202), for the two species. Based on the chemical exposure concentrations, the mysid is expected to be more sensitive to PCBs in the TIE testing with NBH-202 (HQ=1.36 vs. 0.02, respectively) given the lower *(i.e.,* more sensitive) LC_{50} value, while sea urchins would be more sensitive to copper (HQ = 5.43 vs. 0.64, respectively) and ammonia (HQ = 17.7 vs. 0.82, respectively). The comparison of the spike sample and the NBH sample HQs show that the test concentrations in the spike approximated the concentrations of the toxicants of concern in the site sample, except for ammonia, where a reduced potency was chosen to increase the likelihood of demonstrating an effective treatment for the more sensitive sea urchin response.

In summary, the analyses of the chemical exposures suggest that both copper and PCB concentrations are in the exposure range were toxicity could occur, depending on species sensitivity and site-specific water quality conditions. Also, the spike concentrations are in the proper range to adequately assess the effectiveness of the TIE treatments in mitigating the toxic response.

Toxicity Identification Evaluation Test Results and Interpretation
Summaries of the TIE toxicity tests with mysids and sea urchins are provided in Tables 1 and 2, respectively, synthesized from the raw data presented in Appendix A (Aquatec data report). Changes in toxicity are highlighted in yellow, and are indicative of reduction/removal of bioavailability of a toxic constituent that was present in the untreated sample.

The most relevant findings from TIE treatments for each of the targeted toxicant classes are reviewed below, particularly with regard to the relationship between expected toxicity based on species-specific HQs, and observed responses. The results from the spike sample are presented first, to establish the interpretive process.

Results for the Spiked Sample

Metal treatments (STS, EDTA): Tables 2a and 2b show TIE results from 48 hour and 96 hour tests with mysids. Untreated sample results show complete mortality in both 100% and 50% exposures. STS completely removed toxicity in the 50% dilution, and in the undiluted sample survival reached 90% following STS treatment, and 100% following EDTA treatment. This indicates that copper was causing the majority of the toxicity in the untreated sample, given that the metal treatments alone were successful in improving survival to 100% despite the presence of PCBs in the sample. The mysid results also indicate that toxicity of copper was greater than would be expected for exposures to copper alone (i.e., no survival, but HQ was <1; see Table 1), indicating that copper was more toxic in the presence of Aroclor).

Sea urchin results are presented in Tables 3a (survival) and 3b (larval development). While larval development is generally the more sensitive endpoint, and the one most commonly reported for the embryo-larval test (U.S. EPA, 2002), both endpoints demonstrated responses to TIE treatments of the spiked sample. Unlike mysids, only partial mortality was observed in sea urchins exposed to the spike samples. The survival endpoint was less reliable, as a clear dose-response pattern (survival proportional to concentration) was not observed. Where survival responses were low in untreated samples (25% and 50% dilutions), the metal treatments appeared to increase survival, indicating that toxic forms of copper were removed (one anomaly occurred, with lower survival in the STS treatment than in the untreated sample, but EDTA restored survival to 91%). Sea urchin larval development was more affected by copper than expected, with high toxicity occurring in all untreated samples, including the 10% dilution (HQ= 0.7). Copper effects on sea urchin normal development in the spike was removed by STS in the 10% dilution, and by the combination of STS and EDTA in the 100% dilution, indicating that, even for this more sensitive endpoint, the TIE treatments were effective in removing copper from the sample.

Organics Treatment (PCBs): In mysid 48 and 96 hr exposures (Table 2), PCB in the spike was not toxic. This indicates that after available copper was bound the concentration of PCB was insufficient to cause toxicity. Because the estimated HQ was 1.2 for PCB in the sample, it is possible that the estimated concentration was less toxic to mysids than predicted. However, the actual exposure concentration of Aroclor used to derive the HQ (10% of the nominal concentration; losses expected to result largely from sorption to exposure chambers) is uncertain, such that the expectation of toxicity was equally uncertain. Results from the TIE treatments for particulates and organics were similar to control responses, indicating that the treatments had no adverse affect on survival. Similarly, the sea urchin normal development was not affected by either the particulate or organic treatments of the spiked sample.

Ulva Treatment: Ammonia was added to the non-toxic C18 -treated sample to demonstrate efficiency of ammonia removal. For mysids, the concentration of ammonia added (HQ= 0.3) was not be expected to result in toxicity, and the absence of toxicity in the spike sample (90%) indicates that *Ulva* had no adverse affect on survival (Table 2). For the sea urchin, the *Ulva* treatment did not improve larval development (0.3%), indicating that the treatment did not reduce ammonia to a non-toxic level (Table 3b). For the survival endpoint (Table 3a), the 41% survival response at the spike concentration can be used for comparison with results obtained in the site sample (see below), where ammonia is a natural constituent of the sediment matrix.

Low pH (Independent Post-C18 Treatment): As with the *Ulva* treatment, ammonia was added to the non-toxic C18 -treated sample to reduce the proportion of the more toxic unionized ammonia form through pH reduction. In the mysid tests, the ammonia-spiked low-pH sample was not toxic, as expected, although the finding is somewhat uncertain due to variability of pH over time. Similarly, the spiked low-pH sample was non-toxic to sea urchin survival and larval development, indicating that the reduction in unionized ammonia was sufficient to remove toxicity.

Site sample NBH-202

Metal treatments (STS, EDTA): Table 2a shows that for mysids at 48 hours, the EDTA increased survival from 20 to 37%, indicating that metal(s) have likely contributed to toxicity in the filed sample. The 96 hour results (Table 2b) indicate an increased level of toxicity in the untreated sample could not be mitigated by the metal treatments. It also suggests the possibility that reductions in toxicity due to the metal treatments were masked by other sample constituents that remained at highly toxic levels after the STS and EDTA treatments (discussed below).

Table 3a shows that the elutriate prepared from the Harbor sediment was highly toxic, both in survival and development of sea urchin larvae. Sea urchin survival and larval development did not improve following treatments to bind metals, even though the copper concentration appears to be similar to the spiked sample where reduction in toxicity did occur. This indicates a presence of residual contributors to toxicity, including organics, ammonia and/or copper and other metals that were not completely bound by the TIE treatments.

Organics treatment (PCBs): For mysids, the filtration and C18 steps each sequentially removed site sample toxicity at 48 hours (increasing survival to 70 and 93%, respectively; Table 2a), indicating that organics were the principal contributors the toxicity observed at this exposure interval. As with the metal treatment, the 96 hour results (Table 2b) indicate a residual source of toxicity (discussed below) that precluded observed reductions in toxicity due to the metal treatments.

For sea urchins, larval development was not improved by filtration and C_{18} treatments of the site sample (Table 3b), while a slight trend of increasing survival was observed (count per ml increasing from 9% in the untreated sample to 16% in the filtered sample and 21% after the C18 treatment; Table 3b).

Ulva Treatment: Ulva treatment of the site sample was performed to remove ammonia as a source of toxicity. In the NBH-202 sample, *Ulva* completely removed toxicity to mysids at 96 hrs (Table 2b). survival remained at <10% prior to the *Ulva* treatment. This indicates that the mortality due to ammonia did likely mask potential chemical toxicity removed by previous sequential TIE treatments. *Ulva* may also reduce residual toxicity associated with metals and organics. This fact will be important in interpreting the results of the Low pH treatment discussed below.

In the sea urchin exposures to the site sample, the *Ulva* treatment had a large impact on sea urchin survival (increased to 65% from 21%; Table 3a). This indicates that survival was affected by ammonia, and possibly other residual toxicants, as noted above. *Ulva* did not increase normal development (the principal, and more sensitive endpoint for this test; Table 3b). The concentration of total ammonia through the C_{18} treatment was 37 mg/L and was reduced by the *Ulva* treatment to 7.8 mg/L (as unionized, 0.06 mg/L). Reported EC_{50}s for this species exposed to ammonia are as low as1.7 mg/L and 0.06 mg/L as total and unionized ammonia respectively, indicating that the treatment may not have removed enough ammonia; hence ammonia most likely remained a factor contributing to toxicity.

Low pH (independent post-C_{18} treatment): Mysid survival at 48 hours was lower with the low pH treatment than it was following the C_{18}-treatment. Normally, ammonia toxicity would be reduced by this treatment, but in this case, an increased toxicity could be due to residual copper. Copper toxicity may is inversely related to pH in some marine organisms (Ho et al., 1999b) not sequestered by the STS and EDTA treatments. The low pH shift can increase the proportion of the toxic Cu^{2+} ion by an order of magnitude within the pH range evaluated for this study (Leckie and Davis, 1979)

The low pH treatment resulted in 27% sea urchin survival (indicating that unionized ammonia may not have been the principal toxicant for this endpoint. Larval development did not improve with the low pH treatment, most likely due to residual ammonia and other residual toxicants.

Summary of Findings for Site Specific Water Quality Study

The TIE conducted in this study addressed the relative roles of metals, organic constituents and ammonia are contributors to toxicity associated with SPP generated from a New Bedford Harbor sediment (NBH 202). The sequential TIE method relies on evaluation of results from multiple treatments and multiple species. Results with spiked samples demonstrated that the sea urchin (particularly larval development) is more sensitive to copper and ammonia relative to the mysid, in fact, too sensitive for the purposes of this study. Accordingly, the 48 hour mysid results were determined to be most useful in identifying sources of toxicity prior to the *Ulva* treatment. For mysids following 48-hour exposures to 100% SPP, survival gradually increased from 20% to 90%, apparently due to treatments for both metals and organics.

The SPP and elutriate for NBH-202 at 100% strength was highly toxic to both species. *Ulva* eliminated and reduced toxicity, respectively in the 96-hour mysid and sea urchin survival results, where prior treatments had been ineffective. This indicates that ammonia toxicity masked the removal of toxicity that would have been occurred in prior sequential steps that target metals and organics.

Specific Hazard Quotients and TIE results generally both support the finding of multiple sources of toxicity. Copper and ammonia toxicity to sea urchins appeared to have exceeded the capacity of the TIE treatments to sufficiently limit observed effects. Mysids were most affected by PCBs and ammonia, but their sensitivity to copper appears to increase with near-toxic levels of PCBs, as seen with the spike sample responses. The role of PCBs is the most uncertain of the three toxicants due to the need to use toxicity values derived for specific PCB mixtures (e.g. Aroclor 1242) that are different from the mixture presented in the NBH sediment sample.

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U. S. Environmental Protection Agency and United States Army Corps of Engineers. 1998. Evaluation of dredged material proposed for inland disposal: Testing manual, Washington, DC.

Figure 1. Simplified Flow Diagram for Sequential TIE: Fractionation, Testing and Interpretation

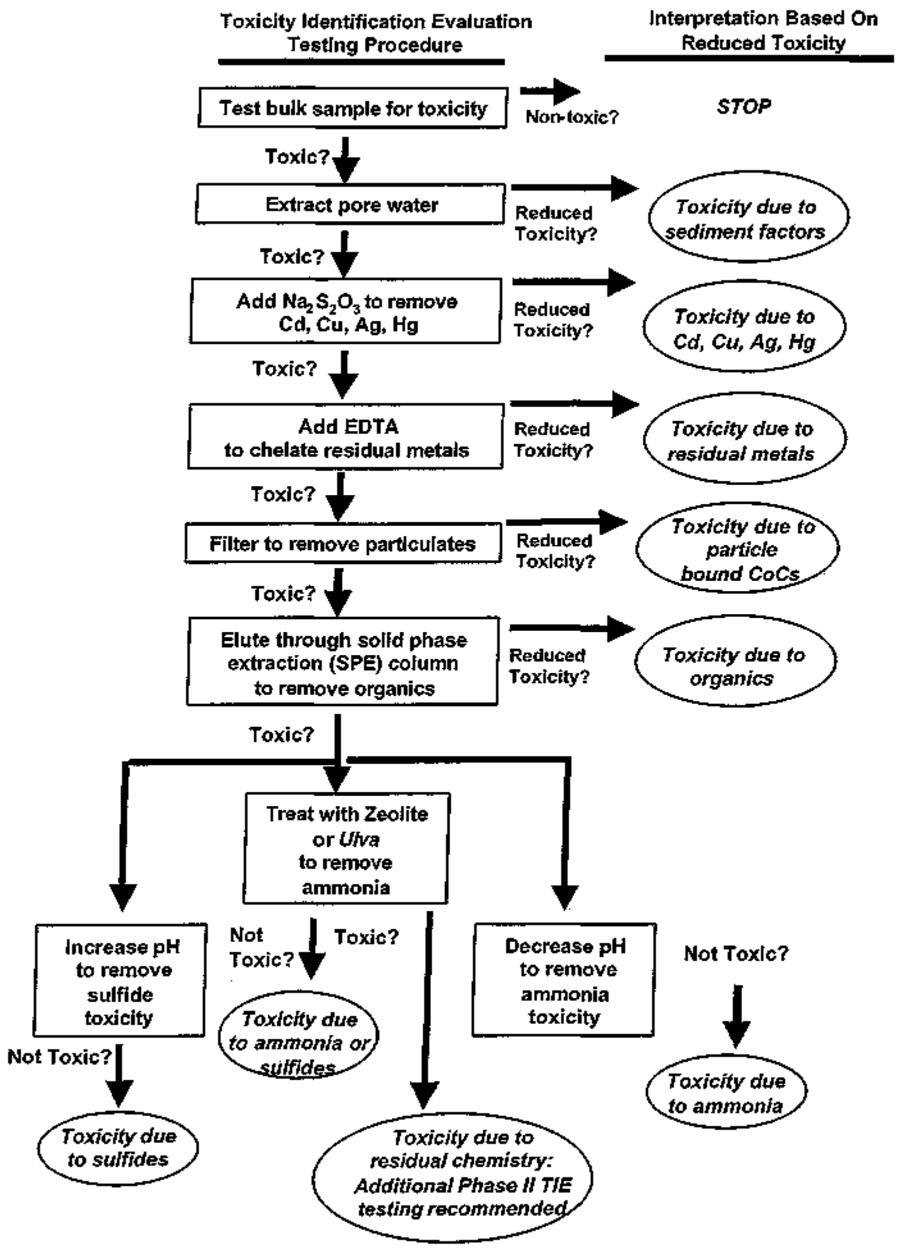

Table 1. Species-specific elutriate Hazard Quotients for chemical exposures to *Americamysis bahia* and *Arbacia punctulata* exposed to New Bedford Harbor Suspended Particulate Phase samples.

	Mysid (*Americamysis bahia* [1])			
Analyte	Acute LC_{50} (ug/L)	Reference for Acute value	HQ for Spike[1,2,3]	HQ for NBH-202-Elutriate
Copper	153	a,g	0.78	0.64
PCB	17	c	1.18	1.36
Unionized ammonia	1.94	f	0.26	0.82

	Sea Urchin (*Arbacia punctulata* [1])			
Analyte	Acute EC_{50} (ug/L)	Reference for Acute value	HQ for Spike[1,2,3]	HQ for NBH-202-Elutriate
Copper	18	g	6.67	5.43
PCB	1000	d	0.02	0.02
total ammonia	4.06	e	3.45	9.33
Unionized ammonia	0.09	b, e	5.56	17.71

1 - Hazard Quotient = elutriate concentration/species LC_{50} (larval development for sea urchin)

2 - Hazard Quotients for spiked sample based on estimate from nominal concentrations

3 Copper = 100% nominal concentration and PCB =10% nominal concentration[h]

a Nacci, Jackim and Walsh. 1986.

b. Bay, S. R. Burgess and D. Nacci. 1993.

c Ho, K.T., R.A. McKinney, A.Kuhn, M.C. Pelletier, and R.M. Burgess.1997.
Value for Aroclor1242; Aroclor 1254 = 57 ug/L

d Adams and Slaughter-Williams. 1988.

e National Beological Service. 1996. Value used is geometric mean of values from Bay et al. and NBS.

f Miller, D.C., S. Poucher, J.A. Cardin and D. Hansen. 1990.

geo. Mean = 1.94 mg/L unionized ammonia

g. SAIC 1993.

h. Ho et al., 1999b.

Table 2 Survival in the mysid, *Americamysis bahia*, after exposures to Spiked Water and Suspended Particulate Phase sediment in the New Bedford Harbor TIE study.

A. 48 hour results

	TIE Treatment[1] Result (% Survival)							
		Metals		Particulates	Organics		Ammonia	
Sample-dilution %	Untreated	STS	EDTA	Filtered	C_{18}		*Ulva*	Low pH[2]
Spike - 50 %	0	100						
Spike - 100 %	0	90	100	100	93		90	100
STA 202 100%	20	20	37	70	93		90	23
PC-100 %	100	100	100	100	93		90	100

B. 96 hour results

	TIE Treatment[1] Result (% Survival)							
		Metals		Particulates	Organics		Ammonia	
Sample-dilution %	Untreated	STS	EDTA	Filtered	C_{18}		*Ulva*	Low pH[2]
Spike - 50 %	0	100						
Spike - 100 %	0	80	97	100	93		90	97
STA 202 100%	0	0	0	0	3		90	3
PC-100 %	100	100	97	97	100		90	100

[1] Treatments were sequential, from left to right (except Low pH, which followed C_{18}- *Ulva*).
Blank cell indicate that no sample was tested.
Yellow highlighting indicates apparent reduction (> 15%) in toxicity.
Bold outline indicates statistically significant change in toxicitiy (a= 0.05).
No toxicity tests were conducted on Spike dilutions after the STS treatment.

Table 3. Responses of the sea urchin, *Arbacia punctulata,* after exposures to spiked water and sediment elutriate in the New Bedford Harbor TIE study.

A. Survival at 72 hrs.

	TIE Treatment[1] Result (% Survival)[2]						
		Metals		Particulates	Organics	Ammonia	
Sample-dilution %	Untreated	STS	EDTA	Filtered	C_{18}	*Ulva*	Low pH
Spike - 10 %	82.0	85.0					
Spike - 25 %	26.0	76					
Spike - 50 %	54.7	79					
Spike - 100 %	81.0	35.0	91	90.0	87.7	41.3	84.0
STA 202 100%	8.7	17	4.7	16	21	65	27.0
PC-100 %	90	88.0	82.3	87.7	92.3	83.0	93.3

B. Normal development at 72 hours.

	TIE Treatment[1] Result (% Normal Development)[3]						
		Metals		Particulates	Organics	Ammonia	
Sample-dilution %	Untreated	STS	EDTA	Filtered	C_{18}	*Ulva*	Low pH
Spike - 10 %	0.7	99					
Spike - 25 %	0.0	0.0					
Spike - 50 %	0.0	0.0					
Spike - 100 %	0.0	0.0	98	98.3	98.0	0.3	96.7
STA 202 100%	0.0	0.0	0.3	3.0	1.3	0	0.0
PC-100 %	100	99.7	99.7	99.7	97.7	98.7	99.3

[1] Treatments were sequential, from left to right (except Low pH, which followed C_{18}- *Ulva*).

[2] The survival endpoint is defined as number of larvae present in 1 ml.

[3] The normal larval development endpoint is defined as achievement of the pluteus stage
Blank cell indicate that no sample was tested.
Yellow highlighting indicates apparent reduction (> 15%) in toxicity.
Bold outline indicates statistically significant change in toxicitiy (a= 0.05).

Aquatec Biological Sciences

Ecology · Environmental Toxicology · Natural Resource Assessments · Microbiology

December 2, 2002

Ms. Sherry Poucher
SAIC
221 Third Street
Newport, Rhode Island 02840

Dear Ms. Poucher:

Enclosed please find a report (two copies, one bound, one unbound) of the toxicity test results for TIE preparations with *Americamysis bahia* and *Arbacia puntulata* completed on samples received on October 31, 2002 (New Bedford).

If you have any questions regarding the report, please contact Dr. Philip C. Downey or me.

Sincerely,

John Williams
Manager, Environmental Toxicology

273 Commerce Street, Williston, VT 05495 Tel: 802.860.1638 Fax: 802.658.3189

Aquatec Biological Sciences

Ecology · Environmental Toxicology · Natural Resource Assessments · Microbiology

Toxicity Detail Report

Science Applications International Corp
221 Third Street

Newport, RI 02840

Date: 12/2/2002
Project: 02065
SDG 6560
Site: New Bedford

Method Description Sea Urchin, Arbacia punctulata, 72-h embryo development
Method: TIEAP
Species: *Arbacia punctulata*

Number	Treatment	Conc(%)	Day	Replicate Normal Development (normal/counted) A	B	C	Average Normal (%)
023135	Control-Filtered	100	3	99 / 100	99 / 100	98 / 100	98.7
023136	NBH_SPP_Cent-C18	100	3	1 / 50	3 / 100	0 / 100	1.6
023138	Spike-C18	100	3	96 / 100	99 / 100	99 / 100	98.0
023139	Control-C18	100	3	96 / 100	98 / 100	99 / 100	97.7
023140	NBH_SPP_Cent-Ulva	100	3	0 / 100	0 / 100	0 / 100	0.0
023142	Spike-Ulva	100	3	0 / 100	0 / 100	1 / 100	0.3
023143	Control-Ulva	100	3	99 / 100	100 / 100	97 / 100	98.7
023144	NBH_SPP_Cent-LOpH	100	3	0 / 100	0 / 100	0 / 100	0.0
023146	Spike-LOpH	100	3	96 / 100	97 / 100	97 / 100	96.7
023147	Control-LOpH	100	3	99 / 100	100 / 100	99 / 100	99.3
023148	NBH_SPP_Cent-Untreat	100	3	0 / 50	0 / 50	0 / 50	0.0
023150	Spike-Untreated	10	3	1 / 100	1 / 100	0 / 100	0.7
023150	Spike-Untreated	25	3	0 / 100	0 / 100	0 / 100	0.0
023150	Spike-Untreated	50	3	0 / 100	0 / 100	0 / 100	0.0
023150	Spike-Untreated	100	3	0 / 100	0 / 100	0 / 100	0.0
023151	Control-Untreated	100	3	100 / 100	100 / 100	99 / 100	99.7
023152	NBH_SPP_Cent-STS	100	3	0 / 50	0 / 100	0 / 50	0.0
023154	Spike-STS	10	3	99 / 100	99 / 100	98 / 100	98.7
023154	Spike-STS	25	3	0 / 100	0 / 100	0 / 100	0.0
023154	Spike-STS	50	3	0 / 100	0 / 100	0 / 100	0.0
023154	Spike-STS	100	3	0 / 100	0 / 100	0 / 100	0.0
023155	Control-STS	100	3	100 / 100	100 / 100	99 / 100	99.7
023156	NBH_SPP_Cent-EDTA	100	3	0 / 50	1 / 50	0 / 28	0.8
023158	Spike-EDTA	100	3	95 / 100	99 / 100	100 / 100	98.0
023159	Control-EDTA	100	3	99 / 100	100 / 100	100 / 100	99.7
023160	NBH_SPP_Cent-Filtered	100	3	3 / 100	6 / 100	0 / 100	3.0
023162	Spike-Filtered	100	3	100 / 100	100 / 100	95 / 100	98.3
023163	Seawater	0	3	100 / 100	99 / 100	100 / 100	99.7

Submitted By:

273 Commerce Street, Williston, VT 05495 Tel: 802.860.1638 Fax: 802.658.3189

Aquatec Biological Sciences

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Toxicity Detail Report

Science Applications International Corp
221 Third Street

Newport, RI 02840

Date: 12/2/2002
Project: 02065
SDG 6560
Site: New Bedford

Method Description: TIE Using Mysidopsis bahia
Method: TIEMY
Species: *Mysidopsis bahia*

		Conc (%)	Test End Day	Start Count	Replicate Survival A	B	C	Average Survival (%)
23135	Control-Filtered	100	4	10	10	10	9	96.7
23137	NBH_SPP_202-C18	100	4	10	0	1	0	3.33
23138	Spike-C18	100	4	10	9	9	10	93.3
23139	Control-C18	100	4	10	10	10	10	100
23141	NBH_SPP_202-Ulva	100	4	10	10	9	8	90
23142	Spike-Ulva	100	4	10	10	9	8	90
23143	Control-Ulva	100	4	10	10	9	8	90
23145	NBH_SPP_202-LOpH	100	4	10	3	0	0	10
23146	Spike-LOpH	100	4	10	10	9	10	96.7
23147	Control-LOpH	100	4	10	10	10	10	100
23149	NBH_SPP_202-Untreated	100	4	10	0	0	0	0
23150	Spike-Untreated	100	4	10	0			
23151	Control-Untreated	100	4	10	10	10	10	100
23153	NBH_SPP_202-STS	100	4	10	3	0	0	10
23154	Spike-STS	50	4	10	10			
23154	Spike-STS	100	4	10	8			
23155	Control-STS	100	4	10	10	10	10	100
23157	NBH_SPP_202-EDTA	100	4	10	0	0	0	0
23158	Spike-EDTA	100	4	10	10	9	10	96.7
23159	Control-EDTA	100	4	10	10	10	9	96.7
23161	NBH_SPP_202-Filtered	100	4	10	0	0	0	0
23162	Spike-Filtered	100	4	10	10	10	10	100
23163	Seawater	0	4	10	10	10	10	100

Submitted By: ____________

Aquatec Biological Sciences

Ecology · Environmental Toxicology · Natural Resource Assessments · Microbiology

Quality Assurance Report

Science Applications International Corporation		Date:	12/2/2002
221 Third Street		Project:	02065
		SDG	6560
Newport, RI	02840	Site:	New Bedford

Qualifiers and Special Conditions

For the untreated spike sample (sample 23150) and the STS-treated spike sample (sample 23154) dilutions of 10%, 25%, 50%, and 100% sample were tested with Arbacia. For the mysids there was only enough sample to run the 100% (one replicate for the untreated spike) or the 50% and 100% (one replicate each for the STS-spike).

Dissolved oxygen concentrations were low in two treatments, sample 23156 and sample 23160 and were aerated briefly before starting the toxicity tests.

For the Arbacia punctulata embryo development test, a subsample of 100 embryos was counted and scored for normal/abnormal developnment. When it was evident that few embryos survived in some test solutions, only 50 embryos were scored. These replicates were sample 23136 replicate A; sample 23148 replicates A,B,C; and sample 23152 replicates A,C.

273 Commerce Street, Williston, VT 05495 Tel: 802.860.1638 Fax: 802.658.3189

Supportive Documentation

Chain-Of-Custody

Toxicity Test Methods

Sea Urchin, Arbacia Punctulata, 72-h embryo development

TIE Using Mysidopsis bahia

Standard Reference Toxicant Control Charts

Chain-Of-Custody

Science Applications International Corporation

Aquatec Biological Sciences
Chain-of-Custody Record

273 Commerce Street
Williston, VT 05495
TEL: (802) 860-1638
FAX: (802) 658-3189

COMPANY INFORMATION	COMPANY'S PROJECT INFORMATION	SHIPPING INFORMATION	VOLUME/CONTAINER TYPE/ PRESERVATIVE (NOTE 4)
Name: Sherry Poucher	Project Name: New Bedford	Carrier: Fed Ex	shipped / 1 gal
Address: 221 Third street		Airbill Number: 8383 0250 4326	500 mL / 1 pt
City/State/Zip: Newport RI 02840	Project Number:	Date Shipped: 10/29/02	
Telephone: (401) 847-4210	Sampler Name(s): John Williams (SPP Prep)	Hand Delivered: ☐ Yes ☐ No	
Facsimile:	Quote #: Client Code:		
Contact Name: Sherry			

SAMPLE IDENTIFICATION (NOTE1)	COLLECTION DATE	COLLECTION TIME	GRAB	COMPOSITE	MATRIX	ANALYSIS/REMARKS (NOTE 2,3)	NUMBER OF CONTAINERS					
NBH-202-SPP	9/12/02	1305	✓		SPP	TIE Manipulations	1 (partial)					
NBH-202-SPP-Clarified by centrifuge	9/14/02	14:00			SPP clear	TIE Manipulations		2 (1 full 1 partial)				

Relinquished by: (signature)	DATE	TIME	Received by: (signature)
[signature]	10/29/02	13:13	Packed for Fed Ex.
Relinquished by: (signature)	DATE	TIME	Received by: (signature)
Relinquished by: (signature)	DATE	TIME	Received by: (signature)

NOTES TO SAMPLER(S): (1) Limit Sample Identification to 30 characters, if possible; (2) Indicate designated Lab Q.C. sample and type (e.g.:MS/MSD/REP) and provide sufficient sample; (3) Field duplicates are separate sample; (4) e.g.: 40 ml/glass/H_2SO_4

Notes to Lab:

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

An Employee-Owned Company Science Applications International Corporation

Chain of Custody Record

Science Applications International Corporation/ 221 Third Street/ Admiral's Gate/ Newport RI 02840 phone (401)847-4210 fax (401)849-9786

Project: NBH - Dredging	Client Name and Contact: Maguire /ACE : Sherry Poucher

Sample No.	Containers No.	Containers Type	Collection Date	Collection Time	Sample Description	Requested Parameters
Control	1	185mL	10/30/02	14:00	Filtered	TIE
NBH_SPP_Cent	1	60mL	↓	15:00	C18	↓
NBH_SPP_202	1	150mL	↓	↓	C18	↓
Spike	1	185mL	↓	↓	C18	↓
Control	1	185mL	↓	↓	C18	↓
NBH_SPP_Cent	1	60mL	↓	1530	UIVA	↓
NBH_SPP_202	1	150mL	↓	↓	UIVA	↓
Spike	1	185mL	↓	↓	UIVA	↓
Control	1	185mL	↓	↓	UIVA	↓
NBH_SPP_Cent	1	60mL	↓	↓	10 PH	↓
NBH_SPP_202	1	150mL	↓	↓	10 PH	↓
Spike	1	185mL	↓	↓	10 PH	↓
Control	1	185mL	↓	↓	10 PH	↓
Sea water	1	1 Gal	10/30/02		~~SE~~ EPA AED Sea Water	Use for Dilutions

Total: 14

Packed/Released By	Date	Time	Received By	Date	Time	Remarks:
Signature: Kate A. Montgomery (signature) Printed Name: Kate A. Montgomery	10/30/02	16:00	Signature: Printed Name:			
Released By Signature: Kate A. Montgomery (signature) Printed Name: Kate A. Montgomery	10/30/02	16:00	**Received By** Signature: (signature) Printed Name: T. Williams	10/31/02	09:30	
Final Destination: Aquatec Williston, VT			Contact Name and Phone Number: John Williams 802 860 1638			Shipping Method: Fed-Ex Page 2 of 2

An Employee-Owned Company Science Applications International Corporation

Chain of Custody Record

Science Applications International Corporation/ 221 Third Street/ Admiral's Gate/ Newport RI 02840 phone (401)847-4210 fax (401)849-9786

Project: NBH - Dredging

Client Name and Contact: Maguire/ACE : Sherry Poucher

Sample No.	Containers No.	Containers Type	Collection Date	Collection Time	Sample Description	Requested Parameters
NBH_SPP-Cent	1	60mL	10/30/02	11:00	Untreated (unt.)	TIE
NBH_SPP_202	1	150mL	↓	↓	Untreated (unt.)	↓
spike	1	150mL			Untreated (unt.)	
Control	1	150mL			Untreated (unt.)	
NBH_SPP_Cent	1	60mL		12:00	Sodium Thiosulfate (STS)	
NBH_SPP_202	1	150mL		↓	Sodium Thiosulfate (STS)	
spike	1	150mL			Sodium Thiosulfate (STS)	
Control	1	150mL			Sodium Thiosulfate (STS)	
NBH_SPP_Cent	1	60mL		13:00	EDTA	
NBH_SPP_202	1	150mL		↓	EDTA	
spike	1	150mL			EDTA	
Control	1	150mL			EDTA	
NBH_SPP_Cent	1	60mL		14:00	Filtered	
NBH_SPP_202	1	150mL		↓	Filtered	
spike	1	185mL	↓	↓	Filtered	↓

Total: 15

Packed/Released By	Date	Time	Received By	Date	Time	Remarks:
Signature: Kate A. Montgomery Printed Name: Kate A. Montgomery	10/30/02	16:00	Signature: Printed Name:			Rec. Temp 1.3°C
Released By Signature: Kate A. Montgomery Printed Name: Kate A. Montgomery	10/30/02	16:00	**Received By** Signature: [signature] Printed Name: John Williams	10/31/02	09:30	

Final Destination: Aquatec Williston, VT

Contact Name and Phone Number: John Williams 8028601638

Shipping Method: Fed-Ex

Page 1 of 2

Toxicity Test Methods

Science Applications International Corporation

Test Protocol

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560
Test Description: *Arbacia punctulata* Embryo development Toxicity Test		

ASSOCIATED PROTOCOL: EPA/ACE 1998. *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Inland Testing Manual* (EPA-823-B-98-004)

1. Test type:	Static, no renewal
2. Test temperature:	20 ± 1°C
3. Light quality:	Ambient laboratory illumination
4. Photoperiod:	Continuous illumination
5. Test chamber size:	20-mL HDPE scintillation vials
6. Test solution volume:	20 ml / replicate
7. Renewal of test concentrations:	None
8. Age of test organisms:	Embryos, approximately 1-h old
9. No. embryos / test chamber:	~ 2000
10. No. of replicate chambers / concentration:	3
11. No. of embryos / concentration:	~ 6000
12. Feeding regime:	None
13. Cleaning:	None during test
14. Aeration:	None
15. Dilution water:	Seawater
16. Test concentrations:	100% for SPP and spike; 10%, 25%, 50%, %100% for spiked untreated and spiked STS treatment
17. Controls:	Seawater
18. Test duration:	72 hours
19. Monitoring:	Daily: Temperature Day 0: DO, temperature, pH, salinity.
19. End points:	Embryo development
20. Reference toxicant test:	Copper sulfate 48-h embryo development
21. Test acceptability (control performance):	70% or greater normal development in control
22. Data interpretation:	Embryo development

Test Protocol

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560
Test Description: *Americamysis bahia* 96-h acute toxicity		

ASSOCIATED PROTOCOL: EPA/ACE 1998. *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Inland Testing Manual* (EPA-823-B-98-004)

1 Test type:	Static, no renewal
2. Test temperature:	25 ± 1°C
3. Light quality:	Ambient laboratory illumination
4. Photoperiod:	16 h light, 8 h dark
5. Test chamber size:	250-mL disposable polystyrene
6. Test solution volume:	Nominally, 200 ml / replicate
7. Renewal of test concentrations:	None
8. Age of test organisms:	1 – 5 days
9. No. mysids / test chamber:	10
10. No. of replicate chambers / concentration:	3
11. No. of mysids / concentration:	30
12. Feeding regime:	Daily, 0.2 mL *Artemia* nauplii
13. Cleaning:	None during test
14. Aeration:	None during test
15. Dilution water:	Seawater
16. Test concentrations:	100% for SPP and spike. Insufficient sample available to test 10% or 25% spiked sample.
17. Controls:	Seawater
18. Test duration:	96 hours
19. Monitoring:	Daily: Temperature Days 0, 4: DO, temperature, pH, salinity.
19. End points:	Survival
20. Reference toxicant test:	Potassium chloride
21. Test acceptability (control performance):	90% or greater survival in control
22. Data interpretation:	Survival (%)

Sea Urchin, Arbacia Punctulata, 72-h embryo development

Science Applications International Corporation

For the *Arbacia punctulata* embryo development test, percent survival may be estimated by using the number of embryos (including normal and abnormal) from a 1-mL aliquot removed from each test vial (preserved embryos) after the test was ended. Presence of any embryo material, no matter how undeveloped or degraded, was scored as "a live embryo" (Actual survival could not be verified because the embryos were preserved.). Data were recorded on the bench sheet labeled as "# in 1-mL".

Percent surviving may be calculated by:

[("# in 1-mL" X 23) / 2000] X 100 = percent survival

23 = the total volume of solution per vial, including preservative

2000 = the nominal number of embryos added per test vial when the test was started.

One exception to this is for Sample 23152 ("Cent SPP-STS") Replicate B. The total volume in this vial was 13 mL after preservation.

Percent surviving = [(29 X 13) / 2000] X 100 = 18.8%

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560

Test Description: *Arbacia punctulata* Embryo development Toxicity Test

Sample	# Normal	# Abnormal	# in (2) 1-mL		Day 0	Day 1	Day 2	Day 3
23136 A	1	49	10	pH	7.9			
Cent SPP B	3	97	29	DO	6.9			
C-18 C	0	100	24	Temp	19.2			20.3
				Salinity	30			
23138 A	96	3	89	pH	7.6			
SPIKE B	99	1	91	DO	8.6			
C-18 C	99	1	83	Temp	20.3			20.4
D				Salinity	30			
23139 A	96	4	101	pH	7.8			
Control B	98	2	85	DO	7.7			
C-18 C	99	1	91	Temp	20.9	19.9		20.3
				Salinity	30			
I/D	T 11/6/02				10/31/02	11/1	11/2	11/3 JW

Sample	# Normal	# Abnormal	# in 1-mL		Day 0	Day 1	Day 2	Day 3
23140 A	0	100	73	pH	7.3			
Cent SPP B	0	100	70	DO	4.1			
ULVA C	0	100	51	Temp	21.6			20.5
				Salinity	30			
23142 A	0	100	35	pH	7.5			
SPIKE	0	100	53	DO	5.1			
ULVA C	1	99	36	Temp	20.2			20.4
				Salinity	30			
23143 A	99	1	88	pH	7.3			
Control	100	0	79	DO	5.2			
ULVA C	97	3	82	Temp	20.4			20.5
				Salinity	30			
I/D	T 11/6/02				10/31/02	11/1	11/2 JG	11/3 JW

Sample	# Normal	# Abnormal	# in 1-mL		Day 0	Day 1	Day 2	Day 3
23144 A	0	100	38	pH	7.2			
Cent SPP B	0	100	24	DO	5.7			
LO PH C	0	100	19	Temp	21.0			20.6
				Salinity	30			
23146 A	96	4	90	pH	8.6			
SPIKE	97	3	76	DO	8.8			
LO PH C	97	3	86	Temp	19.8			20.6
				Salinity	30			
23147 A	(1) 99	1	97	pH	7.1			
Control	100	0	98	DO	8.0			
LO PH C	99	1	85	Temp	20.4		20.3	20.3
D				Salinity	30			
I/D	T 11/6/02				10/31/02	11/1	11/2 JG	11/3 JW

(2) # in 1-mL = 1 mL aliquot of well mixed vial content. Target loading = 2000 embryos per vial. Vial volume = 23 mL (20 mL test sol. + 1 mL embryos + 2 mL preservative)

Abnormals are spherical multicellular/granular masses.

Aquatec Biological Sciences Williston, Vermont — ApTIEToxForms

Reviewed by: T Date: 11/6/02

(1) Considered marginally normal. Pluteus larvae, small, slightly ...

Embryo count X 23 = estimated # of embryos

BIOLOGICAL AND WATER CHEMISTRY DATA

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560
Test Description: *Arbacia punctulata* Embryo development Toxicity Test		

72-h BIOLOGICAL DATA / WATER CHEMISTRY DATA

Sample	# Normal	# Abnormal	# in 1-mL
23148 A	0	50	11
Cent SPP B	0	50	8
UNT C	0	50	5
I/D	[initials]	11/8/02	

	Day 0	Day 1	Day 2	Day 3
pH	7.9			
DO	8.4			
Temp	20.3			20.2
Salinity	30			
	10/31/02	11/1	11/2	11/3 [initials]

72-h BIOLOGICAL DATA / WATER CHEMISTRY DATA

Sample	# Normal	# Abnormal	# in 1-mL
23150 A	1	99	70
SPIKE B	1	99	89
UNT C	0	100	87
10%			
23150 A	0 ①	100	18 ①
SPIKE B	0	100	30
UNT C	0	100	80
25%			
23150 A	0 ①	100	68 ①
SPIKE B	0	100	57
UNT C	0	100	39
50%			
23150 A	0 ①	100	69 ①
SPIKE B	0	100	75
UNT C	0	100	99
100%			
I/D	[initials]	11/8/02	

	Day 0	Day 1	Day 2	Day 3
pH				
DO				
Temp				20.3
Salinity				
pH				
DO				
Temp				20.5
Salinity				
pH				
DO				
Temp				20.5
Salinity				
pH	7.6			
DO	8.7			
Temp	19.9	20.5	20.5	20.5
Salinity	30			
	10/31/02	11/1 [initials]	11/2 [initials]	11/3 [initials]

72-h BIOLOGICAL DATA / WATER CHEMISTRY DATA

Sample	# Normal	# Abnormal	# embryos in 1mL
23151 A	100	0	Not counted
Control	100	0	93
UNT C	99	1	87
I/D	[initials]	11/4/02	

	Day 0	Day 1	Day 2	Day 3
pH	8.0			
DO	8.2			
Temp	20.5			20.5
Salinity	30			
	10/31/02	11/1	11/2	11/3 [initials]

① Abnormal embryos are undeveloped spheres – arrested development at very early stage.

Solution vol = 23 mL, unless otherwise noted (20 mL original test vol + 1 mL embryos + 2 mL formalin) [initials]

BIOLOGICAL AND WATER CHEMISTRY DATA

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560
Test Description: *Arbacia punctulata* Embryo development Toxicity Test		

72-h BIOLOGICAL DATA / WATER CHEMISTRY DATA

Sample	# Normal	# Abnormal	# in 1-mL
23152 A	0	50	11
Cent SPP B	(1) 0	100	29
STS C	0	50	11
I/D	[initials]	11/8/02	

	Day 0	Day 1	Day 2	Day 3
pH	7.7			
DO	8.4			
Temp	20.9			20.6
Salinity	31			
	10/31/02	11/1	11/2	11/3 JW

(1) Total vol Rep B = 13 mL.

72-h BIOLOGICAL DATA / WATER CHEMISTRY DATA

Sample	# Normal	# Abnormal	# in 1-mL
23154 A	99	1	87
SPIKE B	99	1	79
STS C	98	2	89
10%			
23154 A	0	100	85
SPIKE B	0	100	76
STS C	0	100	66
25%			
23154 A	0	100	37
SPIKE B	0	100	69
STS C	0	100	81
50%			
23154 A	0	100	39
SPIKE B	0	100	46
STS C	0	100	24
100%			
I/D	[initials]	11/8/02	

	Day 0	Day 1	Day 2	Day 3
pH				
DO				
Temp				20.6
Salinity				
pH				
DO				
Temp				20.6
Salinity				
pH				
DO				
Temp		20.3	20.7	20.5
Salinity				
pH	7.8			
DO	8.6			
Temp	20.1			20.6
Salinity	30			
	10/31/02	11/1	11/2 JG	11/3 JW

72-h BIOLOGICAL DATA / WATER CHEMISTRY DATA

Sample	# Normal	# Abnormal	# in 1-mL
23155 A	100	0	99
Control	100	0	81
STS C	99	1	84
I/D	[initials]	11/8/02	

	Day 0	Day 1	Day 2	Day 3
pH	8.0			
DO	8.7			
Temp	20.3			20.5
Salinity	30			
	10/31/02	11/1	11/2	11/3 JW

BIOLOGICAL AND WATER CHEMISTRY DATA

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560
Test Description: *Arbacia punctulata* Embryo development Toxicity Test		

72-h BIOLOGICAL DATA / WATER CHEMISTRY DATA

Sample	# Normal	# Abnormal	# in 1 mL		Day 0	Day 1	Day 2	Day 3
23156 A	0	50	8	pH	7.4			
Cent SPP B	1	49	10	DO	1.7/7.2 ← Aerated before testing.			
EDTA C	0	28	5	Temp	20.6			20.6
				Salinity	30			
23158 A	95	5	107	pH	7.8			
SPIKE B	99	1	81	DO	8.6			
EDTA C	100	0	84	Temp	20.1			20.6
				Salinity	30			
23159 A	99	1	76	pH	7.8			
Control B	100	0	90	DO	8.3			
EDTA C	100	0	81	Temp	20.5			20.6
				Salinity	30			
I/D	G	11/11/02			10/31/02 G	11/1	11/2	11/3 JW

72-h BIOLOGICAL DATA / WATER CHEMISTRY DATA

Sample	# Normal	# Abnormal	# in 1-mL		Day 0	Day 1	Day 2	Day 3
23160 A	3	97	20	pH	7.9			
Cent SPP B	6	94	17	DO	3.4/7.0 ← Aerated before testing.			
FILT C	0	100	11	Temp	20.5			20.6
				Salinity	30			
23162 A	100	0	92	pH	7.6			
SPIKE B	100	0	90	DO	8.0			
FILT C	95	5	88	Temp	19.9			20.6
				Salinity	30			
23135 A	99	1	88	pH	7.7			
Control B	99	1	97	DO	7.4			
FILT C	98	2	78	Temp	20.5			20.6
				Salinity	30			
I/D	G	11/11/02			10/31/02 G	11/1	11/2	11/3 JW

72-h BIOLOGICAL DATA / WATER CHEMISTRY DATA

Sample	# Normal	# Abnormal	# in 1-mL		Day 0	Day 1	Day 2	Day 3
23163 A	100	0	83	pH	8.0			
Seawater B	99	1	75	DO	8.6			
C	100	0	85	Temp	20.4	20.4	20.7	20.5
				Salinity	33			
I/D	G	11/11/02			10/31/02 G	11/1 G	11/2 JG	11/3 JW

Client: SAIC   Project: New Bedford 02065   SDG: 6560

Egg Collection and Dilution

Egg injection time: 12:45   No. females used: 4

#eggs in 9:1 dilution of egg stock = 327 = 3270 eggs/mL

Egg dilution:

Volume egg stock = 200 mL

Egg count / 200 = DF = 1.635

(DF X vol. Egg stock) – vol. Egg stock = = 127

volume of FSW added to egg stock = 127

Recount = 227 eggs – added 40 mL.

Confirmation: #eggs in 9:1 dilution of egg stock.   Final egg count =

Final volume of egg stock: 367

Total number of eggs in egg stock: 367 x 2000 = 734,000 eggs

Total number of eggs X 500 = number of sperm required: = 367,000,000 (3.67×10^8)

Sperm Collection and Dilution

Sperm injection time: 12:10   No. males used: 4

Add ~~0.25~~ 0.4 mL sperm to Vial A (containing ~~10~~ 20 mL mL seawater. Serially dilute to Vials B, C, and D. Add 5 mL 10% acetic acid/seawater to vial C. Transfer 1 mL from Vial C to Vial E (contains 4 mL seawater).

Hemacytometer count:, Vial E X 10^4 = Side 1: 171 Side 2: 187 Avg. 179

Avg. X 0.001 = X sperm X 10^7 = 0.179 X 10^7 = 0.0179 X 10^8

Sperm concentration Vial A = 40 X Vial E = 0.716 X 10^8

Sperm concentration Vial B = 20 X Vial E = X 10^8

Sperm concentration Vial D = 5 X Vial E = X 10^8

Vial selected for sperm stock = Vial

Sperm dilution to obtain 500:1 (sperm:egg) Number of eggs in egg stock X 500 = 3.67×10^8

Vial selected as sperm stock = A 0.716×10^8 sperm per mL

Target #sperm / sperm stock per mL = volume of sperm stock to add to egg stock. 3.67 / 0.716 = 5.12 mL

Date / Time Sperm added to egg stock	Fertilization in 1:9 dilution of embryo stock	Time Embryo Development Test Started
13:54	100/100 = 100%	15:00

Initials: [initials] Date: 10/31/02

Test preserved 11/3/02 JW 15:00

Reviewed by: [initials] Date 11/1/02

Laboratory: Aquatec Biological Sciences, Inc. Williston, Vermont

Peak Table: ammonia

File name: A:\110502A.RST
Date: November 05, 2002
Operator: JJG

Peak	Cup	Name	Type	Dil	Wt	Height	Calc. (mg/L)	Flags
1	6	Sync	SYNC	1	1	174482	1.034395	
2	0	CarryOver	CO	1	1	2415	0.011859	
3	0	CarryOver	CO	1	1	182	-0.001407	LO
B	0	Baseline	RB	1	1	0	-0.002491	BL
B	0	Baseline	RB	1	1	0	-0.002491	BL
6	1	Cal 0	C	1	1	134	-0.001694	LO
7	2	Cal 1	C	1	1	35152	0.206406	
8	3	Cal 2	C	1	1	67995	0.401583	
9	4	Cal 3	C	1	1	167974	0.995725	
10	5	Cal 4	C	1	1	841872	5.000472	
11	0	Blank	U	1	1	-1383	-0.010710	LO
B	0	Baseline	RB	1	1	0	-0.002491	BL
13	6	ICV	U	1	1	171595	1.017242	
14	1	ICB	U	1	1	-300	-0.004271	LO
15	31	22621CTEND	U	1	1	13549	0.078027	
16	32	22622CTEND	U	1	1	2548	0.012652	
17	33	22623CTEND	U	1	1	1827	0.008364	
18	34	22624CTEND	U	1	1	865	0.002650	
19	35	22625CTEND	U	1	1	1336	0.005449	
20	36	22626CTEND	U	1	1	1742	0.007861	
21	37	22643CTEND	U	1	1	9685	0.055061	
22	38	22644CTEND	U	1	1	3578	0.018770	
23	39	22645CTEND	U	1	1	12628	0.072553	
24	40	22646CTEND	U	1	1	2160	0.010347	
25	5	CCV	U	1	1	845598	5.022618	
26	1	CCB	U	1	1	-1442	-0.011063	LO
B	0	Baseline	RB	1	1	0	-0.002491	BL
28	41	22647CTEND	U	1	1	420	0.000003	
29	42	22648CTEND	U	1	1	3940	0.020925	
30	43	22655CTEND	U	1	1	3573	0.018741	
31	44	22656CTEND	U	1	1	91378	0.540535	
32	45	22657CTEND	U	1	1	12101	0.069422	
33	46	22658CTEND	U	1	1	3716	0.019593	
34	47	22659CTEND	U	1	1	3217	0.016628	
35	48	22660CTEND	U	1	1	8246	0.046514	
36	49	22661CTEND	U	1	1	9784	0.055649	
37	50	22662CTEND	U	1	1	6265	0.034737	
38	5	CCV	U	1	1	841834	5.000246	
39	1	CCB	U	1	1	-1163	-0.009403	LO
B	0	Baseline	RB	1	1	0	-0.002491	BL
41	51	22663CTEND	U	1	1	8469	0.047840	
42	52	22668CTEND	U	1	1	25019	0.146189	
43	53	23035SPP (201)	U	10	1	191119	11.332678	SPP
44	54	23036SPP (202)	U	10	1	637459	37.857109	Ammonias
45	55	23037SPP (204)	U	10	1	21925	1.272105	10/17/02
46	56	23038SPP (205)	U	10	1	154015	9.127696	
47	57	23039SPP (206)	U	10	1	105337	6.234899	
48	58	23040SPP (207)	U	10	1	232029	13.763792	
49	59	23059SPP (REF)	U	10	1	23615	1.378450	
50	60	23137TIE – (202) end of mysid test, C-18	U	10	1	628496	37.323933	TIE
51	5	CCV	U	1	1	852664	5.064609	Ammonia
52	1	CCB	U	1	1	-1146	-0.009300	LO
B	0	Baseline	RB	1	1	0	-0.002491	BL 11/4/02
54	61	23141TIE – (202) end of mysid test, ULVA	U	1	1	1315797	7.816853	

Peak	Cup	Name	Type	Dil	Wt	Height	Calc. (mg/L)	Flags
55	62	23153TIE (202) end of mysid test, STS		[illegible]	1	610645	36.263691	
56	5	CCV	U	1	1	850516	5.051842	
57	1	CCB	U	1	1	-2047	-0.008715	LO
B	0	Baseline	RB	1	1	0	-0.002491	BL

Suspended Particulate Phase Preparation for TIE

Client: SAIC	Project: 02065, New Bedford FEIR	SDG: 6519

SPP / Elutriate Preparation:
Quantitatively mix Site Sediment with matched Site Water in a 1:4 ratio. Mix this solution 30 minutes with a mixer. At approximately 10 min intervals, manually stir to ensure complete mixing. Allow the solution to settle 1 hour. At 1 hour remove the SPP for the toxicity tests. Ideally, approximately 4.7 L or SPP is needed for the TIE, however, we may be limited by sediment quantity. Approximately 4.2 L of SPP will be shipped to SAIC for the mysid TIE. A sub-sample of approximately 500 mL will be centrifuged (10 min @ 6000 RPM) for the *Arbacia* TIE and shipped to SAIC. The SPP prep water will be the matched site water for Sample 202: Our lab numbers 23024 (sediment) and 23030 (water).

