Dredged Material Management Plan Phase 2

PHYSICAL CHARACTERIZATION OF THE PROPOSED BUZZARDS BAY DISPOSAL SITE

Prepared for:

Massachusetts Coastal Zone Management
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Boston, Massachusetts

Prepared by:
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Physical Characterization of the Proposed Buzzards Bay Disposal Site

An Employee-Owned Company

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TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

1.0 INTRODUCTION

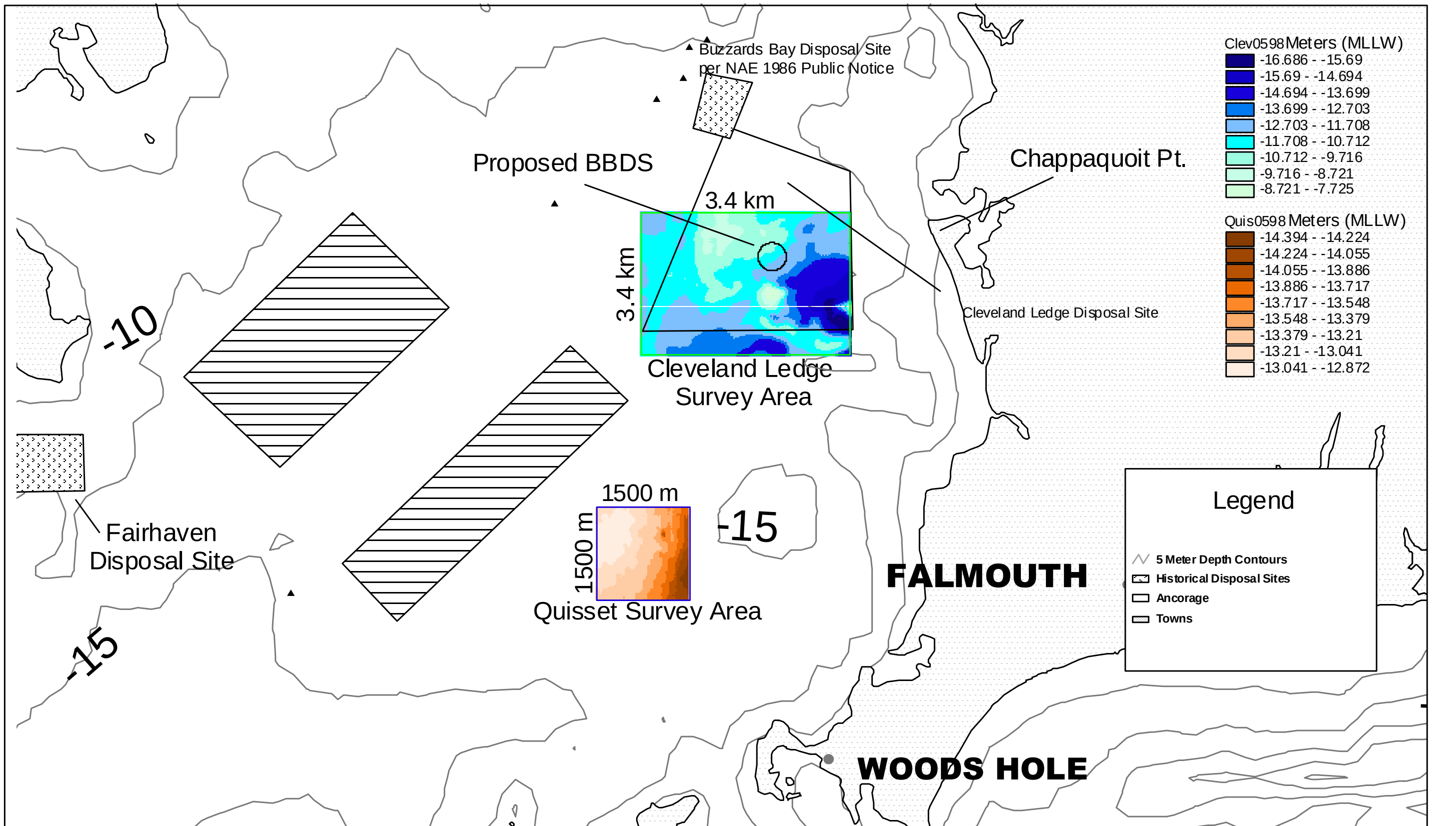
The Massachusetts Department of Environmental Management (DEM) has proposed the designation of an open-water dredged material disposal site within the area of the former Cleveland Ledge Disposal Site (CLDS) in the Buzzards Bay region. On 8 March 1995, the DEM filed an Environmental Notification Form (ENF) describing the proposed area, a 500 yard-diameter circular area with the center located at 41° 36.00' N, 70° 41.00' W (Figure 1-1). In the ENF, the proposed Buzzards Bay Disposal Site (BBDS) would be designated for the receipt of coarse-grained dredged material (20% or less fine-grained silt/clay fraction). Following regulatory response and public comment, a Certificate from the Secretary of Environmental Affairs on the ENF was issued, requiring the preparation of an Environmental Impact Report (EIR) pursuant to the Massachusetts Environmental Policy Act (MEPA). The scope for the EIR (referred to as the MEPA Scope in this document) was described in the Certificate, issued on 10 May 1995. This report fulfills part of the third requirement of the MEPA Scope for the EIR. It is being conducted for the Massachusetts Coastal Zone Management Agency (MCZM) as part of a larger project to develop a Dredged Material Management Plan (DMMP) for the state of Massachusetts.

In response to the ENF, several agencies expressed concerns over the use of the proposed area for the reception of dredged material. The primary concern was the potential effects on the marine fisheries resources in Buzzards Bay, particularly the spawning habitat for winter flounder. In addition, the potential resuspension of material by bottom currents was cited as a major concern. MCZM expressed concerns over long term management of the site. The Cape Cod Commission raised concerns that the proposed site does not address the long-term needs of the region, and that the designation of such a site may affect beneficial environmental goals due to the attractive cost of open-water disposal by comparison. Throughout the various phases of this project, the draft EIR will be addressing all of these concerns as part of the MEPA Scope.

In the original ENF, the DEM proposed that the BBDS would be restricted to coarse-grained material suitable for open-ocean disposal. This original restriction was included because suitable coarse-grained sediment generally was considered to have limited impact on the marine environment, and the DEM, in consultation with MCZM and the Massachusetts Department of Environmental Protection (DEP), was requesting a waiver for the EIR requirement. Following public and regulatory comment, the waiver was denied. Consequently, MCZM filed a Notice of Project Change in March 1998, proposing to designate the site for all physical categories of material suitable for open ocean disposal, from fine- to coarse-grained, subject to all applicable state and federal chemical and biological testing protocols.

1.1 Objectives of the Physical Site Characterization Study

As outlined by the third item of the MEPA Scope (MEPA Scope III), the physical site characteristics of the proposed site, as well as alternate sites within Buzzards Bay, were investigated. The first part of MEPA Scope III required a detailed bathymetric study to determine bottom contours. The physical characterization study conducted for this task included both bathymetry and side-scan sonar in order to investigate the proposed site, as well as alternate



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Dredged Material Management Plan Phase 2

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Date: **07/08/98**

Figure 1-1. Location of survey areas within Buzzards Bay.

N 0 1.5 3 Kilometers

bbdsjason.apr;Historical Sites and Navigational Considerations; bbdslay030498 areas within Buzzards Bay that may be suitable for receiving dredged material. Alternate sites were investigated because of response to the ENF that questioned the use of the historical site within the CLDS without investigating the alternatives that may be more appropriate as a disposal site.

In a separate document, the potential environmental benefits and drawbacks of opening an historic disposal site versus identifying a new site were evaluated (SAIC submitted [a, b]). Several major environmental factors were addressed in order to select an optimum area for dredged material disposal:

- an area of limited potential for sediment resuspension and movement out of the designated area;
- an area that would minimize the impact to the natural benthic community;
- an area that would minimize the impact to area recreational and commercial fisheries;
- an area of water depths sufficient for access by hopper dredges.

The factors of sediment resuspension and water depth were addressed in the assessment of the physical characterization survey data. This report first presents methods (Section 2.0) and results (Section 3.0) for the May 1998 bathymetric and side-scan sonar survey, conducted at two sites within Buzzards Bay (Figure 1-1). Then the implication of these data towards the selection of candidate sites for the BBDS are discussed (Section 4.0).

1.2 Historical Dredged Material Disposal Sites within Buzzards Bay

A search of the literature revealed the location of four separate areas used for the deposition of dredged material in the Buzzards Bay region over the past years. Survey data from the Cleveland Ledge Disposal Site (CLDS) indicated that the area has been used widely in the past for dredged material disposal (SAIC 1991; Menzie et al. 1982). More recently, the area of the proposed BBDS, which is located within the larger area of the CLDS, has been used for disposal (Figure 1-1). Due to concerns about the potential impacts as summarized above, the Commonwealth of Massachusetts has not permitted any disposal at the site since 1989 (SAIC 1991; Maguire 1997). The New England District Army Corps of Engineers (NAE) considers this location to be an approved site with respect to federal permits.

A public notice from the NAE (1986) indicated the use of a disposal site located directly off of the East Cleveland Ledge Light for the purposes of a Cape Cod Canal maintenance dredging project. To what additional extent this site, located on the northwest corner of the CLDS (Figure 1-1), has been used is uncertain. The other historical site that no longer is in use is the Fairhaven Disposal Site, located off of Mattapoisett Neck in Fairhaven, MA. All of the information obtained indicated that the material disposed of at these Buzzards Bay sites has been composed primarily of clean sands (SAIC submitted [a]).

1.3 Distribution of Bottom Sediments in Buzzards Bay

Overall, Buzzards Bay is a net depositional area (CDM 1990); local areas of higher tidal current energy, however, result in some areas of sand and gravel. Fine-grained sediments occur throughout the deeper basins and troughs, while sands are found in the shallow, higher kinetic energy sites (Figure 1-2; Moore 1963; Howes and Goehringer 1996). The optimum location for a disposal site, considering the potential for sediment resuspension alone, is therefore in an area of fine-grained sediment. The discussion of the distribution of bottom sediments below is a first order analysis of the potential for resuspension, and is not intended as a replacement of an analysis of the bottom current structure of the proposed disposal site for designation. A more comprehensive review of the existing information is provided in numerous references (e.g., Maguire 1997; Moore 1963, Howes and Goehringer 1996; SAIC 1989; SAIC 1991).

An extensive study of the bottom sediments of Buzzards Bay, documented with 150 sediment samples collected throughout the bay, indicated that the area of the CLDS had a complex sediment cover (Figure 1-2; Moore 1963). Moore's study indicated that the coarse sand and gravel areas located within pockets of Buzzards Bay were primarily due to scouring by relatively intense tidal currents; one such area is located within the northwest quadrant of the CLDS. Although Moore mentioned "the chaotic over-dredging and over-collecting of the past 40 years," he did not attribute any of the patchy sediment patterns within the CLDS to historical dredged material disposal. The area just northwest of the CLDS, near the location of the NAE site for the disposal of Cape Cod Canal sediments, was also in an area of mixed sediment types, ranging from silt to gravel. Finally, the area of the Fairhaven site was located in an area dominated by gravel (Figure 1-2).

