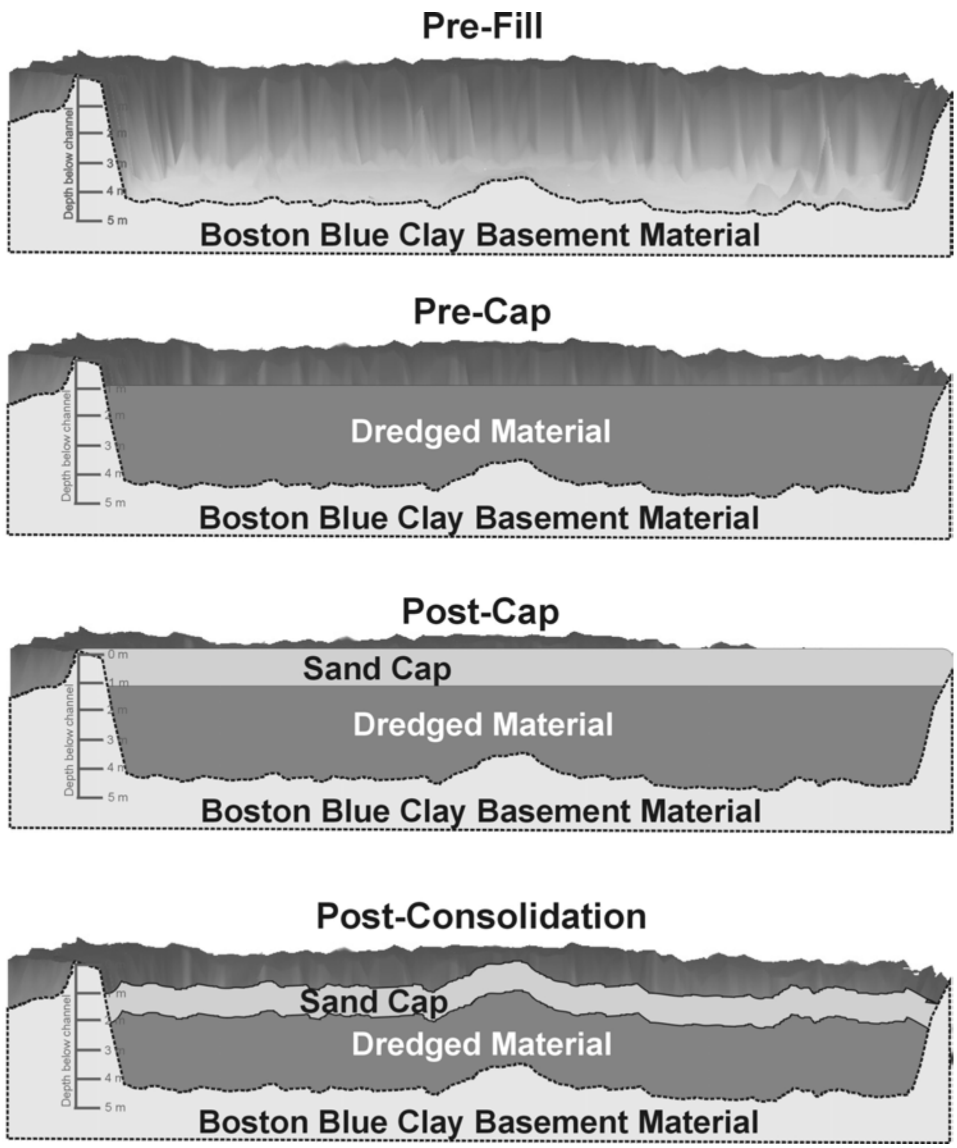
Monitoring Survey Over Boston Harbor CAD Cell M19

Disposal Area Monitoring System DAMOS



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13. ABSTRACT

Cell M19 is one of seven CAD cells constructed in the Mystic River and was one of the final cells completed under the Boston Harbor Navigation Improvement Project (BHNIP). Capping of Cell M19 was completed in summer of 2000 with the placement of a sand cap layer ranging in thickness from 2.5 to 4 feet (0.8 to 1.2 m). Follow-on monitoring performed in 2001 revealed the continued presence of an intact sand cap and benthic recolonization progressing as anticipated one year after the placement of cap. In the winter of 2002, isolated shoals adjacent to Cell M19 were dredged. The material generated from this dredging activity was placed within M19, over the intact sand cap. Supplemental monitoring activity sponsored by the US Environmental Protection Agency, Region 1 (EPA) in spring of 2002 suggested that portions of the sand cap may have been compromised. As a result, the Disposal Area Monitoring System (DAMOS) initiated an investigation over Cell M19 in the summer of 2002 to examine the distribution of sediments and cap integrity within this CAD cell.

The 2002 survey included the use of single-beam bathymetry, side-scan sonar, towed video, and the collection of surface sediment grab samples. The survey data revealed the presence of a strong linear bottom feature and two seafloor depressions within the confines of the cell. The strong linear feature present in the southeastern quadrant of the cell appeared in side scan sonar records as a change in both surface sediment texture and topography. This feature was oriented parallel to the long axis of the CAD cell and located 10 to 15 m north of the new sediment deposit. Bathymetry data indicated this feature was 110 m long and 10 to 25 m wide with depths 1 to 2 m deeper than the majority of the cell. Grab samples indicated the surface sediments along the center of the linear feature were not cap material, while a mixture of sand and silty clay existed adjacent to this feature. The cause of the linear feature is indeterminate, and additional monitoring was recommended to further define the feature. In addition to the linear feature, the summer 2002 survey also indicated the presence of two roughly circular topographic depressions within Cell M19. Consolidation of the sediments placed within M19 during its original construction was likely a factor in the formation of both of these depressions. However, it is unknown whether the recent placement of dense BBC along the southern margin of the cell has expedited the formation of the bottom depression within the southeastern quadrant.

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EXECUTIVE SUMMARY

The Boston Harbor Navigation Improvement Project (BHNIP) was an infrastructure improvement project sponsored jointly by the New England District (NAE) of the U.S. Army Corps of Engineers and the Massachusetts Port Authority (MassPort) between 1997 and 2001. Under the BHNIP, estuarine sediments defined as unsuitable for unconfined open water disposal were removed from the navigation channels in Boston Harbor and placed in a series of confined aquatic disposal (CAD) cells constructed in the bottom of the Mystic and Chelsea Rivers, as well as the Inner Confluence. These sediments were then capped with a layer of sand to isolate the unsuitable dredged material from the environment.

Cell M19 is one of seven CAD cells constructed in the Mystic River and was one of the final cells completed under the BHNIP. Capping of M19 was completed in summer of 2000 with the placement of a sand cap layer ranging in thickness from 2.5 to 4 feet (0.8 to 1.2 m). Follow-on monitoring performed in 2001 revealed the continued presence of an intact sand cap and benthic recolonization progressing as anticipated one year after the placement of cap. In the winter of 2002, isolated shoals adjacent to Cell M19 were dredged. The material generated from this dredging activity was placed within M19, over the intact sand cap. Supplemental monitoring activity sponsored by the US Environmental Protection Agency, Region 1 (EPA) in spring of 2002 suggested that portions of the sand cap may have been compromised. As a result, the Disposal Area Monitoring System (DAMOS) initiated an investigation over Cell M19 in the summer of 2002 to examine the distribution of sediments and cap integrity within this CAD cell.

The 2002 survey included the use of single-beam bathymetry, side-scan sonar, towed video, and the collection of surface sediment grab samples. The results from the initial survey effort indicated the presence of new sediment deposits consisting primarily of Boston Blue Clay (BBC) and oxidized silty clay along the southern boundary of the cell. In addition, a strong linear bottom feature and two seafloor depressions were detected within the confines of the cell. Based on these results, a secondary survey was performed over the eastern portion of Cell M19 to further investigate these features to determine if their formation had impacted the thickness or composition of the cap.

The strong linear feature present in the southeastern quadrant of the cell appeared in side scan sonar records as a change in both surface sediment texture and topography. This feature was oriented parallel to the long axis of the CAD cell and located 10 to 15 m north of the new sediment deposit. Bathymetry data indicated this feature was 110 m long and 10 to 25 m wide with depths 1 to 2 m deeper than the majority of the cell. Grab samples indicated the surface sediments along the center of the linear feature were not cap material, while a mixture of sand and silty clay existed adjacent to this feature. The cause of the linear feature is indeterminate, and additional monitoring was recommended to further define the feature.

In addition to the linear feature, the summer 2002 survey also indicated the presence of two roughly circular topographic depressions within Cell M19. One depression, located in the northeast corner of the CAD cell, displayed a homogenous surface comprised of sand and shell hash indicating that the cap layer remains intact. The second localized bottom depression was noted in the southeastern quadrant of M19, and displayed a surface composed of BBC and oxidized silty clay, which was attributable to the recent placement of sediment dredged from the shoals surrounding the CAD cell. Consolidation of the sediments placed within M19 during its original construction is likely a factor in the formation of both of these depressions. However, it is unknown whether the recent placement of dense BBC along the southern margin of the cell has expedited the formation of the bottom depression within the southeastern quadrant.

With the exception of the area immediately surrounding the linear feature in the southeastern quadrant of M19, the capped surface of the cell appeared to be maintaining its integrity. Various marine organisms have colonized the seafloor within M19 and the surrounding area. The presence of tubiculous worms, finfish, crabs, lobster and lobster fishing gear within the cell suggests this area of seafloor is relatively productive.

1.0 INTRODUCTION

1.1 Background

The Boston Harbor Navigation Improvement Project (BHNIP) was a major infrastructure improvement project sponsored jointly by the New England District (NAE) of the U.S. Army Corps of Engineers and the Massachusetts Port Authority (MassPort). The BHNIP involved the improvement dredging of portions of the main ship channel and three tributary channels in Boston Harbor. The main ship channel includes the Inner Confluence and the mouth of the Reserved Channel, while the tributary channels include the Mystic River, Chelsea River, and the Reserved Channel (Figure 1-1). All of the channels were deepened to –40 ft Mean Lower Low Water (MLLW), except for the Chelsea River, which was dredged to –38 ft MLLW. In addition to the channels, berths at eight marine terminals were also dredged.

Under the BHNIP, estuarine sediments defined as unsuitable for unconfined open water disposal were removed from the navigation channels in Boston's Inner Harbor and placed in a series of confined aquatic disposal (CAD) cells constructed in the bottom of the Mystic and Chelsea Rivers, as well as the Inner Confluence. The unsuitable dredged material placed in the CAD cells was then covered with a layer of capping dredged material comprised of sand to isolate the underlying sediments from the environment.

Cell M19 is one of seven CAD cells constructed in the Mystic River as part of the BHNIP (Figure 1-2). These cells were intensively monitored throughout their development in order to evaluate the success of the disposal technique, as well as to facilitate the refinement of dredged material placement and capping operations (Fredette et al. 2000; Hadden et al. 2000). In addition, various follow-on monitoring surveys have been performed after the completion of capping operations to examine the long-term stability of the cells, determine natural deposition rates, and assess benthic recolonization over the surface of the capped cells (SAIC 1997; SAIC 2001).

Capping operations over Cell M19 were completed in 2000 with the placement of a continuous sand cap layer ranging in thickness from 2.5 to 4 feet (0.8 to 1.2 m; OSI 2000). Since the completion of capping operations, Cell M19 has been the subject of a number of monitoring activities sponsored by NAE and the US Environmental Protection Agency, Region 1 (EPA). In July and August of 2001, a detailed evaluation of the Boston Harbor CAD cells sponsored by the Disposal Area Monitoring System (DAMOS) Program was conducted approximately one year following the capping of the final two cells (M8-11 and M19). The 2001 survey indicated that each CAD cell maintained the vertical stratification of dredged material and overlying cap material that had been noted in earlier postcap

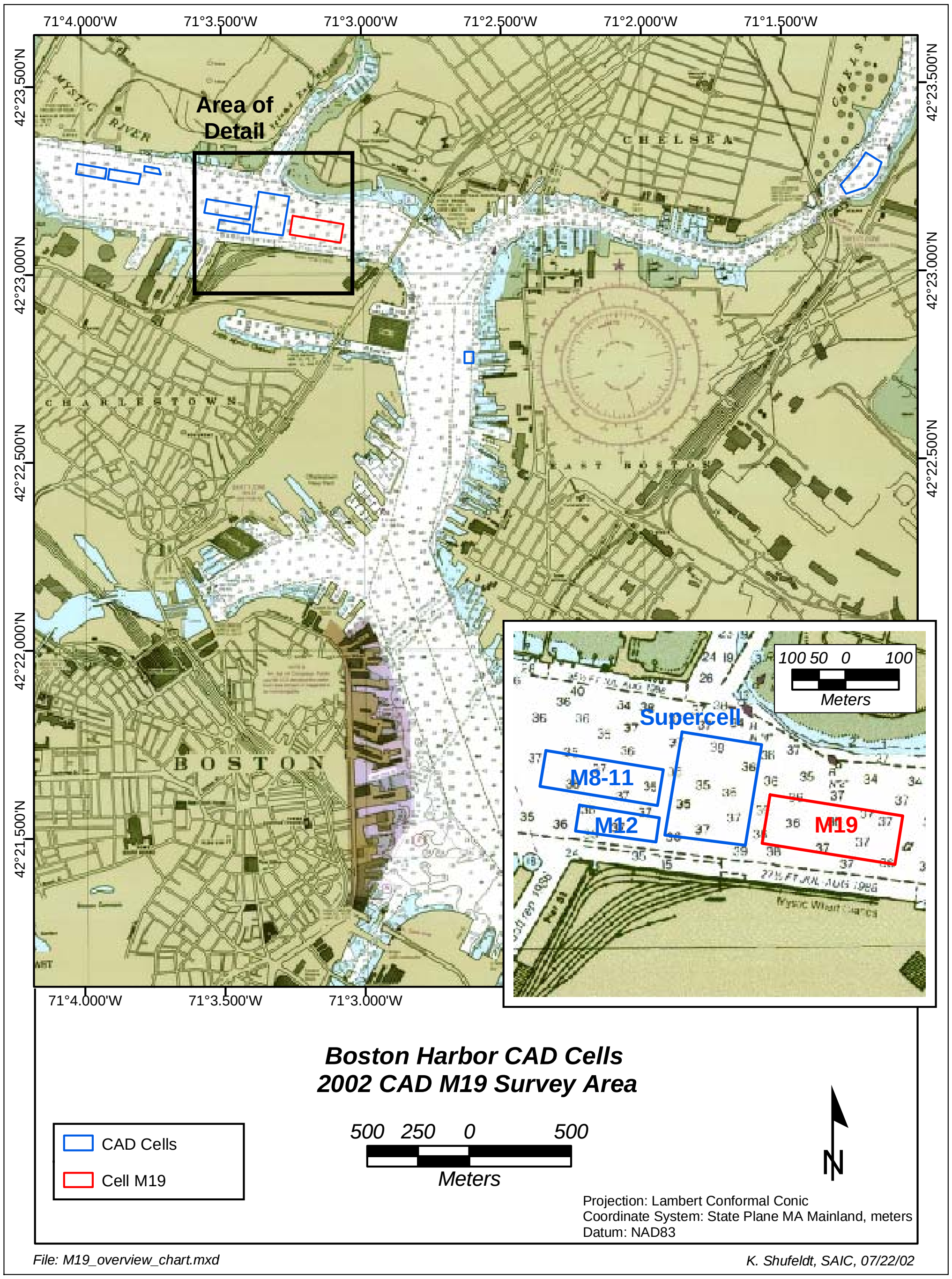


Figure 1-1. Location of the Boston Harbor CAD Cells constructed in the Inner Confluence, Mystic, and Chelsea Rivers as part of the BHNIP. The breakout box to the right displays the M19 and three other Mystic River CAD cells in detail.