SPP / Elutriate Preparation (October 29, 2002)

Water & Sediment Samples	Volume Sediment: Water (mL)	SPP Mix Time	SPP Settle Time	SPP TOX Vol for Mysid	SPP TSS Vol For *Arbacia*	Spin 1 Time 6000 RPM 10 min
					+ mysid	4°C
23030 202-W-ELUT 23024 202-ELUT	4800 mL H_2O, 1200mL Sed = 6L	11:35 – 12:05	12:05 – 13:05	~1200	baseline.	13:50 – 14:00
	JW 10/29/02					

Aquatec Biological Sciences, Inc. TIEForms
Reviewed by: [signature] Date: 12/2/02

TIE Using *Mysidopsis bahia*

Science Applications International Corporation

BIOLOGICAL AND WATER CHEMISTRY DATA

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560
Test Description: *Americamysis bahia* Acute Toxicity Test		

Temp probe T2 P25C 10/31/02 22:22

Sample		Day 0	Day 1	Day 2	Day 3	Day 4		Day 0	Day 1	Day 2	Day 3	Day 4
NUMBER SURVIVING							WATER CHEMISTRY DATA					
23137	A	10	6	1	0	0	pH	7.7			8.1	8.4
SPP	B	10	8	4	3	~~1~~ 0	DO	8.1	6.7		7.4	7.2
C-18	C	10	6	1	0	0	Temp	20.1		25.0	24.2	24.9
							Salinity	30			33	33
23138	A	10	10	10	9	9	pH	7.6				7.1
SPIKE	B	10	10	10	9	9	DO	8.6				5.4
C-18	C	10	10	10	10	10	Temp	20.3			24.2	24.7
	D						Salinity	30				32
23139	A	10	10	10	10	10	pH	7.8				7.2
Control	B	10	10	10	10	10	DO	7.7				4.4
C-18	C	10	10	10	10	10	Temp	~~20.9~~ 20.4	25.5			24.7
		10	T				Salinity	30				32
I/D/T		10/31/02	11/1 15:00	11/2 JG	11/3 JW	11/4		10/31/02	11/1	11/2 JG	11/3 JW	11/4

Ammonia ✓ sample 11/4/02

20:30 20:00

(1) One stuck on petri dish top

Sample		Day 0	Day 1	Day 2	Day 3	Day 4		Day 0	Day 1	Day 2	Day 3	Day 4
NUMBER SURVIVING							WATER CHEMISTRY DATA					
23141	A	10	10	~~9~~ 10 JG	10	10	pH	7.3				8.4
SPP	B	10	9	9	9	9	DO	6.1				7.5
ULVA	C	(1) ~~10~~ 9	9	9	8	8	Temp	20.4	24.7		24.1	24.6
							Salinity	30				32
23142	A	10	10	10	10	10	pH	7.5				7.2
SPIKE	B	10	9	9	9	9	DO	6.1				3.5
ULVA	C	10	10	9	9	8	Temp	20.2		24.5		24.6
							Salinity	30				30
23143	A	10	10	10	10	10	pH	7.3				7.6
Control	B	10	~~10~~ 9	9	9	9	DO	5.2				5.9
ULVA	C	10	9	9	9	8	Temp	20.4				24.7
	D	10	~~10~~	~~10~~			Salinity	30				31
I/D/T		10/31/02	11/1 15:15	11/2 JG	11/3 JW	11/4 20:20		10/31/02	11/1	11/2 JG	11/3 JW	11/4

Ammonia sample ✓ 11/4/02

20.40

Sample		Day 0	Day 1	Day 2	Day 3	Day 4		Day 0	Day 1	Day 2	Day 3	Day 4
NUMBER SURVIVING							WATER CHEMISTRY DATA					
23145	A	10	6	5	5	3	pH	7.7			8.0	7.8
SPP	B	10	6	1	0	0	DO	not measured	6.9		7.3	6.7
LO PH	C	10	7	1	0	0	Temp	21.0	24.9	24.4	24.1	24.9
							Salinity	30			32	34
23146	A	10	10	10	10	10	pH	8.6				7.5
SPIKE	B	10	10	9	9	9	DO	8.8				4.9
LO PH	C	10	10	10	10	10	Temp	19.8			24.2	24.8
							Salinity	30				32
23147	A	10	10	10	10	10	pH	7.1				7.6
Control	B	10	10	10	10	10	DO	8.0				7.3
LO PH	C	10	10	10	10	10	Temp	20.4				24.8
	~~D~~	~~10~~					Salinity	30				32
I/D/T		10/31/02	11/1 15:30	11/2 JG	11/3 JW	11/4 20:28		10/31/02	11/1	11/2 JG	11/3 JW	11/4

No ammonia sample

20.50

14:30 Fed ✓ 19:00 Fed ✓

Final chems measured w/in test containers just prior to final counts 11/4/02

Aquatec Biological Sciences Williston, Vermont SPPToxForms

Reviewed by: ________ Date: 11/5/02

10/31/02 22:10 - all replicates

12/4/02 All reps fed during monitoring

0 written in wrong space 11/1 + 11/2

BIOLOGICAL AND WATER CHEMISTRY DATA

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560
Test Description: *Americamysis bahia* Acute Toxicity Test		

NUMBER SURVIVING

Sample		Day 0	Day 1	Day 2	Day 3	Day 4
23149	A	10	9	5	0	0
SPP	B	10	7	1	0	0
UNT	C	10	6	0	0	0
I/D/T		10/31/02	11/1	11/2 JG	11/3 JW	11/4

21.09 15:35

WATER CHEMISTRY DATA

	Day 0	Day 1	Day 2	Day 3	Day 4
pH	7.9		8.5	8.5	—
DO	9.0	6.6	6.5	7.3	—
Temp	20.0		24.3	24.2	—
Salinity	30		30	31	—
	10/31/02	11/1	11/2 JG	11/3 JW	11/4

NUMBER SURVIVING

Sample		Day 0	Day 1	Day 2	Day 3	Day 4
23150	A	~~10~~				
SPIKE	B	~~10~~				
UNT	C	~~10~~				
~~10%~~						
23150	A	~~10~~				
SPIKE	B	~~10~~				
UNT	C	~~10~~				
~~25%~~						
23150	A	~~10~~				
SPIKE	B	~~10~~				
UNT	C	~~10~~				
~~50%~~						
23150	A	10	0	0	0	0
SPIKE	B	~~10~~				
UNT	C	~~10~~				
100%						
I/D/T		10/31/02	11/1	11/2 JG	11/3	11/4

Insufficient sample to run dilutions (10%, 25%, 50%)

One rep. only at 100%

21:10

WATER CHEMISTRY DATA

	Day 0	Day 1	Day 2	Day 3	Day 4
pH					
DO					
Temp					
Salinity					
pH					
DO					
Temp					
Salinity					
pH					
DO					
Temp					
Salinity					
pH	7.6	7.8			—
DO	8.7	6.9			—
Temp	19.9				—
Salinity	30	30			—
	10/31/02	11/1	11/2	11/3 JW	11/4

SPIKE UNT – only enough solution for one rep – 100%

NUMBER SURVIVING

Sample		Day 0	Day 1	Day 2	Day 3	Day 4
23151	A	10	10	10	10	10
Control	B	10	10	10	10	10
UNT	C	10	10	10	10	10
I/D/T		10/31/02	11/1	11/2 JG	11/3 JW	11/4

21:15 15:50 14:00 Fed ✓ 14:00 Fed ✓ 20:30

WATER CHEMISTRY DATA

	Day 0	Day 1	Day 2	Day 3	Day 4
pH	8.0				8.0
DO	8.2				7.3
Temp	20.5	25.2	24.5	24.2	24.9
Salinity	30				34
	10/31/02	11/1	11/2 JG	11/3 JW	11/4

BIOLOGICAL AND WATER CHEMISTRY DATA

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560
Test Description: *Americamysis bahia* Acute Toxicity Test		

NUMBER SURVIVING / WATER CHEMISTRY DATA

Sample	Day 0	Day 1	Day 2	Day 3	Day 4
23153 A	10	10	6	5	3
SPP B	10	7	0	0	0
STS C	10	6	0	0	0
I/D/T	10/31/02	11/1	11/2 JG	11/3 JW	11/4

	Day 0	Day 1	Day 2	Day 3	Day 4
pH	7.6		8.4		8.3
DO	7.1		6.4		7.1
Temp	19.8		24.5	24.2	24.9
Salinity	30		30		32
	10/31/02	11/1	11/2 JG	11/3 JW	11/4

Ammonia sample ✓ 11/4/02

21:20 15:57

NUMBER SURVIVING / WATER CHEMISTRY DATA

Sample	Day 0	Day 1	Day 2	Day 3	Day 4
23154 A	10				
SPIKE B	10				
STS C	10				
10%					
23154 A	~~10~~				
SPIKE B	10				
STS C	10				
25%					
23154 A	10	10	10	8	10
SPIKE B	~~10~~	/	/	/	/
STS C	~~10~~	/	/	/	/
50%					
23154 A	10	10	9	9	8
SPIKE B	~~10~~	/	/	/	/
STS C	~~10~~	/	/	/	/
100%		15:57			
I/D/T	10/31/02	11/1	11/2 JG	11/3 JW	11/4 20:30

	Day 0	Day 1	Day 2	Day 3	Day 4
pH					
DO					
Temp					
Salinity					
pH					
DO					
Temp					
Salinity					
pH					7.7
DO					5.6
Temp					25.0
Salinity					32
pH	7.8				7.4
DO	8.6				6.4
Temp	20.1			24.2	25.3
Salinity	30				31
	10/31/02	11/1	11/2 JG	11/3 JW	11/4

Insufficient sample to run 10% or 25%. One rep only 25 50% & 100%

SPIKE STS – only enough for 50% – one rep; 100% = one rep.

21:20

NUMBER SURVIVING / WATER CHEMISTRY DATA

Sample	Day 0	Day 1	Day 2	Day 3	Day 4
23155 A	10	10	10	10	10
Control B	10	10	10	10	10
STS C	10	10	10	10	10
I/D/T	10/31/02	11/1	11/2 JG	11/3 JW	11/4

	Day 0	Day 1	Day 2	Day 3	Day 4
pH	8.0				~~7.4~~ 7.9
DO	8.7				~~7.4~~ 7.0
Temp	20.3			24.1	25.1
Salinity	30				31
	10/31/02	11/1	11/2 JG	11/3 JW	11/4

21:20 16:06 14:00 Fed ✓ 13:50 Fed ✓ 20:40

BIOLOGICAL AND WATER CHEMISTRY DATA

Client: SAIC	Project: 02065, New Bedford TIE	SDG: 6560
Test Description: *Americamysis bahia* Acute Toxicity Test		

NUMBER SURVIVING

Sample		Day 0	Day 1	Day 2	Day 3	Day 4
23157	A	10	10	8	0	0
SPP	B	10	7	0	0	0
EDTA	C	10	6	3	0	0
23158	A	10	10	10	10	10
SPIKE	B	10	10	10	10	9
EDTA	C	10	10	10	10	10
23159	A	10	10	10	10	10
Control	B	10	10	10	10	10
EDTA	C	10	10	10	10	9
I/D/T		10/31/02 21:28	11/1 16:30	11/2 JG	11/3 JW	11/4 20:35

WATER CHEMISTRY DATA

	Day 0	Day 1	Day 2	Day 3	Day 4
pH	7.4		8.3	8.2	/
DO	8.0	6.4	6.8	7.2	/
Temp	20.3	24.7		24.2	/
Salinity	31		30	31	~~33~~
pH	7.8				7.5
DO	8.6				4.0
Temp	20.1		24.3		25.2
Salinity	30				32
pH	7.8				7.8
DO	8.3				6.9
Temp	20.5			24.2	25.3
Salinity	30				~~32~~ 31
	10/31/02	11/1	11/2 JG	11/3 JW	11/4

NUMBER SURVIVING

Sample		Day 0	Day 1	Day 2	Day 3	Day 4
23161	A	10	10	8	0	0
SPP	B	10	9	7	0	0
FILT	C	10	10	6	0	0
23162	A	10	10	10	10	10
SPIKE	B	10	10	10	10	10
FILT	C	10	10	10	10	10
23135	A	10	10	10	10	10
Control	B	10	10	10	10	10
FILT	C	10	10	10	10	9
I/D/T		10/31/02 21:35	11/1 16:27	11/2 JG	11/3 JW	11/4 20:47

WATER CHEMISTRY DATA

	Day 0	Day 1	Day 2	Day 3	Day 4
pH	7.6			8.3	
DO	6.0			6.6	
Temp	20.3	25.1		24.2	
Salinity	31			34	32
pH	7.6				7.2
DO	8.0				4.6
Temp	19.9		24.2		25.2
Salinity	30				~~32~~ 31
pH	7.7				7.8
DO	7.4				6.8
Temp	20.5			24.2	25.4
Salinity	30				31
	10/31/02	11/1	11/2 JG	11/3 JW	11/4

NUMBER SURVIVING

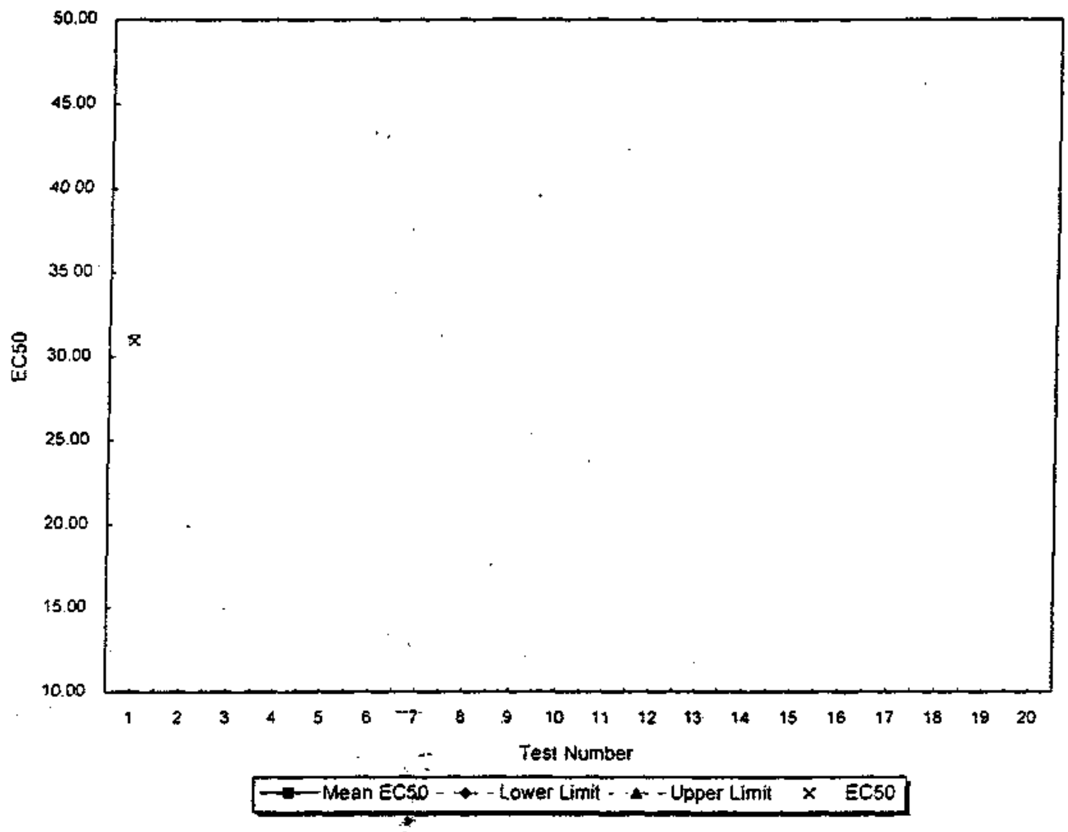
Sample		Day 0	Day 1	Day 2	Day 3	Day 4
23163	A	10	10	10	10	10
Seawater	B	10	10	10	10	10
	C	10	10	10	10	10
I/D/T		10/31/02 21:38	11/1 16:30	11/2 JG 14:15 Fed ✓	11/3 JW 13:30 Fed ✓	11/4 20:50

WATER CHEMISTRY DATA

	Day 0	Day 1	Day 2	Day 3	Day 4
pH	8.0				8.0
DO	8.6				6.9
Temp	20.4			24.1	25.0
Salinity	33				31
	10/31/02	11/1	11/2	11/3 JW	11/4

Reference Toxicant Control Chart
Arbacia punctulata Embryo Development
in Copper sulfate (ug/L)

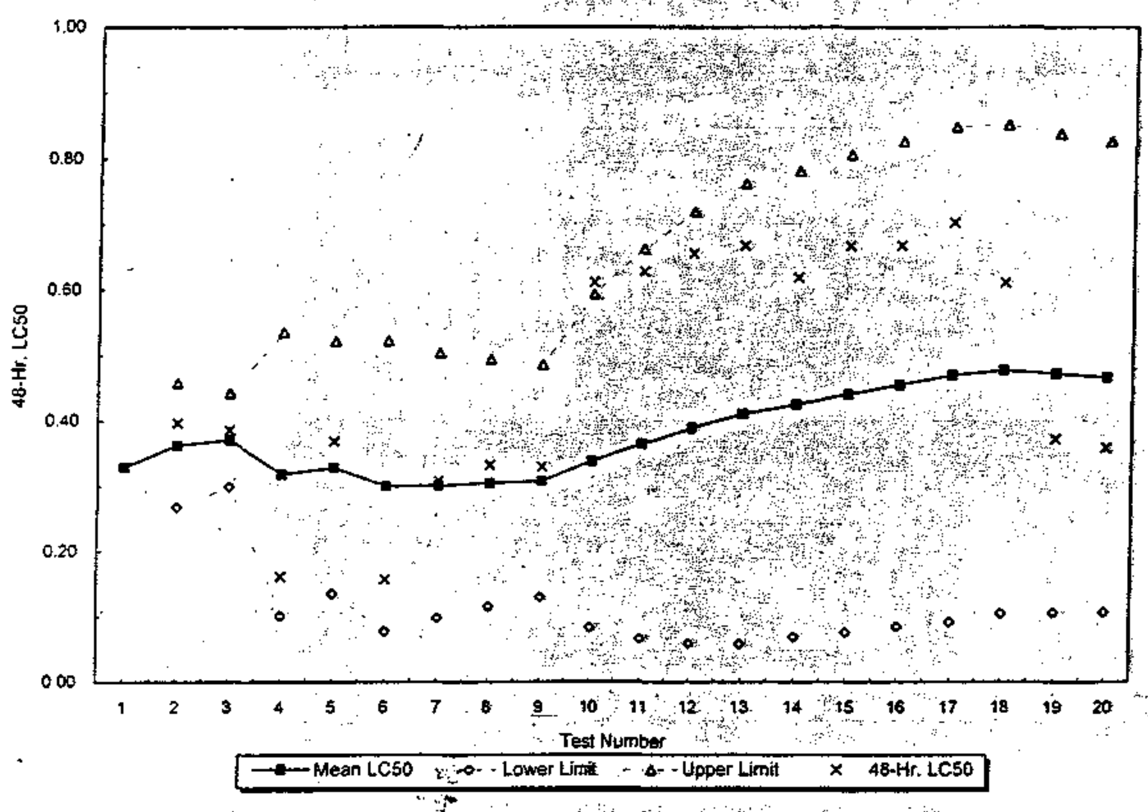
Test Number	Test Date	48-h EC50	Mean EC50	Lower Limit	Upper Limit	Organism Source
1	10/31/02	30.935	30.94			Aquatec Biological Sciences
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						



\qaqc\srts\APEmbDevCUSO

Reference Toxicant Control Chart
Americamysis bahia
in Potassium chloride (g/L)

Test Number	Test Date	Organism Age (Days)	48-Hr. LC50	Mean LC50	Lower Limit	Upper Limit	Organism Source
1	05/24/01	3	0.330	0.33			Aquatic Research Organisms
2	06/06/01	3	0.397	0.36	0.27	0.46	Aquatic BioSystems
3	07/06/01	4	0.386	0.37	0.30	0.44	Aquatic BioSystems
4	08/15/01	3	0.162	0.32	0.10	0.54	Aquatic Research Organisms
5	09/12/01	4	0.369	0.33	0.14	0.52	Aquatic BioSystems
6	10/05/01	3	0.157	0.30	0.08	0.52	Aquatic BioSystems
7	12/05/01	2	0.308	0.30	0.10	0.50	Aquatic BioSystems
8	01/04/02	2	0.333	0.31	0.12	0.49	Aquatic Research Organisms
9	01/04/01	3	0.330	0.31	0.13	0.49	Aquatic BioSystems
10	03/07/02	3	0.612	0.34	0.08	0.59	Aquatic BioSystems
11	03/19/02	2	0.628	0.36	0.07	0.66	Aquatic BioSystems
12	04/08/02	5	0.656	0.39	0.06	0.72	Aquatic BioSystems
13	04/10/02	4	0.668	0.41	0.06	0.76	Aquatic BioSystems
14	06/03/02	4	0.619	0.43	0.07	0.78	Aquatic BioSystems
15	08/15/02	5	0.668	0.44	0.08	0.81	Aquatic BioSystems
16	09/11/02	4	0.668	0.46	0.08	0.83	Aquatic BioSystems
17	09/21/02	5	0.703	0.47	0.09	0.85	Aquatic BioSystems
18	09/30/02	5	0.612	0.48	0.10	0.85	Aquatic BioSystems
19	10/18/02	4	0.373	0.47	0.11	0.84	Aquatic BioSystems
20	11/01/02	3	0.360	0.47	0.11	0.83	Aquatic BioSystems



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Appendix A

Toxicity Testing Data Report and Statistical Analyses

Mysid Survival, Growth and Fecundity Test-48 Hr

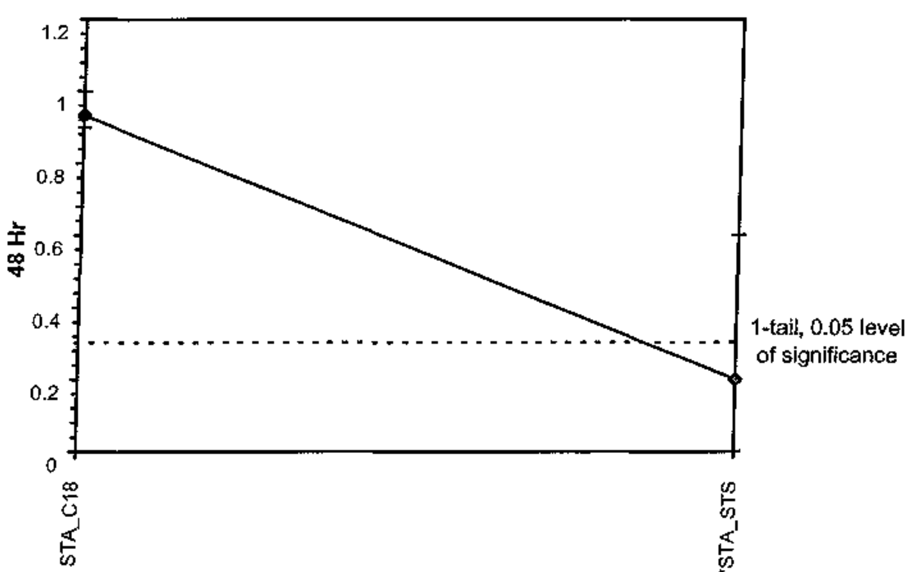
Start Date:		Test ID:	NBHMYS48	Sample ID:	NBH MYS 48
End Date:		Lab ID:		Sample Type:	AMB1-Ambient water
Sample Date:		Protocol:	EPAA 91-EPA Acute	Test Species:	AB-Americamysis bahia
Comments:	New Bedford Harbor, 48hr Americamysis bahia				

Conc-%	1	2	3
STA_C18	1.0000	0.9000	0.9000
STA_STS	0.6000	0.0000	0.0000

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
STA_C18	0.9333	1.0000	0.9333	0.9000	1.0000	6.186	3			
*STA_STS	0.2000	0.2143	0.2000	0.0000	0.6000	173.205	3	3.617	2.920	0.5921

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.860401		0.713		1.320255	2.03981
F-Test indicates equal variances (p = 0.05)	36		199.012			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Heteroscedastic t Test indicates significant differences	0.592053	0.634342	0.806667	0.061667	0.022421	1, 4

Dose-Response Plot



ToxCalc v5.0.23

Reviewed by: SP

Mysid Survival, Growth and Fecundity Test-48 Hr

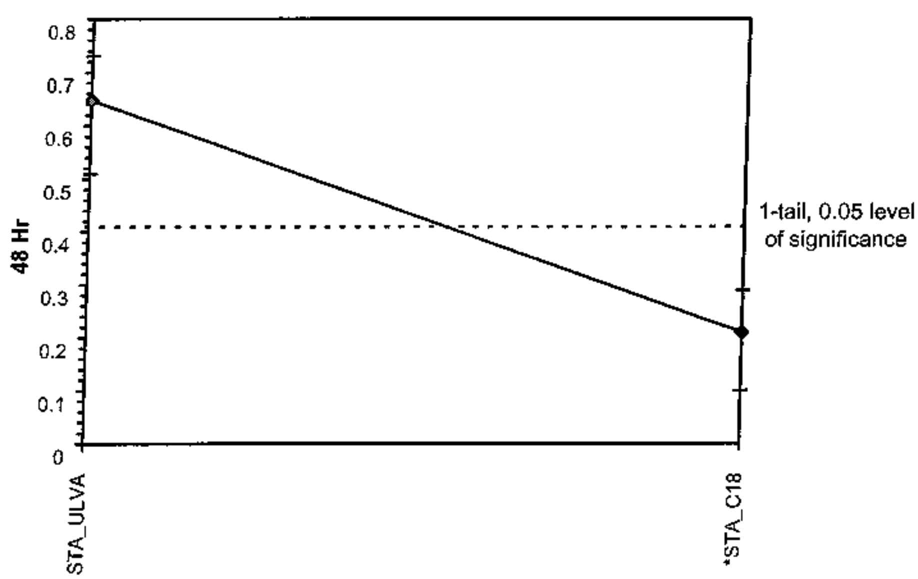
Start Date:		Test ID:	NBHURC72	Sample ID:	NBH URC 72hr
End Date:		Lab ID:		Sample Type:	AMB1-Ambient water
Sample Date:		Protocol:	EPAA 91-EPA Acute	Test Species:	AP-Arbacia punctulata
Comments:	New Bedford Harbor, 72hr Urchin Survival				

Conc-%	1	2	3
STA_ULVA	0.7300	0.7000	0.5100
STA_C18	0.1000	0.2900	0.2400

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
STA_ULVA	0.6467	1.0000	0.6467	0.5100	0.7300	18.449	3			
*STA_C18	0.2100	0.3247	0.2100	0.1000	0.2900	46.899	3	4.889	2.353	0.2102

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.809437		0.713		-0.83728	-1.71803
F-Test indicates equal variances (p = 0.81)	1.467354		199.012			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Heteroscedastic t Test indicates significant differences	0.210199	0.325049	0.286017	0.011967	0.008109	1, 4

Dose-Response Plot



ToxCalc v5.0.23

Reviewed by: SP

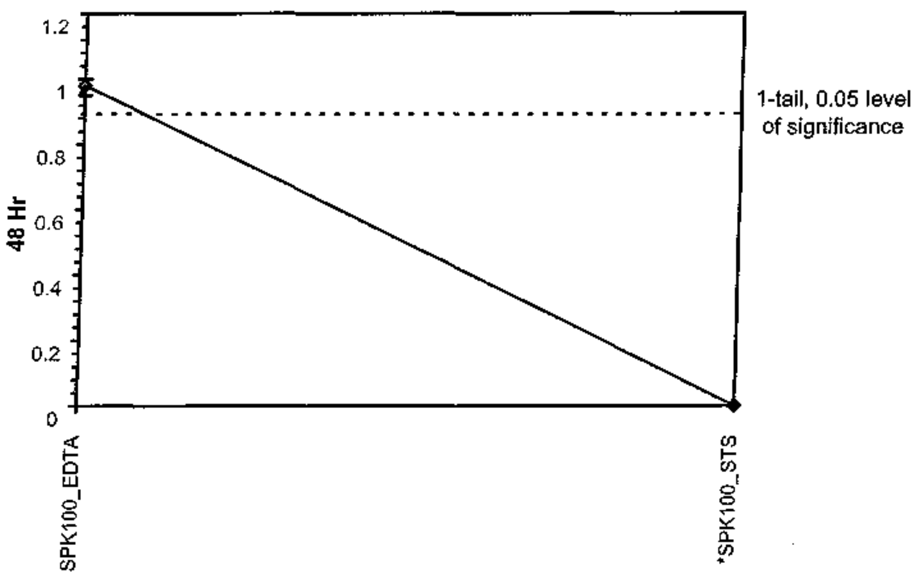
Mysid Survival, Growth and Fecundity Test-48 Hr			
Start Date:	Test ID: NBHURC	Sample ID:	NBH URC
End Date:	Lab ID:	Sample Type:	AMB1-Ambient water
Sample Date:	Protocol: EPAA 91-EPA Acute	Test Species:	AP-Arbacia punctulata
Comments:	New Bedford Harbor, Arbacia punctulata, Normal Development		

Conc-%	1	2	3
SPK100_EDTA	0.9500	0.9900	1.0000
SPK100_STS	0.0000	0.0000	0.0000

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SPK100_EDTA	0.9800	1.0000	0.9800	0.9500	1.0000	2.700	3			
*SPK100_STS	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	3	64.156	2.920	0.0446

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.873051		0.713		-1.15254	2.5
Equality of variance cannot be confirmed						
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Heteroscedastic *t* Test indicates significant differences	0.044604	0.045514	1.4406	0.00035	3.5E-07	1, 4

Dose-Response Plot



 ToxCalc v5.0.23 Reviewed by: SP

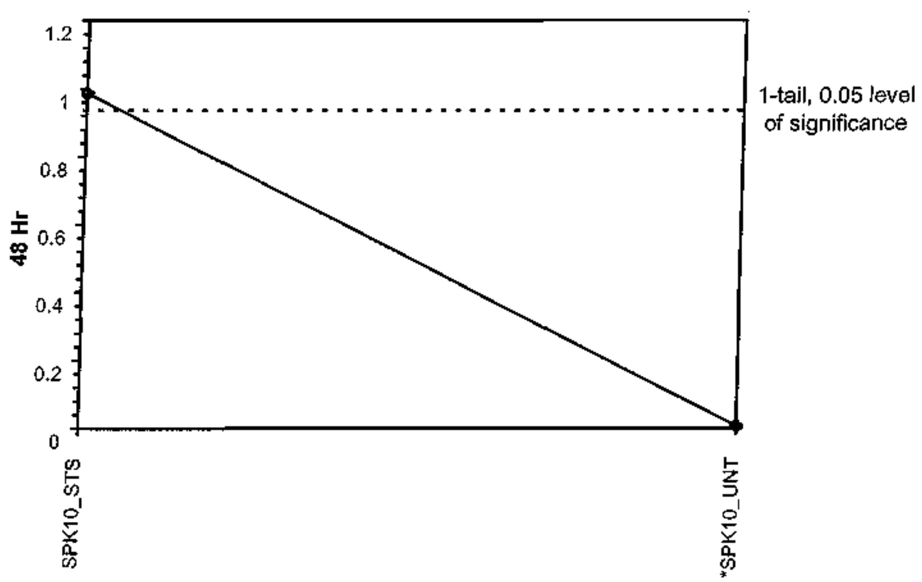
Mysid Survival, Growth and Fecundity Test-48 Hr					
Start Date:		Test ID:	NBHURCS48	Sample ID:	NBH URC 48
End Date:		Lab ID:		Sample Type:	AMB1-Ambient water
Sample Date:		Protocol:	EPAA 91-EPA Acute	Test Species:	AP-Arbacia punctulata
Comments:	New Bedford Harbor, Arbacia punctulata, Normal Development				

Conc-%	1	2	3
SPK10_STS	0.9900	0.9900	0.9800
SPK10_UNT	0.0100	0.0100	0.0000

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SPK10_STS	0.9867	1.0000	0.9867	0.9800	0.9900	0.585	3			
*SPK10_UNT	0.0067	0.0068	0.0067	0.0000	0.0100	86.603	3	207.889	2.132	0.0100

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.639916		0.713		-0.96825	-1.875
F-Test indicates equal variances (p = 1.00)	1		199.012			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Heteroscedastic t Test indicates significant differences	0.01005	0.010185	1.4406	3.33E-05	3.2E-09	1, 4

Dose-Response Plot



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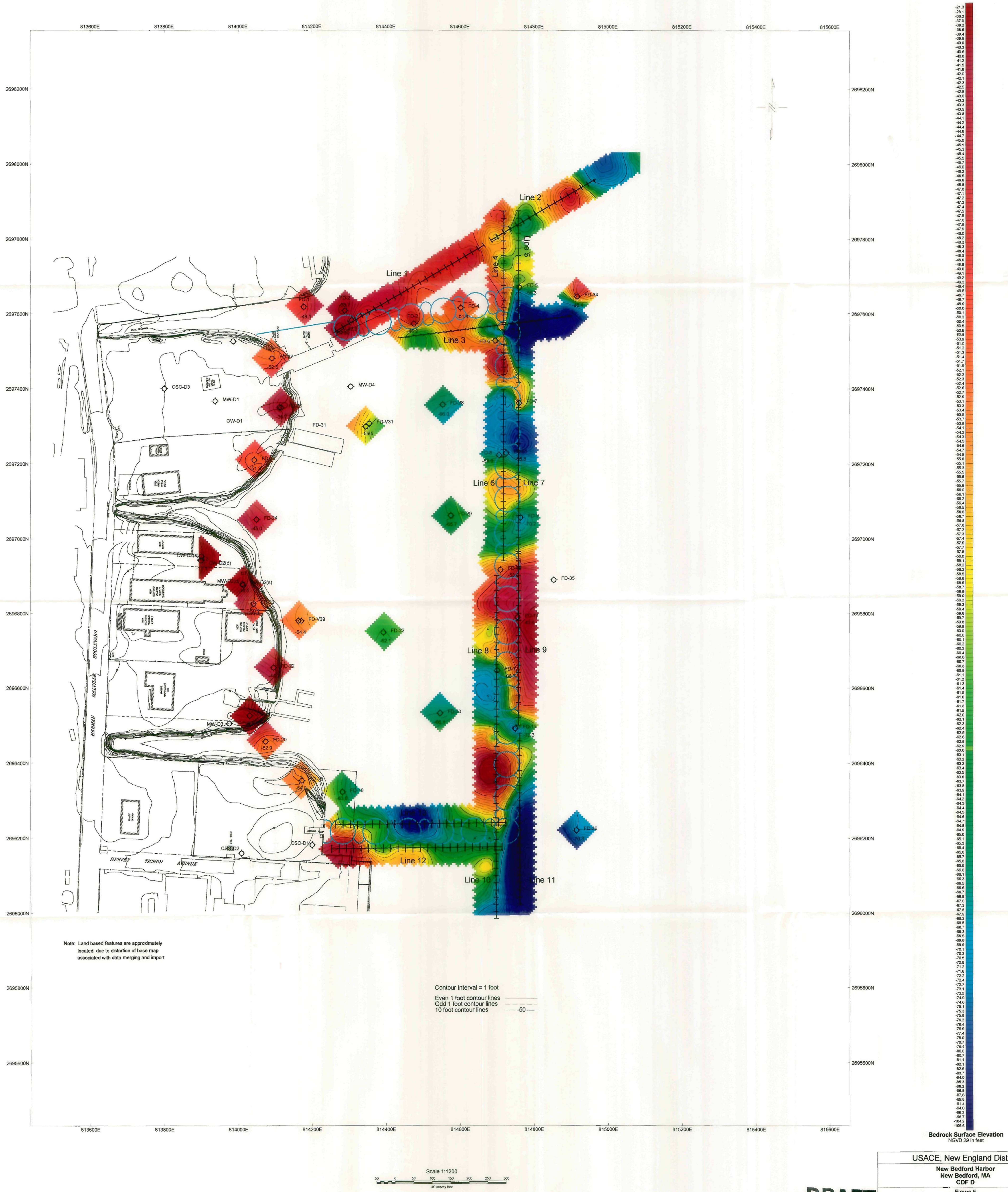


DRAFT

USACE, New England District

New Bedford Harbor
New Bedford, MA
CDF D

Figure 5
Marine Seismic Refraction Elevation of Bedrock Surface

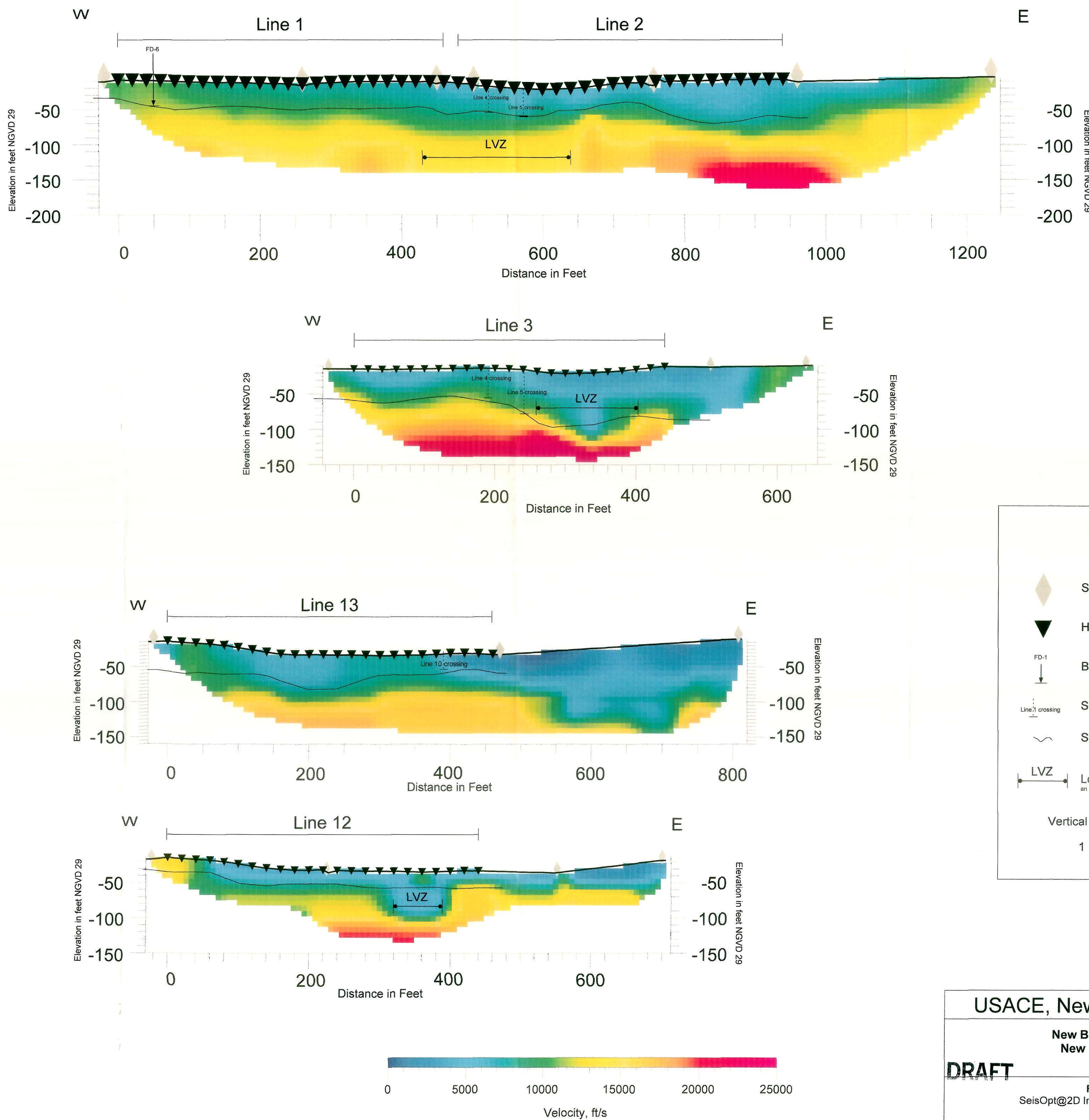
FWENC Geophysics

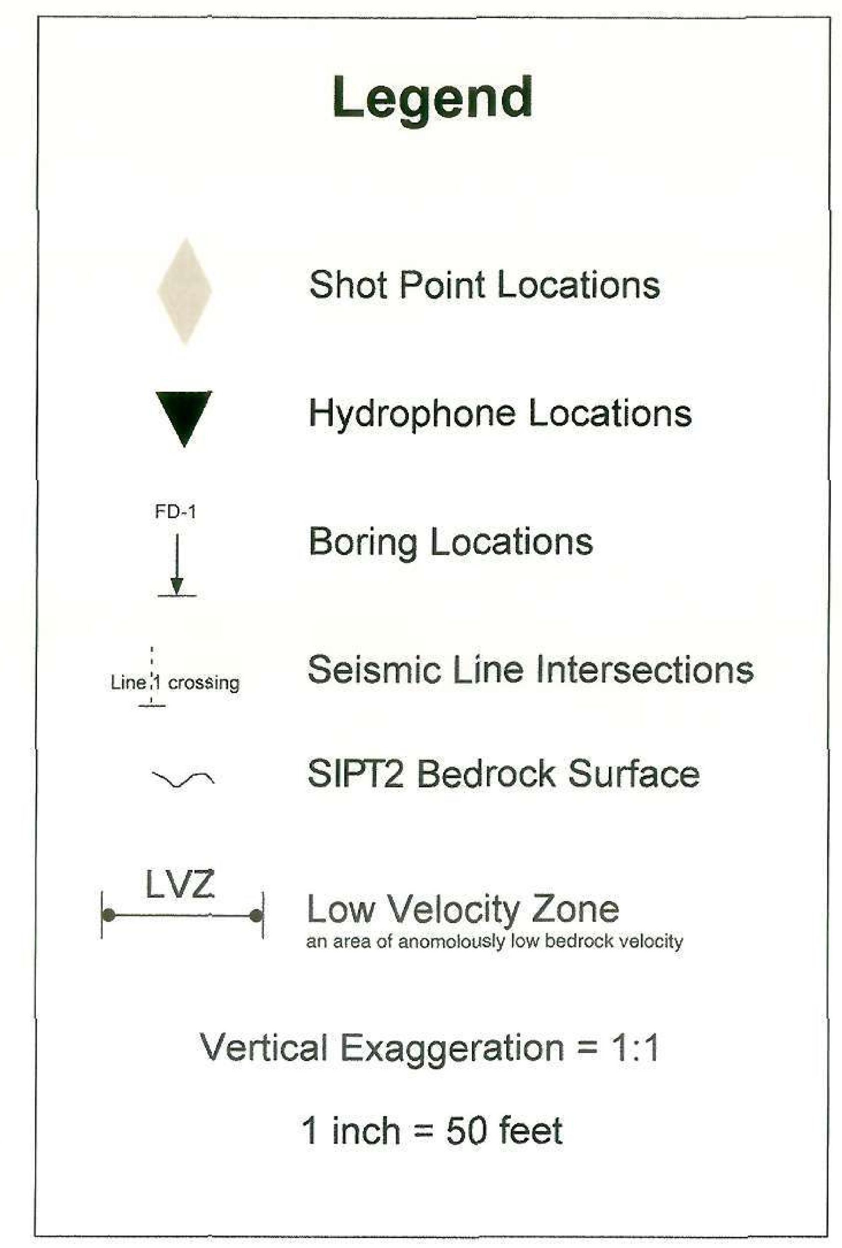
Velocity Model
Lines 1 & 2
Outer Edge of the
Northern CDF Wall

Velocity Model
Line 3
Inner Edge of the
Northern CDF Wall

Velocity Model
Line 13
Inner Edge of the
Southern CDF Wall

Velocity Model
Line 12
Outer Edge of the
Southern CDF Wall





USACE, New England District

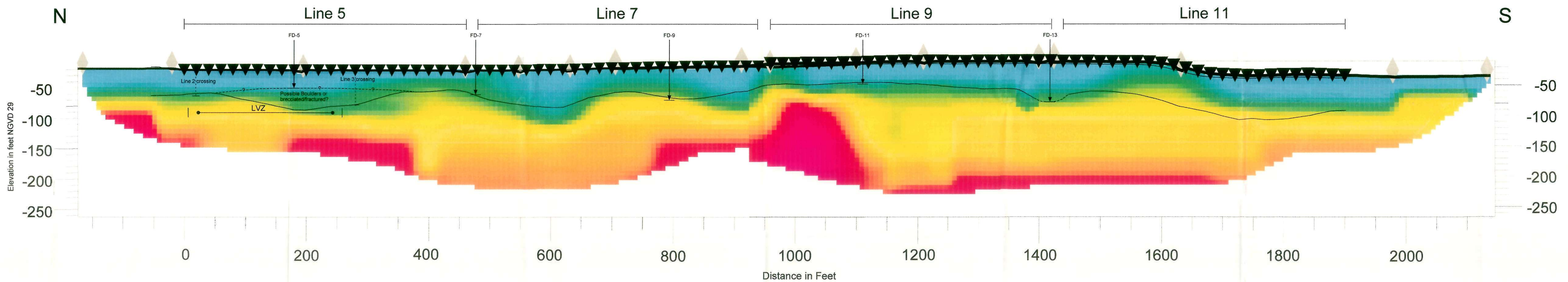
New Bedford Harbor
New Bedford, MA
CDF D

DRAFT

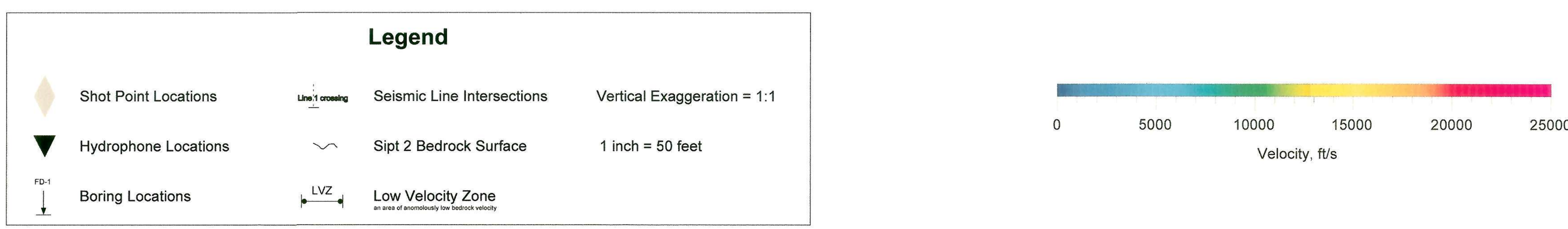
Figure 4B
SeisOpt@2D Inversion Velocity Models

FWENC Geophysics

Velocity Model Lines 5, 7, 9 & 11
Eastern Side of the Outer CDF Wall



Velocity Model Lines 4, 6, 8 & 10
Western Side of the Outer CDF Wall



USACE, New England District

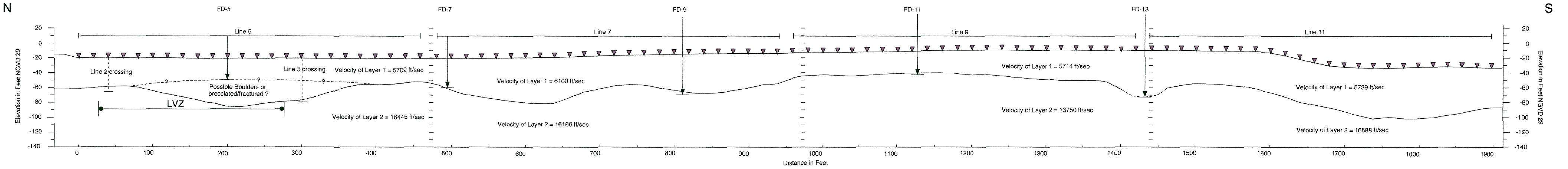
New Bedford Harbor
New Bedford, MA
CDF D