A side-scan survey was conducted in 1981 over the CLDS area, and the results were consistent with Moore's data, in that a wide variety of bottom types were mapped (Menzie et al. 1982; Germano et al. 1989; Maguire 1997). Many of these areas, however, had been affected directly by historical disposal of dredged material. In this study, six major textural regions were mapped, each with characteristic bottom sediment texture and grain size. The largest area was termed the rubble field, consisting of most of the region surveyed, representing numerous topographic highs apparently associated with historical disposal of dredged material (Figure 1-3). A relatively large crater field, with circular depressions interpreted as disposal of sand and gravel onto a mud bottom, was also widespread throughout the survey area. Two areas were interpreted as being representative of the ambient sediment: the west flat area, with an ambient fine sand bottom, and the east flat area, with an ambient mud bottom. The transition from coarser to finer grain size from the western edge of the CLDS to the eastern edge is consistent with Moore's (1963) data, except for the presence of a band of fine-grained silt and clay identified by Moore (Figure 1-2) that was not apparent in the side-scan data.

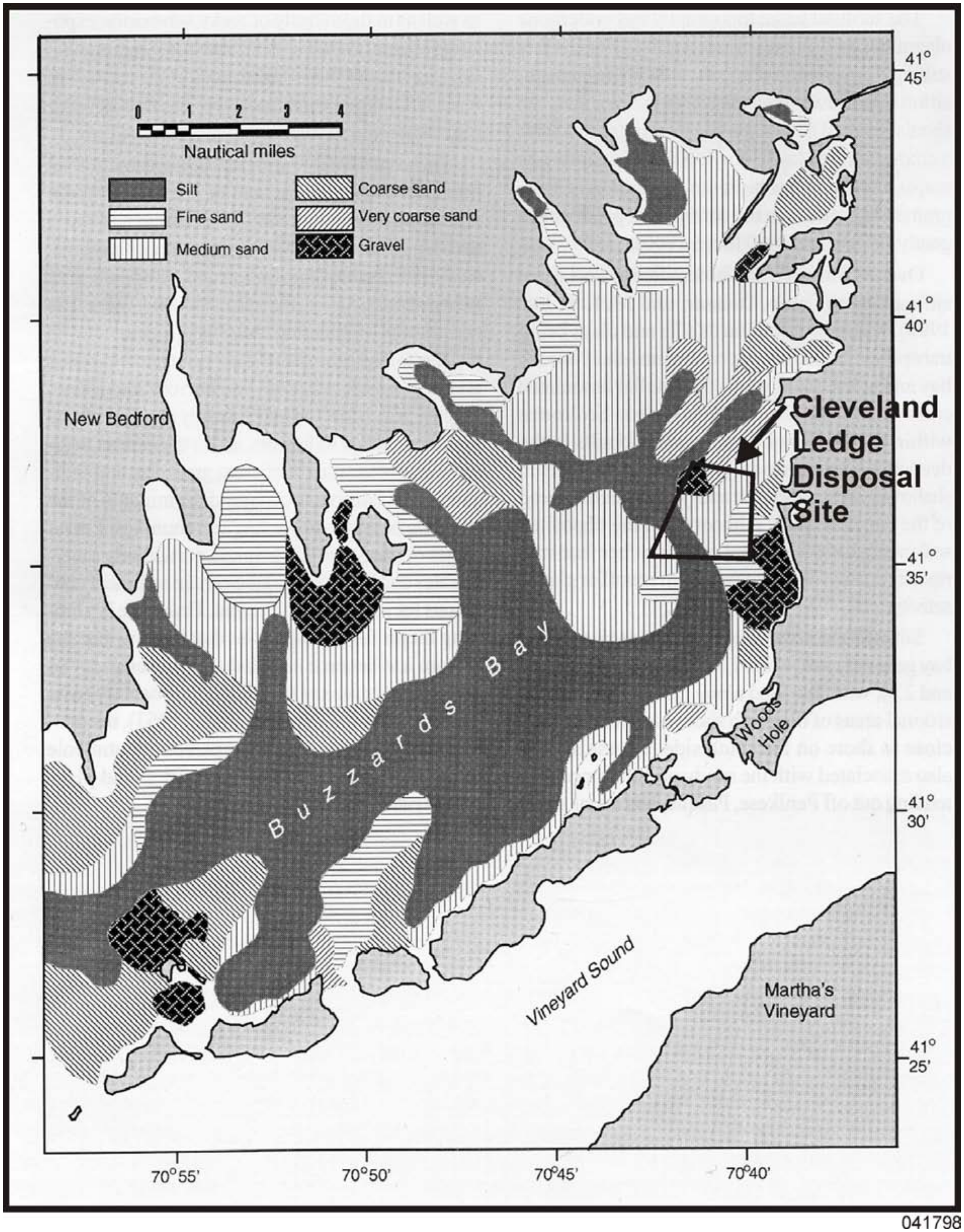

Figure 1-2. Textural distribution of Buzzards Bay sediments (reproduced from Howes and Goehringer 996, original map from Moore 1963) showing approximate location of Cleveland Ledge Disposal Site.

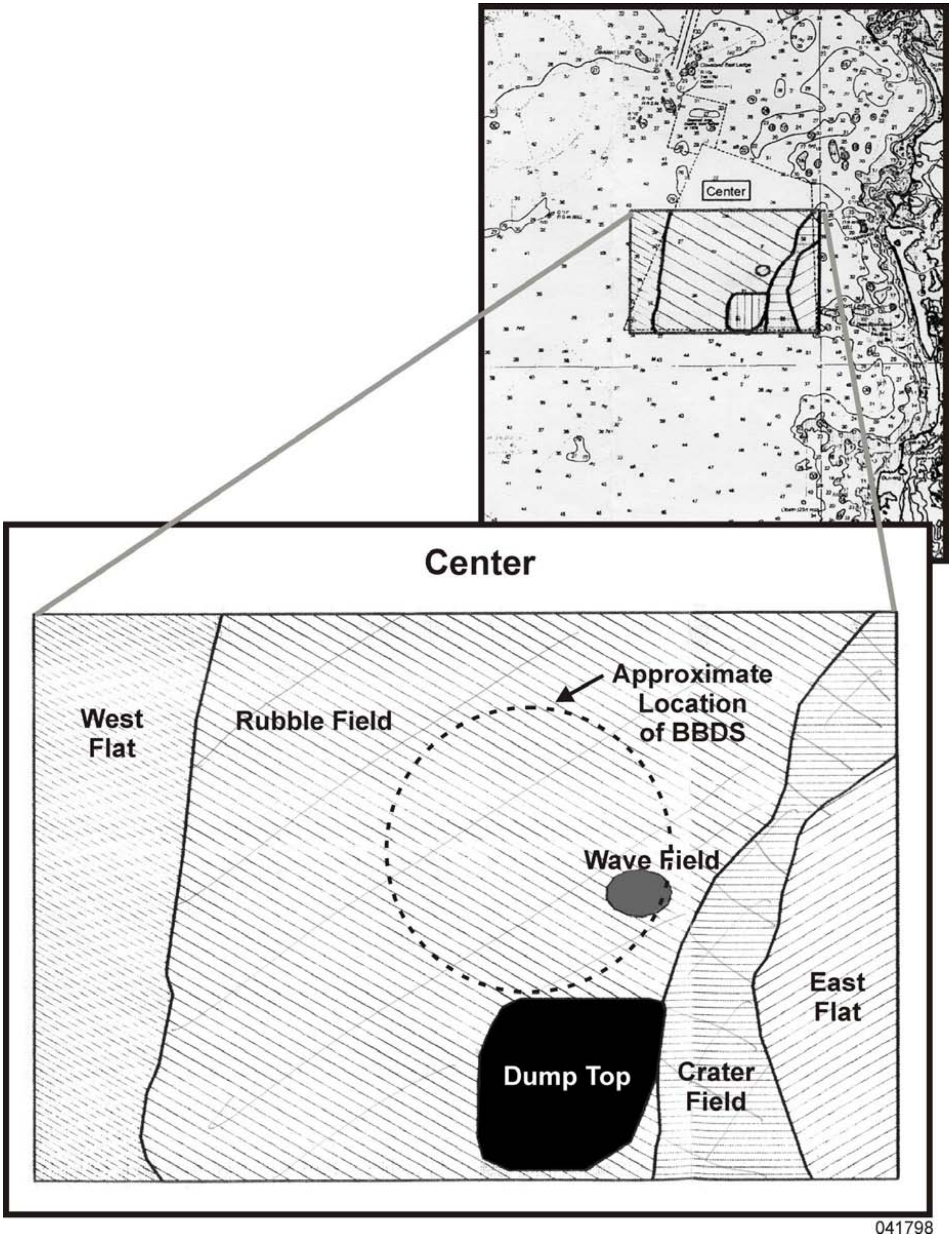

Figure 1-3. Process map of textural regions of the Cleveland Ledge Disposal Site area from the 1981 side-scan sonar survey (reproduced from Maguire 1997, original map from Germano et al. 1989.

An area south of the currently proposed BBDS consisted of a coarse-grained disposal mound, which rose to within 7 m of the sea surface during the 1981 survey. This mound top was apparently the center of previous disposal operations (Figure 1-3). Finally, the area of most concern mapped in the 1981 survey was a wave field, which possibly consisted of large sand waves overlying silt/clay sediments. The investigators of this study suggested that possible bed-load transport was occurring in this area of localized high energy, although the features may have been related to disposal operations.

The proposed BBDS was located within the area termed the rubble field from the 1981 side-scan data, and intersected with the wave field. Because of masking by historical dredged material, the ambient grain size was undetermined from the acoustic data, but the REMOTS® sediment profile data (SAIC 1991), as well as the historical grain size map (Moore 1963), indicated that the ambient grain size in the BBDS was fine-medium sand.

The other source of recent sediment texture data around the area of the CLDS was the three reference areas located near the site. The reference areas were sampled using the REMOTS® sediment profile camera during the 1990 survey (SAIC 1991). Of the three sites, the southern site, located just off the southwestern edge of the CLDS (2,600 m southwest of BBDS), had the most consistent texture of silt and clay. The western reference area (3,940 m west of the BBDS) consisted of a combination of fine-grained sediment and fine sand, and the northern reference area (3,107 m northwest of the BBDS) was most similar to the disposal site itself, with a dominance of fine to medium sand. Water depths of the three sites were consistent with the sediment type, with the fine-grained southern reference area in the deepest water (14 m), followed by the western (12 m) and northern (11 m) reference areas (SAIC 1991).

1.4 Site Selection for Physical Characterization Surveys

The selection process for a reconnaissance survey in Buzzards Bay for the optimum siting of the proposed BBDS was based upon existing information from Buzzards Bay, as well as concerns raised by the MEPA Scope. As a result of the MEPA process, two major concerns were considered when selecting areas for investigation:

- Concerns for the possible resuspension of sediments away from the site boundaries;
- Concerns over impact to the natural benthic habitat of Buzzards Bay.

In addition to resuspension and benthic habitat impact, a larger area was surveyed due to the recognition by DEM of the potential problems of designating a site that is too small. A draft Notice of Project Change stated that “the 500 yd site boundary is too confining and could result in having dredged material spread beyond the prescribed area at initial deposition. In addition, the depths at the original [proposed BBDS] location do not accommodate larger dredges used to dredge the Cape Cod Canal, which have historical been disposed at deeper sites close to the BBDS.” The DEM recommended a new area, a square area with an interior boundary of 600 m x 600 m, serving as the area where material will be released, and an exterior boundary of 1600 x 1600 m, which would limit the area of the spread of dredged material. The site recommended by DEM was located in 11 to 15 m of water approximately 1.4 nmi northwest of Chappaquoit Point (Figure 1-1).

