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Final Report

Boston Harbor Deep Draft Navigation Improvement Project

Biological Resource Surveys
Sidescan Survey of Potential Hard Bottom Habitat Creation Sites

FINAL

BOSTON HARBOR DEEP DRAFT NAVIGATION IMPROVEMENT PROJECT BIOLOGICAL RESOURCE SURVEYS

SIDESCAN SURVEY OF POTENTIAL HARD BOTTOM HABITAT CREATION SITES

Contract Number DACW33-03-D-004
Delivery Order No. 05

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1.0 INTRODUCTION

In early September 2004, CR Environmental, Inc. (CR), under contract to Battelle, conducted aquatic remote sensing investigations to classify benthic substrate composition at five near-shore marine sites: Nantasket Roads, Massachusetts Bay, Broad Sound, Nahant Bay, and Magnolia Bay, MA (Figure 1). Components of the investigations were side-scan sonar surveys, and limited towed underwater video observations and grab sampling of sediments for ground-truthing the side-scan records.

The following sections describe the methods employed for the surveys and data processing followed by a brief description of survey results.

2.0 METHODS

The surveys were conducted aboard CR's 32-ft survey vessel *Cyprinodon*. Mobilization of gear and personnel was conducted on September 1, 2004, at Allerton Harbor in Hull, MA, and survey activities were performed between September 1 and 8, 2004. A 12 hr day of field survey time was allotted for each site that included 1 to 2 hours of transit time, 6 to 8 hours for the side-scan survey and 1 to 2 hours of underwater video and grab sampling operations.

2.1 Navigation

Navigation for the surveys was accomplished using a Trimble AgGPS 132 12-channel Trimble DGPS system capable of receiving the U.S. Coast Guard (USCG) Beacon corrections. The DGPS provided a 1-Hz digital output of sub-meter accurate position data to HYPACK MAX hydrographic survey software running on a laptop PC. Coordinates defining each survey area were provided in Massachusetts Mainland grid (NAD27), U.S. Survey Feet by Battelle. Positions were recorded in the WGS 84 geographic datum (NAD83) and were transformed to the Massachusetts Mainland grid (NAD27) in U.S. Survey Feet. HYPACK was used to plan survey lines, guide the vessel pilot along the lines, and record position data for video drifts and grab samples.

2.2 Side-Scan Sonar

The side-scan sonar survey areas defined by Battelle and the U.S. Army Corps of Engineers, NAE included portions of Nantasket Roads, Massachusetts Bay, Nahant Bay, Broad Sound, and Magnolia Bay. Side-scan sonar surveys were conducted using an Edgetech, Inc. 272TD 100/500-kHz towfish. Surveys were conducted using a 100-kHz frequency and a 100-meter range scale. The towfish was maintained at an altitude of approximately 20-percent of the water depth where possible without risking bottom contact or snagging of the towfish. Survey track lines were spaced 150-meters apart ensuring sufficient overlap of sonar data. Note that a strong thermocline was present during each of the surveys and partially obscured the outer portion of sonar records due to refraction.

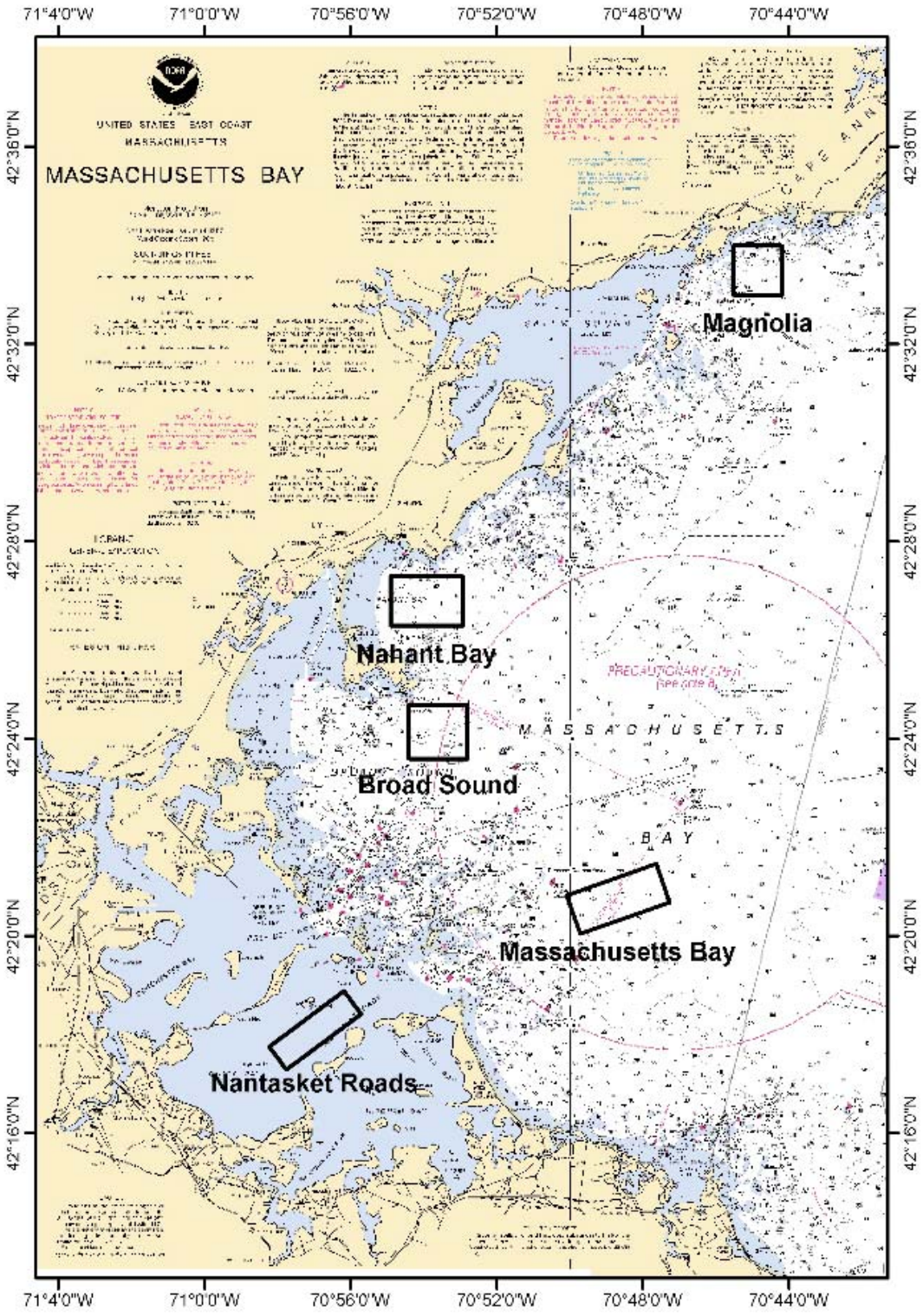


Figure 1. Area Site Map.

Side-scan sonar data was recorded digitally using an Edgetech Model 560 processing computer with an Analog Control Interface (ACI) board and Chesapeake Technology's SonarWiz acquisition software. Precise measurements of towfish layback (offset from DGPS antenna) were recorded during the survey, allowing preparation of accurately geo-referenced sonar mosaics. Processing of sonar data was accomplished using Chesapeake Technology's SonarWeb software.

Components of processing included:

- application of accurate layback,
- estimation of catenary coefficients,
- application of Time Varied Gain (TVG) as necessary,
- Beam Angle Correction (BAC) to correct for acoustic energy loss associated with increasing angle of incidence,
- merging of each survey area's data into georeferenced mosaics.

The mosaic pixel resolution selected for this project was 0.5-meters. Preliminary mosaics were imported into ArcView 3.2a GIS software. Based on interpretation of these mosaics and video observations (methods described below), CR selected and digitized suitable locations for the Sediment Profile Imaging (SPI) survey. Draft mosaics and SPI station coordinates were provided to Battelle, Inc. and Robert Diaz (SPI operator). SPI locations were chosen based on identification of soft bottom areas representing the range of habitat types within a given area. Final versions of sonar mosaics will be provided in geo-referenced JPEG formats and HTML web enabled format suitable for viewing and analysis using ArcView, ArcExplorer, AutoCAD and other GIS software.