DRAFT

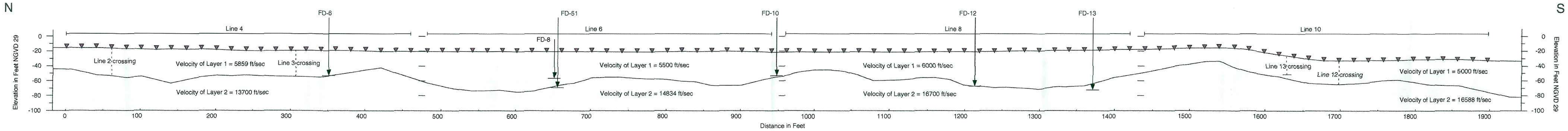
Figure 4A
SeisOpt@2D Inversion Velocity Models

FWENC Geophysics

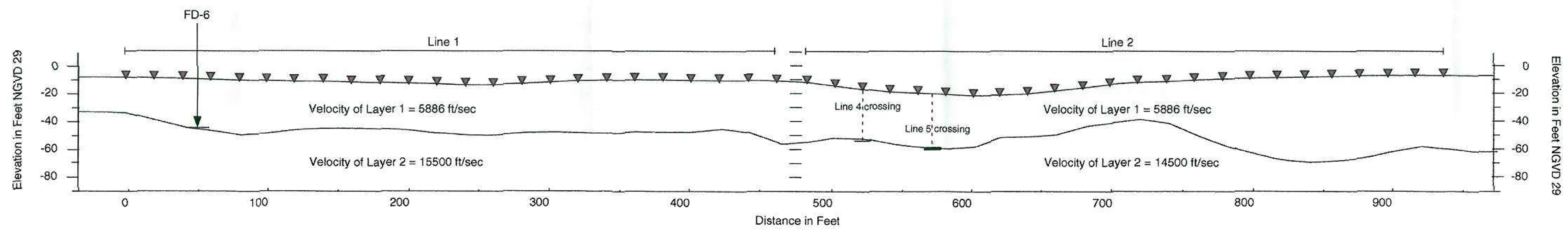
Bedrock Surface Inversion Model Lines 5, 7, 9 & 11
Eastern Side of the Outer CDF Wall



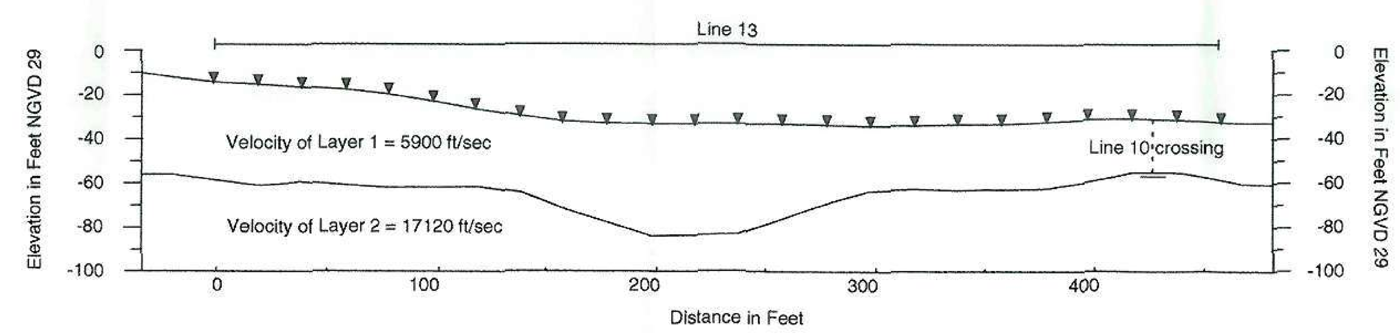
Bedrock Surface Inversion Model Lines 4, 6, 8, & 10
Western Side of the Outer CDF Wall



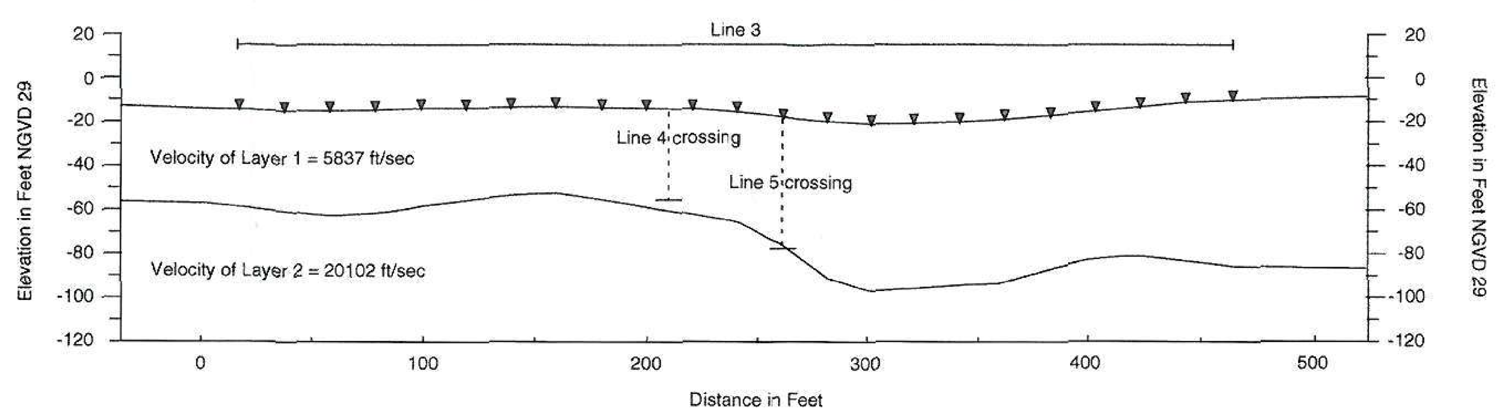
Bedrock Surface Inversion Model Lines 1 & 2
Outer Edge of the Northern CDF Wall



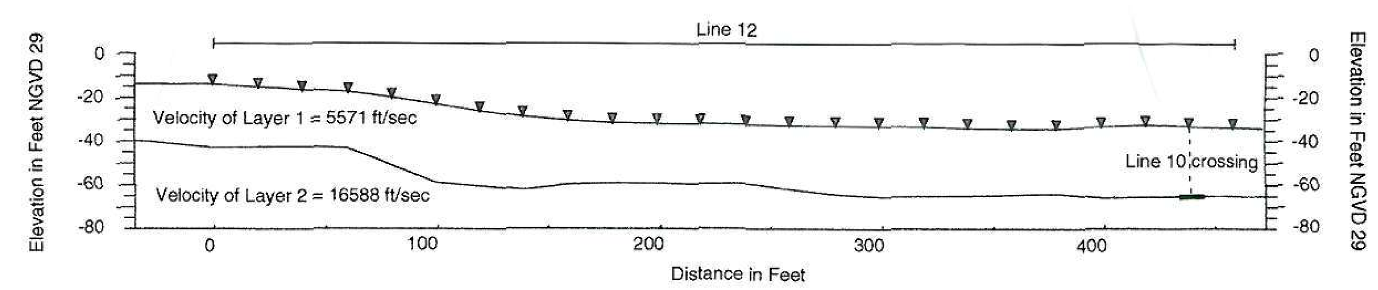
Bedrock Surface Inversion Model Line 13
Inner Edge of the Southern CDF Wall



Bedrock Surface Inversion Model Line 3
Inner Edge of the Northern CDF Wall



Bedrock Surface Inversion Model Line 12
Outer Edge of the Southern CDF Wall



Legend

- ▼ Hydrophone Locations
- FD-1 ↓ Boring Locations
- Line 1 crossing — Seismic Line Intersections
- SIPT 2 Bedrock Surface
- Inferred Bedrock Surface
- LVZ — Low Velocity Zone (an area of anomolously low bedrock velocity)

Vertical Exaggeration = 1:1

1 inch = 50 feet

USACE, New England District

New Bedford Harbor
New Bedford, MA
CDF D

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Figure 3
SIPT 2 Inversion Models

FWENC Geophysics

USACE, New England District

New Bedford Harbor
New Bedford, MA
CDFD

Figure 2
Marine Seismic Refraction Line Locations

FWENC Geophysics

DRAFT

REPORT OF
MARINE GEOPHYSICAL SURVEYS: SEISMIC REFRACTION, SUB-AQUEOUS DISPOSAL CELL FEASIBILITY STUDIES, NEW BEDFORD HARBOR-2001
New Bedford, Massachusetts

December 2001

Prepared for:
The Maguire Group
Foxborough, Massachusetts

Prepared by:
Apex Environmental, Inc.
Brookline, Massachusetts

Revision	Date	Prepared By	Approved By	Pages Affected
0	12/13/01	T. Mannering	J. Borkland	All

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1.0 INTRODUCTION

This "Report of Marine Geophysical Surveys: Seismic Refraction, Sub-aqueous Disposal Cells Feasibility Studies, New Bedford Harbor-2001" was prepared by Apex Environmental, Inc. (Apex) for The Maguire Group, Inc. (Maguire). Apex is supporting Maguire in its completion of feasibility studies concerning proposed Confined Aquatic Disposal (CAD) cells in New Bedford Harbor for Massachusetts Coastal Zone Management (MACZM). MACZM is assessing the feasibility of locating a CAD cell or cells in New Bedford Harbor in order to alleviate the shortage of permanent dredge spoils disposal sites in the area. Two discrete areas of interest within New Bedford Harbor are being assessed by MACZM and Maguire as potential CAD sites: Popes Island North Area, located northeast of Popes Island in New Bedford Harbor; and the Channel Inner Area, located north of Palmer Island in the lower portion of New Bedford Harbor (see Figure 1). The marine geophysical study described in this report covers these two areas.

The results of previous studies (Foster Wheeler, 2001) had indicated that the bedrock surface beneath New Bedford Harbor was somewhat irregular, and that it would be unlikely that drilling data alone would be sufficient to characterize the bedrock surface to the extent desired by design engineers. Therefore, the supplemental geophysical program described in this report was undertaken to provide supporting information and data on the topography and character of the bedrock surface within the survey area.

The objective of this Marine Geophysical Investigation was to detect and map the surface of bedrock beneath the harbor bottom along survey lines in the areas of the proposed CAD cells. The geophysical data on top-of-bedrock was required as part of pre-design feasibility studies, and the data was utilized by Maguire in the determination of the capacity of the proposed cells.

1.1 Background

The geologic setting of New Bedford Harbor has been summarized in previous studies by several investigators. Apex reviewed numerous documents prior to commencing geophysical operations in the harbor, in order to obtain background information concerning the general geologic regime present in and around the Site. Among the documents and reports reviewed as part of background information data gathering were: various reports related to the New Bedford Harbor Superfund Site; *The Bedrock Geology of Massachusetts* (Hatch, N.L., ed., 1991); and *The Bedrock Geologic Map of Massachusetts* (Zen, 1983). A full list of the references reviewed by Apex is included as Section 6 of this report.

The bedrock regime of the greater New Bedford Harbor area (including Fairhaven and Acushnet) is composed of the gray granitic gneiss known as Alaskite Gneiss, (Zen, 1983) described as a 'light gray and pinkish-gray to tan, mafic-poor gneissic granite (and granitic gneiss) commonly containing muscovite'. The bedrock encountered in cores within the harbor area (Foster Wheeler, 2001) is a dark to light gray, massive, hard, salt and pepper granitic gneiss similar to other hard bedrock materials found within the Tertiary to Proterozoic Age Milford-Dedham (Geologic) Zone. The gneissic rock encountered in bedrock cores taken from the study area also contained bands and veins of pegmatitic and quartzitic late-stage intrusive materials, evidence that fracturing within the area was followed by late-stage intrusive influx. The Alaskite Gneiss is moderately fractured (Zen, 1983), with the primary fracture orientation north-northeast to south-southwest in this area. Secondary fractures have been noted (Goldsmith, 1978), which trend in an east-westerly direction. The fractures tend to be high angle (between 60 and 90), and are generally filled either with (quartzitic or pegmatitic) solidified late stage fluids (as "healed" fractures), or with silt (as "open" fractures).

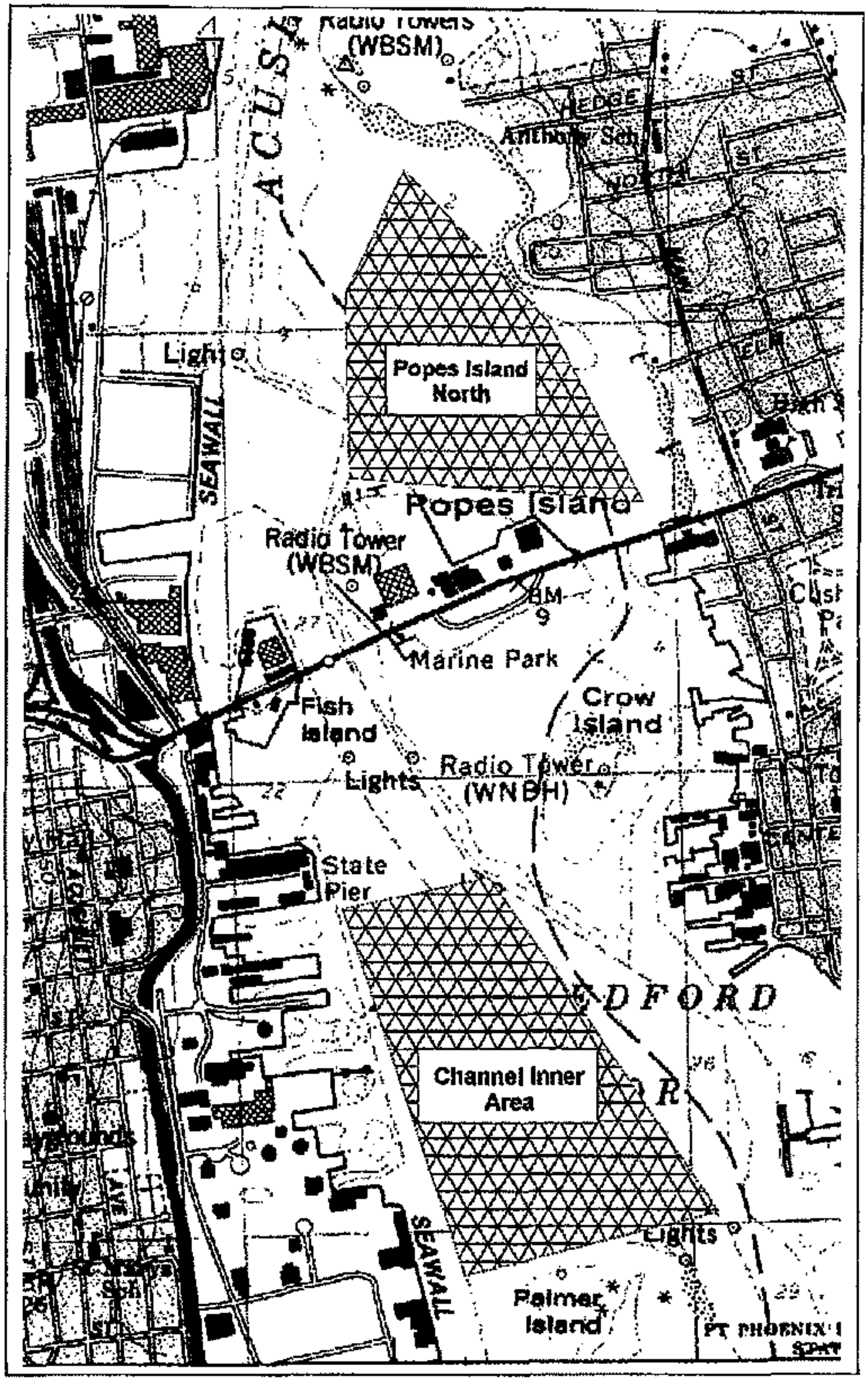


Figure 1. Survey Location Plan

Above the bedrock surface, the sediments of New Bedford Harbor consist of a mixture of marine, glacial, and post-glacial sediments. This area is characteristic of the southern New England marine/glacial sequence that developed upon the retreat of the glaciers at the end of the Pleistocene. The lowest unconsolidated strata in the sequence found at New Bedford Harbor includes a sporadically present glacial till, which consists of a dense mixture of coarse to fine materials with silt, clay, cobbles, and some boulders; and glacial outwash deposits, consisting of coarse to fine sands, silts, and gravels, found above the till (where it exists) and above bedrock (where it does not) throughout the harbor area. The outwash deposits show characteristics of rapidly moving water deposition, evidence of high-energy post-glacial fluvial deposition on a broad scale. Braided stream patterns, cut and fill channels, and filled gullies have been identified throughout the region within the glacio-fluvial sediment column (Goldsmith, 1978). In places, the surface of the glacio-fluvial deposits are separated from the overlying marine deposits by an erosional surface.

The marine sediments (generally found above the glacio-fluvial sediments) consist of poorly graded sands, gravels, silts and clays, sometimes containing shell hash and sometimes displaying seasonal varving. Sandy and gravelly marine deposits represent higher energy beach areas, whereas silts and clays are indicative of deeper and calmer water deposition. These various marine deposits are overprinted on one another throughout the sediment column, suggesting that post-glacial variations in sea level within the harbor area led to complex marine and estuarian depositional regimes.

In some areas, erosional surfaces may exist above the historical marine sediments as well, as evidenced by the presence of peat deposits detected in some borings (conducted by others) in the harbor. The uppermost sedimentary units within the harbor exist as modern estuarian and shallow marine deposits. In deeper water, lower energy areas, these sediments exist as a thick muck layer, consisting of a mixture of silt, fine sand, and decaying organic material (and often contain biogenic "gas" pockets, the residuals of the decomposition process). In shallower areas, the recent bottom sediments may consist of coarser sands and shell hash, indicative of the presence of a higher energy environment.

1.2 Purpose

The work conducted as part of the geophysical program was undertaken to characterize the bedrock surface in the two proposed areas for the potential CAD cells. Seismic refraction data was collected in an attempt to better understand the nature and character of the bedrock surface beneath the sediments in the area of the proposed CAD cells. The seismic data was used in conjunction with boring data to develop a model of the shape and character of the bedrock surface below the sediment in the survey areas. Ultimately, the bedrock character data was used by Maguire in assessing the capacity and feasibility of the proposed CAD cells.

1.3 Approach to the Report Presentation

This report is organized by sections that provide a functional framework for the presentation of the information that was gathered during the work. The following provides an outline of the approach to the presentation of the information.

Section 1.0 (Introduction) includes introductory information, which describes the contractual framework for the program, and the background information. Section 1.1 includes the historical and published geologic framework of the study area upon which the information gathered as part of this investigation is built.

Section 2.0 (Methods) describes the means and methods by which the information was collected, processed and interpreted. This section includes the equipment used to collect the data, along with a definition of the study area, and a description of the data collection, data processing, and data interpretation procedures undertaken.

Section 3.0 (Results) describes the findings of the Seismic Refraction investigation. This section also includes a discussion of the maps generated as part of the seismic data reduction process.

Section 4.0 presents the conclusions of the investigation, including an assessment of the overall geologic findings for the study area, which describes the big picture as determined from the data collected. Section 5.0 presents the Limitations of the program, and Section 6.0 provides a list of references cited throughout this report.

2.0 METHODS

The geophysical method used for this characterization was Marine Seismic Refraction surveying. The survey consisted of a number of seismic lines designed to cover the proposed locations of the two potential CAD sites. The work was performed from survey boats outfitted with the necessary equipment for high quality marine seismic data collection. Apex provided qualified shipboard geophysicists to oversee the collection of the data and operate the seismograph equipment.

Apex geophysicists performed the geophysical survey design, collection oversight, data reduction, and data interpretation for the Marine Seismic Refraction program. Specialty subcontractors with appropriate licenses for the special project requirements assisted in the collection of the geophysical data. The subcontractors utilized to assist with the Seismic Refraction data collection included:

- CR Environmental, Inc. of Falmouth, Massachusetts, providing the survey vessel and US Coast Guard licensed captains for the work, and
- Northeast Geophysical, Inc. of Bangor, Maine, who provided a licensed blaster and assistant for the work.

The survey consisted of 23 seismic refraction spreads: ten refraction spreads collected in the Popes Island North Area; and thirteen spreads in the Channel Inner Area. Each refraction spread consisted of 48 channels, with a nominal hydrophone spacing of 30 feet, such that each spread measured approximately 1410 feet in length. Small seismic charges are emplaced into the sediment of the harbor bottom to provide seismic energy. For this survey seismic energy was generally initiated from both ends of each seismic spread and from "off-set" points off each end of each seismic spread, with three additional shots along the line (located near hydrophones 12, 24, and 36), for a total of seven shot points per seismic spread.

2.1 Marine Seismic Refraction

The following sections describe the equipment used for the Seismic Refraction survey, the data collection methods, and the data processing and data interpretation methodologies for all aspects of the marine geophysical survey.

2.1.1 Equipment

For this marine geophysical survey Apex utilized state-of-the-art equipment, including precision marine navigation, Side Scan Sonar, and a digital seismograph for seismic data recording. The equipment specifications are noted below:

<u>Geophysical Equipment Used</u>

- A Digital 48 channel OYO DAS-1 signal enhancement Seismograph with a Mitchum Industries hydrophone bottom sensor array (a "bay" cable), capable of supporting 48 channels of data collection;

- A Trimble Pro XRS Digital Sub-meter Accuracy DGPS;

- Digital Navigation Software for DGPS integration with real-time steer-to navigation for target and way-point navigation capability (HyPak software); and

- An EG&G DF-1000 Digital Side Scan Sonar with the 560 Topside, coupled to a PC running SonarWizz V2.08c data collection and processing software.

HyPak, a digital navigation software package for DGPS integration which allows real-time steer-to navigation and target and waypoint capability, was used during the payout of the hydrophone "bay" cable to ensure accurate cable and shot point positioning.

2.1.2 Study Area

Marine geophysical data was collected in two separate areas: Popes Island North located North of Popes Island; and the Channel Inner Area located northwest of the hurricane dike within Lower New Bedford Harbor. These two areas correspond with the potential locations of proposed Confined Aquatic Disposal (CAD) cells. The Seismic Refraction data were collected from stationary vessels via a hydrophone cable stretched out on the bottom of the harbor. Twenty-three spreads were collected in the two areas of the harbor; ten spreads were located in the Popes Island North area, and thirteen spreads were used in the Channel Inner Area. All spreads were located in the area of the possible CAD cells as identified by Maguire engineers (See Figure 2). The following seismic lines were surveyed, for a total of approximately 32,430 lineal feet of data collection:

Ten survey spreads in the Popes Island North area as follows:

- Two survey spreads along the eastern-most edge of the possible CAD cell;
- One survey spread along the western-most edge of the proposed CAD cell; and
- Seven approximately east-west trending survey spreads, spaced 400-600 feet apart.

Thirteen survey spreads in the Channel Inner area as follows:

- Two survey spreads along the eastern-most edge of the possible CAD cell (eastern edge of the navigational channel);
- Two survey spreads along the western-most edge of the possible CAD cell;
- One survey spread along the western edge of the navigational channel north of Palmer Island; and
- Seven east-west trending survey spreads, spaced 400-600 feet apart.

Each survey spread consisted of seven shot points (locations where energy was initiated into the subsurface). The location of the Seismic Refraction survey spreads is shown on Figure 2. Spread locations are depicted as a series of crosses, one cross for each hydrophone.

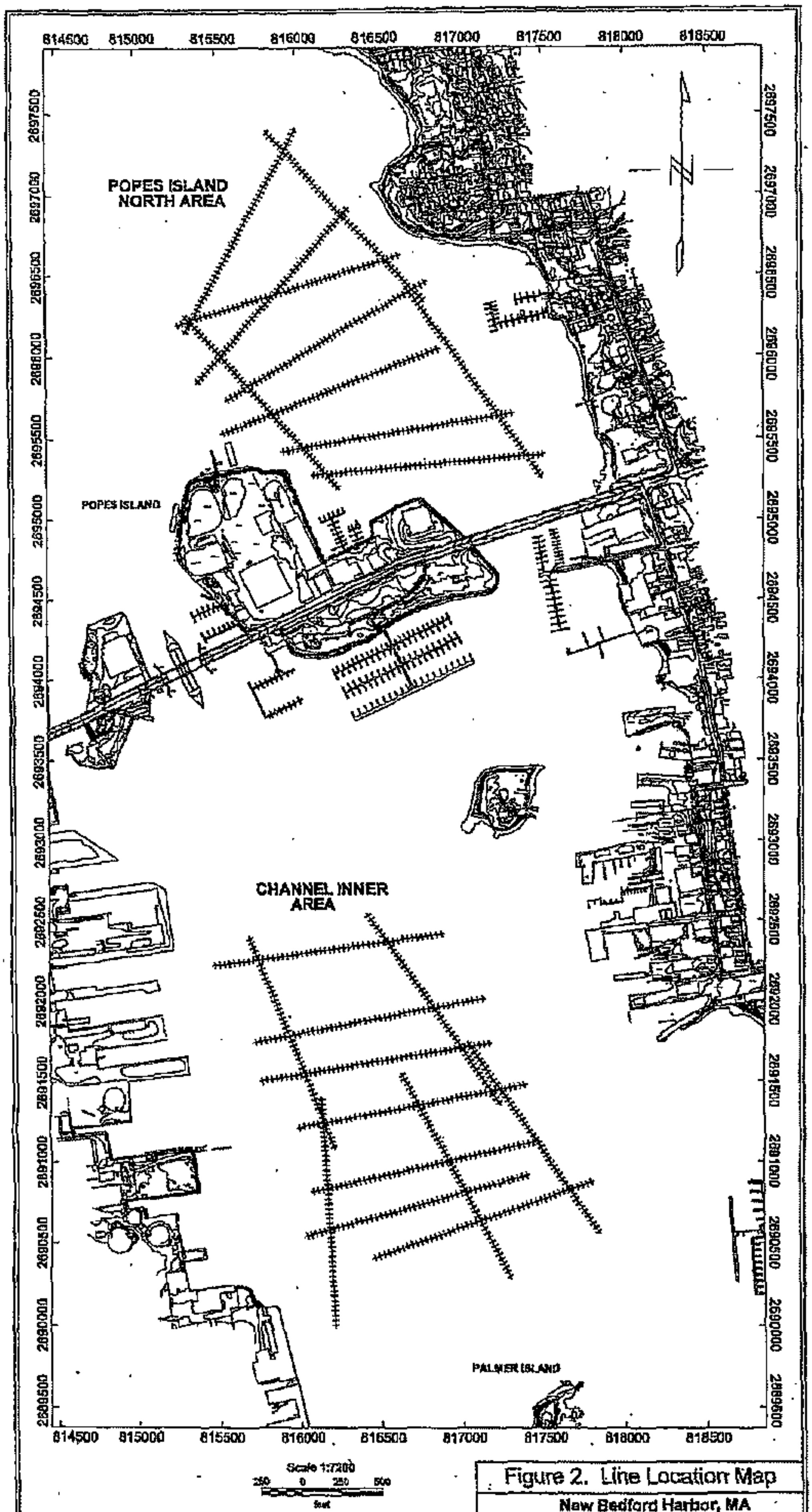


Figure 2. Line Location Map

New Bedford Harbor, MA

2.2 Data Collection

Seismic Refraction data was collected over the proposed CAD cell locations from April 19th through May 11th, 2001. The survey set-up in the harbor consisted of laying out the Mitchum Industries 48 channel, 1410 foot long, hydrophone 'bay' cable, with three anchors attached to it (one at each end and one in the middle) to secure it to the bottom. The seismic refraction cable was deployed from the stern of the seismic recording vessel. Position information was collected while laying out the cable using the steer-to navigation system "Hypak." Real-time X,Y position information was fed into a computer system from the DGPS, which logged the position of the cable as it was deployed. The cable also had specially designed sonar reflectors at phones 1, 24 and 48 to aid in the accurate positioning of the cable using the Side Scan Sonar system. The cable head at one end of the cable was kept on the surface of the water using a large buoy for ease of retrieval and hook-up with the seismic recording system located on the recording vessel.

Once the cable had been deployed onto the harbor bottom, Side Scan Sonar data of the cable position was collected in order to accurately locate the hydrophone cable on the bottom of the harbor. A minimum of two passes per spread were collected, one from each side of the cable, at a water-depth-dependent offset distance (a smaller off-set in shallower water, larger in deeper water) between 25 and 75 feet.

Once the cable was successfully deployed on the harbor bottom, the seismic recording vessel anchored at the end of the hydrophone spread, attached to the cable head, and recorded the seismic data. The seismic shot boat emplaced the seismic charges at pre-determined locations on the harbor bottom using an emplacement tool specially designed for the purpose. All cable and shot point locations were surveyed using DGPS.

For this survey, a single 48 channel 'bay' cable was used. The hydrophone array was connected to the 48 channel OYO DAS-1 digital recording seismograph via a cable head adapter. Hydrophones are highly sensitive transducers that generate a voltage that is proportional to changes in pressure caused by the passing of a seismic wave (i.e., a pressure wave propagating through a medium such as the mud of the harbor bottom). The OYO DAS-1 seismograph collects data digitally and prints out records via a built-in thermal printer. A minimum of two copies of each record were printed out in the field as a back up for the digital data, as well as for initial field interpretation. The seismograph recorded the voltage generated by each hydrophone on the harbor bottom immediately after initiation of a seismic "shot", and displayed the result as a "wiggle trace" (or waveform) for each channel, with the amplitude of the waveform proportional to the strength of the seismic pulse received. Ideally, the seismic signals received from the subsurface are stronger than background noise present in the water column in the area. Vibrational background "noise" (from the fishing fleet and on-land machinery working adjacent to the harbor) was common within the Lower New Bedford Harbor survey area, complicating the data processing, as well as the interpretations rendered, in that area. While background noise did affect the data in some areas, in general the data collected was of excellent quality, and in only a few cases did the background noise overwhelm the seismic signal to the point where the data from a particular hydrophone could not be interpreted. These "noisy" hydrophones were "zeroed" out (not used during processing) in the processing of the data.

The seismic energy was provided by small electrically-primed seismic energy charges consisting of an encapsulated, two-stage, chemically accelerated, physically actuated energy source. These energy capsules were buried into the harbor bottom sediments 18" to 36", and were covered by a ½ inch thick steel plate in order to promote maximum coupling of the energy with subsurface. This approach to the energy initiation maximizes the amount of energy that can be transmitted into the subsurface per shot, which overrides the effect of the biogenic gases in the subsurface.

The OYO DAS-1 seismograph was used to collect the data, to store the data digitally on disk, and to produce "hard copy" records of the data, which were printed out in the field via the built-in thermal printer. The seismic records displayed the "wiggle trace" of each hydrophone recording data (in this case 48 hydrophones). The "wiggle trace" voltage fluctuations were recorded with respect to the time (in milliseconds) after the seismic shot was initiated. In this way, the time for the first energy pulse (known as the "first break") occurring at each hydrophone was recorded. Selected example seismograph records are included in Appendix A.

2.3 Data Processing

The data processing for this study was performed using state-of-the-art, well-tested software. Processing was completed using the USGS seismic interpretation software known as "SIP" (which stands for 'Seismic Interpretation Program'). This software is a standard recognized by the industry and has been used by the United States Geological Survey (USGS) for many of the seismic refraction applications completed by the government.

2.3.1 Side Scan Sonar

One of the first pieces of data to be processed was the Side Scan Sonar data. The results of the Side Scan data processing produced accurate geo-referenced positions of the hydrophone cable lying on the harbor bottom; data that is critical input information for the seismic refraction interpretation program (SIP)

The Side Scan Sonar data was processed using SonarWizz software V 3.07; mosaics of the data were generated with the SonarWeb 3.07 software package. The highest quality Side Scan data were used to create a "mosaic" of the harbor bottom, in which the deployed cable could be seen on the harbor bottom. The Side Scan mosaic image was geo-referenced, and the position of the cable was obtained by digitizing the Side Scan image at short intervals along the sonar image of the cable. Identifying the positions of the cable middle and ends was simplified because custom sonar reflectors had been attached to the seismic cable in the field (see Illustration 1).

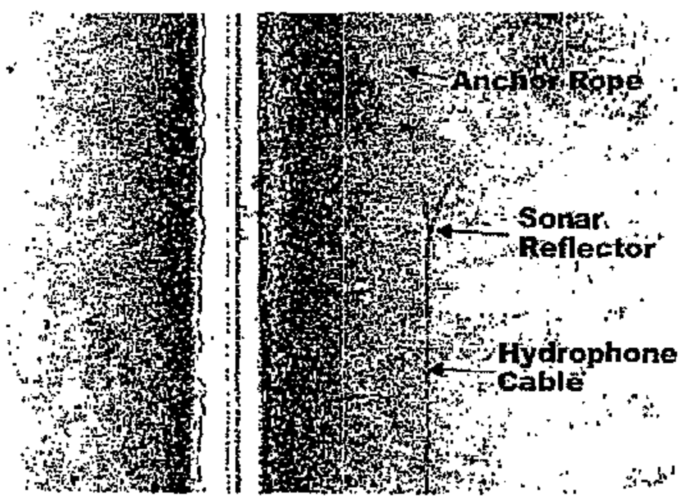


Illustration 1

Sample Side Scan Sonar Image

2.3.2 Seismic Refraction

Data processing began in the field as the data was collected, which enabled the field geophysicists to make changes to the program in the field in order to maximize data quality. Post-processing of the data, resulting in the creation of initial subsurface models, began immediately upon returning from the field. The following steps were followed in the processing of the Seismic Refraction data:

1. Field seismograms were transferred to digital disc media to enable desktop computer processing.
2. The computer program "First-picks" (a module of "SIP") was utilized to enhance and filter the raw seismogram records, including:
   - The data were filtered using a "band-cut" filter to remove high frequency noise which is imparted onto the data by the pressure wave that travels through the water column after a seismic shot; and
   - The gain controls were adjusted until the first breaks of the seismic waveforms were as clear as possible.
3. The "first breaks" of all of the seismic records were then "picked", and a data file of all of the arrival times of the energy first breaks was created for each hydrophone for every shot conducted (usually seven shots per spread).
4. The lateral distance from the shot points to each of the hydrophones was determined by:
   - Producing maps of the DGPS positions of the shots and the Side Scan Sonar spread location; and
   - Time-distance triangulation, using the travel time to the first breaks multiplied by the velocity of water, as calculated from tests performed in the harbor during the survey.
5. The position of each hydrophone on the harbor bottom was determined by analyzing both the DGPS data collected during the deployment of the cable, Side Scan Sonar data collected once the cable was deployed, and the DGPS positions of buoys attached at the ends of the cable.
6. The elevation of each hydrophone along the 'bay' cable was digitized for each seismic spread. The DGPS and Side Scan Sonar data collected in the field during the data collection phase was integrated with maps of the harbor bathymetry produced (and made publically available) by the U.S. Army Corps of Engineers (USACE).
7. The data was then elevation corrected to the harbor bottom by merging the data sets, including the digitized bathymetry (elevation) files for the hydrophones, and the "picked" seismogram waveform files for each spread.
8. From the elevation corrected data, "Time vs. Distance" (see Illustration 2) plots were created using the SIP program, which allows the interpreter to determine the number of layer responses (apparent in the data), which are used by the program to create "layer models".
9. Layer numbers were then assigned to the various layer segments interpreted from the "Time vs. Distance" plots - these layer numbers form the basis on which the model calculates the seismic velocities that it uses in the production of the resultant "depth models".
10. An initial run of the SIP modeling program was conducted using all of the above as input information, and initial resultant depth profiles were generated.

After completing the preliminary runs of the SIP program, the geophysical interpreters identified where inconsistencies in the data sets existed. Inconsistencies occur in the initial runs of seismic models with all of the processing software packages currently in use. The inconsistencies result from three primary sources:

1. The elevation of a particular sensor (hydrophone) along the sensor string is incorrect, either because the sensor has been located improperly along the string, or the bathymetry data in the area of that hydrophone is insufficient.
2. The first energy "break" of the seismic waveform has been incorrectly picked by the interpreter, either because the waveform was "noisy" due to ambient or background vibrations which had interfered with clear signal production, or because the gain control for the waveform was too high or too low.
3. The seismic velocities that were interpreted from the data and were used by the models to create the layer profiles were inaccurate. This occurs primarily because the velocities used by the initial run of the modeling program are chosen automatically by the computer program, which often cannot differentiate between actual lateral velocity changes in the data and "false" velocity profiles which occur when the harbor bottom is not flat; one of the subsurface layers (i.e., bedrock surface) dips; or faults, fractures or other irregularities are present which cause seismic "low-velocity-zones."

Of these, the inconsistencies in velocity represent the largest area for errors found in initial interpreted profiles. A relatively small change in the bedrock velocity chosen for a spread (such as 15,000 ft/sec as opposed to 16,000 ft/sec), can make a dramatic difference in the depth of bedrock interpreted by the model. In order to alleviate errors due to these issues, the data were processed through SIP several times in an iterative fashion. The velocity issues were studied in the further runs of the modeling program, and the inconsistencies were rectified, as were errors resulting from improper initial "picks" or elevation errors.

2.3.3 Calibration Data

Finally, in order to provide the best interpretations possible, calibration data was needed to check the parameters utilized as inputs to the seismic models. The initial un-calibrated models were used to select the best locations for a boring program to provide bedrock elevation calibration data. A geotechnical-drilling program was conducted between June 20 and July 13, 2001 and provided seven calibration points. The geotechnical program involved drilling with a standard drilling rig from a floating barge in the harbor. Samples of soil were collected during drilling using a split-spoon sampler, and rock-core samples were collected of bedrock beneath the sediment using a diamond-bit rock core barrel. Photographs of the rock cores collected are included in Appendix C at the back of this report. Copies of the logs of the borings used for the calibration are included in Appendix D.

Calibration of the SIP models was an iterative process that involved changing the input parameters of layer velocities and "first pick" layer assignments until there was agreement with existing information (boring logs, other SIP models at crossing points, and other geophysical information). The calibration took as many as several dozen iterations to resolve all discrepancies, depending on the data particulars and the line location.

2.4 Data Interpretation

The Rimrock Geophysics software package "SIP2" (which includes the latest version of the USGS SIP program) was used to complete the "first picks" and ray tracing inversion of the seismic data.

Interpretation of the data involved refining models and comparing the seismic data with calibration data, until the most likely model (most reasonable interpretation of data given all input) was found. The objective of the data analysis and interpretation phase was to characterize the responses from the geophysical data. An integrated approach to the analysis and interpretation phase was implemented for this project: data were analyzed and interpreted in association with the lithologic and geotechnical sampling data from the drilling campaign. The computer program Geosoft Oasis Montaj (Montaj) V 5.7, a data processing and analysis (DPA) system for earth science applications, was used to produce color contoured maps for the project. The Montaj software was used to integrate the DGPS, bathymetry and bedrock elevation information onto geo-referenced maps.

Data interpretation involved repeating many of the initial data processing steps described in Section 2.3.2 until the most appropriate best-fit model was generated. For some of the records, the "first breaks" of the seismic records were "re-picked", where the initial "first break" interpretation could be improved in order to achieve a better-fit model.

Another adjustment that was made during interpretation was the modification of hydrophone layer assignments on the "Time vs. Distance" plots (an example is shown in illustration 2), which were created using the SIP program. These layer assignments form the basis upon which the model calculates seismic velocities that it uses in the production of the resultant depth models. Changing the layer assignments revises the morphology of the model, both shape and depth of interface. After numerous iterations, it was determined for this data set that the most accurate models required that all the sections be generated using a two layer case when running the SIP program. Three layer models were attempted for some spreads to see if additional layers (such as the organics or clay layers) could be resolved from the other overburden; however, it appeared that the other layers are either not thick enough or of insufficient velocity difference from the surrounding material to be resolved by the SIP program.

2.5 Data Synthesis

Once all the data had been interpreted, the process of synthesizing all the data sets into one composite interpretation was undertaken. Several data sets were involved (the seismic refraction results, the boring program results, boring information from previous explorations conducted in the harbor, as well as other published geologic data), and the synthesis of the data involved the fusion of these multiple data sets. A direct merging of the data sets and resulting interpretations was not possible; however, as the data sets each were considered to have different confidence levels. Therefore, the first step in the data fusion process was to create a tiered hierarchy of the confidence of the data sets. Most weight was placed on the data with which the geophysicists had the highest confidence, less weight was placed on data that the geophysicists felt they did not have as high a confidence. The data with the highest confidence became the basis by which the final composite interpretations were made. Other data, having lower confidence factors, were then included in the final interpretations of the data in order to fill in data gaps or to add detail to the interpretations.

As with other phases of the process, the synthesis of all the data (historical, geotechnical and geophysical) into a composite interpretation was conducted in an iterative fashion. A basic interpretation was formed from the data with which the geophysicists had the highest confidence. Contour plans of the bedrock surface were generated based upon this high confidence data. These contour plans were then compared to regional geologic maps in an attempt to identify trends in the data that matched with mapped or known trends in the bedrock geology of the area. Slight modifications were then made to the initial interpretations so that the trends resulting from the data were consistent with published information and made sense geologically and geophysically. Finally, the lower tier confidence level data were folded into the interpretations. In some cases the data points were added to the interpretive maps one at a time, so that their effect on the overall models and interpretations could be gauged.

3.0 RESULTS

The following sections describe the results of the Seismic Refraction field survey, as well as the results of the data processing and interpretation of the data collected over the areas of the proposed CAD cells.

3.1 Seismic Refraction

The Seismic Refraction survey was successful in profiling bedrock characteristics at the Site. The advantage of having the sensor array and energy source directly on and in the sediment was apparent in the clear "first breaks" on the seismic records (see example instrument printout in Appendix A) that were obtained from the areas that had proven difficult with other geophysical methods.

As part of the interpretation and analysis of the seismic data, Apex geophysicists studied the Time vs. Distance graphs generated from the processed geophysical data to determine the most appropriate layer model to run final interpretations on. An example of a Time vs. Distance graph for one of the seismic spreads collected from the Popes Island North area is depicted in Illustration 2 below. The Time vs. Distance plot is a graphical means of displaying seismic data, allowing an interpreter the ability to identify the correct number of distinct geologic layers that should be incorporated into the computer models used to compute layer depth estimates. Layers are identified on the Time vs. Distance graphs by "inflection points" in the straight line trends, where a segment of points changes slope from longer-time – per-relative-distance to shorter-time-per-relative-distance (see Illustration 2).

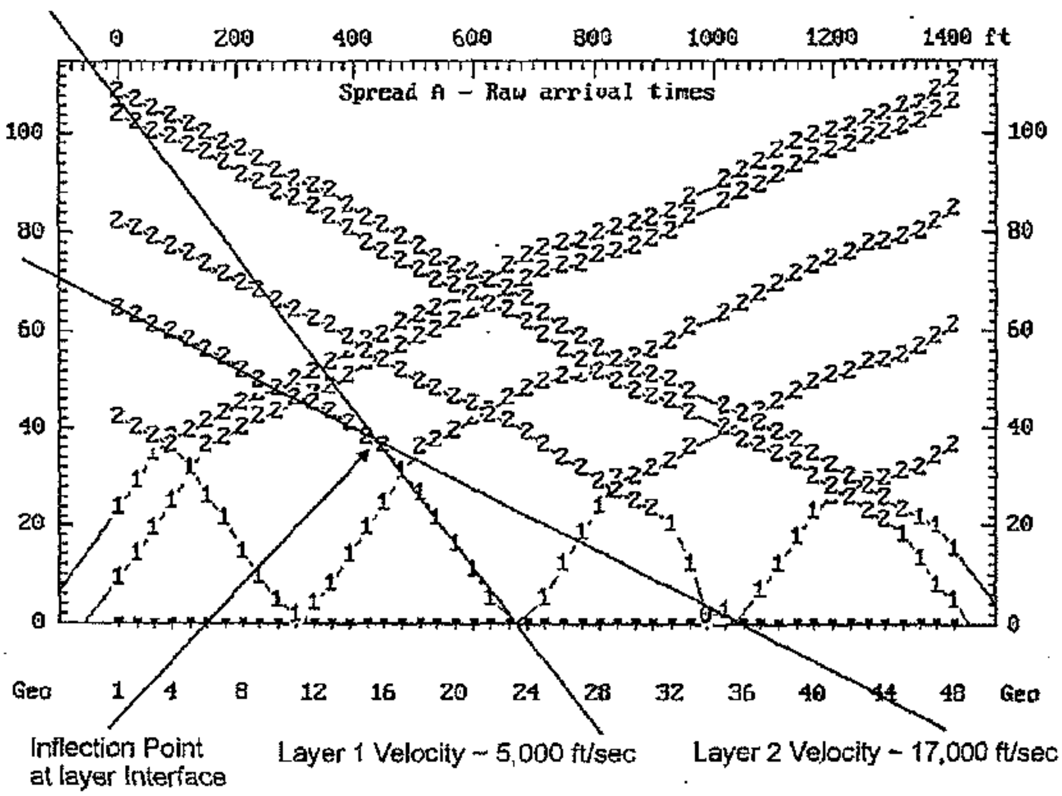


Illustration 2
Time-Distance Plot Example

Apex geophysicists reviewed the Time vs. Distance graphs for all of the seismic spreads to see if it was possible to discern a 3-layer geologic model (i.e., clayey marine sediments, glaciofluvial sediments, bedrock) from the data. After review of the Time vs. Distance graphs, it was concluded that the data would support a two-layer model of the geology (i.e., unconsolidated sediments overlying bedrock), but would not support a three-layer model (see Illustration 2 for a depiction of the two layers discernible). The implication of this observation is that the seismic refraction technique in this instance was unable to resolve multiple sub-layers (such as a clay layer within the unconsolidated sediments), but that a reasonable depiction of the depth to bedrock through the unconsolidated zone was resolved.

Profiles generated from the data, using the subsurface modeling software package SIP2, indicated that the bedrock character in both areas of interest is irregular, marked by undulations of the bedrock surface. The results of the seismic refraction program are best conveyed as contoured surface maps of the bedrock as determined from the interpreted seismic data. Figures 3 and 4 depict the results of the seismic data interpretation for Popes Island and Channel Inner area respectively. The figures display the inferred top of bedrock surface as determined from the seismic refraction data as a color-coded contour elevation (referenced to NGVD29), in order to aid in the identification of trends in the surface (i.e., blue areas are deeper and red/pink/orange areas are shallower). The location of borings used to "calibrate" the seismic interpretations is also shown on these figures. The bedrock models were calibrated such that the elevation of bedrock, at any given line crossing, is within three feet at line intersection points.

The "highest" bedrock surface elevation noted in the Popes Island North Area is in the range of –28 feet NGVD29. The "lows" in the bedrock topography, noted from the data within the possible CAD footprint are in the –95 foot range, NGVD29. The mean elevation of the bedrock surface in the Popes Island North area is –65 feet, NGVD29. (See Figure 3). The "highest" bedrock surface elevation noted in the Channel Inner Area is in the range of –35 feet NGVD29. The "lows" in the bedrock topography, noted from the data within the possible CAD footprint are in the –66 foot range, NGVD29. The mean elevation of the bedrock surface in the Channel Inner area is –53 feet, NGVD29. (See Figure 4).

3.2 Synthesis of Geophysics with the Geotechnical Boring Program

A limited number of pre-survey borings were available from historic sources (see Section 6.0) within the two survey areas. The geophysical data from the Seismic Refraction program was processed and interpreted with the historical geotechnical boring information, as well as that collected as part of this program within the two areas of interest. Where the seismic lines crossed directly over a boring location, the boring data was utilized to calibrate the depth of bedrock models generated as part of the seismic data processing. Borings were generally not used for calibration of seismic models if the boring data was located some distance from the seismic line (for this project, borings located more than approximately 60 feet from a seismic line were not used in the calibration of that seismic line, but were used by the contouring programs in the generation of the bedrock surface).

The following geotechnical borings collected as part of this program were utilized in the calibration of the following seismic lines (See Figures 3 and 4 for locations).

- Seismic Line 20 & 3 = boring NBH-1 (-90.2 feet)
- Seismic Lines 4 & 5 = boring NBH-2 (-63.8 feet)
- Seismic Lines 1, 2 & 7 = boring NBH-3 (-61.7 feet)
- Seismic Line 11 = boring NBH-4 (-58.5 feet)
- Seismic Lines 13 & 15 = boring NBH-5 (-48.1 feet)
- Seismic Line 16 & 19 = boring NBH-6 (-54.6 feet)

- Seismic Lines 7, 18 & 21 = boring NBH-7 (-62.7 feet)

The calibrated seismic lines and selected borings were incorporated into a single interpretation of the bedrock surface (see Figures 3 and 4). The bedrock surface was created by incorporating lines of bedrock elevation data (along the seismic profiles) with spot elevation data (from the selected borings listed below as well as elevations obtained from the calibration borings noted above), and gridding and contouring the resulting merged data set.

Additional historic boring information (Ebasco, 1988) used in the contouring process to create the bedrock surfaces including the following borings;

- Boring BW-103 (-34 feet)
- Boring BW-104 (-39 feet)
- Boring BW-109 (-52 feet)
- Boring BW-110 (-72 feet)
- Boring BW-111 (-79 feet), and
- Boring BW-112 (-49 feet).

3.3 Volume Calculations

Utilizing cell configuration parameters provided by Maguire Group engineers, and the results of the seismic refraction survey, Apex performed preliminary volume calculations for both the Popes Island North and Channel Inner Areas. Calculations were performed using the US Army Corps of Engineers (USACE) bathymetry surface, and the seismic refraction bedrock surface elevation calculated as part of this program. In calculating the volume of each cell, an approximate slope of 3:1 was assumed.

It should be noted that the bathymetry data obtained from the USACE was supplied to Apex as a sorted subset of the shallowest soundings within a 1"=100' paper plot, and as such provides only an approximate pre-engineering cell top elevation surface. Possible artifacts or errors may also exist in the Seismic Refraction surface due to the contouring algorithms that extrapolate the data between successive survey lines. In order to account for these uncertainties, contingency volumes have been incorporated into the various volume estimates. The volume calculations completed for this program, along with the relevant contingency volumes, are presented in the subsections below.