Two sites were selected for the physical characterization reconnaissance survey. The first was within the existing boundaries of the Cleveland Ledge Disposal Site (CLDS), which is the historical area within which the currently proposed BBDS is located (Figure 1-1). Investigating the area within the CLDS had several benefits over limiting the survey to the proposed site. First, deeper areas dominated by fine-grain size have a greater probability of containing dredged material, and have water depths accessible to deeper draft hopper dredges. Second, the presence of historical dredged material deposits would minimize additional benthic impact or change of benthic community structure. Finally, the eastern edge of the survey area is located within the boundaries of the site recommended by the DEM.

Because of the importance of water depth in classifying the site as a dredged material containment site, a site outside of the existing CLDS in slightly deeper waters was selected to serve as a comparable area to investigate the important criteria of sediment containment. This site, named the Quisset site, was located in approximately 15 m of water in an area that has been classified as dominated by fine-grained sediment, indicating limited sediment transport (Figure 1-1). In contrast, this site has not received historical dredged material, so will provide important ambient information to compare and contrast the data collected at the CLDS.

1.5 Survey Objectives

The primary objective of the May 1998 bathymetric and side scan sonar survey was to obtain recent sounding (bathymetric) and side-scan sonar data so that an accurate illustration of the seafloor topography as well as sediment characteristics could be obtained. This information will be used: 1) to determine if the site is suitable for long-term disposal of dredged material; and 2) as a baseline for potential future monitoring.

For the reconnaissance siting surveys, we collected high precision bathymetry data at 50-m lane spacing at all survey areas in order to provide contour maps of potential areas for site designation. In addition, in the area of the BBDS, we collected higher resolution data at 25-m lane spacing. By collecting this baseline information, these data can be used to compare with historical data collected at the proposed BBDS (SAIC 1991). The higher resolution data at the BBDS also were collected to compare with postdisposal bathymetric survey data in the case that Cape Cod Canal material dredged in 1998 was placed at the existing BBDS. After the survey, however, the decision was made to place Cape Cod Canal material in an alternate location.

2.0 METHODS

2.1 Survey Mobilization and Equipment

On 3 May 1998, SAIC scientists met the S/V *Cyprinodon* at the Falmouth Harbor, MA town dock where they installed SAIC navigational and bathymetric equipment to be used during survey operations. Vessel positioning and bathymetric data acquisition were achieved with SAIC's Portable Integrated Navigation Survey System (PINSS). This PC-based system acquires real-time navigation (position, time) and depth soundings from a variety of sensors for subsequent analysis. Vessel position was determined using a GPS receiver. One-to-five meter positioning accuracy was achieved by applying differential corrections to the GPS signals that were acquired from a U.S. Coast Guard differential GPS (DGPS) beacon.

Depth soundings were collected with an Odom DF3200 Echotrac® survey echosounder using a 208 kHz transducer with a 3° beam angle. The Odom simultaneously displayed water depth data on a chart recorder and transferred digital sounding data to the PINSS. The echosounder collected 6-8 soundings per second and transmitted an average value to the PINSS at a rate of one sounding per second. A Seabird Electronics, Inc. Model SBE-19-01 conductivity-temperature-depth (CTD) profiler was used to acquire vertical profiles of sound velocity in the water column at the beginning, and end of the survey day for data processing (Section 2.3). Details of the bathymetric survey operations are provided below.

On 7 May 1998, upon completion of the proposed bathymetric operations, SAIC scientists demobilized the bathymetric equipment and mobilized the S/V *Cyprinodon* for side-scan sonar operations. The side-scan sonar package used was the Edgetech 272TD dual frequency (100 kHz or 200 kHz) towfish with a 260-TH topside recorder and a 380 tape drive leased from Edgetech Technologies, Milford, MA. Two representatives from Edgetech helped with the mobilization of the side-scan recording systems to ensure integration of SAIC's navigational inputs during survey operations. Positioning was achieved and integrated with the same DGPS equipment used for bathymetric operations, as described above.

2.2 Survey Operations

2.2.1 Bathymetry

The Cleveland Ledge bathymetric survey area was a rectangular area (Figure 1-1), 2,300 m (north-south) by 3,400 m (east-west), with 69 survey lanes spaced 50 meters apart orientated north-south. The Quisset Harbor bathymetric survey area, 1,500 m (north-south) by 1,500 m (east-west), contained 31 survey lanes spaced 50 meters apart orientated north-south. Bathymetric survey operations were conducted aboard the S/V *Cyprinodon* during the period of 4-6 May 1998; the Cleveland Ledge survey was conducted 4-5 May; and on the final day of bathymetric survey operations (May 6), the Quisset Harbor survey was conducted.

Following the side-scan sonar survey (Section 2.2.2), on 8 May 1998, the small, high-resolution bathymetric survey over the BBDS area was conducted, consisting of 25 lanes within the boundaries of the Cleveland Ledge survey area. The BBDS area was surveyed with 25 meter line spacing. The survey plan used the original lanes from the Cleveland Ledge plan, with inserted lanes in-between the already 50 m spaced existing lanes. The total survey area was 600 m (north-south) by 600 m (east-west). The data from the lanes that were surveyed during the Cleveland Ledge survey were used to complete the BBDS survey area, thus only leaving 12 lanes to be surveyed for completion of the BBDS data set.

2.2.2 Side-Scan Sonar Survey

Side-scan sonar survey operations were conducted aboard the S/V *Cyprinodon* on 7-8 May 1998. The Cleveland Ledge side-scan sonar survey was conducted over approximately the same area as bathymetry (Figure 1-1), with 29 survey lanes spaced 125 meters apart oriented north-south. Because of the wide swath of side-scan sonar, actual bottom coverage was greater for the side-scan sonar survey. The Quisset Harbor side-scan sonar survey area also was the same approximate size as the bathymetry survey, with 13 survey lanes spaced 125 meters apart oriented north-south. Both areas were surveyed at a 100 kHz frequency and at a 75 m range, achieving a 150 meter swath, thus giving 25 m of overlap between lanes and 125% bottom coverage.

2.3 Bathymetric Data Processing

Using SAIC's Hydrographic Data Analysis System (HDAS), bathymetric soundings were edited for outliers and corrected for sound velocity, transducer draft, and tidal variation. Sound velocity was calculated from CTD data collected on site. Water level data from the Woods Hole, MA tide station were obtained from the NOAA Ocean and Lakes Levels Division (OLLD) web server. The NOAA station provides water level readings at 6-minute intervals referenced to Mean Lower Low Water (MLLW). Following the survey, the water level data from Woods Hole were applied to the bathymetric data from the survey region to remove water level variations due to tides. Note, however, that because the tide at Woods Hole is a few minutes different than the tide at the survey sites, a time adjustment was applied during the data processing.

Following the application of all correctors, the depth soundings were spatially averaged to produce a bathymetric grid of cells each having dimensions of 50 m by 50 m (25 m for the high resolution BBDS survey). The gridded bathymetric data were used to produce topographic maps using Golden Software's Surfer® contouring program.

2.4 Side-scan Sonar Data Processing

The data were stored in hard copy format as well as on 8mm Exabyte tapes. The hard copies were analyzed and classified as to bottom type, including dredged material, showing both the rubbled texture (Figure 2-1a) and cratered texture (Figure 2-1b) described in the 1981 side-scan data set (Germano et al. 1989). Additional bottom type classification included rocky bottom (Figure 2-2), ambient bottom (Figure 2-3a), and target identification (rocky ledge [Figure 2-2b], sand waves [Figure 2-3b] and a sunken barge). In the example images, darker areas are generally topographically higher above ambient bottom, while lower areas (i.e., craters) are lighter. Also, many records were noisy especially along the outer portions of the record (seesaw pattern). Processing of the data was done by SAIC's staff and was used to determine a

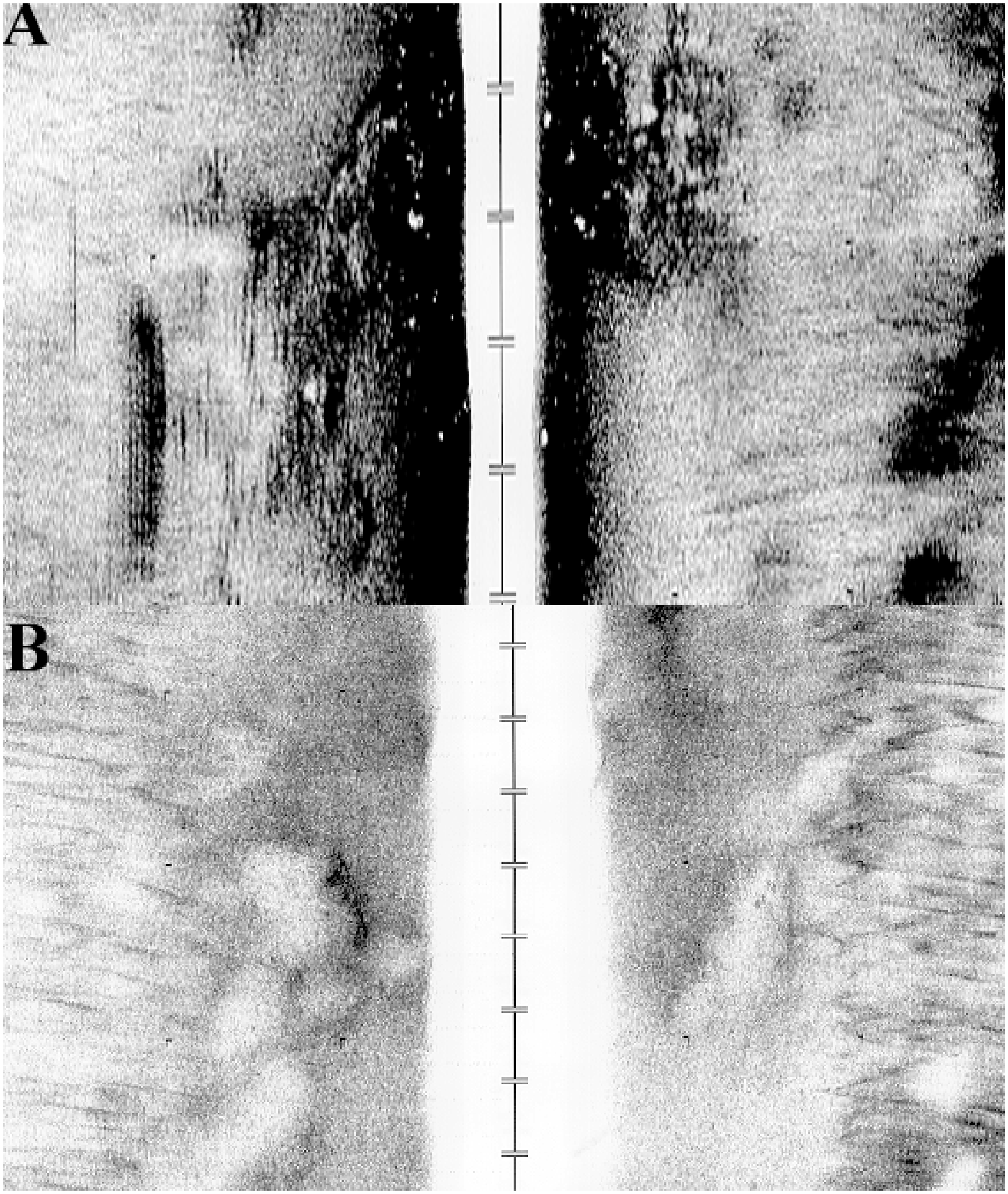

Figure 2-1. Examples of the acoustic appearance of dredged material, including (A) rubbled texture and (B) cratered texture.

general bottom type description for the areas of interest. The visual classification was compiled into an overall process description map of bottom types at the survey areas.

