Post-Storm Monitoring Survey at the New London Disposal Site Seawolf Mound October 2002

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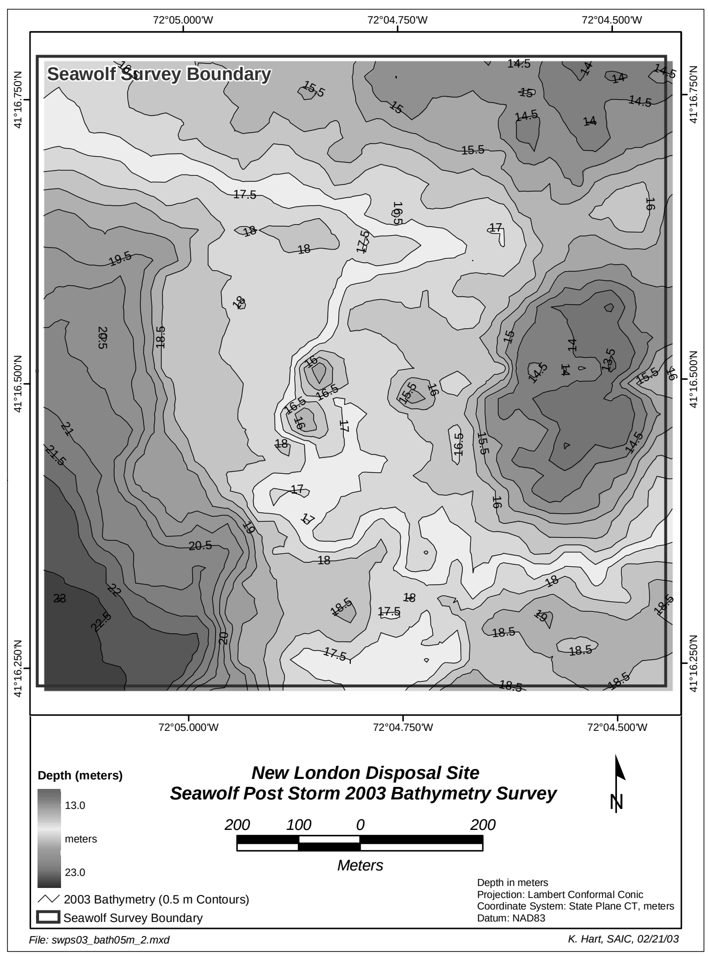

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13. ABSTRACT

The Seawolf Mound is a capped dredged material disposal mound developed in the northwestern quadrant of New London Disposal Site (NLDS) in 1995-96 as the product of a large improvement dredging project in the Thames River, as well as several smaller maintenance dredging projects in adjacent harbors. In accordance with the comprehensive environmental monitoring plan established for the Seawolf Mound prior to initiation of the dredging projects, a post-storm monitoring survey was conducted to assess the stability of the capped mound and determine the potential for widespread erosion of the sediment deposit due to wave-induced sediment transport. The monitoring survey was performed following passage of a storm that met specified wind speed, direction, and duration criteria, which occurred on 16 October 2002. The survey was designed to detect any large-scale changes in the morphology of the mound, as well as any small-scale evidence of surface erosion or winnowing that may have occurred due to wave energy during the storm.

Bathymetric, side-scan sonar, and REMOTS® sediment profile imaging surveys were conducted to characterize post-storm conditions on the mound. Findings indicated no appreciable changes in large-scale mound morphology following the October 2002 storm event. The most prominent depth-difference occurred at the mound apex, indicating a decrease in mound height on the order of 0.25 – 0.5 m. However, sediment profile images from the mound apex region did not show any evidence of recent disturbance or scour of such magnitude, and in fact showed biogenic surface features indicative of stable physical conditions. Similarly, sediment profile images did not display any smaller-scale evidence for storm-related erosion at other areas of the mound. Findings indicated a mound surface consisting of clay cap material, with some areas showing evidence of armoring by shell fragments, sand and pebbles. These results were consistent with previous surveys of the Seawolf Mound. The presence of numerous biogenic surface features, including polychaete and amphipod tubes, fecal deposits, hydroids, burrow openings, and organic detritus, provide further evidence for a lack of storm-related disturbance at the surface across the mound.

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EXECUTIVE SUMMARY

The Seawolf Mound is a capped dredged material disposal mound developed in the northwestern quadrant of New London Disposal Site (NLDS) in 1995-96 as the product of a large improvement dredging project in the Thames River, as well as several smaller maintenance dredging projects in adjacent harbors. The disposal and capping of material generated from improvement dredging associated with homeporting the *Seawolf* class submarines in Groton, CT, as well as smaller maintenance dredging projects, resulted in a total estimated volume of 877,500 m^3 of sediment deposited at the Seawolf Mound. Comprehensive monitoring of the Seawolf Mound was conducted in September 1997, July 1998, August 2000, and June 2001. This report presents the findings of the most recent monitoring survey conducted in October 2002 following the passage of a significant storm event in the eastern Long Island Sound region.

In accordance with the comprehensive environmental monitoring plan established for the Seawolf Mound prior to initiation of the dredging projects, the post-storm monitoring survey was conducted to assess the stability of the capped mound and determine the potential for widespread erosion of the sediment deposit due to wave-induced sediment transport. The monitoring survey was performed following passage of a storm that met specified wind speed, direction, and duration criteria, which occurred on 16 October 2002. The survey was designed to detect any large-scale changes in the morphology of the mound, as well as any small-scale evidence of surface erosion or winnowing that may have occurred due to wave energy during the storm.

Bathymetric, side-scan sonar, and REMOTS® sediment profile imaging surveys were conducted to characterize post-storm conditions on the mound. Findings indicated no appreciable changes in large-scale mound morphology following the October 2002 storm event. The most prominent depth-difference occurred at the mound apex, indicating a decrease in mound height on the order of 0.25 – 0.5 m. However, sediment profile images from the mound apex region did not show any evidence of recent disturbance or scour of such magnitude, and in fact showed biogenic surface features indicative of stable physical conditions. Similarly, sediment profile images did not display any smaller-scale evidence for storm-related erosion at other areas of the mound. Findings indicated a mound surface consisting of clay cap material, with some areas showing evidence of armoring by shell fragments, sand and pebbles. These results were consistent with previous surveys of the Seawolf Mound. The presence of numerous biogenic surface features, including polychaete and amphipod tubes, fecal deposits, hydroids, burrow openings, and organic detritus, provide further evidence for a lack of storm-related disturbance at the surface across the mound.

Biological conditions on the Seawolf Mound showed a continuance of advanced successional stages and stable benthic habitat conditions, consistent with findings from the 2000 and 2001 surveys. Also consistent with previous surveys, conditions over the surface of the mound were slightly improved with respect to the nearby reference areas, indicating that the surficial sediments continue to provide suitable substrate for a stable, advanced benthic community.

1.0 INTRODUCTION

This report presents the results of a post-storm monitoring survey conducted in October 2002 over the Seawolf Mound located within the New London Disposal Site (NLDS). The information acquired from this survey was compared to previous monitoring efforts performed in August 2000 and June 2001 to determine the impacts to the surface of the capped disposal mound after the passage of a significant storm event meeting specific criteria. The storm event occurred on 16 October 2002 and generated heavy winds and large surface waves in the eastern Long Island sound region, as well as the remainder of New England.

1.1 Background

Dredging activity along the New England coast is overseen by the U.S. Army Corps of Engineers, New England District (NAE). Monitoring of the impacts associated with the subaqueous disposal of sediments dredged from harbors, inlets, and bays in the New England region has been overseen by the Disposal Area Monitoring System (DAMOS) Program. Established in 1977, the goals of the DAMOS Program pertain to detailed investigation of dredging and dredged material disposal practices to minimize any adverse physical, chemical, and biological impacts. The activity sponsored by DAMOS helps to ensure that the effects of sediment deposition on the marine environment within pre-defined areas of seafloor are local and temporary. A flexible, tiered management protocol is applied in the long-term monitoring of sediment disposal at ten open-water dredged material disposal sites along the coast of New England (Germano et al. 1994).

Most of the material generated from dredging operations in the eastern Long Island Sound region is transported by barge and deposited at the New London Disposal Site (NLDS). NLDS is located 5.38 km (3.1 nmi) south of Eastern Point, Groton, Connecticut and is centered at 41° 16.306´ N, 72° 04.571´ W (NAD 83; Figure 1-1). The disposal site covers a 3.42 km^2 area of seafloor, with water depths that range from 14 m over the NL-RELIC Mound to 24 m at the southern disposal site boundary (Figure 1-2). Currently, this site is utilized for the unconfined disposal of suitable sediments, as well as subaqueous capping of sediments deemed unsuitable for open water disposal. Presently, there are ten discernible mounds (NL-95 is merged with the Seawolf Mound) within the boundaries of the disposal site (Figure 1-2). When necessary, mounds are constructed in phases to allow for capping of material deemed unsuitable for open-water disposal. Capping is a subaqueous containment method that utilizes material determined to be suitable for open-water disposal, or capping dredged material (CDM), to overlay and isolate deposits of unacceptably-contaminated dredged material (UDM) from the surrounding environment (Fredette 1994).

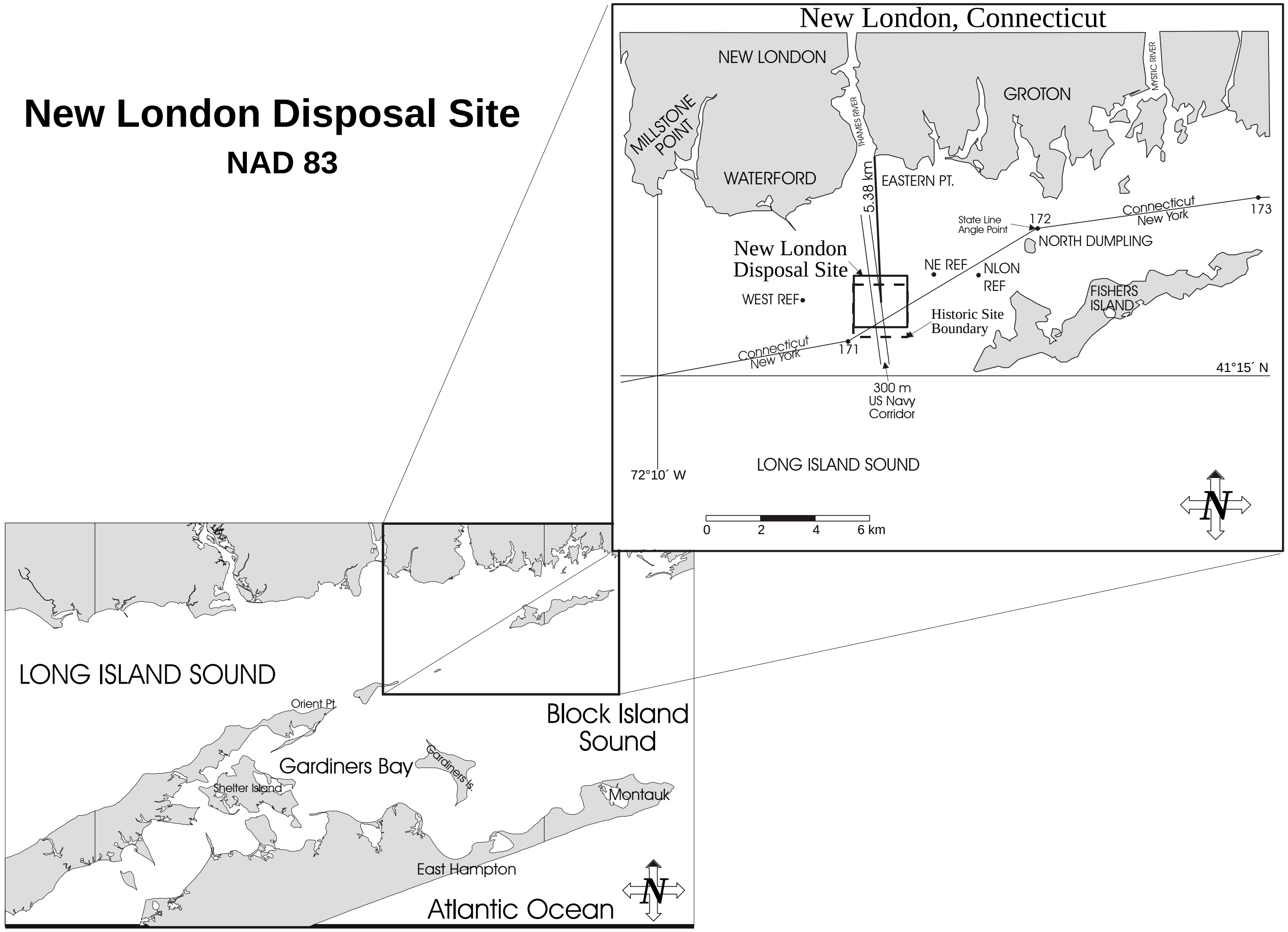


Figure 1-1. Location of the New London Disposal Site in eastern Long Island Sound relative to the Connecticut mainland and several New York islands

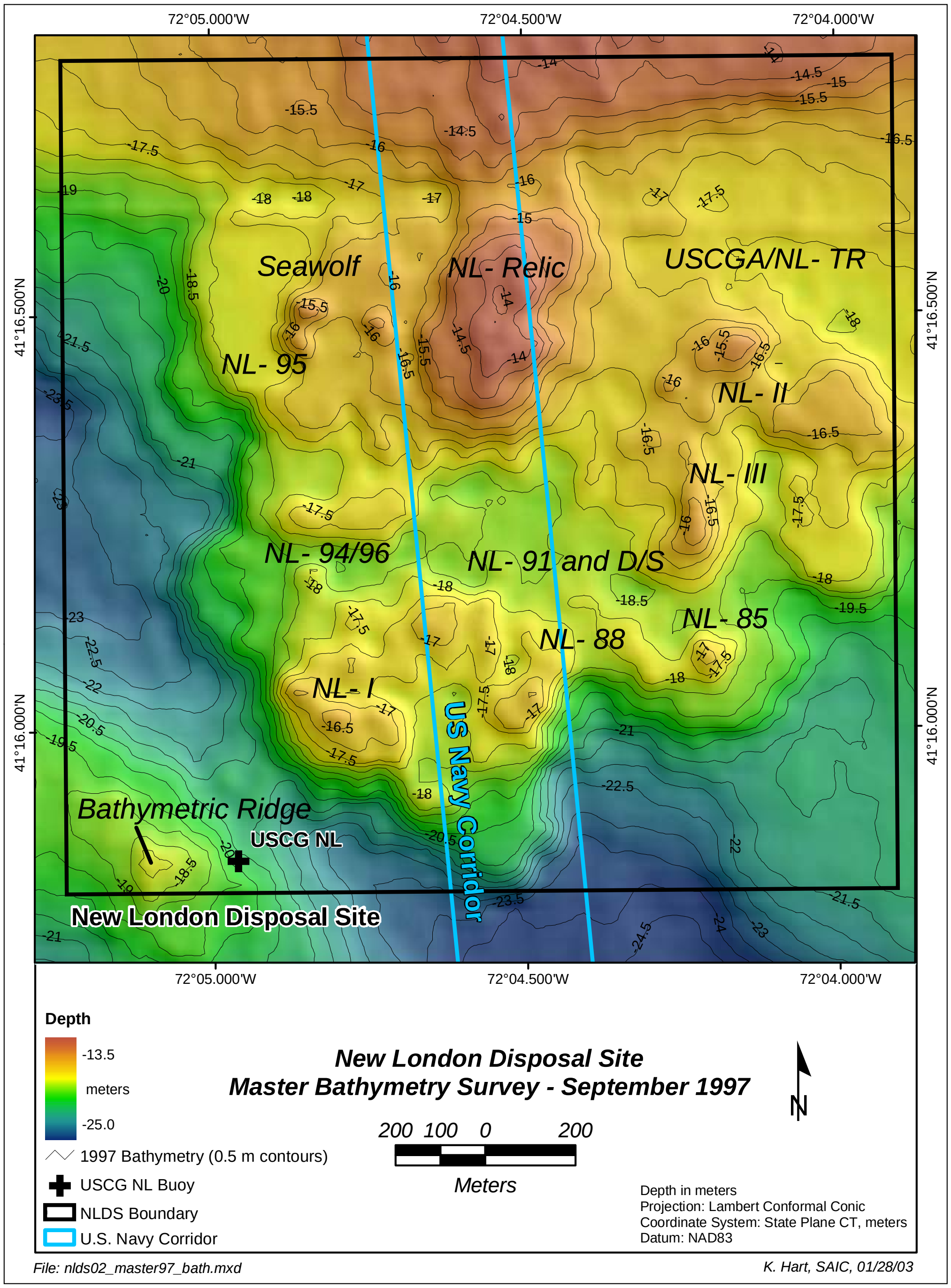


Figure 1-2. Bathymetric chart of the New London Disposal Site complete with the plotted location of the U.S. Coast Guard "NL" buoy, the disposal site boundary (black), and the 300 m U.S. Navy submarine corridor through the center of the site (blue)

In recent years, management objectives have sought to minimize lateral spread of dredged material upon disposal at the NLDS by taking advantage of the topography of the site through filling in depressions between historic disposal mounds. This approach has the dual advantage of maximizing site capacity while minimizing volumes of CDM required to completely cover and contain an unacceptably-contaminated dredged material UDM deposit (Carey 1998). Additionally, in order to reduce the effects of bottom currents and storm-generated waves, sediment mounds at the NLDS are developed in a broad, flat manner, maintaining a minimum water depth of 14 meters. This minimum depth also allows for the safe passage of deep draft Navy vessels transiting through the disposal site (NUSC 1979).

Previous studies have shown that NLDS is relatively protected from the effects of ocean storms due to the configuration of the surrounding landmasses (SAIC 2001a). Fishers Island located approximately 4 km to the east and the South Fork of Long Island protects the disposal site from storm-generated, ocean waves emanating from the east and south (Figure 1-3). The fetch-limited environment tends to buffer the development of large surface waves, which could cause resuspsension of sediment and promote erosional conditions over the surface of the disposal mounds. Furthermore, a number of bathymetric features surrounding NLDS provide a measure of protection from waves as well. Bartlett Reef to the northwest of NLDS and a strong seafloor ridge located in the southwest corner of the disposal site disrupt the orbital velocities associated with the passage of large waves at the disposal site and minimize the shear stress and impact at the bottom boundary layer (Figures 1-2 and 1-3). However, it was theorized that storm systems generating sufficiently strong winds from a southerly or westerly direction could potentially build surface waves capable of impacting the NLDS seafloor.

1.2 Seawolf Mound

The Seawolf Mound is a capped dredged material disposal mound developed in the northwestern quadrant of NLDS during the 1995-96 disposal season as the product of a large improvement dredging project in the Thames River, as well as several smaller maintenance dredging projects in adjacent harbors. The improvement dredging of the Thames River was deemed necessary when the U.S. Navy decided to homeport the *Seawolf* class submarines in Groton, CT (Maguire Group, Inc. 1995). The Seawolf dredging project and a small-scale Mystic River project resulted in the placement of 306,000 m^3 of UDM at NLDS, which was subsequently covered by 556,000 m^3 of CDM (SAIC 2001b). An additional 15,500 m^3 of sediments from Venetian Harbor and Mystic River deemed suitable for open-water disposal were placed at the NDA 95 buoy to the southwest of the main Seawolf Mound. These smaller projects also contributed to the Seawolf Mound and were documented in the depth difference calculations between sequential bathymetric surveys performed as part of the associated environmental monitoring efforts. The

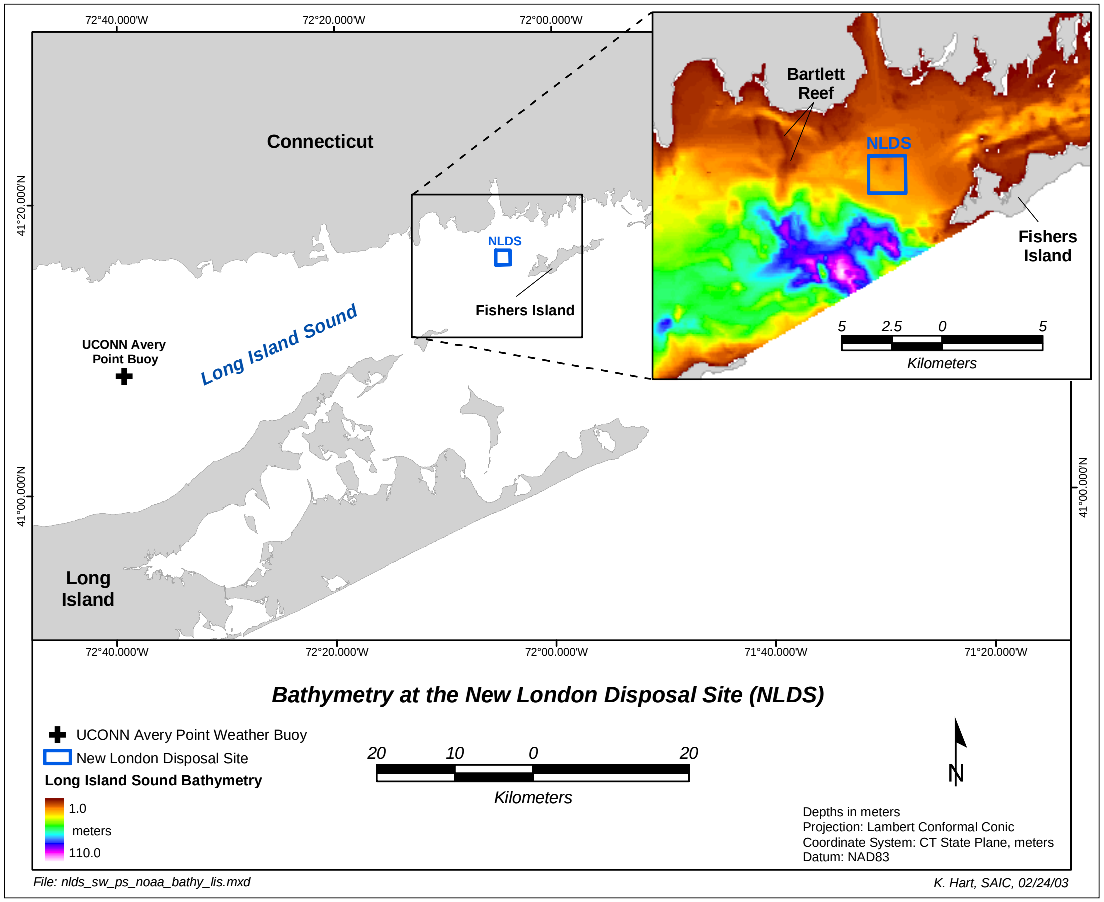


Figure 1-3. Location of the New London Disposal Site relative to various land masses and bathymetric features that serve to limit fetch and protect the site from the effects of waves generated by ocean storms. Eastern Long Island Sound bathymetry data provided by NOAA.

disposal of material generated from both the maintenance and improvement projects resulted in a total estimated volume of 877,500 m^3 of sediment (UDM plus CDM) deposited at the Seawolf Mound. Over the years, the Seawolf Mound has been subject to comprehensive environmental monitoring activity, tracking both the development of this bottom feature and its long-term fate on the NLDS seafloor.