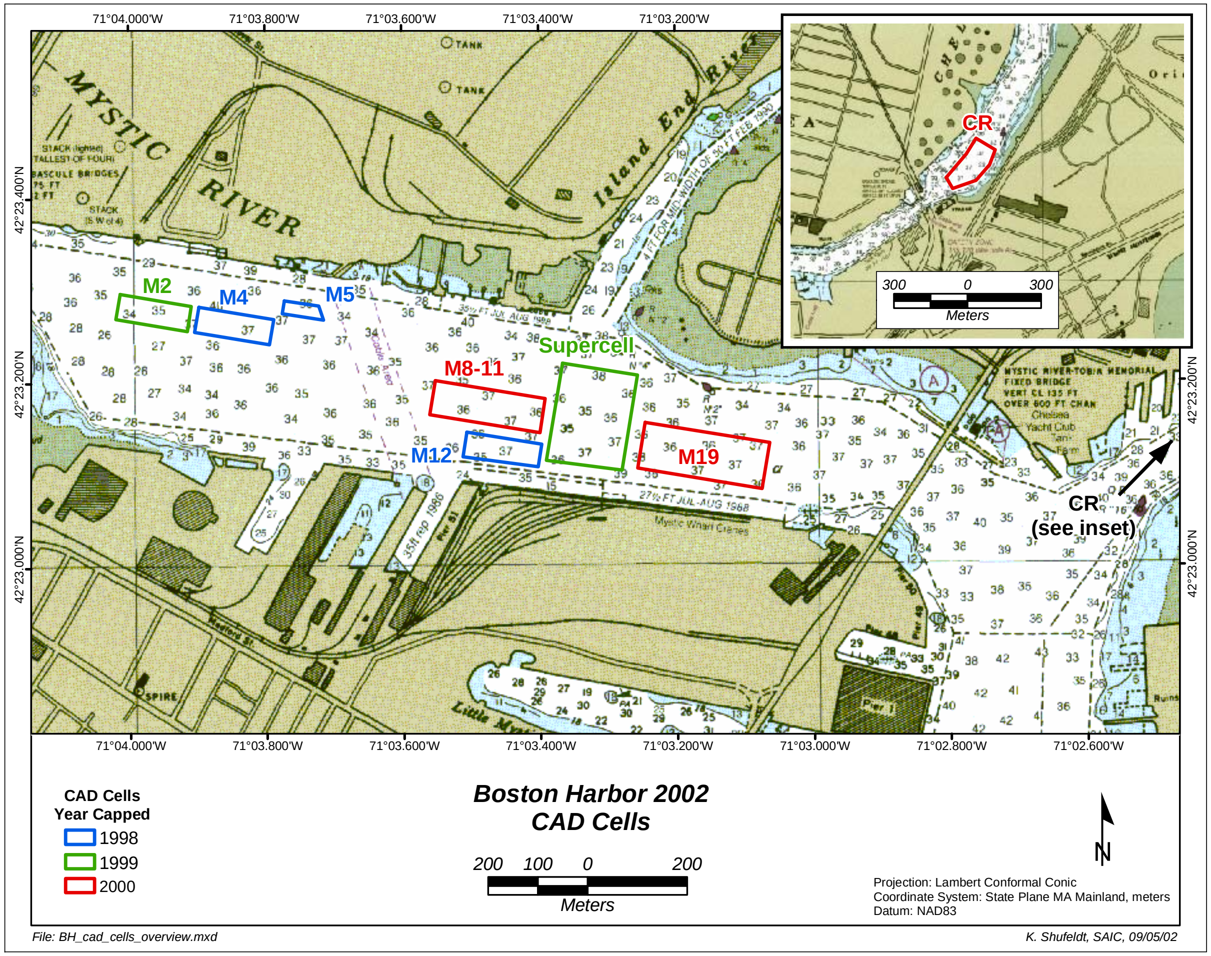


Figure 1-2. Plan view of the CAD cells constructed in the Mystic and Chelsea Rivers between 1998 and 2000 as part of the BHNIP

surveys. The most recently capped cells, including M19, were considered to have the thickest and most distinct cap layer of all the CAD cells (SAIC 2001).

In the winter of 2002, isolated shoals located south of Cell M19 were removed to complete improvement of the deepened channel. The dredging of these isolated shoals required removing the high spots in areas around Cell M19, which was accomplished with a clamshell bucket and direct deposition of the sediment into the cell. This activity likely captured a mixture of sand, silts and clays, as well as the Boston Blue Clay (BBC) basement material. Deposition of these sediments was over the intact sand cap in the cell.

Supplemental monitoring efforts conducted by the US EPA in the winter and spring of 2002 required the installation of gas collection monitors to examine methane production within the capped sediments. During the attempted retrieval of the gas collection devices placed in Cell M19, the EPA diver reports of seafloor conditions suggested the cap might have been disturbed. However, these reports did not provide conclusive information about the location of these observations within the channel. Prompted by these observations, a comprehensive evaluation of CAD Cell M19 was conducted under the DAMOS Program in the summer of 2002 to determine the current conditions over the surface of the cell.

1.2 Objective and Predictions

The objective of the Summer 2002 monitoring survey over Cell M19 was to evaluate the status of the CAD Cell M19 to assure that there were no significant changes at the surface that would suggest disruption of the cap.

The Summer 2002 investigation tested the following predictions:

1) No large-scale bottom features suggestive of cap failure will be identified within Cell M19.

2) A series of small-scale features composed of sand, silt, and clay originating from the bucket-placed sediment will exist over the sand cap, but will have negligible impacts on the integrity of the cap layer.

2.0 METHODS

The primary investigation for the CAD Cell M19 monitoring effort was conducted on 26 June and 10 July 2002. Survey operations consisted of the collection of single-beam bathymetry, side-scan sonar, and sediment grab samples conducted aboard the M/V *Beavertail* on 26 June 2002. Towed video was collected aboard the R/V *Sakonnet* on 10 July 2002. Based upon analysis of the June and July datasets, a secondary survey consisting of bathymetry and sediment grab samples was conducted over a select portion of the cell, from 26 to 27 August on the M/V *Bottom-Time*.

2.1 Navigation and Positioning

Differentially-corrected Global Positioning System (DGPS) data in conjunction with Coastal Oceanographic's HYPACK® navigation and survey software were used to provide real-time navigation to an accuracy of ±3 m for each survey effort. A Trimble DSMPro GPS receiver was used to obtain raw satellite data and provide vessel position information in the horizontal control of North American Datum of 1983 (NAD 83). The DSMPro GPS unit also contains an integrated differential beacon receiver to improve overall accuracy of the satellite data to the necessary tolerances. The U.S. Coast Guard differential beacon broadcasting from Portsmouth, NH (288 kHz) was utilized for real-time satellite corrections due to its geographic position relative to Boston Harbor.

The DGPS data were ported to HYPACK® data acquisition software for position logging and helm display. The target stations for sediment grabs were determined before the commencement of survey operations and stored in a project database. Throughout the survey, individual stations were selected and displayed in order to position the survey vessel at the correct geographic location for sampling. All samples were collected within a 30 ft (10 m) radius of the target location. The position of each sample was logged with a time stamp in Universal Time Coordinate (UTC) and a text identifier to facilitate Quality Control (QC) and rapid input into a Geographic Information System (GIS) database for display use. This same procedure was used to record vessel position throughout the single-beam bathymetry, side-scan sonar, and towed video surveys.

2.2 Bathymetric Data Acquisition

Bathymetric data were collected in conjunction with the side-scan sonar survey as part of the initial survey effort. This was accomplished by interfacing HYPACK® with an Odom Hydrotrac® survey echosounder, as well as the Trimble DGPS system. The Hydrotrac® uses a narrow-beam (3°), 208-kHz transducer to make discrete depth measurements and produce a continuous digital data output and an analog record of the seafloor. The Hydrotrac® transmits approximately 10 digital depth values per second (depending on water depth) to the data acquisition system. Within HYPACK®, the time-tagged position and depth data were merged to create continuous depth records along the actual survey track. These records could be viewed in near real time to ensure adequate coverage of the survey area and verify data quality. A total of six survey lanes spaced at 50 m intervals (corresponding to the side-scan sonar lanes) were occupied parallel to the long axis of Cell M19 as part of the primary survey (Figure 2-1). The secondary survey effort required data collection at a higher resolution over the eastern portion of the CAD cell. A total of 13 survey lanes oriented perpendicular to the long axis of the CAD cell and spaced at 10 m intervals were occupied during the August 2002 field effort (Figure 2-2).

2.2.1 Bathymetric Data Processing

The bathymetric data from both surveys was fully edited and processed using the HYPACK® data processing modules. Raw position and sounding data were edited as necessary to remove or correct questionable data. Sound velocity and draft corrections were also applied. In addition, the sounding data set was reduced to the vertical datum of MLLW using observed tides obtained from the National Oceanic and Atmospheric Administration (NOAA). After the bathymetric data were fully edited and referenced to MLLW, cross-check comparisons on overlapping data were performed to verify the proper application of the correctors and to evaluate the consistency of the data set.

During bathymetric survey data acquisition, an assumed and constant water column sound velocity was entered into the Odom echosounder. In order to account for the variable speed of sound through the water column, a Seabird Instruments, Inc. SEACAT SBE 19-01 Conductivity, Temperature, and Depth (CTD) probe was used to obtain sound velocity profiles at the start, midpoint, and end of each field survey day. An average sound velocity was calculated for each day from the water column profile data, and then entered into a HYPACK® sound velocity correction table. Using the assumed sound velocity entered into the echosounder and the computed sound velocity from the CTD casts, HYPACK® then computed and applied the required sound velocity corrections to all of the sounding records.

Observed tide data were obtained through NOAA's National Water Level Observation Network. The NOAA six-minute tide data were downloaded in the MLLW datum and corrected for tidal offsets. Water level data available from the operating NOAA tide station in Boston Harbor, MA (Station 8443970) were used in support of the 2002 bathymetric survey efforts.

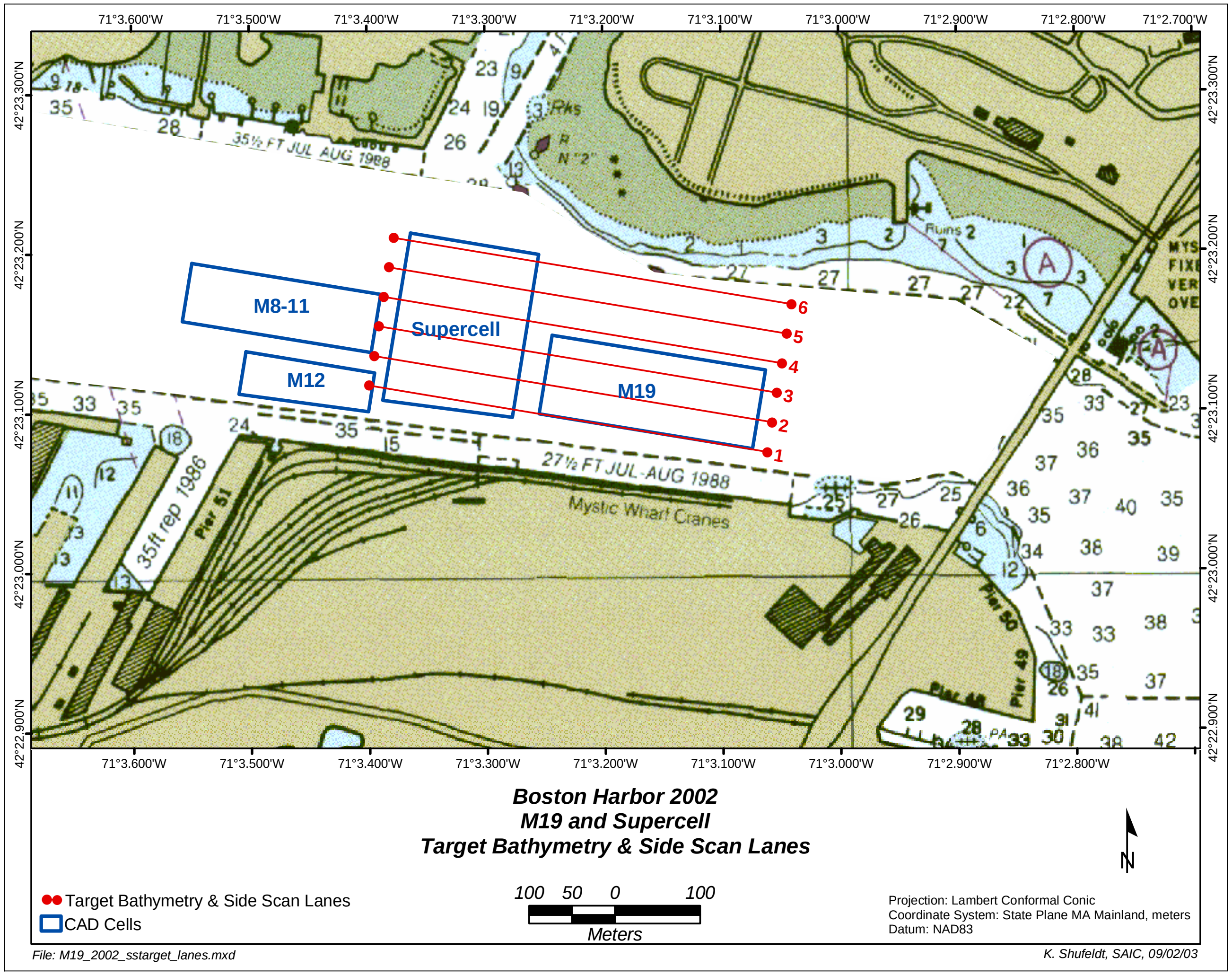


Figure 2-1. Single-beam bathymetry and side-scan sonar survey lanes occupied as part of the primary survey effort completed over Boston Harbor CAD Cell M19 in June 2002