In addition, a digital mosaic was created using Triton Elics International Inc. Isis® side-scan sonar processing software, which includes corrections for speed of sound, slant range, and data processing capabilities for data transformation, mosaics, and digital gain control. An image file (.tif) of the side-scan mosaic was created, and then enhanced and annotated using Adobe® graphics software. The mosaic was imaged in reverse video, that is, the higher peaks (dredged material, rock ledge) were lighter in color while the basins appear darker. This characterization was used in describing the imaged mosaic (Section 3.2).

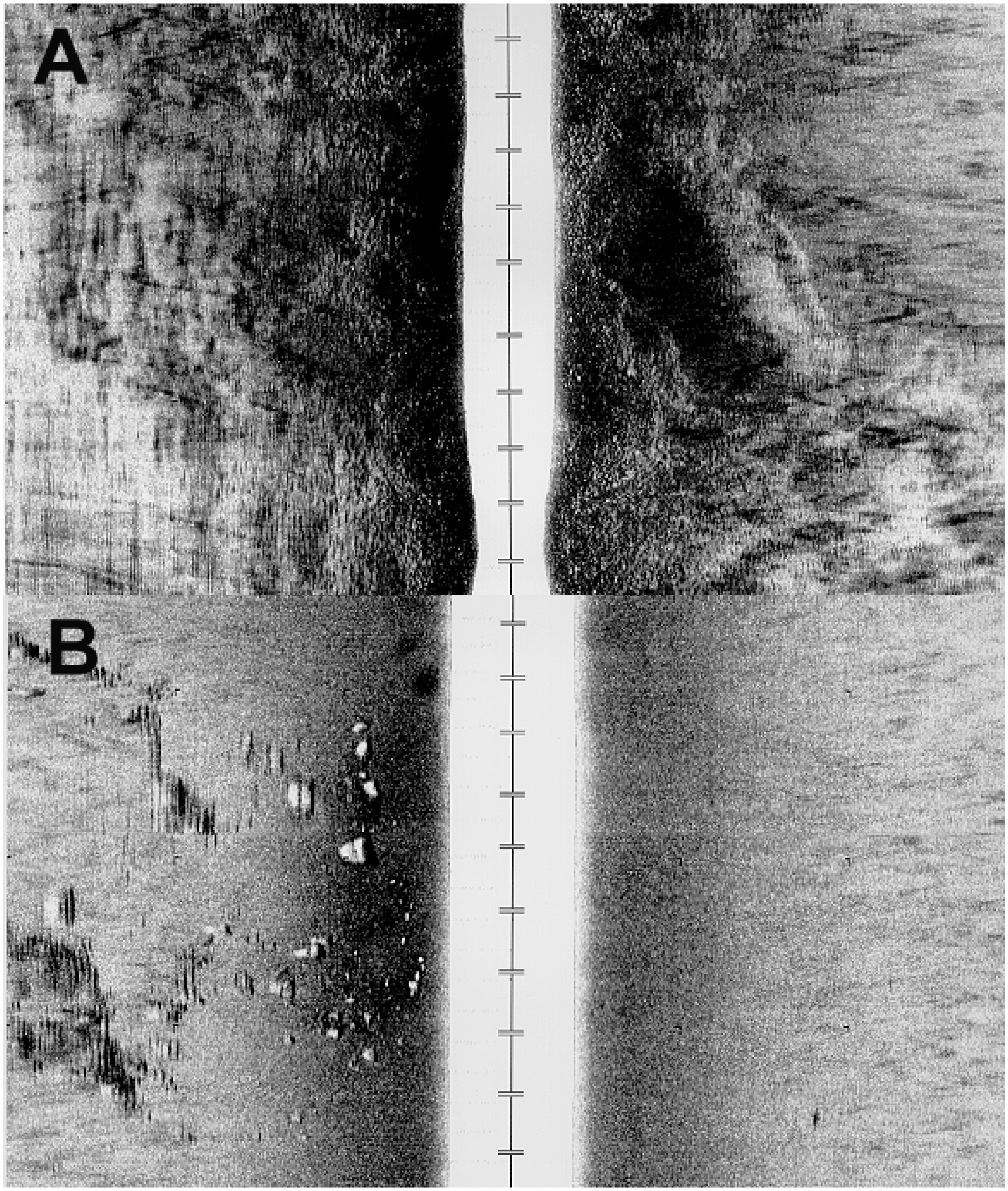

Figure 2-2. Examples of rocky bottom texture from side-scan data including (A) rock ledge (Giffords Ledge) and (B) scattered rocks.

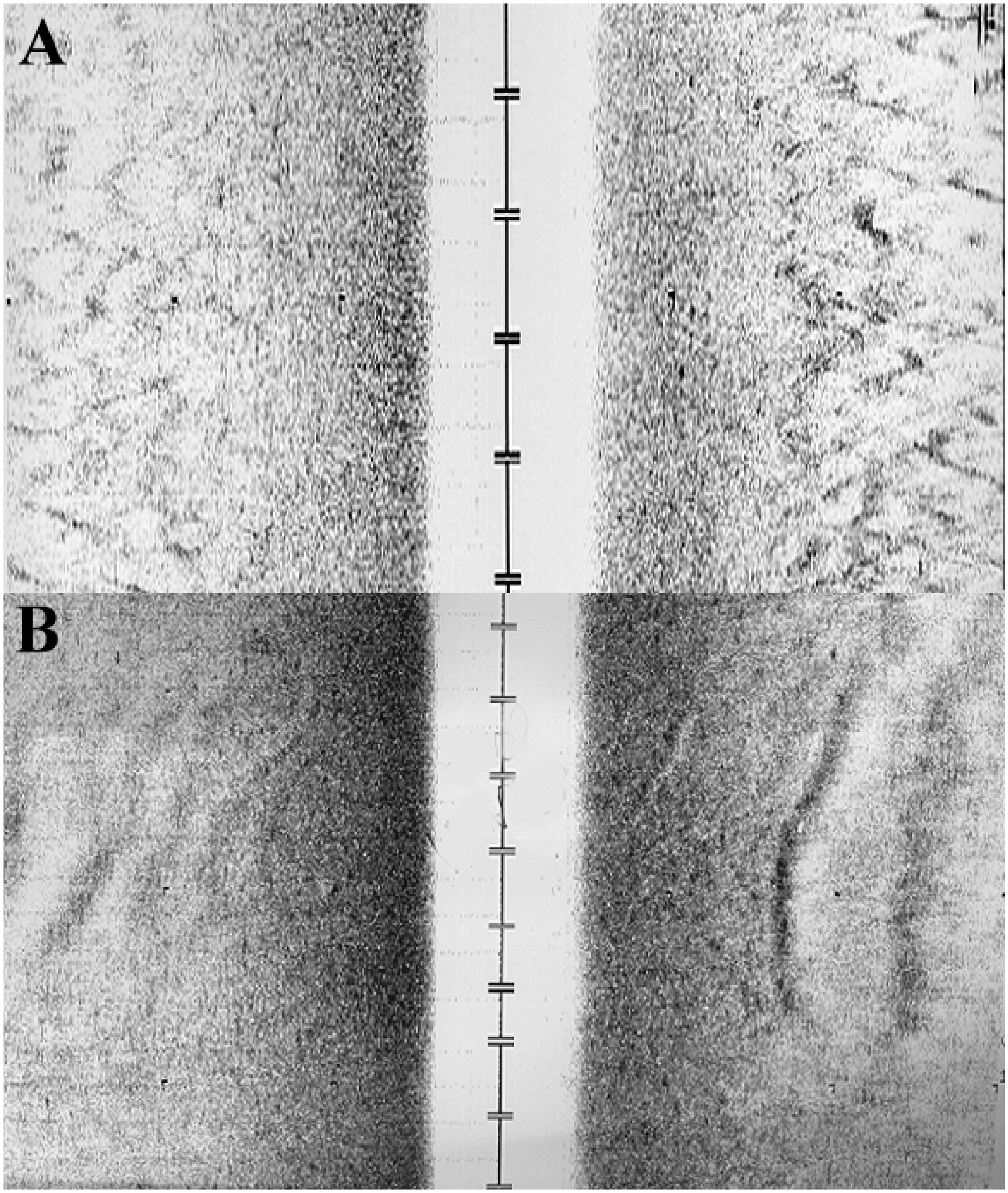

Figure 2-3. Examples of bottom textures from side-scan data showing (A) ambient bottom and (B) sand waves.

3.0 RESULTS

3.1 Topography of the Survey Areas

The bathymetric results are presented in this section to illustrate the topography of the survey areas. All graphics data have been plotted in Massachusetts State Plane coordinates (m), in the NAD83 datum, and depth values are relative to mean lower low water (MLLW).

The topography of the CLDS survey area ranged from 7.8 m located just south of the proposed BBDS, to 16.9 m to the southeastern basin around the natural rock ledge (Giffords Ledge; Figure 3-1). The western edge of the survey area had the most uniform average depths, ranging from 11-13 m. The widespread area of water depths of <11 m located northwest of the proposed BBDS most likely reflects deposits of historical dredged material, as noted in the side-scan data (Section 3.2). This area is south of the NAE (1986) disposal site located for the purposes of Cape Cod Canal maintenance (Figure 1-1), but the area still may have been used in the past for disposal.

The two most striking features of the Cleveland Ledge area bathymetry are Giffords Ledge and the surrounding basin in the southeastern portion of the site, and the topographic peak located south of the proposed BBDS. Giffords Ledge appears on nautical charts, and extends west from Chappaquoit Point. Surrounding Giffords Ledge is the deepest part of the survey area, with depths in the basin reaching >16 m (Figure 3-1). Just south of Giffords Ledge, the basin becomes channelized towards the eastern extent of the survey area between two ridges.

The peak located south of the proposed BBDS, in the shallowest region of the survey area, was also noted in the 1981 survey at the CLDS (Menzie et al. 1982; Germano et al. 1989). From the side-scan data, the feature was named the "Dump Top" and it was concluded that this was the historical center of dredged material disposal, including material from the Cape Cod Canal. Finally, a wider, shallower basin was present along the southern edge of the survey area. This basin was separated from the rest of the survey area by a linear northwest-southeast trending series of topographic highs (10-11 m).

Three-dimensional contour plots are helpful for graphically portraying the topography of the survey area (Figure 3-2). The topography appears relatively steep, but this is misleading and a direct result of the vertical exaggeration in the figure. The exaggeration is added so that the topographic features stand out clearly. In the CLDS survey area, both the historic mound (Dump Top) and the natural rock ledge appear as major topographic features within the area. The proposed BBDS is located nested between the historical dredged material deposits in the northern central area, and the Dump Top. The two basin features also are clearly delineated east and south of the Dump Top.