1.3 Post-Storm Monitoring

A comprehensive environmental monitoring plan was established for the Seawolf Mound prior to its development on the NLDS seafloor during the 1995/96 disposal season. One segment of this plan was to assess the susceptibility of the capped mound to the effects of coastal storms and determine the potential for widespread erosion of the sediment deposit due to wave-induced sediment transport. As a result, weather systems affecting the eastern Long Island Sound region have been monitored over the past seven years to identify the appropriate set of meteorological conditions (wind speeds and maximum fetch) with the potential to impact the surface of the mound. Due to the protected nature of NLDS, a post-storm monitoring event was planned after the passage of a weather system with wind speeds exceeding 40 knots (Strong Gale to Storm force) emanating from the southwest, south, or southeast for one or more hours. The University of Connecticut (UCONN), Avery Point maintains a meteorological station at the New London Ledge Light approximately 4 km north of NLDS. The data obtained from this station was used to evaluate weather conditions and provide insight into the generation of surface waves in the region. Although many coastal storms have impacted the eastern Long Island sound region in the past seven years, only the October 2002 storm detailed below exceeded the criteria established at the outset of the program.

A coastal storm consisting of an intense low-pressure system traveled along the eastern seaboard and impacted the southern New England on 16 October 2002. As the low-pressure center approached the region, strong easterly winds generated large waves in the coastal waters, including Long Island Sound. However, the seas produced by the easterly winds had little effect at NLDS due to the protection (fetch limiting) provided by Fishers Island (Figure 1-3). As the weather system continued to track north, the low-pressure cell passed to the west of NLDS and into the Connecticut River Valley. The counter-clockwise flow around the center of circulation then produced winds from the south and southwest that exceeded the study criteria based upon the measurements recorded by the UCONN meteorological station.

1.4 Survey Objectives and Predictions

As part of the monitoring plan established for the Seawolf Mound, a post-storm monitoring survey was conducted over the Seawolf Mound in October 2002. The objectives of the post-storm environmental monitoring survey over NLDS Seawolf Mound were to:

1) investigate potential large-scale changes in seafloor topography (disposal mound morphology) and assess the distribution and/or relocation of sediment (evidence of seafloor erosion) over the disposal mound due to a recent storm event in eastern Long Island Sound; and

2) quantify the amount surface disturbance (erosion or small-scale winnowing) over the Seawolf Mound due to the passage of storm generated waves.

The October 2002 field effort tested the following predictions:

1) The passage of a significant storm would result in no large-scale changes in disposal mound morphology due to the protective nature of the site and the reduced likelihood of waves capable of eroding significant amounts of dredged material forming within the limited-fetch environment.

2) Surface sediments over the Seawolf Mound would show minimal (small-scale) surface disturbance and would be supporting an undisturbed benthic community despite the passage of a major storm in the Long Island Sound region.

2.0 METHODS

The following section provides an overview of the methods employed during the October 2002 environmental monitoring survey at the NLDS Seawolf Mound. Survey operations were conducted aboard the M/V *Beavertail* from 20 to 22 October 2002 and February 2003. Field data collection efforts consisted of single-beam bathymetry, side-scan sonar, and REMOTS® sediment-profile imaging. The northwestern quadrant of the disposal site was surveyed to identify changes in seafloor topography and assess the distribution and/or relocation of sediment due to a significant storm event. The sediment-profile imaging camera was used to investigate the physical properties of the sediments, as well as to assess the benthic infaunal community status.

2.1 Navigation

During the field operations, Differentially-corrected Global Positioning System (DGPS) data in conjunction with Coastal Oceanographic's HYPACK® survey and data acquisition software were used to provide real-time positioning of the survey vessel to an accuracy of ± 3 m. 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 GPS receiver has an integrated differential beacon receiver to improve the overall accuracy of the satellite data to the necessary tolerances. The U.S. Coast Guard differential beacon broadcasting from Moriches, New York (293 kHz) was utilized for real-time satellite corrections due to its geographic position relative to NLDS.

The DGPS data were ported to Coastal Oceanographic's HYPACK® data acquisition software for position logging and helm display. REMOTS® sampling stations and bathymetric survey lanes were established before the commencement of the field operations and stored in a project database. During the field operations, individual stations were selected and displayed by the navigation system in order to position the survey vessel over the correct geographic coordinates. The position of the vessel during the acquisition of each REMOTS® image was logged with a time stamp in Universal Time Coordinated (UTC) and a text identifier to facilitate Quality Control (QC) and rapid input into a Geographic Information System (GIS) database.

2.2 Bathymetric Data Acquisition and Analysis

2.2.1 Bathymetric Data Acquisition

Bathymetric data were collected over a 1000 × 1000 m area surrounding NLDS Seawolf Mound to examine seafloor topography and assess the potential distribution and/or relocation of sediment within the disposal site boundary due to a recent storm event (Figure 2-1). The bathymetric survey was centered at coordinates 41°16.508´ N, 72° 04.800´ W and consisted of a total of 41 survey lanes spaced at 25 m intervals and oriented north-south. The bathymetric survey area was actually occupied twice in support of the post-storm monitoring event. The first survey was completed during the October 2002 field effort shortly after the passage of the storm event. However, detailed analysis of the single-beam bathymetry indicated an apparent long period swell in the record, likely due to resonance of wave energy within the Long Island Sound basin. This swell was often times 0.75 to 1 m in height and undermined the overall accuracy of the bathymetry. In an effort to provide valid depth difference comparisons the survey was reoccupied in February 2003 in conjunction with other DAMOS field operations in Long Island Sound.

During each bathymetric survey, HYPACK® was interfaced with an Odom Hydrotrac® survey echosounder, as well as the Trimble DGPS. The Hydrotrac® uses a narrow-beam (3°), 208-kHz transducer to make discrete depth measurements and produce a continuous 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 were viewed in near real-time to ensure adequate coverage of the survey area.

2.2.2 Bathymetric Data Processing

The bathymetric data were fully edited and processed using the HYPACK® data processing modules. Raw position and sounding data were edited as necessary to remove or correct questionable values, apply sound velocity and draft corrections, and reduce the depth soundings to the vertical datum of Mean Lower Low Water (MLLW) using observed tides obtained from the National Oceanic and Atmospheric Administration (NOAA).

During bathymetric survey data acquisition, an assumed and constant water column sound velocity was entered into the Odom echosounder. 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 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.

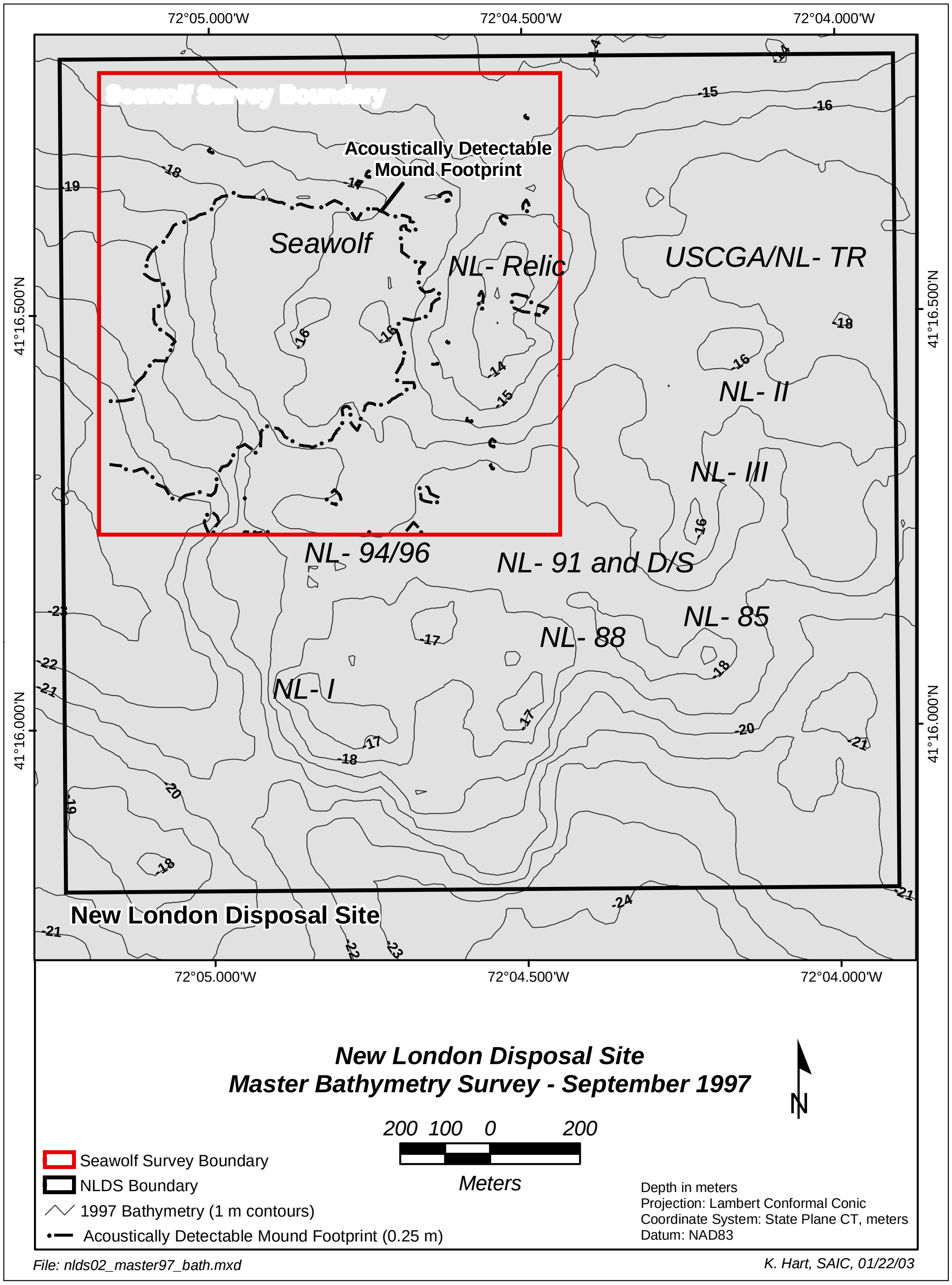


Figure 2-1. Location of the bathymetric survey area over the Seawolf Mound relative to the remainder of NLDS

Observed tide data were obtained from the NOAA tide station in New London, CT (Station number 8461490) through the National Water Level Observation Network. The NOAA six-minute tide data were downloaded in the MLLW datum and corrected for tidal offsets. A two-minute time offset and a height correction of 0.97 was applied to the NOAA tide data to account for the tidal offset between the NOAA tide station and NLDS.

2.2.3 Bathymetric Data Analysis

After the bathymetric data were fully edited and reduced to MLLW, cross-check comparisons on overlapping data were performed in order to verify the proper application of the correctors and to evaluate the consistency of the data set. Once the data were verified, they were then processed through the HYPACK® Mapper routine in order to reduce the size of the full data set in a systematic way. Because of the rapid rate at which a survey echosounder can generate data (approximately ten depths per second), the along-track data density for a single-beam survey tends to be very high (multiple soundings per meter). In most cases, these data sets contain many redundant data points that can be eliminated without any effect on the overall quality of the data. The Mapper routine examines the full dataset along each survey line and averages all data points that fall within a user-specified grid cell to produce a single average value for each cell. The output from this routine is a merged ASCII-xyz file that may contain anywhere from 2 to 10% of the original data set. These greatly reduced, but still representative, data sets are far more efficient to use in the subsequent modeling and analysis routines.

Because single-beam bathymetric survey data typically cover only a small percentage of the total seafloor area (approximately 5%), the analysis relies on interpolating between the discrete survey data points to generate a three-dimensional seafloor surface model. The October 2002 and February 2003 bathymetric survey data were gridded through the ESRI® ArcMap software module to generate depth models for the entire survey area, using a grid cell size of 25 × 25 m. The same system was used to generate a depth model for the June 2001 bathymetric survey data that was later used as the basis of comparison. The February 2003 and June 2001 models were mathematically compared within ArcMap, producing a dataset of calculated depth differences, which is presented in this report. Using this method, any depth differences are related to changes in seafloor topography between the dates of the compared survey grids.

2.3 Side-Scan Sonar Data Acquisition and Analysis

Side-scan sonar surveys consist of collecting back-scattered signals emitted from a towed transducer in a towfish. The acoustic returns are in the form of swath data that are used to create image mosaics that provide a representation of the seafloor, yielding information on sediment type, bottom targets, and generalized seafloor characteristics. Side-scan data provide information on the size of detected objects, height above the seafloor, and their 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.

2.3.1 Side-Scan Sonar Data Acquisition

The area covered in the side-scan sonar survey was centered on the NLDS Seawolf Mound and measured 1000 × 1000 m (Figure 2-1). The side-scan sonar survey consisted of 13 survey lanes oriented north-south and spaced at 75-m intervals to provide a full mosaic of the bottom and assess the distribution of the dredged material deposit within the disposal site. The position of the towfish was calculated in real-time by the HYPACK® navigation system, based on 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.

Side-scan sonar imagery data were acquired with a Datasonics/Benthos SIS-1000® combined digital subbottom profiling and side-scan sonar system that was obtained from the USACE, Baltimore District. Because the SIS-1000 acquires subbottom and side-scan data simultaneously, all of the lanes occupied during the survey operations over the Seawolf Disposal Mound provided both data types. However, only the side-scan sonar data were analyzed for this data report. The side-scan sonar component operates at a swept frequency range of 90 to 110 kHz. The SIS-1000® towfish was towed behind the survey vessel with an armored signal cable that provided power and two-way communication with the SIS-1000® topside data acquisition system. This system recorded acoustic data from the towfish and position information from the navigation system, and displayed real-time imagery on a PC monitor. With the lanes spaced at 75 m intervals and side-scan range scale set to 90 m for each side, over 200% bottom coverage was obtained during the side-scan operations.

2.3.2 Side-Scan Sonar Data Processing and Analysis

During the data acquisition, the side-scan data from each survey lane were saved into a separate file to facilitate post-processing. During post-processing, each north-south survey lane was re-played within Chesapeake Technology's SonarWeb® and adjustments were made to the time-varying-gain (TVG) of the return signal and portions of the records corresponding to water column were removed. The complete set of processed side-scan survey lines was used to generate a mosaic image of the seafloor. SonarWeb® mosaic utility was used to check for coverage gaps between survey lines. After the mosaic was completed, it was saved and exported as a geo-referenced Tagged Image File Format (TIFF) file. The geo-referenced TIFF of the final mosaic was then imported into a GIS for spatial analysis.

2.4 REMOTS® Sediment-Profile Imaging

REMOTS® (Remote Ecological Monitoring of the Seafloor) sediment-profile imaging is a benthic sampling technique used to detect and map the distribution of thin (<20 cm) dredged material layers, delineate benthic disturbance gradients, and monitor the process of benthic recolonization following physical seafloor disturbance. This is a reconnaissance survey technique used for rapid collection, interpretation and mapping of data on physical and biological seafloor characteristics. The DAMOS Program has used this technique for routine disposal site monitoring for over 20 years.

The REMOTS® hardware consists of a Benthos Model 3731 sediment-profile camera designed to obtain undisturbed, vertical, cross-section photographs (in-situ profiles) of the upper 15 to 20 cm of the seafloor (Figure 2-2). Computer-aided analysis of each REMOTS® image yields a suite of standard measured parameters, including sediment grain size major mode, camera prism penetration depth (an indirect measure of sediment bearing capacity/density), small-scale surface boundary roughness, depth of the apparent redox potential discontinuity (RPD, a measure of sediment aeration), infaunal successional stage, and Organism-Sediment Index (OSI, a summary parameter reflecting overall benthic habitat conditions).

Organism-Sediment Index values may range from –10 (azoic with low sediment dissolved oxygen and/or presence of methane gas in the sediment) to +11 (healthy, aerobic environment with deep RPD depths and advanced successional stages). The OSI values are calculated using values assigned for the apparent RPD depth, successional status, and indicators of methane or low oxygen. Because the OSI is calculated using apparent RPD depths and successional stages, indeterminate apparent RPD depths and/or successional stages lead to indeterminate OSI values. REMOTS® image acquisition and analysis methods are described fully in Rhoads and Germano (1982; 1986) and in the recent DAMOS Contribution No. 128 (SAIC 2001b).

The REMOTS® survey performed over NLDS Seawolf Mound consisted of a 29-station radial arm sampling grid within the 1.0 km^2 survey boundary (Table 2-1; Figure 2-3). The station grid employed during the 1997, 1998, and 2000 survey efforts was reoccupied in October 2002 to facilitate time-series comparisons among data sets. The REMOTS® images collected from these stations were used to assess benthic community

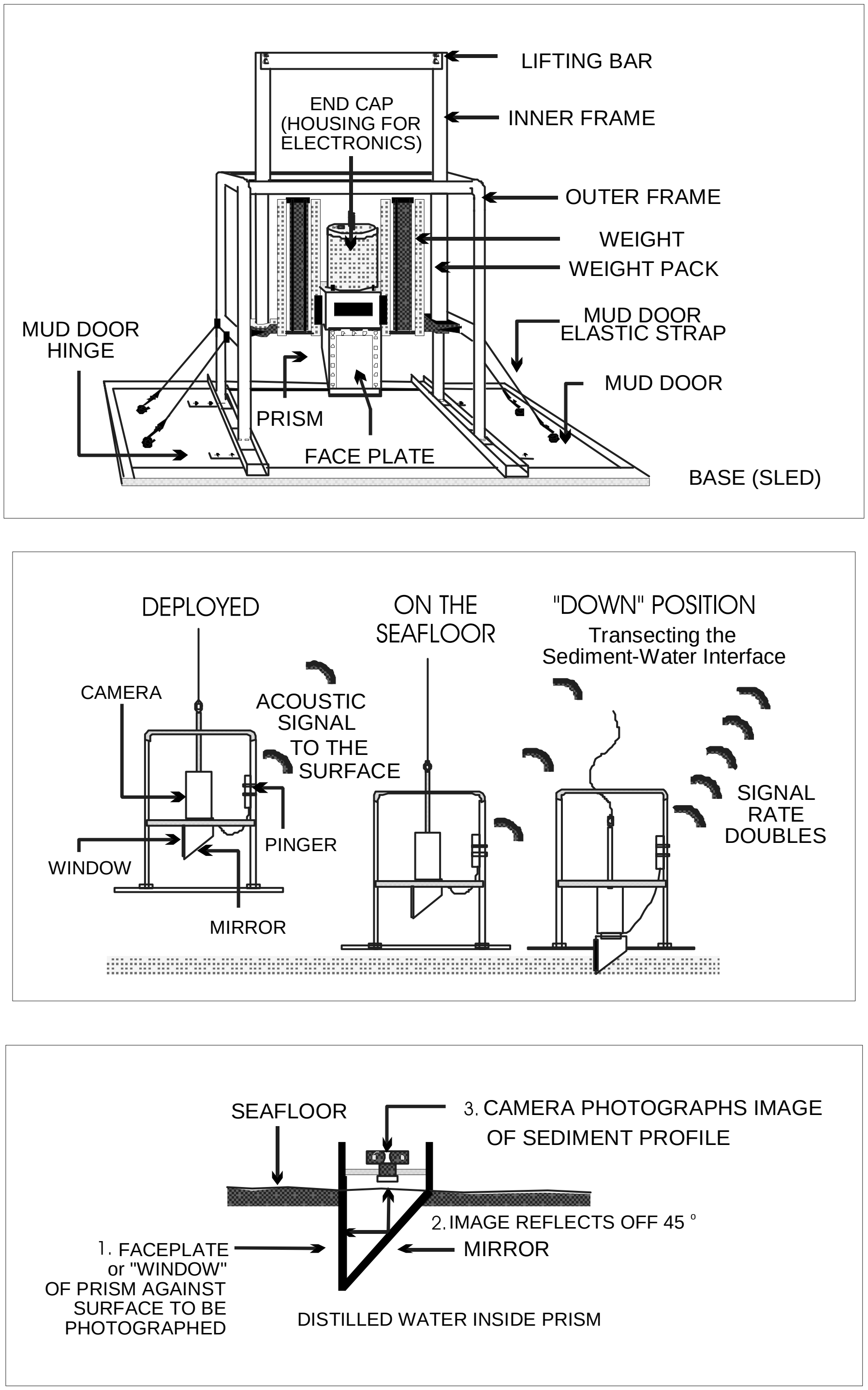


Figure 2-2. Schematic diagram of the Benthos, Inc. Model 3731 REMOTS® sediment-profile camera and sequence of operation on deployment

Table 2-1.
REMOTS® Station Locations over the Seawolf Mound and Reference Areas October 2002 (NAD 83)

Area	Station	Latitude	Longitude
Seawolf Mound 41° 16.456´ N 72° 04.863´ W	SWLFCTR	41° 16.456´ N	72° 04.863´ W
	75N	41° 16.496´ N	72° 04.863´ W
	150N	41° 16.537´ N	72° 04.863´ W
	300N	41° 16.618´ N	72° 04.863´ W
	450N	41° 16.699´ N	72° 04.863´ W
	75NE	41° 16.485´ N	72° 04.824´ W
	150NE	41° 16.514´ N	72° 04.787´ W
	300NE	41° 16.571´ N	72° 04.711´ W
	450NE	41° 16.628´ N	72° 04.636´ W
	75E	41° 16.456´ N	72° 04.810´ W
	150E	41° 16.456´ N	72° 04.756´ W
	300E	41° 16.456´ N	72° 04.648´ W
	75SE	41° 16.427´ N	72° 04.824´ W
	150SE	41° 16.399´ N	72° 04.787´ W
	300SE	41° 16.341´ N	72° 04.711´ W
	75S	41° 16.415´ N	72° 04.863´ W
	150S	41° 16.375´ N	72° 04.863´ W
	300S	41° 16.294´ N	72° 04.863´ W
	75WSW	41° 16.436´ N	72° 04.910´ W
	150WSW	41° 16.416´ N	72° 04.956´ W
	300WSW	41° 16.375´ N	72° 05.049´ W
	450WSW	41° 16.334´ N	72° 05.142´ W
	75W	41° 16.456´ N	72° 04.917´ W
	150W	41° 16.456´ N	72° 04.970´ W
	300W	41° 16.456´ N	72° 05.078´ W
	75NW	41° 16.485´ N	72° 04.901´ W
	150NW	41° 16.514´ N	72° 04.939´ W
	300NW	41° 16.571´ N	72° 05.015´ W
	450NW	41° 16.628´ N	72° 05.091´ W
NE-REF 41° 16.686´ N 72° 03.371´ W	NE-REF 1	41° 16.669´ N	72° 03.349´ W
	NE-REF 2	41° 16.673´ N	72° 03.260´ W
	NE-REF 3	41° 16.834´ N	72° 03.332´ W
	NE-REF 4	41° 16.707´ N	72° 03.426´ W
NLON-REF 41° 16.666´ N 72° 01.971´ W	NLON-REF 1	41° 16.778´ N	72° 01.934´ W
	NLON-REF 2	41° 16.576´ N	72° 01.934´ W
	NLON-REF 3	41° 16.654´ N	72° 01.929´ W
	NLON-REF 4	41° 16.616´ N	72° 02.016´ W
WEST-REF 41° 16.206´ N 72° 05.971´ W	WEST-REF 1	41° 16.212´ N	72° 05.970´ W
	WEST-REF 2	41° 16.246´ N	72° 05.915´ W
	WEST-REF 3	41° 16.336´ N	72° 05.934´ W
	WEST-REF 4	41° 16.130´ N	72° 05.982´ W
	WEST-REF 5	41° 16.209´ N	72° 05.994´ W