3.3.1 Popes Island Area

Volumes were calculated using five cell configurations in the Popes Island North Area. Cell 1 incorporates all of the area of the Seismic Refraction footprint. Cell 2 and Cell 3 comprise of the eastern, and western halves of the Seismic Refraction footprint respectively. Cell 4 is the northern and Cell 5 the southern portion of the Seismic Refraction footprint. A separation distance of 100 feet was maintained between Cells 2 and 3 and Cells 4 and 5. Figures 5A and 5B show the different cell configurations. A bedrock contingency factor of three feet was assumed, and a loss of volume due to a cap of three feet was also factured into these calculations. Table 1 below summarizes the calculations for the Popes Island North Area.

Table 1. Volumetric Calculations for the Popes Island North Area

POPES ISLAND NORTH	CELL 1	CELL 2	CELL 3	CELL 4	CELL 5
Volume without Contigencies	3614996	1715847	1372450	1226522	1530796
3' Irregular Bedrock Contigency	113610	37779	29997	13056	31389
3' Cap Contingency	235278	121389	105555	87498	136386
Total Volume	3266108	1556679	1236898	1125968	1363021

All volumes are in cubic yards

3.3.2 Channel Inner Area

The Channel Inner Area cell configuration consists of only two cells. Cell 1 comprises the entire Seismic Refraction footprint (see Figure 6); Cell 2 also comprises the Seismic Refraction footprint, but without the southeastern portion of the area.

Irregular bedrock "contingency" (to allow for bedrock irregularities) of three feet was assumed, and a loss of volume due to a cap of three feet was also factored into the calculations. The Channel Inner Area volume calculations are shown in Table 2 below.

Table 2. Volumetric Calculations for the Channel Inner Area

CHANNEL INNER AREA	CELL 1	CELL2
Volume without Contigencies	1618131	1272217.5
3' Irregular Bedrock Contigency	175278	118611
3' Cap Contingency	220278	161943
Total Volume	1222575	991664

All volumes are in cubic yards

4.0 CONCLUSIONS

Marine geophysical investigations were conducted at two locations within New Bedford Harbor during April and May of 2001 as part of pre-design activities undertaken in support of feasibility studies being conducted at two potential Confined Aquatic Disposal (CAD) cells. Seismic Refraction surveying was performed in the study area because it was determined that other geophysical methods (e.g. Uniboom, Sub-bottom Seismic Profiling, etc.) would not yield all the information necessary to support the feasibility effort. The seismic data was augmented by a geotechnical-drilling program conducted in June and July of 2001. The information gained from the geotechnical drilling program was used to calibrate the data profiles generated from the seismic refraction survey.

4.1 Geophysics Program

The survey was conducted in and around possible areas for the proposed CAD cells. A Seismic Refraction exploration seismograph system was deployed in order to obtain information on the bedrock surface within the area anticipated to contain possible CAD cells. The following issues were relevant to the data collection and interpretation for the survey areas:

- These techniques were undertaken because previous geophysical methods had been attempted, and while useful for other purposes, were not particularly successful in achieving the desired result for the particular geotechnical design parameters required;
- Biogenic gas in the sediment (remnants of decaying organic matter), precluded other methods from successful implementation for bedrock profiling. This survey was designed and undertaken in an attempt to overcome the "gas" issue; and
- Vibrational background "noise" (associated with equipment operations at the fish fleet) was common at the western side of the Channel Inner Area, complicating the data processing and interpretations rendered in that area.

The marine seismic data was collected in order to assess the depth to bedrock beneath the two areas proposed as locations for possible CAD cells. Profiles generated from the data using subsurface modeling software indicate that the bedrock character in both areas of interest is irregular, marked by undulations of the bedrock surface.

4.1.1 Popes Island Area

The shallowest bedrock encountered in the seismic data was –28.5 feet on Lines 1 at the northeastern end of the survey area. This is within approximately 500 feet of where bedrock outcrops on Marsh Island. The deepest bedrock, at –95.1 feet, is found on Line 20 where it crosses line 5, at the farthest western edge of the survey area. A possible relict bedrock channel trending northwest to southeast runs through the middle of the survey area. This channel inference is further supported by bedrock surface elevation data to the northeast of the survey area collected by another contractor (Foster Wheeler, 2001) in a report submitted to the USACE. In some places the bedrock elevation varies by as much as 36-feet of elevation change over 120-feet of lateral change (or approximately a 25% slope), indicating that there is some relatively steep bedrock topographic variation within the possible CAD footprint.

4.1.2 Channel Inner Area

The presence of several "Low Velocity Zones" (or "LVZs") was noted on several seismic lines in this area. These anomalies in the data occur at locations where the velocity of the energy wave traveling through the bedrock material is reduced, usually because the bedrock is fractured or severely weathered in that zone. LVZs are often indicators of faulted or severely fractured bedrock, and the locations of the LVZs noted in the data during this study are shown in Figures 3. It should be noted that data in the LVZs may be somewhat subjectively interpreted, as the actual velocity within such a zone can only be determined relatively, and can vary dramatically depending upon the material, the amount of fracturing, and the amount of weathering.

In the Channel Inner Area, the presence of LVZs imply that two north-south trending fracture zones may cross through this area. These fracture zones are evident in the Time-Distance plots for most of the east-west refraction spreads (lines 10, 11, 12, 15, 19, 21 and 22). Fracturing in the rock is made evident on Time-Distance plots as a time offset in the linear normal move-out of first breaks. An example of a Time-Distance plot showing the effects of fracturing is shown below in Illustration 3. In areas of fracturing, void spaces or sediment filled fractures (or even highly weathered rock) create a localized Low Velocity Zone (LVZ). Within these zones, the seismic velocity is much slower than that of the surrounding material. Because Seismic Refraction utilizes time and distance measurements to calculate a bedrock geometry, data that contains LVZ's will tend to imply that a bedrock surface is lower than it actually is (increase in time at a fixed velocity increases distance by the geometric relation T=d/v).

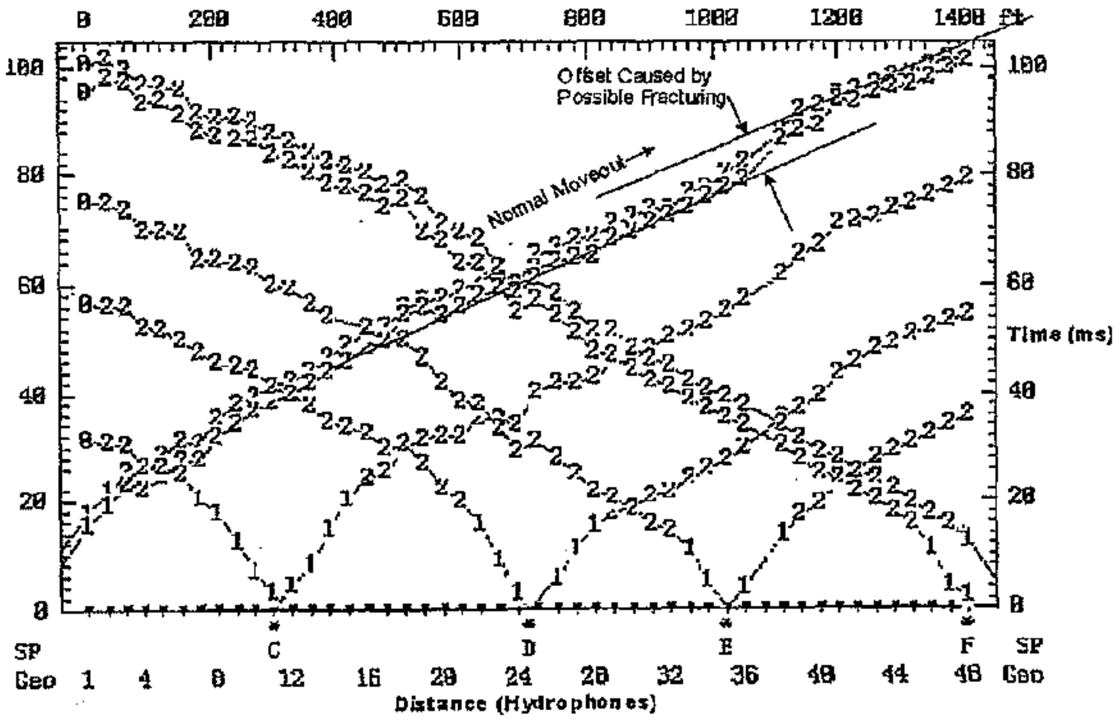


Illustration 3.
Time-Distance Plot Showing Areas of Possible Fracturing

4.2 The Big Picture

The discussions presented above have thus far concentrated upon providing interpretations of the datasets collected within the study areas during the field program. The following paragraphs attempt to present the results of the geotechnical and geophysical investigations conducted at the possible CAD locations within the context of the larger geological setting of New Bedford Harbor. This section represents a synthesis of the information collected and presented as part of this program, coupled with the available historical geologic information and interpretive insights obtainable. It should be noted that this synthesis of information is based upon the data available at the present time, and the appropriate level of care should be exercised in utilizing the synthesized interpretation for specific information needs.

An overall assessment of the bedrock surface topography is presented in Figures 3 and 4. The results of the geotechnical and geophysical investigations are generally consistent with the findings of regional geological investigators (Zen, et. al., 1978). The geologic map of the area indicates that the geologic setting in the vicinity of the study area is dominated by a Gneissic terrane. The literature makes frequent reference to the fact that the New Bedford Harbor region experienced both glacial, fluvial, and marine influences from the period known as the Pleistocene (glacial period) until the present. The bedrock geology is characterized by several large fold structures that have been mapped in the vicinity of the study area, having relatively symmetrical synclinal limbs and east west to northeast-southwest trending axes. According to the Geologic Map of Massachusetts (Zen, 1978), the study area lies between two such fold structures: one just to the north with its axis at the headwaters of the Harbor near the Acushnet-Fairhaven boundary; and one to the south with its axis trending from the southernmost tip of New Bedford toward South Dartmouth. The Popes Island North study area lies in a zone of granitic gneiss that lies between the two folds, but primarily along the outermost limb of the more southerly of the two folds in the region. The Geologic Map (Zen, 1978) also depicts regional faults that run through the area. One of the regional faults mapped in the area appears to trend through a portion of the study area. This fault is mapped as a north-south trending fault extending from East Freetown (to the north of Acushnet) down to and into New Bedford Harbor (with its trend coinciding with the shape of the harbor from approximately the Middle Harbor southward).

The geologic inferences presented in the literature, and noted above, are supported by the geotechnical and geophysical information collected as part of this program. The bedrock surface topography, as modeled from the seismic line and geotechnical boring data, shows evidence of the glacial and post-glacial fluvial/marine period that predates the current period of marine induration. In studying the Popes Island North Area contour map of the bedrock surface elevation (Figure 3), the feature that is most immediately recognizable is the "relict" channel cut in the bedrock (indicated by blue colors on the contour plan). This lineal feature is approximately 250 to 300 feet wide and runs through the study area from northwest to southeast. At its deepest point, the bedrock channel may extend down to as low as elevation –90 feet. This relict channel likely developed as part of the preglacial drainage pattern in the area, or as a result of syn- or post-glacial meltwater action, and was probably scoured by high energy stream action, which cut through the tough granitic gneiss found in the area by following weaknesses in the rock.

In addition to the channel identified in the bedrock surface, the seismic and geotechnical boring data collected as part of this program indicates that the former channel was bounded on either side by steep-sided bedrock scarps and mounds, which overlooked the central river channel. The highest bedrock elevation identified within the study area is located along the top of these scarps near the eastern shoreline and is found at approximately -28 feet.

The Channel Inner Area data shows similar trends as does the Popes Island North Area. Deeper bedrock depths (to –60-feet NGVD) in the center of the survey area appear to roughly outline a relict channel. The former "channel" is bounded on the east, west, and south by shallower rock (to as high as –34-feet NGDV). The rock actually outcrops at Palmer Island, approximately 500-feet south of the study area. Seismic "Low Velocity Zones" and "time-shift" offsets noted on some of the seismic lines collected from the Channel Inner Area support the interference that a series of roughly north-south trending sub-parallel fractures dictated the location of the relict channel (see Figure 4).

The seismic and boring information obtained from the study area strongly supports this inference, as fractured rock is noted in rock cores and on seismic data in patterns that coincide with the overall trend of the relict channel. A north-south trending fracture zone probably defined the location of the bedrock channel that runs through the area, and ultimately led to the shape of this portion of the harbor.

In summary, the data gathered as part of this program was intended to provide detailed information on the character of the bedrock within the two study areas (Popes Island North Area and Channel Inner Area). Both the geotechnical and geophysical data collected enhanced existing ideas as to the general geologic structure and bedrock character within the study area. Several detailed features (i.e., the channel cut into the bedrock surface) were identified as part of this effort. A contour plan of the bedrock surface was prepared utilizing the calibrated seismic refraction data supplemented by geotechnical drilling data. The bedrock elevation surface plan depicts the variations in the bedrock surface that can be expected within the study areas, and will prove useful in the design of structures which require a knowledge of the elevation and character of the bedrock surface.

5.0 LIMITATIONS

The following limitations apply to all geophysical surveys conducted by Apex Environmental, Inc. it's subsidiaries and subcontractors. Every attempt has been made to conduct this survey to maximize the quality of the data collected and the interpretations rendered. However, a geophysical investigation is an indirect method of subsurface exploration whereby subsurface characteristics are inferred or interpreted from measurements collected at the ground or water surface. Many variables may affect these measurements. Due to the indirect, interpretive nature of geophysics, findings are generally considered precursory and subject to verification by more direct methods of investigation such as test borings or test pits. The following limitations are considered when evaluating geophysical data:

1. Subsurface features can be interpreted from the appropriate geophysical methods only insofar as they produce a discernible geophysical signature. They must have adequate homogeneity, size, and appropriate physical or chemical properties sufficient to contrast with the surrounding medium and be within reasonable proximity to the sensors. Additionally, their signature must be distinguishable from and not masked by background noise or interference.

2. Lithologic data inferred on the basis of geophysical data may not be identical to geologic or hydrogeologic data. Lithologies are generally interpreted from some geophysical signature (e.g., velocity differences) that may be the result of many factors (including density, susceptibility, angle to the sensors, amount of weathering, etc.). Lithology divisions based upon seismic velocity for example may not necessarily be identical to lithology changes identified by drilling. The discrepancy is generally related to formation density and/or compaction (i.e., a dense till may have a higher density than a weathered bedrock, and the difference can be difficult to resolve with seismic data).

3. Complex geological configurations may be impossible to resolve with surface geophysical methods. The resolution of geophysical data is limited by the spatial geometry of sensors, strength of signal, and distance of the object or layer of interest from the energy source and the sensor array used. Resulting interpretations are rendered by modeling geophysical response to known or presumed geometric relationships. The complexity of the relationships that can be modeled is limited by the resolution allowed by the method and geometry of equipment layout used, and the limitations of the software used.

4. Apex is not responsible for data quality in areas having excessive "background noise" which affect the specific physical parameters of the subsurface that are being measured by a particular geophysical technique. Examples of background noise include: heavy traffic on a nearby roadway, which induces vibrational energy into the ground which in turn interferes with seismic data collection; heavy machinery (i.e., boat, sand-blaster, or torch) operation adjacent to or in the water near a marine seismic survey line; or underground utilities (such as electric lines, tunnels, sewers, etc.), which can interfere with seismic instrumentation.

No guarantee or warranty (other than that stipulated in the contract under which this work was promulgated), expressly stated or implied, is given concerning the data and interpretations rendered in this report. All information is presented as "for information only." Apex Environmental, Inc., its parent company or any subsidiary, is not liable for any losses resulting from the misuse, misrepresentation, or misinterpretation of any information presented in this report by any person or entity.

6.0 REFERENCES

Goldsmith, Richard, 1978, Geologic Map of the Fall River – New Bedford Area, Massachusetts, U.S. Geological Survey Open File Map 78-484, Department of the Interior, U.S. Geological Survey, publications center, Lakewood, CO.

Hatch, N.L., (ed.), 1991, *The Bedrock Geology of Massachusetts*, publication of the U.S. Geological Survey, USGS - Department of the Interior; Reston, VA, 106 p.

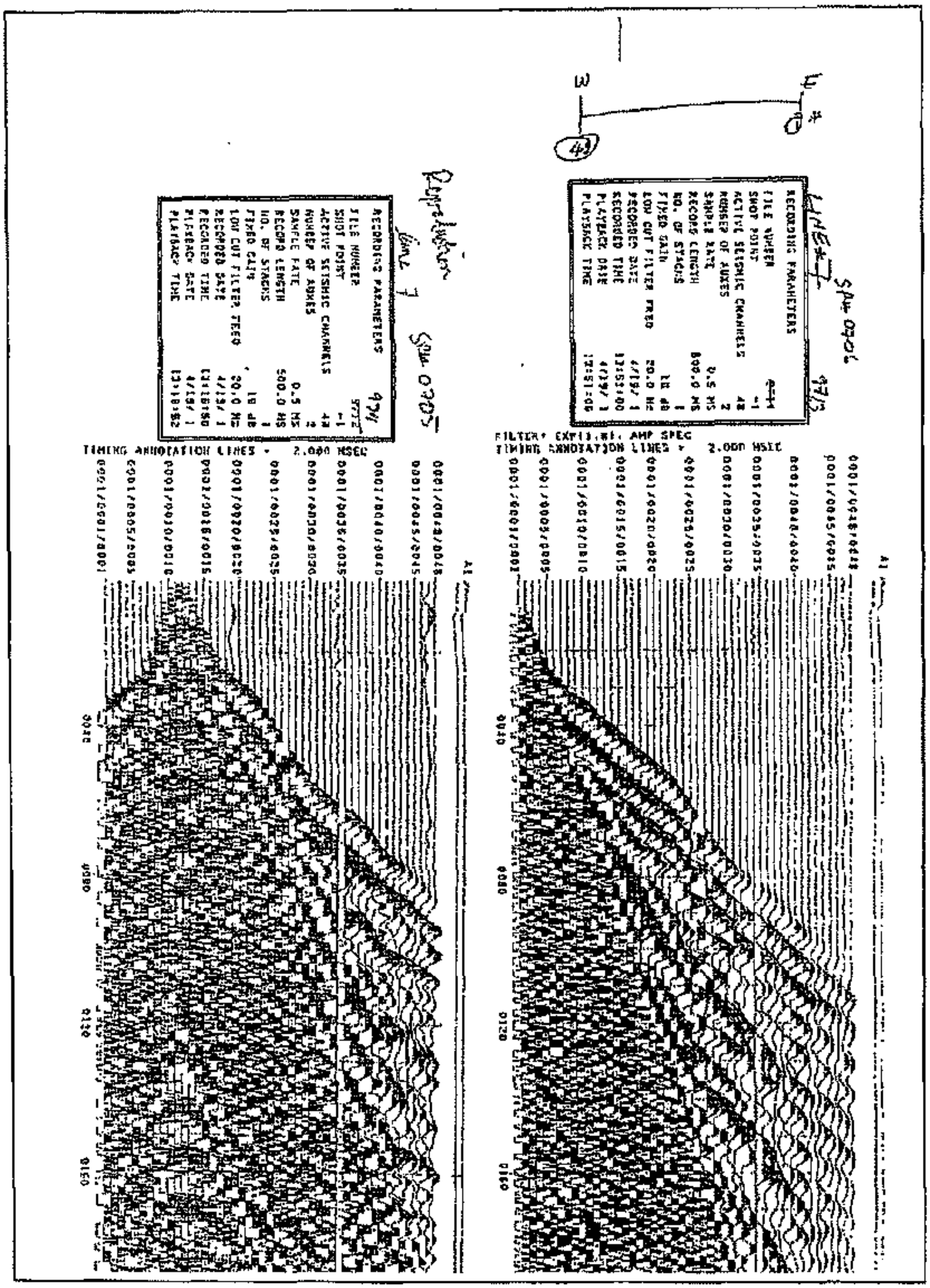
Zen, E-an (editor), 1983, Bedrock Geologic Map of Massachusetts (3 sheets), state Bedrock Geologic Maps publication of the U.S. Geological Survey, U.S. Department of the Interior, U.S. Geological Survey, publications center, Lakewood, CO.

Ebasco Services, Inc. 1988, *Final Draft – Preliminary Geotechnical Investigation of Engineering Properties – New Bedford Harbor*, US Environmental Protection Agency Region I, Records Center, Canal St, Boston, MA.

US Army Corps of Engineers, 1960, *Hurricane Projection Project: New Bedford-Fairhaven Hurricane Barrier (Design Memorandum No.2 Site Geology)*, US Army Corps of Engineers New England District, Waltham, MA.

Foster Wheeler Environmental Corporation, 2001, *Report Of Marine Geophysical Surveys: Phase I Uniboom & Seismic Refraction And Phase II Seismic Refraction, New Bedford Harbor Superfund Site Operable Unit #1*, Foster Wheeler Environmental Corporation, Boston, MA.

APPENDIX A
Example Seismograph Record



APPENDIX B

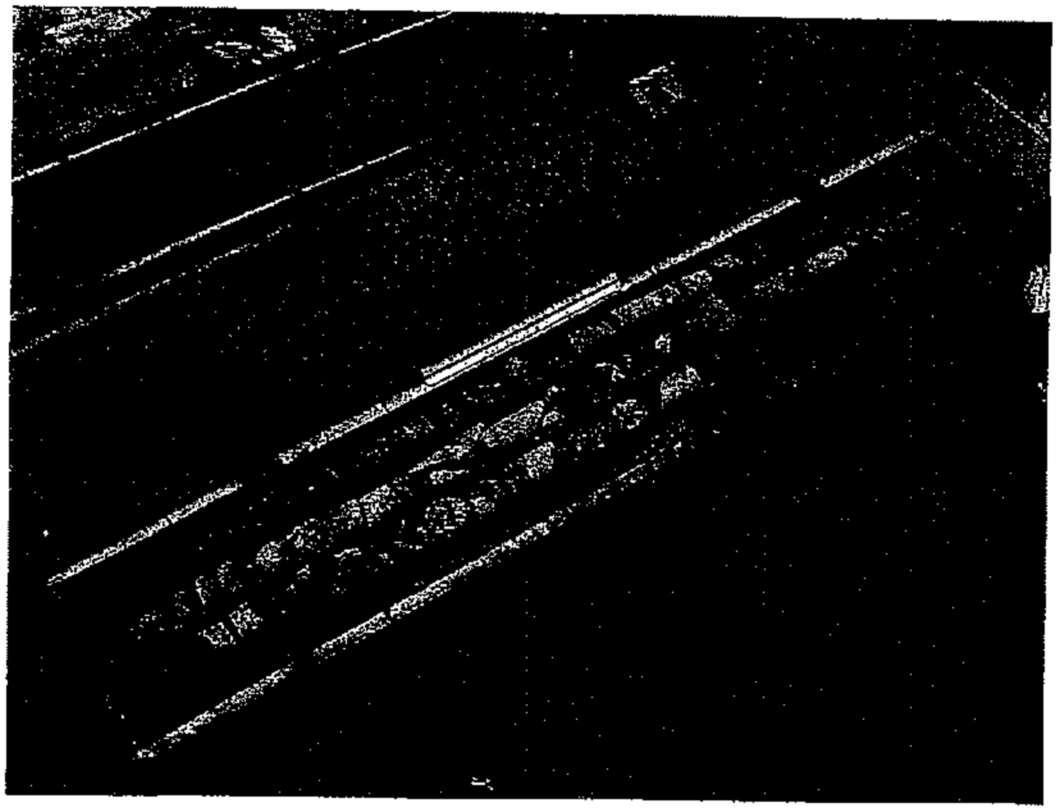
Data CD

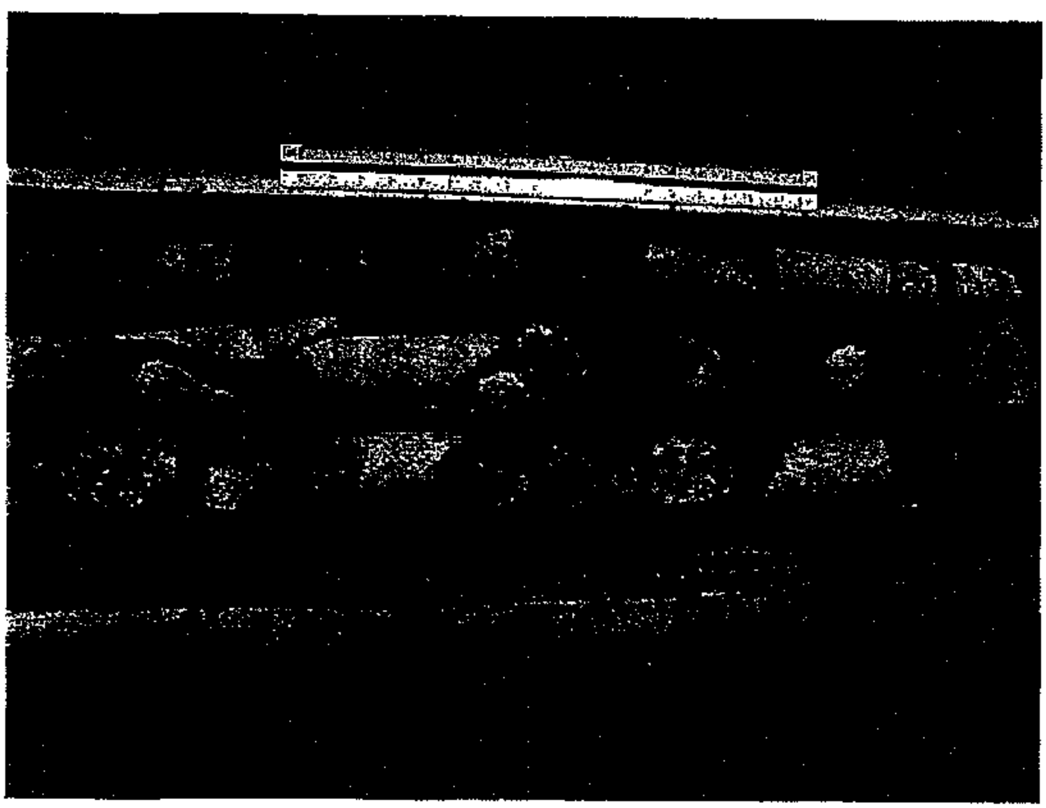
APPENDIX C

Photographs of Rock Cores Used for Seismic Calibration

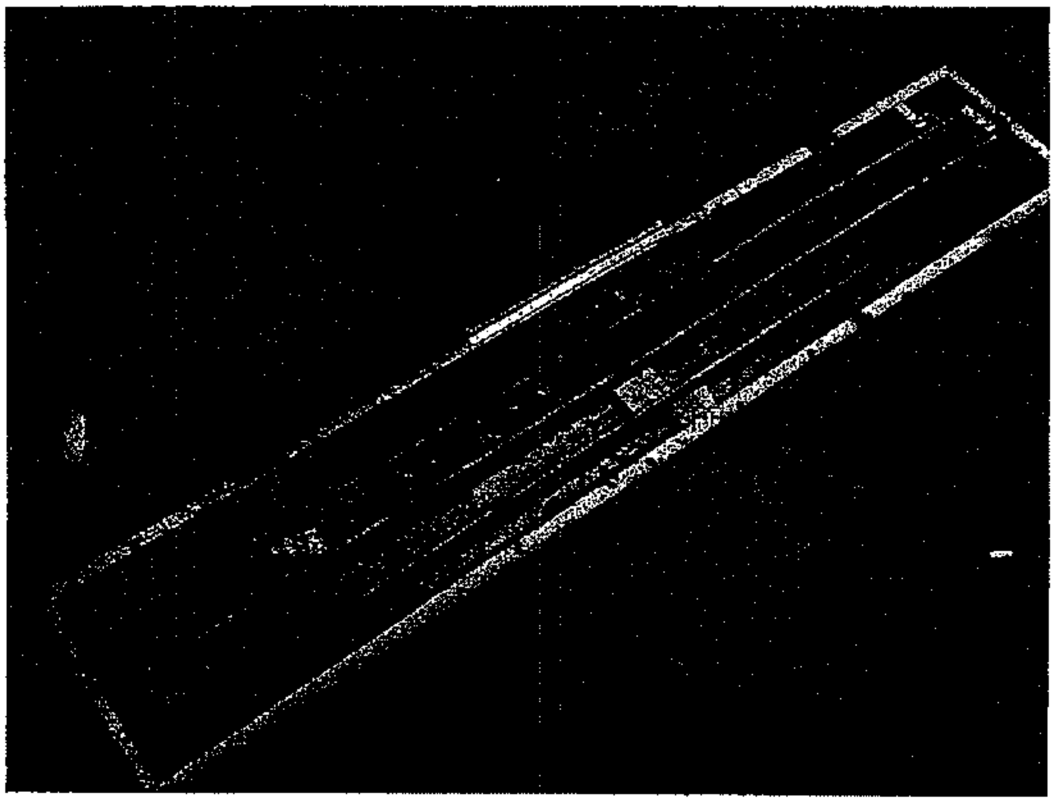
(Borings collected by The Maguire Group as part of the DMMP feasibility study)

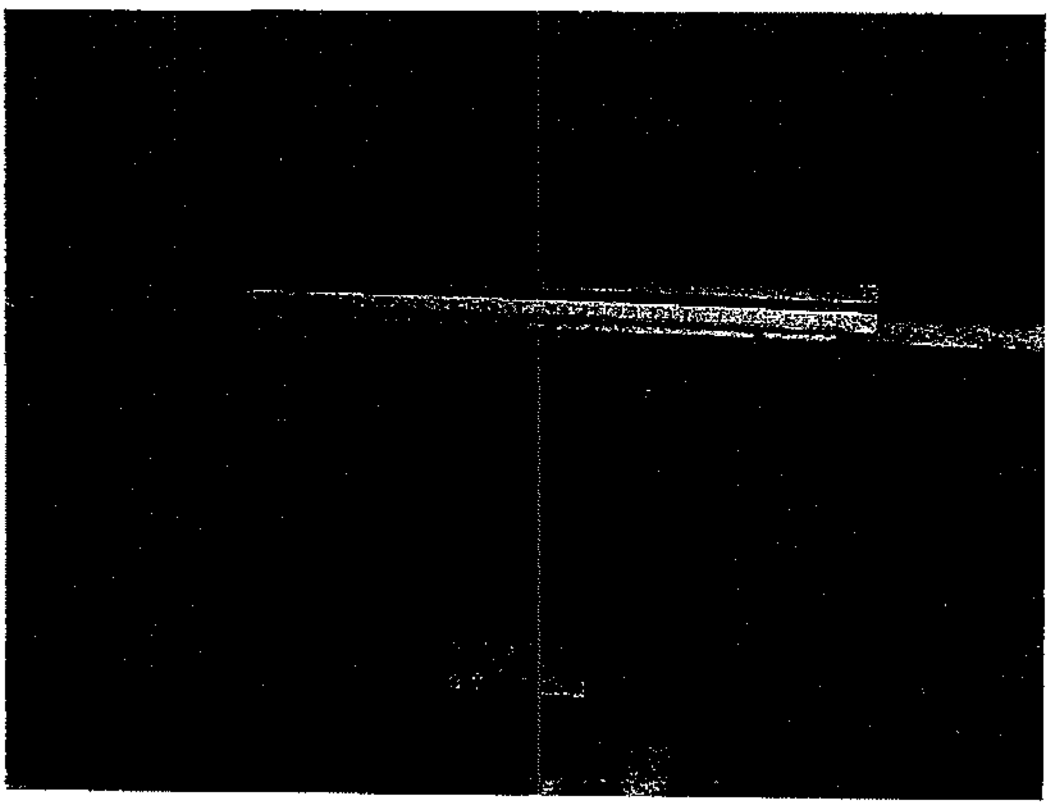
Boring NBH-1



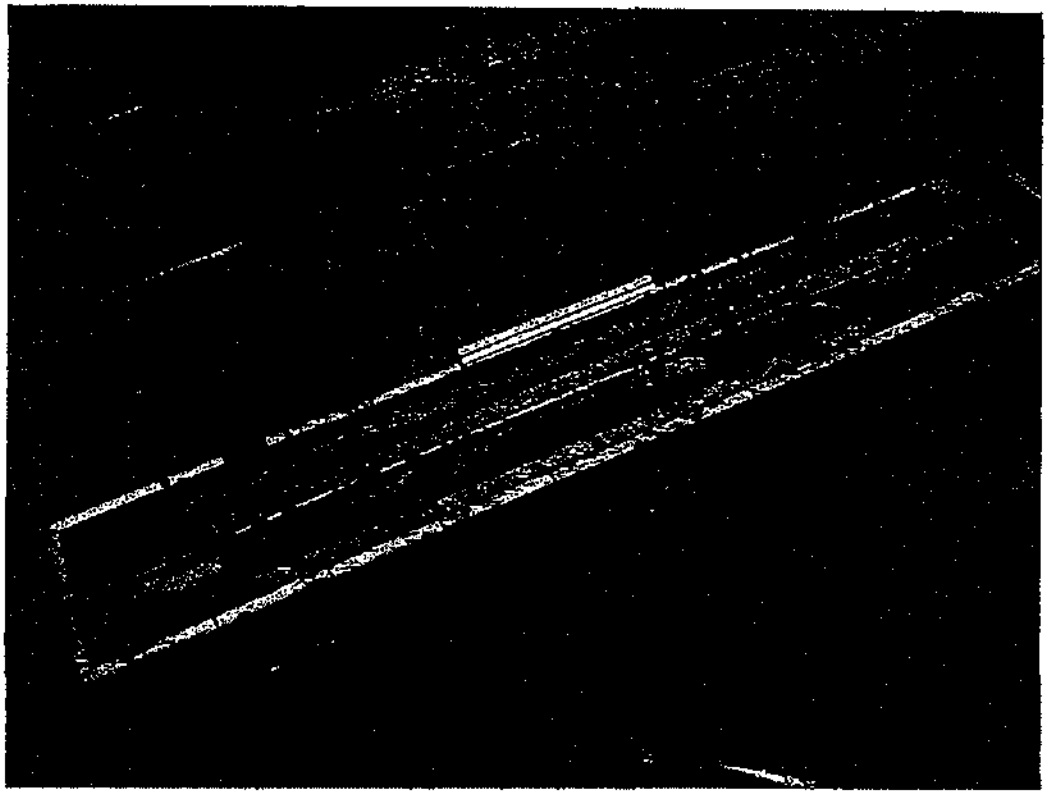


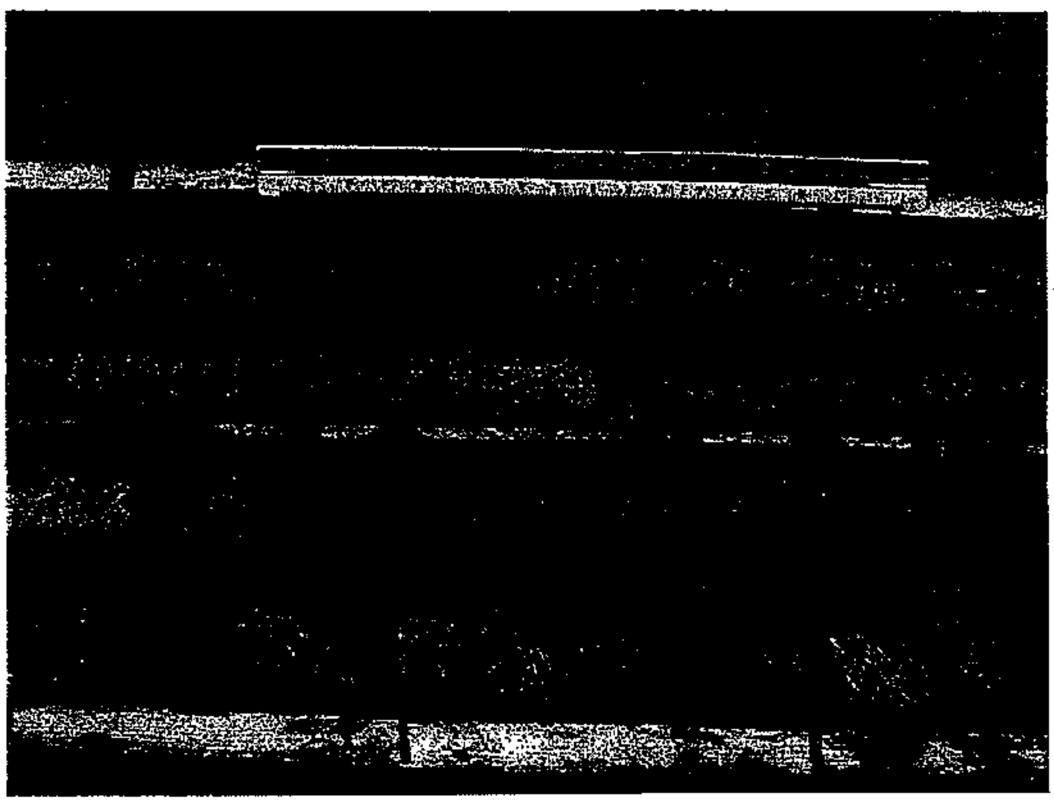
Boring NBH-3



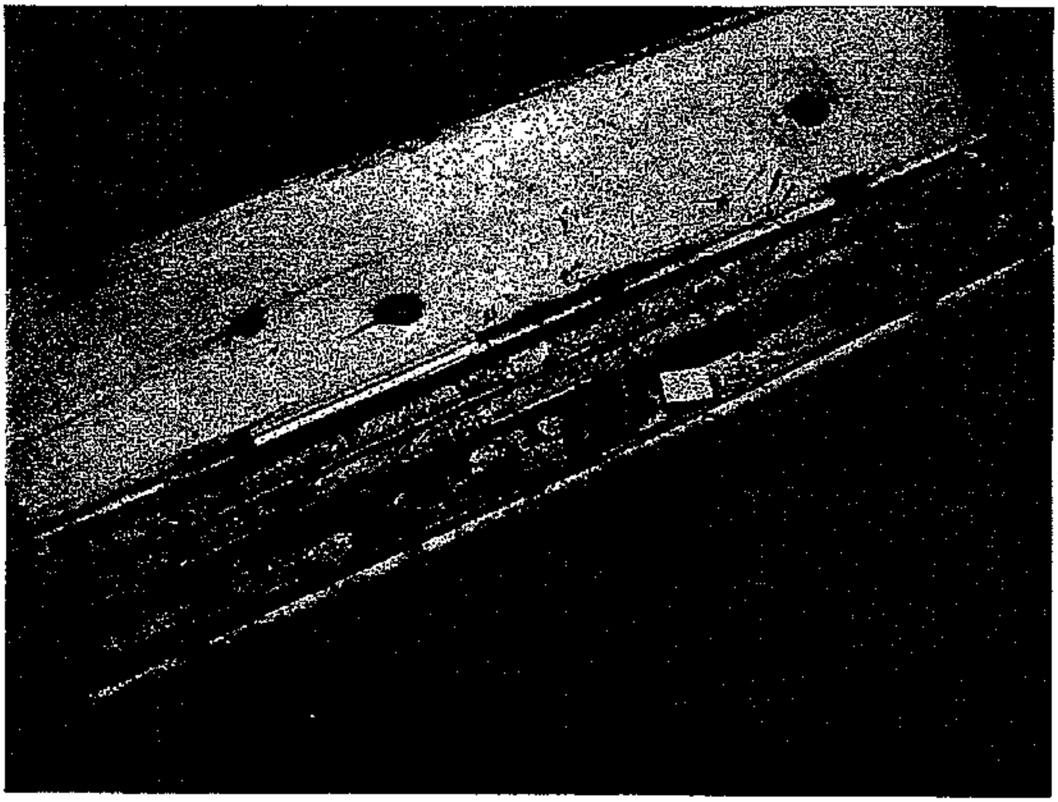


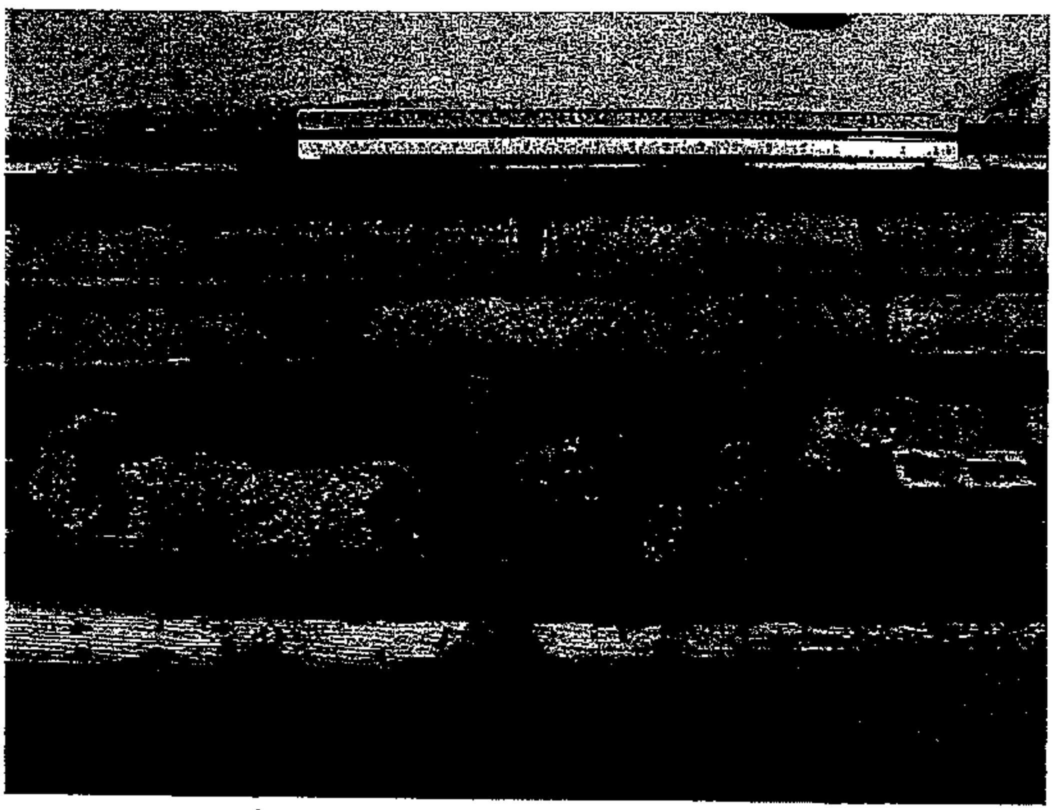
Borings NBH-2 and NBH-4





Borings NBH-6 and NBH-7





APPENDIX D

Boring Logs of Borings Used for Seismic Calibration

(Borings collected by The Maguire Group as part of the DMMP feasibility study)

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 3

TO Maguire Group, Inc.	ADDRESS Foxborough, MA	HOLE NO. NBH-1	
PROJECT NAME Harbor Aquatic Disposal Cell	LOCATION New Bedford, MA	PROJ. NO.	
REPORT SENT TO above / Feasibility Study	OUR JOB NO. 02-011	SURF. ELEV. -6.2' MSL	

GROUND WATER OBSERVATIONS

At ______ after ______ Hours

At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR.		DATE
Type	HW-NW	S/S	NV-II	Start	6/20/01
Size I.D.	4" 3"	1-3/8"		Complete	6/27/01
Hammer Wt.	300#	140#	BIT	Boring Foreman	J. Medeiros
Hammer Fall	24"	30"	Dia.	Inspector/Engr.	

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		0.0-2.0	D	Wt.	of	Rods			Dark Gray Organic SILT, trace shells	1	24	12
5												
		7.0-9.0	D	Wt.	of	Rods				2	24	24
10												
		12.0-14.0	D	Wt.	of	Rods				3	24	24
15												
		17.0-19.0	D	Wt.	of	Rods				4	24	24
20												
		22.0-24.0	D	Wt.	of	Rods				5	24	24
25												
		27.0-29.0	D	Wt.	of	Rods				6	24	18
								28.0	Dark Brown PEAT, little silt			
30												
		32.0-34.0	D	Wt.	of	Rods				7	24	12
		34.0-36.0	D	3	4	4		34.0	Gray SILT and fine Sand, trace dark brown peat	8	24	12
35						5						
		38.5-40.5	D	6	10	10		38.5	Gray fine SAND and Silt	9	24	1

OUND SURFACE TO ______ USED ______ CASING: THEN ______

ample Type: D=Drive C=Cored W=Washed, P=Fixed Piston UT=Shelby Tube, T=Test Pit A=Auger, E = Open End Rod, 300# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency
0-10	Loose	0-4	Soft
10-30	Med. Dense	4-8	M./Stiff
30-50	Dense	8-15	Stiff
50+	Very Dense	15-30	V-Stiff
		30 + Hard	

SUMMARY:

Earth Boring 87.5'

Rock Coring 15'

Samples 17

HOLE NO NBH-1

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

TO Maguire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-1

PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO.

REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -6.2' MSL

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
						9			Gray fine SAND and Silt			
		~~43.5-46.5~~	~~D~~	~~5~~	~~4~~	~~5~~				~~10~~	~~24~~	~~12~~
45						8		44.0	Gray fine to medium SAND, some silt, trace fine gravel & coarse sand			
		49.0-51.0	D	4	5	6		49.0	Gray fine to coarse SAND and fine to medium Gravel, little silt	11	24	8
50						7						
		54.0-56.0	D	9	12	18		54.0	Dark Gray & Brown coarse to fine SAND and fine to medium Gravel, little silt (Odor Noted)	12	24	12
55						20						
		59.0-61.0	D	9	4	7		59.0	Grayish Brown medium to coarse SAND, some fine gravel, little silt [illegible]	13	24	18
60						21						
		64.0-66.0	D	3	4	4				14	24	8
65						9						
70												
		71.0-73.0	D	3	3	8				15	24	18
						11						
75								75.0				
		76.0-78.0	D	53	29	17			Yellow Brown & Gray silty fine to coarse SAND and Gravel	16	24	12
						20						
80									(80' to 81' - Boulder)			
		82.0-82.5	D	100					" some weathered rock	17	6	4
								84.0				
85												

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
OE = Open End Rod
HD# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 87.5'
Rock Coring 15'
Samples 17

HOLE NO NBH-1

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 3 OF 3

TO Maguire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-1
PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO.
REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -6.2' MSL

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		87.5-92.5	C						Gray GRANITE	C1	60	36
		RQD = 0%										60%
90												
		92.5-97.5	C							C2	60	30
		RQD = 0%										50%
95												
		97.5-102.5	C							C3	60	40
		RQD = 0%										66.7%
100												
								102.5	Bottom of Boring 102.5'			

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
OE = Open End Rod
300# hammer

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 87.5'
Rock Coring 15'
Samples 17
HOLE NO. NBH-1

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

TO Maguire Group, Inc.	ADDRESS Foxborough, MA	HOLE NO. NBH-2
PROJECT NAME Harbor Aquatic Disposal Cell	LOCATION New Bedford, MA	PROJ. NO.
REPORT SENT TO above / Feasibility Study	OUR JOB NO. 02-011	SURF. ELEV. -7.8' MSL

GROUND WATER OBSERVATIONS

At ______ after ____ Hours

At ______ after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW-NW	S/S	NV-II
Size I.D.	4" 3"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	Dia.

	DATE
Start	6/29/01
Complete	7/2/01
Boring Foreman	J. Medeiros
Inspector/Engr.	

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev./ Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		0.0-2.0	D	Wt.	of	Rods			Black Organic SILT, trace shells	1	24	8
		3.5-5.5	D	Wt.	of	Rods				2	24	20
5												
		9.0-11.0	D	Wt.	of	Rods				3	24	24
10						11		10.0	Gray Brown fine SAND, little silt & medium sand			
		14.0-[illegible]	[illegible]	WOR	3	3		14.0	Brown fine to medium SAND, trace silt	4	24	10
15						5						
20												
		22.0-24.0	D	Wt.	Rods	3		22.0	Gray silty fine SAND	5	24	15
						3						
25												
		27.0-29.0	D	3	4	4				6	24	22
						3						
30												
		32.0-34.0	D	5	9	13		32.0	Gray medium to fine SAND, trace silt, coarse sand & fine gravel	7	24	10
						12						
35								36.0				
		38.0-40.0	D	11	7	7			Gray fine to coarse SAND, some fine to medium gravel, little silt	8	24	6
						10						

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
P=Test Pit A=Auger
E = Open End Rod
300# hammer

Proportions Used

trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 59'
Rock Coring 10'
Samples 11

HOLE NO. NBH-2

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 2 OF 2

TO Maguire Group, Inc.	ADDRESS Foxborough, MA	HOLE NO. NBH-2	
PROJECT NAME Harbor Aquatic Disposal Cell	LOCATION New Bedford, MA	PROJ. NO.	
REPORT SENT TO above / Feasibility Study	OUR JOB NO. 02-011	SURF. ELEV. -7.8' MSL	

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION (Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.)	SAMPLE No.	Pen"	Rec."
		43.0-45.0	D	6	9	15 / 14			Gray Brown silty fine SAND (compact), trace fine gravel	9	24	10
45												
								46.0				
		48.0-50.0	D	8	5	9 / 7			Gray silty very fine SAND	10	24	12
50												
								52.0				
		~~53.5-55.5~~	~~D~~	~~34~~	~~15~~	~~11~~ / ~~11~~			TILL	~~11~~	~~24~~	~~0~~
55												
								56.0				
		59.0-64.0	C				Min/Ft 5		Gray GRANITE	C1	60	54
60		RQD = 78%					[illegible]					90%
							7					
		64.0-69.0	C				6			C2	60	54
65		RQD = 99%					6					90%
							5					
							5					
							6					
								69.0	Bottom of Boring 69'			

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
V = Open End Rod
300# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 59'
Rock Coring 10'
Samples 11

HOLE NO. NBH-2

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 2

TO Maquire Group, Inc.	ADDRESS Foxborough, MA	HOLE NO. NBH-3A	
ROJECT NAME Harbor Aquatic Disposal Cell	LOCATION New Bedford, MA	PROJ. NO.	
EPORT SENT TO above / Feasibility Study	OUR JOB NO. 02-011	SURF. ELEV. -7.2' MSL	

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		DATE
At ______ after ____ Hours	Type	HW-NW	S/S	NV-II	Start	7/12/01
	Size I.D.	4" 3"	1-3/8"		Complete	7/13/01
At ______ after ____ Hours	Hammer Wt.	300#	140#	BIT	Boring Foreman	J. Medeiros
	Hammer Fall	24"	30"	Dia.	Inspector/Engr.	