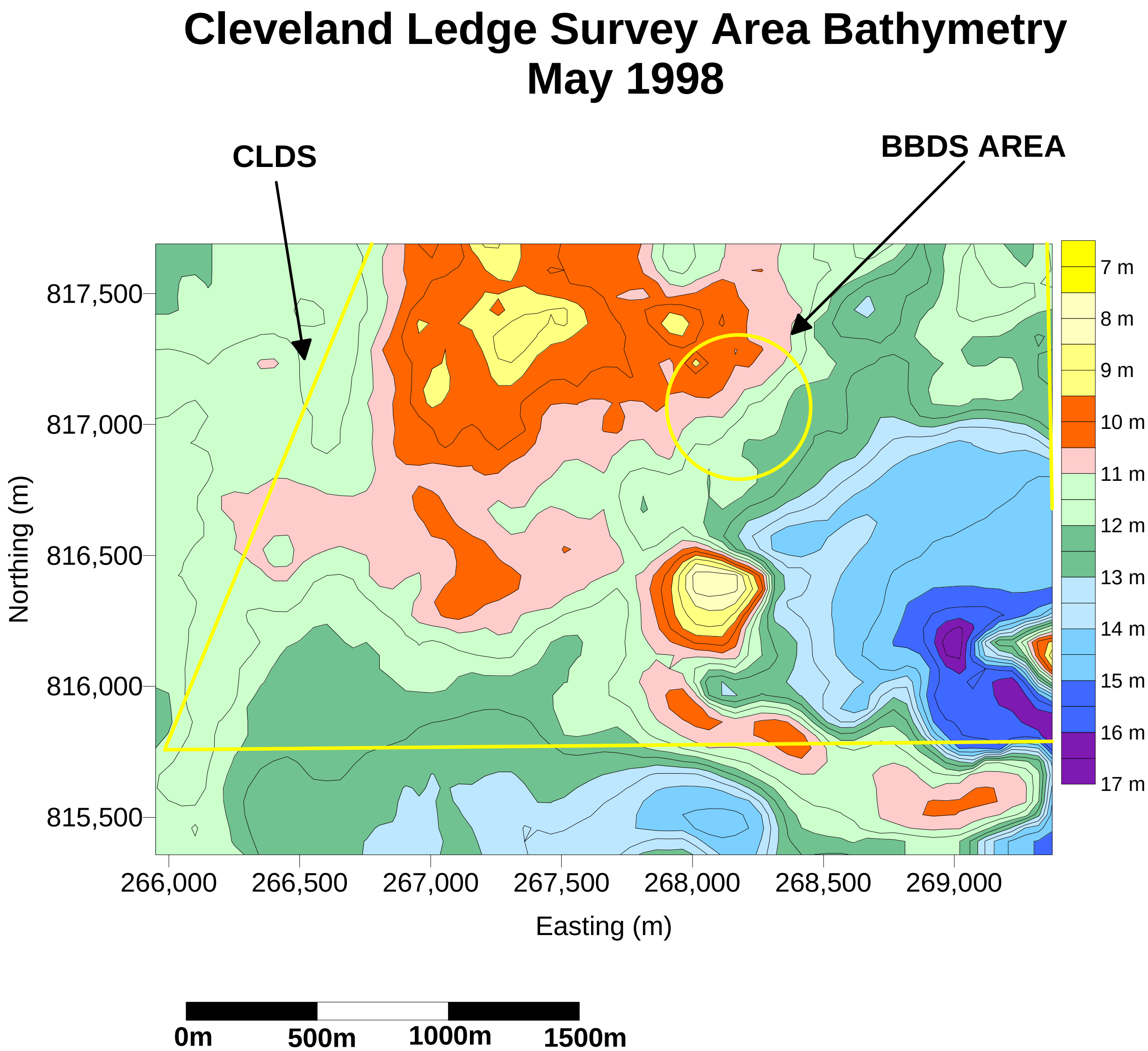

Figure 3-1. Bathymetric results from the Cleveland Ledge Survey Area (NAD 83), contour interval = 0.5 m.

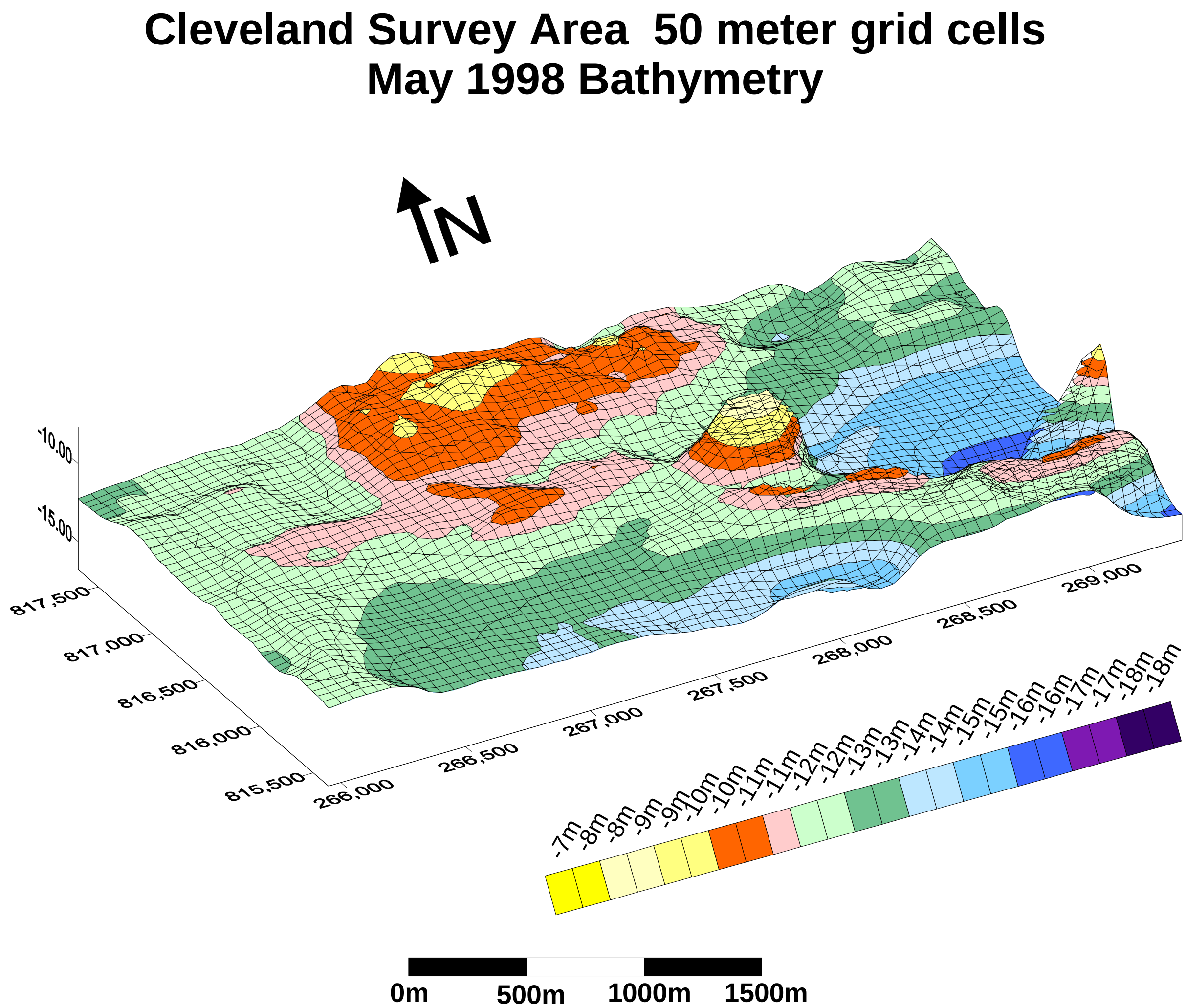

Figure 3-2. Three-dimensional view of the Cleveland Ledge Survey Area bathymetry.

The BBDS area was surveyed at 25 m lane spacing providing a high-resolution data set for monitoring future disposal. On Figure 3-3, the same color scale is used from the larger area survey (Figure 3-1). The topography sloped gently from the northwest to southeast. Depths ranged from 9.6 m in discrete shallower areas, to 13.2 m in the southeast (Figure 3-3). Although the higher topography in the northwest may be due to historical disposal of dredged material, there appears to be no discrete center, or mound, of disposal within the BBDS itself.

A high-resolution bathymetric survey was conducted at the BBDS, at 25 m lane spacing, in 1990 (SAIC 1991). These data were compared with data collected from this study to determine the overall change in depth between 1990-98. This analysis was conducted in order to provide a first order estimate of the stability of the material within the proposed BBDS area itself.

In 1990, the topography was similar, sloping from 9.5 m in the northwest, to slightly deeper waters in the southeast (14.0 m; Figure 3-4). In order to quantify the relative change in depth during the eight years between surveys, a depth difference map was generated. Creation of a depth difference map over a specific area requires two bathymetric grids of the same size and resolution (grid cell size). Each depth (grid cell) value from the older survey is then subtracted from the depth value from the more recent survey. The results are then contoured as a bathymetric map, but the contours depict the positive and negative differences between the two surveys. Positive differences indicate that material has accumulated, and negative differences suggest that material has either eroded or compacted since the prior survey. The error of this method, or the change in depth considered below the resolution of the method, is normally 0.5-1.0 ft. Because of the different methods used between 1990 and 1998 in both navigation and bathymetric methods, an error of 0.25 m was assumed (0.82ft).

The depth difference plot created using this method shows that that, overall, there has been little change in depth between the two surveys (Figure 3-4). All areas within 0.25 m of depth change were color-coded white. The topographic change over this period generally was < 0.5 m, and was dominated by areas with changes of < 0.25 m. The data are consistent with the record of no disposal at the BBDS area during the interim period between surveys. The apparently random pattern of depth changes may indicate local redistribution of sediment.

The Quisset survey area was generally flat, with a gentle slope again from the northwest to the southeast (Figure 3-5). The topography ranged from 12.8 m in the shallowest area down to 14.4 m in the southeast. A natural depression approximately 100 m in diameter resided within the northeast quadrant of the survey area. The depression had a bottom depth at the center of about 14.2 m. Overall, the Quisset area was relatively flat and consistent with little topographic variation throughout.

3.2 Seafloor Characterization

Bathymetry is a useful tool for illustrating seafloor topography, but is limited in providing seafloor characterization information. The side-scan sonar data were used to classify the bottom types in support of the bathymetric data. In general, areas of high reflectance, or high