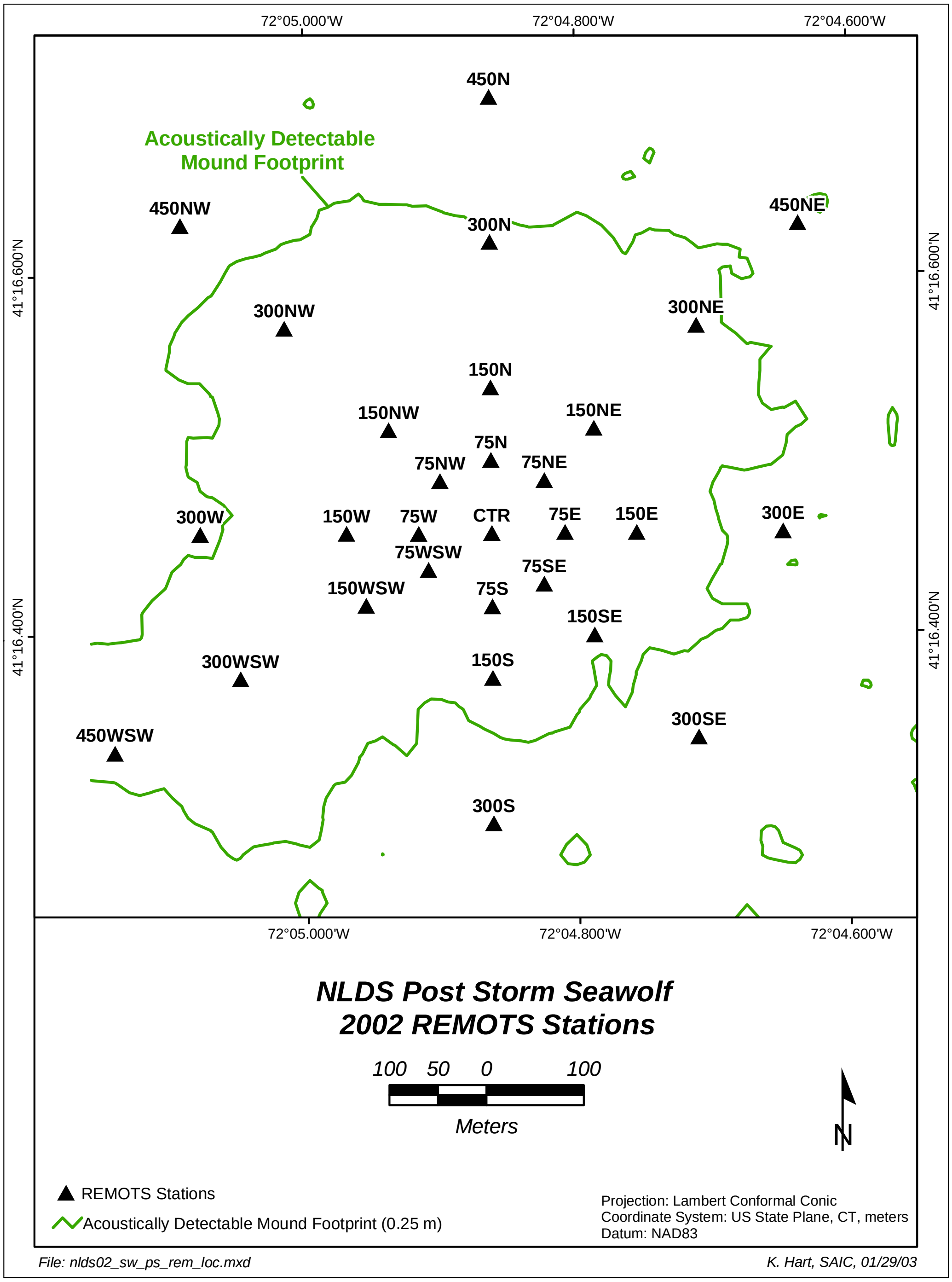


Figure 2-3. Distribution of the October 2002 REMOTS® sediment-profile imaging stations over the Seawolf Disposal Mound, relative to the acoustically detectable disposal mound footprint (green)

status and the physical nature of the sediments within and surrounding the disposal site. The sampling grid was centered at the location of Station SWLFCTR at coordinates 41° 16.456´ N, 72° 04.863´ W. The sampling grid consisted of eight radial arms with stations spaced 75 m, 150 m, and 300 m from the center, as well as stations 450 m from the center at the NE, N, NW and WSW arms, and one station at the center (Table 2-1). In order to cover the footprint of the mound, an arm extending SW from the center had been replaced with a WSW radian. All 29 stations established over NLDS Seawolf Mound were successfully sampled during the October 2002 survey.

Reference areas are typically sampled during DAMOS monitoring surveys to provide a comparative assessment of the environmental conditions existing on the ambient seafloor. A total of 13 stations were distributed among the three reference areas surrounding NLDS: five stations were established around WEST-REF (center coordinates 41° 16.206´ N, 72° 05.971´ W), while four stations were distributed over both NLON-REF (center coordinates 41° 16.666´ N, 72° 01.971´ W) and NE-REF (center coordinates 41° 16.686´ N, 72° 03.371´ W). Each reference station was established in close proximity to NLDS Seawolf Mound to provide a basis of comparison of the habitat conditions to those on the ambient seafloor of eastern Long Island Sound (Table 2-1; Figure 2-4). At each of the disposal mound and reference area REMOTS® stations occupied in the October 2002 survey, the camera was lowered into the seafloor multiple times to obtain at least three replicate images of suitable quality for subsequent analysis.

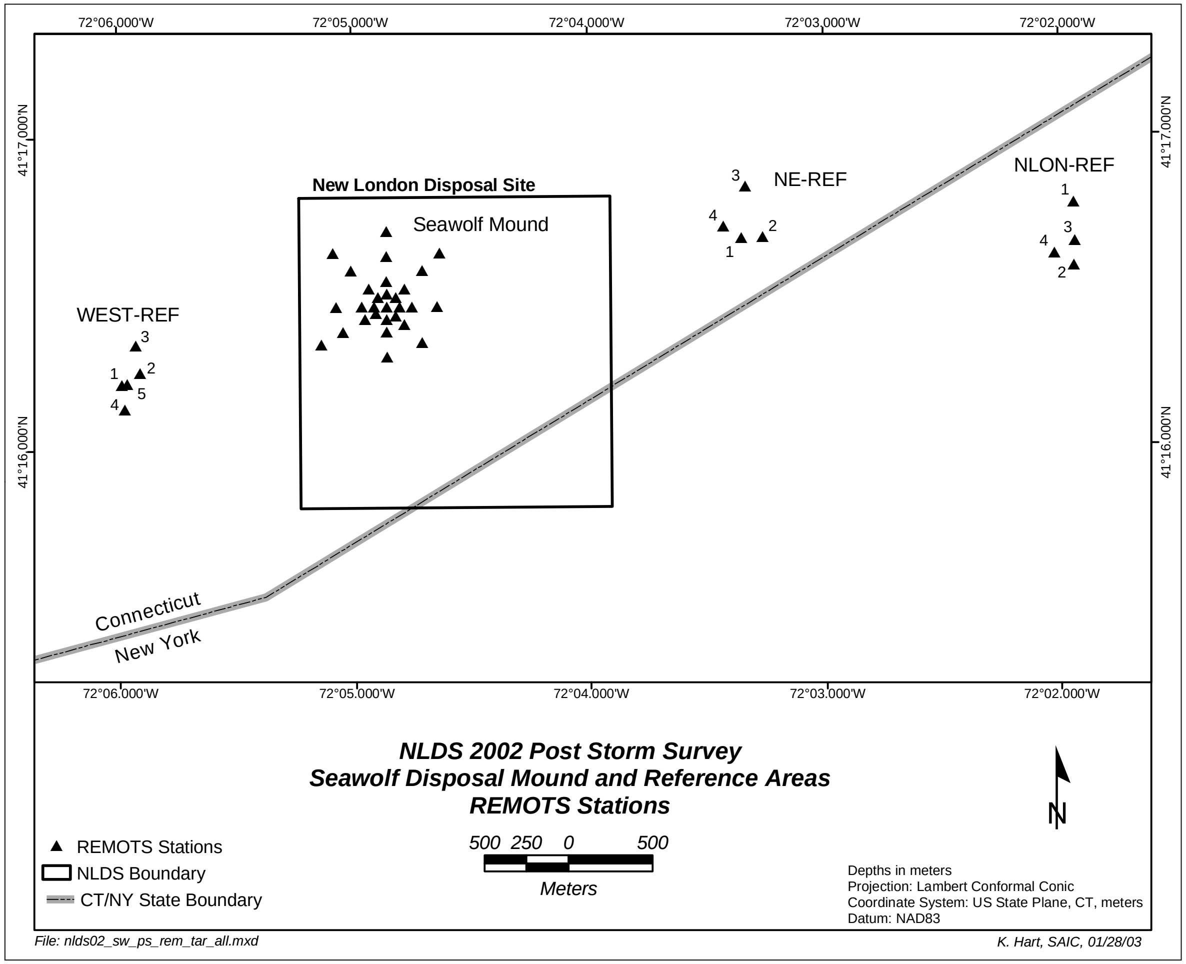


Figure 2-4. REMOTS® survey grids established over the Seawolf Disposal Mound within NLDS and surrounding reference areas as part of the October 2002 field operations

3.0 RESULTS

3.1 Meteorological Observations

Weather data from the station located at the New London Ledge Light indicated the passage of a significant storm event in the eastern Long Island Sound region occurred on 16 October 2002. Winds from the east gradually increased over a 12-hour period as the storm center tracked north along the eastern seaboard, reaching a maximum, sustained velocity of 60 knots (Figure 3-1). Winds were primarily emanating from the northeast and east for the majority of the storm event. The sustained winds decreased to below 30 knots and shifted to the south and southwest as the low-pressure center crossed over Long Island and entered Long Island Sound at approximately 17:00 EST. Winds then gradually increased from the south and southwest as the storm center proceeded north along the Connecticut River Valley. The criteria for the post-storm monitoring survey were met after the wind shifted to the southwest and increased to speeds over 40 knots in the New London region (Figure 3-1).

Supplemental information on environmental conditions was obtained from the UCONN, Avery Point weather buoy located in central Long Island Sound (coordinates 41° 08.250´ N, 72° 39.300´ W; Figure 1-3). Wave and additional meteorological data indicated that the surface waves generated by the storm event were primarily from an easterly direction due to the prevailing wind direction (Figure 3-2A). The surface waves in central Long Island Sound were in excess of 2.5 m in height during the most intense period of the storm (Figure 3-2B). As winds shifted from the east to the south and southwest in the evening hours, wave heights subsided to approximately 1.2 m in height. Once the low-pressure system center passed through Long Island Sound, wind speeds increased from the southwest and produced waves from the southwest building to a height of over 1.5 m (Figures 3-2A &B).

Located within the lee of Fishers Island, NLDS was likely sheltered from the effects of the easterly winds and any large, storm-generated waves originating from Block Island Sound. The fetch increased as the winds rotated into a more southerly and southwesterly direction, but most of the energy transfer from the southerly wind served to diminish the surface waves established earlier by the easterly winds. Strong southerly winds exceeding 35 knots were recorded over a 3.5 hour period only. As a result, the seas within eastern Long Island Sound would not have sufficient time to absorb the energy from the wind and set-up waves large enough to impact the seafloor.

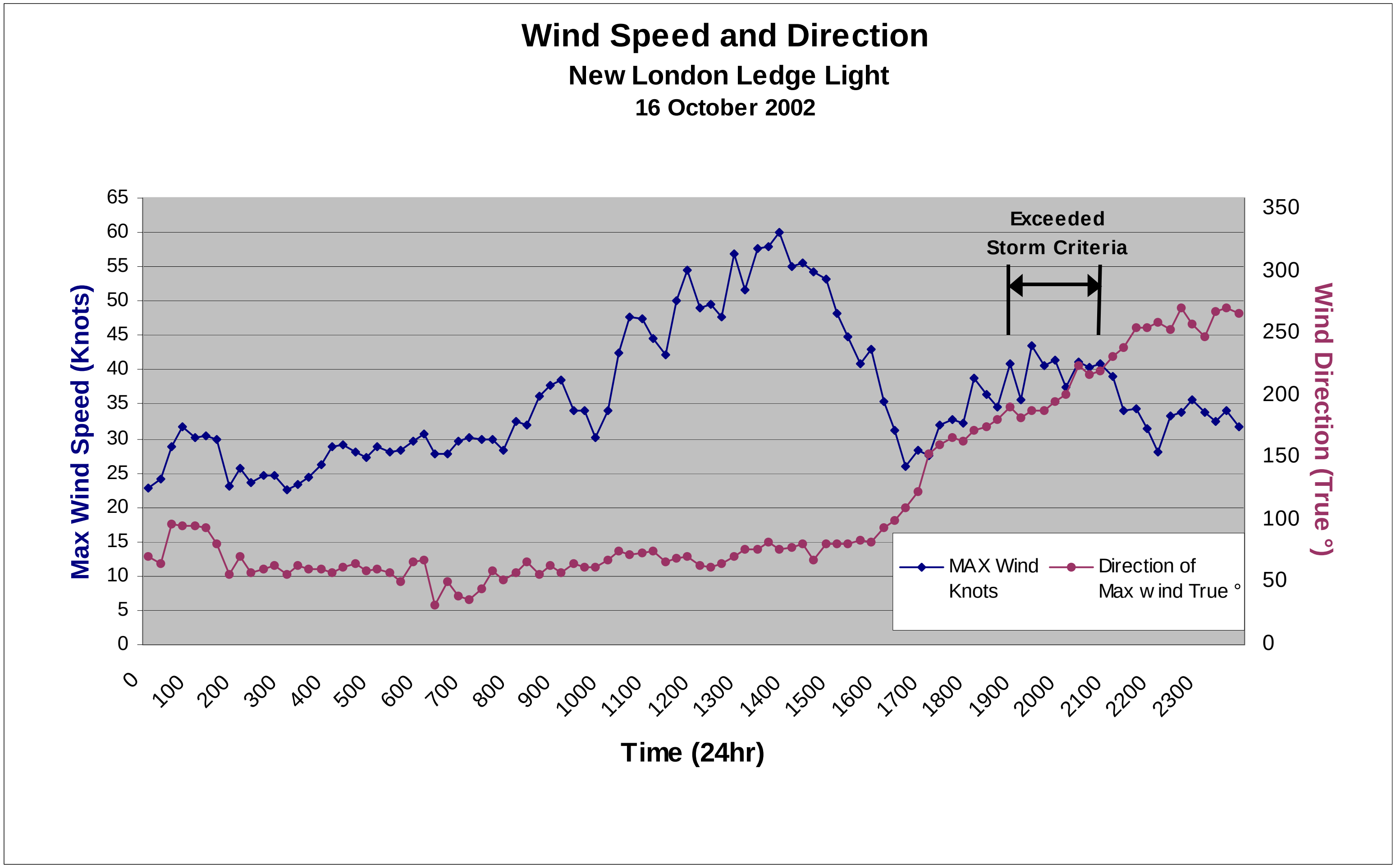
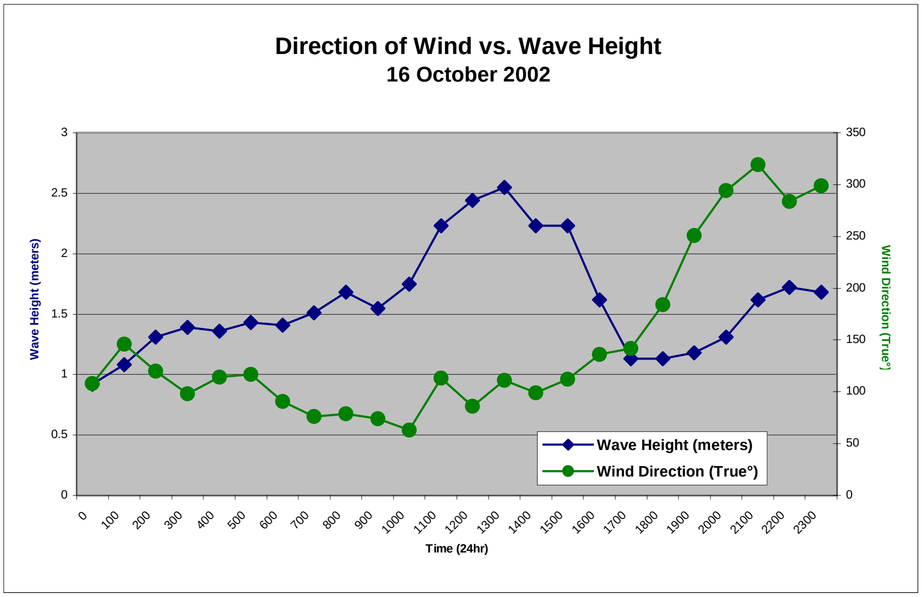
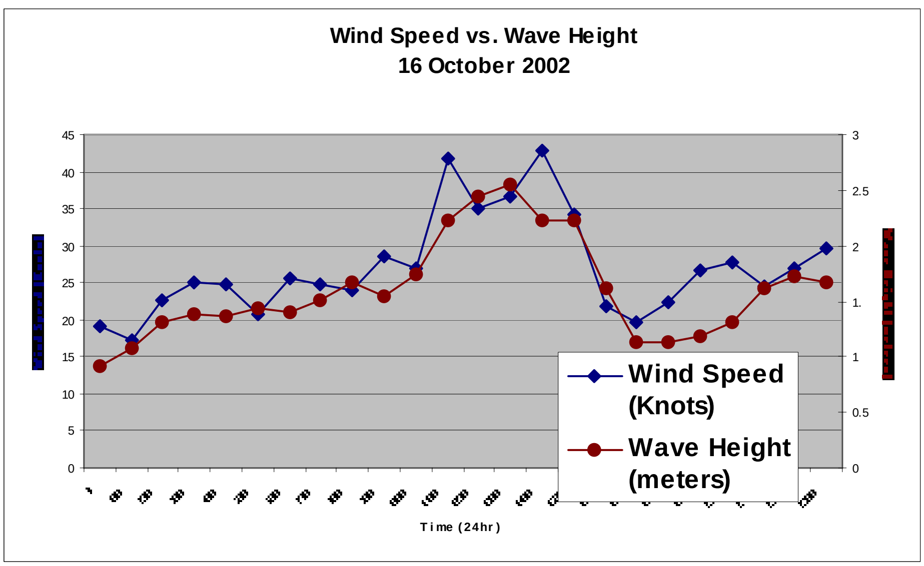


Figure 3-1. Graphic displaying wind speed and direction for 16 October 2002 at the UCONN meteorological station located at New London Ledge Light



A



B

Figure 3-2. Graphics showing the correlation between wave height and wind direction (A), as well as wave height and wind speed (B) at the UCONN meteorological/oceanographic buoy located in Central Long Island Sound Bathymetry

3.2 Bathymetry

As stated in Section 2.2.1, the February 2003 bathymetry data collected over the Seawolf Mound were utilized to examine seafloor topography and facilitate post-storm comparisons with prior data sets. This bathymetric survey showed depths ranging from 13.5 m over the NL-RELIC Mound to 22.5 m in the southwest corner of the 1.0 km^2 survey area (Figure 3-3). Water depths within the survey area were generally consistent with the results of the previous August 2000 survey suggesting no widespread movement of sediment or additional dredged material deposition over the past three years (Figure 3-4). The Seawolf Mound continued to display two small apex regions near the center of the mound with minimum depths of 15.5 to 16 m.

Depth difference comparisons between the February 2003 and August 2000 data sets displayed a very small area with an apparent minor reduction (0.25 to 0.5 m) in disposal mound height near the northernmost apex of the mound (Figure 3-5). This reduction could be attributed to small-scale erosion or it could represent continued consolidation at the apex of the mound over the three-year period. Positive depth differences were also detected in these comparisons despite no reported dredged material placement activity in the immediate vicinity of the Seawolf Mound. In addition, these areas of apparent accumulation were closely correlated to areas of strong seafloor slope, suggesting these features were primarily survey artifacts. Depth difference comparisons between the post-storm survey of February 2003 and the October 1995 baseline provide an updated view of the Seawolf Mound showing a similar disposal mound footprint to that detected in 1997, as well as dredged material thickness values ranging from 0.25 to nearly 4 m (Figure 3-6).

3.3 Side-Scan Sonar

A complete 100 kHz image mosaic, representing 200% side-scan bottom coverage, was created for the entire NLDS Seawolf Mound survey area (Figure 3-7). In the mosaic, darker areas represent stronger acoustic returns (higher reflectance) and indicate dense seafloor surface materials, while the lighter areas of the mosaic represent weaker acoustic returns (low reflectance) and indicate softer seafloor surface material (unconsolidated fine sand, silt, or clay). Although some resolution was lost when creating the small-scale mosaic over a large area, the survey provided a useful overview of the site and enabled a broad seafloor characterization of the entire survey area.