2.3 Underwater Video Observations & Grab Samples

CR's towed underwater video sled was deployed at each site in order to ground-truth sonar data and to provide more detailed descriptions of benthic substrates and biota. The sled consists of a light-weight aluminum frame, Deep Sea Power and Light Multi-SeaCam high resolution color video camera and two 250 watt lights. This system was cabled to the surface and underwater video data was displayed in real time on a flat screen monitor. Five controlled video drifts were conducted at each site. Each drift lasted between 5 to 15 minutes. Video drifts were not performed in the rock ledge areas due to risk of damage to or loss of the equipment. Video data was recorded on both DVD and VHS tape. Position data was recorded simultaneously with video recordings using HYPACK. This allowed correlation of video observations with side-scan sonar data. This position data was exported from HYPACK as a delimited ASCII text file including Latitude, Longitude, Northing, Easting and precise time.

At least one benthic grab sample was collected at each survey area. Grab stations were chosen to be co-located with video drift transects. Grabs were collected using a modified Ted Young grab. Grab contents were digitally photographed and described based on grain size and texture. Table 1 shows coordinates for each grab sample collected.

Table 1. Grab Sample Coordinates.

GRAB_ID	X	Y	LAT	LONG	TIME	DATE
Broad Sound	761413.2	512555.9	42.40503	-70.9024	16:22:12	9/2/2004
Mass Bay	785352.4	491739.3	42.34741	-70.8144	16:54:57	9/2/2004
Magnolia 1	805481.9	567046.7	42.55358	-70.7374	16:18:28	9/3/2004
Magnolia 2	805580.3	567224.5	42.55407	-70.737	16:20:06	9/3/2004
Nahant Bay	764844.8	527410.5	42.44572	-70.8893	17:42:52	9/7/2004
Nantasket	745224.6	470653.5	42.29034	-70.9633	15:38:20	9/8/2004

Mass Mainland State Plane, NAD27, US Foot

2.4 Bottom Classification Maps

Maps of dominant benthic substrates were created based on evaluation of side-scan sonar, video and benthic grab data. An ArcView GIS project was constructed using the appropriate NOAA Nautical chart as a primary base layer. Sonar mosaics were laid over these charts. Video drift transects and grab stations were then laid over the mosaics. Polygons representing dominant substrate classes were digitized based on GIS data examination. Polygons were saved in .SHP format and were used to create maps of substrate composition. Note that these maps are considered "wide-area" classifications, and do not identify small patches of outlying substrate or individual features. For instance, an area interpreted as "Gravel and Cobble" may contain some sand and small boulders. Similarly, a large area of sand (either flat or rippled) would be classified as sand, without digitizing small patches of mud or gravel in the same area.

Dominant substrate classes included: ledge/rock, cobble, gravel-cobble mix, coarse sand through small cobble mix, coarse sand and gravel, sand, muddy sand, and mud.

3.0 RESULTS

Side-scan sonar mosaics and bottom classification maps are included as Figures 2 through 13. Selected screen captures of the underwater video footage from each site are presented in Plates 1-5. The following sections provide a brief description of the bottom substrate types and a general description of the observed marine biota for each survey site.

3.1 Nantasket Roads

Figures 2 and 3, respectively, are a side-scan sonar mosaic and a bottom classification map for the Nantasket Roads survey area. This site was relatively shallow with depths ranging from zero (ledge outcrops) to approximately 50-feet. The dominant substrate texture classes were interpreted to be (in decreasing order of dominance): coarse sand and gravel, sand, ledge/rock, and mud. Anthropogenic debris and fixed fishing gear (e.g., lobster traps) were widespread at this survey area.

Video drift locations are shown on Figure 3. Sea scallops were the dominant marine organism observed on the drift video footage. They were plentiful in the coarse sand and gravel bottom. Also observed were moon snails, sulfur sponge, cerianthid anemones, hydroids, juvenile

flounder, and sculpins. Numerous amphipod tubes were observed in the mud bottom during Drift 2 (Plate 1).

3.2 Massachusetts Bay

Figures 4 and 5, respectively, are a side-scan sonar mosaic and a bottom classification map for the Massachusetts Bay survey area. This site was the deepest of the survey areas with depths ranging from approximately 75-feet to 110-feet. The dominant substrate texture classes were interpreted to be (in decreasing order of dominance): sand, coarse sand and gravel, mud, and cobble. Anthropogenic debris and fixed fishing gear (e.g., lobster traps) were widespread at this survey area.

Side-scan sonar imagery identified numerous ring-shaped features. CR's experience with similar imagery suggests that these features are small mounds of disposed coarse material (e.g., construction debris). An example of a line of these mounds is provided on Figure 6.

Sand waves of varying size were also widespread at the Massachusetts Bay site. Because the orientation of the sonar survey transects partially obscured these features, the crests of which are oriented perpendicular to dominant bottom currents, CR collected additional sonar data with survey lanes oriented parallel to bottom currents to better illustrate the nature of these sand waves. Figure 7 provides an example of sand waves identified at this site.

Video drift locations at the Massachusetts Bay site are shown on Figure 4. Rock crabs were dominant in the mud/sand bottom. Several seastars, red hake, and sand shrimp were also observed at the soft bottom transects. In the gravel bottom, cobble and areas of sand waves, hydroids, sulfur sponge, cunner, flounder, sculpin, and ocean pout were observed (Plate 2).

3.3 Broad Sound

Figures 8 and 9, respectively, are the side-scan sonar mosaic and bottom classification map for the Broad Sound survey area. This site was of intermediate depth, with depths ranging from approximately 45-feet to 90-feet. The dominant substrate texture classes were interpreted to be (in decreasing order of dominance) muddy sand, and a gravel/cobble mix. The coarser gravel/cobble mix roughly bisects the site along an east/west orientation.

Video drift locations are shown on Figure 9. At the Broad Sound site, rock crabs were the dominant marine biota at both the muddy/sand and gravel/cobble bottom video transects. Numerous sea scallops were noted at the gravel/bottom areas. Also observed were northern starfish, hermit crabs, flounder, red hake, and sculpin (Plate 3).

3.4 Magnolia

Figures 10 and 11, respectively, are a side scan sonar mosaic and a bottom classification map for the Magnolia survey area. This site was of intermediate depth with depths ranging from approximately zero (ledge outcrops) to 95-feet. The dominant substrate texture classes were

interpreted to be (in decreasing order of dominance): sand (generally smooth and well-sorted), ledge/rock, and a coarse sand/gravel mix.

Video drift locations at the Magnolia site are shown on Figure 11. Numerous rock crabs were observed in burrows in the coarse sand bottom. Fish recorded at this site included both juvenile and adult flounder and skates. Also common were patches of drifting kelp and red algae and isolated patches of ocean quahog shells (Plate 4).