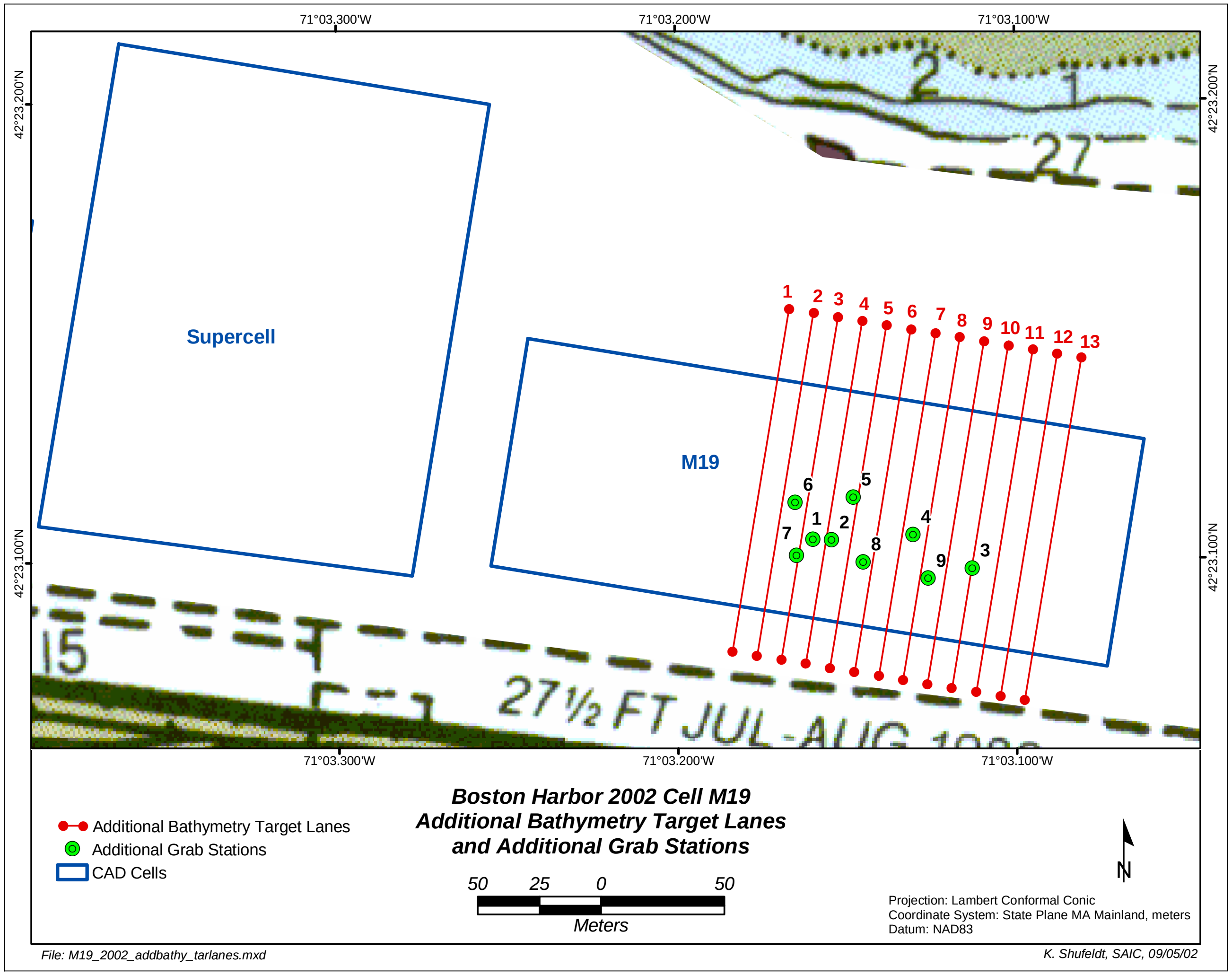


Figure 2-2. Bathymetric survey lanes and sediment grab sample stations occupied over Cell M19 as part of the secondary survey effort completed in August 2002

2.2.2 Bathymetric Data Analysis

The goal of the bathymetric data analysis was to create seafloor surface models from the fully processed data and evaluate these models in an attempt to identify any unique topographic features. For the initial CAD Cell M19 survey, the sorted ASCII-XYZ files were imported into ESRI's ArcMap software, and a grid system was defined over the CAD Cell M19 survey area. Because the first survey track-lines were spaced at 50 m intervals, a cell size of 25 m (along-track) by 25 m (cross-track) was specified to ensure sufficient data coverage to fill each cell and to minimize the effects of data extrapolation (by the gridding algorithm) between track-lines. The gridding method utilized for the primary survey effort averaged all of the single-beam data points that fell within each cell and generated a single depth value that was assigned to the center of each cell. The end result of this process was a matrix of depth values that defined a three-dimensional surface model of the survey area.

The secondary survey in August 2002 provided a more defined look at the southeastern portion of the cell as indicated in Figure 2-2. Bathymetric data acquisition, processing, and analysis procedures were similar to those used in the initial survey in June 2002. However, lane spacing was reduced from 50 m to 10 m and orientation of the lanes was modified to focus on the eastern portion of Cell M19 and to run perpendicular to the linear feature observed in the primary survey. A cell size of 10 m (along-track) by 10 m (cross-track) was specified to minimize the effects of data extrapolation (by the gridding algorithm) over these more closely spaced lanes. The gridding method was again used to average the single-beam data in the additional survey and produce a three-dimensional surface model.

2.3 Side-Scan Sonar

Side-scan sonar data were collected as part of the primary survey effort to examine the composition of the seafloor within Cell M19 and adjacent areas. Side-scan sonar is a swath data type that provides an acoustic representation of the seafloor, yielding information on sediment type, bottom targets, and generalized seafloor characteristics by detecting the back-scattered signals emitted from a towed transducer housed in a towfish (Figure 2-3). Side-scan data provide information on size of an object, height above the seafloor, and its horizontal distance from the towfish. Dense objects (e.g., rocks and firm sediment) reflect strong signals and appear as dark areas on the side-scan records. Conversely, areas characterized by soft features (e.g., muddy sediments), which absorb sonar energy, appear as lighter areas in the side-scan records.

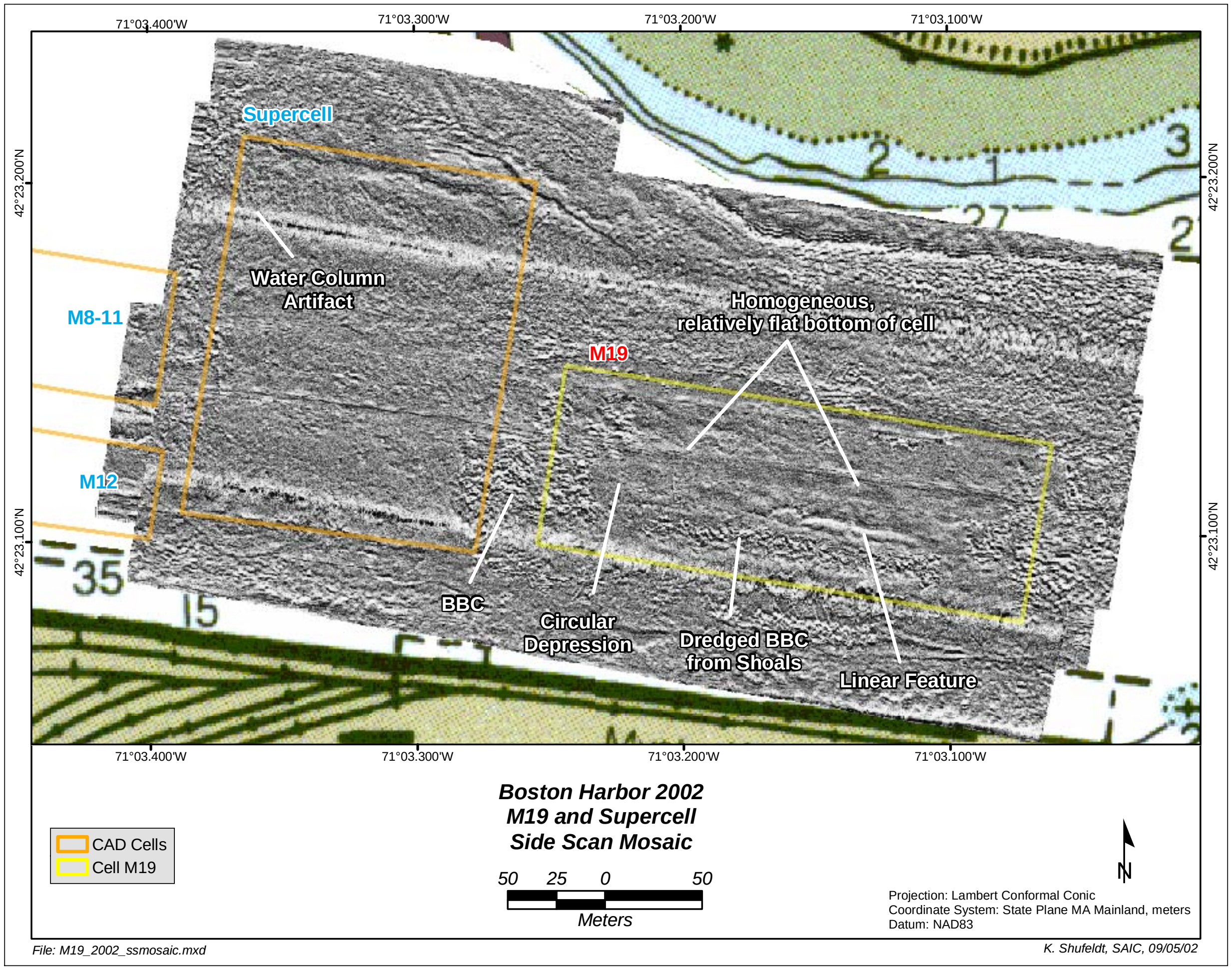


Figure 2-3. Example of the side-scan sonar mosaic developed from the data collected as part of the primary survey effort completed over Boston Harbor CAD Cells, M19 and the Supercell in June 2002. The labels correspond to major seafloor features within Cell M19.

2.3.1 Side-Scan Sonar Data Collection

Survey lanes for side-scan sonar were planned using the HYPACK® survey-planning module to cover the desired survey area. A total of six survey lanes parallel to the long axis of the Mystic River and spaced at 50 m intervals were occupied as part of the initial survey (Figure 2-1). Sonar data were collected with an EdgeTech DF-1000 side-scan sonar towfish interfaced with a Triton® Elics ISIS® system, which was used for data display and storage. The DF-1000 was powered by the EdgeTech Digital Control Interface (DCI) integrated within ISIS® and was capable of collecting data at both a frequency of 100 kHz and 500 kHz simultaneously. The ISIS® system allowed the user to control the power of the sonar as well as the range scale settings. The position of the towfish was calculated in real-time based upon cable scope (layback) and speed of the survey vessel. This information was embedded within the digital side-scan sonar data to allow for the geo-referencing of each acoustic return.

2.3.2 Side-Scan Sonar Data Processing

Using Triton-Elics ISIS® software version 5.0, the sonar data were played back digitally and the water column was removed to produce better quality imaging for mosaicing purposes. Upon playback of the side-scan records, adjustments were made to the time-varying-gain (TVG) of the return signal and to the embedded navigation information. The TVG adjustments allow the user to alter the gain tracking of the return signal based on the time elapsed since the initial outgoing pulse. As each line was processed in ISIS®, it was imported into the Delph Map module, checked for processing accuracy, and overlaid to form a mosaic (Figure 2-3). The development of a side-scan mosaic aids in data interpretation and display within a GIS, as well as serving as a background to support other disciplines, such as grab sampling.

2.4 Towed Video Sled Data Acquisition

A towed video sled operated by CR Environmental, Inc. was used to conduct a benthic video survey over CAD Cell M19 as part of the primary survey effort. A high-resolution 8-mm video camera, contained within a specialized pressure housing, was mounted on an aluminum tow sled and used to transmit video imagery to a recording device aboard the survey vessel (Figure 2-4). The sled was lowered to the seafloor by a mechanical cable and pulled along a series of longitudinal and transverse transect lines relative to the long axis of the cell. Video was recorded on tape by the video camera and simultaneously transferred to the survey vessel via coaxial cable. A topside Super VHS video recording system, as well as a digital video disk (DVD) recording system, captured the video images and provided a time stamp for correlation with navigation data.

Figure 2-4. Photograph of the CR Environmental towed video sled upon deployment

The survey plan included the completion of two longitudinal and five transverse transects in an effort to assess the surface of the CAD cell (Figure 2-5). The video sled continually snagged on unmarked lobster gear, which ran longitudinally through the cell, while attempting to conduct the transverse transects. After entangling the video sled on lobster fishing gear multiple times the survey plan was altered to include seven longitudinal lanes across the cell rather than two. In addition, one partial line in a transverse orientation (Line 3) was occupied in the northwestern quadrant of the cell. The position of the video sled was calculated based on cable layback and logged continuously by the HYPACK® navigation system during the survey operation. The resulting data files recorded the track lines of the surface vessel and benthic video sled as illustrated in Figure 2-5.

Analysis of the towed video data included classifying the major sediment types viewed, as well as documenting noteworthy objects or bottom features. A written log was kept during the review of the video, noting any significant changes in sediment type. If a sediment type was present for five or more seconds it was noted in the log; however, minor changes or patchiness lasting less than five seconds were not included in the classification. The primary viewing also noted some biological activity within the cell. However, observational rather than quantitative data on biota were recorded, as the primary focus of the analysis was on the surface sediments within Cell M19.

2.5 Sediment Grab Sampling

A series of ten stations were established within the boundaries of Cell M19 as part of the primary survey for the collection of sediment grab samples to serve as ground truth data for side-scan sonar and towed video results. The initial target grab sample locations were selected at the original intersections of towed video lanes and collected during the June 2002 survey, prior to the changes in the video survey design (Table 2-1; Figure 2-5). Based on the results of the June 2002 survey, nine additional grab samples were collected from the eastern portion of Cell M19 as part of the secondary effort (Table 2-2; Figure 2-2). The same sample collection and analysis procedures utilized in the preliminary survey were used for this supplemental survey.