Based on the full area mosaic, the majority of the survey area was characterized by lower density sediments comprised of fine-grained sediment (silt to fine sand), consistent with the findings of previous surveys (Figure 3-7). However, a high reflectance feature was prominent across the center and toward the western part of the mosaic. This darker

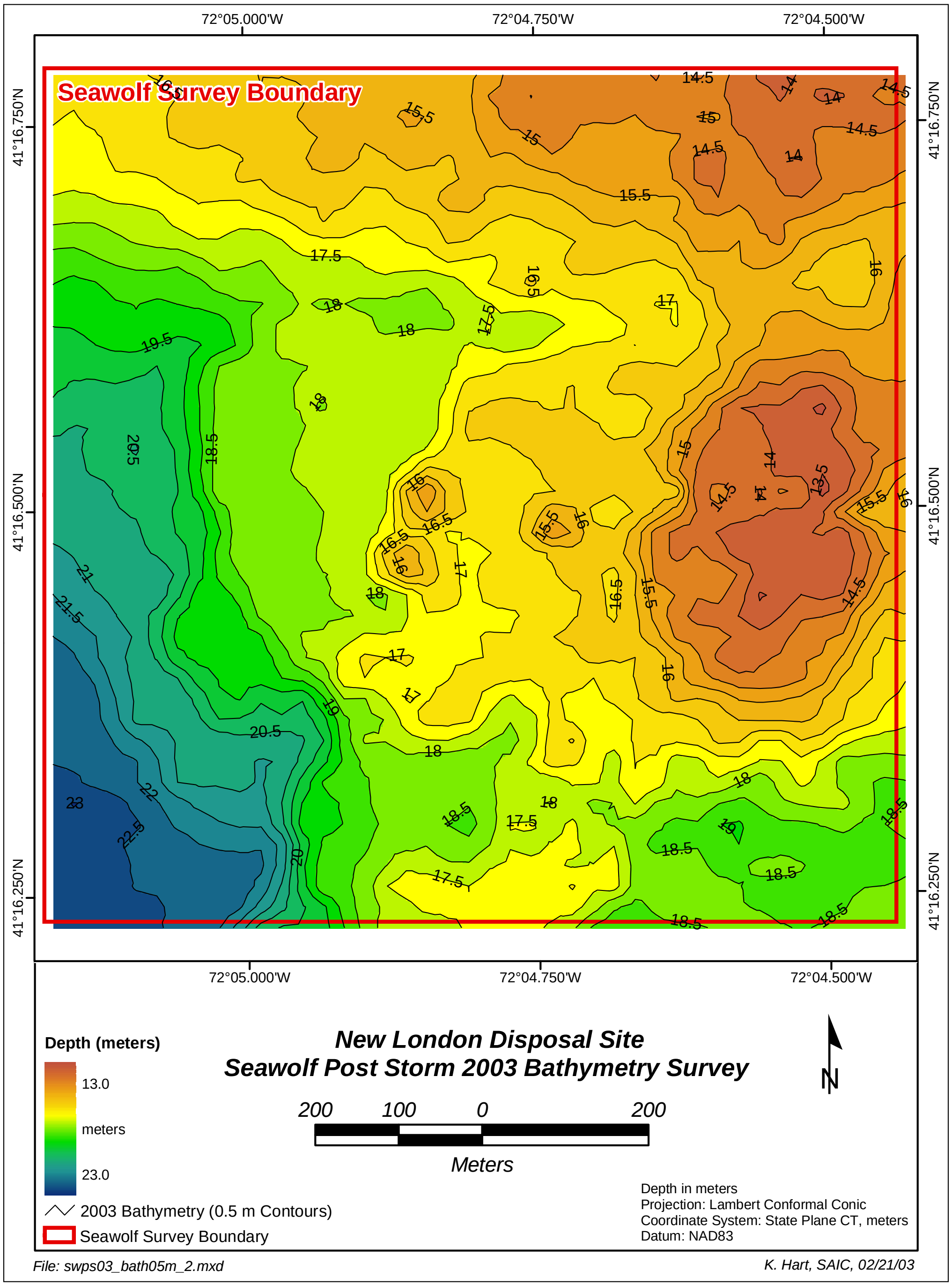


Figure 3-3. Bathymetric chart of the 1000 × 1000 m survey area occupied over the Seawolf Mound in February 2003, 0.5 m contour interval

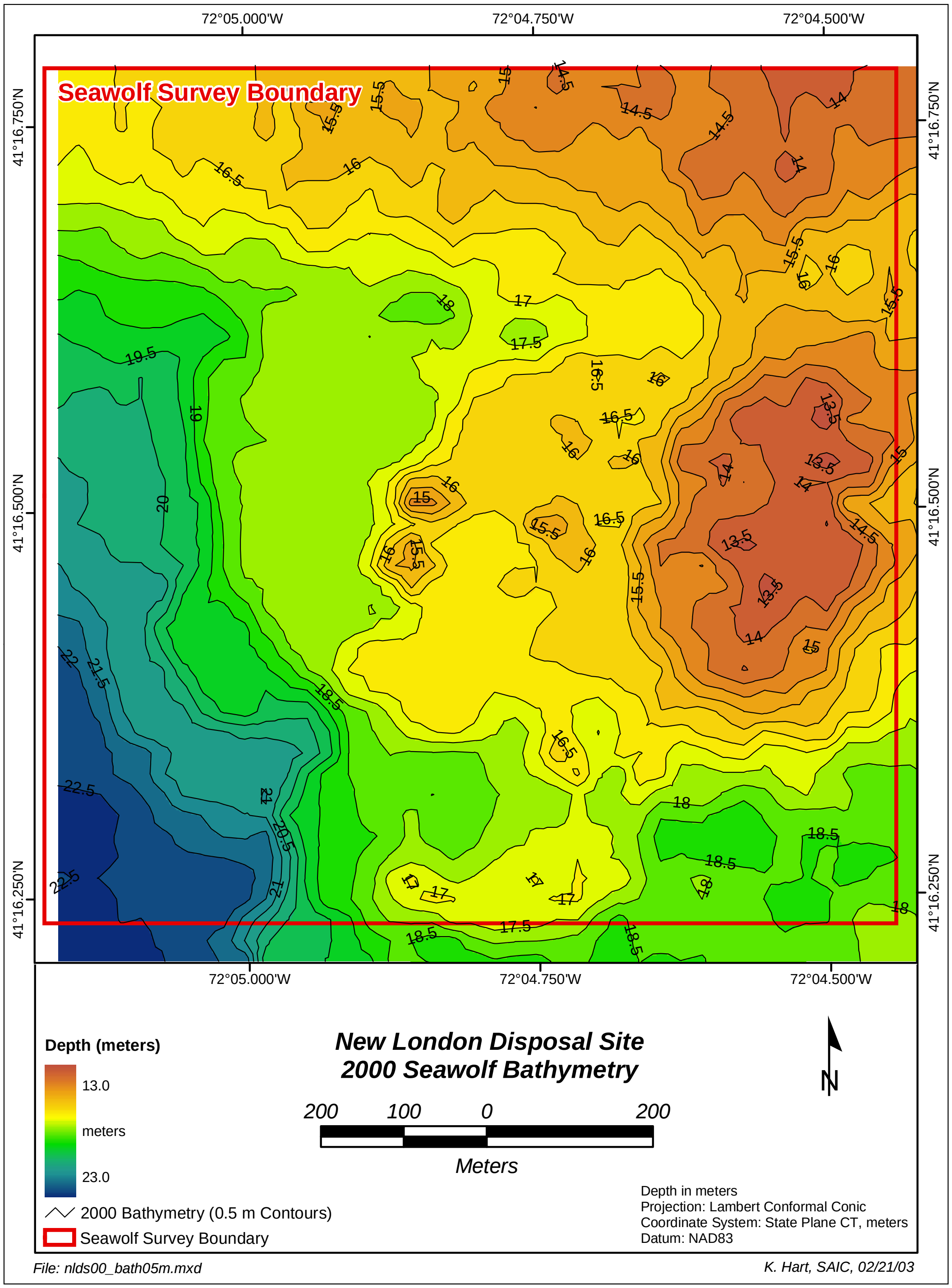


Figure 3-4. Bathymetric chart of the 1000 × 1000 m survey area occupied over the Seawolf Mound in August 2000, 0.5 m contour interval

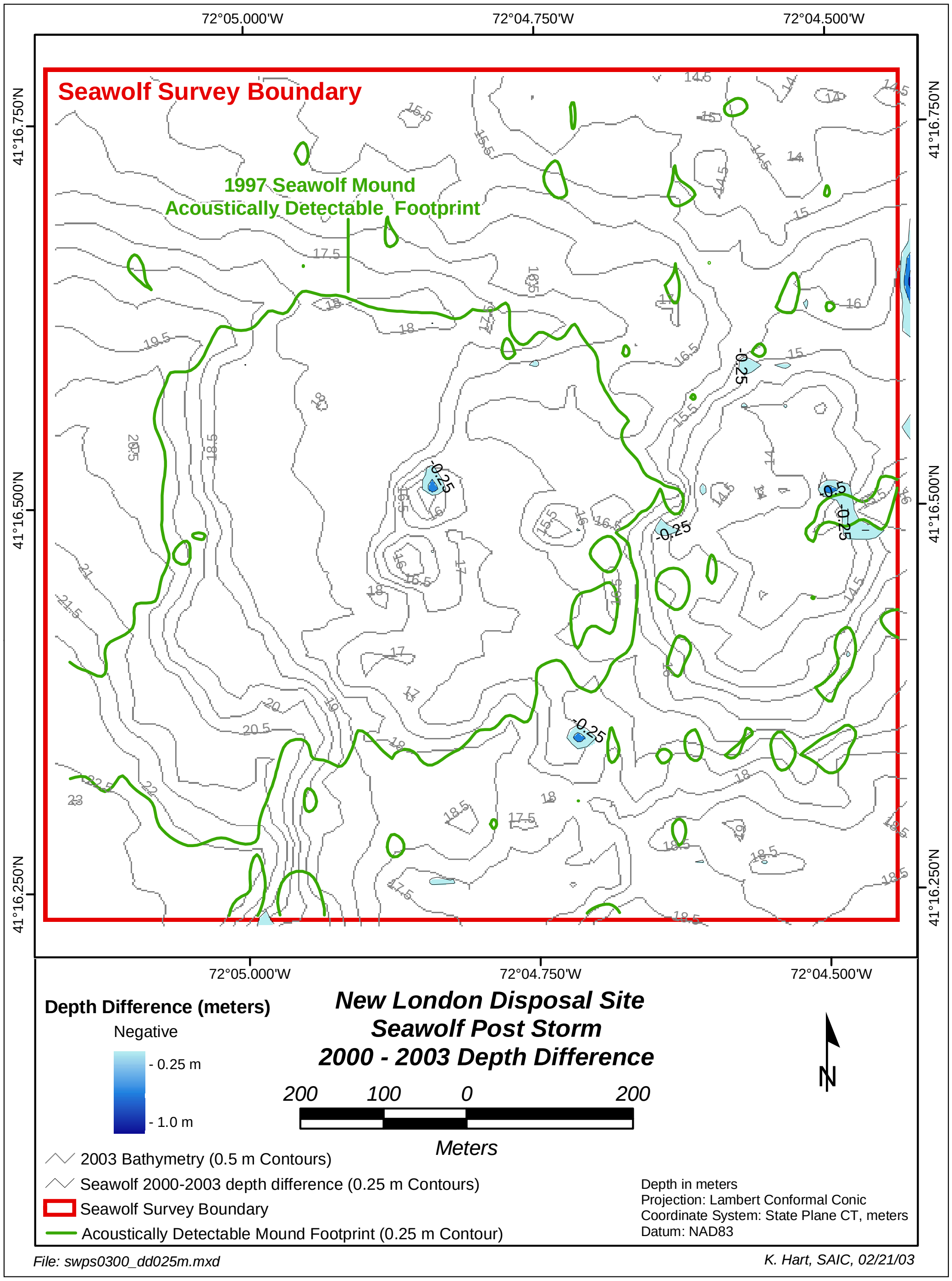


Figure 3-5. Depth difference comparison between the February 2003 and August 2000 bathymetric surveys showing apparent reduction in disposal mound height (blue) over the Seawolf Mound, 0.25 m contour interval

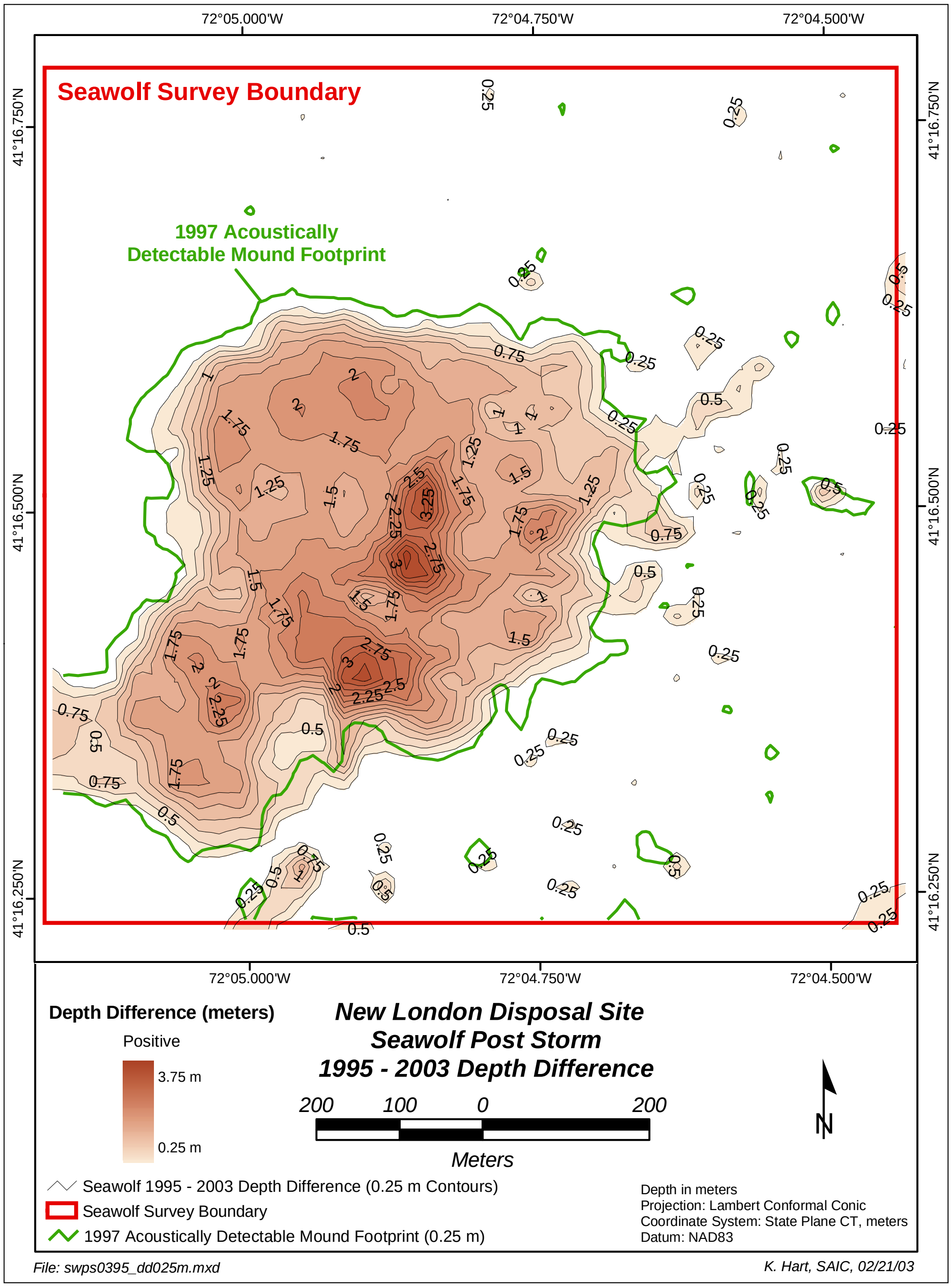


Figure 3-6. Depth difference comparison between the February 2003 post-storm and October 1995 baseline surveys displaying the acoustically detectable dredged material thickness and disposal mound footprint (red) relative to the footprint detected in the July 1997 monitoring survey (green)

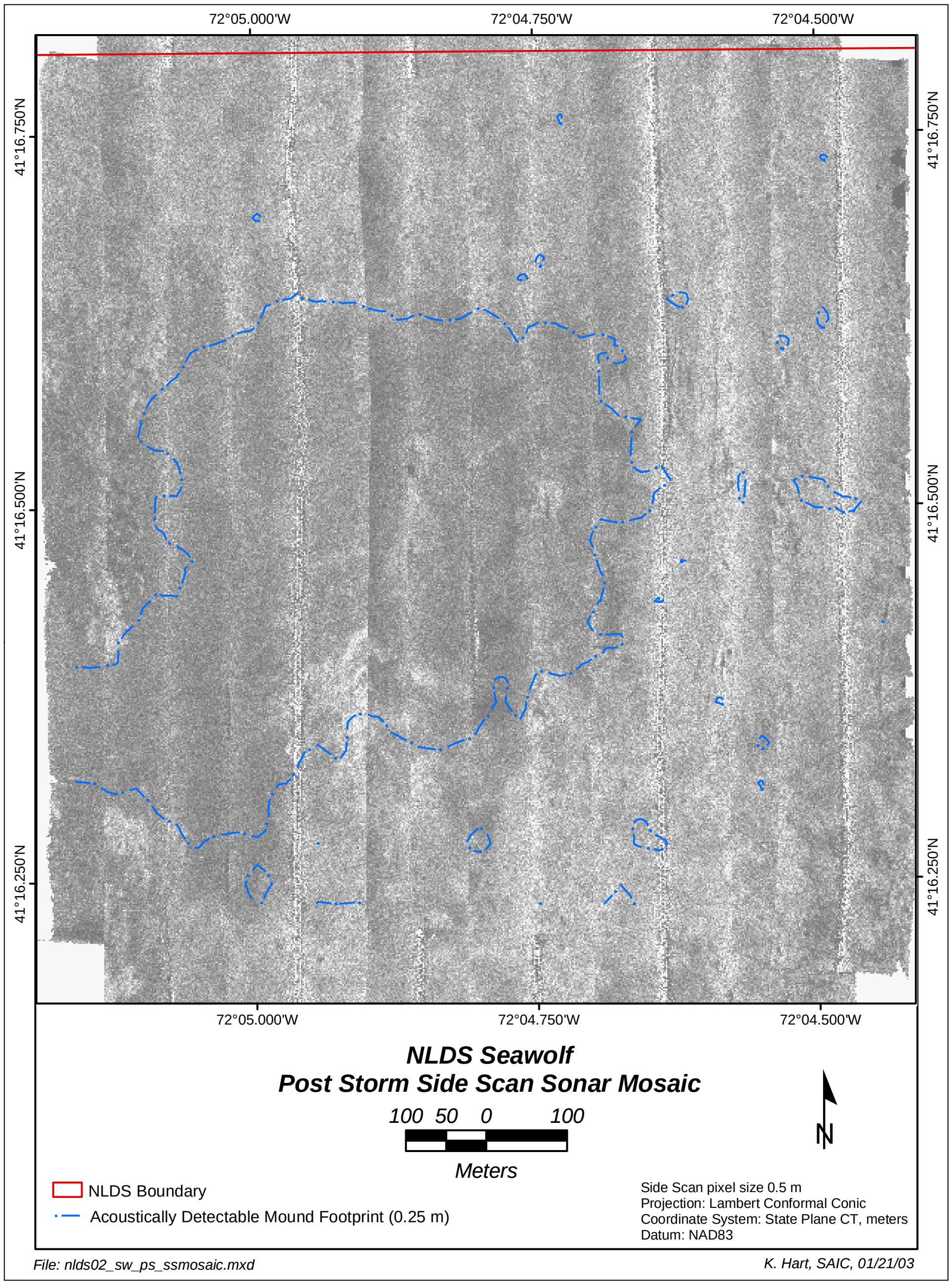


Figure 3-7. Side-scan sonar mosaic developed for the Seawolf Mound as part of the October 2002 post-storm monitoring survey. The darker acoustic returns correlate with the 1997acoustically detectable mound footprint (blue) and are indicative of a dense, firm surficial sediment layer (Gardiner's Clay).

area corresponds with the acoustically detectable footprint of the Seawolf Mound and is likely the product of the firm glacial clay cap material (i.e., Gardiners Clay) (Figure 3-7). The high reflectance area shows the position and extent of the Seawolf cap material and displays the contrast in surface texture between the dredged material deposit and historic bottom sediments. Although some resolution was lost in the mosaic, the individual survey lanes provided further information regarding small-scale features (i.e., lobster traps) on the seafloor.

Large-scale erosional surfaces caused by resuspension of sediment during the October storm event were not evident in either the side-scan sonar mosaic (due to its scale) or in individual survey lane data. In side-scan sonar surveys, sand waves or scattering of high-reflectance sediment (possibly indicating a reshaping of the disposal mound) could indicate movement of sediment caused by high-amplitude surface waves during a storm event. Such features were not present in the data. Furthermore, as discussed previously, the shape and size of the mound corresponded well with the acoustically detectable mound footprint indicating that the storm event did not have a significant impact on the distribution of dredged material on the seafloor (Figure 3-7). When combined with the bathymetric data, the side-scan sonar mosaic did not display any strong correlations to water depth or seafloor morphology (Figure 3-8).

3.4 REMOTS® Sediment-Profile Imaging

3.4.1 Seawolf Mound

REMOTS® sediment-profile imaging was used to evaluate evidence of surface disturbance and to monitor cap distribution over the Seawolf disposal mound following a significant storm event in eastern Long Island Sound. An additional objective of the REMOTS® survey was to assess the distribution of dredged material and evaluate the continued recovery of the surface sediments over the Seawolf Mound within the boundaries of NLDS by assessing benthic conditions and infaunal successional status. These results were then compared to ambient sediment data obtained from three reference areas surrounding the disposal site; data were further compared to previous surveys to monitor cap distribution. The complete set of October 2002 REMOTS® image analysis results for the disposal mound and reference area stations is provided in Appendix A; these results are summarized in Tables 3-1 and 3-2.