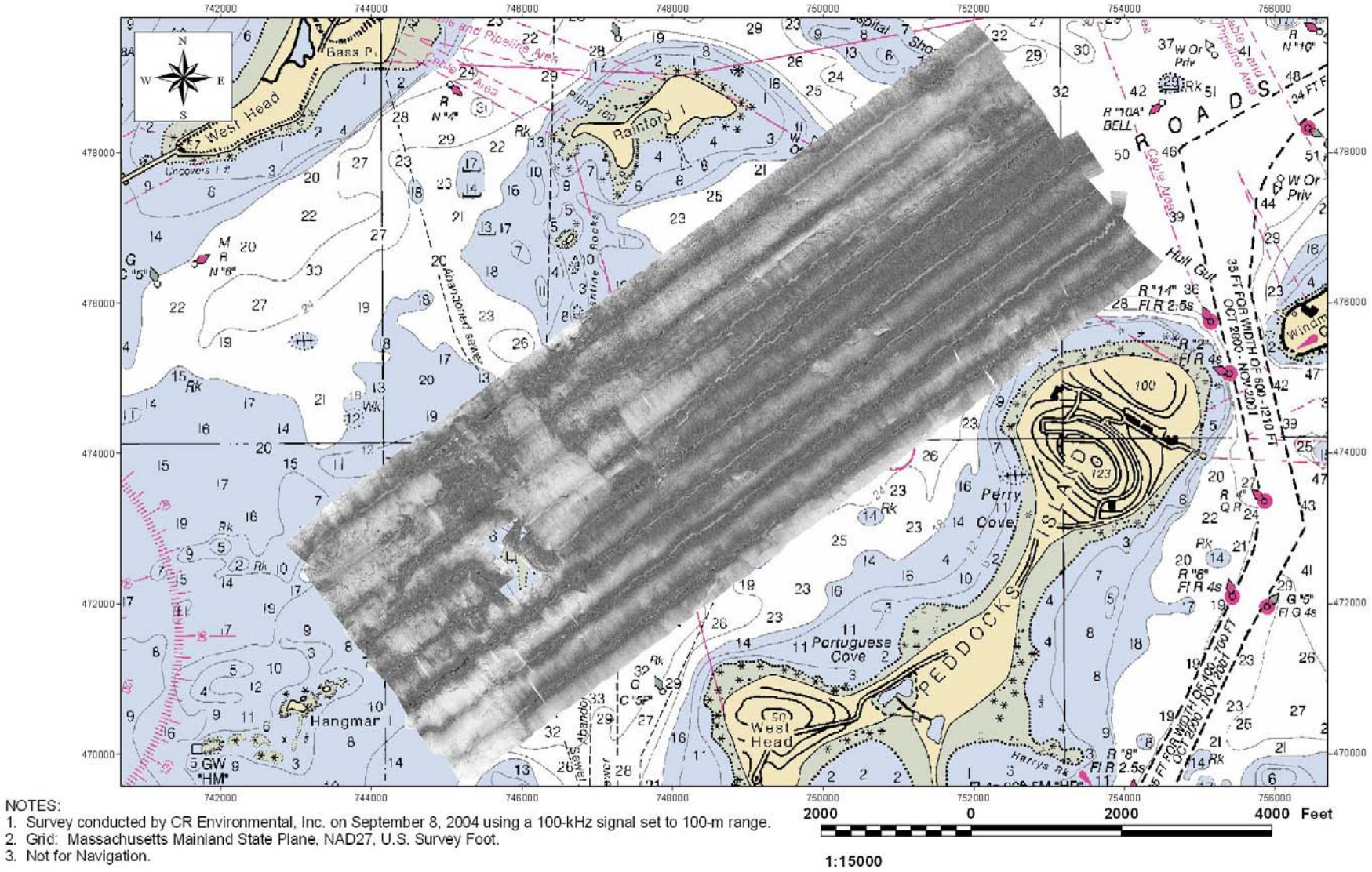
3.5 Nahant Bay

Figures 12 and 13, respectively, are a side scan sonar mosaic and a bottom classification map for the Nahant Bay survey area. This site was of intermediate depth, with depths ranging from approximately 30-feet to 75-feet. The dominant substrate texture classes were interpreted to be (in decreasing order of dominance): sand, and a mixture of coarse sand to small cobble. Coarser material appeared to be concentrated along the northern, southern, and western site boundary.

Video drift locations are shown on Figure 13. Rock crabs and small hermit crabs were the dominant invertebrates along most of the Nahant Bay video transects. At Drift 4, sand dollars were extremely abundant on the fine hard sand bottom type. Also observed at the Nahant site were seastars, sulfur sponge, red hake, juvenile sculpin, ocean pout, and flounder (Plate 5).

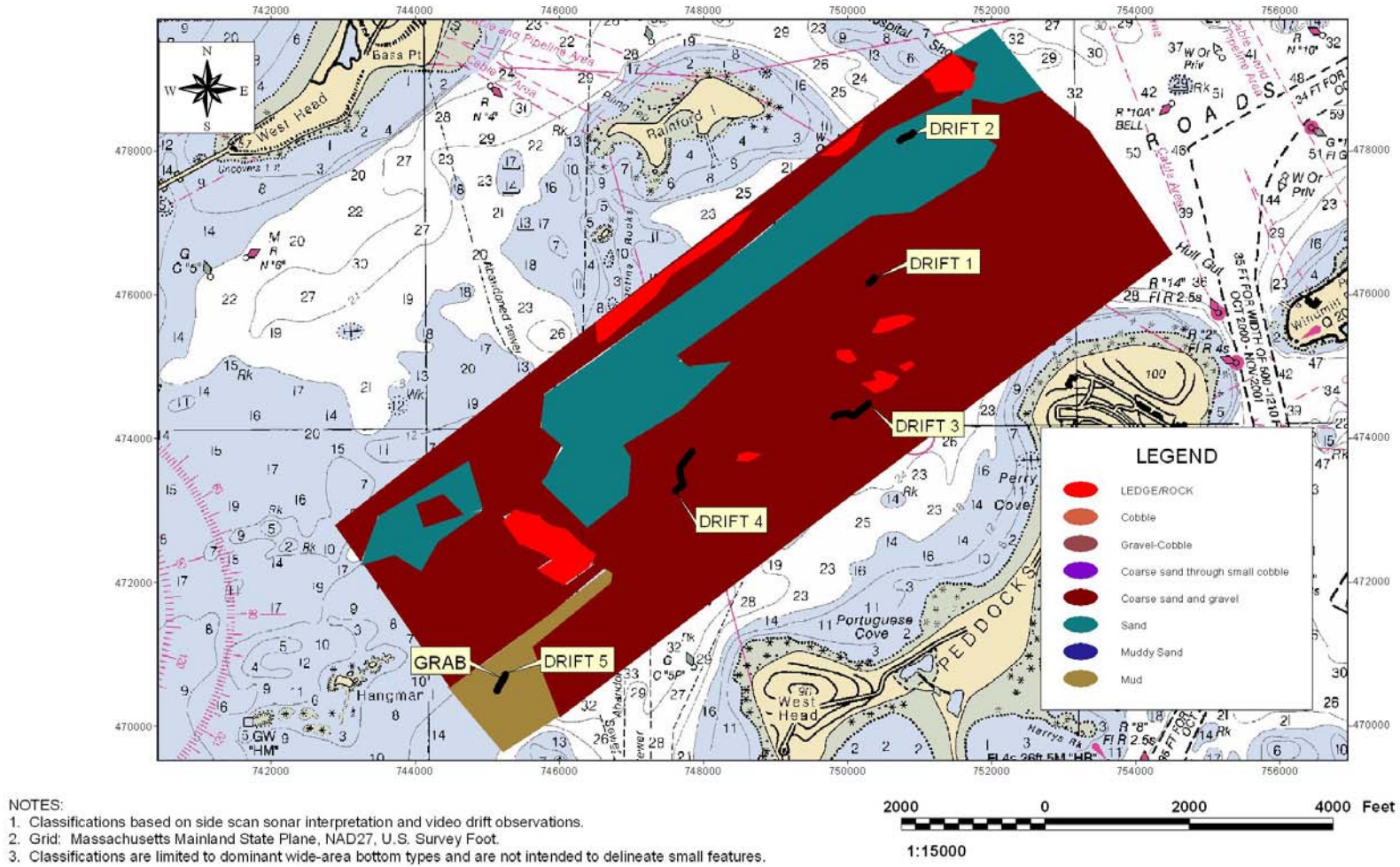
4.0 DELIVERABLES

All raw and processed side-scan sonar data in HTML and GIS format will be provided to Battelle on a DVD. Selected video screen captures of the underwater video on DVD and the unedited underwater video data on both DVD and VHS tape will also be provided.



NOTES:
1. Survey conducted by CR Environmental, Inc. on September 8, 2004 using a 100-kHz signal set to 100-m range.
2. Grid: Massachusetts Mainland State Plane, NAD27, U.S. Survey Foot.
3. Not for Navigation.

Figure 2. Side Scan Mosaic of Nantasket Roads.