A 0.1 m^2 Young-modified Van Veen grab sampling device was used to collect sediments to a depth of 25 cm below the sediment-water interface. The grab sampler device was lowered to the seafloor on a winch wire to obtain a discrete sample and recovered. After the grab sampler was brought on deck, the captured sediment was carefully examined and described in detail. Color, lithology, texture, water content, and odor were noted. Descriptive logs were based on visual inspection and followed a

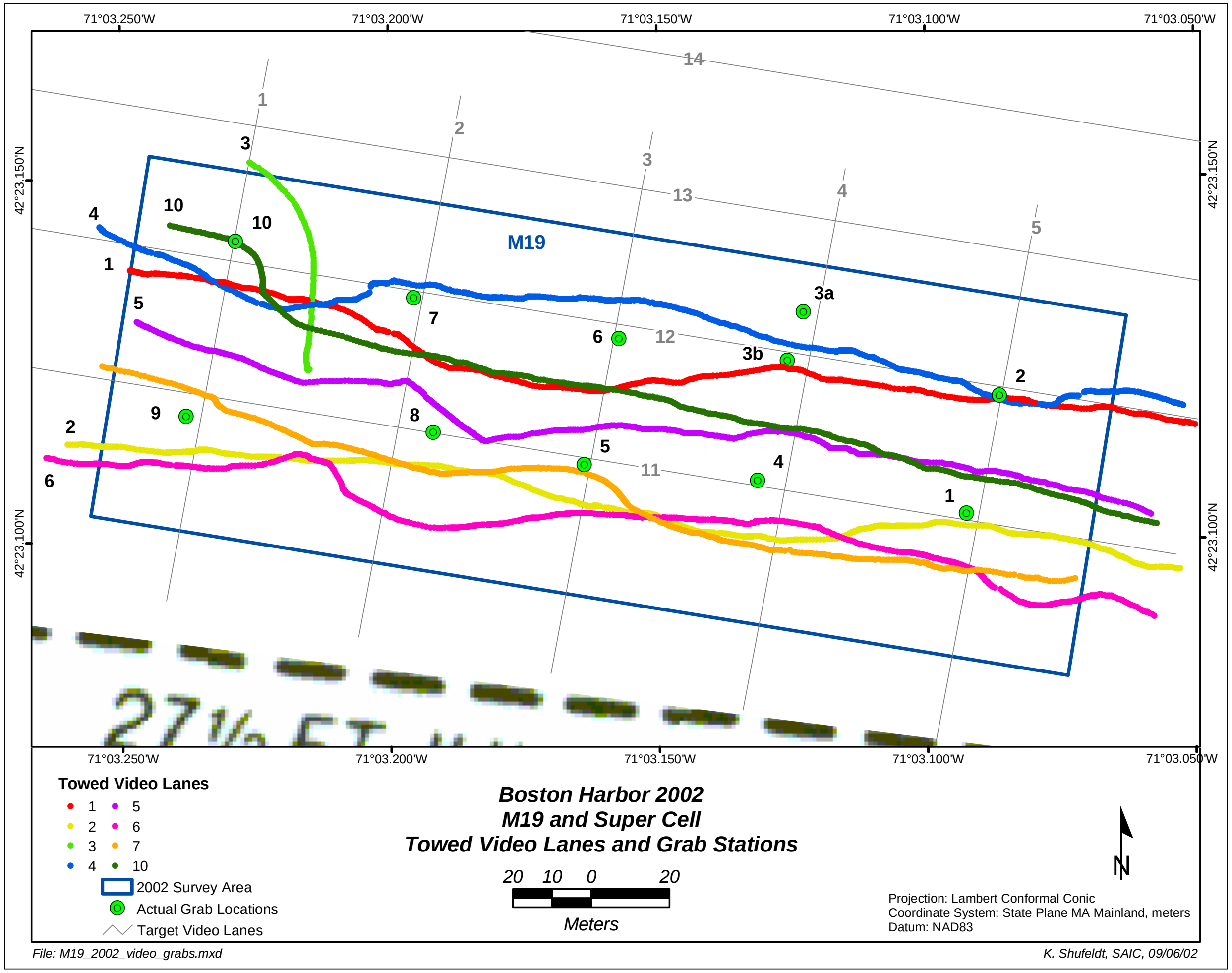


Figure 2-5. Target video transects established for the primary survey effort (gray) versus the actual track lines (colors) completed in July 2002, relative to the location of the sediment grab samples collected in the June 2002 field operation

Table 2-1.
Location of Sediment Grab Samples Collected During the Primary Survey

Grab Sample	Latitude	Longitude
	NAD 83	
1	42° 23.1036´ N	71° 03.0924´ W
2	42° 23.1198´ N	71° 03.0864´ W
3a	42° 23.1312´ N	71° 03.114´ W
3b	42° 23.1246´ N	71° 03.126´ W
4	42° 23.1084´ N	71° 03.134´ W
5	42° 23.1102´ N	71° 03.1638´ W
6	42° 23.1276´ N	71° 03.1572´ W
7	42° 23.1336´ N	71° 03.1952´ W
8	42° 23.115´ N	71° 03.1917´ W
9	42° 23.1174´ N	71° 03.2377´ W
10	42° 23.1414´ N	71° 03.2286´ W

Table 2-2.
Location of Sediment Grab Samples Collected During the Secondary Survey

Grab Sample	Latitude	Longitude
	NAD 83	
L1	42° 23.1092´ N	71° 03.1605´ W
L2	42° 23.109´ N	71° 03.155´ W
L3	42° 23.1027´ N	71° 03.1135´ W
L4	42° 23.1101´ N	71° 03.1309´ W
L5	42° 23.1183´ N	71° 03.1486´ W
L6	42° 23.1172´ N	71° 03.1657´ W
L7	42° 23.1056´ N	71° 03.1654´ W
L8	42° 23.1041´ N	71° 03.1457´ W
L9	42° 23.1005´ N	71° 03.1266´ W

modification of American Society for Testing and Materials (ASTM) Method D2488 for the description and identification of soils (visual procedure). The grabs were photographed with a digital camera prior to discarding the sediment sample. No subsamples from the individual grabs were retained for additional analysis.

3.0 RESULTS

The data obtained as part of the 2002 monitoring activity over Cell M19 were collected as part of two distinct survey operations. The findings of the primary survey performed in June and July 2002 prompted a more focused secondary survey effort over the eastern portion of Cell M19. The information from both surveys has been integrated in the subsections below to provide a summary of results for each type of data collected.

3.1 Single-Beam Bathymetry

The initial single-beam bathymetry survey was conducted concurrent with the side-scan sonar operations and based on 50 m lane spacing. These data indicated the depths within CAD Cell M19 ranged from 14.5 to 17.9 m, with an average depth of 15.5 m displayed within the majority of the cell (Figure 3-1). As anticipated, the shallowest regions within the CAD cell corresponded to the margins of the bottom feature. However, the bathymetric survey also displayed two depressions within Cell M19. These depressions were located in both the eastern and western portions of the cell, slightly south of the midline. According to the primary survey data (50 m lane spacing), the deepest depth recorded in the cell was in the western circular depression (17.9 m). Based on the results of the sidescan sonar survey as described in Section 3.2 below, a higher resolution, single-beam bathymetric survey (10 m lane spacing) was performed over the eastern portion of Cell M19 to investigate one of the bottom features identified in the primary survey. The higher resolution bathymetric data indicated water depths ranged from 15.5 to 16 m within the majority of the refined survey area. In addition, the August 2002 survey documented the presence of two bottom depressions within the eastern portion of Cell M19, the most prominent of which was detected within the southeastern quadrant of the cell (Figure 3-2). A smaller, less pronounced seafloor depression, displaying depths of 16.75 m, was identified in the northeastern corner of the cell. This smaller depression was approximately 1 m deeper than the water depths detected over the surrounding cell surface and likely resulted from uneven settling of sediment deposited within the cell as part of the BHNIP.

The location of the larger depression corresponded to the position of the bottom feature detected in the June 2002 survey. This seafloor depression appeared much more pronounced in the higher resolution data set relative to the primary survey, with depths ranging from 16.25 to 18 m (Figure 3-2). Measurements made along the 16.25 m contour indicated the trough was approximately 25 m wide and 110 m long, running parallel to the long axis of the CAD cell. A series of depth profiles were plotted with vertical exaggeration to facilitate examination of the feature, which appeared as a distinct trough within the CAD cell with a maximum depth of approximately 18 m, or 2.5 m deeper then the remainder of the CAD cell (Figure 3-3).

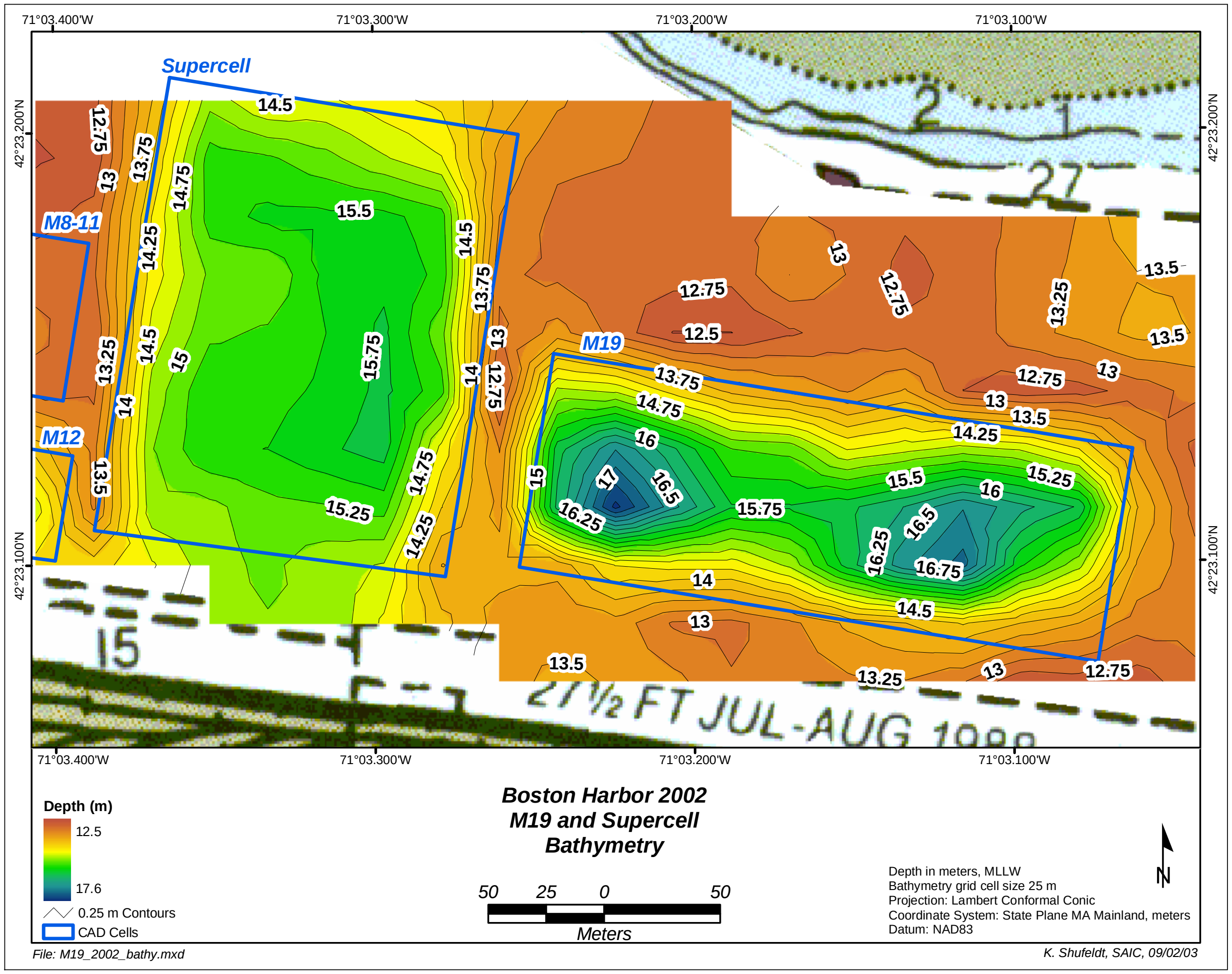


Figure 3-1. Bathymetric chart showing water depths within the survey area as detected during the primary survey effort (June 2002), 0.25 m contour interval. Depth contours are based upon data collected over survey lanes spaced at 50 m intervals.

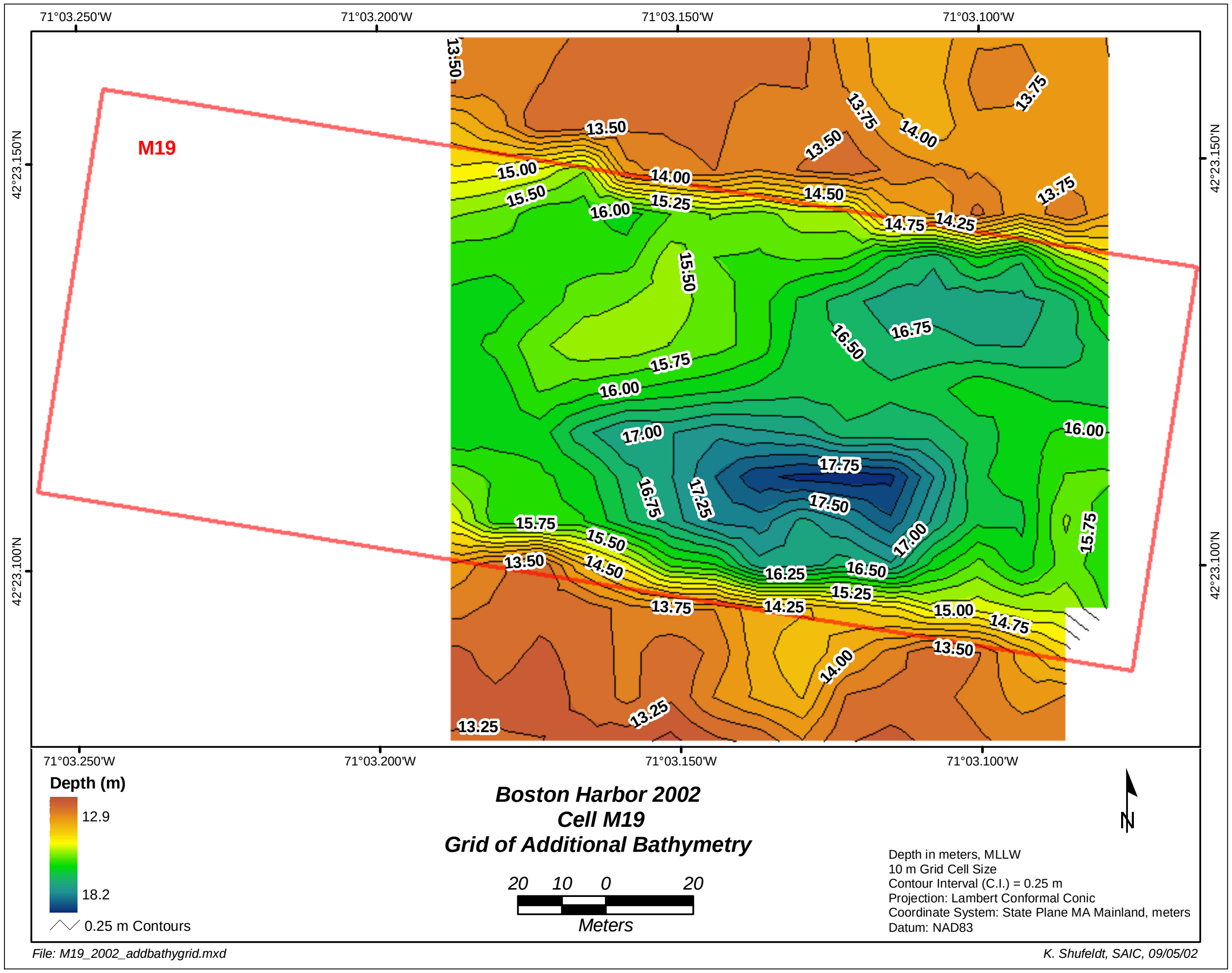


Figure 3-2. Bathymetric chart of the eastern portion of Cell M19 surveyed as part of the secondary field effort, 0.25 m contour interval