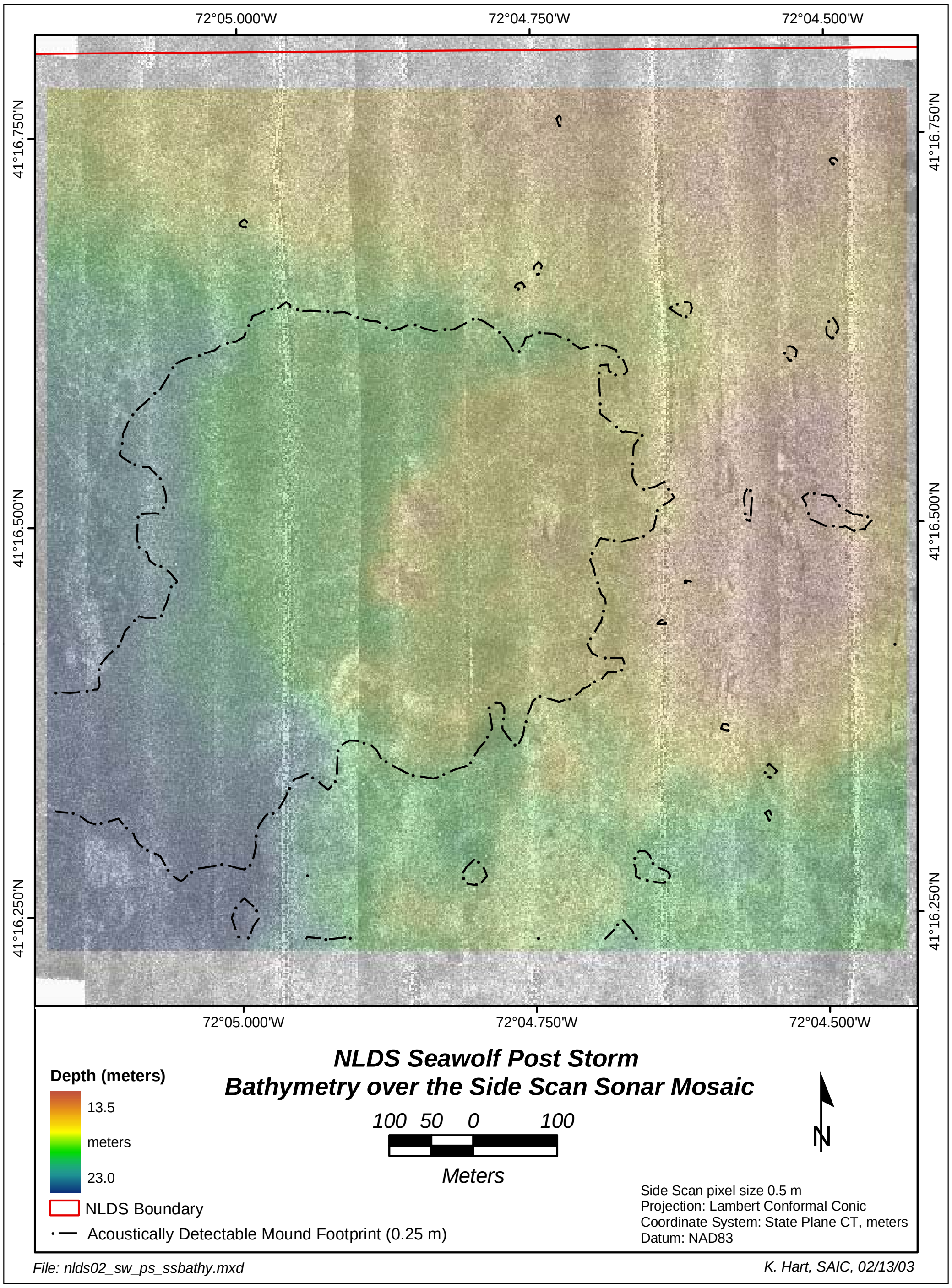


Figure 3-8. Map showing the bathymetric data overlaid on the side-scan sonar mosaic from the post-storm monitoring survey performed over the Seawolf Mound at NLDS

Table 3-1. REMOTS® Sediment-Profile Imaging Results Summary for the Seawolf Mound, October 2002

Station	Grain Size Major Mode (# replicates)	Camera Penetration Mean (cm)	Dredged Material Thickness Mean (cm)	Number Of Reps with Dredged Material	Boundary Roughness Mean (cm)	Successional Stages Present	Highest Stage Present	RPD Mean (cm)	OSI Mean	OSI Median
150E	> 4 phi (3)	13.24	> 13.24	3	0.72	I,III	ST I on III	1.83	6.67	7
150N	> 4 phi (3)	13.18	> 13.18	3	1.77	I,II,III	ST II on III	2.15	7.00	8
150NE	> 4 phi (3)	14.61	> 14.61	3	1.12	I,III	ST III	3.02	8.33	10
150NW	> 4 phi (3)	14.54	> 14.54	3	1.51	I,III	ST III	2.17	7.00	8
150S	> 4 phi (3)	14.82	> 14.82	3	0.79	I,II,III	ST II on III	3.07	9.33	10
150SE	> 4 phi (2), 4 to 3 phi (1)	12.44	> 12.44	3	1.45	I,III	ST I on III	2.70	8.00	8
150W	> 4 phi (3)	16.13	> 16.13	3	0.60	I,II,III	ST II on III	2.41	8.67	9
150WSW	> 4 phi (3)	15.17	> 15.17	3	2.02	I,II,III	ST I on III	2.53	7.33	8
300E	2 to 1 phi (3)	3.49	> 3.49	3	1.75	I	ST I	3.01	5.33	5
300N	> 4 phi (3)	15.83	> 15.83	3	1.12	I,III	ST I on III	2.57	6.33	6
300NE	> 4 phi (3)	16.75	> 16.75	3	1.05	I,II,III	ST II on III	3.65	9.33	9
300NW	> 4 phi (3)	15.15	> 15.15	3	1.07	I,II,III	ST II on III	1.77	6.67	8
300S	> 4 phi (2), 3 to 2 phi (1)	12.67	> 12.67	3	1.90	I,INDET	ST I	2.28	4.50	4.5
300SE	> 4 phi (2), 4 to 3 phi (1)	8.55	> 6.52	2	3.28	I,III	ST I on III	2.42	7.33	8
300W	> 4 phi (3)	11.59	> 11.59	3	1.09	I,II	ST II	1.64	4.33	4
300WSW	> 4 phi (3)	15.48	> 15.48	3	1.57	I,III	ST I on III	2.99	9.67	10
450N	> 4 phi (1), 4 to 3 phi (2)	8.90	0.00	0	1.40	I,III	ST I on III	2.52	7.33	8
450NE	> 4 phi (2), 4 to 3 phi (1)	11.19	> 7.60	2	1.06	I,II,III	ST II on III	2.22	7.33	8
450NW	4 to 3 phi (3)	11.42	0.00	0	1.76	I,II,III	ST II on III	2.64	9.00	9
450WSW	> 4 phi (3)	16.57	> 16.57	3	1.16	I,II,III	ST I on III	2.42	6.67	7
75E	> 4 phi (3)	14.19	> 14.19	3	1.29	I,III	ST I on III	1.58	6.33	7
75N	> 4 phi (3)	12.24	> 12.24	3	2.82	I,II	ST II	2.57	5.67	7
75NE	> 4 phi (3)	13.27	> 13.27	3	0.62	I,III	ST I on III	2.62	6.33	6
75NW	> 4 phi (3)	13.44	> 13.44	3	0.88	I,III,INDET	ST I on III	2.88	7.50	7.5
75S	> 4 phi (3)	16.08	> 16.08	3	0.70	I,II,III	ST II on III	3.28	9.00	11
75SE	> 4 phi (3)	13.93	> 13.93	3	1.14	I,II,III	ST II on III	2.71	7.67	9
75W	> 4 phi (3)	16.19	> 16.19	3	1.13	I,III	ST I on III	2.23	7.00	8
75WSW	> 4 phi (3)	17.54	> 17.54	3	0.84	I,II,III	ST I on III	2.22	7.33	8
CTR	> 4 phi (3)	12.75	> 12.75	3	2.02	I,II,III	ST III	2.03	7.33	8
AVG		13.49	> 12.60	2.7	1.37			2.49	7.25	7.8
MAX		17.54	> 17.54	3.0	3.28			3.65	9.67	11
MIN		3.49	0.00	0.0	0.60			1.58	4.33	4

Table 3-2. REMOTS® Sediment-Profile Imaging Results Summary from the NLDS Reference Areas, October 2002

Station	Grain Size Major Mode (# replicates)	Camera Penetration Mean (cm)	Boundary Roughness Mean (cm)	Successional Stages Present	Highest Stage Present	RPD Mean (cm)	OSI Mean	OSI Median
NE-REF								
1	> 4 phi (3)	9.74	0.60	II,III	ST II to III	2.85	8.00	8
2	> 4 phi (3)	9.04	0.65	II	ST II	2.46	6.67	7
3	> 4 phi (3)	10.18	0.84	II,III	ST II on III	3.19	9.00	10
4	> 4 phi (3)	9.32	0.48	II	ST II	3.19	7.67	8
NLON-REF								
1	> 4 phi (1), 4 to 3 phi (2)	4.89	1.44	I,INDET	ST I	2.01	4.50	4.5
2	4 to 3 phi (3)	7.13	0.51	II,III	ST II on III	2.16	7.00	6
3	4 to 3 phi (3)	3.53	1.42	II,INDET	ST II	3.08	8.00	8
4	4 to 3 phi (3)	4.09	0.72	II,III	ST II on III	2.33	7.33	7
WEST-REF								
1	> 4 phi (1), 4 to 3 phi (2)	7.88	1.06	I,II,III	ST II on III	2.31	6.00	5
2	4 to 3 phi (3)	4.53	1.19	I,III	ST I on III	2.12	5.67	5
3	3 to 2 phi (2), 4 to 3 phi (1)	3.84	1.08	I,INDET	ST I	2.20	4.50	4.5
4	3 to 2 phi (3)	4.45	1.04	I	ST I	2.13	4.33	4
5	3 to 2 phi (3)	8.08	0.98	I,II,III	ST II on III	2.19	6.33	6
AVG		6.67	0.92			2.48	6.54	6.4
MAX		10.18	1.44			3.19	9.00	10
MIN		3.53	0.48			2.01	4.33	4

3.4.1.1 Dredged Material Distribution and Physical Sediment Characteristics

Historic dredged material was evident in the REMOTS® images at the majority of the Seawolf Mound stations occupied. When present, the thickness of the historic dredged material exceeded the penetration depth of the REMOTS® camera (i.e., dredged material greater than penetration; Table 3-1; Figure 3-9). The dredged material comprising the surface sediments within the Seawolf Mound was fine-grained, composed mainly of silt-clay (>4 phi), while the reference areas were characterized by a mixture of surface sediments that were either very fine sand (4 to 3 phi), fine sand (3 to 2 phi), or silt-clay (>4 phi; Tables 3-1 & 3-2; Figure 3-10). In addition, surface sand overlying fine-grained sediment (sand over mud stratigraphy) was noted at many stations (Figure 3-11). This generally consisted of thin, distinct layers of sand accumulation at the sediment-water interface in replicate images from stations 75NE, 75NW, 75S, 75SE, 75W, 75WSW on the plateau located around the mound center, and stations 300S, 300SE, and 300WSW near the edges of the mound (Appendix A1).

Ambient sediment consisting of silty sand, often poorly sorted, was detected in all replicates of Stations 450N and 450NW and in one replicate each of Stations 300SE and 450NE located on the outer edges of the cap deposit (Appendix A1; Figure 3-9). Dredged material was detected at Station 300E. However this sediment does not appear to be Seawolf Mound CDM (gray clay); rather it consists of a poorly sorted mixture of sand and pebbles (Figure 3-12). Based on apparent similarities between the dredged material at Station 300E and the recently deposited supplemental CDM over the nearby Dow/Stonington (D/S) Mound, it is possible this consists of material that was intended for disposal at the D/S Mound approximately 400 m to the southeast.

The penetration depth of the sediment-profile camera serves as a measure of sediment density or compaction. Mean camera penetration measurements for the Seawolf Mound stations varied from 3.5 cm at Station 300E, where poorly sorted medium sand, shells, and pebbles were present, to 17.5 cm at Station 75WSW (Table 3-1). The overall average of 13.5 cm indicates relatively soft sediments exist over the Seawolf Mound. Camera prism pull-aways prevented the analysis of key parameters (e.g., RPD, successional status, and OSI) in three replicate images.

The two apexes of the Seawolf Mound are represented by Stations CTR and 150N, which would have been the areas most likely impacted by storm wave erosion, as they exhibit the shallowest water depths over the mound. Two of the three replicate images at Station CTR displayed pebbles, rocks and large shell fragments (Figure 3-13A), and one replicate image at Station 150N included large shells at the surface. However, multiple

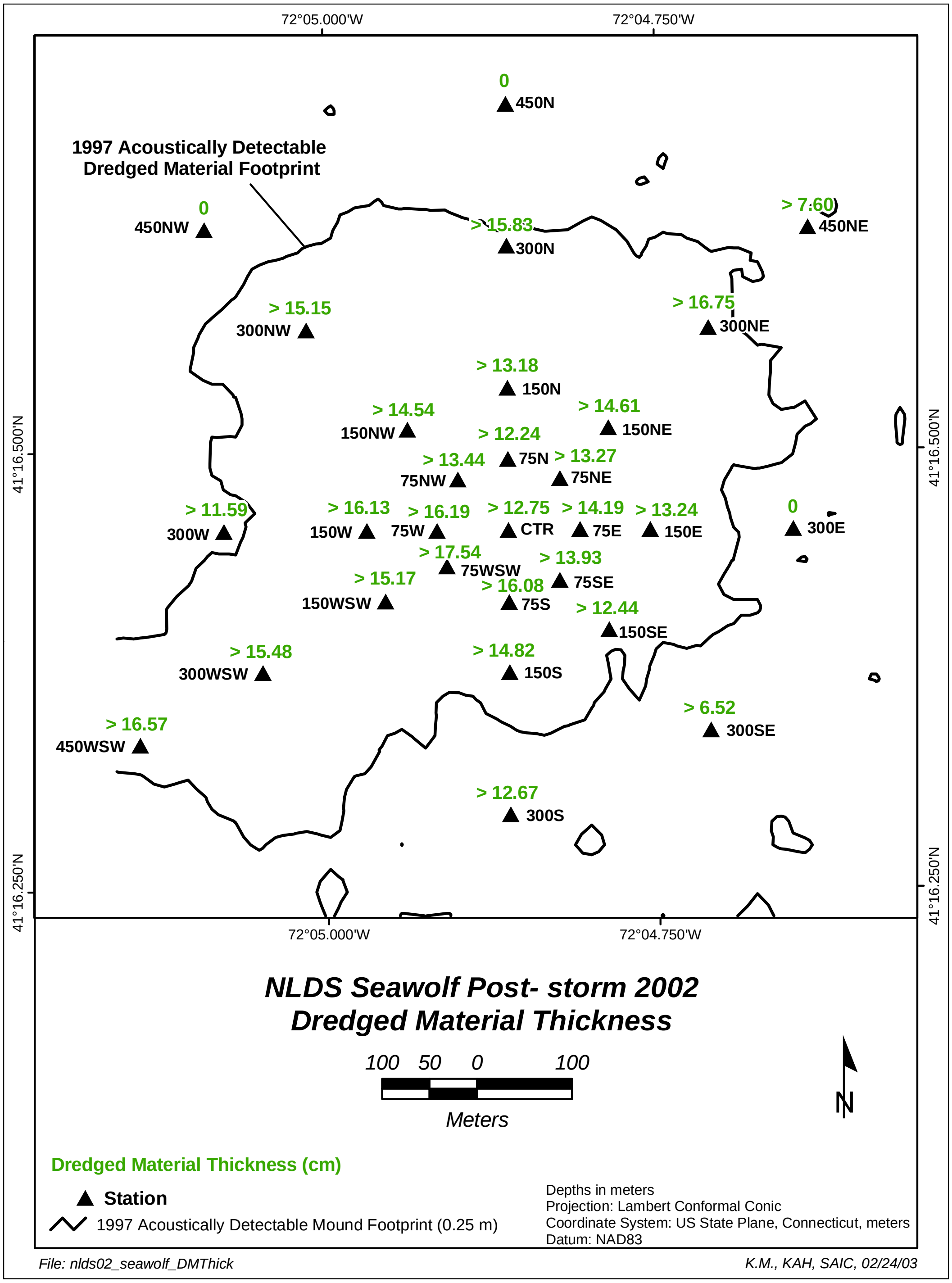
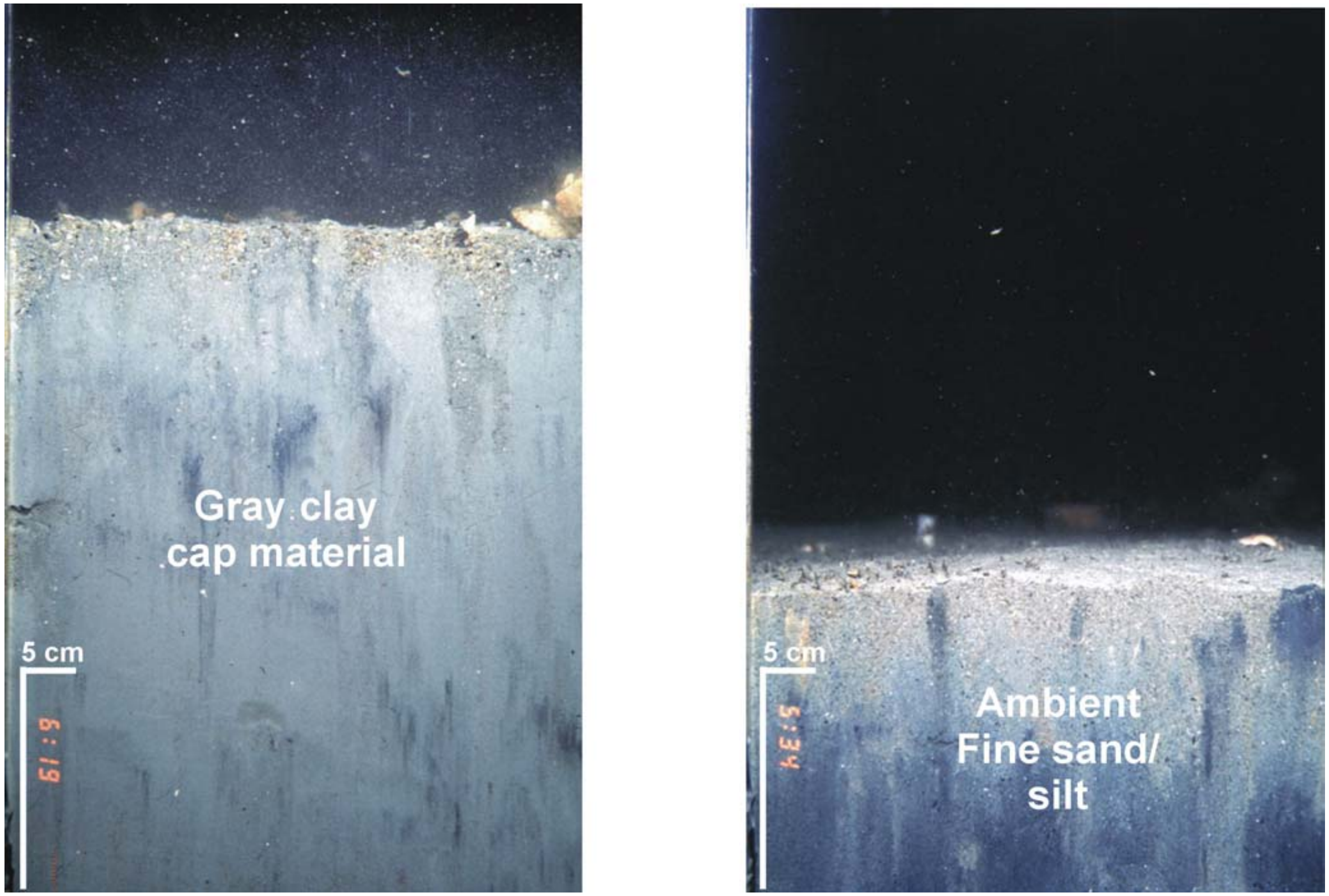


Figure 3-9. Map of dredged material thickness over the Seawolf Mound as detected by sediment-profile imaging



A **B**

Figure 3-10. REMOTS® images obtained from Seawolf Mound Station 150N (A) and reference area Station NLON-REF4 (B) illustrating fine-grained, gray cap material (>4 phi) characterizing the majority of the sediments over the Seawolf Mound and ambient fine sand and silt at the NLON reference area (4 to 3 phi).

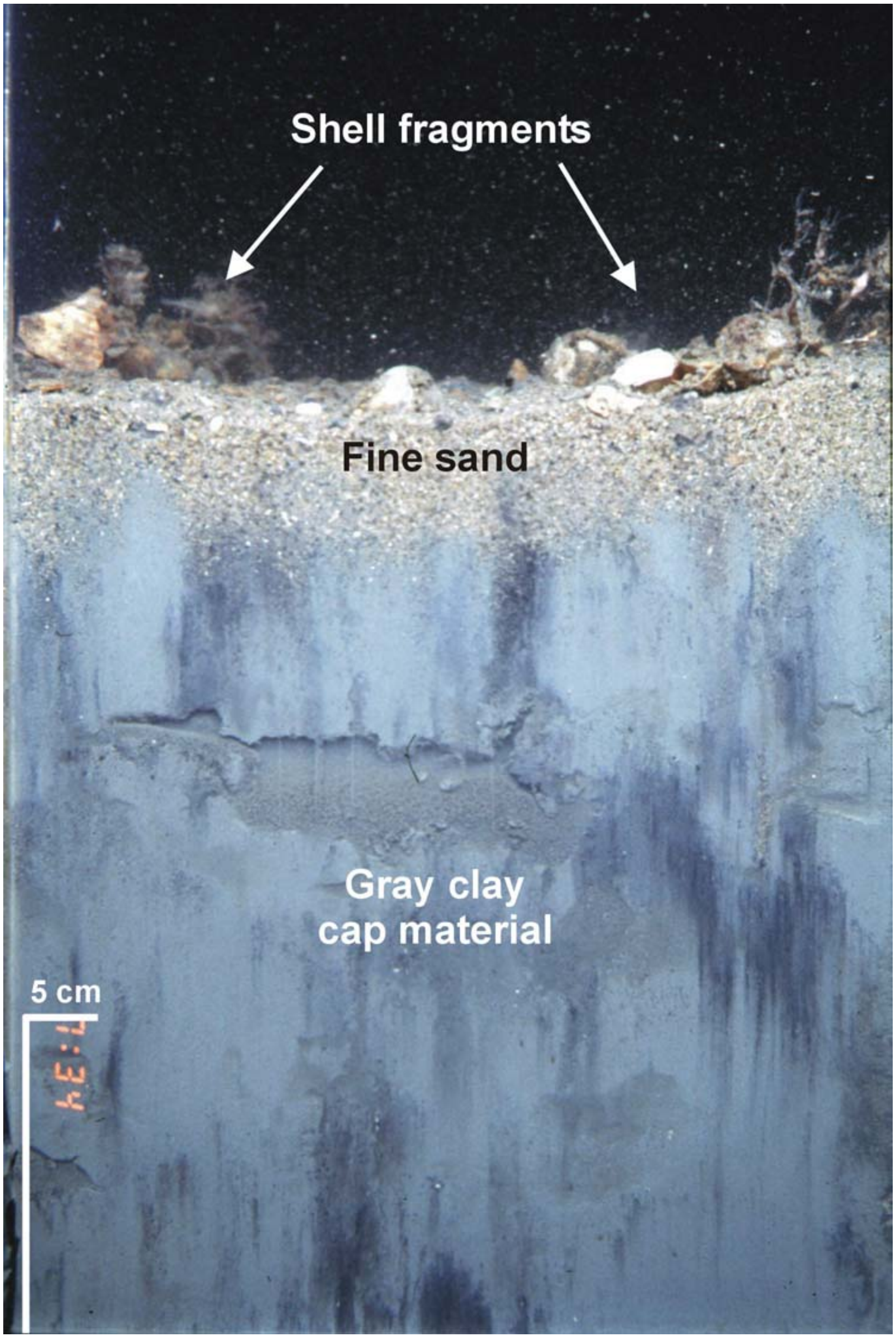
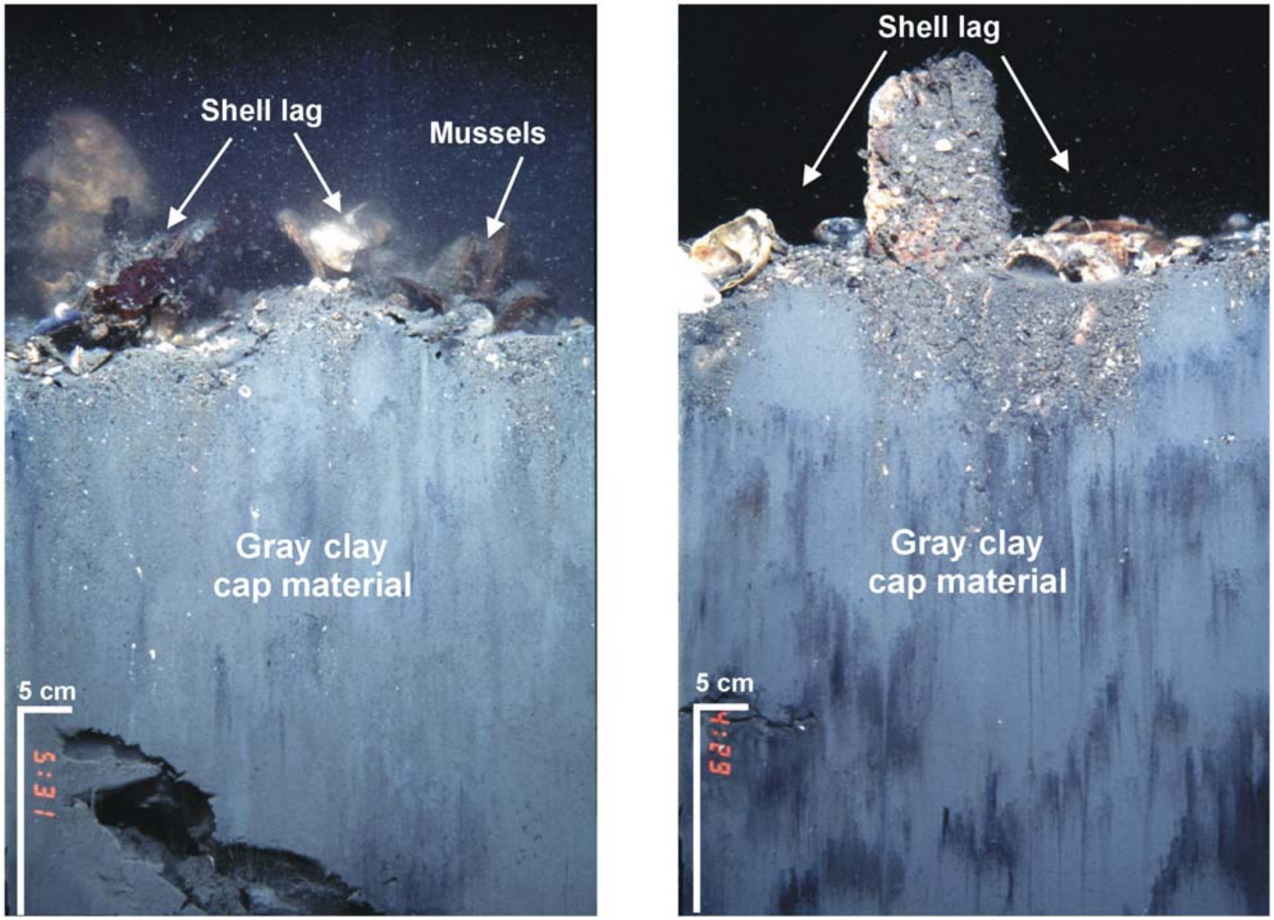


Figure 3-11. REMOTS® image collected from Station 150S displaying a sand over gray clay stratigraphy

Figure 3-12. REMOTS® image from Station 300E illustrating dredged material comprised of poorly sorted sand and pebbles, likely representative of newly deposited CDM intended for the nearby Dow/Stonington (D/S) Mound. The presence of pebbles and shell hash over finer-grained sediment may suggest some minor small-scale winnowing of the surface sediments.