NOTES:
1. Classifications based on side scan sonar interpretation and video drift observations.
2. Grid: Massachusetts Mainland State Plane, NAD27, U.S. Survey Foot.
3. Classifications are limited to dominant wide-area bottom types and are not intended to delineate small features.

2000 0 2000 4000 Feet

1:15000

Figure 3. Dominant Substrate Classes and Video Drift Locations of Nantasket Roads.

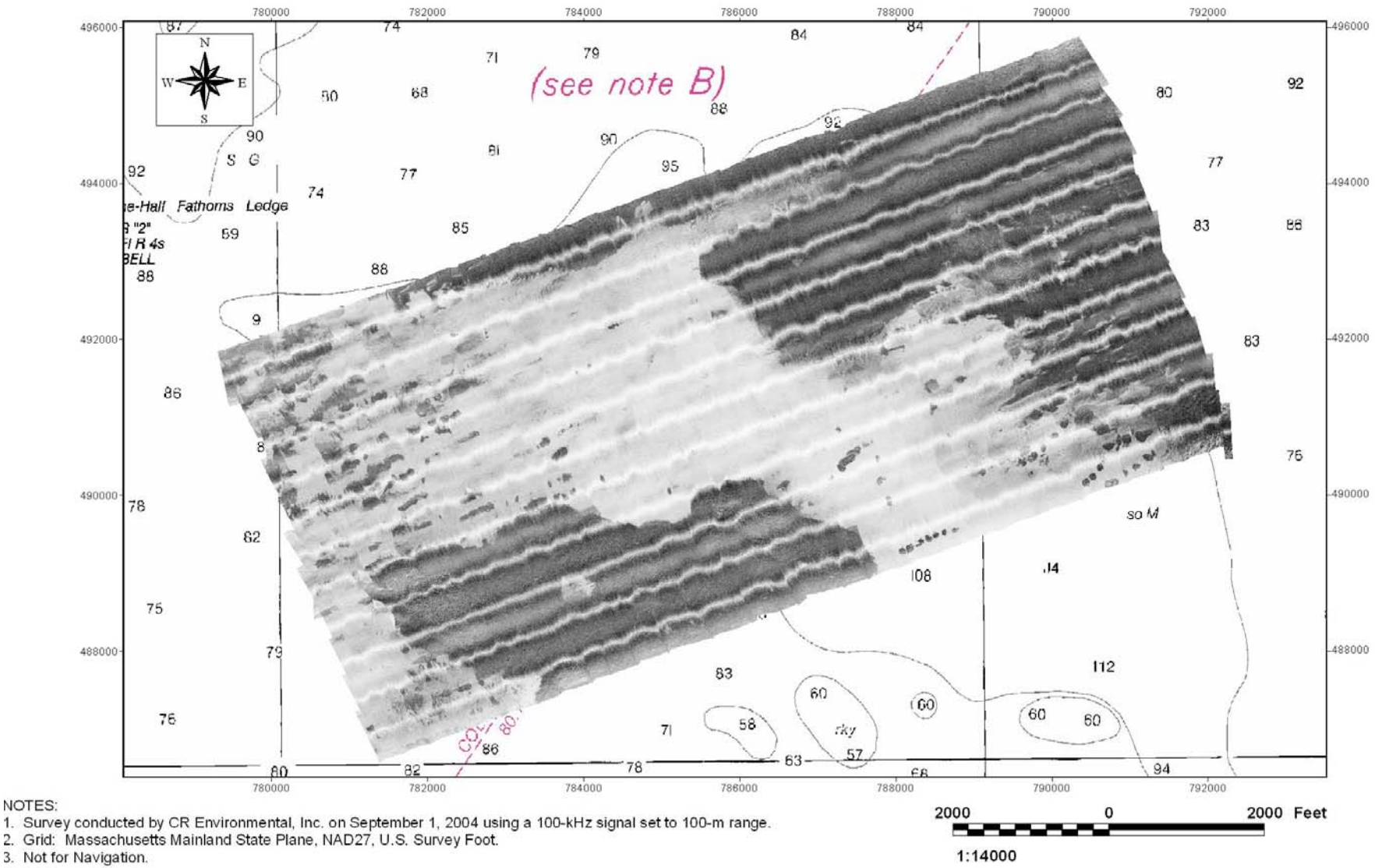


Figure 4. Side Scan Sonar Mosaic of Massachusetts Bay Site.

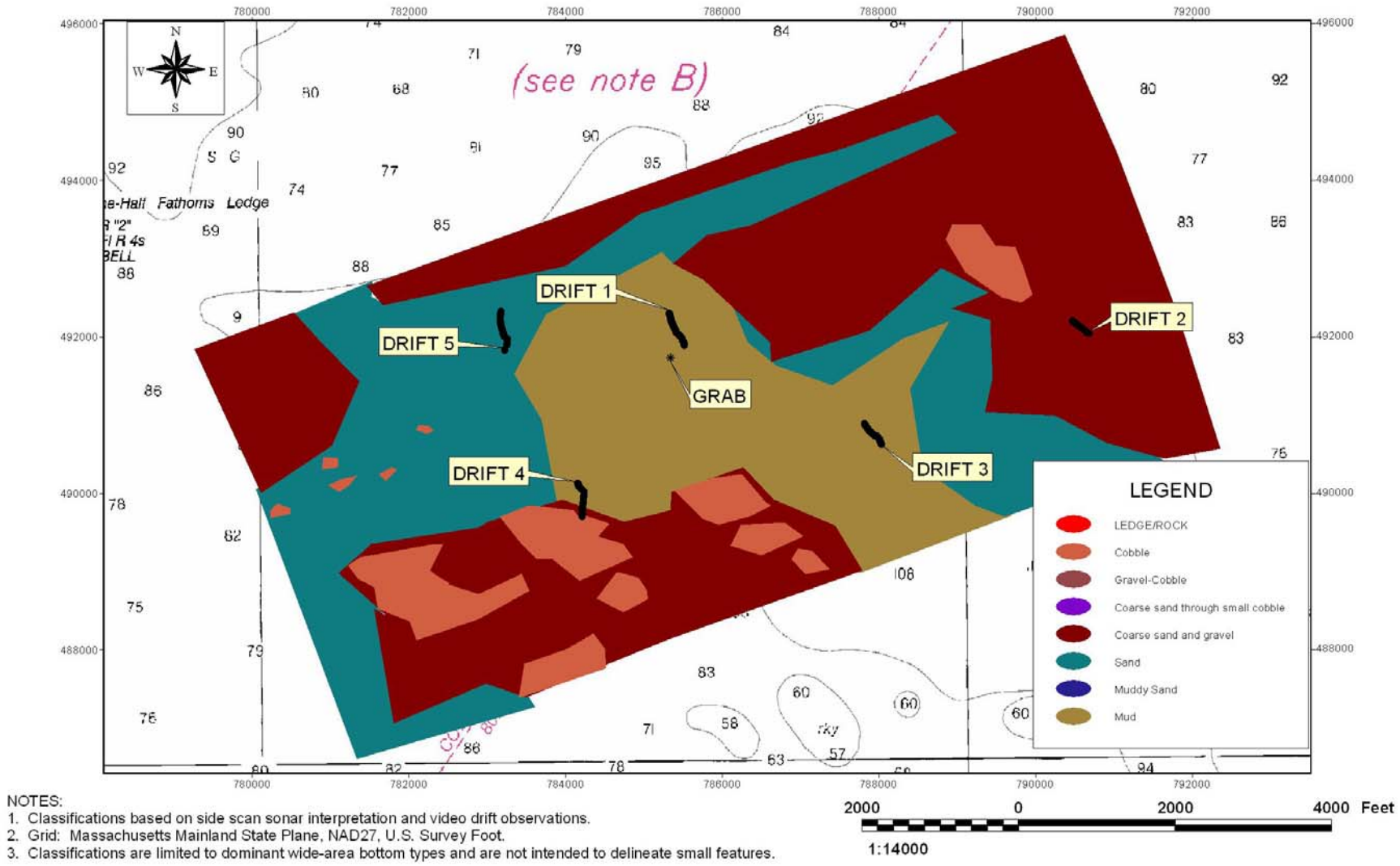


Figure 5. Dominant Substrate Classes and Video Drift Locations of Massachusetts Bay Site.