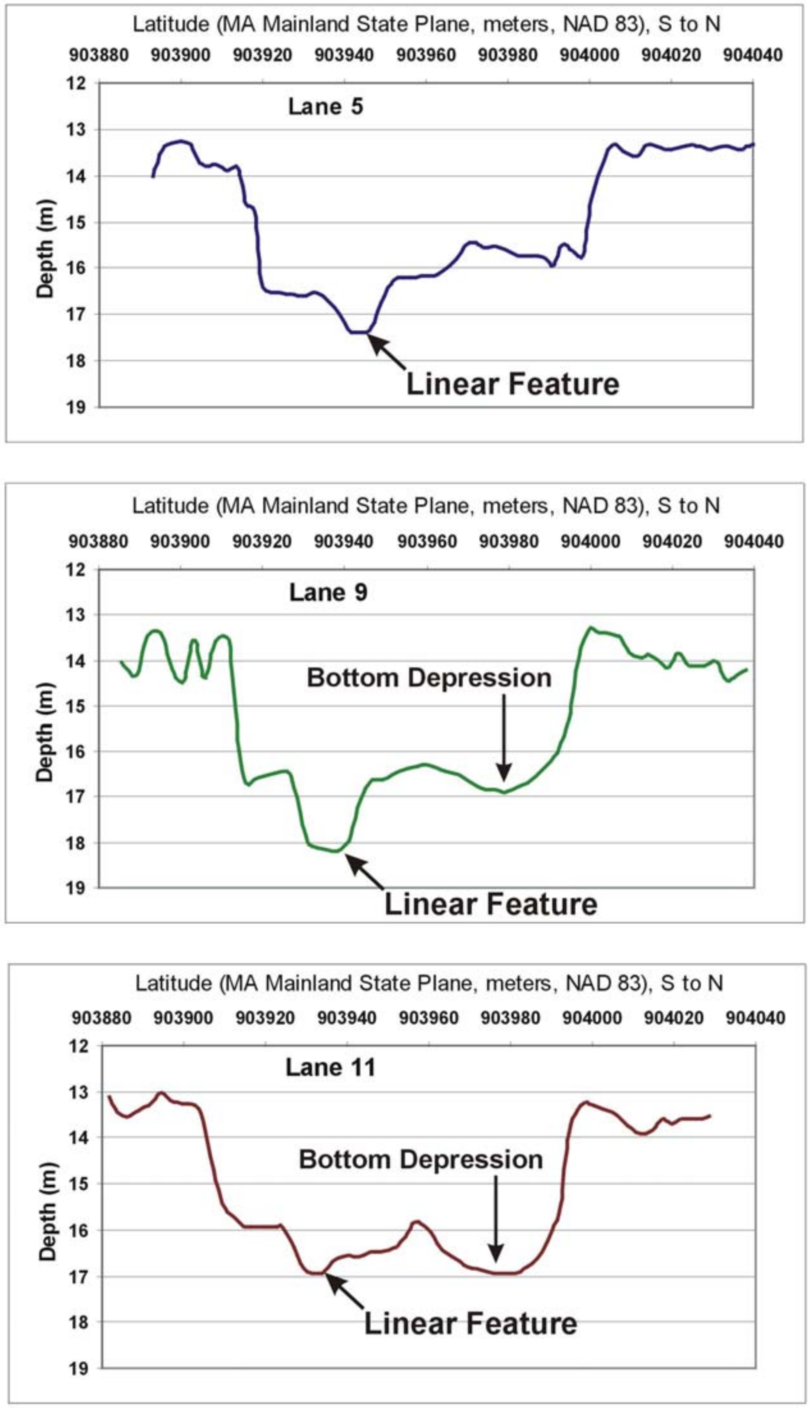


Figure 3-3. Profile plots of bathymetric data collected along Lanes 5, 9, 11 during the secondary survey showing the morphology of the linear feature and less pronounced bottom depression within the eastern portion of Cell M19, vertical exaggeration = 22.9

3.2 Side-Scan Sonar

The side-scan sonar imagery displayed both Cell M19 and the Supercell, as well as the various textures of sediment composing the seafloor within the Mystic River (Figure 3-4). The majority of surficial sediments within the CAD cells displayed similar acoustic reflection characteristics, indicative of a homogenous surface composed of sand. Areas outside the confines of the CAD cells displayed a highly reflective (i.e., dense), rough surface texture indicative of BBC disturbed by prior dredging activity. This rough texture was attributed to the use of a clamshell bucket on the surface of the clay and spud anchoring systems, creating pinnacles, pockets, and chunks of clay that remain after dredging. Because much of the estuarine sediment (unconsolidated silts and clays) was removed from Mystic River as part of the BHNIP, BBC had become the dominant material within the navigational channel. The acoustic reflection properties of BBC contrast with those of the smoother sand cap material within the CAD cells, which tended to differentiate the cells from the surrounding river bottom.

Cell M19 was completed in 2000 with the placement of a 1 m thick sand layer to serve as cap. Additional dredging activity adjacent to the cell occurred in the winter of 2002, with the material (primarily consolidated clay) removed with a clamshell bucket and placed in Cell M19 on top of the existing cap. Based upon the rough texture in the side-scan sonar mosaic, this material has apparently collected along the southern margin of the cell (Figure 3-5A). Two additional seafloor features were detected within Cell M19 in close proximity to the new BBC deposits, and included a distinct linear feature in the southeast quadrant of the cell and a circular depression located along the western boundary (Figures 3-5B and 3-5C).

Based upon the sonar data, the linear feature was approximately 90 m in length and 10 m wide. Located less than 10 m north of the new BBC deposit within Cell M19, the surface sediment within this feature appeared to be unique with regard to sonar reflection relative to other surfaces (sand and BBC) within the cell. The weaker sonar return corresponding to this feature could be the result of signal attenuation and suggested the surface sediment was composed of unconsolidated silt (Figure 3-5B). In addition, the side-scan data displayed a small ridge along the northern edge that casts an acoustic shadow over a portion of the feature. When the bathymetric data collected as part of the secondary survey were overlaid with the side-scan sonar imagery, a strong correlation between the location of the linear feature and the apparent bottom depression was noted (Figure 3-6).

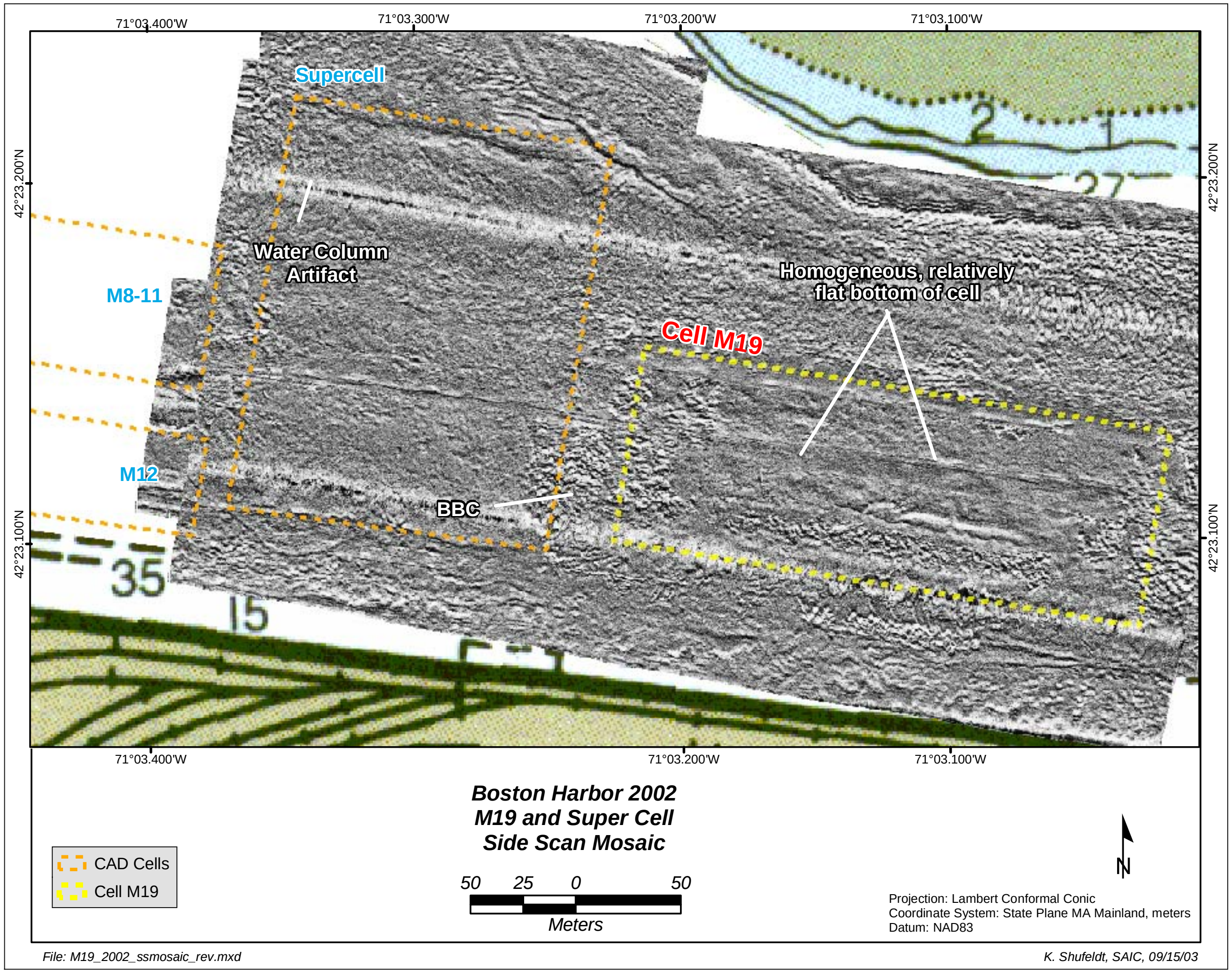


Figure 3-4. Side-scan sonar mosaic showing sediment type and texture within the entire survey area

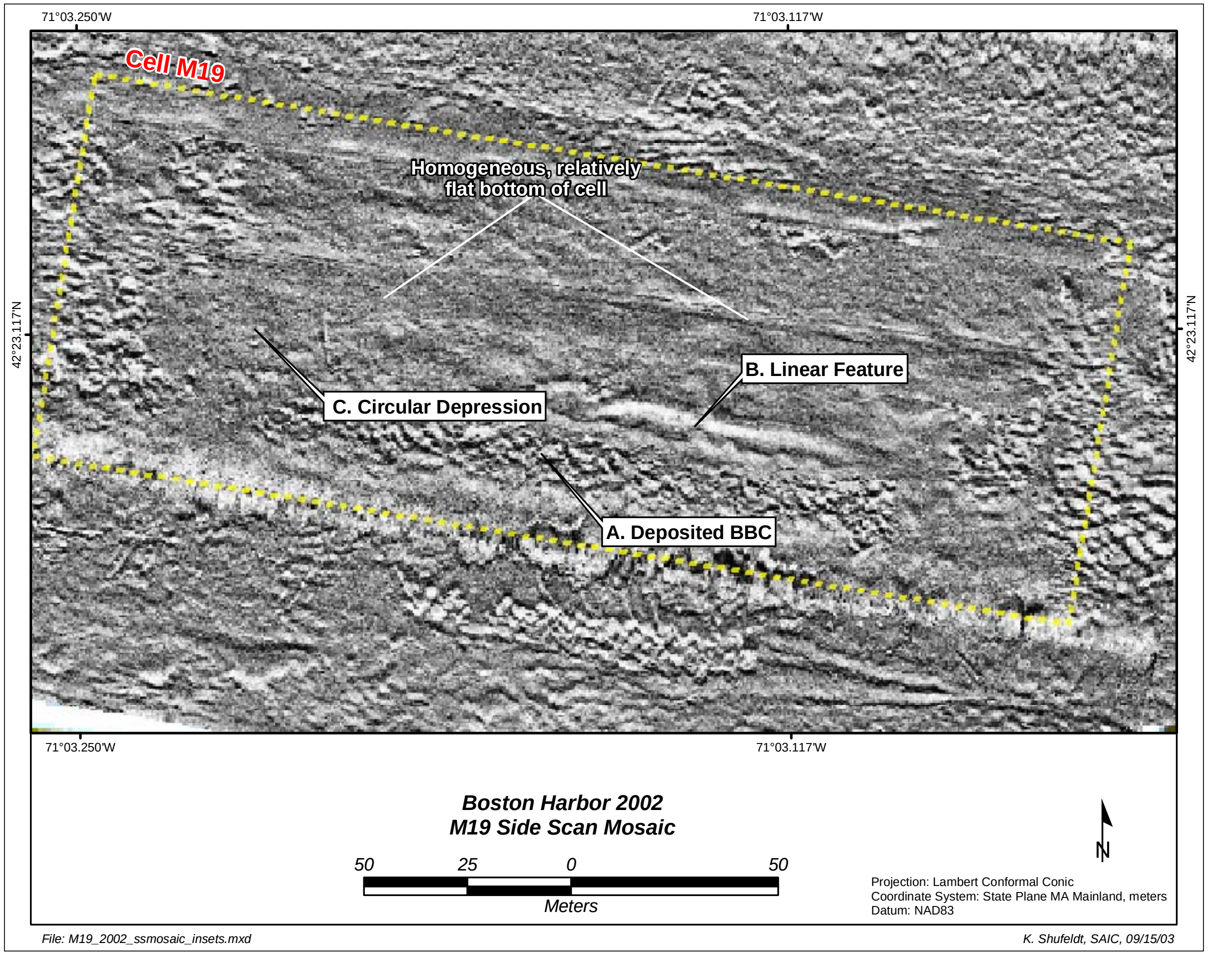


Figure 3-5. Side-scan sonar mosaic focusing on three particular areas of interest within Cell M19 displaying recently deposited BBC (A), a strong linear seafloor feature (B), and circular depression in the western portion of the cell (C)