A **B**

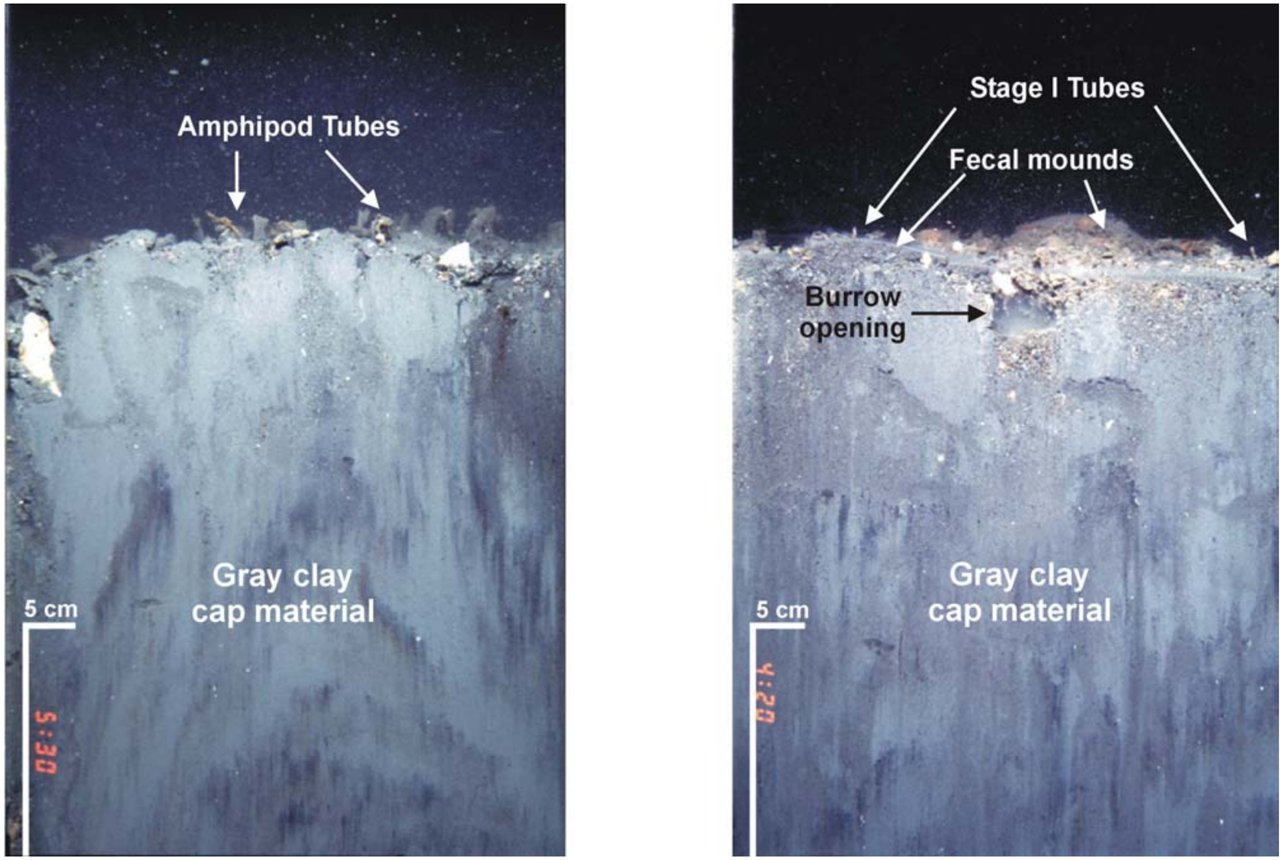
Figure 3-13. REMOTS® images from Stations CTR (A) and 150NW (B) as an example of sand, pebbles, and shells at the sediment-water interface resulting from small-scale erosion or winnowing stations across the Seawolf Mound also exhibited pebbles and large shells at the sediment-water interface as part of lag deposits and armoring layers (e.g., Station 150NW, Figure 3-13B; Station 300S and 300SE).

Additionally, the images from Station CTR (Figure 3-14A) and Station 150N (Figure 3-10A) also indicated the presence of undisturbed polychaete and amphipod tubes, fecal mounds, and burrow openings that are indicative of minimal surface disturbance. Overall, surface conditions at the two mound apex stations were not anomalous in comparison to the other Seawolf Mound stations, suggesting no difference in storm effects at the shallowest portions of the mound.

Replicate-averaged boundary roughness values for the REMOTS® stations over the Seawolf Mound ranged from 0.6 cm at Station 150W to 3.3 cm at Station 300SE, with an overall average of 1.4 cm indicating only minor small-scale surface relief (Table 3-1). There was no obvious spatial pattern to these relatively low boundary roughness values across the surveyed area. In general, boundary roughness values at the reference areas were lower than those at the Seawolf Mound and were mainly attributed to biogenic activity (Table 3-2). Surface roughness at stations over the Seawolf Mound was primarily attributed to physical effects in 73 of the 87 replicate images (84%). This includes the pebbles, shells and/or shell hash over finer grained sediment that were observed in many of the replicate images over the Seawolf Mound suggesting some small-scale winnowing may be occurring over certain stations (Figure 3-13). Evidence for biological surface reworking was detected in the remaining replicate images, including observations of burrowing infauna, burrow openings, biogenic mounds, polychaete tubes and amphipod tubes (*Ampelisca*) at the sediment-water interface (Figure 3-14). Surface roughness at Station CTR was somewhat variable, with one replicate indicating an armored, disturbed surface (physical) and another replicate displayed an intact amphipod tube mat (biological) suggesting minimal surface disturbance (Figure 3-14A).

3.4.1.2 Biological Conditions and Benthic Recolonization

Three parameters were used to assess the benthic recolonization rate and overall health of the disposal site relative to the reference areas: apparent Redox Potential Discontinuity (RPD) depth, Organism-Sediment Index (OSI), and infaunal successional status. These three parameters were mapped on station location plots to outline the biological conditions at each station at both the Seawolf Mound and the reference areas (Figures 3-15 and 3-16).



A **B**

Figure 3-14. REMOTS® images obtained from Stations CTR (A) and 300NW (B) illustrating biogenic surface roughness as a result of polychaete and amphipod tubes (*Ampelisca*), as well as fecal mounds and a burrow opening at the sediment-water interface. The presence of intact amphipod tubes over Station CTR, located at the mound apex, suggests minimal surface disturbance in this replicate image (A).

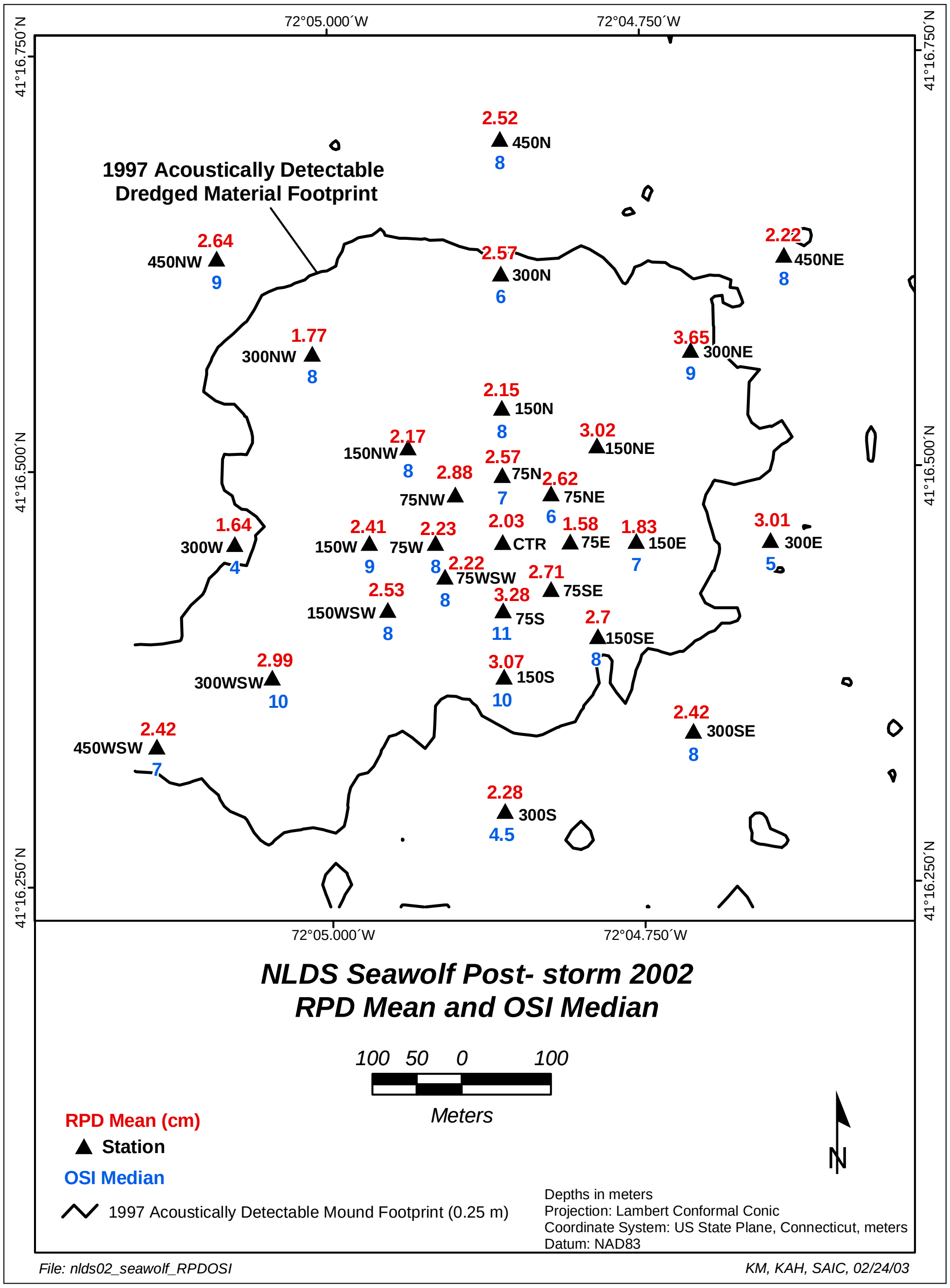


Figure 3-15. Map of mean RPD depths (red) and median OSI values (blue) calculated for the Seawolf Mound REMOTS® stations occupied during the October 2002 post-storm monitoring survey

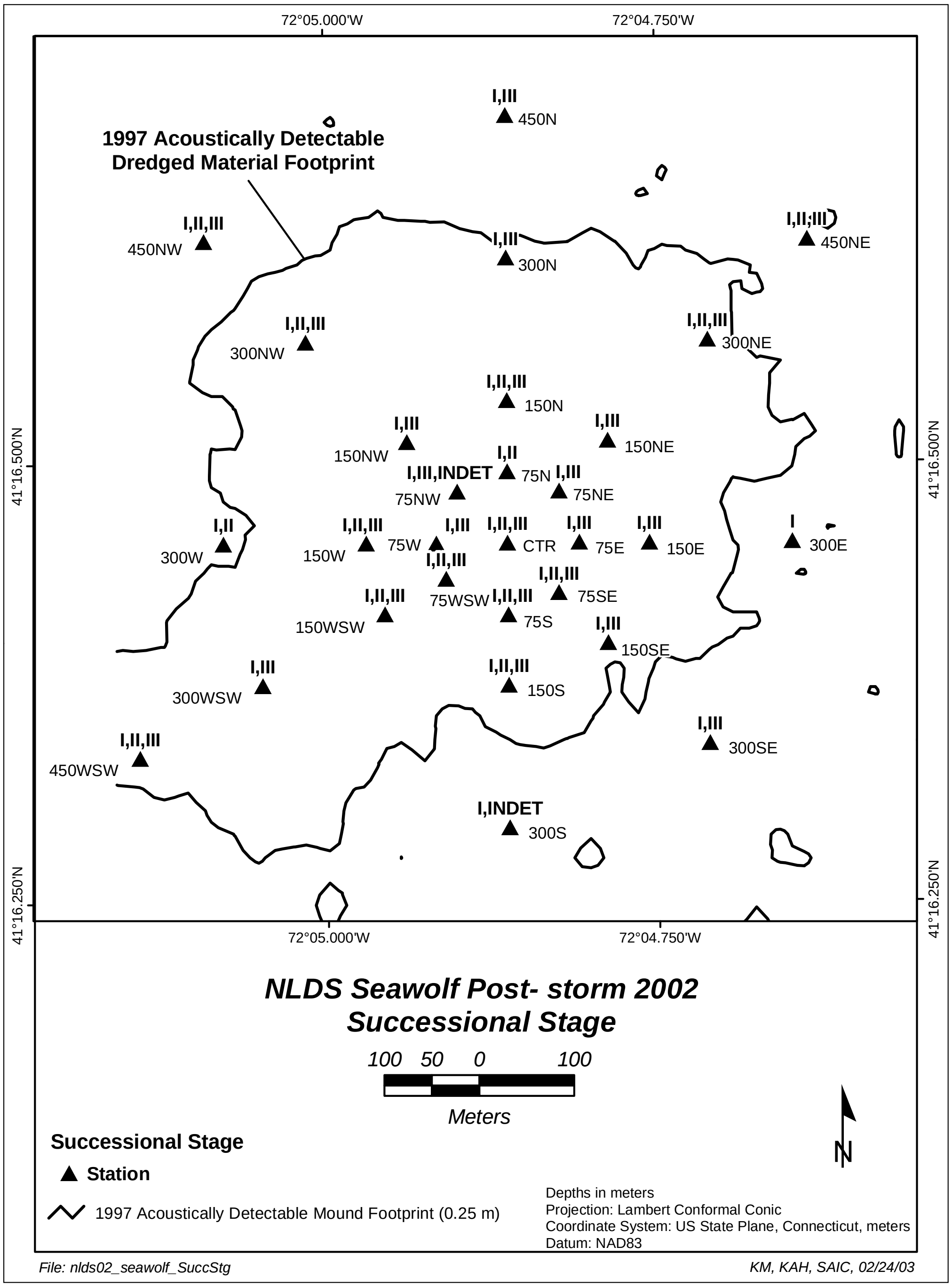


Figure 3-16. Map of successional stage assemblages present over the Seawolf Mound REMOTS® stations occupied during the October 2002 post-storm monitoring survey

The redox potential discontinuity (RPD) measured in each image provides an estimate of the apparent depth of oxygen penetration into the surface sediment. The replicate-averaged RPD measurements for the Seawolf Mound were moderately deep, ranging from 1.6 cm at Station 75E to 3.7 cm at Station 300NE (Table 3-1; Figure 3-15). The overall average RPD value of 2.5 cm was indicative of relatively well-aerated surface sediments. RPD values at the reference areas were similar to the disposal site, and displayed an overall average of 2.5 cm (Table 3-2). Replicate A of Station 300NE provided an example of a fairly deep RPD of 6.4 cm, with tan sandy silt over gray clay (Figure 3-17). The presence of relatively deep RPD depths within several days of a major storm event suggests that the surface sediments had not been significantly disturbed by the wind-generated waves (i.e., relatively deep RPD depths would indicate that no substantial erosion of surface sediments had occurred). None of the replicate images obtained within the Seawolf Mound showed any evidence of apparent low dissolved oxygen conditions, visible redox rebounds, or methane gas entrained within the sediment.

Infaunal successional status indicated the presence of an advanced benthic community across the Seawolf Mound. A mixture of Stage I polychaetes and Stage II amphipods was observed at the sediment surface together with Stage III feeding voids at depth (Stage I on III or II on III successional status; Table 3-1; Figures 3-16 and 3-17). Benthic infaunal populations composed of Stage I taxa only occurred at only 2 of the 29 stations (7%; Stations 300E and 300S). The sediments at most of the remaining stations appeared to be supporting larger bodied Stage III organisms, as evidence of Stage III activity was detected in 25 of the 29 stations (86%). Evidence of Stage III activity included active feeding voids produced by head-down, deposit-feeding infauna, as well as the actual imaging of errant polychaetes within the sediment matrix (Figure 3-17). Scattered or isolated Stage II tube-dwelling amphipods (*Ampelisca* sp.) were observed at the sediment-water interface at 15 of the 29 stations (52%; Figures 3-14A and 3-16). The reference areas also exhibited an advanced successional stage, with Stages II and/or III present at 10 of the 13 stations (Table 3-2). Overall, the presence of a diverse mixture of Stages I, II, and III at stations over the Seawolf Mound indicated an advanced benthic recolonization status; the benthic community remained relatively undisturbed despite the storm event.

Replicate-averaged median OSI values for the Seawolf Mound stations ranged from +4 at Station 300W to +11 at Station 75S (Table 3-1; Figure 3-15). The overall average of +7.8 reflects undisturbed or non-degraded benthic habitat conditions as a result of moderately deep RPDs and an advanced benthic recolonization status over the majority of the Seawolf Mound at the time of the survey (Figure 3-17). Lower OSI values ($\leq +6$) were observed primarily at the 300 m radius stations (300N, 300E, 300S, and 300W) located on the fringe of the cap and were primarily due to a reduction in Stage III activity

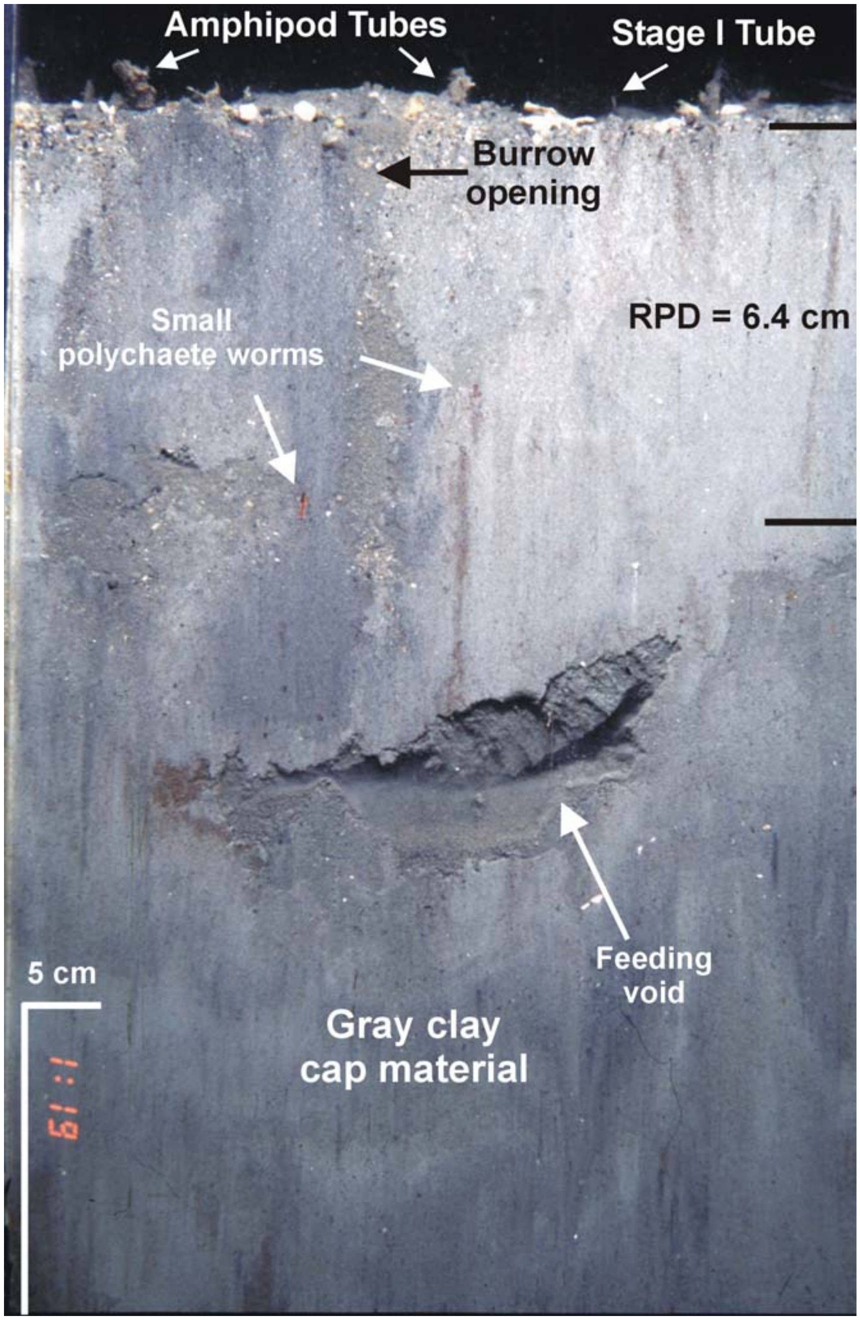


Figure 3-17. REMOTS® image collected from Station 300NE displaying Stage I polychaete tubes and Stage II amphipod tubes in historic dredged material over Stage III feeding voids at depth (Stage II on III successional status). A well developed RPD (6.4 cm) and an advanced successional status resulted in an OSI of +11 indicative of undisturbed benthic habitat quality.

at these stations (Figure 3-16). The overall average median OSI value for the Seawolf Mound was higher than the overall value calculated for the reference area stations (+7.8 Seawolf Mound vs. +6.4 Reference Areas). This can primarily be attributed to a greater prevalence of Stage III organisms at the Seawolf Mound stations than at the reference areas (see section 3.4.2.2 below).