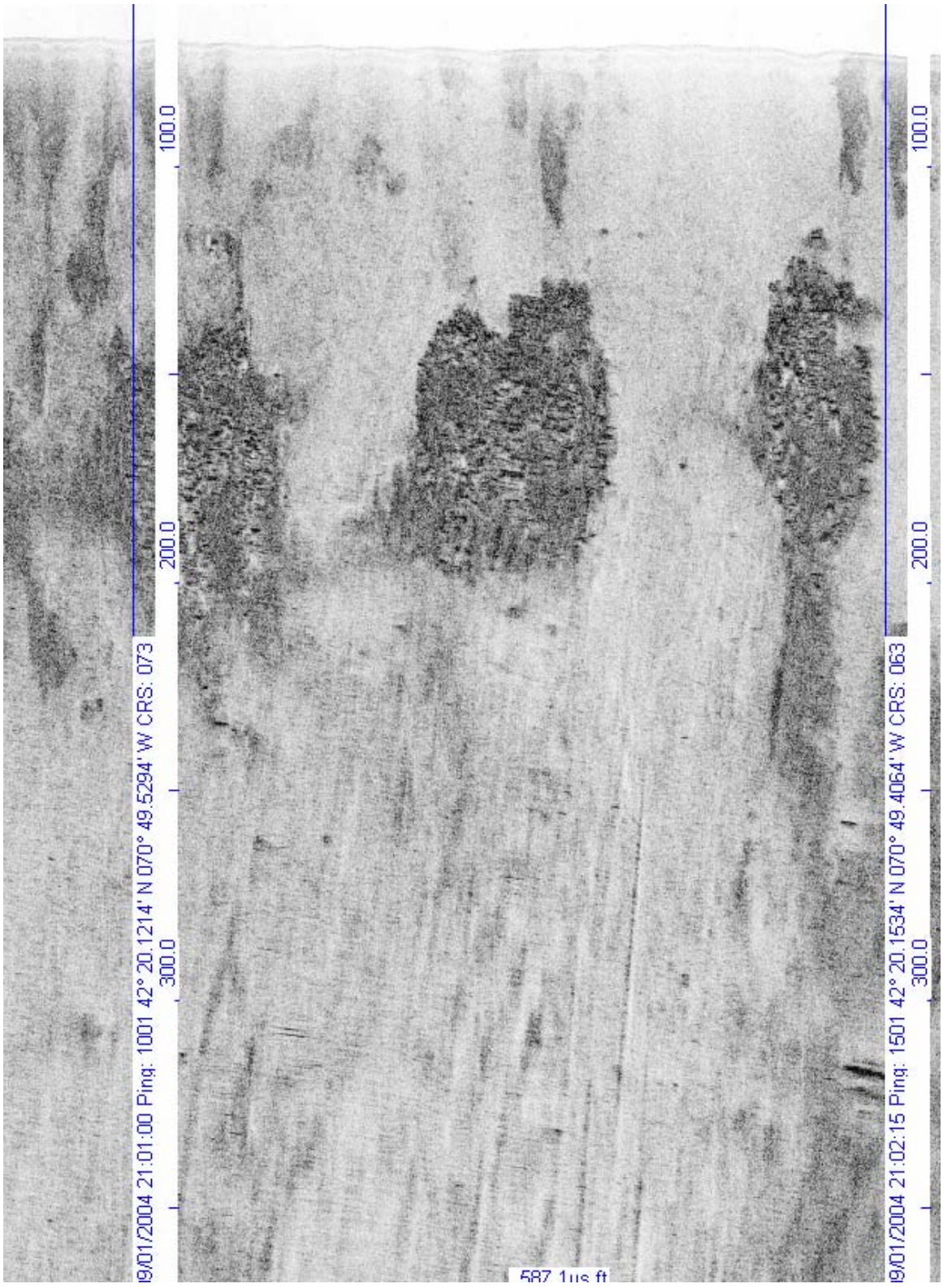


Figure 6. Example of likely Disposal-related Features Near the Southern Boundary of the Massachusetts Bay Survey Site.

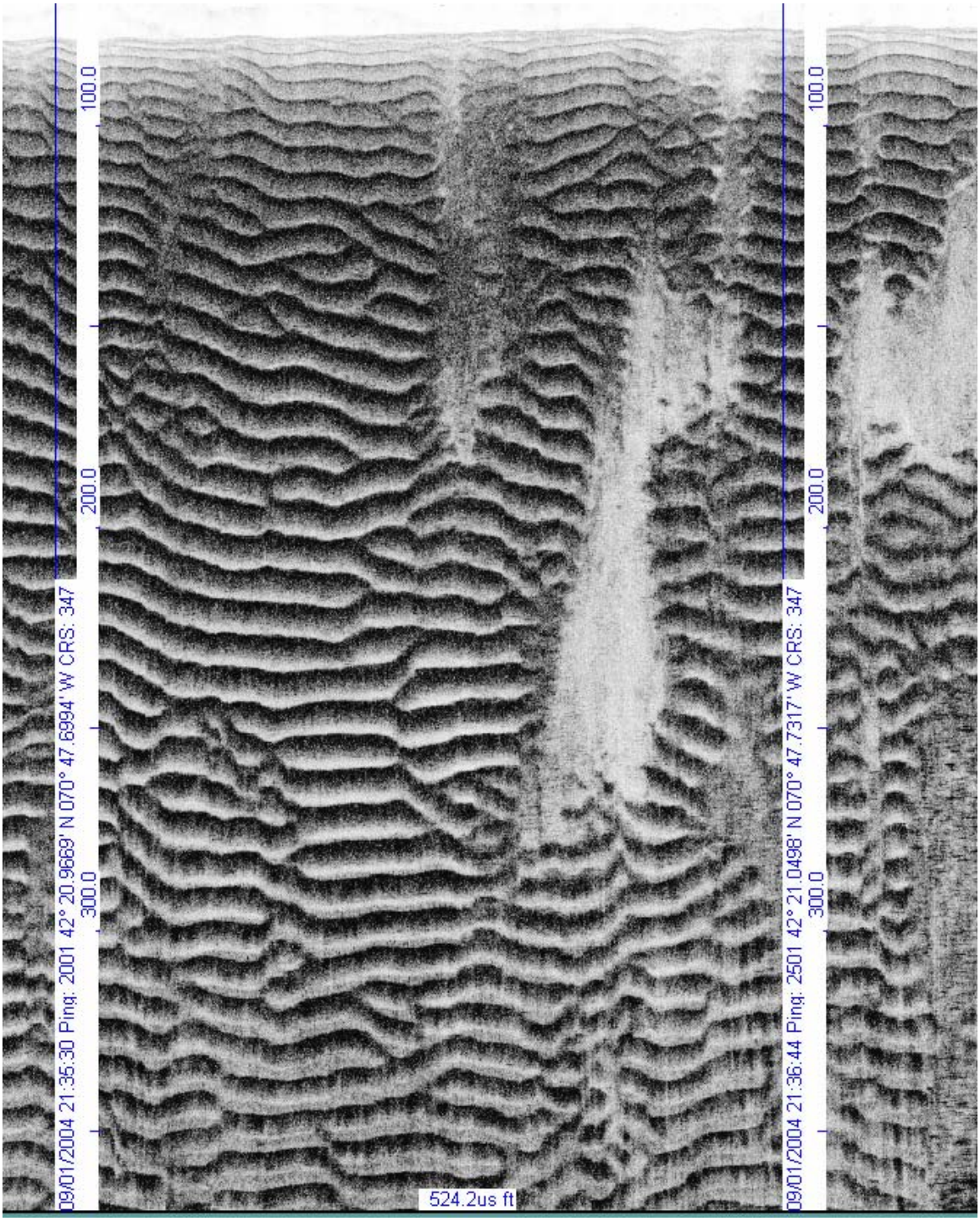
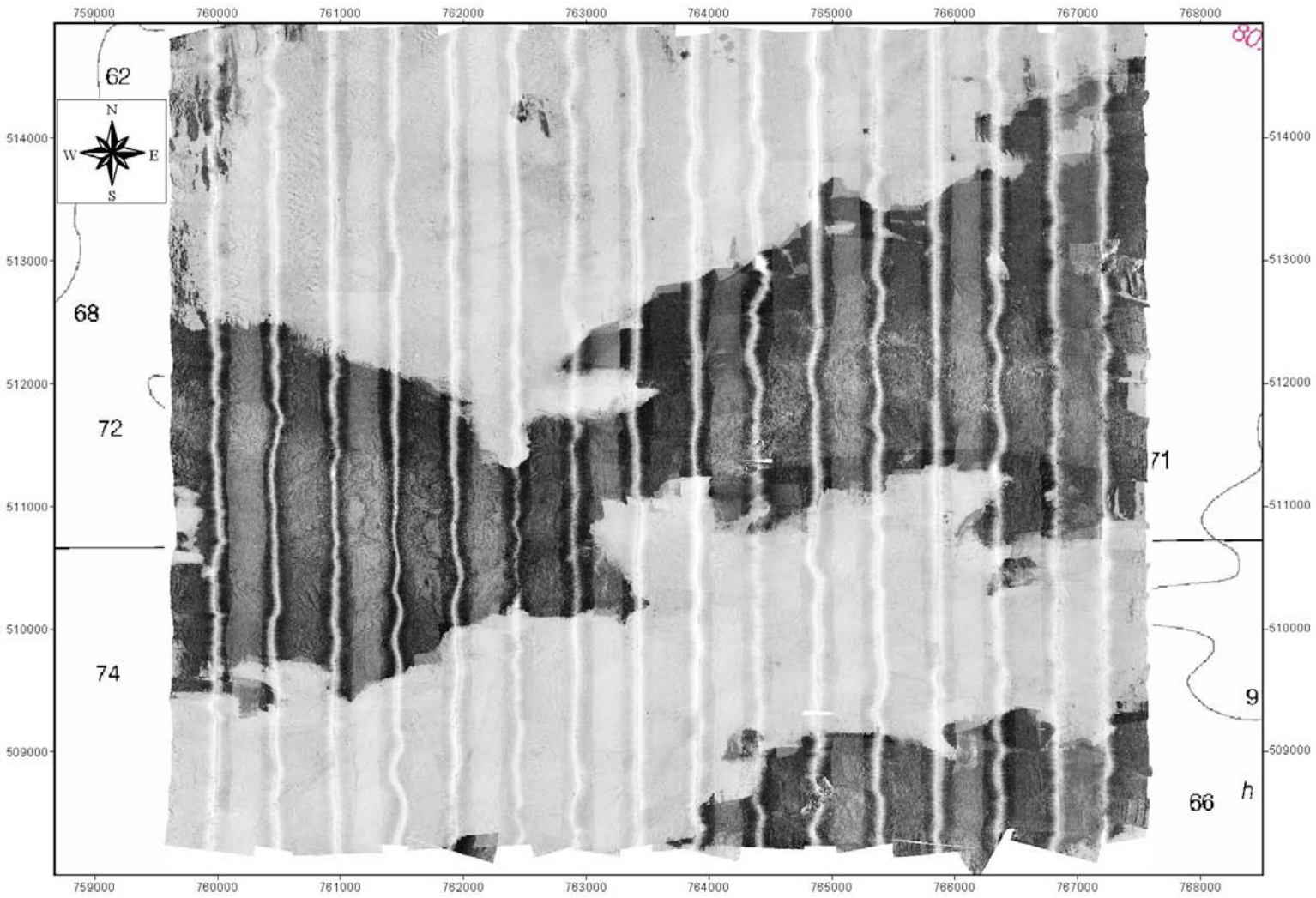