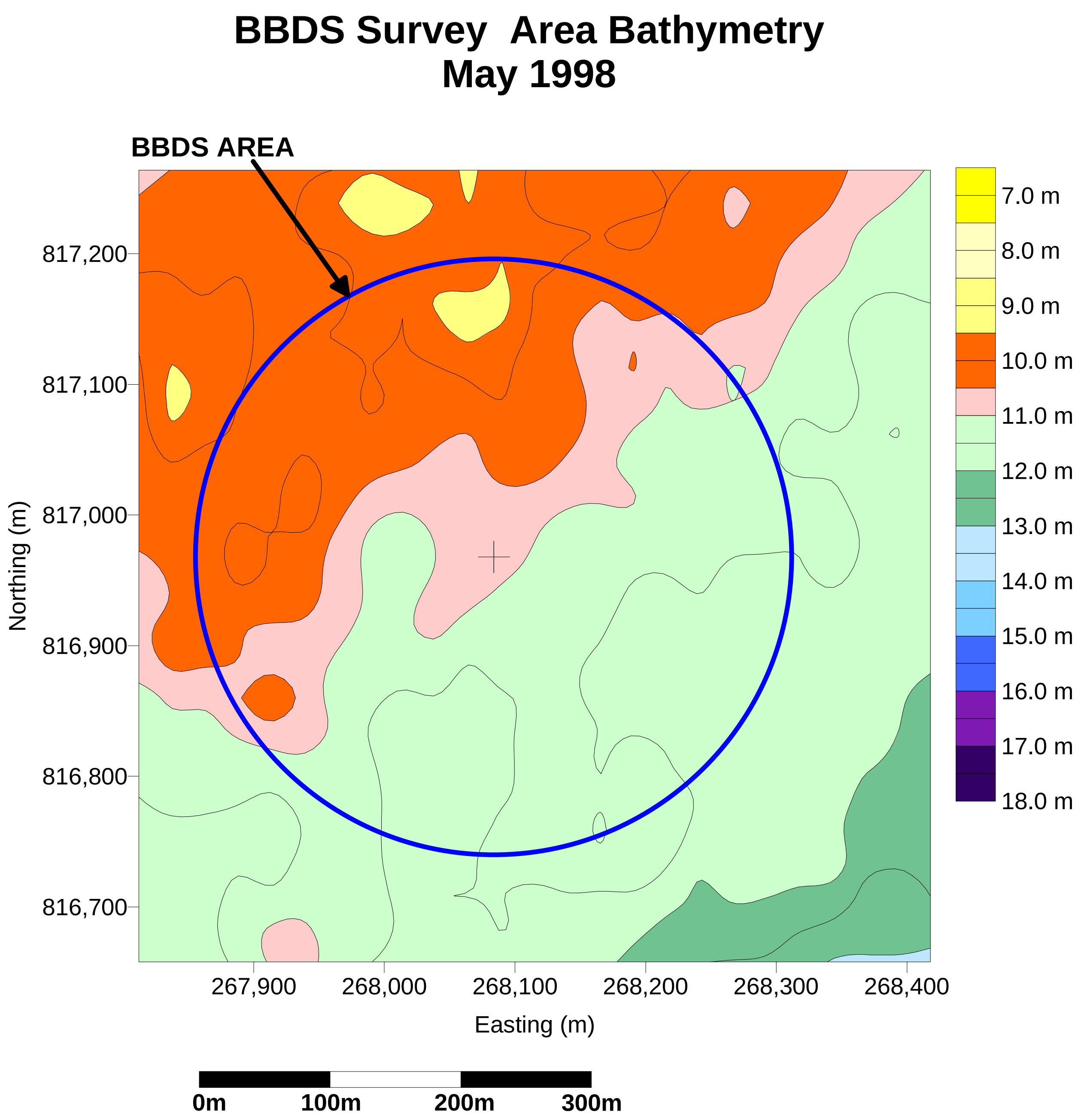

Figure 3-3. Bathymetric results from the BBDS Survey Area (NAD 83), contour interval = 0.2 m.

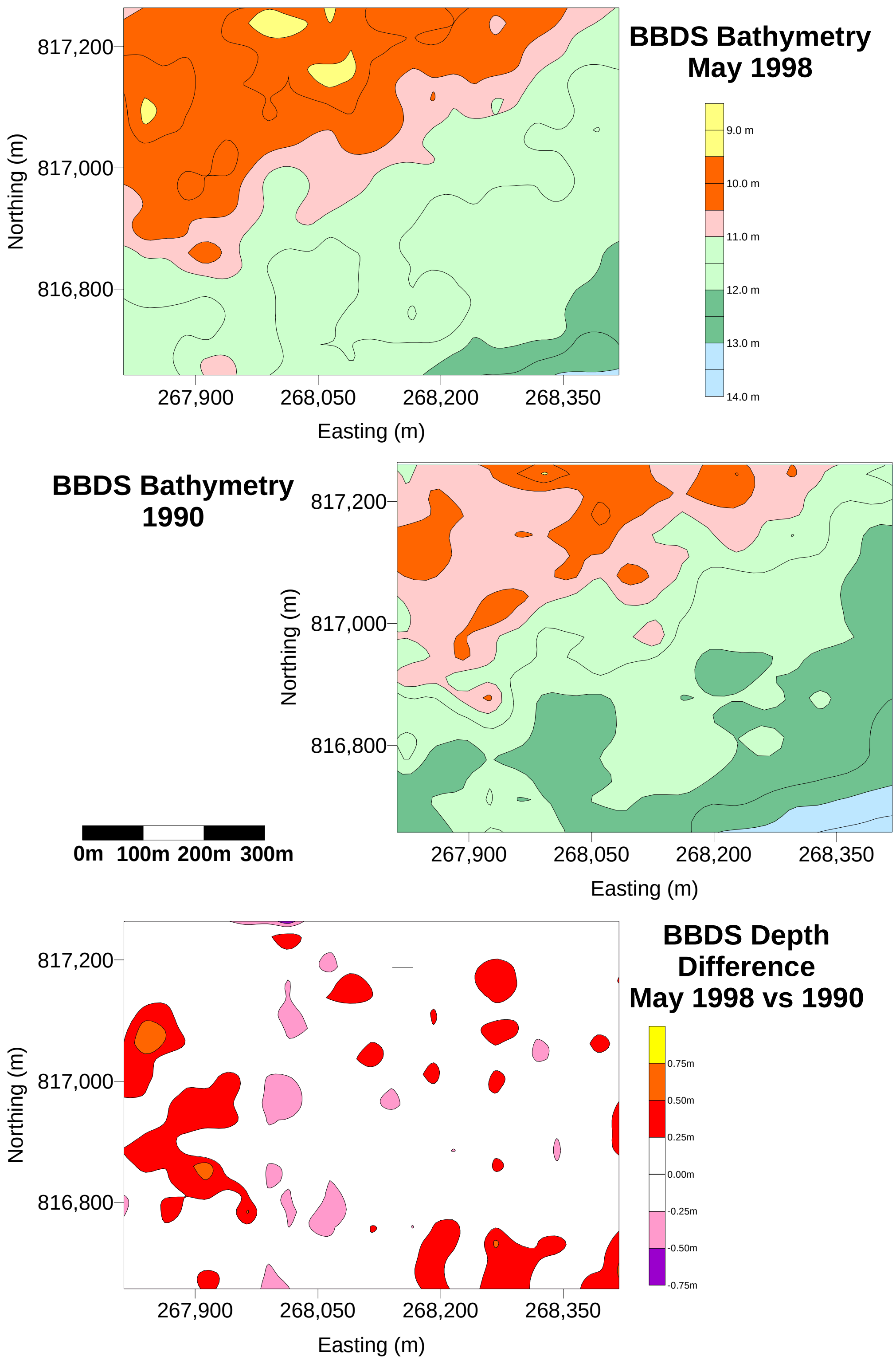

Figure 3-4. Depth difference results (bottom) from the 1998 (top) and 1990 (middle) bathymetric surveys.

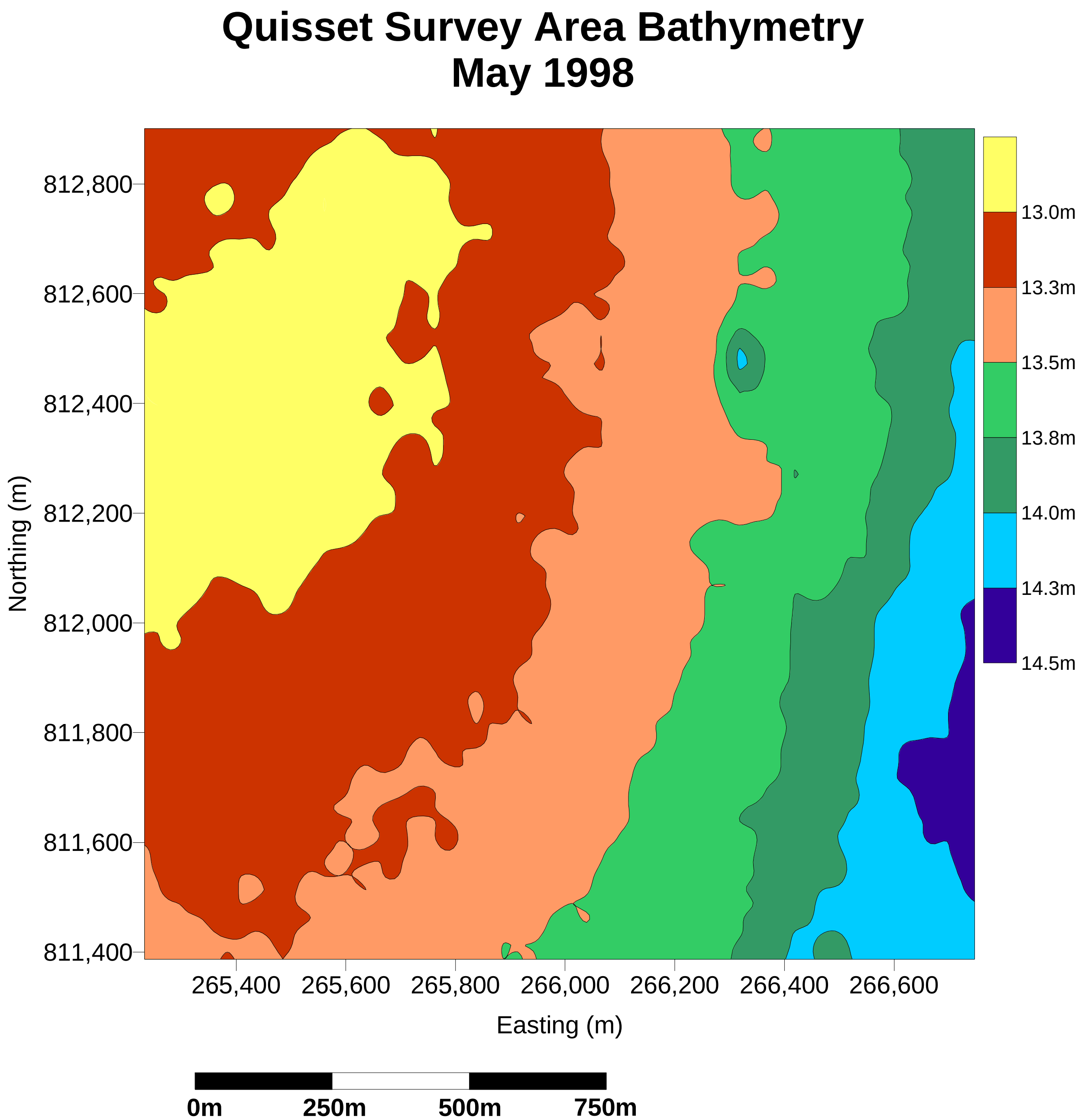

Figure 3-5. Bathymetric results from the Quisset Survey Area (NAD 83), contour interval = 0.2 m.

backscatter, are associated with areas of coarser-grained sediment and uneven topography. Areas of low reflectance or backscatter are commonly dominated by finer-grained sediment. In addition, using groundtruth data from sediment samples, side-scan sonar can be used to create maps of depositional and erosional areas (e.g., Knebel and Circé 1995). Targets, such as sunken vessels, lobster pots, and discrete dumps of dredged material, are distinct on side-scan records because of the difference in the acoustic reflective properties between the target relative to the background.

For this analysis, the analog (paper) records were analyzed as to bottom type, and a generalized process map was created. Examples of these bottom types are presented Section 2.0. Then, a digital mosaic was created of the whole area in order to provide a large-scale view of the seafloor character of the survey area. A mosaic of the CLDS area only was created, as the seafloor was quite uniform in the Quisset area. Some specific features of the Quisset area, however, are presented.

Overall, the analysis of the side-scan data suggested that deposition of dredged material has been widespread throughout the Cleveland Ledge survey area (Figure 3-6). The dredged material pattern was distinctive, characterized by a blotchy pattern of high reflectance material on top of a more uniform acoustic background (Figure 2-1). The bottom was also strewn with rocks in much of the dredged material area (Figure 2-2a). This dredged material/rocky bottom area was present throughout the northern and central areas of the survey, and absent along the western edge of the survey, the southern basin, and in most of the basin surrounding Giffords Ledge (Figure 3-6). In some areas, the appearance of craters associated with dredged material dumps was apparent as described in the 1981 survey data (Menzie et al. 1982; Germano et al. 1989). The presence of these craters suggested that the dredged material was dumped in areas of finer-grained sediment. In the 1998 survey, the craters (Figure 2-16) were noted as being concentrated in the northern part of the eastern basin, consistent with the interpretation of the relatively deep basin being dominated by fine-grained sediment.