LOCATION OF BORING

epth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		0.0-2.0	D	Wt.	of	Rods			Black Organic SILT	1	24	6
5		4.0-6.0	D	Wt.	of	Rods			" color change to Gray	2	24	24
10		9.0-11.0	D	Wt.	of	Rods				3	24	24
								11.0	PEAT, some organic silt			
15		16.5-18.5	D	8	8	20 / 23		16.0	Brown fine to coarse SAND, some fine to medium gravel, trace silt & shells	4	24	2
20		21.5-23.5	D	2	3	3 / 8		21.5	Gray fine to coarse SAND, some silt & fine to coarse gravel	5	24	5
25		26.0-28.0	D	3	2	3 / 5		26.0	Brown coarse to fine SAND, some fine gravel, little silt	6	24	4
30		31.0-33.0	D	3	3	4 / 5		31.0	Light Brown fine SAND, some silt, little fine gravel	7	24	1
35		37.0-39.0	D	5	5	6 / 8				8	24	0

OUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type	Proportions Used		140 lb. Wt x 30" fall on 2" O.D. Sampler				SUMMARY:
D=Drive C=Cored W=Washed	trace	0 to 10%	Cohesionless	Density	Cohesive	Consistency	Earth Boring 57.5'
UP=Fixed Piston UT=Shelby Tube	little	10 to 20%	0-10	Loose	0-4	Soft	Rock Coring 10'
T=Test Pit A=Auger	some	20 to 35%	10-30	Med. Dense	4-8	M./Stiff	Samples 12
E = Open End Rod	and	35 to 50%	30-50	Dense	8-15	Stiff	
*300# hammer			50+	Very Dense	15-30	V-Stiff 30 + Hard	HOLE NO. NBH-3A

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 2 OF 2

TO Maguire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-3A
PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO.
REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -7.2' MSL

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		41.0-43.0	D	2	3	3			Brown fine SAND, little silt	9	24	8
						2						
45												
		46.0-48.0	D	1	1	2				10	24	12
						3						
50		50.0-52.0	D	26	30	33		50.0	Brown weathered GRANITE and silty Sand	11	24	12
						33						
		54.0-54.5	D	100					" color change to Gray with little sand	12	6	4
55												
							Min/Ft					
		57.5-62.5	C				5	57.5		C1	60	52
		RQD = 90%					5		GRANITE			86.7%
60							5					
							5					
							5					
		62.5-67.5	C				5			C2	60	58
		RQD = 85%					5					96.7%
65							5					
							5					
							5					
								67.5	Bottom of Boring 67.5'			

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
V= Open End Rod
G# hammer

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency
0-10	Loose	0-4	Soft
10-30	Med. Dense	4-8	M./Stiff
30-50	Dense	8-15	Stiff
50+	Very Dense	15-30	V-Stiff
		30 +	Hard

SUMMARY:
Earth Boring 57.5'
Rock Coring 10'
Samples 12

HOLE NO. NBH-3A

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 2

TO Maguire Group, Inc. — ADDRESS Foxborough, MA — HOLE NO. NBH-4

PROJECT NAME Harbor Aquatic Disposal Cell — LOCATION New Bedford, MA — PROJ. NO.

REPORT SENT TO above / Feasibility Study — OUR JOB NO. 02-011 — SURF. ELEV. -29.5' MSL

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		DATE
At ____ after ____ Hours	Type	HW-NW	S/S	NV-II	Start	7/3/01
	Size I.D.	4" 3"	1-3/8"		Complete	7/5/01
At ____ after ____ Hours	Hammer Wt.	300#	140#	BIT	Boring Foreman	J. Medeiros
	Hammer Fall	24"	30"	Dia.	Inspector/Engr.	

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION (Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.)	SAMPLE No.	Pen"	Rec
		0.0-2.0	D	Wt.	of	Rods			Black Organic SILT, trace shells	1	24	6
5		5.0-7.0	D	Wt.	Rods	3				2	24	24
						4		6.0	Black & Gray Brown fine to coarse SAND, some silt & gravel			
								8.0				
		9.0-11.0	D	1	2	2			Tan fine SAND, little medium sand, trace silt	3	24	8
10						3						
15												
		16.0-18.0	D	3	5	8		16.0	Tan fine to coarse SAND, little silt & fine gravel	4	24	8
						9						
20												
		21.0-23.0	D	10	9	10				5	24	6
						29		22.0	Brown & Dark Brown coarse to fine SAND and fine to coarse Gravel, little silt			
25												
		27.0-29.0	D	29	22	19			" color change to Yellow Brown	6	24	8
						100						
							Min/Ft	29.0				
30		30.0-35.0	C				4		QUARTZ & Green Red GRANITE	C1	60	34
		RQD = 95%					1					56.7%
							5					
							6					
							7					
35		35.0-41.0	C				7	35.0	Green Gray GRANITE	C2	72	72
		RQD = 85%					6					100%
							6					
							8					
							8					

GROUND SURFACE TO ____ USED ____ CASING: THEN ____

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit-A=Auger
OE = Open End Rod
^300# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 30'
Rock Coring 11'
Samples 6

HOLE NO. NBH-4

GUILD DRILLING CO., INC.

100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 2 OF 2

TO Maguire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-4

PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO.

REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -29.5' MSL

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec
							8					
								41.0	Bottom of Boring 41'			

GROUND SURFACE TO ________ USED ________ CASING: THEN ________

Sample Type	Proportions Used		140 lb. Wt x 30" fall on 2" O.D. Sampler					SUMMARY:
D=Drive C=Cored W=Washed	trace	0 to 10%	Cohesionless	Density	Cohesive	Consistency		Earth Boring 30'
UP=Fixed Piston UT=Shelby Tube	little	10 to 20%	0-10	Loose	0-4	Soft	30 + Hard	Rock Coring 11'
TP=Test Pit A=Auger	some	20 to 35%	10-30	Med. Dense	4-8	M/Stiff		Samples 6
OE = Open End Rod	and	35 to 50%	30-50	Dense	8-15	Stiff		
300# hammer			50+	Very Dense	15-30	V-Stiff		

HOLE NO. NBH-4

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 1

TO Maquire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-5
PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO.
REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -27.8' MSL

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		DATE
At ______ after ____ Hours	Type	HW	S/S		Start	7/5/01
	Size I.D.	4"	1-3/8"		Complete	7/5/01
At ______ after ____ Hours	Hammer Wt.	300#	140#	BIT	Boring Foreman	J. Medeiros
	Hammer Fall	24"	30"		Inspector/Engr.	

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION (Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.)	Sample No.	Pen"	Rec."
		0.0-2.0	D	Wt.	of	Rods			Black Organic SILT	1	24	12
5		4.0-6.0	D	Wt.	of	Rods				2	24	14
10		9.0-11.0	D	5	4	3		9.0	Brown fine to coarse SAND, some fine to coarse	3	24	8
						4			gravel, little silt			
								12.0				
15		14.0-16.0	D	14	9	5			Brown silty fine SAND, little fine gravel	[illegible]	[illegible]	[illegible]
						6						
20		19.0-20.3	D	30	14	100/3"			" some coarse sand & fine to medium gravel	5	15	3
								20.3	Bottom of Boring 20.3'			

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type
D=Drive C=Cored W=Washed
P=Fixed Piston UT=Shelby Tube
T=Test Pit A=Auger
O = Open End Rod
300# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M. Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 20.3
Rock Coring ______
Samples 5

HOLE NO. NBH-5

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 1

TO Maguire Group, Inc.	ADDRESS Foxborough, MA	HOLE NO. NBH-6
PROJECT NAME Harbor Aquatic Disposal Cell	LOCATION New Bedford, MA	PROJ. NO.
REPORT SENT TO above / Feasibility Study	OUR JOB NO. 02-011	SURF. ELEV. -28.6' MSL

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		DATE
At ____ after ____ Hours	Type	HW-NW	S/S	NV-II	Start	7/9/01
	Size I.D.	4" 3"	1-3/8"		Complete	7/9/01
At ____ after ____ Hours	Hammer Wt.	300#	140#	BIT	Boring Foreman	J. Medeiros
	Hammer Fall	24"	30"	Dia.	Inspector/Engr.	

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION (Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.)	No.	Pen"	Rec."
		0.0-2.0	D	Wt.	of	Rods			Black Organic SILT	1	24	11
		4.0-6.0	D	Wt.	Rods	3			" trace shells	2	24	20
5						10						
								6.0	Rusty Brown coarse to fine SAND, some fine to medium gravel, trace silt			
		7.5-9.5	D	11	6	6				3	24	7
						8						
10												
		14.0-16.0	[illegible]	[illegible]	[illegible]	4			" color change to Brown	4	24	6
15						6						
		18.5-20.5	D	3	2	3			" & fine Gravel	5	24	2
20						5						
		23.5-25.5	D	36	30	42		23.5	Brown fine to coarse SAND and Gravel, little silt	6	24	7
25						31						
							Min/Ft	26.0				
		27.0-32.0	C				7		GRANITE	C1	60	56
		RQD = 100%					8					93.3%
							8					
30							8					
							8					
		32.0-37.0	C				7			C2	60	54
		RQD = 92%					7					90%
							7					
35							7					
							7					
								37.0	Bottom of Boring 37'			

GROUND SURFACE TO ____ USED ____ CASING: THEN ____

Sample Type: D=Drive C=Cored W=Washed UP=Fixed Piston UT=Shelby Tube TP=Test Pit A=Auger OE = Open End Rod 300# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M.Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 27'
Rock Coring 10'
Samples 6
HOLE NO. NBH-6

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 2

TO Maguire Group, Inc.	ADDRESS Foxborough, MA	HOLE NO. NBH-7
PROJECT NAME Harbor Aquatic Disposal Cell	LOCATION New Bedford, MA	PROJ. NO.
REPORT SENT TO above / Feasibility Study	OUR JOB NO. 02-011	SURF. ELEV. -28.7' MSL

GROUND WATER OBSERVATIONS

At ______ after ______ Hours

At ______ after ______ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW-NW	S/S	NV-II
Size I.D.	4" 3"	1-3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	Dia.

	DATE
Start	7/10/01
Complete	7/11/01
Boring Foreman	J. Medeiros
Inspector/Engr.	

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		0.0-2.0	D	Wt.	of	Rods			Black Organic SILT, little shells	1	24	22
								2.0				
		4.0-6.0	D	2	2	4			Gray fine to coarse SAND and fine to medium	2	24	20
5						8			Gravel, little silt, trace shells (organic)			
		9.0-11.0	D	5	6	7		9.0	Light Brown silty fine SAND, little fine to medium	3	24	12
10						10			gravel			
		13.0-15.0	D	4	6	10		13.0	Brown fine to medium SAND, little silt & coarse sand,	4	24	9
						11			trace fine gravel			
15												
		18.0-20.0	D	3	4	8		18.0	Brown fine SAND, little silt	5	24	8
						6						
20												
		23.0-25.0	D	2	4	3				6	24	12
						5						
25												
								28.0	BOULDERS			
30												
							Min/Ft	34.0	Weathered GRANITE			
35		35.0-40.0	C				5			C1	60	20
	RQD = 40%						7					33.3%
							8					
							3					
							3					

OUND SURFACE TO ______ USED ______ CASING: THEN ______

mple Type
=Drive C=Cored W=Washed
=Fixed Piston UT=Shelby Tube
=Test Pit A=Auger
= Open End Rod
C# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 35'
Rock Coring 8'
Samples 6

HOLE NO. NBH-7

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 2 OF 2

TO Maguire Group, Inc. | ADDRESS Foxborough, MA | HOLE NO. NBH-7

PROJECT NAME Harbor Aquatic Disposal Cell | LOCATION New Bedford, MA | PROJ. NO.

REPORT SENT TO above / Feasibility Study | OUR JOB NO. 02-011 | SURF. ELEV. -28.7' MSL

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./ Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec.
		40.0-41.5	C	RQD = 0%			19		Weathered GRANITE	C2	18	6 33.3
		41.5-43.0	C	RQD = 0%			8			C3	18	6 33.3
								43.0	Bottom of Boring 43'			

GROUND SURFACE TO ______ USED ______ CASING: THEN ______

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
OE = Open End Rod
300# hammer

Proportions Used

trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	
50+	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 35'
Rock Coring 8'
Samples 6

HOLE NO. NBH-7

ADDENDUM TO
MARINE GEOPHYSICAL SURVEYS: SEISMIC REFRACTION, SUB-AQUEOUS DISPOSAL CELL FEASIBILITY STUDIES, UPDATED DATA AND MODEL REVISION

NEW BEDFORD HARBOR
New Bedford, Massachusetts

Prepared for:

Massachusetts Coastal Zone Management Agency
251 Causeway Street, Suite 900
Boston, MA 02202

CZM

Submitted by:

Maguire Group Inc.

MAGUIRE GROUP

July 2003

ADDENDUM TO
MARINE GEOPHYSICAL SURVEYS:
SEISMIC REFRACTION, SUB-AQUEOUS
DISPOSAL CELL FEASIBILITY STUDIES,
UPDATED DATA AND MODEL REVISION

NEW BEDFORD HARBOR
New Bedford, Massachusetts

Prepared for:

Maguire Group Inc.

Prepared by:

Apex Environmental, Inc.
Boston, Massachusetts

July 2003

Revision	Date	Prepared By	Approved By	Pages Affected
1	8/25/03	T. Mannering	J. Borkland	All

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INTRODUCTION

This "Addendum to Marine Geophysical Surveys: Seismic Refraction, Sub-aqueous Disposal Cells Feasibility Studies – Updated Data and Model Revision, New Bedford Harbor" was prepared by Apex Environmental, Inc. (Apex) for The Maguire Group, Inc. (Maguire). Apex is supporting Maguire in its completion of feasibility studies concerning proposed Confined Aquatic Disposal (CAD) cells in New Bedford Harbor for The Massachusetts Coastal Zone Management (MACZM). MACZM is assessing the feasibility of locating a CAD cell or cells in New Bedford Harbor in order to alleviate the shortage of permanent dredge spoils disposal sites in the area under a comprehensive Dredged Material Management Plan (DMMP). Two discrete areas of interest within New Bedford Harbor are being evaluated as potential CAD sites: the Popes Island North Area, located northeast of Popes Island in New Bedford Harbor; and the Channel Inner Area, located north of Palmer Island in the lower portion of New Bedford Harbor (See Figure 1).

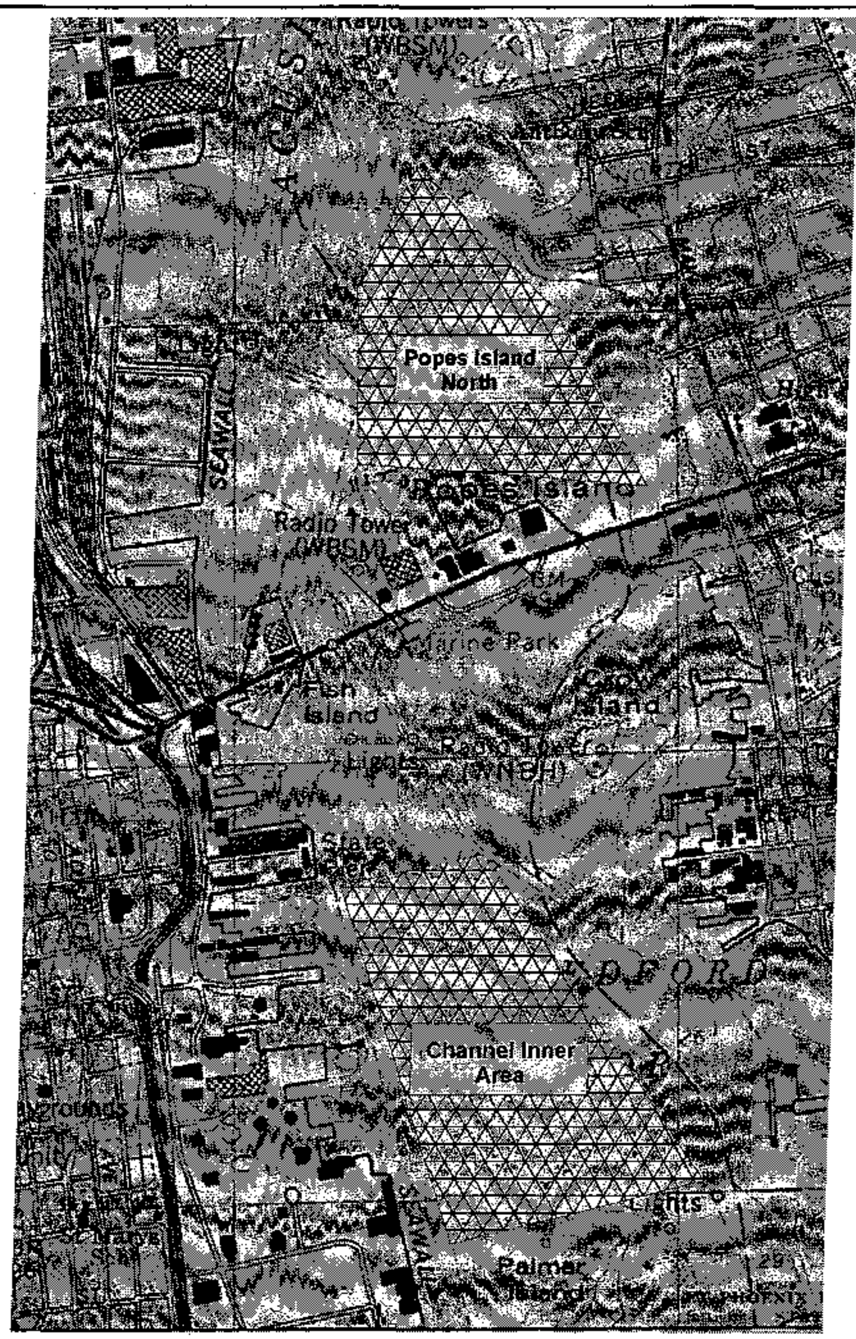
The initial geophysical investigation entitled "Marine Geophysical Surveys: Seismic Refraction, Sub-aqueous Disposal Cells Feasibility Studies, New Bedford Harbor-2001", was undertaken to provide information and data on the topography and character of the bedrock surface within the survey area. This report is an addendum to the 2001 investigation, and describes the methodology of merging additional geotechnical boring information into updated bedrock models, and the re-calculation of the capacity of the proposed CAD cells.

Seismic Refraction Background

Marine geophysical data was collected in two separate areas: Popes Island North Area, located north of Popes Island in the middle portion of New Bedford Harbor; and the Channel Inner Area, located northwest of the hurricane dike within the lower portion of New Bedford Harbor. These two areas represent the potential locations of the Confined Aquatic Disposal (CAD) cells proposed under MACZM's DMMP. Apex collected the initial seismic refraction data over the proposed CAD cell locations from April 19th through May 11th, 2001. Data was collected across a total of 23 seismic refraction spreads (or lines) in the two areas. Ten refraction spreads were collected in the Popes Island North Area, and thirteen spreads in the Channel Inner Area. Each refraction spread was collected utilizing a 48-channel seismograph (data was collected from 48 hydrophones deployed on the harbor bottom simultaneously), with a nominal hydrophone spacing of 30 feet, such that each spread measured approximately 1,410 feet in length. (Details of the data collection and processing techniques utilized for the 2001 investigation can be found in section 2 of Apex's initial report entitled *"Marine Geophysical Surveys: Seismic Refraction, Sub-aqueous Disposal Cell Feasibility Studies, New Bedford Harbor, 2001."*

Small seismic charges were emplaced into the sediment of the harbor bottom to provide seismic energy. The charges were set off, and a digital seismograph recorded the resulting voltage generated by each hydrophone on the harbor bottom. The voltage is displayed as a "wiggle trace" (or waveform) for each channel. The "wiggle trace" voltage fluctuations were recorded with respect to the time (in milliseconds) after the seismic shot was initiated. Selected example seismograph records are included in Appendix A. The computer program "SIP2" (Seismic Interpretation Program - Version 2) was utilized to enhance and filter the raw seismogram records.

Time vs. Distance plots (See Illustration 1) were created using the SIP program. These graphs are a plot of the time taken for energy to reach each hydrophone along the "seismic array" and are used to determine the number of layers (apparent in the data). Layer numbers were then assigned to the various layer segments interpreted from the "Time vs. Distance" plots - these layer numbers form the basis on which the model calculates the seismic velocities that it uses in the production of the resultant "depth models". The Time vs. Distance plot is a graphical means of displaying seismic data, allowing an interpreter the ability to identify the correct number of distinct geologic layers to be incorporated into the computer models used to compute layer depth estimates. Layers are identified on the Time vs. Distance graphs by "inflection points" in the straight line trends, where a segment of points change slope from longer-time-per-relative-distance to shorter-time-per-relative-distance (see Illustration 1).



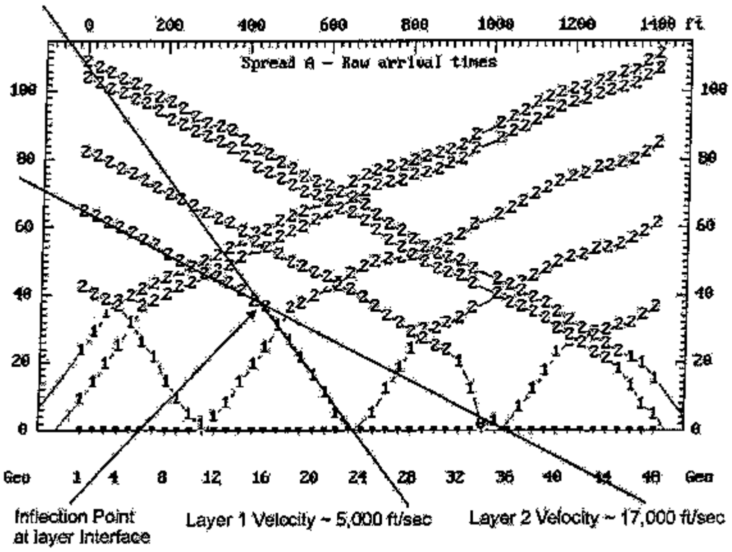


Illustration 1
Time-Distance Plot Example

Structure of the Report Presentation

This report summarizes the information obtained during this additional phase of the geophysical model preparation. This phase involved the merging of additional Phase II geotechnical boring information with the original (2001) seismic refraction data in order to update the bedrock models and calculate the potential capacity of the proposed CAD cells. The revised models for both Popes Island North and Channel Inner Areas are presented in this report.

This report is organized by sections that provide a functional framework for the presentation of additional boring information and model refinements. The following provides an outline of the approach to the presentation of the information.

Section 1.0 (Introduction) Describes the contractual framework for the program and background information and a brief description of the means and methods by which the initial seismic refraction data was collected.

Section 2.0 (Methods) Describes the means and methods by which the Phase II geotechnical information was incorporated into the previously generated seismic refraction models.

Section 3.0 (Results) Describes the revised findings of the Seismic Refraction investigation and also includes a discussion of the maps generated as part of the additional seismic data reduction process.

Section 4.0 (Conclusions) presents the conclusions of the investigation, including an assessment of the potential volumes of the proposed CAD cells.

Section 5.0 presents the limitations of the program.

Section 6.0 provides a list of references cited throughout this report.

RE-INTERPRETATION AND ADDITION OF NEW INFORMATION

Calibration Data

The depth to bedrock information collected from two phases of geotechnical borings drilled in the harbor was used to calibrate the parameters utilized as inputs to the seismic models. The calibration of the Seismic Interpretation Program (SIP) models was an iterative process that involved changing the input parameters of layer velocities and "first pick" layer assignments until there was agreement with existing information (boring logs, other seismic model lines at crossing points, and other geophysical information). The calibration took as many as several dozen iterations to resolve all discrepancies, depending on the data particulars and the line location. The initial 2001 models were used to select the Phase II boring locations in order to provide the most beneficial bedrock elevation calibration data. The additional calibration points were selected based upon locations where seismic lines crossed within areas of low model confidence in order to take advantage of higher data density in those areas. Coincident line boring selection also allows the boring information to be used to calibrate more than one line. Calibration borings were also performed in areas that had the greatest change in elevation over a short distance in order to minimize the discrepancies within the models.

The Phase I geotechnical-drilling program was conducted between June 20 and July 13, 2001 and provided seven calibration points (NBH-1 through 7). These boring locations were used in the calibration of the initial model. The Phase II drilling program was conducted between October 15 – 23, 2002, providing an additional four calibration points (NBH-8 thru NBH-11), which were used for this re-interpretation.

Both Phase I & II geotechnical drilling programs were conducted with a barge mounted drill rig in the harbor. Samples of soil were collected during the drilling program using a split-spoon sampler. Rock-core samples were collected from the borings using a diamond-bit rock core barrel.

Data Re-Processing

Initial re-processing of the data was performed using the United States Geological Survey (USGS) seismic interpretation software "SIP" ('Seismic Interpretation Program'). This software is a standard processing software package recognized by the industry and has been used by the USGS for many of the seismic refraction applications completed by the government.

Data processing began as additional depth to bedrock information was made available. Initial depth-to-bedrock information was re-run using the final models from 2001 as a starting point. Based on the comparisons between the existing models and the new depth to bedrock elevation information gained through the 2002 drilling program, various lines were re-analyzed using the following steps:

1. From the bedrock elevation corrected data, "Time vs. Distance" (see Illustration 1) plots were created, allowing the interpreter to determine the number of layer responses (apparent in the data), which are used by the program to create "layer models".
2. Layer numbers were assigned to the various layer segments interpreted from the "Time vs. Distance" plots. These layer numbers form the basis on which the model calculates the seismic velocities that it uses in the production of the resultant "depth models".
3. SIP modeling was conducted using the above as input information, and resultant depth profiles were generated. Models were re-run adjusting the layer velocities until the resulting model was correctly calibrated to specific boring elevations. The velocity issues were studied in further runs of the modeling program, and the inconsistencies were rectified, as were errors

resulting from improper initial "picks" or elevation errors. A more detailed examination of the "Time vs. Distance" plots was completed to refine the models in both areas. Additional velocity calculations were utilized to help correct for (as well as to illustrate) potential fractures, high velocity zones (HVZ) and low velocity zones (LVZ). This information was inserted back in the SIP software in order to re-run partial lines (zeroing out particular phones) at the modified velocities. The resulting information, analyzed using the newly calculated differing velocities, were combined to produce a more accurate final seismic line. The approach utilized was an iterative process that involved the merging and interpretation of all lines into a single model in order to identify potential modeling problems.

Synthesis of Geophysics with Geotechnical Borings

The geophysical data from the Seismic Refraction program was processed and interpreted with historical geotechnical boring information as well as that collected in the Phase II geotechnical program. Where the seismic lines crossed directly over a boring location, the boring data was utilized to calibrate the depth of bedrock models generated as part of the seismic data processing.

Table 1. Geotechnical borings collected as part of this program were utilized in the calibration of the following seismic lines (See Figures 3 and 4 for locations).

Phase	Area	Boring ID	Bedrock Ele (NGVD29)	Line/Positions
I	Popes Island	NBH-1	-90.2 feet	Seismic Line 20 & 3
I	Popes Island	NBH-2	-63.8 feet	Seismic Lines 4 & 5
I	Popes Island	NBH-3	-61.7 feet	Seismic Lines 1, 2 & 7
I	Channel Inner	NBH-4	-58.5 feet	Seismic Line 11
I	Channel Inner	NBH-5	-48.1 feet	Seismic Lines 13 & 15
I	Channel Inner	NBH-6	-54.6 feet	Seismic Lines 16 & 19
I	Channel Inner	NBH-7	-62.7 feet	Seismic Lines 7, 18 & 21
II	Popes Island	NBH-8	-92.5 feet	Seismic Lines 5 & 7
II	Channel Inner	NBH-9	-49.0 feet	Seismic Lines 11 & 18
II	Channel Inner	NBH-10	-51.1 feet	Seismic Lines 14 & 22
II	Channel Inner	NBH-11	-62.2 feet	Seismic Lines 10 &17

Additional historic boring information (Ebasco, 1988) was used in the contouring process to create the bedrock surfaces. However, this data was not used for direct calibration purposes because details of the data collection process were not known. Ebasco borings utilized are listed below.

- Boring BW-103 (-34 feet)
- Boring BW-104 (-39 feet)
- Boring BW-109 (-52 feet)
- Boring BW-110 (-72 feet)
- Boring BW-111 (-79 feet), and
- Boring BW-112 (-49 feet).

The calibrated seismic lines and selected borings were incorporated into a single interpretation of the bedrock surface (see Figures 3 and 4). The bedrock surface was created by integrating lines of bedrock elevation data (along the seismic profiles) with spot elevation data (from the selected borings listed above as well as elevations obtained from the calibration borings noted above), and gridding and contouring the resulting merged data set.

Data Interpretation

Interpretation of the data involved the refining of the models and comparison of the seismic data with calibration data until the most likely model (most reasonable interpretation of data) was found. The computer program Geosoft Oasis Montaj (Montaj) V 5.15, a data processing and analysis (DPA) system for earth science applications, was used to produce color-contoured maps for the project. The Montaj software was used to integrate the revised modeled bedrock elevation surface information and boring elevation into geo-referenced maps.

Data interpretation involved repeating many of the initial data processing steps described previously until the most appropriate best-fit model was generated. For some of the records, the "first breaks" of the seismic records were "re-picked", where the initial "first break" interpretation could be improved in order to achieve a better-fit model.

Another adjustment that was made during data interpretation was the modification of hydrophone layer assignments on the "Time vs. Distance" plots. These layer assignments form the basis upon which the model calculates seismic velocities which are uses in the production of the resultant depth models. Changing the layer assignments revises the morphology of the model, both the shape and depth of interface.

RESULTS

Profiles generated from the data, using the subsurface modeling software package SIP2, indicated that the bedrock character in both areas of interest is irregular, and marked by undulations of the bedrock surface. The results of the re-interpretation of the refraction data are best conveyed as contoured surface maps of the bedrock as determined from the interpreted seismic data. Figures 2 and 3 depict the results of the seismic data interpretation for Popes Island and Channel Inner area respectively. The figures display the inferred top of bedrock surface as determined from the seismic refraction data as a color-coded contour elevation (referenced to NGVD29), in order to aid in the identification of trends in the surface (i.e., blue areas are deeper and red/pink/orange areas are shallower). The location of borings used to "calibrate" the seismic interpretations is also shown on these figures. The bedrock models were calibrated such that the elevation of bedrock, at any given line crossing, is within three feet at line intersection points.

The "highest" bedrock surface elevation noted in the Popes Island North Area is in the range of –28 feet (NGVD29). The "lows" in the bedrock topography, noted from the data within the possible CAD footprint are in the –95 foot range (NGVD29). The mean elevation of the bedrock surface in the Popes Island North area is –66 feet (NGVD29). (See Figure 2). The "highest" bedrock surface elevation noted in the Channel Inner Area is in the range of –35 feet (NGVD29). The "lows" in the bedrock topography, noted from the data within the possible CAD footprint are in the –66 foot range (NGVD29). The mean elevation of the bedrock surface in the Channel Inner area is –52 feet (NGVD29). (See Figure 3).

Model Confidence

Maps showing the seismic model confidence have been generated and are shown in Figures 4 and 5. These maps were constructed based on the quality of the raw data collected in the field and on issues inherent in the data such as LVZ and potential fracturing, which can reduce the accuracy of the velocities and corresponding depths.

Popes Island North Area

Data collected in the Popes Island North Area exhibited low "noise" and was of high quality. As a result, there is a high confidence in the modeled bedrock surface there. Adding to the confidence in this area is supporting seismic data northwest of the survey area (Foster Wheeler, 2001). There is an area on the western edge of the model which has been assessed a "moderate" confidence level, due in part to the deep bedrock and the changing harbor topography.

Channel Inner Area

Data collected in the Channel Inner Area had a large amount of inherent "noise" due to the many shipping and fishing businesses around the harbor front. Background noise was greatest on the western (New Bedford) side of the harbor, and affected the western extents of most seismic lines. Extremely shallow bedrock found in the southern portion of the study area added to the "noisy" or low quality data. Potential faulting or fracturing that trends north-south through the center of the area also affected seismic velocities and the models calculated using these velocities. Every effort was made to filter and compensate for the effects of LVZs on the models, but the amplitude and strength of the raw signal was severely diminished after passing through these zones. The Channel Inner Area confidence map (Figure 5) shows a moderate model confidence level on approximately the western ¼ of the survey area because of the uncertainties discussed above.

Volume Calculations

Utilizing cell configuration parameters provided by Maguire engineers, existing bathymetric information, and the results of the seismic refraction survey, Apex performed preliminary volume calculations for both the Popes Island North and Channel Inner Areas. Calculations were performed using a combination of US Army Corps of Engineers (USACE) (Conditions survey 1996) and Apex Environmental, Inc. (Post dredge survey State Pier Dredge Project, 2002) bathymetry data, and the revised 2002 seismic refraction bedrock surface elevation calculated as part of this program. In calculating the volume of each cell, a slope of 3:1 was assumed.

It should be noted that the bathymetry data obtained from the USACE was supplied to Apex as a subset of the shallowest soundings within a 1"=100' paper plot. As such this data provides only an approximate pre-engineering mudline surface. Possible artifacts or errors may also exist in the Seismic Refraction surface due to the contouring algorithms that extrapolate the data between successive survey lines. In order to account for these uncertainties, contingency volumes have been incorporated into the various volume estimates. The volume calculations completed for this program, along with the relevant contingency volumes, are presented in the subsections below.

Popes Island Area

Volumes were calculated using a proposed configuration of six cells in the Popes Island North Area (See Illustration 2). Cell 1 was designed for a capacity of 1.8 million cubic yards. Cells 2 through 6 were designed to accommodate approximately 50,000 cubic yards of material each. A separation distance of 100 feet was maintained between each of the cells. For the cell volume calculations, a bedrock "buffer" of 10 feet was assumed so that the base of the cells terminate in sediment material. There is an additional loss of cell volume since the upper four (4) feet of sediment in the Popes Island North Area is assumed to be contaminated and should be placed back into the cell taking up volume associated with the top four (4) feet of material. Additionally, a cap of four (4) feet of "clean" material will be placed on top, for a cell total of eight (8) feet of depth subtracted from the calculations for each cell. Table 2 below summarizes the calculations for the Popes Island North Area. Illustration 3 shows a graphical breakdown of the division of available volume and geological types.

Table 2. Volume Calculation summary for the Popes Island North Area CAD configuration shown in Illustration 2.

Cell	Average Bedrock Elevation	Average Bathymetric Elevation	Sediment Thickness	Available Dredge Depth	Total Dredged Volume	Total Storage Capacity
1	-75 ft	-8 ft	**67 ft**	57 ft	**2,275,000 CY**	**1,841,000 CY**
2	-50 ft	-6 ft	**44 ft**	34 ft	**82,375 CY**	**48,100 CY**
3	-54 ft	-8 ft	**46 ft**	36 ft	**83,800 CY**	**49,500 CY**
4	-57 ft	-9 ft	**48 ft**	38 ft	**84,950 CY**	**50,700 CY**
5	-58 ft	-9 ft	**47 ft**	39 ft	**65,450 CY**	**51,200 CY**
6	-57 ft	-8 ft	**49 ft**	39 ft	**85,450 CY**	**51,200 CY**

Average Bedrock Elevation –Average Bathymetric Elevation = Sediment Thickness
Sediment Thickness – Bedrock buffer (10-feet) = Available Dredge Depth
Total Dredged volume = Available Dredge Depth X (length and width of cell) using 3:1 slope
Total Storage Capacity = Total Volume dredge – (top 4-foot contaminated material)

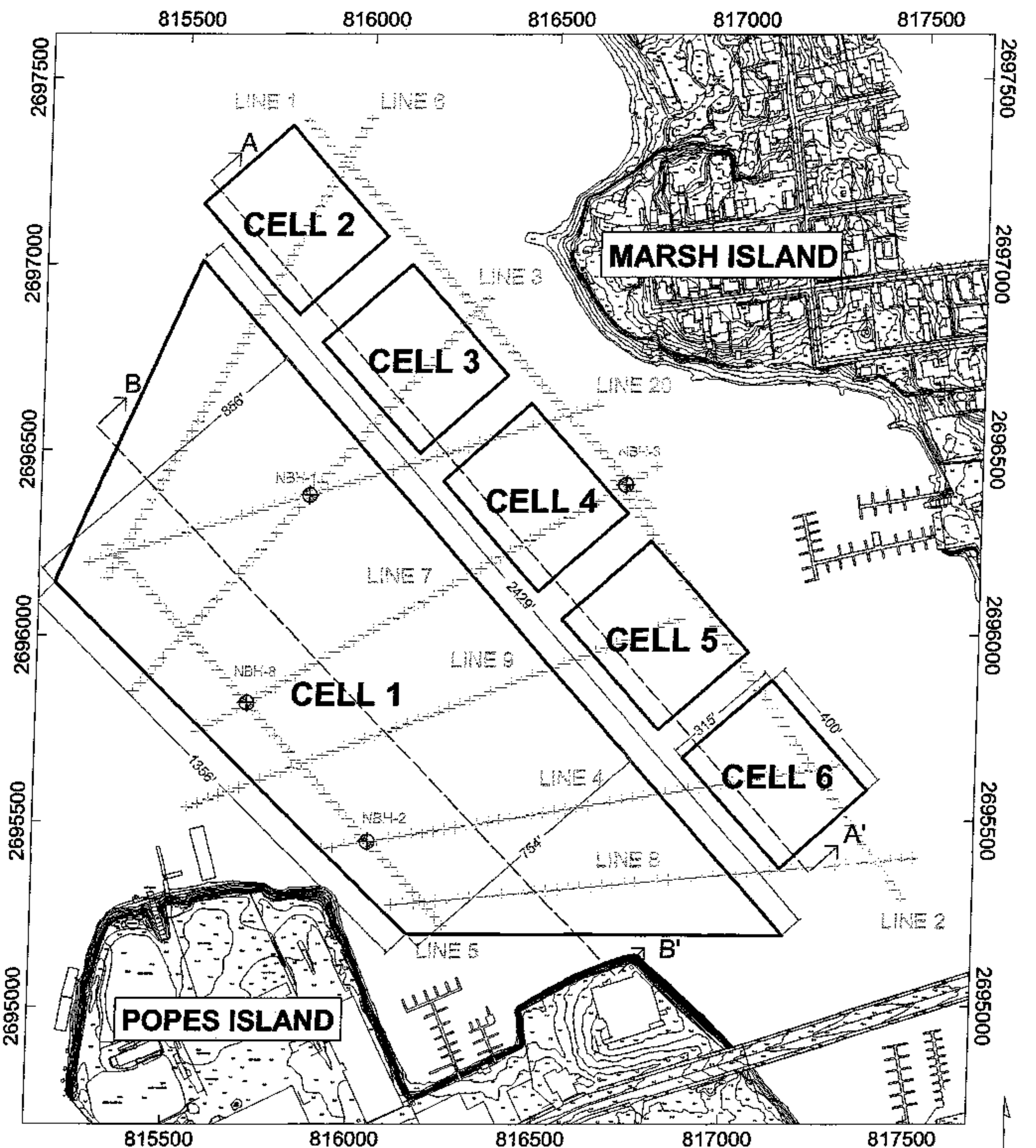
Table Assumptions:

- All volumes were calculated as Volume-Of-the-Void (VOV) and do not take into account sediment properties (i.e. bulking, etc.). The volumes are approximate, and are based on average elevations within each proposed cell.
- **Average Bedrock Elevations** were calculated using Oasis Montaj V5.16 minimum curvature model of the bedrock surfaces within each of the proposed CAD cells. A mathematical modeling cell size of 12 was maintained to construct the minimum curvature model of the bedrock surface.
- **Average Bathymetric Elevations** were calculated in a manner similar to the Average Bedrock Elevations, utilizing the USACE bathymetric data 1997 and a mathematical cell size of 8.
- **Sediment Thickness** was calculated by subtracting Bathymetric/Mud line Elevation from the Bedrock Elevation.
- **Available Dredge Depth** is the depth of material excavated in order to leave a 10-foot buffer so that the proposed CAD cell terminates in sediment material above modeled bedrock. The available dredge depth can also be thought of as the depth of material to the bottom of the proposed CAD cell.
- **Total Volume Dredged** is the amount of material needed to be removed to form the proposed CAD cell given the average dredge depth and assuming a 3:1 (H:V) side slope for each cell.
- **Total Storage Capacity** is the final volume after disposing of the top 4-feet of "contaminated" material back into the cell and allowing for the 4-feet of clean cap material.

Cross Section Profiles –Popes Island North Area

Stratagraphic cross sections were extracted from profile cuts through proposed CAD Cells 2 – 6 (A-A') and CAD Cell 1 (B-B' in the Pope Island North Area). The locations of the cross sections are shown on Illustration 2. The cross sections are presented in Illustrations 4 (A-A') and 5 (B-B'). The cross sections were constructed by digitizing the modeled bedrock surface and the bathymetric surface over the length of the profile. Boring information collected as part of the project was extrapolated to the profile center line to depict the types and thickness of geology encountered.

Illustration 2 Popes Island Area Proposed CAD Cell Configuration



LEGEND

- PROPOSED CELL EXTENT
- HYDROPHONE LOCATION
- BORING LOCATION
- A A' CROSS SECTION LOCATION

Scale 1:4800

250 0 250

US survey foot

NAD83(CSRS98) / Massachusetts CS83 Mainland zone

NOTES:

1. Base Plan of the New Bedford harbor area was obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83). Vertical Datum referenced to NGVD29.
3. Boring information and position supplied by The Maguire Group.

REV.	DESCRIPTION	BY	DATE

ILLUSTRATION 2

POPES ISLAND NORTH AREA - CELL CONFIGURATION SEISMIC REFRACTION - 2002 REVISED MODEL

MIDDLE NEW BEDFORD HARBOR
BRISTOL COUNTY, NEW BEDFORD, MASSACHUSETTS

Apex
374 Congress St
Suite 500
Boston MA 02210
617 728-0070

SCALE: 1" = 400'	DRAWN	DESIGN	CHECKED	[illegible]
	TDM	TDM	JAB	SHEET 1 OF 1

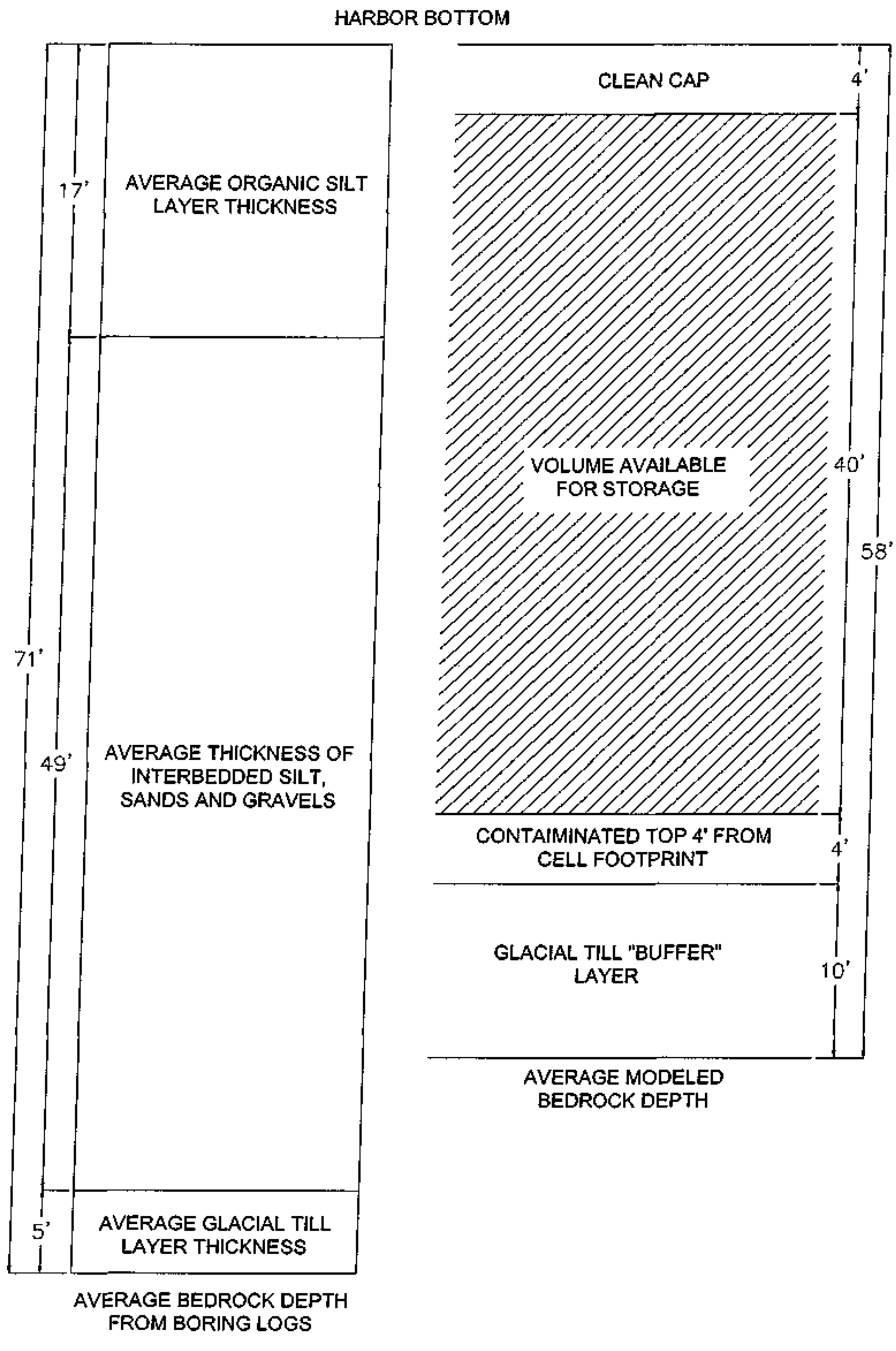


Illustration 3
Breakdown of the division of available storage capacity and an average geological cross section from the borings conducted in the Popes Island Area.

Illustration 4 Popes Island Area Cross Section Profile A-A’

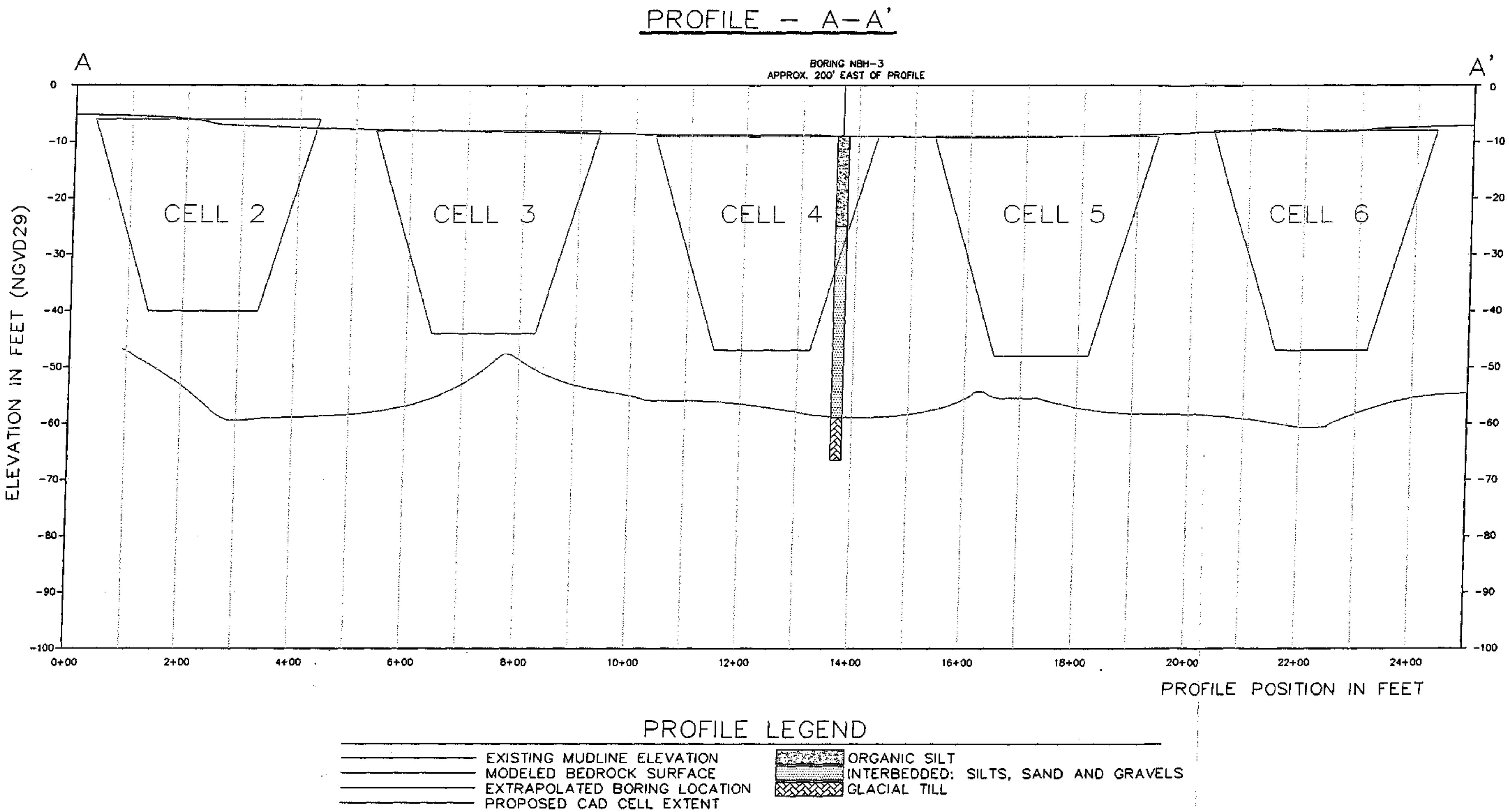


ILLUSTRATION 4 POPES ISLAND PROFILE A-A'.
Stratagraphic cross section was extracted from a profile cut through proposed CAD Cells 2 - 6 (A-A'). The cross section digitizes the modeled bedrock surface and the bathymetric surface over the length of the profile shown on Illustration 2. Proposed CAD cells used in the volume calculations are also shown utilizing the proposed 3:1 side slopes. Boring information collected as part of the project is extrapolated to the profile center line to depict basic geological units encountered.