Figure 7. Example of Extensive Field of Sand Waves Observed at the Massachusetts Bay Survey Area.



NOTES:
1. Survey conducted by CR Environmental, Inc. on September 2, 2004 using a 100-kHz signal set to 100-m range.
2. Grid: Massachusetts Mainland State Plane, NAD27, U.S. Survey Foot.
3. Not for Navigation.

Figure 8. Side Scan Sonar Mosaic of Broad Sound Site.

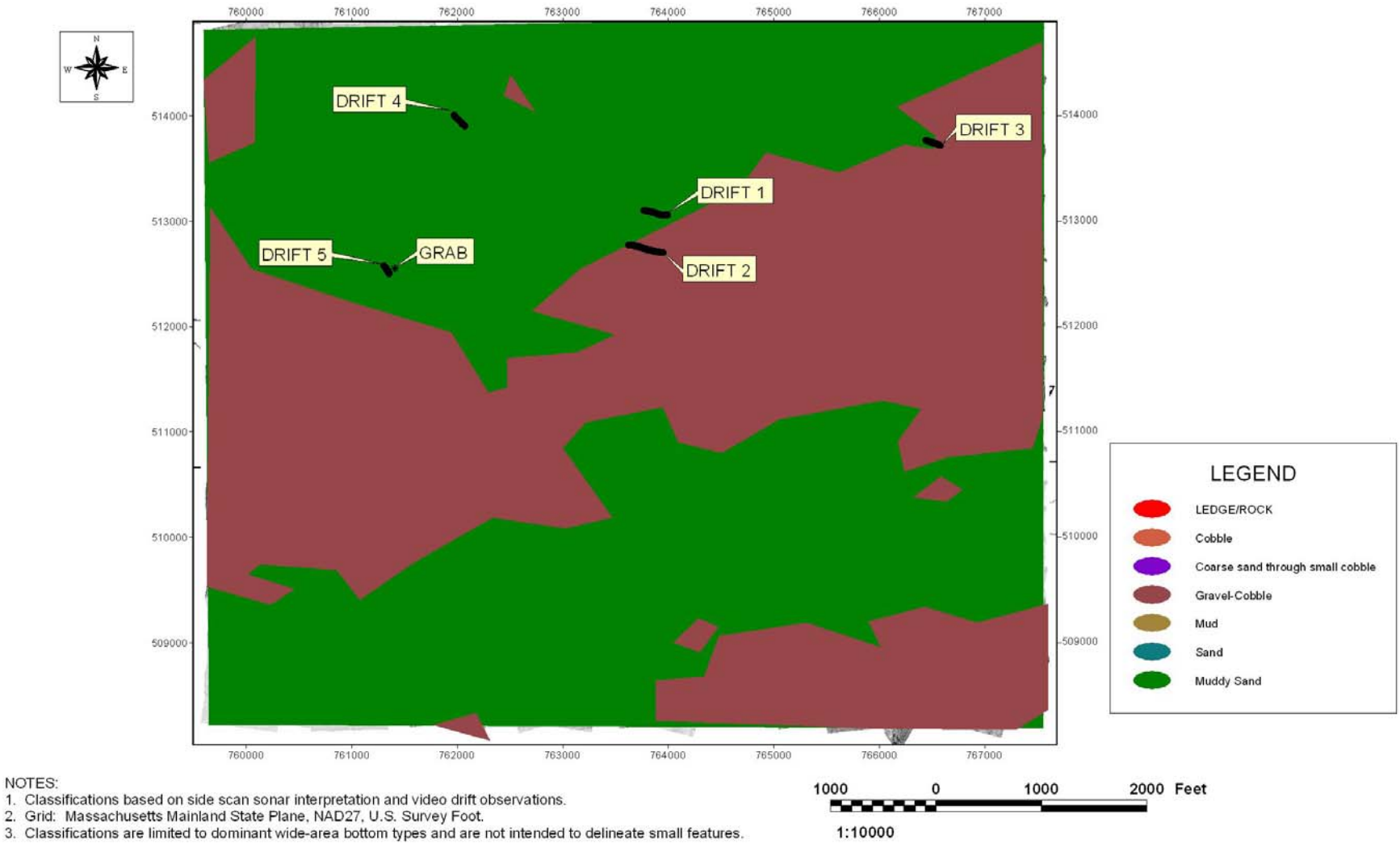