Besides the two primary side-scan sonar patterns of ambient (Figure 2-3a) and dredged material (Figure 2-1), several other less common features were noted. Giffords Ledge stood out as one of the most highly reflective features in the survey area (Figure 2-2b). In the side-scan mosaic, Giffords Ledge was a bright feature (in reverse video) in the southeastern corner of the survey area (Figure 3-7). The side-scan mosaic showed the bottom character of large areas documented by bathymetry. In order to highlight these features, bathymetric contours were plotted overlying the side-scan mosaic. Because the side-scan image was not registered (i.e., no coordinate system associated with the image), the relationship between the bathymetric contours and the side-scan image was estimated based on major features including Giffords Ledge and the Dump Top.

Surrounding Giffords Ledge, the deep basin (16 m; Figure 3-1) was characterized by low reflectance with the cratered texture suggesting dredged material on fine-grained sediment. In the southeast corner of the mosaic, an unusual bottom type present in the survey area was an area of uniform high-reflectance, located along the northwest-southeast ridge separating the two basins (Figure 3-1). This feature was unusual in that it appeared exactly as ambient (Figure 2-3), but with much stronger backscatter indicating a harder bottom. We interpreted this area as a natural glacial ridge, probably associated with the moraine and glacial outwash deposits throughout the area (Howes and Goehringer 1996).

The Quisett survey area was dominated by low reflectance, uniform backscatter with little variation. In addition to numerous lobster pits, one feature with important implications to disposal site designation was the presence of sand waves (Figure 2-3b). Although a wave field was noted in the 1981 survey (Figure 1-3), no sediment waves were noted in the Cleveland Ledge survey area.

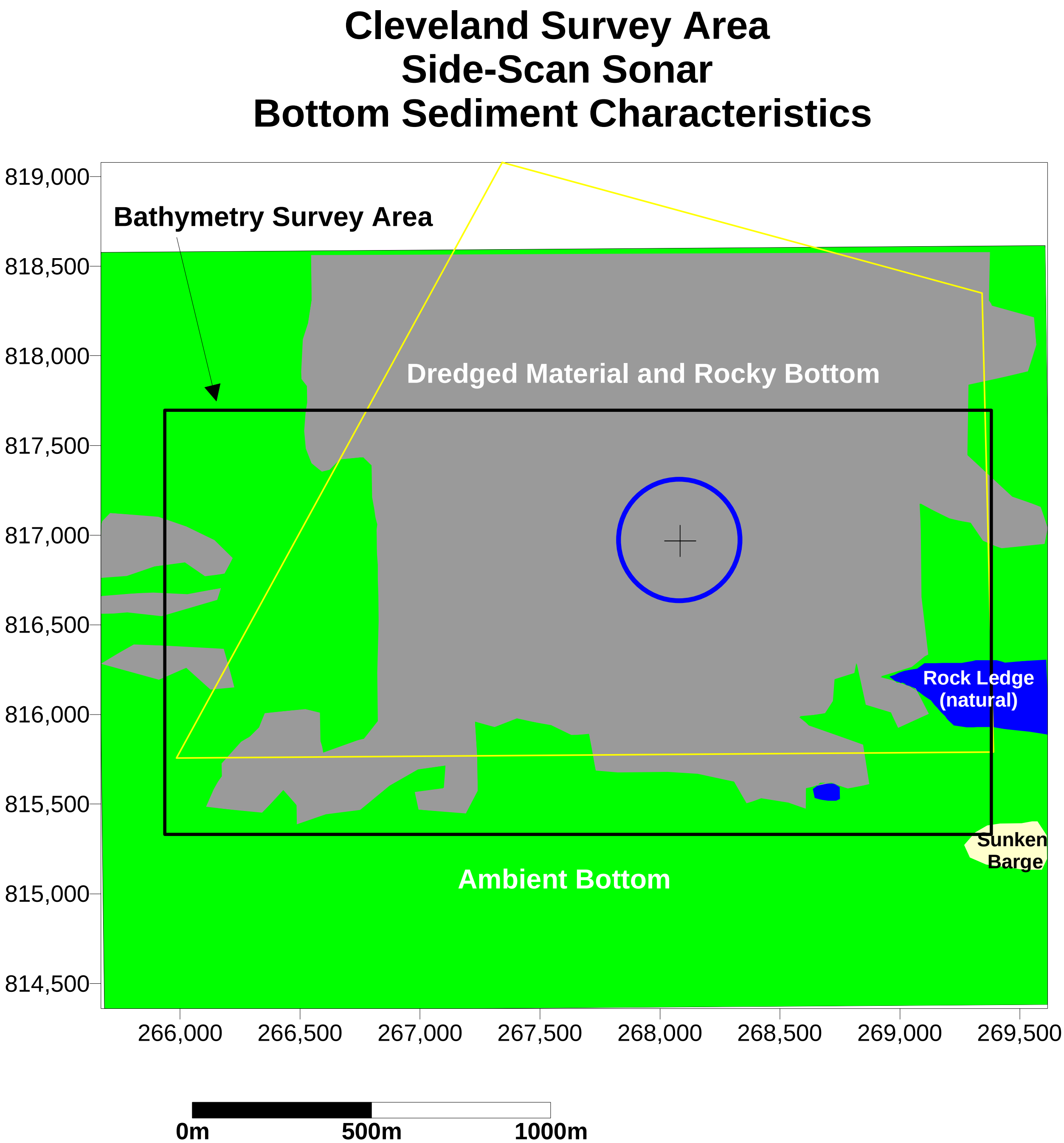

Figure 3-6. Interpretive process map of bottom character at the Cleveland Ledge Survey Area.

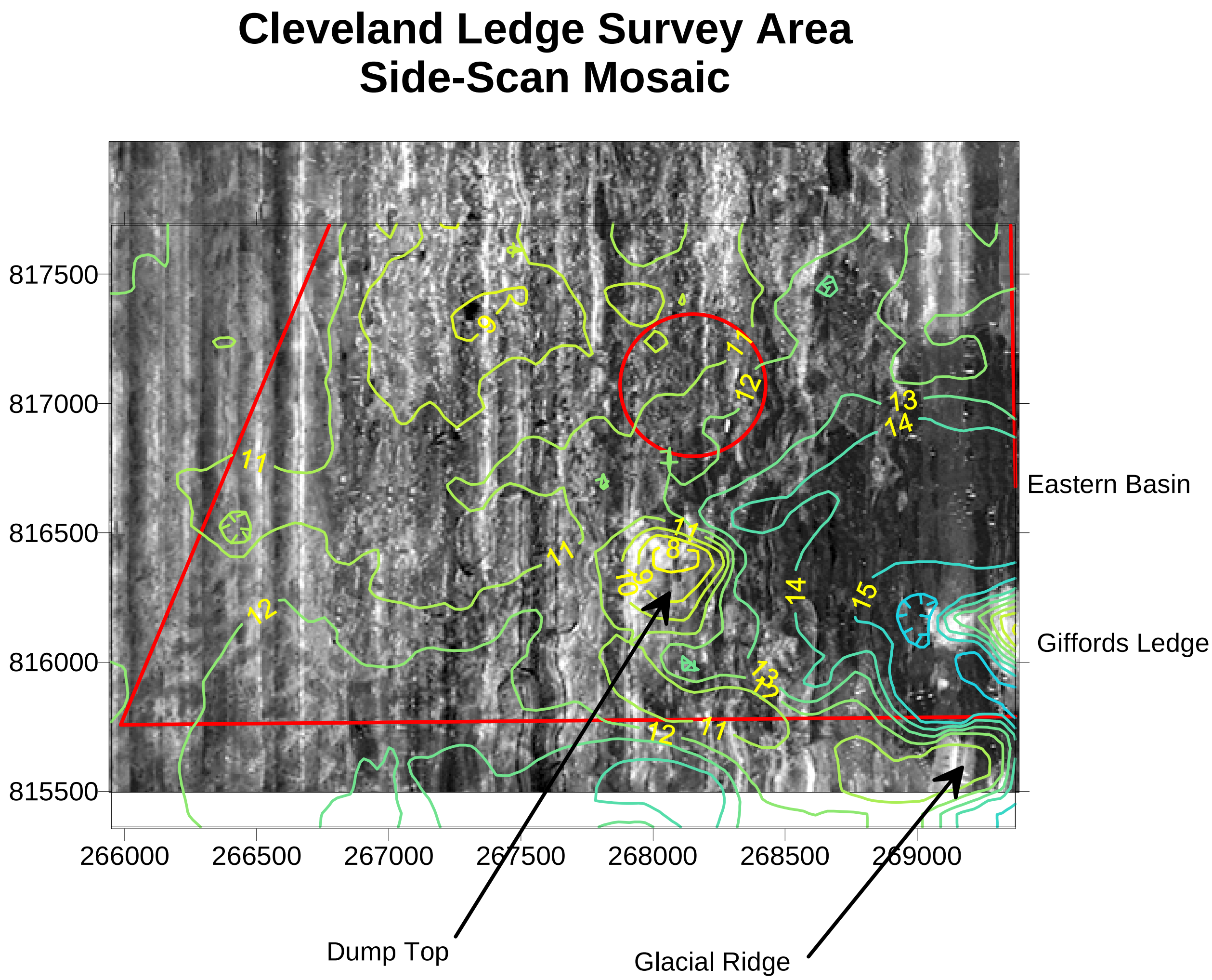

Figure 3-7. Side-scan mosaic of the Cleveland Ledge Survey Area overlaid by approximate location of bottom contours.

4.0 DISCUSSION

The seafloor topography and characterization survey data were evaluated in the context of narrowing the options for designation of a disposal site. In the next phase of the MEPA field process, more intensive biological, chemical, and physical survey data will be collected as baseline information on specific areas suitable for disposal of dredged material. Because these surveys necessarily will be conducted over smaller regions, the physical data must be used to select discrete candidate sites for further investigation. Therefore, this section includes specific recommendations for candidate regions for designation of the BBDS.

The objectives of evaluating the physical characterization data were to recommend potential disposal areas based on:

- limiting the potential for sediment resuspension and movement out of the designated area;
- minimizing impact to the natural seafloor;
- locating a site deep and large enough a) for sufficient long-term capacity; b) to prevent material transport outside of site boundaries during normal disposal operations; and c) for navigational access by hopper dredges.

4.1 Limiting Sediment Transport

As discussed in Section 1.3, areas within Buzzards Bay that will be most effective as a dredged material containment site will be in deeper areas dominated by fine-grained sediment. Shallower areas with coarser grain size tend to be areas of higher bottom current energy, increasing the chance for resuspension of the dredged material. Within the Cleveland Ledge survey area, much of the seafloor was impacted from historical disposal, rendering evaluation of the ambient grain size more difficult. Historical data (Moore 1963), as well as more recent information on the grain size at reference areas around the disposal site (SAIC 1991), indicated that the ambient grain size was dominated by fine sand, with a transition to more fine-grained sediment towards the southern edge of the CLDS. The fine-grained “east flat” area from the 1981 side-scan survey (Figure 1-3) was most likely the outskirts of the Eastern Basin (Figure 3-7). Although there is no grain size data from the Quisset site, Moore’s data suggested that the dominant grain size is silt (Figure 1-2).

Considering all of these data, the areas most likely to contain fine-grained dredged material is in the deepest part of the bay. Silt is generally found deeper than the 12.2-m contour (Howes and Goehringer 1996), which is similar to the depth required for hopper dredge access. Water depths of the proposed BBDS ranged primarily from 10-12 m (Figure 3-3), although these depths do not reflect the physical environment because much of the area is dominated by dredged material. The data do suggest, however, that the proposed BBDS is not the most practical area due to the limited access to hopper dredges, and the corresponding limited capacity of the site.