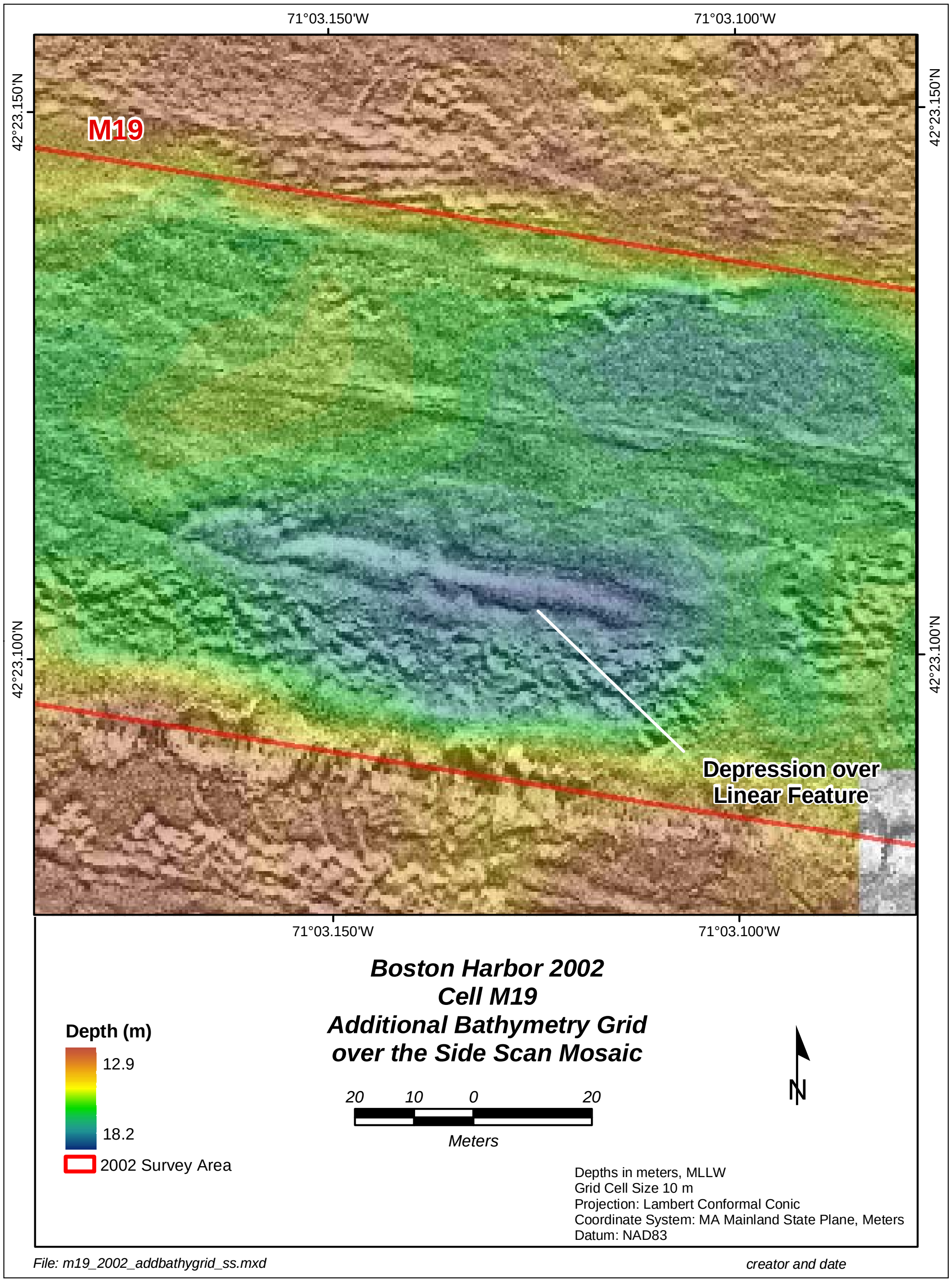


Figure 3-6. Side-scan sonar mosaic overlaid with the additional bathymetric survey data showing the correlation in depth measurements to the acoustic signature of the linear feature located in the southeastern quadrant of Cell M19

The side scan data collected over the western portion of Cell M19 suggested the surface sediments within the circular depression detected in the original bathymetric survey were composed of sand (Figure 3-5C). Despite the 1 to 2 m difference in depth, the sonar returns from this area of seafloor displayed the same reflective qualities as those observed within the majority of the CAD cell. However, the origin of this feature cannot be determined based solely on the data collected as part of the 2002 monitoring surveys.

3.3 Sediment Grab Sampling

Eleven sediment grab samples were collected from ten stations located throughout the cell as part of the primary survey. Table 3-1 lists each sample description, and digital images of the individual samples are included in Figure 3-6. Station 3 was sampled twice; Grab 3A was collected just outside of the 10 m sampling radius, while 3B was within the target area. Both grabs were photographed and described to illustrate the small-scale variability within the cell.

Although the individual grab samples varied in thickness and composition, the majority of the grab samples contained sand. Grabs 6, 7, and 8 contained tan, sand cap material with no evidence of a surface depositional layer of silty clay. Grab 10 also contained sand, with a few chunks of BBC on the surface, presumably due to the location of the sample relative to the western wall of the CAD cell (Figure 3-7). Grabs 1, 2, and 3B all contained a surface layer of silty clay over sand. Thickness of silty clay ranged from 2 to 8 cm above approximately 18 to 20 cm of sand. Grab 5 had similar silty clay over sand layering, but the silty clay layer on the surface was substantially thicker (15 cm) and may be part of the additional dredged material recently placed within the cell (Figure 3-7). Grabs 3A and 9 contained all BBC, which was likely attributable to the proximity of each sample relative to the cell walls. Grab 4 was unique in that it did not contain any sand or BBC, but displayed wet, silty clay throughout (25 cm depth; Figure 3-3). Overall, the grab samples collected in the northern portion of the cell (Stations 2, 3, 6, 7, and 10) contained primarily sand, while samples collected along the southern portion contained a mix of sediments including oxidized silty clay over sand, BBC, and black silty clay.

As part of the secondary survey effort, an additional nine sediment grab samples were collected within and adjacent to the linear bottom feature located in the southeastern quadrant of Cell M19. All of the grab samples collected in close proximity to this linear feature contained a surface layer of oxidized, greenish-tan to black silty clay, with the thickness of the oxidized layer varying from station to station (Table 3-2; Figure 3-8). Three grabs were collected from within the linear feature (Grab L1, L2, and L3; Figure 3-8). Grab L1 was primarily wet, very soft, silty clay.

Table 3-1.
Descriptions of Grab Samples Collected During the Primary Survey

Lab Analysis Date(s):	6/26/2002
Lab Technician(s):	Walter & Cole
Site_Name	Boston Harbor
Survey_name	2002 M19 Survey
Data_Type	visiual description/grabs

Sample_ID	Top Depth (cm)	Bottom Depth (cm)	SAIC_lab_description
Grab 1	0	5	greenish black to brown, no odor, wet, soft, silty CLAY
Grab 1	5	25	greenish black to gray, no odor, moist, hard, SAND
Grab 2	0	8	dark gray-black, no odor, wet, soft, silty CLAY
Grab 2	8	25	dark gray, no odor, wet, hard, SAND w/ shell fragment (CAP)
Grab 3A	0	15	chunks of BBC w/ tubes on the surface
Grab 3B	0	2	greenish- brown to tan, no odor, wet, very soft, silty clay
Grab 3B	2	20	dark gray to tan, no odor, moist, hard, SAND w/ BBC noduls
Grab 4	0	25	brown oxidized layer over black, no odor, wet, very soft, silty CLAY (ambient or DM?)
Grab 5	0	15	brown oxidized layer over black, petroleum odor, wet, very soft, silty CLAY (ambient or DM?)
Grab 5	15	25	dark gray to black, no odor, moist, hard, SAND
Grab 6	0	25	brown to tan, no odor, wet, soft-firm, clayey SAND with shell fragments (CAP)
Grab 7	0	25	brown to tan, no odor, wet, soft to firm, clayey SAND (CAP)
Grab 8	0	25	split surface sediment type 1: brown to black, no odor, wet, very soft, silty CLAY (ambient/DM like) type 2: dark gray to tan, no odor, moist, hard, clean SAND (CAP)
Grab 9	0	15	BBC w/ tubes on surface
Grab 10	0	25	brown to tan, no odor, moist, hard, SAND (CAP) w/ a few chunks of BBC at surface

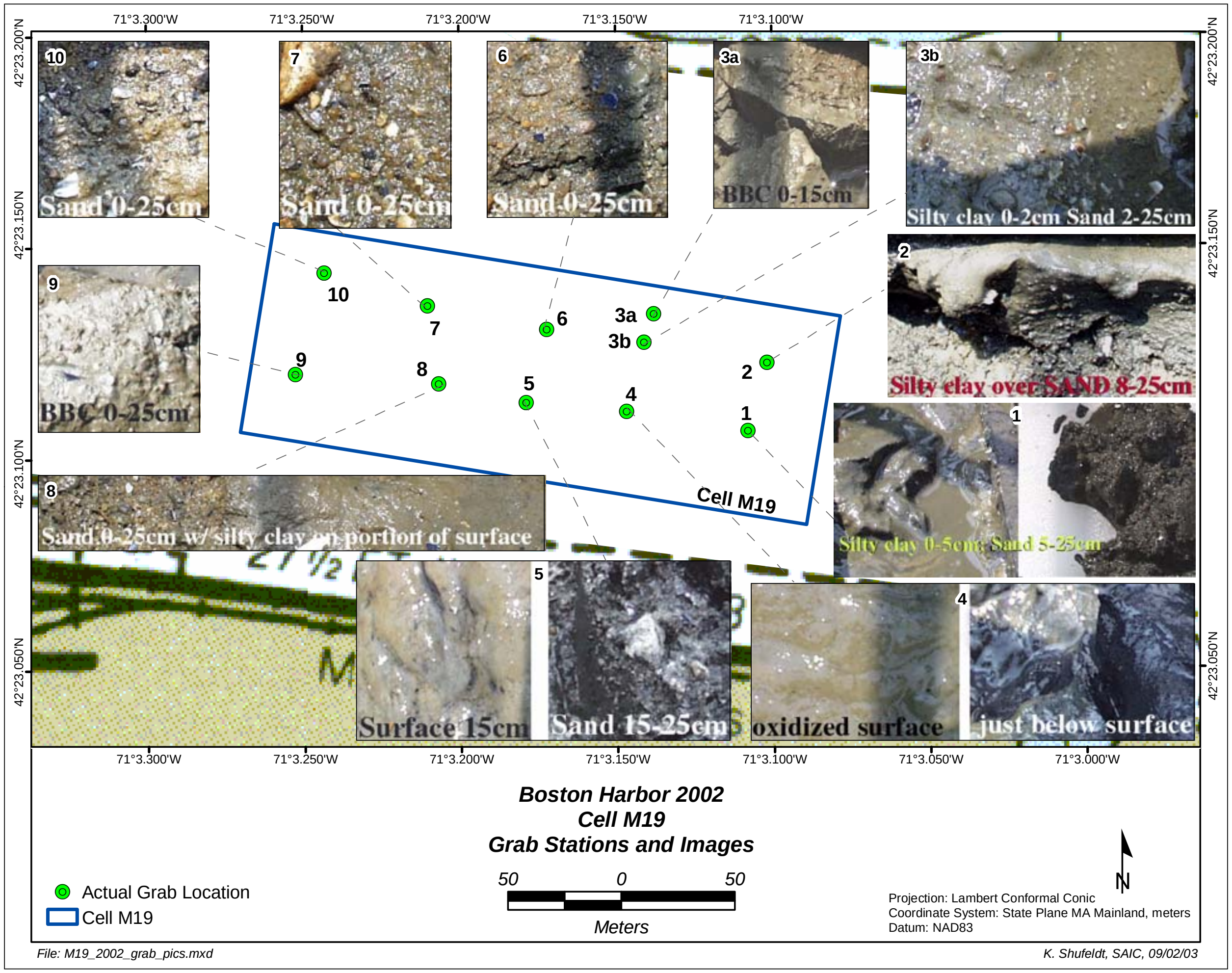


Figure 3-7. Images of the sediment acquired within the individual grab samples collected as part of the primary survey effort, relative to the sampling locations within the cell

Table 3-2.

Descriptions of Grab Samples Collected During the Secondary Survey

<u>Lab Analysis Date(s):</u> 8/27/2002
<u>Lab Technician(s):</u> Walter
Site_Name Boston Harbor
Survey_name 2002 M19 Survey
Data_Type visiual description/grabs

Sample_ID	Top Depth (cm)	Bottom Depth (cm)	SAIC_lab_description
Grab L1	0	15	oxidized greenish tan to black, no odor, wet, very soft, silty CLAY with 1-5% sand intermixed
Grab L2	0	15	oxidized greenish brown to black, no odor, wet, very soft, silty CLAY
Grab L2	15	20	greenish black to gray, no odor, moist, firm, SAND
Grab L3	0	15	greenish- brown to black, no odor, wet, very soft, silty clay
Grab L4	0	5	oxidized brown to black, no odor, wet, very soft, silty CLAY
Grab L4	5	10	gray, no odor, moist, hard SAND with shell fragments
Grab L5	0	6	oxidized tan-black, no odor, wet, very soft, silty CLAY
Grab L5	6	9	gray, no odor, moist, hard, SAND with shell fragments
Grab L6	0	4	oxidized tan-black, no odor, wet, very soft, silty CLAY
Grab L6	4	14	gray, no odor, moist, hard, SAND
Grab L7	0	6	oxidized tan-brown, no odor, wet, very soft, silty CLAY
Grab L7	6	8	black, petroleum odor, wet, very soft, sitly CLAY
Grab L7	8	12	black, petroleum odor, moist, hard, SAND
Grab L8	0	1	tan, no odor, wet, very soft, silty CLAY
Grab L8	1	11	black, no odor, wet, very soft, silty CLAY
Grab L8	11	13	mixed: black, petroleum odor, wet, soft, silty CLAY and dark gray to black, SAND
Grab L9	0	15	greenish-brown and black, no odor, wet, very soft, silty CLAY
Grab L9	15	20	black, wet, soft, sandy silty CLAY

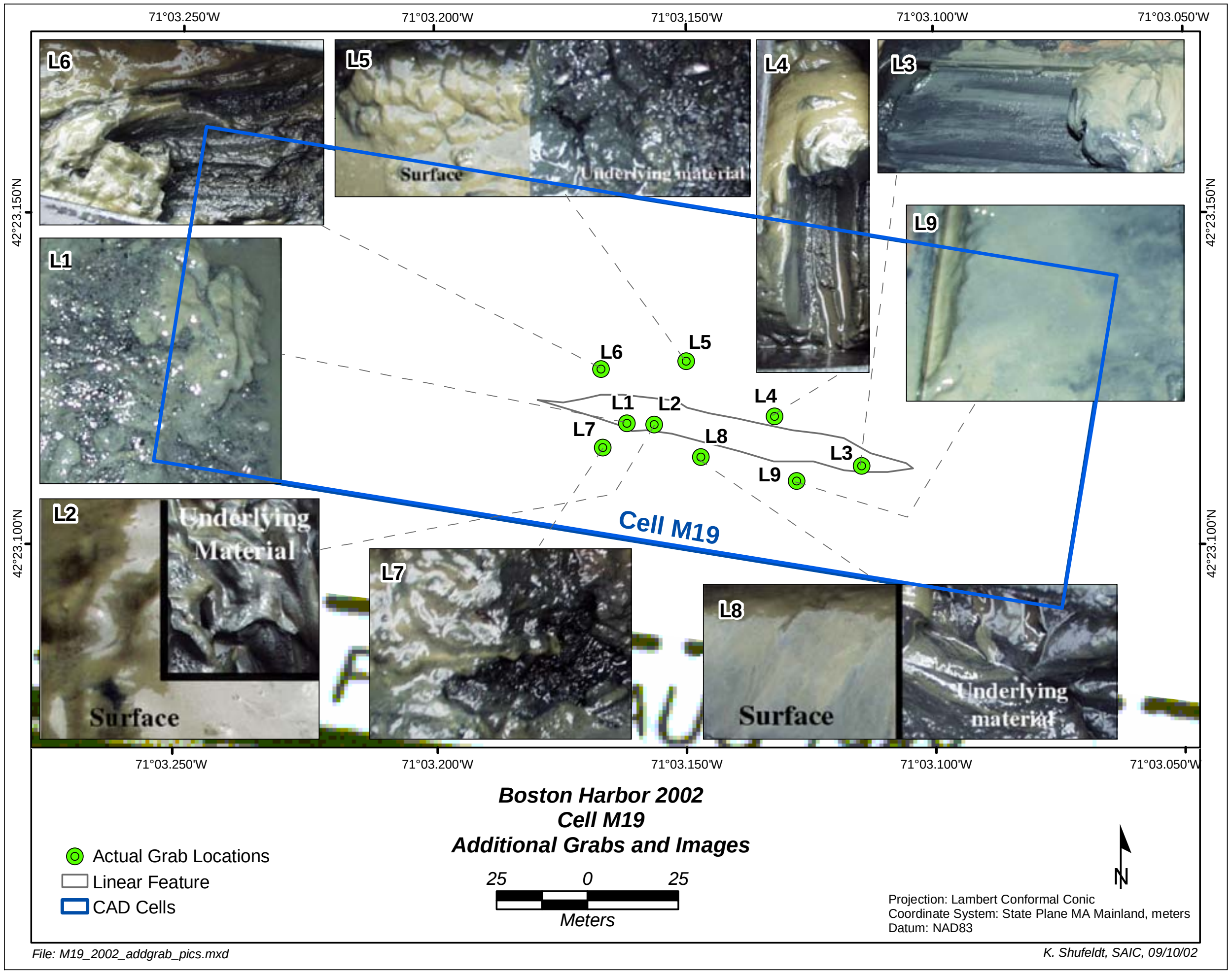


Figure 3-8. Images of the sediment acquired within the individual grab samples collected as part of the secondary survey effort, relative to the sampling locations and linear feature identified within Cell M19

However, Grab L1 also contained trace amounts of sand and shell fragments. Grab L2 contained a 15 cm thick layer of silty clay over a layer of dark sand, which was detected below 15 cm interval and continued to the limits of penetration. Grab L3 contained primarily black silty clay, with a thin (<3 cm) layer of oxidized silty clay, and no indication of sand (Table 3-2).