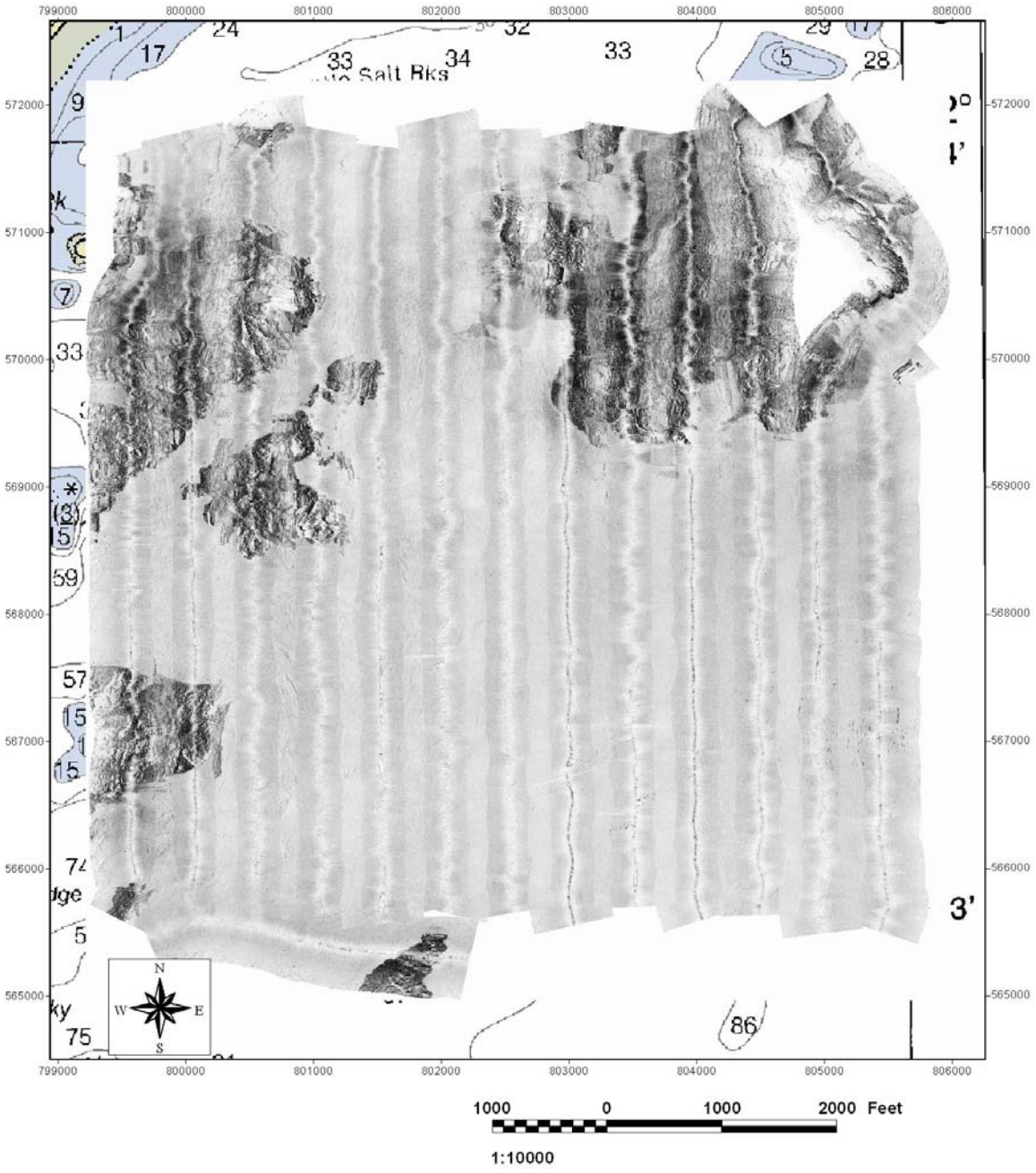
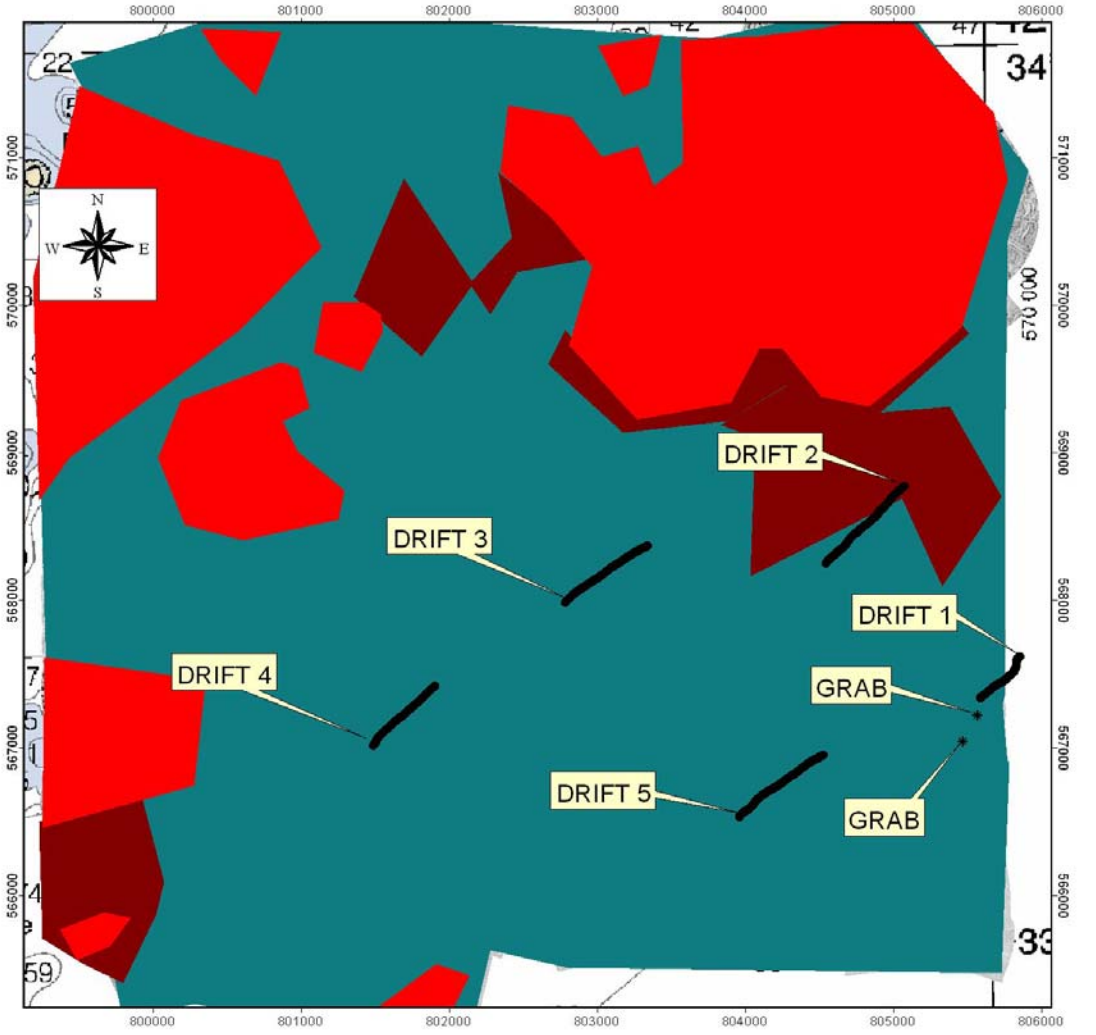


Figure 9. Dominant Substrate Classes and Video Drift Locations of Broad Sound Site.



NOTES:
1. Survey conducted by CR Environmental, Inc. on September 3, 2004 using a 100-kHz signal set to 100-m range.
2. Grid: Massachusetts Mainland State Plane, NAD27, U.S. Survey Foot.
3. Not for Navigation.

Figure 10. Side Scan Sonar Mosaic of Magnolia Site.