Water depths throughout the CLDS that were >12.0 m were extracted from the bathymetric data and highlighted (Figure 4-1). Although this depth is only a generalization, it provides a reference depth to assess the survey areas. Within the Cleveland Ledge survey area, much of the eastern third of the survey area, except for Giffords Ledge, was in water depths >12.0 m, as well as the wide shallow basin along the southern edge (Figure 4-1). All of the Quisset survey area had water depths of >12.0 m.

Another factor that is important in evaluating the potential for sediment transport outside of a site is the availability of natural or man-made barriers that serve to limit the spread of dredged material at a disposal site. For example, in Long Island Sound, mounds of historical dredged material have been used to create barriers to down-slope transport of recently placed material (Fredette 1994; Morris et al. 1996). Offshore of Portland Harbor in Maine, natural containment from bedrock outcrops and glacial moraine deposits was used to demonstrate the ability to place and cap dredged material in deep water (Morris et al. 1998). In the Cleveland Ledge survey area, the eastern basin provided the best potential for a confined site, surrounded by dredged material mounds to the west and natural glacial ridges to the east and south (Figure 3-1). This topographic configuration could be used to advantageously for dredged material containment. In the Quisset area, the natural sloping seafloor suggested no natural barriers to sediment transport.

The primary factor in evaluating the potential for resuspension, more important than ambient grain size, water depth, and containment topography, is the water column current structure. In general, the strongest tidal currents are found in the shallow areas of Buzzards Bay, especially around the margins (Moore 1963; Howes and Goehringer 1996). The presence of the deep (>16 m) channel located south of the eastern basin may represent an area of erosional scour around the rock outcrop. Therefore, although the basin itself could serve as a potential containment site as suggested above, the on-site current structure would have to be evaluated prior to site designation.

4.2 Minimizing Impact to the Ambient Seafloor

The physical data, although not useful to assess benthic habitats of the survey areas, can be used to assess the existing benthic environment relative to historical environmental impact. In general, the presence of historical dredged material deposits suggests that the area has already been impacted, and therefore additional disposal potentially would minimize additional benthic impact or change of benthic community structure. Aside from dredged material disposal, another source of historical environmental impact to the eastern side of the area was the West Falmouth oil spill (Hampson and Sanders 1969).

Of the two areas located in optimal water depths for site designation (Figure 4-1), the southern site is outside of the existing CLDS boundaries, and was relatively free of historical dredged material (Figure 3-6), as was the Quisset site. Locating the new dredged material disposal site outside of historical dredged material disposal sites has at least one important drawback. Assuming that the selected area is in relatively deeper waters (>12.0 m), and is

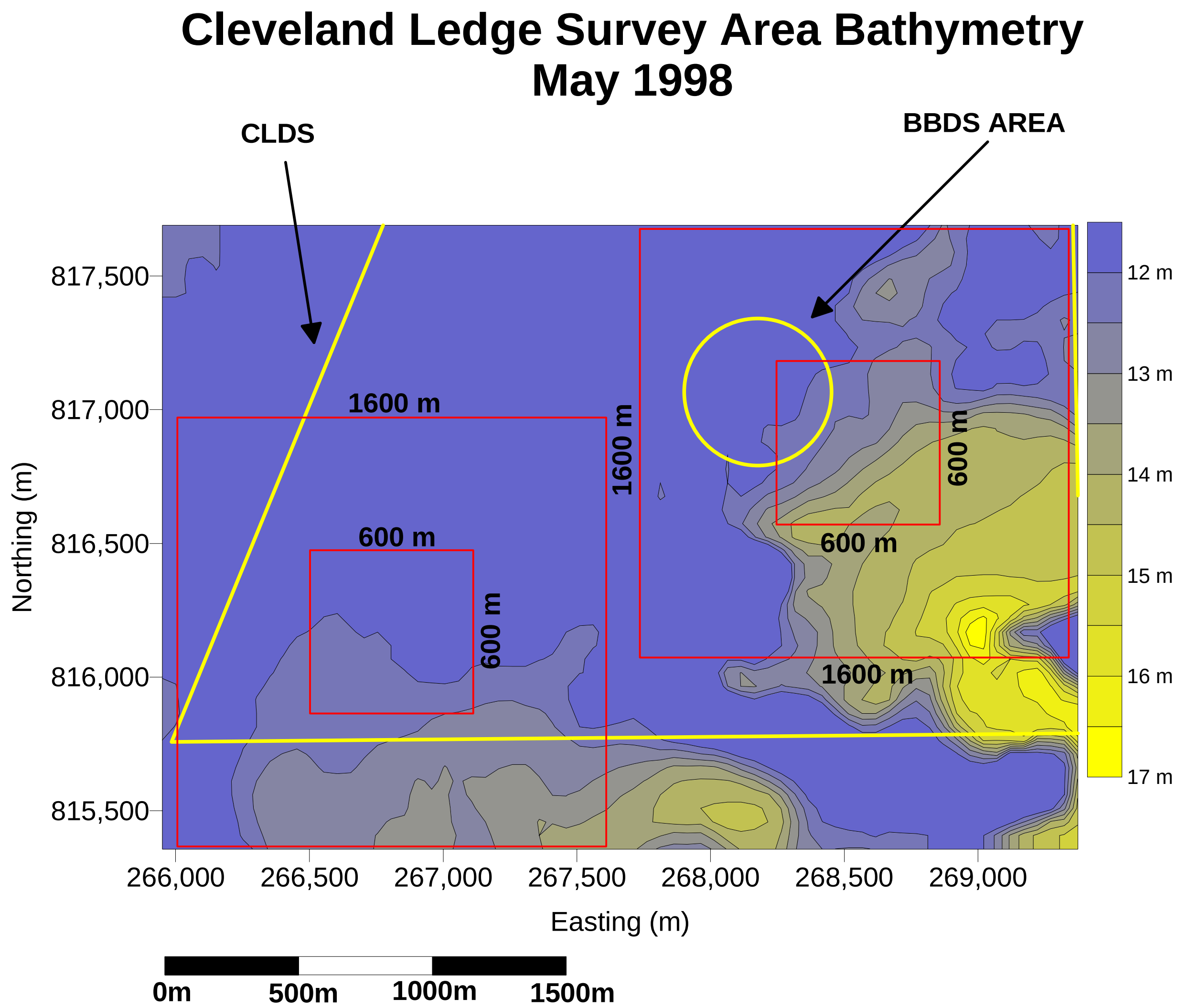

Figure 4-1. Bathymetry of the Cleveland Ledge Survey Area highlighting water depths of greater than 12 m.

dominated by fine-grained sediment (Section 4.1), there will be an increased potential for benthic environmental impact. The majority of the dredged material likely to be deposited at the site is coarse-grained (SAIC submitted [a]). Therefore, dredged material deposition potentially will alter the ambient benthic community dominated by deposit feeders (most common in fine-grained sediments), to the coarse-grained filter feeding benthic community more typical of the areas already impacted by dredged material disposal (SAIC 1991). This impact will need to be investigated during the MEPA process biological studies conducted at the site.

4.3 Site Capacity and Navigational Constraints

The size of the two areas highlighted in Figure 4-1 was determined from the recommendation by DEM, in the draft Notice of Project Change. The DEM noted that the size of the proposed site was too confining, potentially resulting in dredged material spread beyond the prescribed area. The suggested size for a new site was a square area with an interior boundary of 600 m x 600 m, serving as the area where material will be released, and an exterior boundary of 1600 x 1600 m, which would limit the area of the spread of dredged material. This size was used to provide perspective of the size of the site relative to the currently proposed BBDS.

Using the DEM’s recommended site size, three locations have met the requirements for water depth and capacity for site designation: the Eastern Basin site and the Southern Basin site (Figure 4-1), and the Quisset site. Once a candidate disposal site is finalized, and a minimum water depth is established, the capacity of each site can be calculated. As observed in the historical area termed the Dump Top (Figure 1-3), long-term disposal will create a mound that eventually becomes difficult to access as the ambient water depth decreases. This is especially true for a smaller site, and if the ambient grain size is sand because sand is relatively incompressible so that consolidation below the dredged material will be limited. Therefore, a deeper water site not only has the advantage of reducing the possibility of resuspension, but the site also will have more long-term capacity.

While both the Eastern and Southern basin sites within the CLDS (Figure 4-1), and the Quisset site, have sufficient water depth for access by hopper dredges, there may be navigational constraints in using the Eastern Basin site within the CLDS. Currently the BBDS is not used for hopper disposal of sand due to the shallow water depth, and on most nautical charts the entire area of the CLDS shows no depth information. The NAE (1986) disposal site located directly off of the East Cleveland Ledge Light is easily accessed from the main channel (Figure 1-1). Access to the Southern Basin and Quisset sites have good access from the main channel. The same properties of the Eastern Basin that make the site potentially optimal for dredged material confinement, including the presence of surrounding topographic barriers, at the same time create potential difficulties for navigational access.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 *Conclusions*

- The areas most likely to contain fine-grained dredged material is deeper than the 12.2 m contour, which is similar to the depth required for hopper dredge access.
- Water depths of the proposed BBDS ranged primarily from 10-12 m, suggesting that the proposed BBDS is not the most practical area due to the limited access to hopper dredges and the corresponding limited capacity.
- Within the Cleveland Ledge survey area, two regions had overall water depths of >12.0 m, as did all of the Quisset survey area.
- Three sites were recommended based on water depth alone: the Eastern Basin; the Southern Basin, and the Quisset site.
- The size of the two sites within the Cleveland Ledge survey area were based on DEM recommendations for an interior and exterior boundary which would limit the area of the spread of dredged material.
- The Eastern Basin site provided the best potential for a confined site, surrounded by dredged material mounds to the west and natural ridges to the east and south.
- The presence of the deep (>16 m) channel located south of Giffords Ledge may represent an area of erosional scour, which should be further investigated.
- All three sites have a limited presence of dredged material except for the northern half of the Eastern Basin.
- The presence of historical dredged material within parts of the Eastern Basin site suggests that prior impact, minimizing additional benthic impact or change of benthic community structure as a result of additional deposition.
- Dredged material deposition within the Southern and Quisset sites potentially will alter the ambient benthic community dominated by deposit feeders (most common in fine-grained sediment), to the coarse-grained filter feeding benthic community more typical of the areas already impacted by dredged material disposal.
- While all three candidate sites have sufficient water depth for access by hopper dredges, there may be navigational constraints in accessing the Eastern Basin site.

5.2 *Recommendations*

The location of the currently proposed BBDS has several drawbacks. First, the ambient sand grain size, proximity to the wave field indicated in the 1981 side-scan data, as well as previous historical evidence of coarsening of the tops of the historical dredged material mounds, suggest there is potential for removal of fine-grained dredged material from the site. Second, the ambient water depth of the site (10-11 m) is consistent with the dominance of sand, and is too shallow to allow access by deeper draft hopper dredges. Finally, the 500 yd diameter site may be too small to contain long-term disposal of dredged material.

Three alternate sites have been recommended. Of these three, the Eastern Basin site potentially has the greatest potential for meeting the objectives of the project. First, it has sufficient water depth and capacity. Second, it has high potential for confinement. Third, it is dominated by fine-grained sediment, suggesting a depositional area. At the same time, much of the area has already been impacted by disposal, limiting further benthic impact. This area is consistent with the description provided by the DEM (1.4 nmi northwest of Chappaquoit Point). There are two major concerns: the nature of the channel located south of Giffords Ledge, and the potential for limited hopper access.

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