Illustration 5 Popes Island Area Cross Section Profile B-B'

PROFILE – B–B'

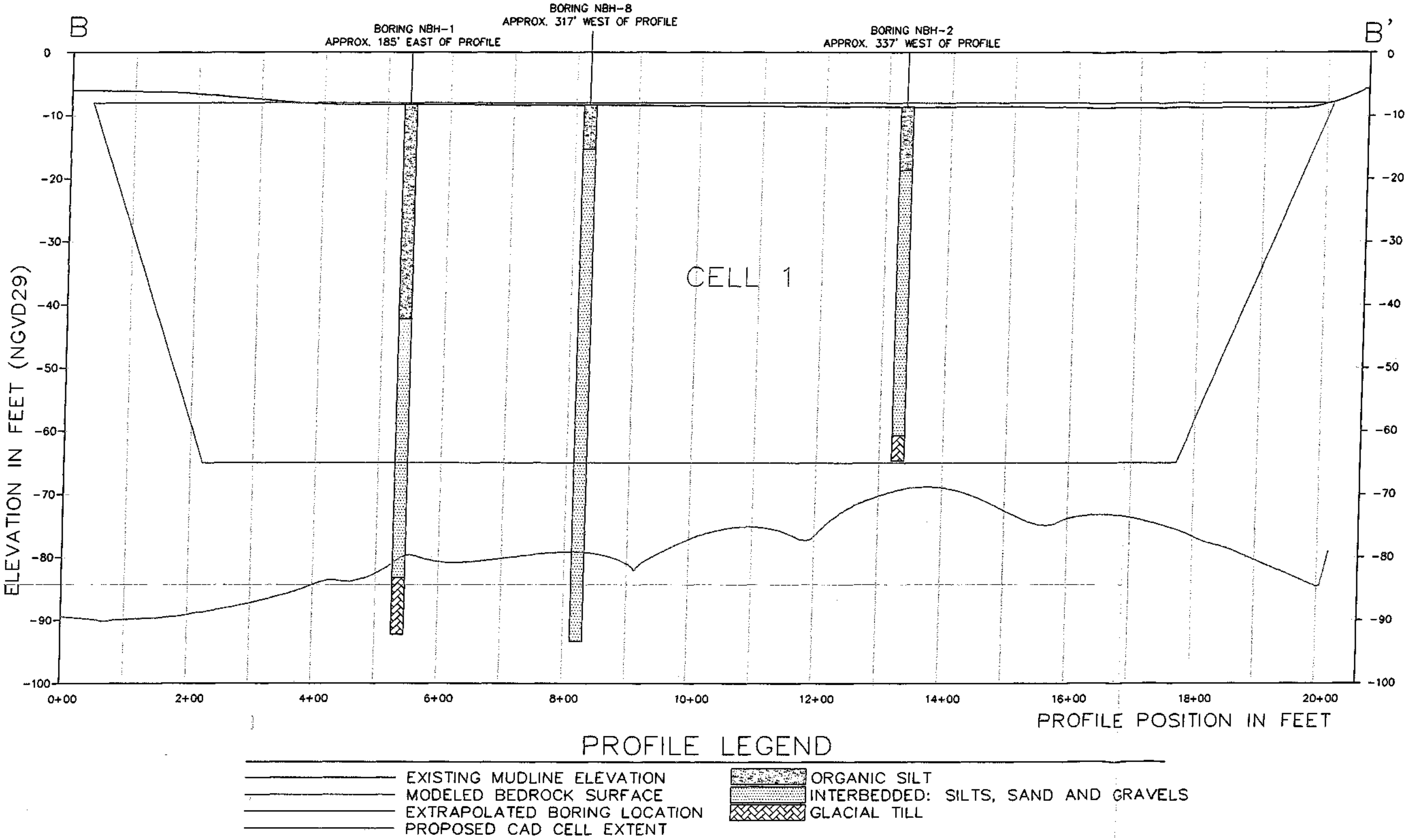


ILLUSTRATION 5 POPES ISLAND PROFILE B-B'.
Stratagraphic cross section was extracted from a profile cut through proposed CAD Cell 1 (B-B'). The cross section digitizes the modeled bedrock surface and the bathymetric surface over the length of the profile shown on Illustration 2. Proposed CAD cells used in the volume calculations are also shown utilizing the proposed 3:1 side slopes. Boring information collected as part of the project is extrapolated to the profile center line to depict basic geological units encountered.

Channel Inner Area

After investigating the potential storage volume within the Channel Inner Area, it is apparent that the shallow bedrock and general location of the proposed cell may severely limit the potential capacity in this area. Volumes were calculated assuming three cells in the Channel Inner Area (See Illustration 7). All Cells were designed to accommodate approximately 50,000 cubic yards of material. A separation distance of 100-feet was maintained between each of the cells. Illustration 6 shows the cell configuration.

For the cell volume calculations, a bedrock "buffer" of 10 feet was assumed so that the base of the cells terminate in sediment material approximately 10-feet higher than modeled bedrock. There is an additional loss of cell volume since the upper four (4) feet of sediment in the Popes Island North Area is assumed to be contaminated and should be placed back into the cell taking up volume associated with the top four (4) feet of material. Additionally, a cap of four (4) feet of "clean" material will be placed on top, for a cell total of eight (8) feet of depth subtracted from the calculations for each cell.

In addition, the proposed CAD cells are located within the federal channel and associated maneuvering /anchorage area. In order to account for future dredging activities, which may disturb the "clean" material cap, an additional contingency of three (3) feet was assumed. This additional contingency is expected to be either an additional cap thickness of 3-feet, or a depressed surface (i.e. leaving the final grade 3-feet below required depths). This extra compensation was added to protect the cap from being dredged as part of on going maintenance dredging during normal harbor/port operations. Illustration 7 below shows an estimate of the division of the available volume for the Channel Inner Area. Table 3 below summarizes the calculations for the Channel Inner Area.

Table 3. Volume Calculation summary for the Channel Inner Area CAD configuration shown in Illustration 6.

Cell	Average Bedrock Elevation	Average Bathymetric Elevation	Sediment Thickness	Available Dredge Depth	Total Dredged Volume	Total Storage Capacity
1	-57 ft	-31 ft	**26 ft**	16	**213,000 CY**	**48,500 CY**
2	-57 ft	-31 ft	**26 ft**	16	**213,000 CY**	**48,500 CY**
3	-58 ft	-28 ft	**30 ft**	20	**111,900 CY**	**55,750 CY**

Average Bedrock Elevation –Average Bathymetric Elevation = Sediment Thickness
Sediment Thickness – Bedrock buffer (10-feet) = Available Dredge Depth
Total Dredged volume = Available Dredge Depth X (length and width of cell) using 3:1 slope
Total Storage Capacity = Total Volume dredge – (top 4-foot contaminated material)

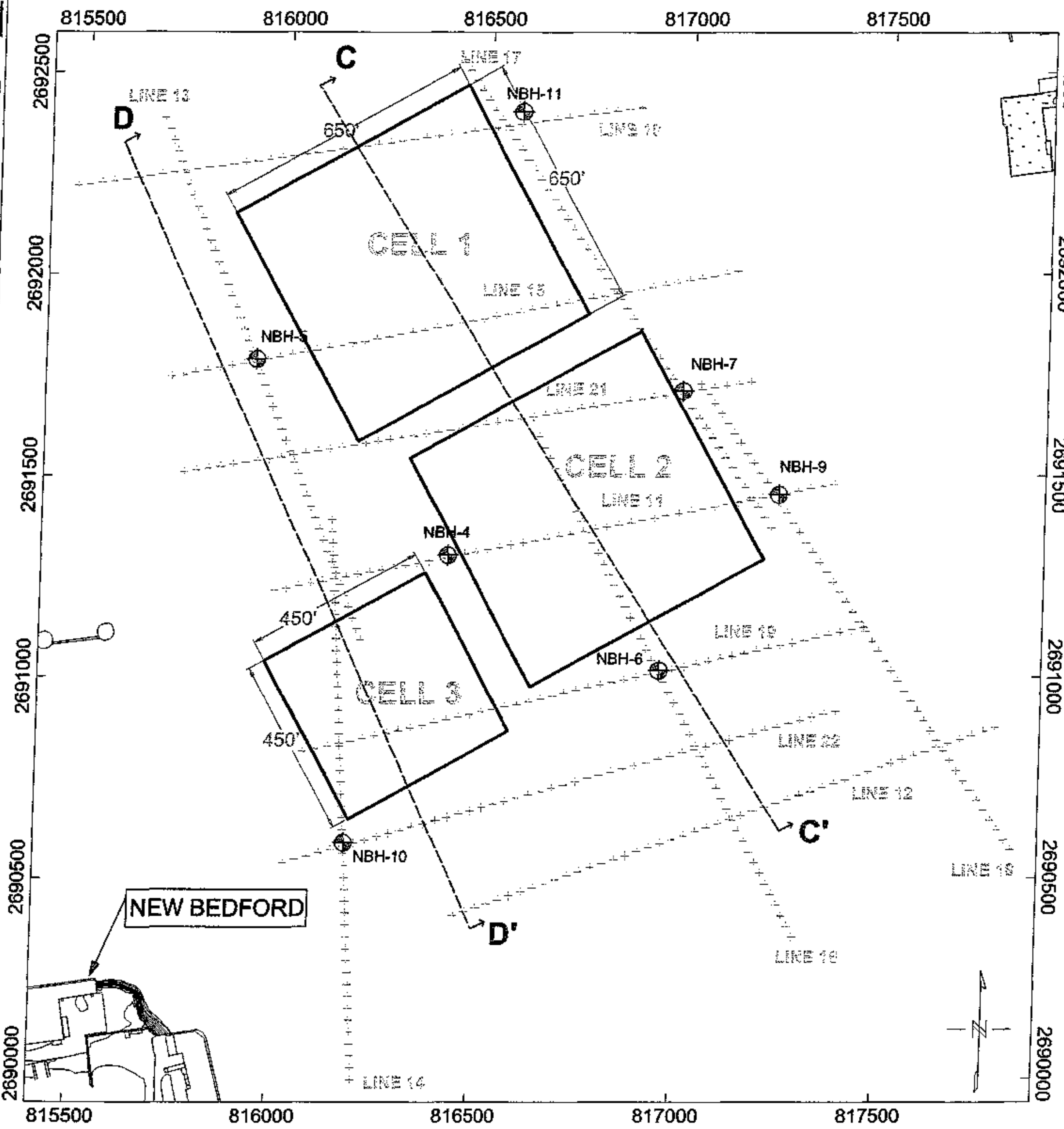
Table Assumptions:

- All volumes are calculated as Volume of the Void (VOV) and do not take into account sediment properties (i.e. bulking, etc.). The volumes are approximate, and are based on average elevations within each proposed cell.
- **Average Bedrock Elevations** were calculated using Oasis Montaj V5.16 minimum curvature model of the bedrock surfaces within each of the proposed CAD cells. A mathematical modeling cell size of 12 was maintained to construct the minimum curvature model of the bedrock surface.
- **Average Bathymetric Elevations** were calculated similarly to the Average Bedrock Elevations using the USACE bathymetric data 1997 and a mathematical cell size of 8.

- **Sediment Thickness** was calculated by subtracting Bathymetric/Mud line Elevation from the Bedrock Elevation.
- **Available Dredge Depth** is the depth of material excavated allowing the proposed CAD cell to terminate allowing a 10-foot sediment buffer between the bottom of the CAD cell and the bedrock surface. The available dredge depth can also be thought of as the depth of material to the bottom of the proposed CAD cell.
- **Total Volume Dredged** is the amount of material needed to be removed to form the proposed CAD cell given the average dredge depth and assuming a 3:1 (H:V) side slope for each cell.
- **Total Storage Capacity** is the final volume after disposing of the top 4-feet of "contaminated" material back into the cell and allowing for the 4-feet of clean cap material. A maintenance dredge contingency of 3-feet is also allowed for.

Cross Section Profiles – Channel Inner Area

Two Stratagraphic Cross Section were extracted from a profile cut through the Channel Inner Area proposed CAD cells 1 and 2 (C-C') and proposed CAD cell 3 (D-D'). Cross section locations can be seen in Illustration 6. Cross sections are shown on Illustration 8 and 9. The cross sections were constructed by digitizing the modeled bedrock surface and the bathymetric surface over the length of the profile. Boring information collected as part of the project was also extrapolated to the profile center line to depict the types and thickness of geology encountered.



LEGEND

- PROPOSED CELL EXTENT
- HYDROPHONE LOCATION
- BORING LOCATION
- CROSS SECTION LOCATION

Scale 1:4200

250 0 250

US survey foot

NAD83 / Massachusetts CS83 Mainland zone

NOTES:

1. Base Plan of the New Bedford harbor area was obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83). Vertical Datum referenced to NGVD29.
3. Boring information and position supplied by The Maguire Group.

REV.	DESCRIPTION	BY	DATE
1.	MOD CAD CONFIGURATION	TDM	05/13/03

ILLUSTRATION 6

CHANNEL INNER AREA
SEISMIC REFRACTION - REVISED MODEL

LOWER NEW BEDFORD HARBOR
BRISTOL COUNTY, NEW BEDFORD, MASSACHUSETTS

Apex
374 Congress St
Suite 600
Boston MA 02210
617 728-0070

SCALE:	DRAWN:	DESIGN:	CHECKED:	PROJECT# 6570.001.01
	TDM	TDM	JAB	

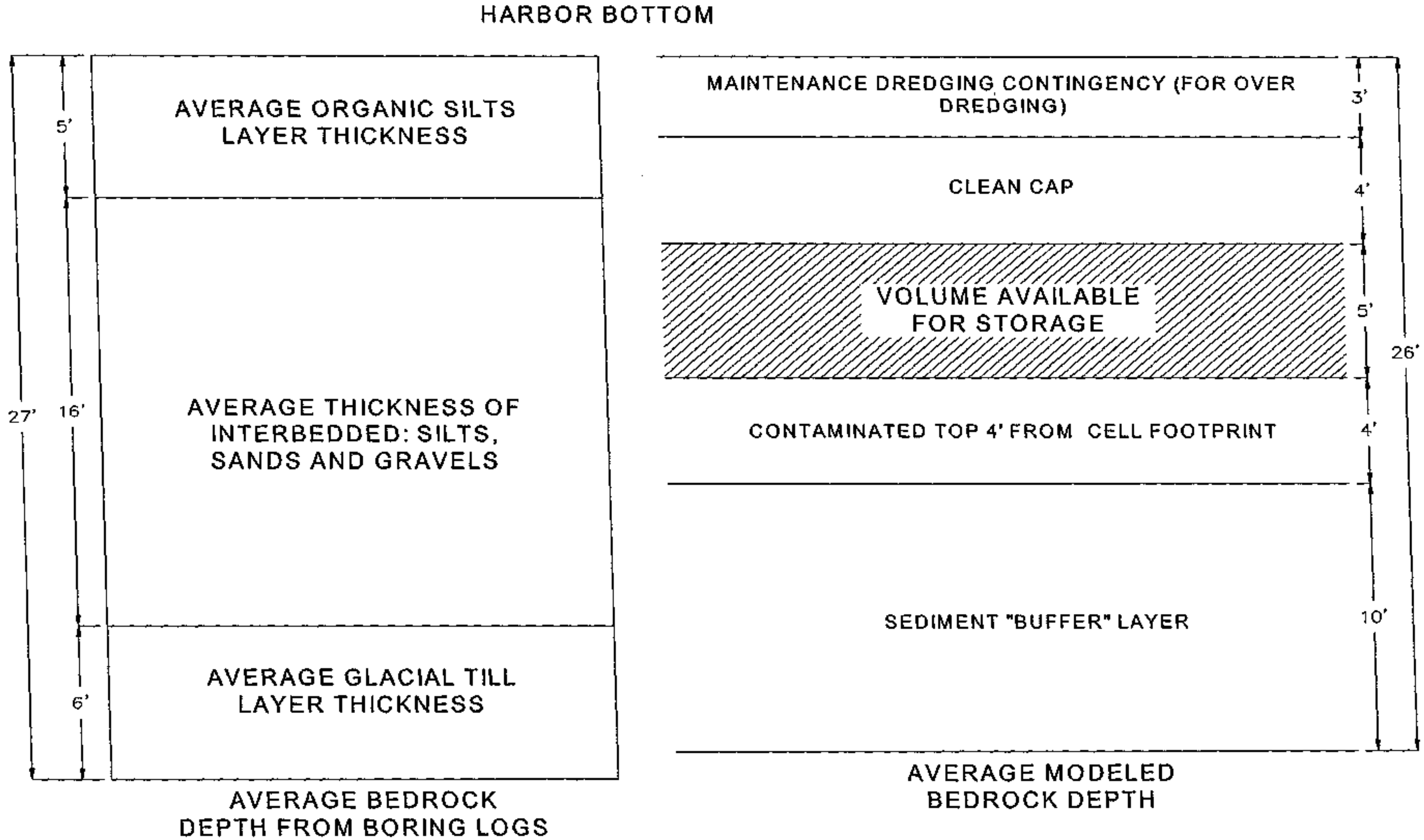


Illustration 7
Breakdown of the division of available storage capacity and average geological cross section as seen in the borings conducted in the Channel Inner Area

Illustration 8 Channel Inner Area Cross Section Profile C-C'

PROFILE – C–C'

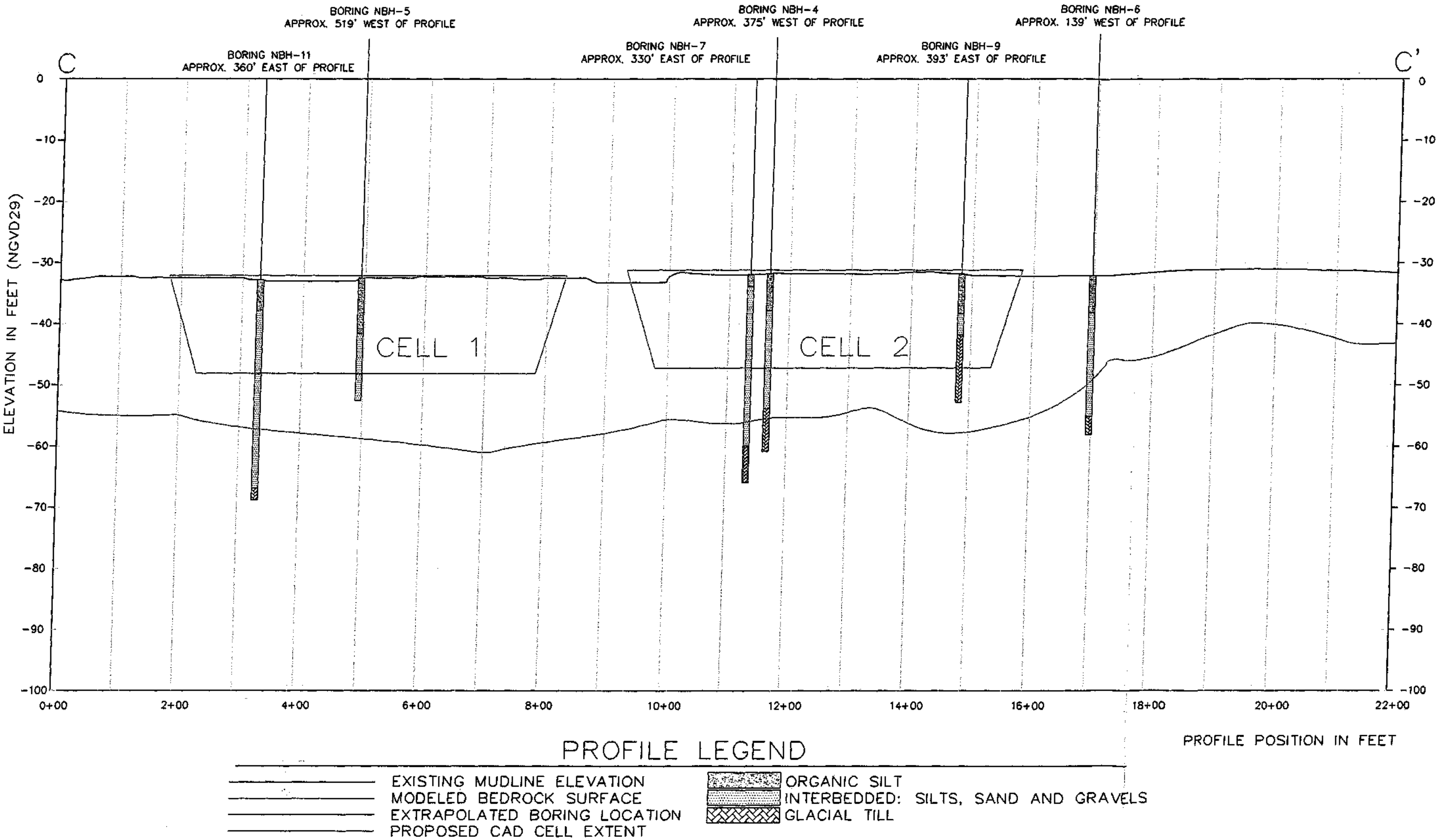
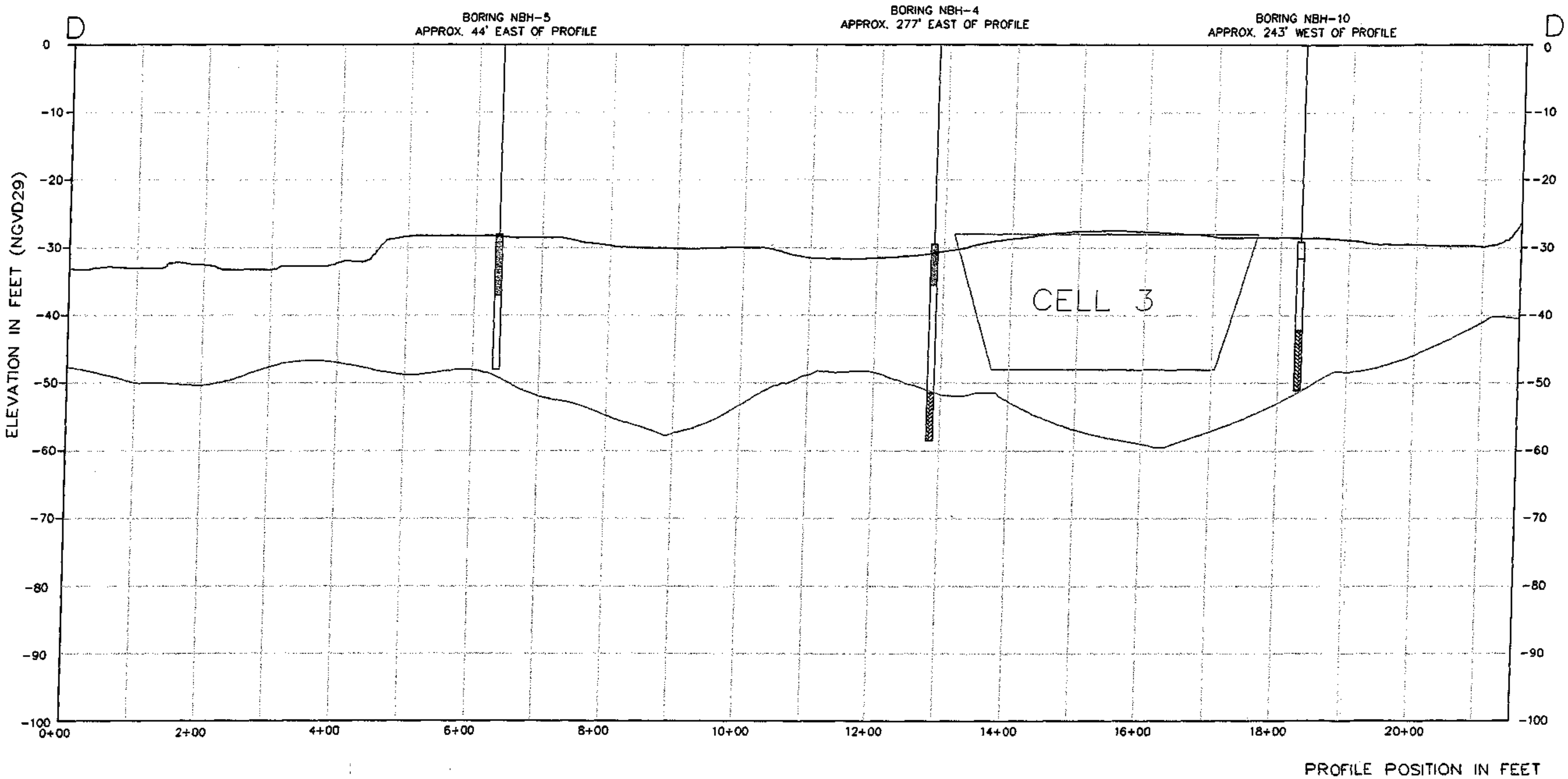


ILLUSTRATION 8 CHANNEL INNER AREA PROFILE C-C'.
Stratagraphic cross section was extracted from a profile cut through proposed Channel Inner Area CAD Cells 1 and 2 (C-C'). The cross section digitizes the modeled bedrock surface and the bathymetric surface over the length of the profile shown on Illustration 6. Proposed CAD cells used in the volume calculations are also shown utilizing the proposed 3:1 side slopes. Boring information collected as part of the project is extrapolated to the profile center line to depict basic geological units encountered.

Illustration 9   Channel Inner Area Cross Section Profile D-D'

PROFILE – D–D''



PROFILE LEGEND

- EXISTING MUDLINE ELEVATION
- MODELED BEDROCK SURFACE
- EXTRAPOLATED BORING LOCATION
- PROPOSED CAD CELL EXTENT
- ORGANIC SILT
- INTERBEDDED: SILTS, SAND AND GRAVELS
- GLACIAL TILL

ILLUSTRATION 9 CHANNEL INNER AREA PROFILE D-D'.
Stratagraphic cross section was extracted from a profile cut through proposed Channel Inner Area CAD Cell 3 (D-D'). The cross section digitizes the modeled bedrock surface and the bathymetric surface over the length of the profile shown on Illustration 6. Proposed CAD cells used in the volume calculations are also shown utilizing the proposed 3:1 side slopes. Boring information collected as part of the project is extrapolated to the profile center line to depict basic geological units encountered.

CONCLUSIONS

Seismic refraction models were re-interpreted utilizing additional boring information obtained in a recent boring program to construct the new revised bedrock models.

Models generated by the re-interpretation of the data collected in the initial field program indicate that the bedrock character in both areas of interest is irregular and small adjustments have been made to refine the existing models.

Popes Island Area

The shallowest bedrock encountered in the seismic data was –31 feet on Lines 1 and 6 at the northeastern end of the survey area. This is within approximately 500 feet of where bedrock outcrops on Marsh Island. The deepest bedrock, at –93 feet, is found at the farthest northwestern edge of the survey area where lines 5, 6 and 20 meet. The thickness of sediment above modeled bedrock varies from between 24 - 86 feet, with an average of 58 feet. A possible relict bedrock channel trending northwest to southeast runs through the middle of the survey area. This lineal feature is approximately 250 to 300 feet wide and runs through the study area from northwest to southeast. At its deepest point, the bedrock channel may extend below –90 feet NGVD29. This channel inference is further supported by bedrock surface elevation data to the northeast of the survey area collected by another contractor (Foster Wheeler, 2001) in a report submitted to the USACE. In some places the bedrock elevation varies by as much as 36-feet of elevation change over 120-feet of lateral change (or approximately a 25% slope), indicating that there is some relatively steep bedrock topographic variation within the possible CAD footprint.

Channel Inner Area

The shallowest bedrock encountered in the seismic data was –36 feet on Lines 14 and 16 at the southern end of the survey area. This is within approximately 1100 feet north of where bedrock outcrops on Palmer Island. The deepest bedrock, at –65 feet, is found in the center of the survey area at line 16. The thickness of sediment over bedrock varies between 3 and 39 feet, with an average thickness of 22 feet. This average sediment thickness was used in the volume estimates of the area. Due to construction requirements, there is a limited capacity for a potential CAD cell in this area. The presence of several "Low Velocity Zones" (or "LVZs") was noted on several seismic lines in this area. These anomalies in the data occur at locations where the velocity of the energy wave traveling through the bedrock material is locally reduced, usually because the bedrock is fractured or severely weathered in that zone. LVZs are often indicators of faulted or severely fractured bedrock, and the locations of the LVZs noted in the data during this study are shown in Figure 3. These areas of possible fracturing were further supported by information on rock quality (RQD) obtained in borings at or near to these zones. For example boring NBH-7, in which nine feet of weathered rock was recovered, exhibited 33% RQD values. It should be noted that data in the LVZs may be subjectively interpreted, as the actual velocity within such a zone can only be determined relatively, and can vary dramatically depending upon the material, the amount of fracturing, and the amount of weathering.

In the Channel Inner Area, the presence of LVZs imply that a northeast-southwest trending fracture zone and two north-south trending fracture zones may cross in this area. These fracture zones are evident in the Time-Distance plots for most of the east-west refraction spreads (lines 10, 11, 12, 15, 16, 17, 19, 21 and 22). Fracturing in the rock is made evident on Time-Distance plots as a time offset in the linear normal move-out of first breaks. An example of a Time-Distance plot showing the effects of fracturing is shown below in Illustration 10. In areas of fracturing, void spaces or sediment filled fractures (or even highly weathered rock) create a localized Low Velocity Zone (LVZ). Within these zones, the seismic velocity is much slower than that of the surrounding material. Because Seismic Refraction utilizes time and distance measurements to calculate bedrock geometry, data that contains LVZ's will tend to imply that a bedrock surface is lower than it actually is (increase in time at a fixed velocity increases distance by the geometric relation T=d/v).

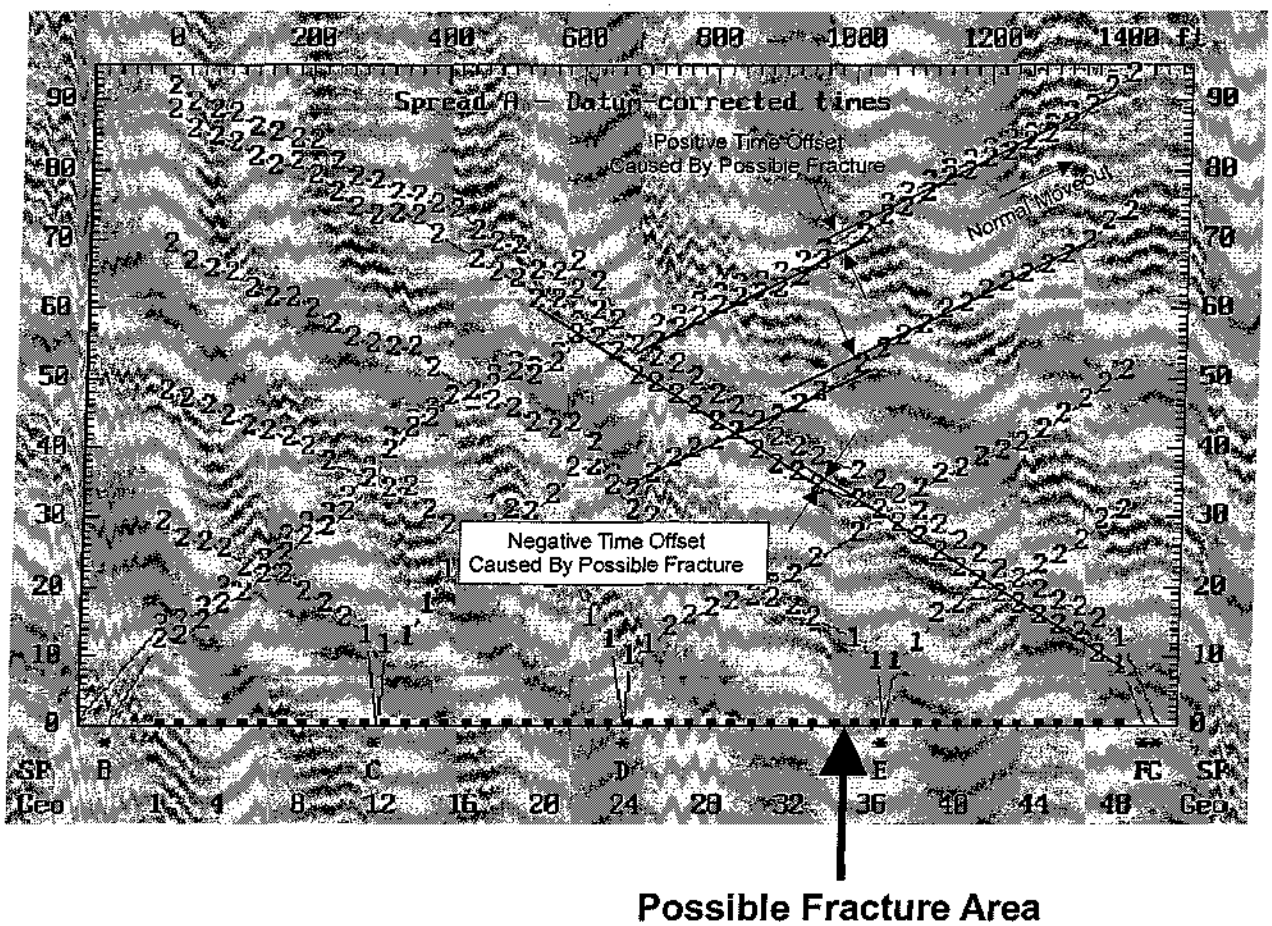


Illustration 10.
Time-Distance Plot Showing Areas of Possible Fracturing

In order to refine the thickness of contaminated organic silts to be deposited back into the proposed CAD cells a sub-bottom profiler survey could be utilized. The sub-bottom profiler uses high frequency seismic reflection to image stratagraphic interfaces such as those between organic silts and interbedded silts, sands and gravels. A survey using a similar approach was attempted within the harbor to help and identify depth to bedrock but was unsuccessful due to large amounts of reflective gasses. However, it is anticipated that a focused high resolution program is likely to yield the results necessary to define this layer, more accurately. By better defining this layer, a more accurate volume estimate can be achieved of the CAD cell parameters, which is expected, in turn, to yield a better overall design.

Summary

The Plan Map in Figure 6 is a depiction of the modeled total thickness of sediment within the two proposed CAD areas (Popes Island North & Channel Inner). As can be seen through a comparison of these two areas, there is limited sediment thickness (capacity) in the Channel Inner area. The average sediment thickness in the Channel Inner area is approximately 23 feet; with average water depths in the area of approximately 30 feet. The Popes Island North area has an average sediment thickness of approximately 58 feet; while the bathymetric depths range between approximately 8-10 feet of water.

LIMITATIONS

The following limitations apply to all geophysical surveys conducted by Apex Environmental, Inc. it's subsidiaries and subcontractors. Every attempt has been made to conduct this survey to maximize the quality of the data collected and the interpretations rendered. However, a geophysical investigation is an indirect method of subsurface exploration whereby subsurface characteristics are inferred or interpreted from measurements collected at the ground or water surface. Many variables may affect these measurements. Due to the indirect, interpretive nature of geophysics, findings are generally considered precursory and subject to verification by more direct methods of investigation such as test borings or test pits. The following limitations are considered when evaluating geophysical data:

1. Subsurface features can be interpreted from the appropriate geophysical methods only insofar as they produce a discernible geophysical signature. They must have adequate homogeneity, size, and appropriate physical or chemical properties sufficient to contrast with the surrounding medium and be within reasonable proximity to the sensors. Additionally, their signature must be distinguishable from and not masked by background noise or interference.

2. Lithologic data inferred on the basis of geophysical data may not be identical to geologic or hydrogeologic data. Lithologies are generally interpreted from some geophysical signature (e.g., velocity differences) that may be the result of many factors (including density, susceptibility, angle to the sensors, amount of weathering, etc.). Lithology divisions based upon seismic velocity for example may not necessarily be identical to lithology changes identified by drilling. The discrepancy is generally related to formation density and/or compaction (i.e., a dense till may have a higher density than a weathered bedrock, and the difference can be difficult to resolve with seismic data).

3. Complex geological configurations may be impossible to resolve with surface geophysical methods. The resolution of geophysical data is limited by the spatial geometry of sensors, strength of signal, and distance of the object or layer of interest from the energy source and the sensor array used. Resulting interpretations are rendered by modeling geophysical response to known or presumed geometric relationships. The complexity of the relationships that can be modeled is limited by the resolution allowed by the method and geometry of equipment layout used, and the limitations of the software used.

4. Apex is not responsible for data quality in areas having excessive "background noise" which affect the specific physical parameters of the subsurface that are being measured by a particular geophysical technique. Examples of background noise include: heavy traffic on a nearby roadway, which induces vibrational energy into the ground which in turn interferes with seismic data collection; heavy machinery (i.e., boat, sand-blaster, or torch) operation adjacent to or in the water near a marine seismic survey line; or underground utilities (such as electric lines, tunnels, sewers, etc.), which can interfere with seismic instrumentation.

No guarantee or warranty (other than that stipulated in the contract under which this work was promulgated), expressly stated or implied, is given concerning the data and interpretations rendered in this report. All information is presented as "for information only." Apex Environmental, Inc., its parent company or any subsidiary, is not liable for any losses resulting from the misuse, misrepresentation, or misinterpretation of any information presented in this report by any person or entity.

REFERENCES

Goldsmith, Richard, 1978, Geologic Map of the Fall River – New Bedford Area, Massachusetts, U.S. Geological Survey Open File Map 78-484, Department of the Interior, U.S. Geological Survey, publications center, Lakewood, CO.

Hatch, N.L., (ed.), 1991, *The Bedrock Geology of Massachusetts*, publication of the U.S. Geological Survey, USGS - Department of the Interior; Reston, VA, 106 p.

Zen, E-an (editor), 1983, Bedrock Geologic Map of Massachusetts (3 sheets), state Bedrock Geologic Maps publication of the U.S. Geological Survey, U.S. Department of the Interior, U.S. Geological Survey, publications center, Lakewood, CO.

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US Army Corps of Engineers, 1960, *Hurricane Projection Project: New Bedford-Fairhaven Hurricane Barrier (Design Memorandum No.2 Site Geology)*, US Army Corps of Engineers New England District, Waltham, MA.

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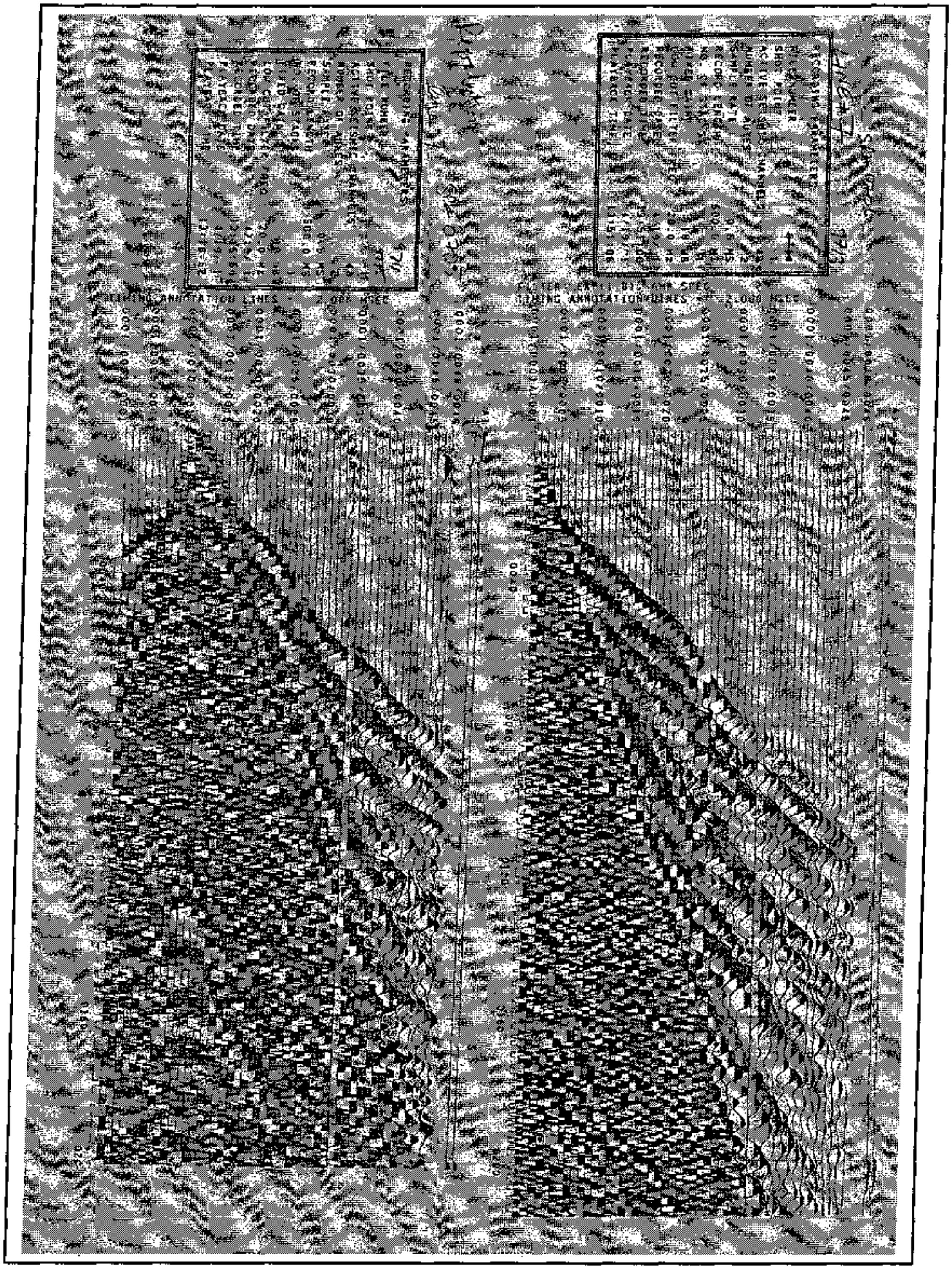
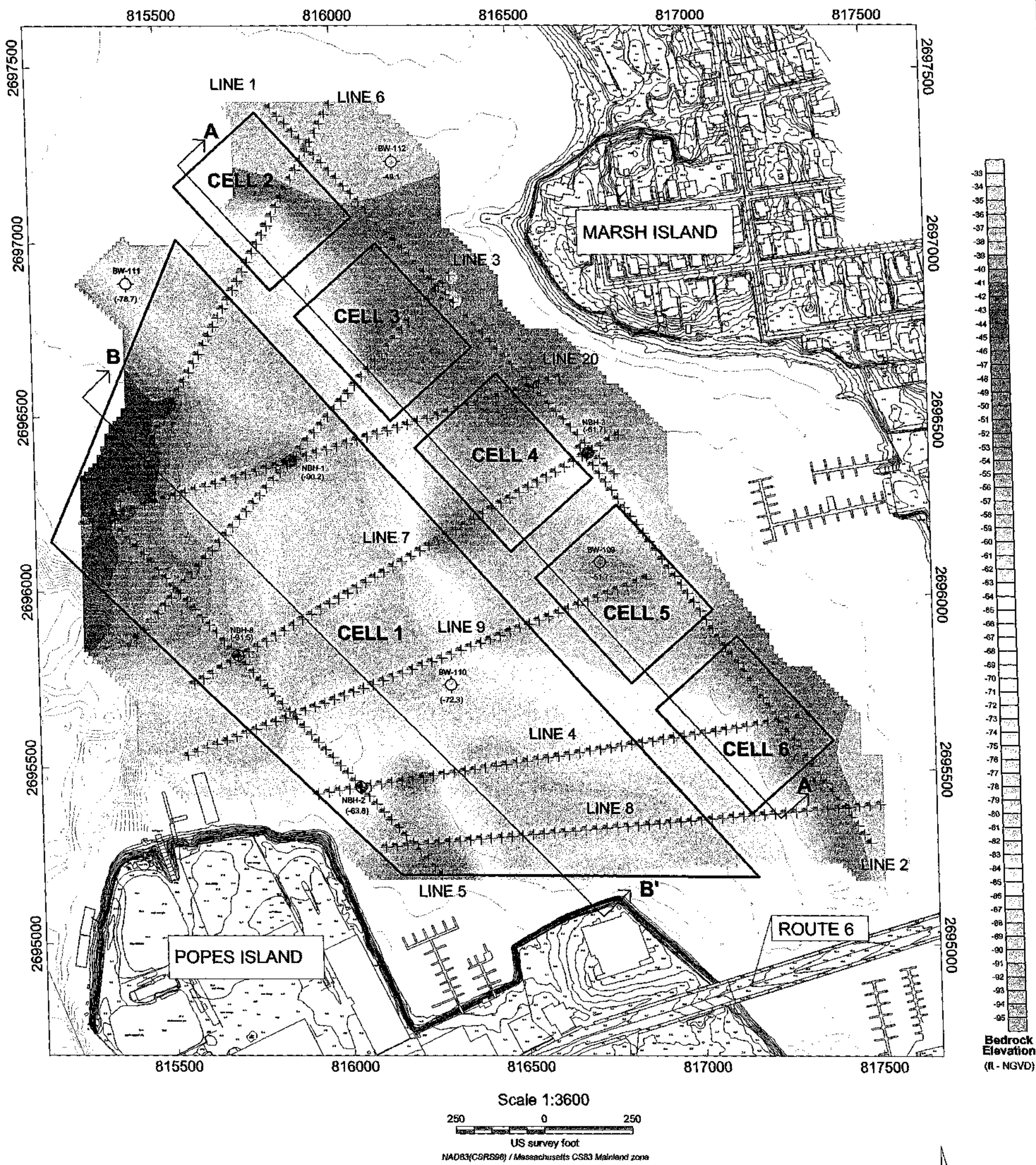
APPENDIX A
Example Seismograph Record





LEGEND

- SEISMIC CALIBRATION BORING
- EBASCO BORING (APPROXIMATE LOCATION)
- HYDROPHONE LOCATION (PHONE NUMBER & BEDROCK ELEVATION)
- 1' BATHYMETRIC CONTOUR
- PROPOSED CAD CELL EXTENTS
- CROSS SECTION LOCATION

NOTES:

1. Base Plan of the New Bedford harbor area was obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83). Vertical datum NGVD29.
3. Boring information and position supplied by The Maguire Group.

REV.	DESCRIPTION	BY	DATE
1.	MODIFIED DEPTH TO BEDROCK	TDM	01/08/02
2.	CAD CELL CONFIGURATION	TDM	05/05/03

FIGURE 2 - BEDROCK ELEVATION

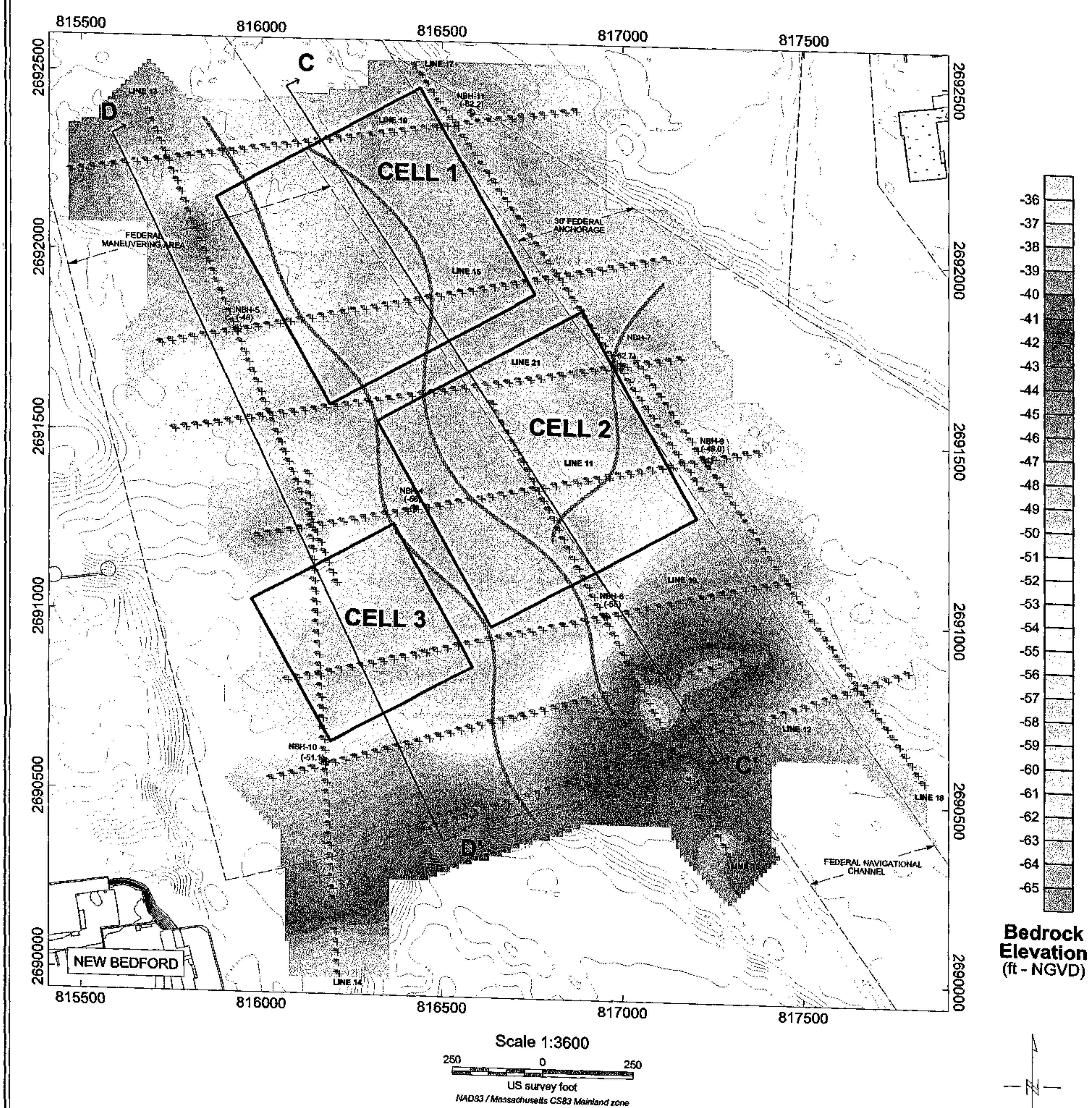
POPES ISLAND NORTH AREA
SEISMIC REFRACTION - REVISED MODEL

MIDDLE NEW BEDFORD HARBOR
BRISTOL COUNTY, NEW BEDFORD, MASSACHUSETTS

Apex

374 Congress St
Suite 500
Boston MA 02210
617 728-0070

SCALE: 1" = 100'	DRAWN:	DESIGN:	CHECKED:	PROJECT# 6510.001.01
	TDM	TDM	JAB	



LEGEND:

- POSSIBLE FRACTURE ZONE INFERED FROM SEISMIC DATA
- SEISMIC CALIBRATION BORING (MAGUIRE)
- FEDERAL CHANNEL, ANCHORAGE AND MANEUVERING AREA LINE
- HYDROPHONE LOCATION (PHONE NUMBER & BEDROCK ELEVATION INDICATED)
- 2' BATHYMETRIC CONTOUR
- PROPOSED CAD CELL EXTENT
- CROSS SECTION LOCATION

NOTES:

1. Base Plan of the New Bedford harbor area was obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83). Vertical Datum referenced to NGVD29.
3. Boring information and position supplied by The Maguire Group.