Grabs L4, L5, and L6 were collected to the north of the linear feature (Figure 3-8). All three of these samples contained a 4 to 6 cm thick layer of oxidized silty clay over a layer of gray sand likely in excess of 10 cm thick (Table 3-2). All three samples collected north of the linear feature were limited in penetration due to the underlying sand cap.

Grabs L7, L8, and L9 were collected south of the linear feature (Figure 3-8). Grabs L7 and L8 both contained some sand. Grab L7 contained three distinct layers: a 6 cm thick oxidized silty clay over black, silty clay, on top of a layer of black sand. Both the sand and the black silty clay above it emitted a strong petroleum odor and were similar to the sediment placed in the CAD cell prior to capping. Grab L8 displayed similar results, with three distinct layers detected. However, the surface layer of oxidized, silty clay was very thin (1 cm) over an interval of black silty clay. A layer of black silty clay and sand was observed in the grab sample at 11 to 13 cm penetration. Grab L9 did not contain any sand and had a thick (15 cm) layer of oxidized silty clay over black silty clay.

The surface sediments observed in the grab samples showed relatively consistent conditions based on location with respect to the trough disturbance area. Grab L3 was collected near the deepest portion of the trough, in 17.75 m of water, and indicated that the surface in this region consisted of silty clay with no evidence of sand. Grabs L4, L8, and L9 were collected from an area surrounding the linear feature with a water depth of approximately 17 m, and yielded a 5 to 15 cm layer of silty clay over either sand or a mixture of sand and silty clay. Grabs L1 and L2 were also collected in depths of approximately 17 m and contained both silty clay and sand. Grab L1 contained highly mixed sand and silty clay, while Grab L2 contained a 15 cm thick layer of silty clay over sand.

Grabs L5, L6, and L7 were all collected from areas less then 16.25 m deep and approximately 10 m outside of the linear feature. All of these grabs (L5, L6, and L7) contained less than 6 cm of silty clay over a layer of sand likely in excess of 10 cm thickness.

3.4 Towed Video

The towed video survey was conducted in July 2002 as part of the primary survey effort to document the composition of surface sediments within Cell M19. A series of eight transects were occupied in and around the CAD cell. Upon review of the video data, the CAD cell sediments were classified into six categories:

1) Oxidized Silty Clay—soft surface sediments with limited or no shell fragments apparent. Frequently this surface condition was viewed as a small cloud of sediment at the leading edge of the video camera (Figure 3-9A).

2) Oxidized Silty Clay and Shell Fragments—a veneer of soft surface sediments (silty clay) over a thick shell layer. These areas were believed to consist primarily of cap material (Figure 3-9B).

3) Oxidized Silty Clay and Boston Blue Clay—softer silts and clays surrounding various-sized BBC nodules on the surface of the CAD. BBC originated from the CAD cell construction as well as the dredging of the surrounding shoals (Figures 3-9C and 3-9D).

4) Sand—an indication of cap with no noticeable accumulation of silty clay (Figure 3-10A).

5) Shell Fragments—an indication of cap material and frequently armoring the surface of the CAD (Figure 3-10B).

6) Boston Blue Clay (BBC)—the basement material of Boston Harbor as well as the sidewalls of the CAD cell. The additional dredging placed BBC in the southern portion of the CAD frequently resulted in pinnacles of BBC (Figure 3-11).

Individual transects are displayed as color-coded track lines in Figure 3-12 from a plan view perspective. Each transect was run by drifting along the desired transect with minimal navigation adjustments with the survey vessel engines. When the engines were utilized to maintain alignment, the camera lost focus, resulting in missing sections of transect lanes. Video transects indicated the presence of fine silty clays at the surface, as well as extensive BBC in the southern end of the cell, while sand, shell fragments, and other indicators of cap material were present along the northern portion of the cell (Figure 3-12). Although multiple transects were run along the east-west axis to provide the desired bottom coverage, no video transects ran directly over the linear feature noted in the side-scan sonar survey.

A. Soft bottom covered in oxidized silty clay

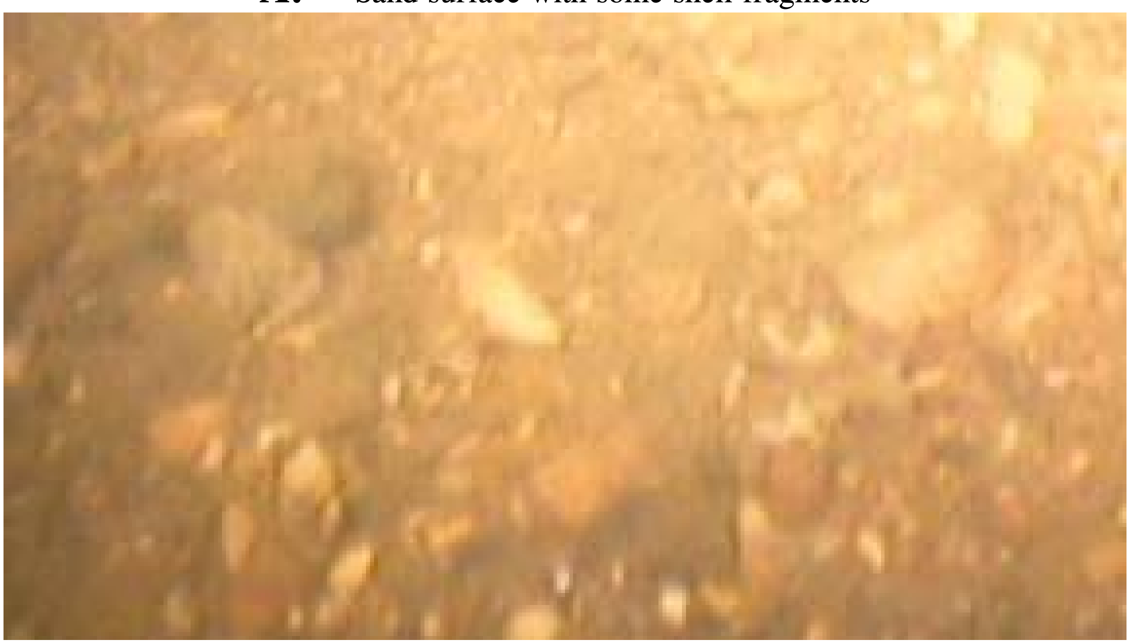
C. Small nodules of BBC surrounded by oxidized silty clay

B. Oxidized silty clay with some shell fragments

D. BBC nodules surrounded by oxidized silty clay

Figure 3-9. Example images obtained from the towed video footage showing the various non-cap sediment types encountered during the July 2002 survey

A. Sand surface with some shell fragments



B. Shell fragments

Figure 3-10. Example images obtained from the towed video footage showing the various sediment types defined as cap material encountered during the July 2002 survey

Figure 3-11. Pinnacle of BBC located at the margin of Cell M19. The surface of the cohesive clay clumps have been heavily colonized by tubicolous polychaete worms, which filter feed from the water column

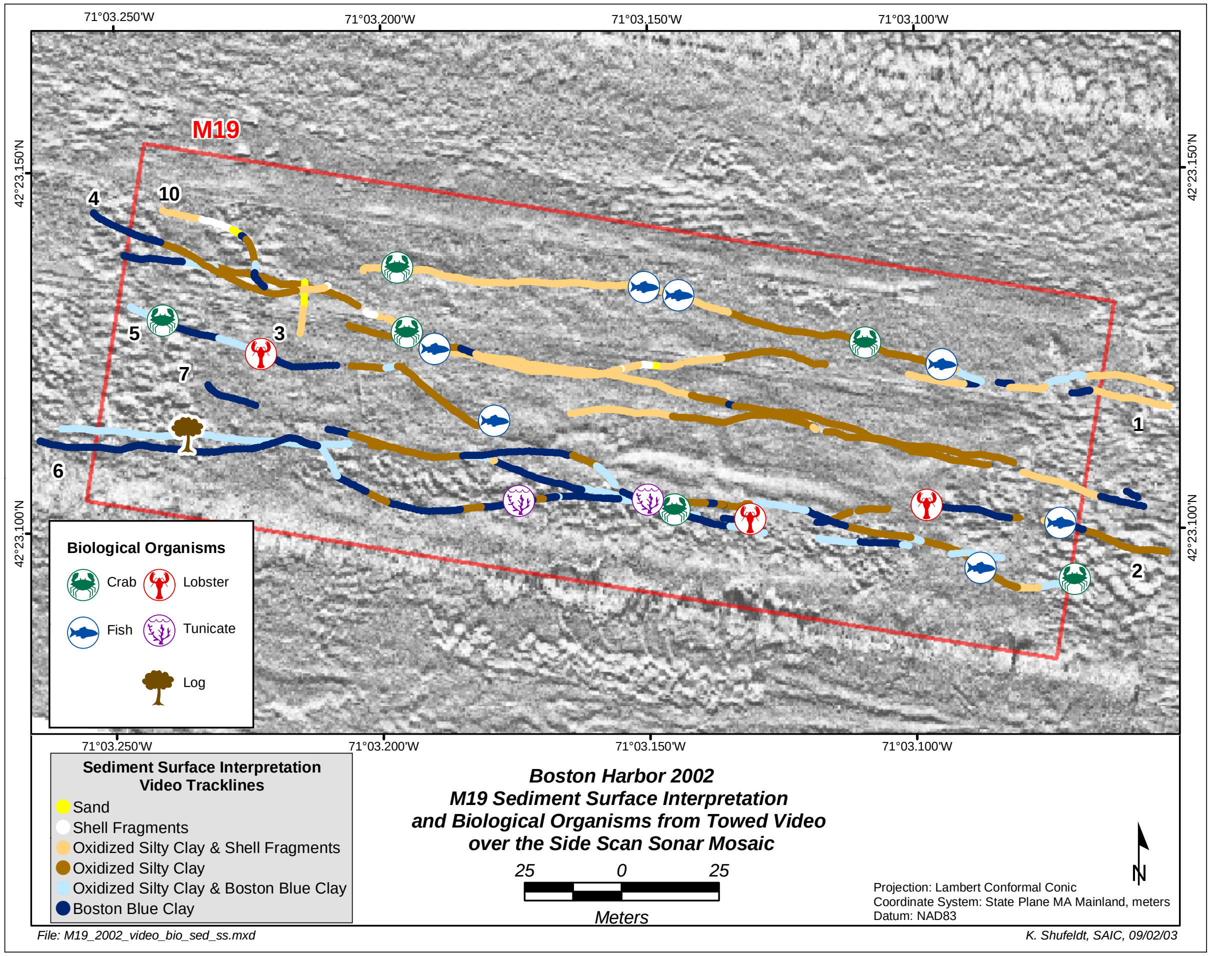


Figure 3-12. Interpretive map of video imagery showing types of sediment and organisms encountered along individual track lines relative to location within Cell M19. Side-scan sonar is used as a background layer to demonstrate the correlation between sediment texture and composition.

Overall, the video data suggested a veneer of oxidized silty clay existed at the sediment-water interface within the entire cell. In general, fine silts and clays were present throughout the cell as well as sand and shell fragments. The cell was divided into two major surface types: 1) the cap-like sand and shell; and 2) the oxidized silty clays and BBC (Figure 3-12). The northern portion of the cell contained sand and shell fragments frequently covered in a thin layer of silty clay. The video collected over the southern portion of the cell was dominated by oxidized silty clay; frequently the silty clay surrounded nodules of BBC. There were areas of BBC along the cell boundaries as well as along the entire southern edge of the cell. The BBC along the southern edge of the cell was presumed to be the result of the dredging of the shoals in the vicinity of Cell M19.

The most notable surface disruptions detected in the video collected within Cell M19 were the tracks left in the surface sediment by the video sled on previous transits. Otherwise no distinct surface disturbances, pits, or crevasses were noted in the towed video. The linear feature detected in the side-scan sonar was not covered by any of the towed video lanes (Figure 3-12). However, sediments adjacent to this feature were classified as silty clays intermixed with BBC.

Although the primary objective of the towed video analysis was to document the condition of the surface sediments within the CAD cell, biological activity that was observed was also recorded during analysis. Various species of macrofauna were identified in the video record with example images provided in Figure 3-13. Figure 3-12 indicates individual species seen, as well as a reference to the location. Fish were frequently seen darting in front of the camera, many so quickly that species could not be identified. Both small and large benthic species (likely flounder) were noted as they emerged from the oxidized silty clay in front of the approaching video sled (Figure 3-13A). Lobsters were most frequently noted between BBC pinnacles, and were seen in sandy areas of the CAD cell as well (Figure 3-13B). The video record also documented the presence of lobster fishing gear running the length of the Cell M19. Tunicates were present throughout the cell and were often moved or suspended by the passage of the video camera (Figure 3-13C). Various species of crabs were observed, including spider crabs and blue crabs (Figure 3-13D).