3.4.2 NLDS Reference Areas

3.4.2.1 Physical Sediment Characteristics

A layer of tan sand over gray or black silty clay was observed at the NE-REF stations, while a higher input of sand (sand over muddy fine sand) was detected at the remaining NLON-REF and WEST-REF stations. Dredged material was not detected in any of the analyzed images. The major modal grain size was 4 to 3 phi (very fine sand) for most of the stations, however a grain size major mode of >4 phi (silt-clay) was observed at all the NE-REF stations, and a grain size major mode of 3 to 2 phi (fine sand) was detected at three of the WEST-REF stations (Table 3-2; Figures 3-10B and 3-18). Considerable amounts of shell fragments (hash/lag) and large shells were observed at a majority of the reference station replicates, particularly at WEST-REF. In addition, reduced sediment was observed at depth in many replicate images at the reference area stations, in particular WEST-REF stations (Figure 3-18).

Due to a higher fraction of sand at the reference area stations, reference area mean camera penetration values were relatively low, with the shallowest penetration (3.5 cm) at Station NLON-REF3 and the deepest penetration (10.2 cm) at Station NE-REF3 (6.7 cm mean; Table 3-2). Coarser surface sediments and the presence of shell fragments resulted in underpenetration of the camera prism and prevented the analysis of key parameters (e.g., RPD, successional status, and OSI) in a few replicate images.

Replicate-averaged boundary roughness values for the reference areas were lower than those of the disposal site stations, ranging from 0.5 cm at Station NE-REF4 to 1.44 cm at Station NLON-REF1 (overall average of 0.9 cm; Table 3-2). Surface roughness was attributed primarily to biogenic activity at the NE-REF and NLON-REF stations as a result of numerous juvenile and adult amphipod tubes (*Ampelisca*) as well as polychaete tubes at the sediment-water interface (Figure 3-19). Physical factors were the primary cause of surface roughness at the WEST-REF stations.

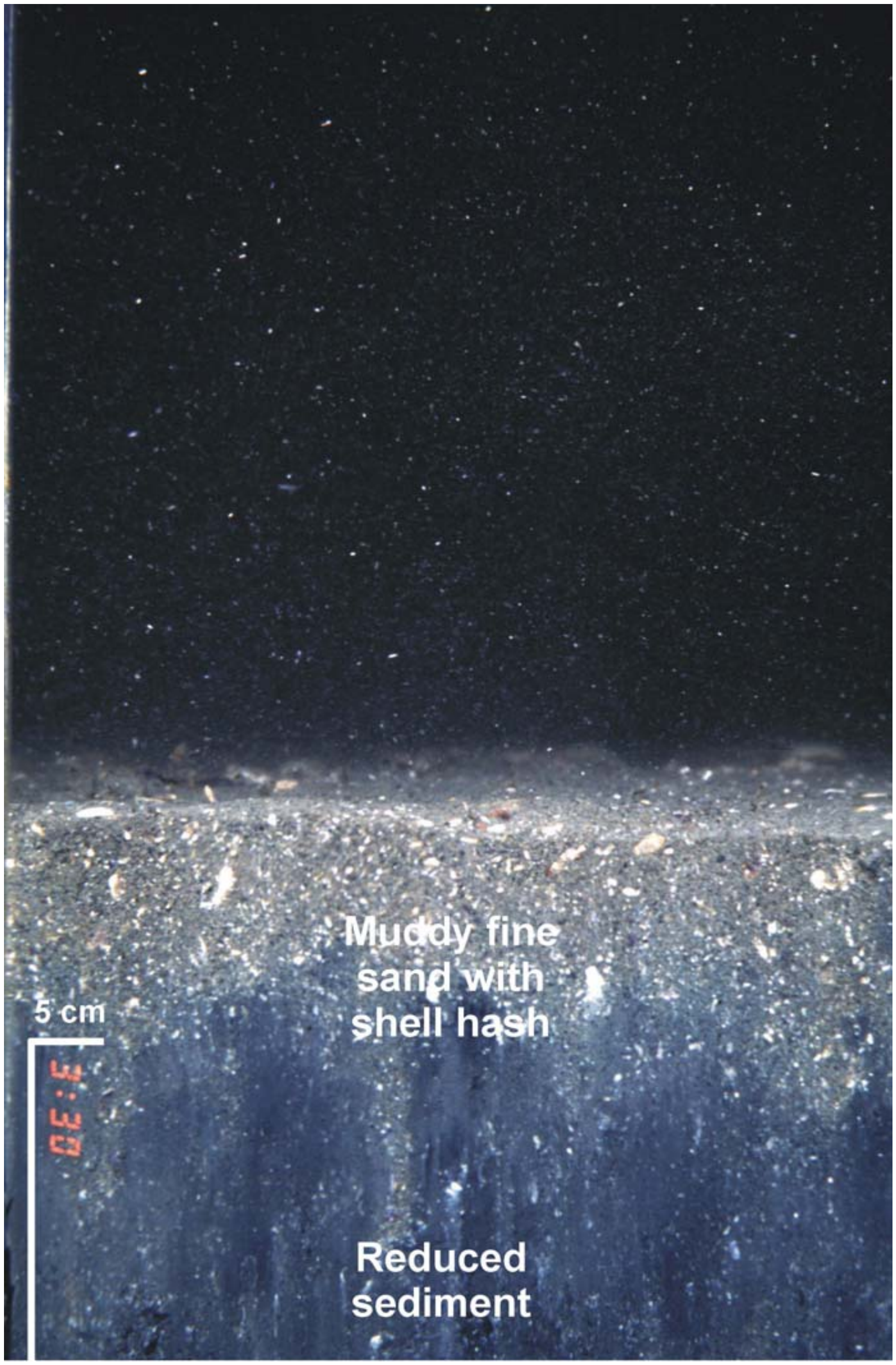
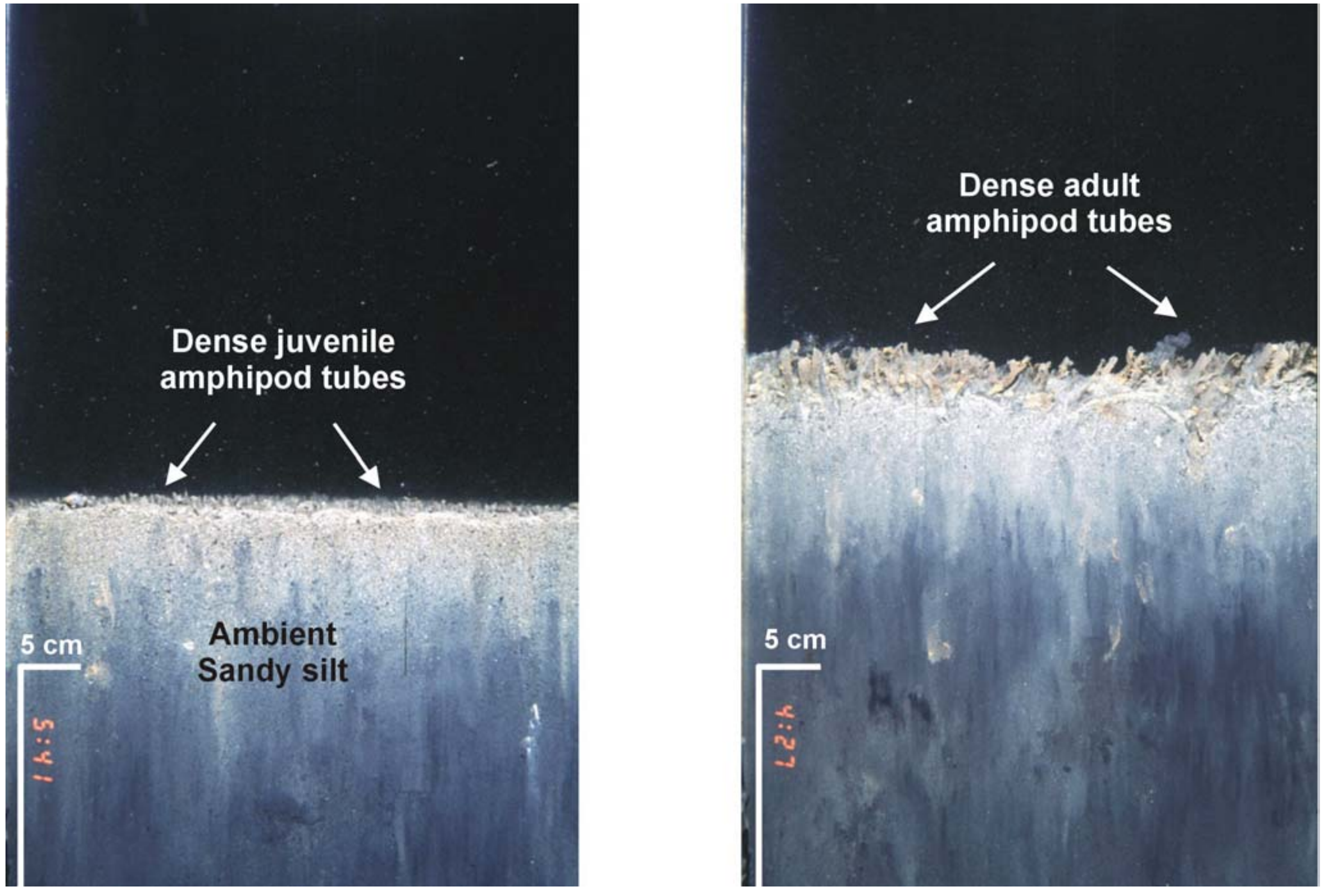


Figure 3-18. REMOTS® image from reference Station WEST-REF5 showing ambient muddy fine sand with considerable amounts of shell hash (grain size major mode of 3 to 2 phi). Reduced sediment is visible at sediment depth.



A **B**

Figure 3-19. REMOTS® images obtained from Stations NLON-REF2 (A) and NE-REF1 (B) displaying biogenic surface roughness and a Stage II successional status as a result of dense juvenile and adult amphipod tubes (*Ampelisca*) at the sediment-water interface.

3.4.2.2 Biological Conditions

The apparent mean RPD values at the reference areas ranged from 2.0 cm at Station NLON-REF1 to 3.2 cm at Stations NE-REF3 and NE-REF4 (Table 3-2). The overall average RPD value of 2.5 cm is considered indicative of well-oxygenated surface sediments within the reference areas and was comparable to the composite value calculated for the disposal site (2.5 cm). No indicators for low dissolved oxygen conditions, methane, or visible redox rebounds were present at the reference areas.

Similar to the disposal site stations, a combination of successional stages was observed at the reference areas, with surface-dwelling Stage I polychaetes, Stage II amphipods, and Stage III head-down, deposit feeding invertebrate communities present. Advanced Stage III activity occurred in 7 of the 13 reference area stations (54%), and when present was consistently accompanied by Stage I polychaetes and/or Stage II amphipods at the sediment-water interface (Table 3-2). Low-order seres (Stage I) occurred alone at 3 of the 13 stations (23%). Stage II and III individuals were absent from two stations at the WEST-REF reference area and one station from NLON-REF reference area. Dense aggregations (mat) of juvenile and adult tube-dwelling amphipods (*Ampelisca* sp.) were observed at the sediment-water interface at 9 of the 13 stations (69%; Figure 3-19).

Generally, the Seawolf Mound median OSI values (calculated from the replicate images for each station) were higher than at the reference areas, which ranged from +4 at Station WEST-REF4 to +10 at Station NE-REF3, and had an overall average of +6.4 (Table 3-2). The slightly lower values at the NLDS reference areas could be attributed to a slightly higher occurrence of only Stage I organisms and subsequent decrease in the evidence of advanced Stage III activity. However, the overall average of +6.4 at the reference areas is indicative of undisturbed or non-degraded benthic habit conditions (OSI values > +6). The highest median OSI value calculated for a reference area station, +10, corresponded to Station NE-REF3 where Stage III organisms and relatively deep RPD depths were detected in two replicate images (Figure 3-20).

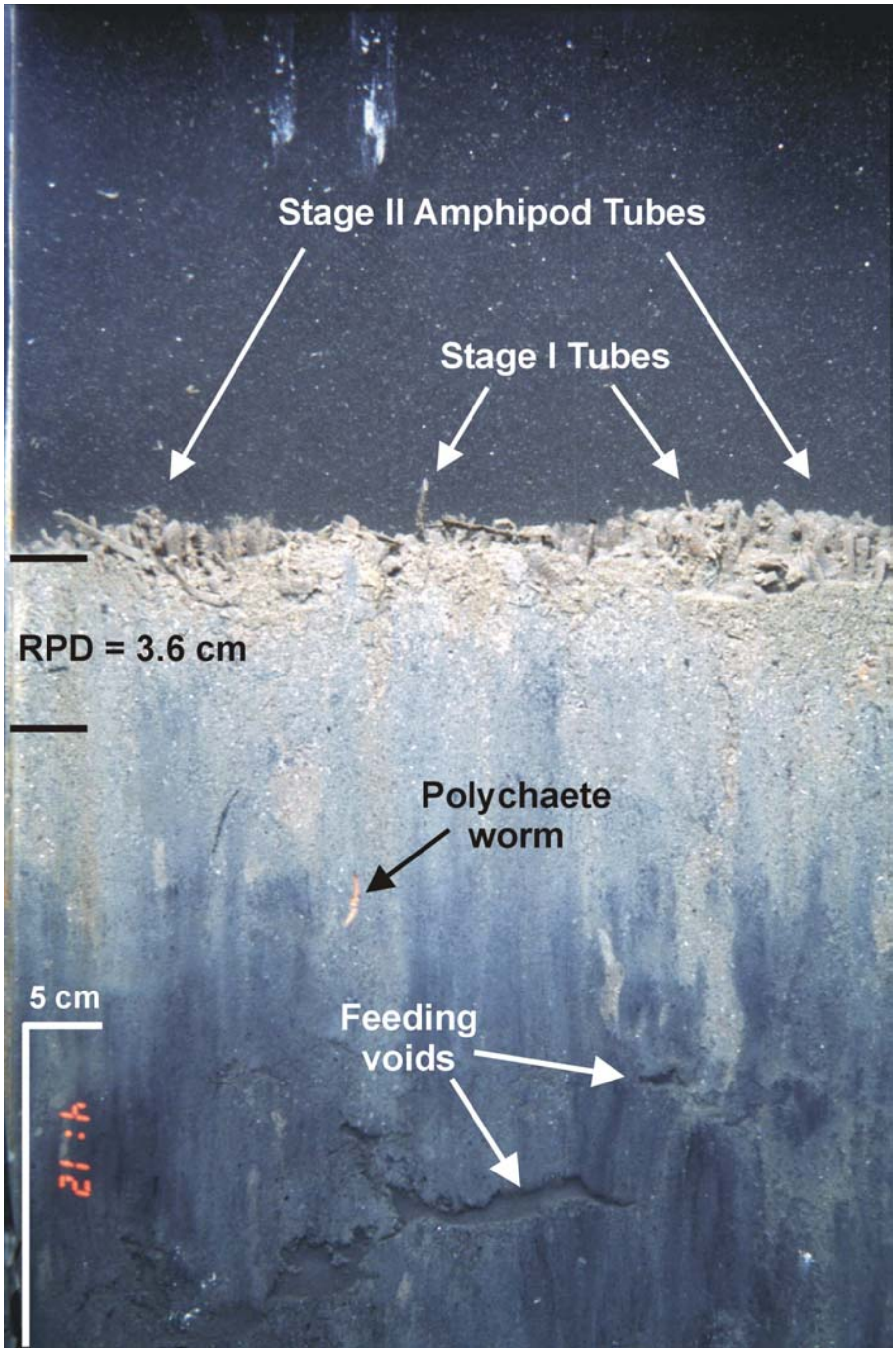


Figure 3-20. REMOTS® image from Station NE-REF3 illustrating biologically active sediment with a well developed RPD (3.6 cm) and an OSI of +10. Polychaete and amphipod tubes are visible at the sediment-water interface, while a burrowing polychaete is detected at depth.

4.0 DISCUSSION

4.1 Seawolf Mound Stability Following the Storm Event

Long-term monitoring of the Seawolf Mound has indicated the continued presence of a stable feature on the seafloor following initial mound consolidation (SAIC 2001b; SAIC 2001c). Comparisons of sequential bathymetric surveys over time has shown that the Seawolf Mound underwent a period of rapid and widespread consolidation in 1996 and 1997 soon after its development in the northwest quadrant of NLDS. Monitoring surveys performed since 1997 have documented a substantial decrease in disposal mound consolidation and the persistence of a stable feature on the seafloor (SAIC 2001b). The comparison of bathymetric surveys conducted over the Seawolf Mound in September 1997 and July 1998 indicated only small, isolated areas of apparent consolidation. When compared to the July 1998 results, the August 2000 survey showed no appreciable change in topography of the mound, indicating stable conditions. The post-storm bathymetry data were compared to the August 2000 survey, and the results indicated only small areas of minor depth changes on the order of 0.25 to 0.5 m.

The side-scan sonar data collected as part of the post-storm survey indicated the presence of a uniform mound surface composed of a higher density dredged material (characteristic of the clay cap material) relative to the surrounding sediments. No evidence indicating recent sediment resuspension or transport (i.e., bedforms, variation in surface sediment composition, etc.) was detected. These sonar results support the conclusions made from the bathymetric depth difference comparisons regarding the continued stability of the Seawolf Mound and general lack of appreciable (i.e., measurable) changes in mound height and morphology resulting from the October 2002 storm event.

In addition to using the bathymetric and side-scan sonar survey results to assess the post-storm condition of the Seawolf Mound, the REMOTS® survey results were used to identify smaller-scale (centimeter-level) evidence of scour at the mound surface. The sediment profile images provided more detail on surface conditions of the mound than could be obtained from the acoustic data, given the resolution of the bathymetric depth-difference comparisons and the side-scan sonar mosaic.

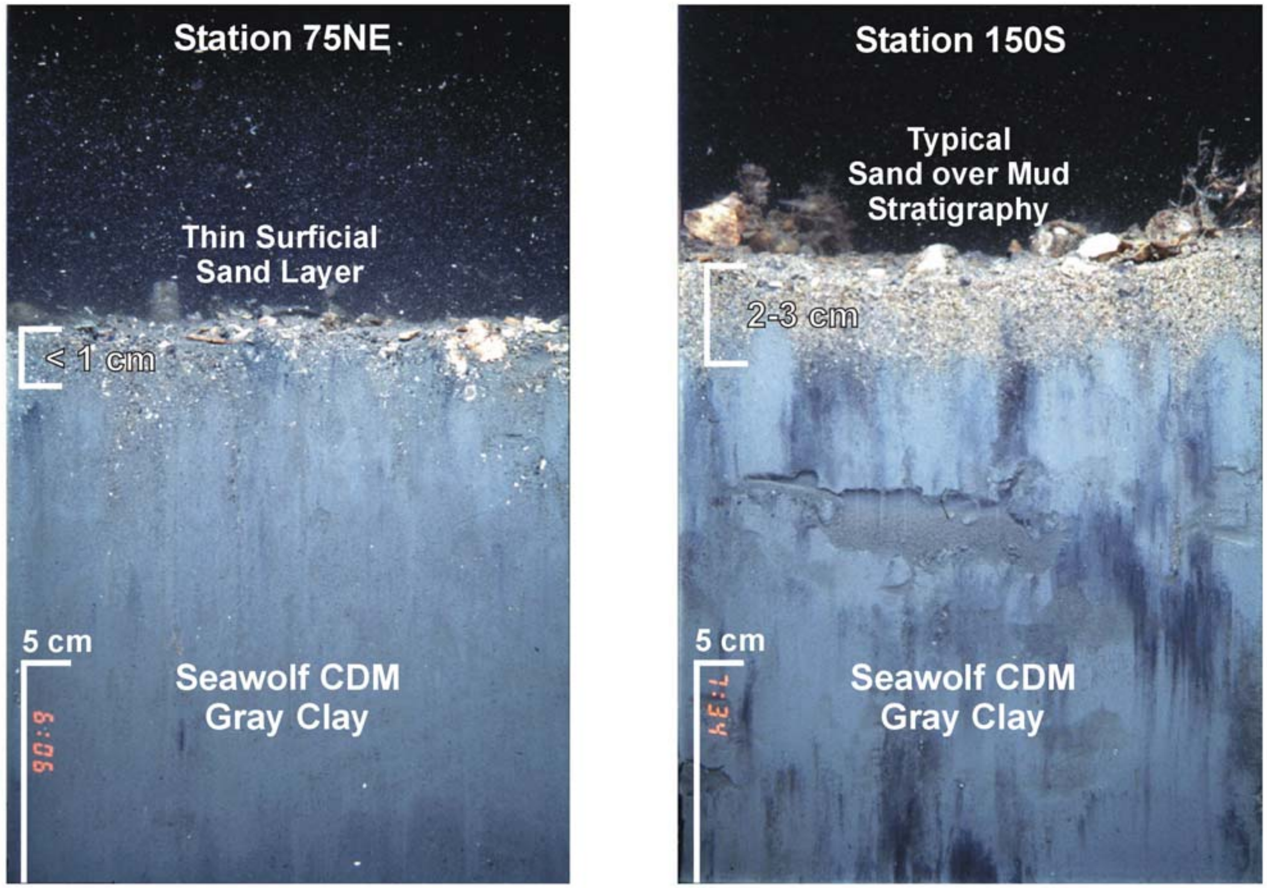
The post-storm sediment profile images of the Seawolf Mound and reference areas yielded results that generally were comparable to previous surveys conducted in August 2000 (SAIC 2001c) and June 2001 (SAIC 2002). The surficial sediment at the stations occupied as part of the post-storm monitoring survey, as well as previous monitoring surveys (1997 through 2000), consisted predominantly of silt and clay with some sand present.

Numerous stations over the mound displayed shell hash and/or lag deposits at the sediment-water interface, while the reference areas characteristically displayed slightly coarser sediments (very fine and fine sand) over organic-rich silt. Long-term monitoring of the Seawolf Mound and New London reference areas has provided evidence for seasonal periods of accretion of worm tubes and accumulation of organic detritus (spring and summer), followed by erosion from fall and winter storms that winnows the fine-grained surface sediments, leaving a lag deposit of coarser-grained material and shell hash (SAIC 2001b, 2001c). This winnowing process creates an armored layer of sand, shell fragments, or pebbles that is presumably more resistant to erosion. This assessment corresponds with the long-term observations of no appreciable erosion or accretion over the surface of the Seawolf Mound, resulting in stable mound morphology (SAIC 2001b, 2001c).

The REMOTS® images collected at the mound apex stations (Stations CTR and 150N) were of particular interest given the results of the bathymetric depth difference comparisons . The photos collected from Stations CTR and 150N indicated the presence of an armored mound surface with significant biological activity, typical of previous (e.g., pre-storm) surveys (Figure 3-13). Although coarse grain material was detected at the sediment-water interface, the presence of a measureable redox potential discontinuity layer and substantial biological activity provides strong evidence that the 0.25 to 0.5 m of depth change detected with bathymetry was the result of consolidation and not erosion (Table 3-1).