REV.	DESCRIPTION	BY	DATE
1.	MODIFIED DEPTH TO BEDROCK	TDM	01/08/02
2.	POSSIBLE CAD CELL CONFIGURATION	TDM	05/05/03
3.	MOD CAD CELL CONFIGURATION	TDM	05/13/03

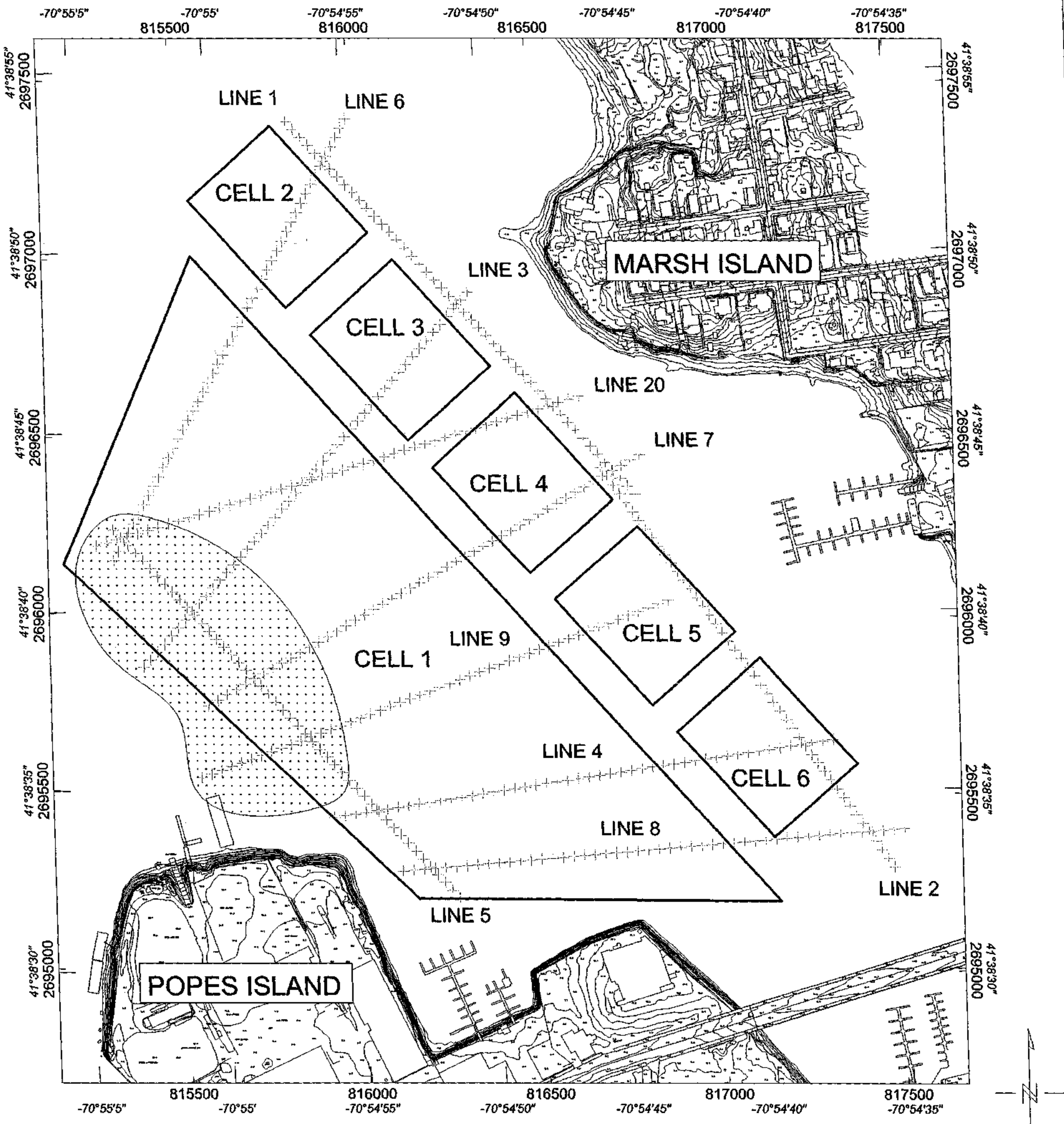
FIGURE 3 - BEDROCK ELEVATION

CHANNEL INNER AREA
SEISMIC REFRACTION - REVISED MODEL

LOWER NEW BEDFORD HARBOR
BRISTOL COUNTY, NEW BEDFORD, MASSACHUSETTS

Apex Environmental, Inc.
374 Congress St
Suite 500
Boston MA 02210
617 728-0070

SCALE:	DRAWN:	DESIGN:	CHECKED:	PROJECT# 6510.001.01
	TDM	TDM	JAB	



LEGEND

- MODERATE DATA CONFIDENCE LEVEL
- HYDROPHONE LOCATION
- PROPOSED CAD CELL EXTENT

Scale 1:3600

250 0 250

US survey foot

NAD83(CSRS98) / Massachusetts CS83 Mainland zone

NOTES:

1. Base Plan of the New Bedford harbor area was obtained from the US Army Corps of Engineers and has not been field verified.

2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).

REV.	DESCRIPTION	BY	DATE
1.	MODIFIED DEPTH TO BEDROCK	TDM	01/08/02
2.	CAD CELL CONFIGURATION	TDM	05/05/03

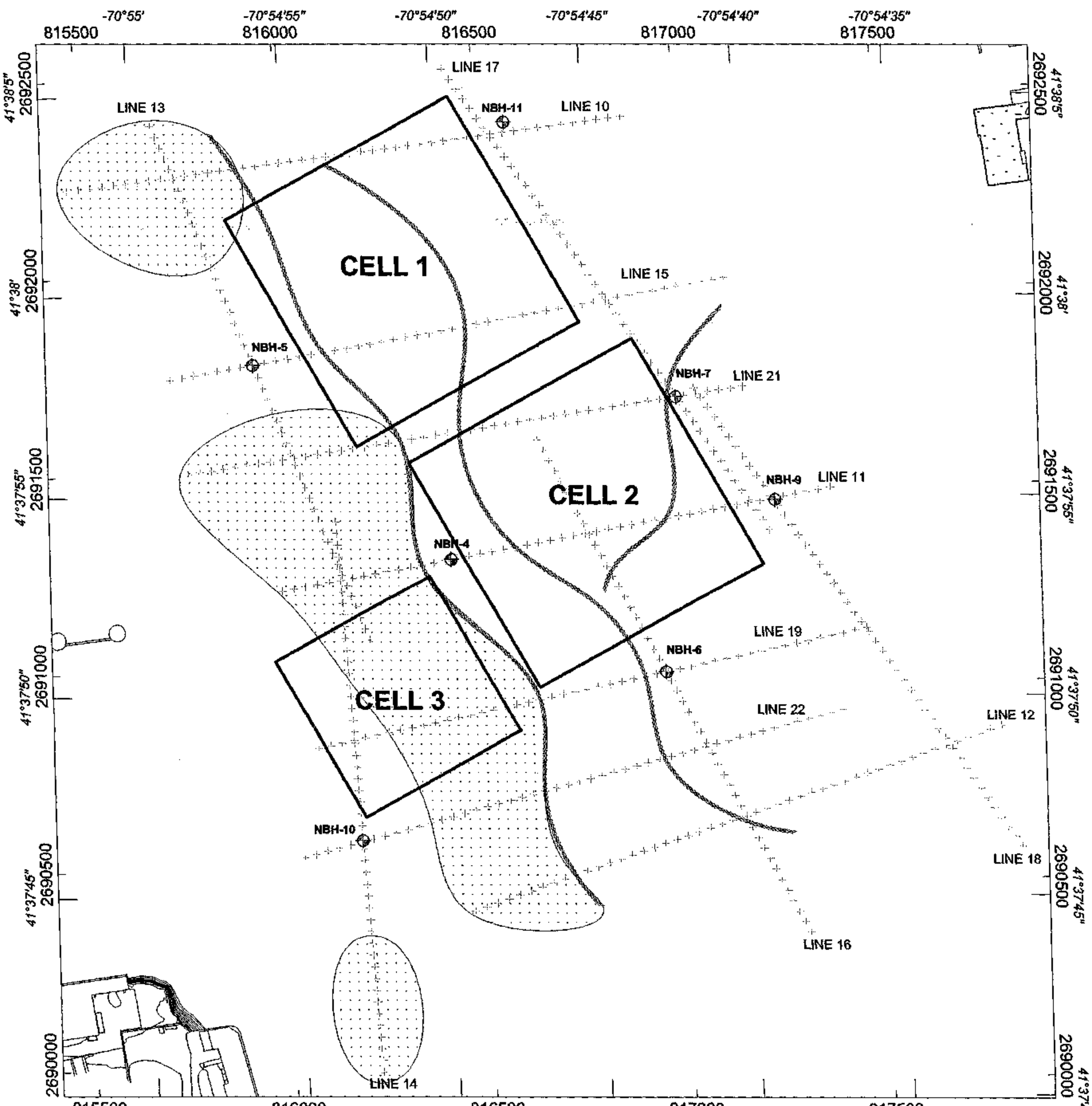
FIGURE 4

POPES ISLAND NORTH AREA - CONFIDENCE LEVELS
SEISMIC REFRACTION - REVISED MODEL

MIDDLE NEW BEDFORD HARBOR
BRISTOL COUNTY, NEW BEDFORD, MASSACHUSETTS

Apex environmental, inc.
374 Congress St
Suite 500
Boston MA 02210
617 728-0070

SCALE: 1" = 300'	DRAWN:	DESIGN:	CHECKED:	PROJECT# 6510.001.01
	TDM	TDM	JAB	SHEET 4 OF 6



LEGEND:

- POSSIBLE FRACTURE ZONE INFERED FROM SEISMIC DATA
- MODERATE DATA CONFIDENCE LEVEL
- HYDROPHONE LOCATION
- POSSIBLE CAD CELL EXTENTS

Scale 1:3600

250 0 250

US survey foot

NAD83 / Massachusetts CS83 Mainland zone

NOTES:

1. Base Plan of the New Bedford harbor area was obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).

REV.	DESCRIPTION	BY	DATE
1.	MODIFIED DEPTH TO BEDROCK	TDM	01/08/02
2.	POSSIBLE CAD CELL CONFIGURATION	TDM	05/05/03
3.	MOD CAD CELL CONFIGURATION	TDM	05/13/03

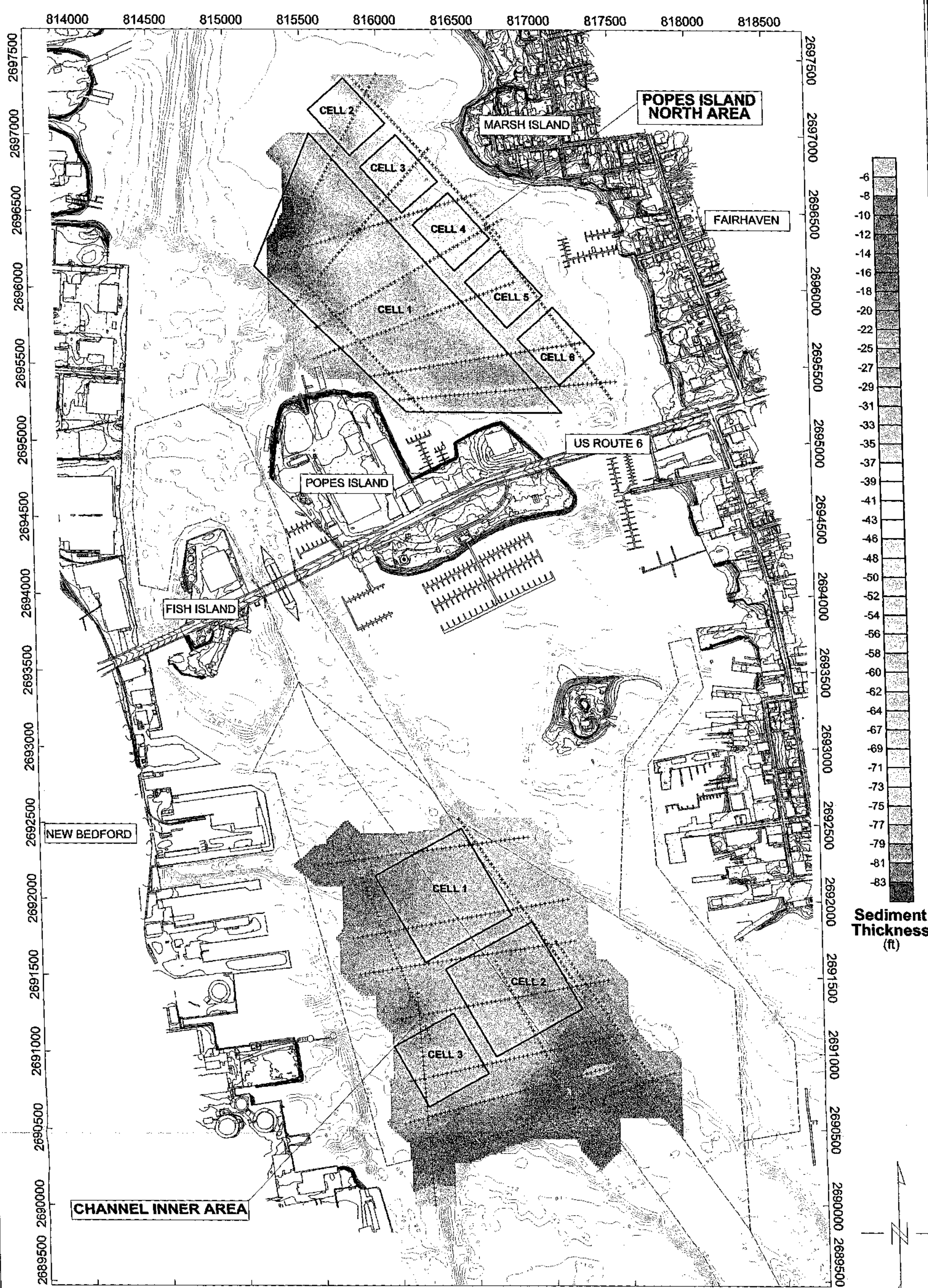
FIGURE 5

CHANNEL INNER AREA - CONFIDENCE LEVELS
SEISMIC REFRACTION - REVISED MODEL

LOWER NEW BEDFORD HARBOR
BRISTOL COUNTY, NEW BEDFORD, MASSACHUSETTS

Apex Environmental, Inc.
374 Congress St
Suite 500
Boston MA 02210
617 728-0070

SCALE: 1" = 300'	DRAWN:	DESIGN:	CHECKED:	PROJECT# 5510.001.01
	TDM	TDM	JAB	



Scale 1:7200

250 0 250 500 750

US survey foot

NOTES:

1. Base Plan of the New Bedford harbor area was obtained from the US Army Corps of Engineers and has not been field verified.
2. Coordinates are shown in the State Plane Coordinate System, Massachusetts Mainland Zone 2001, Referenced to the 1983 North American Datum (NAD83).
3. Sediment Thickness Calculated as the Difference Between Bedrock and Mudline Elevations.

LEGEND

- FEDERAL CHANNEL, ANCHORAGE AND MANEUVERING AREA
- 2 FOOT BATHYMETRIC CONTOUR
- + HYDROPHONE LOCATION
- POSSIBLE CAD CELL CONFIGURATION

REV.	DESCRIPTION	BY	DATE
1.	POSSIBLE CAD CONFIGURATION	TDM	05/05/03
2.	MOD CAD CONFIGURATION	TDM	05/13/03

FIGURE 6 - SEDIMENT THICKNESS MAP

CHANNEL INNER & POPES ISLAND NORTH AREAS
SEISMIC REFRACTION - REVISED MODEL

NEW BEDFORD HARBOR
BRISTOL COUNTY, NEW BEDFORD, MASSACHUSETTS

Apex environmental, inc.
374 Congress St
Suite 500
Boston MA 02210
617 728-0070

SCALE:	DRAWN:	DESIGN:	CHECKED:	PROJECT# 8518.001.01
	TDM	TDM	JAB	

Sample Date: 8/3/11

APEX

BORING LOG

Project:	New Bedford Harbor	Project No:	6690.013	N: 2696460
Location:	CAD3			E: 815755
Mudline Elevation (MLLW): -7.0 feet				
Casing Type:	4" Vibracore	Total Boring Depth: 5.4'		Boring No: A-CAD3A-2011-VC1
Vibracore Dia:	4"	Recovery Length Vibracore: 5.4'		
Drill Co:	Apex Cos.	Method:	Vibracore	Sheet: 1 of 1
Driller:	JER/CAS/RM	Log By:	CAS	

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.3	0-0.3	N/A	5.4/5.4	Black organic SILT, some shell hash, little fine sand.	
0.9	0.3-0.9	N/A		Black organic SILT, little shell hash, little fine sand.	
3.3	0.9-3.3	N/A		Light gray SILT, trace shell hash, trace fine sand.	
5.4	3.3-5.4	N/A		Light gray SILT, trace shell hash, trace fine sand.	

Comments:

Sample Date: 8/3/11

BORING LOG

Project: New Bedford Harbor	Project No: 6690.013	N: 2696713	
Location: CAD3		E: 815801	
Mudline Elevation (MLLW): -6.8 feet			
Casing Type: N/A	Total Boring Depth: 9.0'	Boring No: A-CAD3A-2011-VC2	
Vibracore Dia: 2"	Recovery Length Peat Corer: 9.0'		
Drill Co: Apex Cos.	Method: Russian Peat Corer	Sheet: 1 of 1	
Driller: JER/CAS/RM	Log By: CAS		

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.8	0-0.8	N/A	9.0/9.0	Black organic SILT, trace fine sand, trace shell hash.	
1.7	0.8-1.7	N/A		Dark grey and dense organic SILT, trace fine sand.	
3.0	1.7-3.0	N/A		Light grey organic SILT, trace shell hash.	
6.6	3.0-6.6	N/A		Light grey organic SILT.	
7.8	6.6-7.8	N/A		Light grey organic SILT.	
9.0	7.8-9.0	N/A		Light grey organic SILT.	

Comments: Sediment at this sample location was soft and loose and sampling with the vibracore was not feasible. Sample was washing out of the 4-inch vibracore; therefore, peat-core samples were collected at 3-foot intervals to 9 feet below mudline.

Sample Date: 8/3/11

APEX

BORING LOG

Project:	New Bedford Harbor	Project No: 6690.013	N: 2696919
Location:	CAD3		E: 815846
Mudline Elevation (MLLW): -6.2 feet			
Casing Type:	4" Vibracore	Total Boring Depth: 7.0'	Boring No: A-CAD3A-2011-VC3
Vibracore Dia:	4"	Recovery Length Vibracore: 7.0'	
Drill Co:	Apex Cos.	Method: Vibracore	Sheet: 1 of 1
Driller:	JER/CAS/RM	Log By: CAS	

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.3	0-0.3	N/A	7.0/7.0	Vibracore: Black organic SILT.	
3.8	0.3-3.8	N/A		Vibracore: Light grey SILT, little fine sand, little shell hash.	
7.0	3.8-7.0	N/A		Vibracore: Light grey SILT, little shell hash, trace fine sand.	

Comments:

Sample Date: 8/3/11

APEX

BORING LOG

Project: New Bedford Harbor		Project No: 6690.013	N: 2696959
Location: CAD3			E: 815662
Mudline Elevation (MLLW): -5.3 feet			
Casing Type: 4" Vibracore	Total Boring Depth: 4.7'		Boring No: A-CAD3A-2011-VC4
Vibracore Dia: 4"	Recovery Length Vibracore: 4.7'		
Drill Co: Apex Cos.	Method: Vibracore		Sheet: 1 of 1
Driller: JER/CAS/RM	Log By: CAS		

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.25	0-0.25	N/A	4.7/4.7	Black organic SILT, trace fine sand, trace shell hash.	
0.4	0.25-0.4	N/A		Dark grey SILT and SHELL HASH, some fine to medium sand.	
1.4	0.4-1.4	N/A		Dark grey SILT and fine to medium SAND.	
2.6	1.4-2.6	N/A		Dark grey SILT and fine to coarse SAND.	
3.4	2.6-3.4	N/A		Black organic SILT and fine to coarse SAND.	
4.7	3.4-4.7	N/A		Light grey fine to coarse SAND, little fine gravel, trace medium gravel.	

Comments:

Sample Date: 8/3/11

APEX

BORING LOG

Project: New Bedford Harbor		Project No: 6690.013	N: 2697012
Location: CAD3			E: 815476
Mudline Elevation (MLLW): -3.9 feet			
Casing Type: 4" Vibracore	Total Boring Depth: 2.9'		Boring No: A-CAD3A-2011-VC5
Vibracore Dia: 4"	Recovery Length Vibracore: 2.9'		
Drill Co: Apex Cos.	Method: Vibracore		Sheet: 1 of 1
Driller: JER/CAS/RM	Log By: CAS		

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.5	0-0.5	N/A	2.9/2.9	Black organic SILT and SHELL HASH, little fine sand.	
1.4	0.5-1.4	N/A		Silty fine to medium SAND, little shell hash.	
2.6	1.4-2.6	N/A		Brown / grey fine to medium SAND.	
2.9	2.6-2.9	N/A		Brown fine to medium SAND.	

Comments:

Sample Date: 8/4/11

BORING LOG

Project: New Bedford Harbor	Project No: 6690.013		N: 2696777 E: 815436
Location: CAD3			
Mudline Elevation (MLLW): -4.2 feet			
Casing Type: 4" Vibracore	Total Boring Depth: 3.5'		Boring No: A-CAD3A-2011-VC6
Vibracore Dia: 4"	Recovery Length Vibracore: 3.5'		
Drill Co: Apex Cos.	Method: Vibracore		Sheet: 1 of 1
Driller: JER/CAS/RM	Log By: CAS		

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.3	0-0.3	N/A	3.5/3.5	Black organic SILT, little fine sand, trace shell hash.	
0.7	0.3-0.7	N/A		Dark grey fine to medium SAND and SILT, little shell hash.	
2.1	0.7-2.1	N/A		Dark grey SILT, some fine sand.	
2.4	2.1-2.4	N/A		Light grey inorganic SILT and fine SAND.	
3.5	2.4-3.5	N/A		Brown fine to medium SAND.	

Comments:

Sample Date: 7/28/11

APEX

BORING LOG

Project:	New Bedford Harbor	Project No:	6690.013	N: 2696928
Location:	CAD3			E: 814927
Mudline Elevation (MLLW): -6.2 feet				
Casing Type:	4" Vibracore	Total Boring Depth: 10.4'		Boring No: A-CAD3-2011-VC1
Vibracore Dia:	4"	Recovery Length Vibracore: 10.4'		
Drill Co:	Apex Cos.	Method:	Vibracore	Sheet: 1 of 1
Driller:	JER/CAS	Log By:	CAS	

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
1.4	0-1.4	N/A	10.4/10.4	Black organic SILT, some shell hash, some fine to coarse sand.	
4.0	1.4-4.0	N/A		Dark grey SILT and fine to coarse SAND and SHELL HASH, odor.	
6.7	4.0-6.7	N/A		Light grey SAND and SILT, trace fine gravel (localized at 6.3 feet), trace wood chips, odor.	
10.0	6.7-10	N/A		Light grey inorganic SILT, very slight odor.	
10.4	10-10.4	N/A		Red-orange-brown fine to medium SAND.	

Comments:

Sample Date: 7/28/11

APEX

BORING LOG

Project:	New Bedford Harbor	Project No: 6690.013	N: 2696908
Location:	CAD3		E: 815052
Mudline Elevation (MLLW): -3.8 feet			
Casing Type:	4" Vibracore	Total Boring Depth: 4.0'	Boring No: A-CAD3-2011-VC2
Vibracore Dia:	4"	Recovery Length Vibracore: 4.0'	
Drill Co:	Apex Cos.	Method: Vibracore	Sheet: 1 of 1
Driller:	JER/CAS	Log By: CAS	

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
2.0	0-2	N/A	4.0/4.0	Black organic SILT and SHELL HASH, some fine sand.	
2.5	2-2.5	N/A		Dark grey / brown fine to coarse SAND and SHELL HASH.	
4.0	2.5-4.0	N/A		Light grey inorganic SILT.	

Comments:

Sample Date: 7/28/11

BORING LOG

Project:	New Bedford Harbor	Project No: 6690.013	N: 2696862
Location:	CAD3		E: 815175
Mudline Elevation (MLLW): -3.8 feet			
Casing Type:	4" Vibracore	Total Boring Depth: 6.0'	Boring No: A-CAD3-2011-VC3
Vibracore Dia:	4"	Recovery Length Vibracore: 6.0'	
Drill Co:	Apex Cos.	Method: Vibracore	Sheet: 1 of 1
Driller:	JER/CAS	Log By: CAS	

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.2	0-0.2	N/A	6.0/6.0	Black organic SILT.	
1.2	0.2-1.2	N/A		Black organic SILT and grey coarse SAND.	
1.4	1.2-1.4	N/A		Dark grey SILT and SHELL HASH.	
2.0	1.4-2.0	N/A		Dark grey SILT and fine to coarse SAND, some shell hash.	
3.2	2.0-3.2	N/A		Grey / light brown fine gravel.	
6.0	3.2-6.0	N/A		Inorganic SILT.	

Comments:

Sample Date: 7/28/11

APEX

BORING LOG

Project: New Bedford Harbor	Project No: 6690.013		N: 2696820 E: 815297
Location: CAD3			
Mudline Elevation (MLLW): -3.9 feet			
Casing Type: 4" Vibracore	Total Boring Depth: 3.0'		Boring No: A-CAD3-2011-VC4
Vibracore Dia: 4"	Recovery Length Vibracore: 3.0'		
Drill Co: Apex Cos.	Method: Vibracore		Sheet: 1 of 1
Driller: JER/CAS	Log By: CAS		

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.4	0-0.4	N/A	3.0/3.0	Black organic SILT and SHELL HASH.	
2.0	0.4-2.0	N/A		Black organic SILT and fine to coarse SAND, little fine gravel, little shell hash.	
3.0	2.0-3.0	N/A		Light grey inorganic SILT.	

Comments:

Sample Date: 7/28/11

APEX

BORING LOG

Project: New Bedford Harbor Project No: 6690.013	N: 2696521
Location: CAD3	E: 815257
Mudline Elevation (MLLW): -5.5 feet	
Casing Type: 4" Vibracore Total Boring Depth: 3.7'	Boring No: A-CAD3-2011-VC5
Vibracore Dia: 4" Recovery Length Vibracore: 3.7'	
Drill Co: Apex Cos. Method: Vibracore	Sheet: 1 of 1
Driller: JER/CAS Log By: CAS	

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.3	0-0.3	N/A	3.7/3.7	Black organic SILT.	
2.7	0.3-2.7	N/A		Grey silt and fine to medium SAND and SHELL HASH, slight organic odor.	
3.7	2.7-3.7	N/A		Light grey fine to coarse SAND, some fine gravel.	

Comments:

Sample Date: 7/28/11

APEX

BORING LOG

Project: New Bedford Harbor	Project No: 6690.013		N: 2696569
Location: CAD3			E: 815125
Mudline Elevation (MLLW): -5.9 feet			
Casing Type: 4" Vibracore	Total Boring Depth: 3.1'		Boring No: A-CAD3-2011-VC6
Vibracore Dia: 4"	Recovery Length Vibracore: 3.1'		
Drill Co: Apex Cos.	Method: Vibracore		Sheet: 1 of 1
Driller: JER/CAS	Log By: CAS		

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.4	0-0.4	N/A	3.1/3.1	Black organic SILT and SHELL HASH.	
1.0	0.4-1.0	N/A		Dark grey SILT, little fine sand, little shell hash.	
2.1	1.0-2.1	N/A		Light grey SILT, some fine to coarse sand, trace shell hash.	
2.7	2.1-2.7	N/A		Light grey SILT, some fine to medium sand.	
3.1	2.7-3.1	N/A		Light grey / brown fine to coarse SAND and FINE GRAVEL.	

Comments:

Sample Date: 7/28/11

APEX

BORING LOG

Project: New Bedford Harbor	Project No: 6690.013		N: 2696625
Location: CAD3			E: 814992
Mudline Elevation (MLLW): -6.7 feet			
Casing Type: 4" Vibracore	Total Boring Depth: 5.3'		Boring No: A-CAD3-2011-VC7
Vibracore Dia: 4"	Recovery Length Vibracore: 5.3'		
Drill Co: Apex Cos.	Method: Vibracore		Sheet: 1 of 1
Driller: JER/CAS	Log By: CAS		

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.5	0-0.5	N/A	5.3/5.3	Black organic SILT and SHELL HASH.	
1.0	0.5-1.0	N/A		Black organic SILT and SHELL HASH, little fine to coarse sand.	
2.15	1.0-2.15	N/A		Dark grey SILT, little fine sand, trace shell hash.	
4.35	2.15-4.35	N/A		Medium to dark grey SILT and fine to medium SAND, slight odor.	
5.1	4.35-5.1	N/A		Light grey fine to medium SAND.	
5.3	5.1-5.3	N/A		Light grey fine to coarse SAND, little fine gravel.	

Comments:

Sample Date: 8/2/11

BORING LOG

Project:	New Bedford Harbor	Project No: 6690.013	N: 2696681
Location:	CAD3		E: 814848
Mudline Elevation (MLLW): -8.9 feet			
Casing Type:	4" Vibracore	Total Boring Depth: 6.2'	Boring No: A-CAD3-2011-VC8
Vibracore Dia:	4"	Recovery Length Vibracore: 6.2'	
Drill Co:	Apex Cos.	Method: Vibracore	Sheet: 1 of 1
Driller:	JER/CAS	Log By: CAS	

Depth Below Mudline (Feet)	Interval (Feet)	Blow Count	Pen/Rec (Feet)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Remarks
0.75	0-0.75	N/A	6.2/6.2	Black organic SILT, trace shell hash.	
1.55	0.75-1.55	N/A		Dark grey SILT, little sand, organic odor.	
2.6	1.55-2.6	N/A		Dark grey SILT, little fine sand, trace shell hash.	
6.20	2.6-6.2	N/A		Dark grey SILT, trace fine to medium sand, organic odor.	

Comments:

VIBRACORE LOG

Project:	New Bedford Harbor	Project No: 6515.003	Lat 41 38.7407 N
Location:	DMMP North of Popes Island	CAD 2	Long 70 55.1221 W
Elevation at mudline: -5.6'		Datum: MLLW	
Casing Type: Polycarbonate		Penetration: 14.0 ft	Boring No: VC-101
Casing Diameter: 3"		Recovery: 10.7 ft	
Drill Co:	TGB	Method: Vibracore	Sheet: 1 of 1
Driller:	RR	Log By: KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 101 0-1		Black organic silt; some shell hash, organic odor.
2	VC2007 101 1-2		Dark gray silt; little shell fragments.
3	VC2007 101 2-3		
4	VC2007 101 3-4		Dark gray silt; little shell fragments, trace very fine sand.
5	VC2007 101 4-5		
6	VC2007 101 5-6		
7	VC2007 101 6-7		Dark gray interbedded silt and fine sand.
8	VC2007 101 7-8		
9	VC2007 101 8-9	9.4 ft	Dark gray silt.
10	VC2007 101 9-10		Peat
11			
12			NO RECOVERY below 10.7 ft
13			
14			

Bottom of Exploration at 14 ft

Comments:
Penetration: 14.0'.
No Refusal

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8002 N
Location: DMMP North of Popes Island		CAD 2	Long 70 55.1221 W
Elevation at mudline: -6.4'	Datum: MLLW		
Casing Type: Polycarbonate	Penetration: 9.5 ft		Boring No: VC-102
Casing Diameter: 3"	Recovery: 8.8 ft		
Drill Co: TGB	Method: Vibracore		Sheet: 1 of 1
Driller: RR	Log By: KvN, GCD		

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 102 0-1		Black organic silt; little shell fragments.
2	VC2007 102 1-2	2.3 ft	Dark gray silt; some fine to medium sand.
3	VC2007 102 2-3		Gray fine to medium sand; some silt.
4	VC2007 102 3-4		
5	VC2007 102 4-5		
6	VC2007 102 5-6		
7			Gray fine to coarse sand; trace fine gravel.
8			Brown fine sand.
9			NO RECOVERY below 8.8 ft
10			Bottom of Exploration at 9.5 ft
11			
12			
13			
14			
15			

Comments:
Penetration: 9.5 ft
No Refusal

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.6962 N
Location: DMMP North of Popes Island		CAD 2	Long 70 54.9832 W
Elevation at mudline: -6.8'	Datum: MLLW		
Casing Type: Polycarbonate	Penetration: 14.0 ft		Boring No: VC-103A
Casing Diameter: 3"	Recovery: 11.4 ft		
Drill Co: TGB	Method: Vibracore		Sheet: 1 of 1
Driller: RR	Log By: KvN, GCD		

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 103 0-1		Black to dark gray organic silt; trace shell fragments.
2	VC2007 103 1-2		Gray silt; trace shell fragments.
3	VC2007 103 2-3		Dark gray silt; little clay, trace shells.
4	VC2007 103 3-4		Gray clay; some silt.
5	VC2007 103 4-5		
6	VC2007 103 5-6		
7	VC2007 103 6-7		Gray clay; some silt, trace shell fragments.
8	VC2007 103 7-8		Gray silt.
9	VC2007 103 8-9		
10	VC2007 103 9-10		
11	VC2007 103 10-11	10.9 ft	(trace peat at 10.3 ft)
12	Not sampled		Peat; trace sand.
			NO RECOVERY below 11.4 ft
20			

Bottom of Exploration at 20 ft

Comments:
Penetration: 20.0 ft.
No refusal.
Bottom of core barrel contains gray clayey silt.

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8754 N
Location: DMMP North of Popes Island		CAD 2	Long 70 55.0158 W
Elevation at mudline: -3.6'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	14.0 ft	Boring No: VC-104
Casing Diameter: 3"	Recovery:	11.9 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 104 0-1	0.4 ft	Black organic silt; some fine sand. Dark gray fine sand; little silt, little shell fragments.
2	VC2007 104 1-2		Gray fine sand.
3	VC2007 104 2-3		
4	Not Sampled		Tan fine to medium sand.
5			
6			Tan fine to coarse sand. (6 inch thick oxidized layer at 8.75 ft)
7			
8			
9			
10			
11			
12			
13			NO RECOVERY below 11.9 ft
14			

Bottom of Exploration at 14 ft

Comments:
Penetration: 14.0'.
No Refusal.

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8438 N
Location: DMMP North of Popes Island		CAD 2	Long 70 54.9236 W
Elevation at mudline: -5.4'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	20.0 ft	Boring No: VC-105
Casing Diameter: 3"	Recovery:	13.2 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	MB, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 105 0-1		Black organic silt; some shell fragments.
2	VC2007 105 1-2		Dark gray organic silt; little shell fragments.
3	VC2007 105 2-3		Gray organic silt; trace fine to coarse sand.
4	VC2007 105 3-4		
5	VC2007 105 4-5		
6	VC2007 105 5-6		Gray to tan very fine sand; little to some silt.
7	VC2007 105 6-7		Brown fine to coarse sand; little fine gravel.
8	Not Sampled		
9			
10			Gray very fine sand; some silt.
11			Gray silt.
12			Tan fine to coarse sand; little fine gravel.
13			Gray medium to coarse sand; some fine gravel.
14			NO RECOVERY below 13.2 ft
20			

Bottom of Exploration at 20 ft

Comments:
Penetration: 20.0 ft
No refusal.

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8486 N
Location: DMMP North of Popes Island		CAD 2	Long 70 54.9985 W
Elevation at mudline: -4.3'	Datum: MLLW		
Casing Type: Polycarbonate	Penetration: 10.0 ft		Boring No: VC-118
Casing Diameter: 3"	Recovery: 5.7 ft		
Drill Co: TGB	Method: Vibracore		Sheet: 1 of 1
Driller: RR	Log By: MB, GCD		

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 118 0-1		Tan fine sand; some shell fragments.
			Dark gray to black fine sand; some silt, little shell fragments.
2	VC2007 118 1-2		Gray silt and fine sand.
3	VC2007 118 2-3		
4	Not Sampled		Tan fine to medium sand.
5			
6			
7			NO RECOVERY below 5.7 ft
8			
9			
10			

Bottom of Exploration at 10 ft

Comments:
Penetration: 10.0 ft.
Refusal at: 10.0 ft.

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8443 N
Location: DMMP North of Popes Island		CAD 2	Long 70 55.0801 W
Elevation at mudline: -3.3'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	10.0 ft	Boring No: VC-119
Casing Diameter: 3"	Recovery:	5.4 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 119 0-1	0.9 ft	Black organic silt; some fine sand, little shell fragments.
2	VC2007 119 1-2		Tan very fine sand.
3	VC2007 119 2-3		Light gray silt.
4	VC2007 119 3-4		Interbedded light gray very fine sand and silt.
5	Not Sampled		
6			NO RECOVERY below 5.4 ft
7			
8			
9			
10			

Bottom of Exploration at 10 ft

Comments:
Penetration: 10.0 ft.
No refusal

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.7604 N
Location: DMMP North of Popes Island		CAD 2	Long 70 54.9495 W
Elevation at mudline: -6.9'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	20.0 ft	Boring No: VC-120
Casing Diameter: 3"	Recovery:	11.0 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 120 0-1	0.7 ft	Black organic silt. Strong odor.
2	VC2007 120 1-2		Dark gray silt; trace shell fragments.
3	VC2007 120 2-3		Gray silt; trace shell fragments.
4	VC2007 120 3-4		
5	VC2007 120 4-5		Gray silt. (increasing stiffness with depth)
6	VC2007 120 5-6		
7	VC2007 120 6-7		
8	VC2007 120 7-8		
9	VC2007 120 8-9		
10	VC2007 120 9-10		
11	VC2007 120 10-11		
20			NO RECOVERY below 11.0 ft

Bottom of Exploration at 20 ft

Comments:
Penetration: 20.0 ft.
No refusal

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.7407 N
Location: DMMP North of Popes Island		CAD 2	Long 70 55.1221 W
Elevation at mudline: -5.6'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	14.0 ft	Boring No: VC-101
Casing Diameter: 3"	Recovery:	10.7 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 101 0-1		Black organic silt; some shell hash, organic odor.
2	VC2007 101 1-2		Dark gray silt; little shell fragments.
3	VC2007 101 2-3		
4	VC2007 101 3-4		
5	VC2007 101 4-5		Dark gray silt; little shell fragments, trace very fine sand.
6	VC2007 101 5-6		
7	VC2007 101 6-7		
8	VC2007 101 7-8		Dark gray interbedded silt and fine sand.
9	VC2007 101 8-9		Dark gray silt.
10	VC2007 101 9-10	9.4 ft	Peat
11			
12			NO RECOVERY below 10.7 ft
13			
14			

Bottom of Exploration at 14 ft

Comments:
Penetration: 14.0'.
No Refusal

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8002 N
Location: DMMP North of Popes Island		CAD 2	Long 70 55.1221 W
Elevation at mudline: -6.4'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	9.5 ft	Boring No: VC-102
Casing Diameter: 3"	Recovery:	8.8 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 102 0-1		Black organic silt; little shell fragments.
2	VC2007 102 1-2	2.3 ft	Dark gray silt; some fine to medium sand.
3	VC2007 102 2-3		Gray fine to medium sand; some silt.
4	VC2007 102 3-4		
5	VC2007 102 4-5		
6	VC2007 102 5-6		
7			Gray fine to coarse sand; trace fine gravel.
8			Brown fine sand.
9			NO RECOVERY below 8.8 ft
10			Bottom of Exploration at 9.5 ft
11			
12			
13			
14			
15			

Comments:
Penetration: 9.5 ft
No Refusal

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.6962 N
Location: DMMP North of Popes Island		CAD 2	Long 70 54.9832 W
Elevation at mudline: -6.8'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	14.0 ft	Boring No: VC-103A
Casing Diameter: 3"	Recovery:	11.4 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 103 0-1		Black to dark gray organic silt; trace shell fragments.
2	VC2007 103 1-2		
3	VC2007 103 2-3		Gray silt; trace shell fragments.
			Dark gray silt; little clay, trace shells.
4	VC2007 103 3-4		
5	VC2007 103 4-5		Gray clay; some silt.
6	VC2007 103 5-6		
7	VC2007 103 6-7		Gray clay; some silt, trace shell fragments.
8	VC2007 103 7-8		
9	VC2007 103 8-9		Gray silt.
10	VC2007 103 9-10		
11	VC2007 103 10-11	10.9 ft	(trace peat at 10.3 ft)
12	Not sampled		Peat; trace sand.
			NO RECOVERY below 11.4 ft
20			

Bottom of Exploration at 20 ft

Comments:
Penetration: 20.0 ft.
No refusal.
Bottom of core barrel contains gray clayey silt.

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8754 N
Location: DMMP North of Popes Island		CAD 2	Long 70 55.0158 W
Elevation at mudline: -3.6'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	14.0 ft	Boring No: VC-104
Casing Diameter: 3"	Recovery:	11.9 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
	VC2007 104	0.4 ft	Black organic silt; some fine sand.
1	0-1		Dark gray fine sand; little silt, little shell fragments.
2	VC2007 104 1-2		Gray fine sand.
3	VC2007 104 2-3		
4	Not Sampled		Tan fine to medium sand.
5			
6			Tan fine to coarse sand. (6 inch thick oxidized layer at 8.75 ft)
7			
8			
9			
10			
11			
12			
13			NO RECOVERY below 11.9 ft
14			

Bottom of Exploration at 14 ft

Comments:
Penetration: 14.0'.
No Refusal.

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8438 N
Location: DMMP North of Popes Island		CAD 2	Long 70 54.9236 W
Elevation at mudline: -5.4'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	20.0 ft	Boring No: VC-105
Casing Diameter: 3"	Recovery:	13.2 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	MB, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 105 0-1		Black organic silt; some shell fragments.
2	VC2007 105 1-2		Dark gray organic silt; little shell fragments.
3	VC2007 105 2-3		Gray organic silt; trace fine to coarse sand.
4	VC2007 105 3-4		
5	VC2007 105 4-5		
6	VC2007 105 5-6		Gray to tan very fine sand; little to some silt.
7	VC2007 105 6-7		Brown fine to coarse sand; little fine gravel.
8	Not Sampled		
9			
10			Gray very fine sand; some silt.
11			Gray silt.
12			Tan fine to coarse sand; little fine gravel.
13			Gray medium to coarse sand; some fine gravel.
14			NO RECOVERY below 13.2 ft
20			

Bottom of Exploration at 20 ft

Comments:
Penetration: 20.0 ft
No refusal.

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8486 N
Location: DMMP North of Popes Island		CAD 2	Long 70 54.9985 W
Elevation at mudline: -4.3'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	10.0 ft	Boring No: VC-118
Casing Diameter: 3"	Recovery:	5.7 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	MB, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 118 0-1		Tan fine sand; some shell fragments. / Dark gray to black fine sand; some silt, little shell fragments.
2	VC2007 118 1-2		Gray silt and fine sand.
3	VC2007 118 2-3		Tan fine to medium sand.
4	Not Sampled		
5			
6			
7			NO RECOVERY below 5.7 ft
8			
9			
10			

Bottom of Exploration at 10 ft

Comments:
Penetration: 10.0 ft.
Refusal at: 10.0 ft.

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.8443 N
Location: DMMP North of Popes Island		CAD 2	Long 70 55.0801 W
Elevation at mudline: -3.3'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	10.0 ft	Boring No: VC-119
Casing Diameter: 3"	Recovery:	5.4 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 119 0-1	0.9 ft	Black organic silt; some fine sand, little shell fragments.
2	VC2007 119 1-2		Tan very fine sand.
3	VC2007 119 2-3		Light gray silt.
4	VC2007 119 3-4		Interbedded light gray very fine sand and silt.
5	Not Sampled		
6			NO RECOVERY below 5.4 ft
7			
8			
9			
10			

Bottom of Exploration at 10 ft

Comments:
Penetration: 10.0 ft.
No refusal

VIBRACORE LOG

Project: New Bedford Harbor		Project No: 6515.003	Lat 41 38.7604 N
Location: DMMP North of Popes Island		CAD 2	Long 70 54.9495 W
Elevation at mudline: -6.9'	Datum:	MLLW	
Casing Type: Polycarbonate	Penetration:	20.0 ft	Boring No: VC-120
Casing Diameter: 3"	Recovery:	11.0 ft	
Drill Co: TGB	Method:	Vibracore	Sheet: 1 of 1
Driller: RR	Log By:	KvN, GCD	

Depth below mudline (ft)	Sample ID	Depth of Strata Break (ft)	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1	VC2007 120 0-1	0.7 ft	Black organic silt. Strong odor.
			Dark gray silt; trace shell fragments.
2	VC2007 120 1-2		
3	VC2007 120 2-3		Gray silt; trace shell fragments.
4	VC2007 120 3-4		
5	VC2007 120 4-5		Gray silt. (increasing stiffness with depth)
6	VC2007 120 5-6		
7	VC2007 120 6-7		
8	VC2007 120 7-8		
9	VC2007 120 8-9		
10	VC2007 120 9-10		
11	VC2007 120 10-11		
20			NO RECOVERY below 11.0 ft

Bottom of Exploration at 20 ft

Comments:
Penetration: 20.0 ft.
No refusal

Apex environmental, Inc.

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I			Boring No: M201
Location:	New Bedford, MA		Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694497	Easting: 814858		Date: 10/07/2002	
Length:	5.5'	Recovery:	3'	
Drill Company:	CR	Method:	Vibracore	
Driller:	CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt, odor noted.	M201-1	
2'	1-2	OL/OH	Similar to 0-1', 2 to 3 small stones recovered,	M201-2	
3'	2-3	SM	Light gray, small stones, well-graded, sand: 50%, silt 20%.	M201-3	
4'			Bottom of Exploration		
5'					
6'					
7'					

Comments:

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M202
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694418	Easting: 814729	Date: 10/07/2002	
Length: 7'	Recovery:	5'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt, odor noted, trace shell fragments.	M202-1	
2' 3' 4'	1-4	OL/OH	Black organic silt, odor noted, trace sand.	M202-2	
	4-4.5	SM	Fine brown sand.		
5' 6' 7'			Bottom of Exploration		

Comments:

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M203
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694549	Easting: 814679	Date: 10/04/2002	
Length: 7'	Recovery:	4.75'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt, odor noted.	M203-1	
2'	1-2.8	ML	Black silt.	M203-2 M203-3	
3' 4'	2.8-4.5	SP	Light gray fine sand, firm, 60% clay.	M203-4 M203-5	
	4.5-4.75	SM	Fine sand.		
5' 6' 7'			Bottom of Exploration		

Comments:

BORING LOG

Apex environmental, Inc.

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M204
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694516	Easting: 814511	Date: 10/04/2002	
Length: 6.5'	Recovery:	3.5'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt, odor noted.	M204-1	
2'	1-2	ML	Black silt.	M204-2	
	2-2.5	ML	Black silt.		
3'	2.5-3	ML	Black silt, sheen noted, 2 to 3 small stones.	M204-3	
	3-3.5	SM	Coarse sand, poorly sorted.		
4'			Bottom of Exploration		
5'					
6'					
7'					

Comments:

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M205
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694284	Easting: 814506	Date: 10/04/2002	
Length: 7'	Recovery: 4'		
Drill Company: CR	Method: Vibracore		
Driller: CR	Log By: MM		

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-2	OL/OH	Black organic silt, well sorted, odor noted.	M205-1	
2'				M205-2	
3'	2-3	OL/OH	Black organic silt, well sorted, sheen noted.	M205-3	
4'	3-4	OL/OH	Black organic silt, well sorted, shell and wood fragments present.	M205-4	
5'			Bottom of Exploration		
6'					
7'					

Comments:

BORING LOG

Apex environmental, Inc.

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M206
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2643556	Easting: 815442	Date: 10/11/2002	
Length: 9'	Recovery:	5.5'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt with trace fine sand (10%), odor noted.	M206-1	
2'	1-2	SP	Dark gray sandy clay, top 3" is black, shell fragments present.	M206-2	
3'	2-3	CL	Gray silty clay, 5% sand, peat present at 2.5'.	M206-3	
4'	3-4	CL	Gray silty clay, 10% sand, peat present at 3.5'.	M206-4	
5'	4-5	CL	Gray silty clay, minor shell fragments.	M206-5	
	5-5.5	SM	Light gray fine sand.	M206-6	
6' 7'			Bottom of Exploration		

Comments:

BORING LOG

Apex environmental, Inc.