NOTES:
1. Classifications based on side scan sonar interpretation and video drift observations.
2. Grid: Massachusetts Mainland State Plane, NAD27, U.S. Survey Foot.
3. Classifications are limited to dominant wide-area bottom types and are not intended to delineate small features.

Figure 11. Dominant Substrate Classes and Video Drift Locations of Magnolia Site.

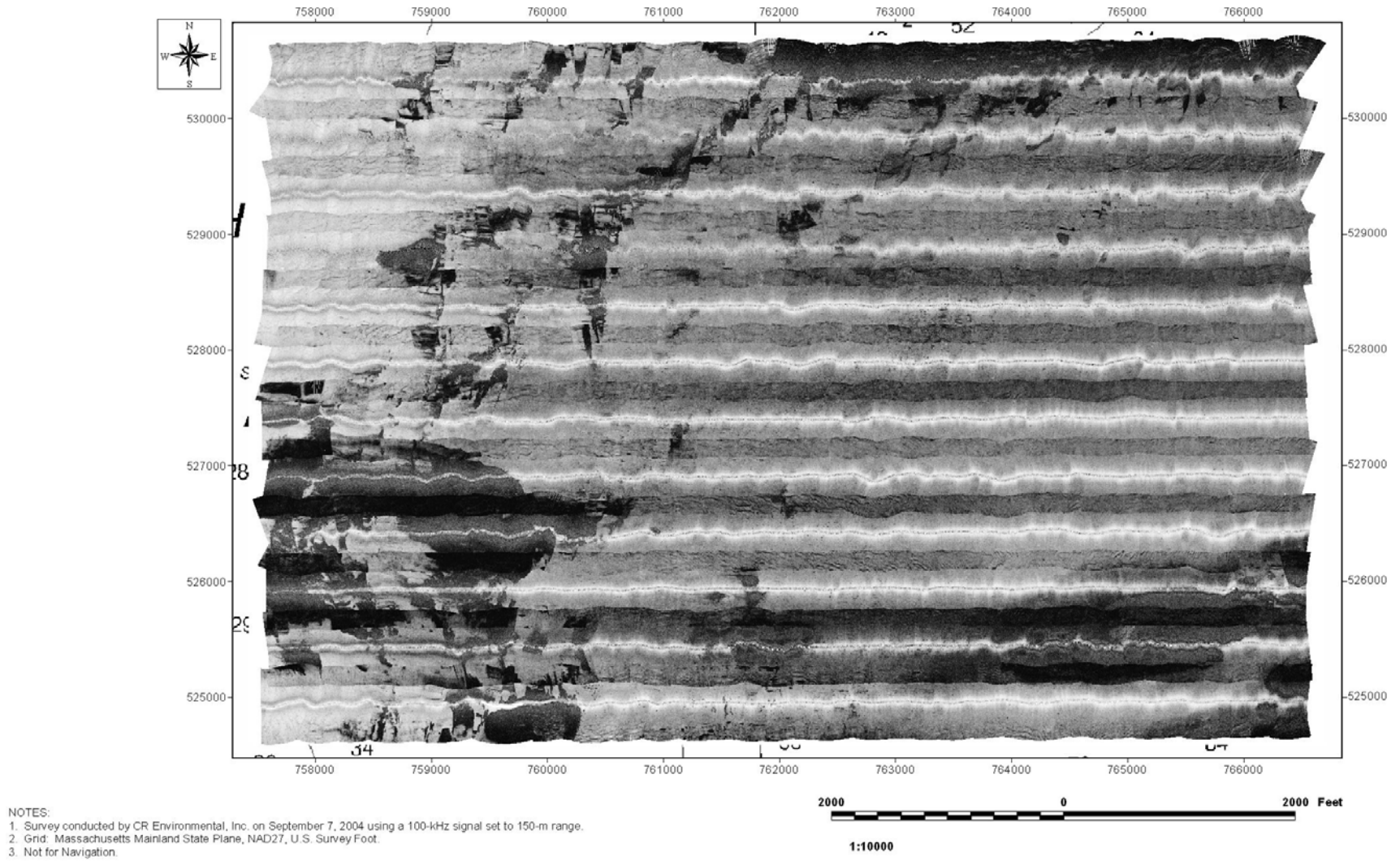


Figure 12. Side Scan Sonar Mosaic of Nahant Bay.

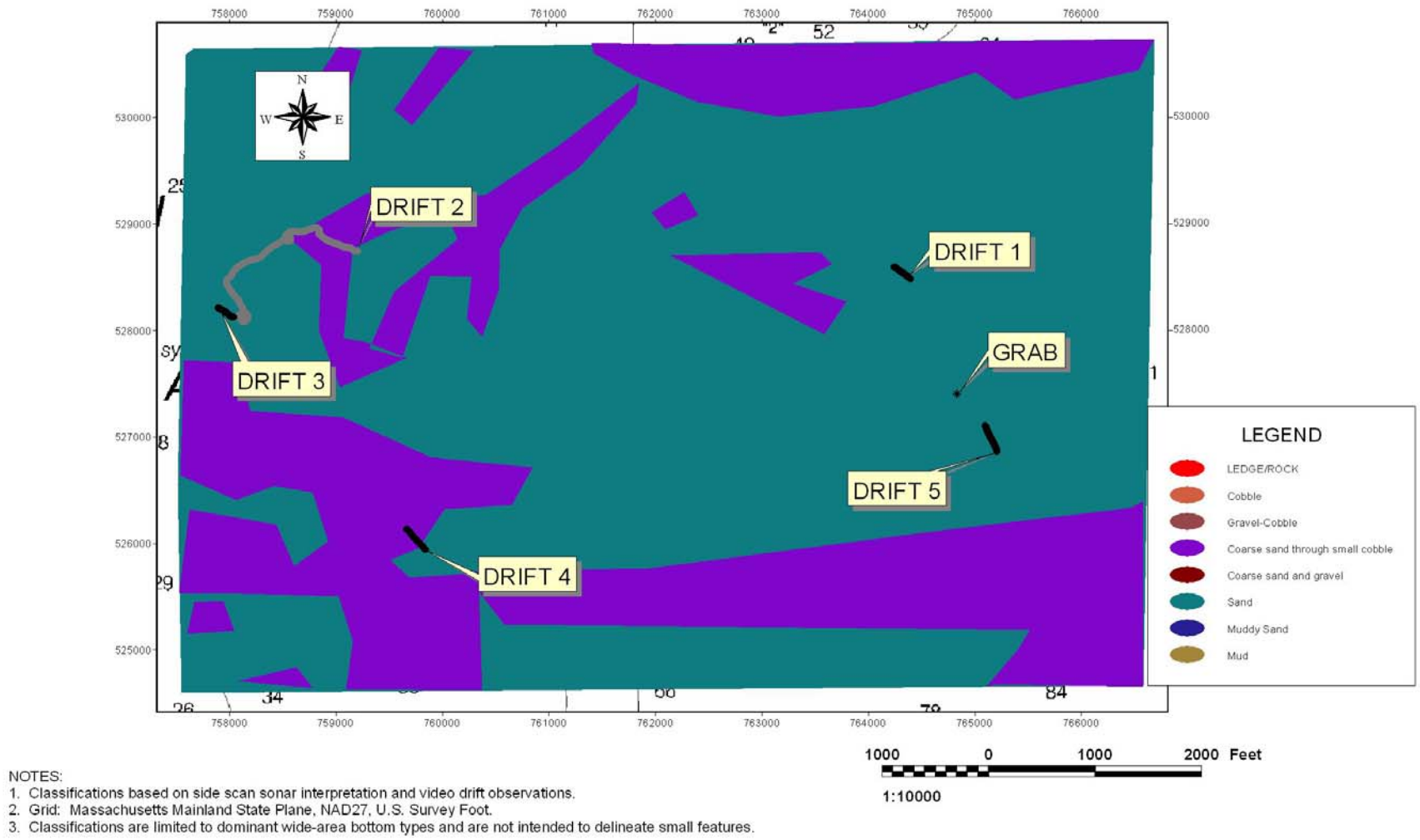


Figure 13. Dominant Substrate Classes and Video Drift Locations of Nahant Bay.

Attachments