A. Flounder stirring up the soft oxidized silty clay surface sediment

B. Shell fragments with lobster in upper right hand corner of image

C. Tunicate sitting on soft oxidized sitly clay; suspended cloud of silty clay approaching in front of camera

D. Spider Crab hanging onto a chunk of BBC

Figure 3-13. Example images obtained from the towed video footage showing the various organisms detected within Cell M19 during the July 2002 survey

4.0 DISCUSSION

The objective of the Summer 2002 survey over Cell M19 was to verify that no large-scale features existed within this CAD cell that would indicate a major disruption of the cap. Based on all of the 2002 survey results, the majority of cap layer within Cell M19 appears to be intact. Side-scan sonar, sediment grab sampling, and towed video data indicate that the northern portion of the CAD cell remains covered in sand and shell hash with minimal oxidized silty clays accumulating along with shell hash from natural deposition. As anticipated, there are distinct areas of BBC and silty clay on the surface of the CAD along the southern portion of the cell. This material appears to be supported by the capped cell and is presumed to be the product of dredging activity over nearby shoals. Based on observations of BBC over sand in grab samples from this area, and lack of any evidence of the original dredged material placed in the cell prior to capping, the newly deposited dredged material does not appear to be having any impact on the integrity of the sand cap. The presence of the prominent trough feature and a broader depression in the eastern portion of the cell prompted more detailed surveys to ensure cap integrity in these areas of the cell.

Side-scan sonar collected as part of the primary survey effort detected the presence of a strong linear feature in the southeastern quadrant of Cell M19. The origin of this feature is currently unknown. It is located approximately 10 to 15 m north of the new BBC deposit that resulted from recent dredging/disposal activity adjacent to M19.

The results of the secondary, more detailed survey effort over the eastern portion of the cell indicated a significant increase in depth and a change in the surface sediment characteristics associated with the linear feature. The detailed bathymetric data collected in August 2002 indicated it was a trough with a maximum depth of 18.2 m. The grab samples collected within the trough did not yield the sandy surface noted in previous surveys performed over this CAD cell (SAIC 2001). A layer of black silty clay, similar to the ambient sediments of the Mystic River as well as the sediment placed in the CAD prior to capping, was collected in many of the grab samples. This material was observed in layers of various thickness and appeared to be limited to the area immediately surrounding the linear feature, indicating that the extent of the substrate disturbance was limited. The grabs collected within the linear feature contained up to 25 cm of silty clay, while samples collected just north or just south of the linear feature contained a substantially thinner layer of silty clay over a layer of sand.

Given the limited penetration of the grab sampling device (maximum of 25 cm), the depth to which the surface layer of silty clay extends within the center of the trough is unknown. As a result, whether the cap has been disturbed in this area of the cell was not determined from data collected as part of this survey. It is recommended that this linear feature be examined further. Additional analysis, including multibeam bathymetry and vibracoring over the cell, would provide the data needed to further define the linear feature and the impact of the feature on the surface of the CAD. Multibeam would provide more detailed information on the topography of the trough and lateral limits of disturbance, and vibracores would provide a clearer indication of the degree of disturbance to the 1 m sand cap originally placed in the cell. This information would be useful in determining if corrective measures are warranted to ensure a functioning cap in this area, and if so, what kind of measures would be suitable.

Apart from the linear feature identified in the southeastern quadrant, single-beam bathymetry detected two other areas of interest described as minor seafloor depressions within Cell M19 (Figure 4-1). One of the depressions was located within the southwestern portion of M19 and the second in the northeast corner of the CAD cell. When viewed by side-scan sonar, sediment grab samples, and towed video the surface sediment over these minor depressions in the northeast corner of Cell M19 appeared to have reasonably homogenous surfaces with no evidence of cap breaching. It is presumed that these seafloor depressions have been caused by subsidence and consolidation within the underlying dredged material rather than disturbance of the sand cap layer.

Early CAD cell investigations performed over the 1997 Inner Confluence CAD cell indicated that the surface of the CAD cell could take on the topography of the BBC basement material at the bottom of the cell (SAIC 1997). As the dredged material within the capped cell consolidates the surface topography would begin to mirror the topography of the firm basement material (Figure 4-2). A time-series comparison using the bathymetric data set compiled for Cell M19 during the construction, filling, and capping process would need to be performed to verify that consolidation of the dredged material over deeper areas within the CAD cell is driving the formation of the seafloor depressions. However, based on the results of the recent surveys in the cell, formation of the depressions does not appear to be affecting the integrity of the sand cap.

Side-scan sonar and video data from transects completed over the southeastern portion of the cell indicated that oxidized silty clays, BBC, and sand exist within that seafloor depression. This finding was expected given the recent placement of dredged sediments along the southern boundary. However, it is not possible to determine if the recent addition of dredged material caused or expedited the formation of this depression, since it may have existed prior to the placement of additional dredged material. As monitoring of M19 continues in the future, studies should include evaluations of this area to ensure the BBC deposits are not displacing sand cap material over time and affecting the cap function of isolating the finer-grained dredged material below.

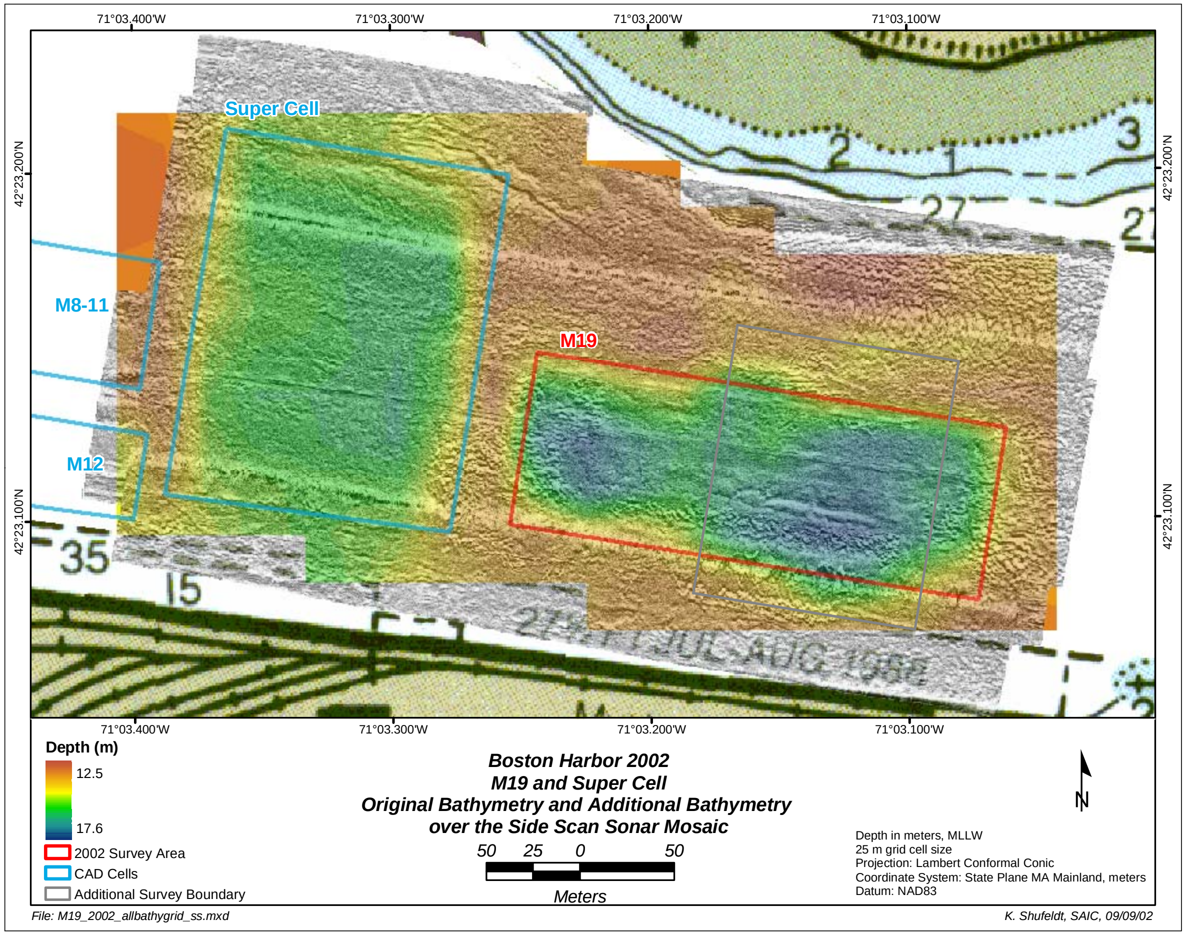


Figure 4-1. Combined bathymetric survey grids overlaid with the side-scan sonar mosaic showing correlation of depth information and seafloor texture

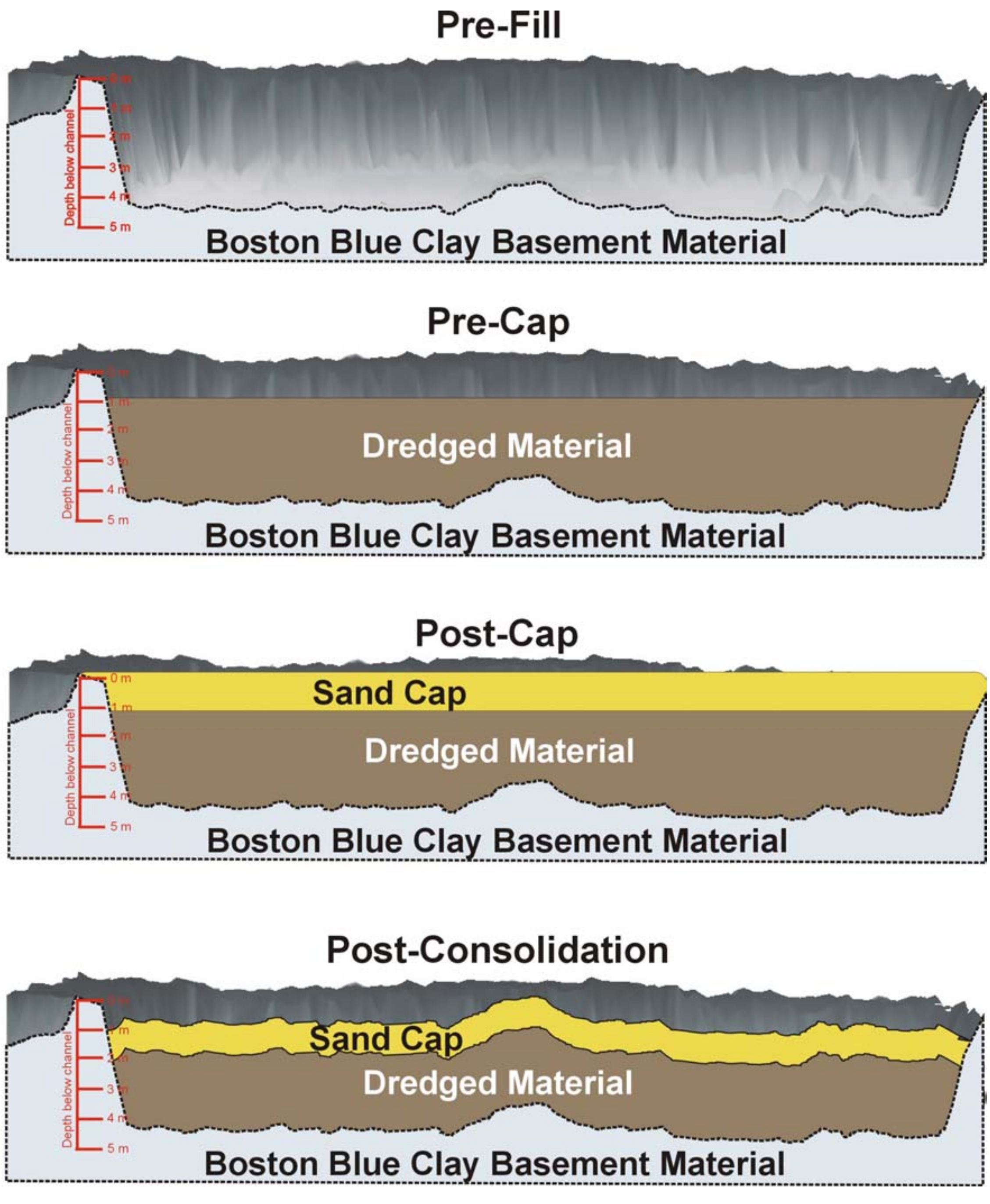


Figure 4-2. Schematic diagram showing consolidation pattern within a CAD cell that would likely result in the formation of seafloor depressions. Actual pre-fill bathymetric data from Cell M19 were used to represent the morphology of the Boston Bluer Clay basement material

The towed video imagery documented the presence of various forms of macrofauna within Cell M19 approximately two years post-completion. Multiple species of fish and crabs were seen interacting with the surface sediments within the cell. The identification of several lobsters and the presence of lobster fishing gear within the video record suggest the CAD cell areas may be relatively productive, and offer a source of forage for these larger invertebrates. The firm BBC clumps within the cell and surrounding area appear to be supporting large populations of tubiculous polychaetes worms. These filter-feeding, tube-dwelling worms live in dense colonies and may serve as a food source for lobster and finfish inhabiting the lower Mystic River.

5.0 CONCLUSIONS

- Based on the side-scan sonar and video imagery, deposits of recently placed dredged material were detected within Cell M19, generally in a limited area along the southern boundary of the CAD cell. The sand cap that was in place prior to the deposition of this new material has been covered, but is apparently capable of physically supporting these sediments. Cap integrity within the immediate area does not appear to have been affected by the placement of this additional dredged material in the cell.

- A deeper, linear feature was detected in the southeastern quadrant of the cell, approximately 10 to 15 m north of the new BBC deposits. The linear feature is a distinct trough and comprises the most significant feature noted in both side-scan sonar and bathymetry data sets for the cell. The origin of the trough is currently unknown and could not be determined from the survey data. Based on single-beam bathymetry, this feature is 110 m long and 10 to 25 m wide with water depths 1.5 m to 2.5 m deeper than the remainder of the cell.

- The linear feature runs parallel to the BBC deposits formed along the southern edge of the cell and may be the trench EPA divers reported while retrieving the sampling gear in the spring of 2002. Sediment grab samples yielding material similar to the Mystic River dredged material originally placed in the cell beneath the sand cap suggest that cap integrity in close proximity to this linear feature may be compromised or rapid sedimentation in this very deep depression is occurring. Nonetheless, further investigation of this bottom feature within Cell M19 is recommended in future surveys.

- Two roughly circular bottom depressions were identified within Cell M19 and indicate areas within the CAD where sediments have compressed and settled. The first depression was located in the southwest quadrant of the cell adjacent to new deposits of BBC along both the western wall and southern boundary of the CAD cell. A second depression was identified in the northeastern quadrant of the cell.

- The surface depressions within the CAD cell were likely the product of consolidation of capped dredged material and the resulting "mirroring" of the topographic features in the basement material comprising the floor of the CAD cell as noted in postcap surveys performed over the 1997 Inner Confluence CAD cell. Although a formal comparison to the pre-disposal cell configuration has not been done, minor variations in consolidation across the cell are not expected to affect the integrity and function of the sand cap.

- Various forms of macrofauna have apparently colonized the substrate within Cell M19. Based upon the number of finfish, crabs, and lobsters, as well as the presence of lobster fishing gear within the CAD cell, this area appears to be a relatively productive area of seafloor.

6.0 REFERENCES

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