Project: New Bedford Harbor Dredge - Phase I		Boring No: M207
Location: New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2643537 Easting: 815616	Date: 10/11/2002	
Length: 9' Recovery:	6.1'	
Drill Company: CR Method:	Vibracore	
Driller: CR Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-3.25	OL/OH	Black organic silt, increasing cohesion with depth, no sheen.	M207-1	
2'				M207-2	
3'				M207-3	
4'	3.25-5	ML	Olive gray silt with an interbedded small sand lens composed of fine to medium sand with organic matter in sand.	M207-4	
5'				M207-5	
6'	5-6	SM	Medium to coarse sand with interbedded silt and shell fragments; 50% coarse sand, 30% medium sand, 10% gravel, 10% organics.	M207-6	
7'			Bottom of Exploration		

Comments:

environmental, Inc.

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M208
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2693334	Easting: 815617	Date: 10/08/2002	
Length: 9'	Recovery:	6'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt.	M208-1	
2'	1-2	OL/OH	Black organic silt with trace fine sand.	M208-2	
3'	2-3	OL/OH	Black organic silt with trace sand.	M208-3	
4'	3-4.5	OL/OH	Black organic silt with trace sand.	M208-4	
5' 6'	4.5-6	SM	Gray fine to medium sand with trace gravel and cobbles.	M208-5	
7'			Bottom of Exploration		

Comments:

BORING LOG

Apex environmental, Inc.

Project:	New Bedford Harbor Dredge - Phase I			Boring No: M209
Location:	New Bedford, MA		Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2693189	Easting: 815553		Date: 10/07/2002	
Length:	8'	Recovery:	4.8'	
Drill Company:	CR	Method:	Vibracore	
Driller:	CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt, odor noted.	M209-1	
2'	1-2	OL/OH	Black organic silt, sheen noted.	M209-2	
3'	2-3	OL/OH	Black organic silt with small wood fragments.	M209-3	
4'	3-4	CL	Dark to medium gray clay.	M209-4	
	4-4.8	SM	Coarse gray sand.	M209-5	
5'			Bottom of Exploration		
6'					
7'					

Comments:

Apex environmental, Inc.

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I			Boring No: M210
Location:	New Bedford, MA		Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2693296	Easting: 815770		Date: 10/07/2002	
Length:	9.6'	Recovery:	6.3'	
Drill Company:	CR	Method:	Vibracore	
Driller:	CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt with trace sand, odor noted.	M210-1	
2'	1-2	OL/OH	Black organic silt with trace sand, odor noted.	M210-2	
3'	2-3	OL/OH	Black organic silt with trace sand, sheen noted.	M210-3	
4'	3-4	OL/OH	Black organic silt grading to silty clay, odor noted.	M210-4	
5'	4-5	CL	4-4.6': Gray silty clay.		
		SM	4.6-5': Gray fine sand with shell fragments.		
6'	5-6.2	CL	Dark gray clay with trace silt and shell fragments, dense clay at botto of core.		
7'			Bottom of Exploration		

Comments:

BORING LOG

Apex environmental, Inc.

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M211
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2693473	Easting: 815483	Date: 10/11/2002	
Length: 10.5'	Recovery:	7'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1' 2'	0-2	OL/OH	Black organic silt, increasing cohesion with depth, minor shell fragments.	M211-1 M211-2	
3'	2-3	ML	Olive gray silt with 0.5" lenses of medium to coarse sand.	M211-3	
4'	3-4.5	ML	Similar to 2-3' with black organic material lenses (0.25 to 0.5" thick),	M211-4	
5'	4.5-5.6	ML	Similar to 3-4.5' with shell fragments.	M211-5	
6'	5.6-6.5	SW	Gray coarse sand and gravel.	M211-6	
7'	6.5-7	6.5-6.8' 6.8-7'	Brown sand and gravel with silt. Yellow coarse sand and gravel.	M211-7	

Comments: Bottom of Exploration

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M212
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2693412	Easting: 815537	Date: 10/11/2002	
Length: 10'	Recovery:	8.8'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt, sheen and odor noted.	M212-1	
2'	1-2	OL/OH	Black organic silt, sheen and odor noted.	M212-2	
3'	2-3	CL	Silty clay with shell fragments at 3', sheen noted.	M212-3	
4'	3-4	CL	Dark gray sandy clay with shell fragments in top 3'.	M212-4	
5'	4-4.8	SM	Light gray fine sand.	M212-5	
	4.8-5.4	SM	Medium gray sand.	M212-6	
6'	5.4-6	SM	Light gray fine sand.	M212-7	
7'	6-7	SM	Dark gray medium sand with trace black sand.	M212-8	
8'	7-8.8	SM	Medium brown sand wuth slight orange tint.		
9'			Bottom of Exploration		

Comments: Photographs taken.

BORING LOG

Apex environmental, Inc.

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M213
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2693332	Easting: 815487	Date: 10/11/2002	
Length: 8'	Recovery:	6.5'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt.	M213-1	
2'	1-2	OL/OH	Black organic silt.	M213-2	
3'	2-3	OL/OH	Black organic silt.		
	3-3.5	OL/OH	Black organic silt with trace fine sand.	M213-3	
4'	3.5-4	OL/OH	Black organic silt with trace fine sand.		
	4-4.5	OL/OH	Black organic silt with trace fine sand, gray clay, and shells.	M213-4	
5' 6'	4.5-6.5	SW	Gray fine to medium sand with trace rounded gravel.	M213-5	
7'					

Comments: Bottom of Exploration

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M214
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694323	Easting: 815073	Date: 10/07/2002	
Length: 9'	Recovery:	4'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Shell fragments, organics, dark to light gray medium sand.	M214-1	
2'	1-2	SM	Brown medium sand with with brown fine sand lens.		
3'	2-3	SW	Fine sand with trace brown medium sand and cobbles.		
4'	3-4	SW	Poorly graded brown coarse sand with cobbles of various sizes.		
5'			Bottom of Exploration		
6'					
7'					

Comments:

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M215
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694503	Easting: 815130	Date: 10/11/2002	
Length: 3.5'	Recovery:	2.9'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	SM	Medium to coarse sand with trace shell fragments and silt.		
2' 3'	1-2.9	SM	Yellow medium sand with interbedded silt and coal/wood, small coarse gravel visible at end of core.		
4' 5' 6' 7'			Bottom of Exploration		

Comments:

BORING LOG

Apex environmental, Inc.

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M216
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694082	Easting: 815185	Date: 10/07/2002	
Length: 7'	Recovery:	4.2'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organics with trace sand, sheen noted, strong odor, shell fragments.	M216-1	
2'	1-2.5	ML	Black silt with shell fragments, trace sand and gray fine silt, large stone in middle of core.	M216-2	
3'	2.5-3.3	SM	Dark gray medium sand.	M216-3	
4'	3.3-4.2	SM	Brown medium sand with orange tint, well graded.	M216-4	
5'			Bottom of Exploration		
6'					
7'					

Comments:

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M217
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695189	Easting: 815202	Date: 10/07/2002	
Length: 9'	Recovery:	6.9'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organics with trace fine sand and silt, slight odor.	M217-1	
2'	1-2	OL/OH	Black organics with fine sand and silt, slight odor, wood fragments.	M217-2	
3'	2-3	SM	Brown medium sand, shell fragments, black lens at 28".	M217-3	
4'	3-4.5	SM	Brown/gray medium sand, well sorted.	M217-4	
5' 6' 7'	4.5-6.9	SW	Top 3" composed of poorly sorted cobbles, remainder is composed of light gray medium sand.	M217-5	

Comments: Bottom of Exploration

BORING LOG

Apex environmental, Inc.

Project: New Bedford Harbor Dredge - Phase I			Boring No: M218
Location: New Bedford, MA		Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695315	Easting: 815240	Date: 10/07/2002	
Length: 10'	Recovery:	4'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	ML	Gray sandy silt, slight odor, wood fragment present.	M218-1	
2'	1-2	ML	Light gray sandy silt with 3-4 wood fragments.	M218-2	
3'	2-3	SM	Light brown fine sand with trace silt, gray lens present from 30-33".		
4'	3-4	SM	Light gray fine sand with shell fragments in bottom 3" and clay in bottom 1".		
5'			Bottom of Exploration		
6'					
7'					

Comments:

BORING LOG

Apex environmental, Inc.

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M219
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695520	Easting: 815248	Date: 10/11/2002	
Length: 9'	Recovery:	4.5'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black silt, organics, odor and sheen noted.	M219-1	
2'	1-2	SM	Light gray medium sand with 1" lens of light gray clay at 1.5'.	M219-2	
3'	2-3	SM	Light to brownish medium sand.	M219-3	
4'	3-4.5	SM	Light gray medium sand with shell fragments.	M219-4	
5'			Bottom of Exploration		
6'					
7'					

Comments: Strong odor throughout.

Apex environmental, Inc.

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I			Boring No: M220
Location:	New Bedford, MA		Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694469	Easting: 815271		Date: 10/04/2002	
Length:	5.8'	Recovery:	3.5'	
Drill Company:	CR	Method:	Vibracore	
Driller:	CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt, wood and shell fragments, odor noted.	M220-1	
	1-1.8	OL/OH	Black organic silt, wood and shell fragments, odor noted.		
2'	1.8-2	SM	Light gray medium sand.		
3'	2-3	SM	Light gray medium sand.		
	3-3.5	SM	Brown medium sand.		
4'			Bottom of Exploration		
5'					
6'					
7'					

Comments:

BORING LOG

Apex environmental, Inc.

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M221
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694149	Easting: 814334	Date: 10/07/2002	
Length: 10'	Recovery:	4'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black silt	M221-1	
2'	1-2	OL/OH	Black silt with trace sand (10%), dark gray silt at 2'.	M221-2	
3'	2-3	SW	Gray fine sand, some cobbles in middle, poorly graded.		
4'	3-4	SW	Light gray fine sand, last 5" composed of black cobbles of various sizes (50% stones, 30% sand, 10% fine sand).		
5'			Bottom of Exploration.		
6'					
7'					

Comments:

BORING LOG

Apex environmental, Inc.

Project: New Bedford Harbor Dredge - Phase I			Boring No: M222
Location: New Bedford, MA		Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2693895	Easting: 814370	Date: 10/04/2002	
Length: 7'	Recovery:	3.6'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	OL/OH	Black organic silt, surface shells, worm tubes, odor and sheen noted.	M222-1	
2'	1-2.6	OL/OH	Black organic silt.	M222-2	
3'	2.6-3	SW	Black coarse sand, poorly sorted, minor shell fragments, small stones.	M222-3	
	3-3.6	SW	Brown coarse sand and gravel, poorly sorted, small cobbles.	M222-4	
4'			Bottom of Exploration.		
5'					
6'					
7'					

Comments: Actual projected sample location M223 renamed M222 in Hypack samples.

Apex environmental, Inc.

BORING LOG

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M223
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2694006.5	Easting: 814346	Date: 10/04/2002	
Length: 9'	Recovery:	5.5'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-3	OL/OH	Black organic silt, slight sheen, one shell fragment.	M223-1	
2'				M223-2	
3'				M223-3	
	3-3.5	SM	Gray fine sand, poorly soretd, one shell fragment.	M223-4	
	3.5-3.8	SM	Granular sand, well sorted.		
4'	3.8-4.2	SM	Light gray fine to medium sand, trace shell fragments.		
	4.2-4.8	SM	Black medium sand and silt.		
5'	4.8-5.5	SW	Coarse sand and gravel, small cobbles, poorly sorted.	M223-5	
6'			Bottom of Exploration.		
7'					

Comments: Actual projected sample location M222 renamed M223 in Hypack samples.

BORING LOG

Apex environmental, Inc.

Project:	New Bedford Harbor Dredge - Phase I		Boring No: M224
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2693725	Easting: 814388	Date: 10/07/2002	
Length: 9'	Recovery:	4'	
Drill Company: CR	Method:	Vibracore	
Driller: CR	Log By:	MM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1	CL	Gray clay with trace gravel and silt, and shell fragments.	M224-1	
2'	1-2	CL	Gray clay and shell fragments.		
3'	2-3	CL	Gray clay, shell fragments, and pieces of metal.		
4'	3-4	CL	Gray clay with shell fragments concentrated at 4'.		
5'			Bottom of Exploration.		
6'					
7'					

Comments:

BORING LOG

Project:	North Terminal Dredging Phase 1		Boring No: M401
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2696055.18	Easting: 814518.72	Date: 04/04/2003	
Length: 6.5'	Recovery:	4.7'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1.8	OL/OH	Black organic silt, strong sheen noted.	M401-1 (0-1') M401-2 (1-1.8')	
2' 3' 4'	1.7-4.7	SM	Gray silty sand with slight layering of OL/OH, firm and well compacted.		
5' 6' 7'			Bottom of Exploration		

Comments:

BORING LOG

Apex environmental, Inc.

Project:	North Terminal Dredging Phase 1		Boring No: M402
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2696055.06	Easting: 814706.68	Date: 04/04/2003	
Length: 5'	Recovery:	3.6'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1.8	OL/OH	Black organic silt.	M402-1 (0-1') M402-2 (1-1.8')	
2'	1.8-2.4	SM	Gray fine to medium sand with silt.	M402-3 (1.8-3.0')	
3'	2.4-3.3	SM	Gray medium sand with organic silts and fine sand. Small amounts of coarse sand and fine gravel.		
	3.3-3.6	SM	Yellow medium to coarse sand with little silt and no organics. Stone at 1.5" from top of layer break.		
4'			Bottom of Exploration		
5'					
6'					
7'					

Comments: Rock in first core attempt.

BORING LOG

Apex environmental, Inc.

Project:	North Terminal Dredging Phase 1		Boring No: M403
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695885.64	Easting: 814506.45	Date: 04/04/2003	
Length: 7'	Recovery:	4.9'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1.9	OL/OH	Black organic silt.	M403-1 (0-1') M403-2 (1-1.9')	
2'–3'	1.9-3	SM	Fine sand with 1/4" layers of OL/OH		
	3-3.7	SM	Fine to medium sand with black silt (sand is clean).		
4'	3.7-3.9	CL	Olive gray clay.		
5'	3.9-4.9	SW	Yellow medium sand (sand is clean).		
6'–7'			Bottom of Exploration		

Comments:

BORING LOG

Apex environmental, Inc.

Project: North Terminal Dredging Phase 1			Boring No: M404
Location: New Bedford, MA		Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695927.25	Easting: 814805.84	Date: 04/04/2003	
Length: 6.5'	Recovery:	4.5'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'				M404-1 (0-1')	
2'	0-3	OL/OH	Black organic silt. Sheen noted.	M404-2 (1-2')	
3'				M404-3 (2-3')	
	3-3.75	SM	Fine gray sand with silt, shells noted.	M404-4 (3-4')	
4'	3.75-4.5	SW	Medium sand with little silt, some thin 1/4" layers of consolidated OL/OH, shells and wood noted.		
5'			Bottom of Exploration		
6'					
7'					

Comments:

BORING LOG

Project:	North Terminal Dredging Phase 1		Boring No: M405
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695735.88	Easting: 814658.02	Date: 04/04/2003	
Length: 5'	Recovery:	2.9'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1.2	OL/OH	Black organic silt, sheen noted.	M405-1 (0-1.2')	
	1.2-1.4	SM	Fine sand and silt.		
	1.4-1.8	SM	Gray medium sand with silt.		
2'	1.8-2	SW	Black medium sand with silt.		
3'	2-2.9	SW	Yellow medium to coarse sand and gravel.		
4'			Bottom of exploration.		
5'					
6'					
7'					

Comments: Second attempt.

BORING LOG

Project:	North Terminal Dredging Phase 1		Boring No: M406
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695614	Easting: 814475.15	Date: 04/04/2003	
Length: 5.5'	Recovery:	4.3'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1.4	OL/OH	Black organic silt. Thin piece of material noted at 1.3'.	M406-1 (0-1.4')	
2'	1.4-2.6	SM	Gray silt and fine sand with 1/4" layer of fine brown sand. Soft	M406-2 (1.4-2.4')	
3', 4'	2.6-4.3	SM	Medium to coarse sand with silt.		
5', 6', 7'			Bottom of Exploration		

Comments: Second attempt. First attempt no recovery.

BORING LOG

Apex environmental, Inc.

Project:	North Terminal Dredging Phase 1		Boring No: M407
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695618.73	Easting: 814892.89	Date: 04/04/2003	
Length: 6.5'	Recovery:	5.2'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'				M407-1 (0-1')	
2'	0-2.9	OL/OH	Black organic silt.	M407-2 (1-2')	
3'				M407-3 (2-2.9')	
4'	2.9-4	SM	Black/gray fine sand and silt with OL/OH layers between 3.7' - 4'.		
5'	4-5.2	SW	Brown/gray fine sand grading to medium sand.		
6'			Bottom of Exploration		
7'					

Comments: Third attempt.

BORING LOG

Apex environmental, Inc.

Project:	North Terminal Dredging Phase 1		Boring No: M408
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695445.39	Easting: 814820.77	Date: 04/04/2003	
Length: 6'	Recovery:	3.5'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'				M408-1 (0-1')	
2'	0-2.2	OL/OH	Black organic silt.	M408-2 (1-2')	
3'	2.2-3.1	SM	Gray fine sand and black organic silt.	M408-3 (2-3')	
	3.1-3.5	SM	Brown fine sand and silt.		
4'			Bottom of Exploration		
5'					
6'					
7'					

Comments:

Apex environmental, Inc.

BORING LOG

Project:	North Terminal Dredging Phase 1		Boring No: M409
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695468.94	Easting: 814583.11	Date: 04/04/2003	
Length: 5'	Recovery:	3.1'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1.9	OL/OH	Black organic silt.	M409-1 (0-1')	
2'				M409-2 (1-2')	
	1.9-2.3	SM	Gray/brown fine sand with silt and trace black organics.		
3'	2.3-3.1	SM	Medium sand with silt and trace coarse sand, wood piece noted.		
			Bottom of exploration.		
4'					
5'					
6'					
7'					

Comments:

BORING LOG

Apex environmental, Inc.

Project:	North Terminal Dredging Phase 1		Boring No: M410
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695317.92	Easting: 814505.29	Date: 04/04/2003	
Length: 5'	Recovery:	3.8'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'				M410-1 (0-1')	
2'	0-2.5	OL/OH	Black organic silt, sheen noted.	M410-2 (1-2')	
	2.5-3	OL	Gray/black organic silt, stiff, sheen noted.	M410-3 (2-3')	
3'	3-3.6	SM	Gray fine sand with trace black organic silt.		
	3.6-3.8	SW	Gray sand and gravel with coarse silt and sand.		
4'			Bottom of exploration		
5'					
6'					
7'					

Comments: Definitely refusal.

BORING LOG

Project:	North Terminal Dredging Phase 1		Boring No: M411
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695264.44	Easting: 814722.04	Date: 04/07/2003	
Length: 5'	Recovery:	3.4'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
	0-0.8	OL/OH	Black organic silt	M411-1 (0-0.8')	
1'	0.8-1.6	SM	Gray fine sand with silt.	M411-2 (0.8-1.6')	
2'	1.6-2.6	SW	Yellow medium to coarse sand with 1/4" layers of gray fine sand.		
3'	2.6-3.4	SW	Sample lost when returning core barrel, presumed sandy.		
4'			Bottom of exploration		
5'					
6'					
7'					

Comments: First attempt 7' penetration, core barrel fell over. Used second core. Third attempt, 6' penetration and 3' recovery.

BORING LOG

Project:	North Terminal Dredging Phase 1		Boring No: M412
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695103.46	Easting: 814900.57	Date: 04/07/2003	
Length: 5.5'	Recovery:	3.3'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-2	OL/OH	Black organic silt and clay with sand and 1/4" layer of medium sand at 1.1'.	M412-1 (0-1')	
2'				M412-2 (1-2')	
3'	2-3.5	SW	Gray fine sand with little silt.		
4'			Bottom of exploration		
5'					
6'					
7'					

Comments: First attempt logged. Four total attempts.
Second attempt: 7'/2.8', all OL/OH.
Third attempt: 6'/-, no recovery.
Fourth attempt: 7'/2', all OL/OH.

BORING LOG

Project:	North Terminal Dredging Phase 1		Boring No: M413
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695168.78	Easting: 814451.77	Date: 04/07/2003	
Length: 6.5'	Recovery:	4.7'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-2	OL/OH	Black organic silt , sheen noted at 1.9'.	M413-1 (0-1') M413-2 (1-2')	
2'	2-2.6	OL	Dark gray clay and silt.		
3'	2.6-3.1	SM	Gray medium sand with layers of black organic silt.		
	3.1-3.9	SM	Medium yellow sand and silt.		
4'	3.9-4.7	SM	Coarse sand with silt.		
5'			Bottom of exploration		
6'					
7'					

Comments: Large number of interbedded OL/OH.

BORING LOG

Project:	North Terminal Dredging Phase 1		Boring No: M414
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2696094.69	Easting: 814963.43	Date: 04/07/2003	
Length: 7.5'	Recovery:	5.1'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-2.3	OL/OH	Black organic silt.	M414-1 (0-1')	
2'				M414-2 (1-2.3')	
3'	2.3-3.1	SM	Fine brown sand and silt, loose.	M414-3 (2-3.1')	
4'	3-4.8	SC	Olive-brown clay with sand. 1.5" layer of dark gray sand and silt at 4.0'.		
5'	4.8-5.1	SP	Coarse sand and gravel with little medium sand.		
6'			Bottom of exploration		
7'					

Comments:

Apex environmental, Inc.

BORING LOG

Project:	North Terminal Dredging Phase 1		Boring No: M415
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695257.30	Easting: 815018.69	Date: 04/07/2003	
Length: 5'	Recovery:	3.5'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1.5	OL/OH	Black organic silt.	M415-1 (0-1.5')	
2'	1.5-2	SW	Fine brown sand.		
	2-2.4	SM	Light gray silty sand. Fine grained.		
3'	2.4-3.5	SW	Coarse sand and gravel (cobbles approx. 2") with little silt.		
4'			Bottom of exploration		
5'					
6'					
7'					

Comments:

Apex environmental, Inc.

BORING LOG

Project: North Terminal Dredging Phase 1			Boring No: M416
Location: New Bedford, MA		Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695068.75	Easting: 814643.74	Date: 04/07/2003	
Length: 5'	Recovery:	3.4'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-0.9	OL/OH	Black organic silt with shell and wood fragment, sheen noted.	M416-1 (1-0.9')	
2' 3'	0.9-3.4	OH	Blue/gray clay with fine sand and silt, cohesive.		
4' 5' 6' 7'			Bottom of exploration		

Comments: Three photos taken.

BORING LOG

Apex environmental, Inc.

Project:	North Terminal Dredging Phase 1		Boring No: M417
Location:	New Bedford, MA	Project No: 6505.009.01	See Site Map for Boring Locations
Northing: 2695009.09	Easting: 814731.64	Date: 04/07/2003	
Length: 5'	Recovery:	1.8'	
Drill Company: CR	Method:	Vibracore	
Driller: Ray & Sal	Log By:	TM	

Depth (FT.)	Interval (feet)	USCS Class	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Sample ID	Notes
1'	0-1.3	OL/OH	Black organic silt with trace fine sand and some shell fragments.	M417-1 (0-1.3')	
	1.3-1.8	SM	Gray fine sand and silt, cohesive.		
2'			Bottom of exploration		
3'					
4'					
5'					
6'					
7'					

Comments:
13:44- No recovery
13:54- 1/2' recovery, wood, shells, etc. Point moved North 50'. No refusal.
14:03- 5'/1.8', 1.3' OL/OH, 0.5' clay. No refusal.
14:13- 1.5'/?, OL/OH. No refusal.
14:20- 2'/1.2', 0.9' OL/OH, 0.3' clay.
14:29- 1.2'/?, 0.6' OL/OH, 0.6' yellow layered clay with fine sand (see photo).

MAGUIRE GROUP INC.		VIBRACORE LOG	
PROJECT:	16421 - MACZM - DMMP	BORING NO.	NBH-201-SED
LOCATION:	New Bedford Harbor, MA	PAGE 1 OF	1
DRILLING CO:	CR Environmental	DATE STARTED:	10/10/2002
EQUIPMENT:	Cyprinodon	DATE FINISHED:	10/10/2002
DRILLED BY:	Capt. Eric Steele	SEDIMENT ELEVATIOI	33.5 Feet
INSPECTED BY:	Dorian Bertram		

Location Coordinates
817,019 m E
2,690,933 m N

	CASING	SAMPLER	CORE BAR
TYPE:	VibraCore	PE Liner	
SIZE ID:	4"	4"	
PENETRATION:	12'	12'	

SAMPLE DATA

DEPTH (ft)	SAMPLING DEPTH FROM - TO	STRATA CHANGE (ft)	LITHOLOGY (Description of materials)	SAMPLE ID	PEN/ RECOV (in./in.)	HNU
	0-1.5		**MARINE: SILT**; organic Silt, dark gray, slight sheen, shell fragments, saturated.	S-1	126/126	
	1.5-3.3			S-2		
			MARINE: SANDY SILT; organic Silt, 10-15% fine Sand, dark gray, saturated.			
	3.3-5			S-3		
5.0						
			GRAVELLY SAND; 10-15% fine sub-rounded Gravel, coarse to fine Sand, brown, saturated.			
10.0						
			Bottom of Vibracore - 10.5'			
15.0						
20.0						

GENERAL REMARKS:

MAGUIRE GROUP INC.	VIBRACORE LOG

PROJECT:	16421 - MACZM - DMMP	BORING NO.	NBH-202-SED
LOCATION:	New Bedford Harbor, MA	PAGE 1 OF	1
DRILLING CO:	CR Environmental	DATE STARTED:	10/10/2002
EQUIPMENT:	Cyprinodon	DATE FINISHED:	10/10/2002
DRILLED BY:	Capt. Eric Steele	SEDIMENT ELEVATIOI	Not Determined
INSPECTED BY:	Dorian Bertram		

Location Coordinates
816,046 m E
2,691,483 m N

	CASING	SAMPLER	CORE BAR
TYPE:	VibraCore	PE Liner	
SIZE ID:	4"	4"	
PENETRATION:	12'	12'	

SAMPLE DATA

DEPTH (ft)	SAMPLING DEPTH FROM - TO	STRATA CHANGE (ft)	LITHOLOGY (Description of materials)	SAMPLE ID	PEN/ RECOV (in./in.)	
	0-2		**MARINE: SILT;** organic Silt, <5% fine Sand, sheen, black, saturated.	S-2	64/64	
	2-4		**MARINE: SILTY CLAY;** non-plastic Clay, organic Silt, gray, saturated.	S-2		
5.0	4-5.3		**MISCELLANEOUS FILL: SILTY SAND;** medium to fine Sand, 10-15% organic non-plastic fines, shell and metal fragments.	S-3		
			Bottom of Vibracore - 5.3'			
10.0						
15.0						
20.0						

GENERAL REMARKS:

MAGUIRE GROUP INC.		VIBRACORE LOG	
PROJECT:	16421 - MACZM - DMMP	BORING NO.	NBH-203-SED
LOCATION:	New Bedford Harbor, MA	PAGE 1 OF	1
DRILLING CO:	CR Environmental	DATE STARTED:	10/10/2002
EQUIPMENT:	Cyprinodon	DATE FINISHED:	10/10/2002
DRILLED BY:	Capt. Eric Steele	SEDIMENT ELEVATIOI	Not Determined
INSPECTED BY:	Dorian Bertram		

Location Coordinates
816,497 m E
2,691,987 m N

	CASING	SAMPLER	CORE BAR
TYPE:	VibraCore	PE Liner	
SIZE ID:	4"	4"	
PENETRATION:	12'	12'	

SAMPLE DATA

DEPTH (ft)	SAMPLING DEPTH FROM - TO	STRATA CHANGE (ft)	LITHOLOGY (Description of materials)	SAMPLE ID	PEN/ RECOV (in./in.)	
	0-2.7		**MARINE: SILTY CLAY;** non-plastic Clay, organic Silt, gray, saturated.	S-1	60/60	
	2.7-5		**GRAVELLY SILTY SAND;** 10-15% coarse to fine Gravel, coarse to fine Sand, 10-15% non-plastic organic Fines, gray, saturated.	S-2		
5.0						
			Bottom of Vibracore - 5'			
10.0						
15.0						
20.0						

GENERAL REMARKS:

MAGUIRE GROUP INC.		VIBRACORE LOG	
PROJECT:	16421 - MACZM - DMMP	BORING NO.	NBH-204-SED
LOCATION:	New Bedford Harbor, MA	PAGE 1 OF	1
DRILLING CO:	CR Environmental	DATE STARTED:	10/10/2002
EQUIPMENT:	Cyprinodon	DATE FINISHED:	10/10/2002
DRILLED BY:	Capt. Eric Steele	SEDIMENT ELEVATIOI	Not Determined
INSPECTED BY:	Dorian Bertram		

Location Coordinates
817,274 m E
2,695,483 m N

	CASING	SAMPLER	CORE BAR
TYPE:	VibraCore	PE Liner	
SIZE ID:	4"	4"	
PENETRATION:	12'	12'	

SAMPLE DATA

DEPTH (ft)	SAMPLING DEPTH FROM - TO	STRATA CHANGE (ft)	LITHOLOGY (Description of materials)	SAMPLE ID	PEN/ RECOV (in./in.)	
	0-1.5		**MARINE: SILTY SAND;** medium to fine Sand, organic non-plastic Fines, shell fragments and quahogs, charcoal gray to olive, saturated.	S-1	56/56	
	1.5-2.2		**MARINE: SAND;** medium to fine Sand, olive, saturated.	S-2		
	2.2-4.6		**MARINE: CLAY;** inorganic and organic non-plastic Clay.	S-3		
5.0						
			Bottom of Vibracore - 4.6'			
10.0						
15.0						
20.0						

GENERAL REMARKS:

MAGUIRE GROUP INC.	VIBRACORE LOG

PROJECT:	16421 - MACZM - DMMP	BORING NO.	NBH-205-SED
LOCATION:	New Bedford Harbor, MA	PAGE 1 OF	1
DRILLING CO:	CR Environmental	DATE STARTED:	10/10/2002
EQUIPMENT:	Cyprinodon	DATE FINISHED:	10/10/2002
DRILLED BY:	Capt. Eric Steele	SEDIMENT ELEVATIOI	Not Determined
INSPECTED BY:	Dorian Bertram		

Location Coordinates
816,178 m E
2,696,663 m N

	CASING	SAMPLER	CORE BAR
TYPE:	VibraCore	PE Liner	
SIZE ID:	4"	4"	
PENETRATION:	12'	12'	

SAMPLE DATA

DEPTH (ft)	SAMPLING DEPTH FROM - TO	STRATA CHANGE (ft)	LITHOLOGY (Description of materials)	SAMPLE ID	PEN/ RECOV (in./in.)	
	0-2		**MARINE: SILT;** inorganic non-plastic Silt, shell hash, wood debris, peat, dark gray to olive gray, saturated.	S-1	150/150	
	2-4		**MARINE: SILT;** inorganic non-plastic Silt, gray, saturated.	S-2		
5.0	4-6		**MARINE: SILT;** SAME AS ABOVE.	S-3		
	6-8		**MARINE: SILT;** SAME AS ABOVE.	S-4		
10.0						
			Bottom of Vibracore - 12.5'			
15.0						
20.0						

GENERAL REMARKS:

MAGUIRE GROUP INC.	VIBRACORE LOG
PROJECT: 16421 - MACZM - DMMP	BORING NO. NBH-206-SED
LOCATION: New Bedford Harbor, MA	PAGE 1 OF 1
DRILLING CO: CR Environmental	DATE STARTED: 10/10/2002
EQUIPMENT: Cyprinodon	DATE FINISHED: 10/10/2002
DRILLED BY: Capt. Eric Steele	SEDIMENT ELEVATIOI Not Determined
INSPECTED BY: Dorian Bertram	

Location Coordinates
816,044 m E
2,696,107 m N

	CASING	SAMPLER	CORE BAR
TYPE:	VibraCore	PE Liner	
SIZE ID:	4"	4"	
PENETRATION:	12'	12'	

SAMPLE DATA

DEPTH (ft)	SAMPLING DEPTH FROM - TO	STRATA CHANGE (ft)	LITHOLOGY (Description of materials)	SAMPLE ID	PEN/ RECOV (in./in.)	
	0-2		**MARINE: SILT**; organic non-plastic Silt, shell hash, gray, saturated.	S-1	144/144	
	2-4		**MARINE: SILT**; SAME AS ABOVE.	S-2		
	4-6		**MARINE: SILT**; SAME AS ABOVE.	S-3		
5.0						
	6-7		**MARINE: SILT**; SAME AS ABOVE.	S-4		
10.0						
			Bottom of Vibracore - 12'			
15.0						
20.0						

GENERAL REMARKS:

APEX

ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA - NEW BEDFORD, MA - HOLYOKE, MA

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

58H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

PROJECT

NEW BEDFORD HARBOR
USEPA LOWER HARBOR CAD CELL
CFDA NO.:66.802

OWNER

NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
52 FISHERMAN'S WHARF
NEW BEDFORD, MA 02745

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	6724
CADD FILE	SAP FIGURE2-6
DESIGNED BY	GCD
DRAWN BY	GCD
CHECKED BY	CMM
DATE	1/24/12
DRAWING SCALE	1"=250'

GRAPHIC SCALE

SCALE: 1"=250'
0 250 500 FEET

SHEET TITLE

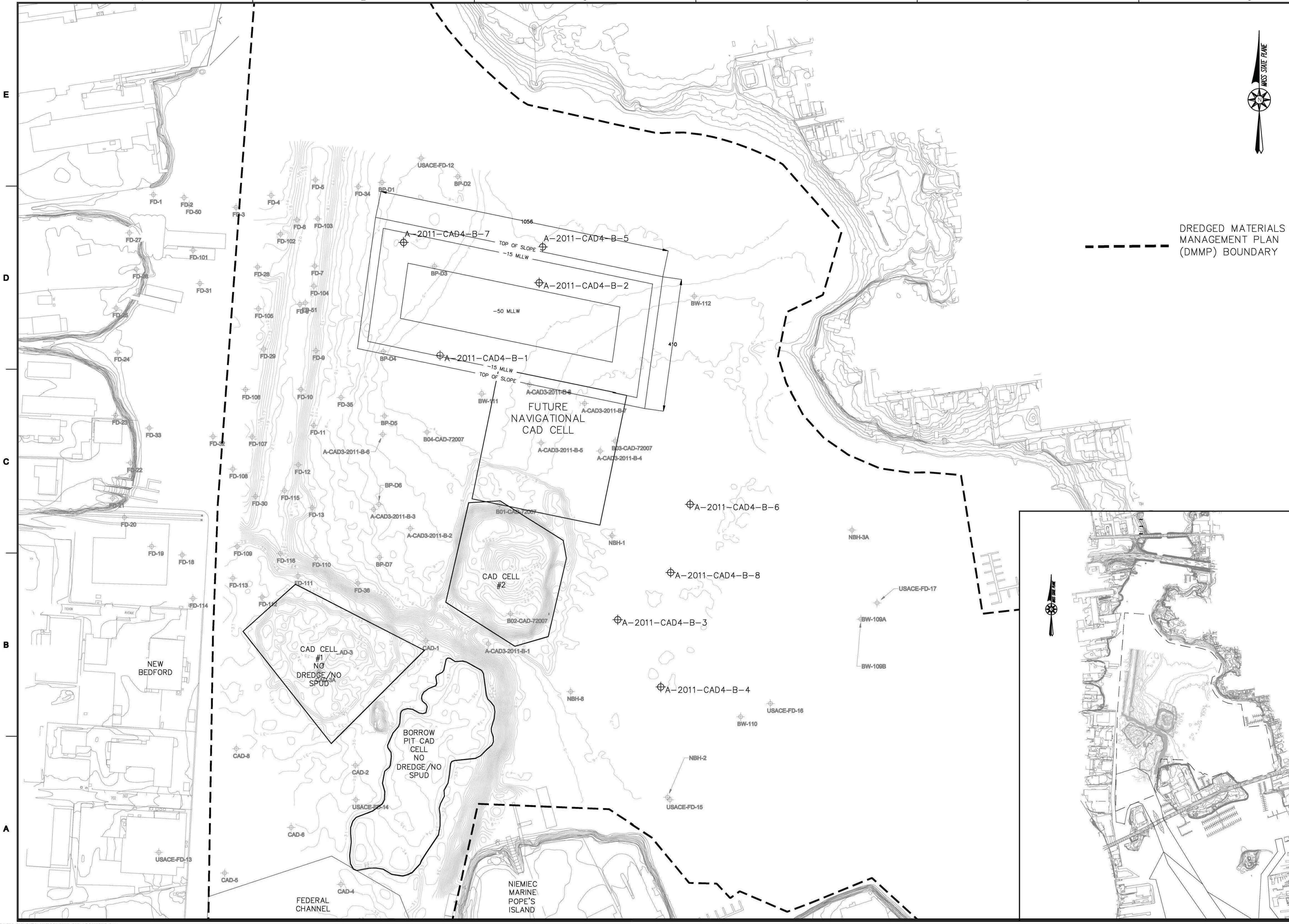
HISTORIC VIBRACORE LOCATION PLAN

DRAWING NO.

FIG-3

2 OF 9

P:\Jobs\6724 EPA CAD Cell\PLANS\SAP FIGURE2-6.dwg



DREDGED MATERIALS MANAGEMENT PLAN (DMMP) BOUNDARY

APEX

ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA - NEW BEDFORD, MA - HOLYOKE, MA

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

58H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

PROJECT
NEW BEDFORD HARBOR
USEPA LOWER HARBOR CAD CELL
CFDA NO.:66.802

OWNER
NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
52 FISHERMAN'S WHARF
NEW BEDFORD, MA 02745

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	6724
CADD FILE	CONCEPT_CAD_LOCATIONS
DESIGNED BY	GCD
DRAWN BY	GCD
CHECKED BY	CAD CELL
DATE	1/24/12
DRAWING SCALE	1"=150'

GRAPHIC SCALE
SCALE: 1"=150'
0 150 300 FEET

SHEET TITLE

CONCEPTUAL LHCC LOCATION PLAN 1

DRAWING NO.

FIG-4

P:\Jobs\6724 EPA CAD Cell\PLANS\CONCEPT_CAD_LOCATIONS.dwg

APEX

ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA - NEW BEDFORD, MA - HOLYOKE, MA

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

58H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

PROJECT
NEW BEDFORD HARBOR
USEPA LOWER HARBOR CAD CELL
CFDA NO.:66.802

OWNER
NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
52 FISHERMAN'S WHARF
NEW BEDFORD, MA 02745

NO.	DATE	DESCRIPTION	BY

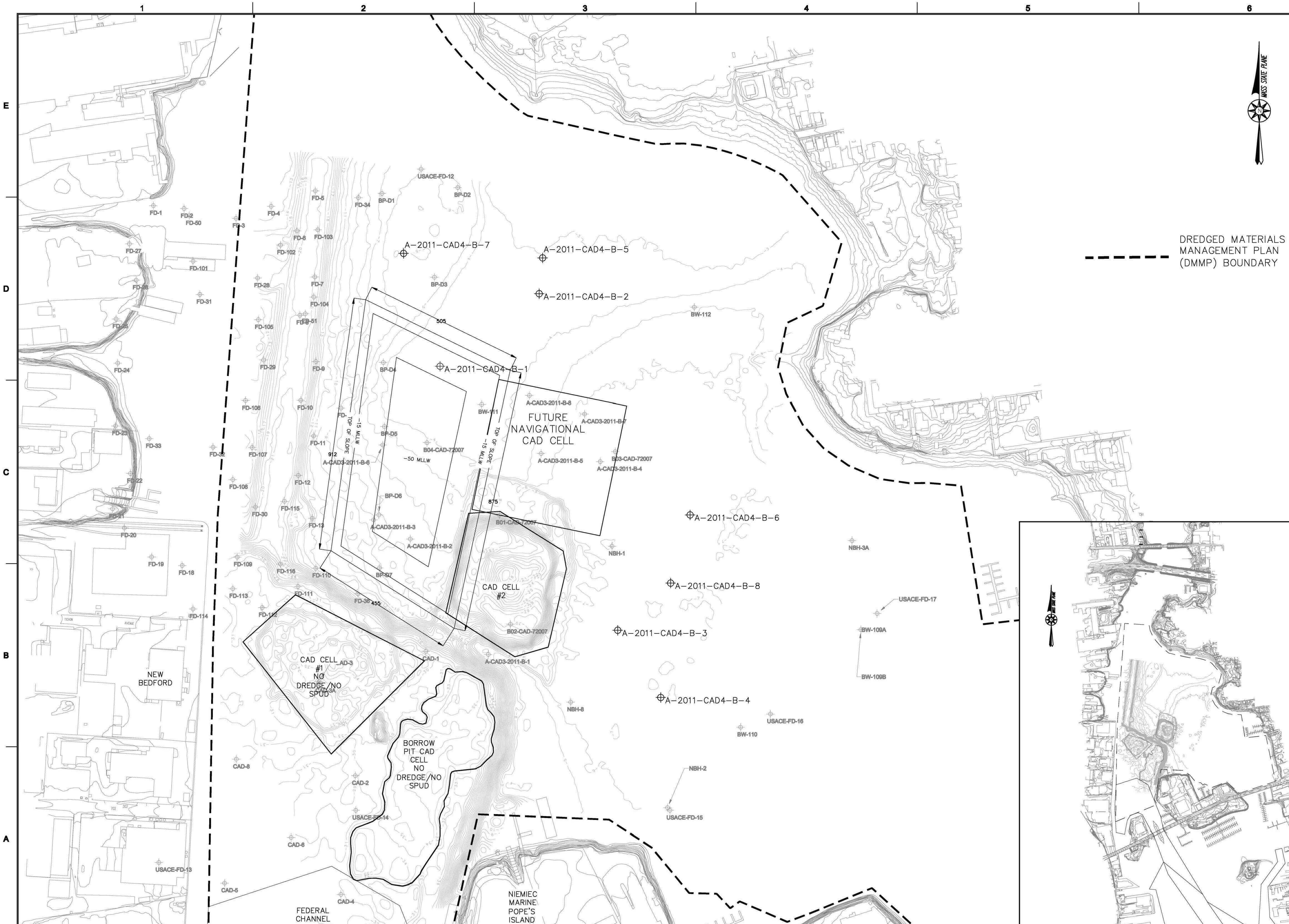
PROJECT NO.	6724
CADD FILE	CONCEPT_CAD_LOCATIONS
DESIGNED BY	GCD
DRAWN BY	GCD
CHECKED BY	CAD CELL
DATE	1/24/12
DRAWING SCALE	1"=150'

GRAPHIC SCALE
SCALE: 1"=150'
0 150 300 FEET

SHEET TITLE
CONCEPTUAL LHCC LOCATION PLAN 2

DRAWING NO.
FIG-5

P:\Jobs\6724 EPA CAD Cell\PLANS\CONCEPT_CAD_LOCATIONS.dwg



APEX

ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA - NEW BEDFORD, MA - HOLYOKE, MA

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

58H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

PROJECT
NEW BEDFORD HARBOR
USEPA LOWER HARBOR CAD CELL
CFDA NO.:66.802

OWNER
NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
52 FISHERMAN'S WHARF
NEW BEDFORD, MA 02745

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	6724
CADD FILE	CONCEPT_CAD_LOCATIONS
DESIGNED BY	GCD
DRAWN BY	GCD
CHECKED BY	CAD CELL
DATE	1/24/12
DRAWING SCALE	1"=150'

GRAPHIC SCALE
SCALE: 1"=150'
0 150 300 FEET

SHEET TITLE
CONCEPTUAL
LHCC
LOCATION PLAN 3

DRAWING NO.
FIG-6

6 OF 9

P:\Jobs\6724 EPA CAD Cell\PLANS\CONCEPT_CAD_LOCATIONS.dwg

APEX

ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA -
NEW BEDFORD, MA - HOLYOKE, MA

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

58H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

PROJECT

NEW BEDFORD HARBOR
USEPA LOWER HARBOR CAD CELL
CFDA NO.:66.802

OWNER

NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
52 FISHERMAN'S WHARF
NEW BEDFORD, MA 02745

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	6724
CADD FILE	CONCEPT_CAD_LOCATIONS
DESIGNED BY	GCD
DRAWN BY	GCD
CHECKED BY	CAD CELL
DATE	1/24/12
DRAWING SCALE	1"=150'

GRAPHIC SCALE
SCALE: 1"=150'
0 150 300 FEET

SHEET TITLE

CONCEPTUAL
LHCC
LOCATION PLAN 4

DRAWING NO.

FIG-7

7 OF 9

P:\Jobs\6724 EPA CAD Cell\PLANS\CONCEPT_CAD_LOCATIONS.dwg

![APEX logo]

ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA - NEW BEDFORD, MA - HOLYOKE, MA

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

55H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

PROJECT
NEW BEDFORD HARBOR
USEPA LOWER HARBOR CAD CELL
CFDA NO.:66.802

OWNER
NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
52 FISHERMAN'S WHARF
NEW BEDFORD, MA 02745

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	6724
CADD FILE	CONCEPT_CAD_LOCATIONS
DESIGNED BY	GCD
DRAWN BY	GCD
CHECKED BY	CAD CELL
DATE	1/24/12
DRAWING SCALE	1"=150'

GRAPHIC SCALE
SCALE: 1"=150'
0 150 300 FEET

SHEET TITLE

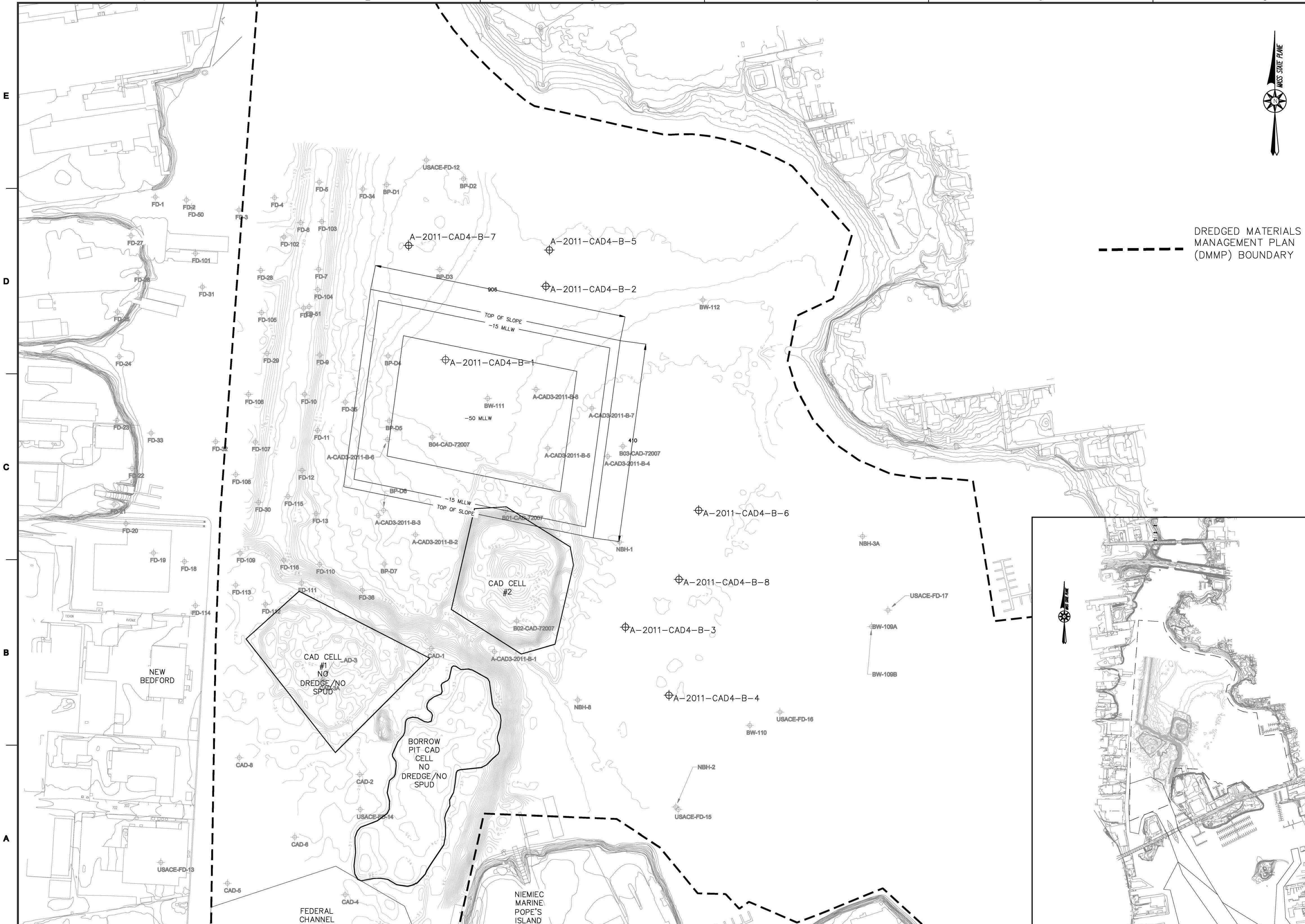
CONCEPTUAL
LHCC
LOCATION PLAN 5

DRAWING NO.

FIG-8

8 OF 9

P:\Jobs\6724 EPA CAD Cell\PLANS\CONCEPT_CAD_LOCATIONS.dwg



ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA -
NEW BEDFORD, MA - HOLYOKE, MA

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

58H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

PROJECT
NEW BEDFORD HARBOR
USEPA LOWER HARBOR CAD CELL
CFDA NO.:66.802

OWNER
NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
52 FISHERMAN'S WHARF
NEW BEDFORD, MA 02745

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	6724
CADD FILE	CONCEPT_CAD_LOCATIONS
DESIGNED BY	GCD
DRAWN BY	GCD
CHECKED BY	CAD CELL
DATE	1/24/12
DRAWING SCALE	1"=150'

GRAPHIC SCALE
SCALE: 1"=150'
0 150 300 FEET

SHEET TITLE

CONCEPTUAL
LHCC
LOCATION PLAN 6
(JOINT CAD CELL)

DRAWING NO.

FIG-9

P:\Jobs\6724 EPA CAD Cell\PLANS\CONCEPT_CAD_LOCATIONS.dwg