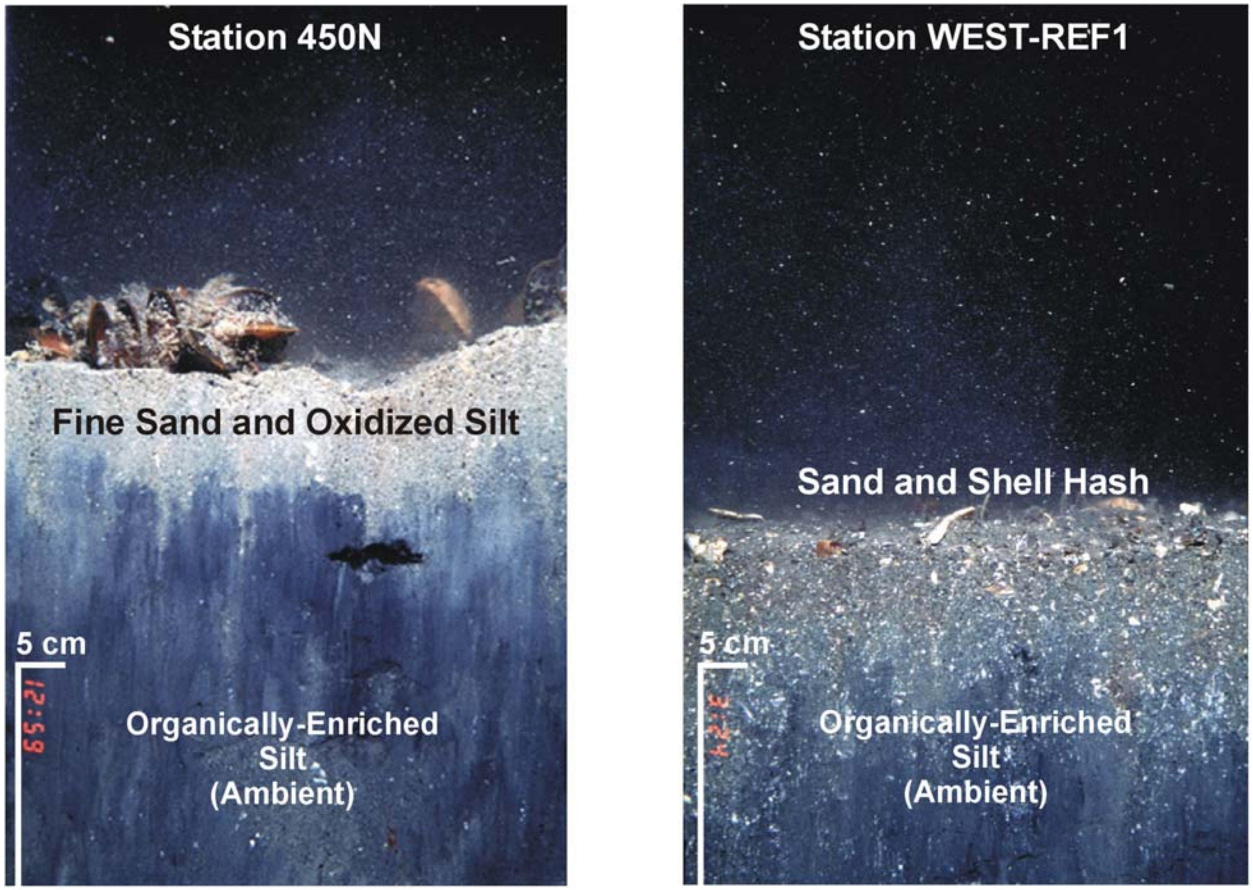
The presence of a 2 to 3 cm layer of sand at the sediment-water interface, overlying fine-grained material below, was noted at numerous stations during the post-storm monitoring survey (Figures 4-1A & B). This sand over mud stratigraphy is common throughout this region of eastern Long Island Sound and has been documented during monitoring surveys over Seawolf, as well as several other NLDS disposal mounds (SAIC 2001a; SAIC 2001b, SAIC 2001c). In addition, similar sediment layering has been detected in the ambient sediments within the confines of NLDS and surrounding the disposal site (Figures 4-2A & B). The widespread presence of well sorted, sand layers over fine-grained material is indicative of natural processes in the region resulting in gradual bedload transport of fine sand.

The observation of a relatively thin surface sand layer (1 cm) at Stations 75NE, 75NW, 75S, 75SE, 75W, 75WSW around the mound center during the post-storm survey could represent small-scale, localized redistribution of sand on the mound plateau that may or may not be attributable to the October 2002 storm event (Figure 4-1A). Similarly, the occurrence of patches of sand, as well as much coarser material including pebbles and large shells, at the surface of images from Stations 300S, 300SE, and 300WSW, suggests either winnowing of fine-grained material, or transport of the coarse material from the



A B

Figure 4-1. REMOTS® images from Stations 75NE (A) and 150S (B) displaying differences in surficial sand layer thickness at stations within a 75 m radius of the Seawolf Mound center versus other areas of the capped disposal mound



A **B**

Figure 4-2. REMOTS® images from Station 450N adjacent to the Seawolf Mound (A) and Station WEST-REF1 displaying sand over mud stratigraphy in ambient sediments within the eastern Long Island Sound region surrounding, ambient substrate over the armored, relatively compact cap material along the edges of the mound. Comparison of the pre-storm survey images to those from previous surveys indicated fairly substantial increases in the amount of coarse material at the sediment surface (Figure 4-3). It is possible that the October 2002 storm event may have contributed to the transport and distribution of this coarse material over the flanks of the mound.

Conditions at Station 300E indicated a distinct change in surficial sediments between the August 2000 survey and the post-storm survey (SAIC 2001b). No dredged material was detected at Station 300E during the 2000 survey, with all three replicate images displaying ambient sandy mud with organic detritus (Figure 4-4A). The material observed in the October 2002 post-storm images consisted of poorly sorted, medium sand, pebbles and rocks, which did not appear similar to the Seawolf CDM (gray clay; Figures 4-4B & C). The shallow camera prism penetration at this station (3.5 cm on average) suggests that a relatively thick layer of this material was present below the sediment-water interface. The strong contrast in sediment types between the August 2000 and October 2002 surveys, as well as the potential thickness of this surficial sediment layer suggests the material detected at Station 300E consisted of a new deposit (i.e., placed after the 2000 survey) rather than a product of bedload transport and distribution of coarser grained material. Based on similarities in composition to the supplemental cap material placed over the Dow/Stonington (D/S) Mound in prior years, it is possible that it represents a portion the material that was directed to capping points located 400 m to the southeast.

4.2 Comparison of Benthic Habitat Conditions to Previous Surveys

Dredged material has not been deposited over the Seawolf Mound since the 1995/96 disposal season, allowing seven years for the surface of the disposal mound to recover from the initial benthic disturbance. Monitoring surveys conducted in the years following mound formation initially indicated slow benthic recovery over the mound, followed by recovery with benthic habitat condition indicators (RPD, successional stages present, and OSI) approaching and even exceeding conditions at nearby reference areas. Initial surveys following formation of the capped mound showed a patchy distribution of deposit feeders, and it was hypothesized that a lack of organic material (i.e., food source) and the cohesive nature of the glacially-derived clay used as CDM may have been limiting benthic recolonization of the mound (SAIC 2001b). However, habitat conditions at numerous stations over the mound had improved by the August 2000 survey, with conditions similar to the nearby reference areas (SAIC 2001c). The REMOTS data and benthic community analyses performed over a limited number of stations in June 2001 survey indicated similar results (SAIC 2002).

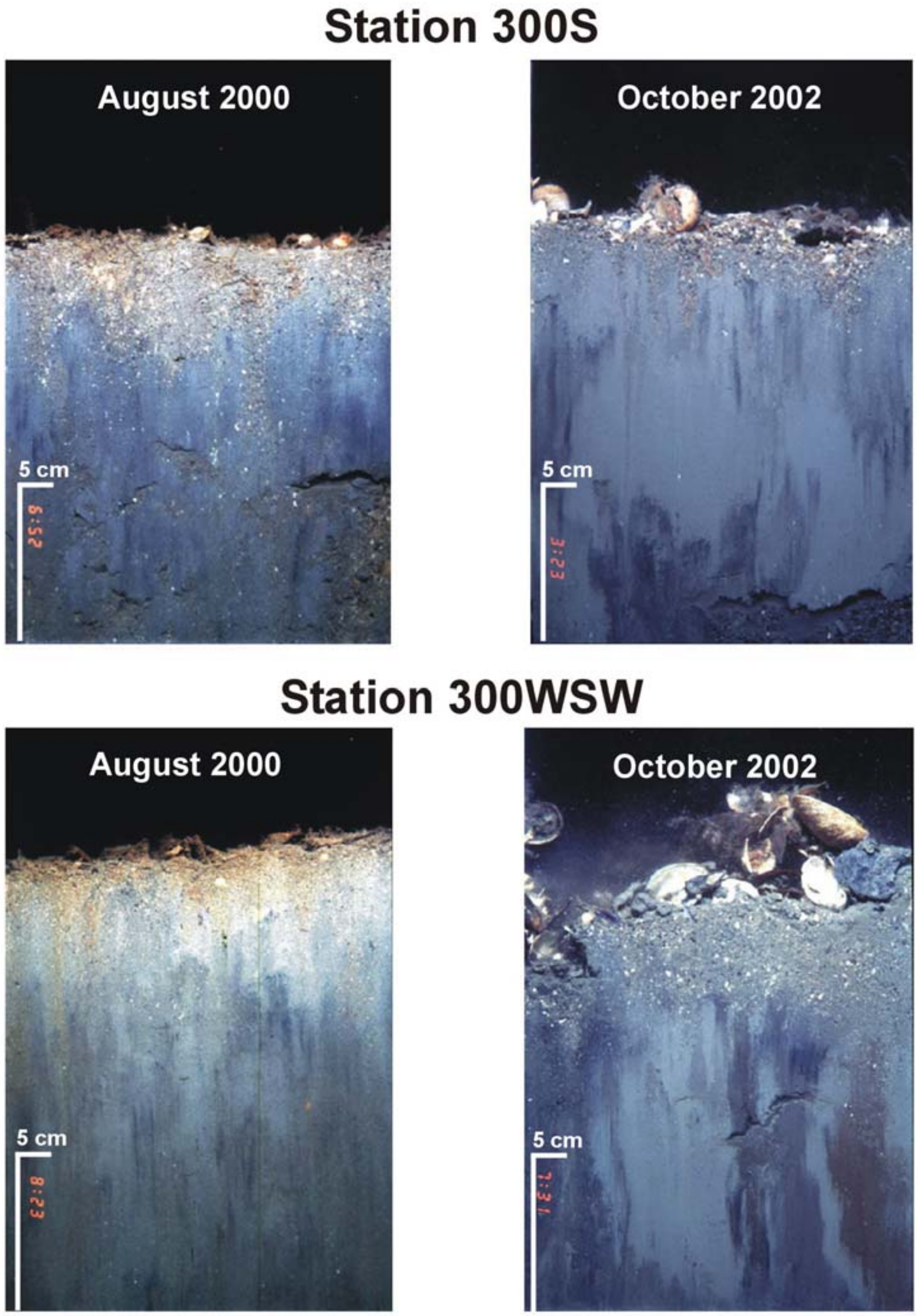


Figure 4-3. REMOTS® images obtained from Stations 300S and 300WSW during the August 2000 and October 2002 surveys comparing the amount of coarse material present at the sediment-water interface following the passage of significant storm event

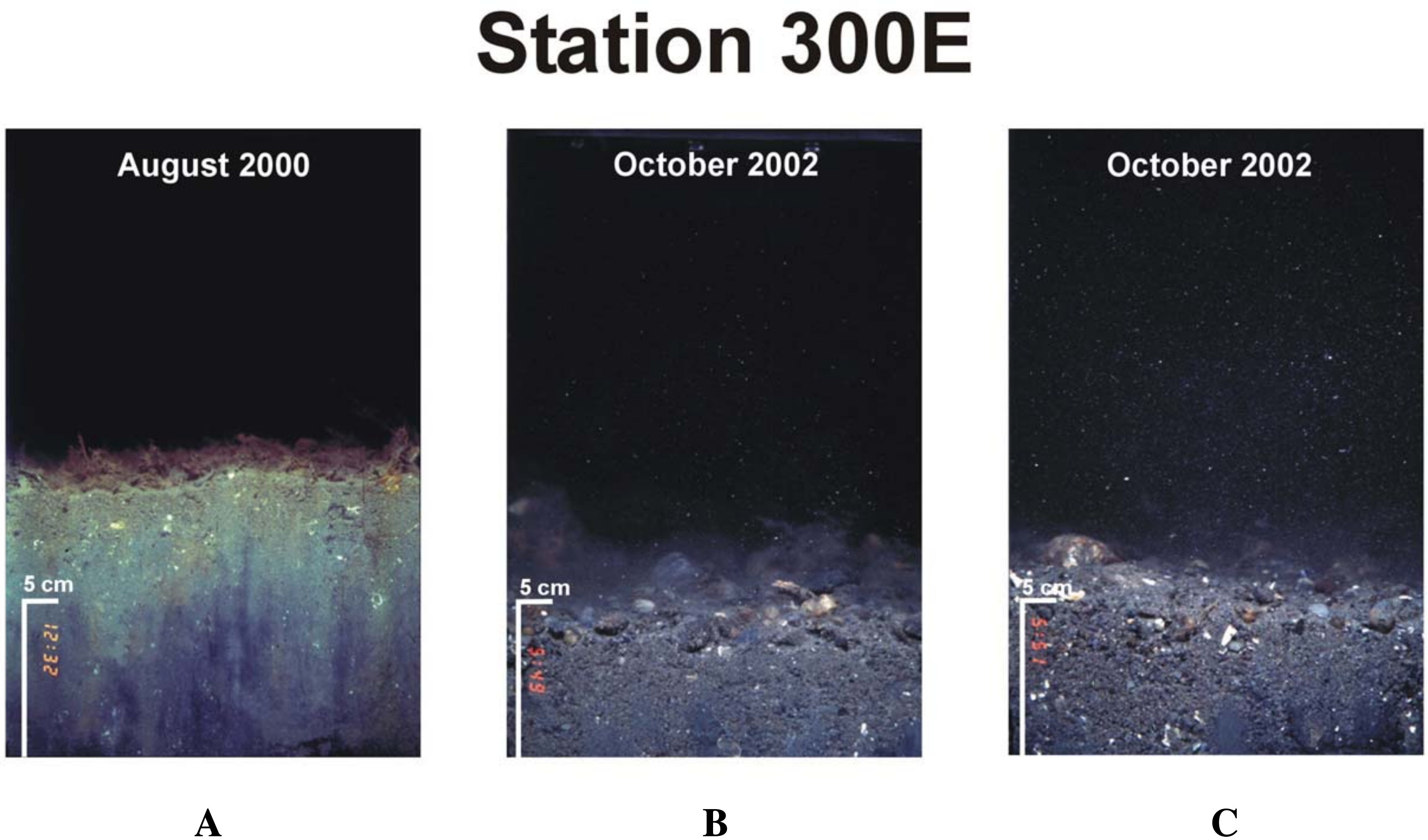


Figure 4-4. REMOTS® images obtained from Station 300E in August 2000 (A) and October 2002 (B &C) showing a distinct change in surface sediment composition within a two-year period. This change is possibly attributable to placement of a new sediment deposit composed of a poorly sorted mixture of medium sand and pebble over Seawolf CDM

Results of the post-storm monitoring survey indicated that benthic habitat conditions were comparable to the previous, pre-storm surveys conducted in 2000 and 2001, in terms of RPD depths, successional stages present, and median OSI calculations (Table 4-1). Additionally, comparison of the post-storm survey reference area results to these previous surveys indicates no post-storm degradation of conditions at the reference areas. In fact, slight improvements in benthic habitat conditions compared to 2001 survey results were noted, which were likely attributable to the timing of survey operations and differences in bottom water quality (October 2002 versus August 2000; Table 4-2). In general, the post-storm survey results indicated that the Seawolf Mound stations continued to have slightly deeper average RPD depths, and a slightly greater prevalence of Stage III organisms, yielding slightly higher OSI values, than the reference areas. These results, in terms of the range of values for each indicator, as well as median values by station, indicate no detectable effects on the benthic community or habitat conditions in the NLDS region resulting from the October 2002 storm event.

Table 4-1. REMOTS® Sediment-Profile Imaging Results Summary for the Seawolf Mound, 1997 – 2002

Station		RPD Mean (cm)					Successional Stages Present					Highest Stage Present					OSI Median				
Seawolf	**Area**	1997	1998	2000	2001	**2002**	1997	1998	2000	2001	**2002**	1997	1998	2000	2001	**2002**	1997	1998	2000	2001	**2002**
CTR	Apex	NA	1.24	2.44	1.65	**2.03**	INDET	I, II, III	I, II, III	I,II,III	**I,II,III**	INDET	ST_I_ON_III	ST_I_ON_III	ST_II_ON_III	**ST_III**	NA	6.5	5	6	**8**
75E	Plateau	0.71	1.63	4.35	2.26	**1.58**	I, II, III	II, III	II, III	I,II,III	**I,III**	ST_II_TO_III	ST_II_ON_III	ST_II_ON_III	ST_II_ON_III	**ST_I_ON_III**	5.5	7.5	9	9	**7**
150N	Apex	NA	1.76	2.48	2.03	**1.77**	II	AZOIC, I	II, III	I,II,III	**I,II,III**	ST_II	ST_I	ST_II_ON_III	ST_II_ON_III	**ST_II_ON_III**	NA	4	7	8	**8**
150W	Plateau	1.59	1.01	3.48	2.69	**2.41**	I, II	I, III	I, II, III	I,II,III	**I,II,III**	ST_II	ST_I_ON_III	ST_II_ON_III	ST_I_ON_III	**ST_II_ON_III**	4	7	11	8	**9**
300SE	Apron	1.91	1.99	3.62	2.83	**2.42**	II, III	I, II	I, II, III	I,III	**I,III**	ST_II_ON_III	ST_II	ST_II_ON_III	ST_I_ON_III	**ST_I_ON_III**	8	5	9	9	**8**
300WSW	Plateau	0.47	2.06	2.02	3.39	**2.99**	I, II, III	I, II, III	II, III	I,II,III	**I,III**	ST_II_ON_III	ST_II_ON_III	ST_II_ON_III	ST_II_ON_III	**ST_I_ON_III**	3	3	6	9	**10**
AVG		1.17	1.62	3.07	2.47	**2.20**											5.13	5.50	7.83	8.17	**8.33**
MAX		1.91	2.06	4.35	3.39	**2.99**											8.00	7.50	11.00	9.00	**10.00**
MIN		0.47	1.01	2.02	1.65	**1.58**											3.00	3.00	5.00	6.00	**7.00**

Table 4-2. REMOTS® Sediment-Profile Imaging Results Summary from the NLDS Reference Areas, 1997 – 2002

Reference Area Station	RPD Mean (cm)					Successional Stages Present					Highest Stage Present					OSI Median				
Survey:	1997	1998	2000	2001	**2002**	1997	1998	2000	2001	**2002**	1997	1998	2000	2001	**2002**	1997	1998	2000	2001	**2002**
NLON-REF																				
1	2.27	3.29	2.48	2.05	**2.01**	I,II,III	I,II	I,II	I,II,III	**I**	ST_I_ON_III	ST_II	ST_II	ST_II_ON_III	**ST_I**	5	6	5	8	**4.5**
2	2.55	2.56	1.96	1.64	**2.16**	I,II,III	II,III	I,II	I	**II,III**	ST_II_ON_III	ST_II_ON_III	ST_II	ST_I	**ST_II_ON_III**	9	8	6	4	**6**
3	2.48	2.52	2.8	2.62	**3.08**	II,III	I,III	II,III	I,III	**II**	ST_II_TO_III	ST_I_ON_III	ST_II_ON_III	ST_I_ON_III	**ST_II**	7.5	5	8	7	**8**
4	1.81	2.5	2.41	2.61	**2.33**	I,II,III	I,II	II	I	**II,III**	ST_II_ON_III	ST_I_TO_II	ST_II	ST_I	**ST_II_ON_III**	5	7	7	5	**7**
5				1.89					I,III					ST_I_ON_III					4	
SUMMARY	**2.28**	**2.72**	**2.41**	**2.16**	**2.40**											**6.25**	**6.5**	**6.5**	**5**	**6.5**
NE-REF																				
1	1.92	1.87	1.99	1.59	**2.85**	I,II,III	I,II	I,II	I,III	**II,III**	ST_II_ON_III	ST_II	ST_I_TO_II	ST_I_ON_III	**ST_II_ON_III**	6	5.5	5	5.5	**8**
2	2.43	1.85	3.58	1.99	**2.46**	II, III	II	I,II	I,II,III	**II**	ST_II_TO_III	ST_II	ST_I_TO_II	ST_I_ON_III	**ST_II**	6.5	6	7	5.5	**7**
3	2.59	2.01	2.4	2.05	**3.19**	I,II	I,II,III	I,III	I,II,III	**II,III**	ST_II	ST_I_ON_III	ST_I_ON_III	ST_II_ON_III	**ST_II_ON_III**	7	6	9	6	**10**
4	2.65	1.55	2.5	1.77	**3.19**	I,II	I,II,III	I,II,III	II,III	**II**	ST_II	ST_II_ON_III	ST_I_ON_III	ST_II_ON_III	**ST_II**	7	7	6	7	**8**
5	2.07	1.71				I,II,III	I,II				ST_II_ON_III	ST_II				8	5			
SUMMARY	**2.33**	**1.80**	**2.62**	**1.85**	**2.92**											**7**	**6**	**6.5**	**5.8**	**8.0**
WEST-REF																				
1	2.42	3.68	3.3	1.0	**2.3**	I,II	I,II,III	II,III	I,II	**I,II,III**	ST_II	ST_I_ON_III	ST_II_ON_III	ST_I_TO_II	**ST_II_ON_III**	6	10	8	3	**5**
2	3.48	2.9	2.46	2.69	**2.12**	II,III	I,II	II	I	**I,III**	ST_II_ON_III	ST_I_TO_II	ST_II	ST_I	**ST_I_ON_III**	10	7	7	5	**5**
3	2.10	3.98	3.16	1.81	**2.2**	II	NA	II,III	I	**I**	ST_II	NA	ST_II_ON_III	ST_I	**ST_I**	6	NA	8	4	**4.5**
4	1.75	2.74	2.5	2.22	**2.13**	I,II	II	I,II	I,II,III	**I**	ST_II	ST_II	ST_II	ST_II_ON_III	**ST_I**	5.5	8	7	7	**4**
5			3.06		**2.19**			I,II		**I,II,III**			ST_II		**ST_II_ON_III**			8		**6**
SUMMARY	**2.44**	**3.33**	**2.90**	**1.93**	**2.19**											**6**	**8**	**8**	**4.5**	**5**
AVG	2.35	2.55	2.63	2.00	**2.48**											6.81	6.71	7.0	5.46	**6.38**
MAX	3.48	3.98	3.58	2.69	**3.19**											10	10	9	8	**10**
MIN	1.75	1.55	1.96	1.00	**2.01**											5	5	5	3	**4**

5.0 CONCLUSIONS

- No large-scale changes in disposal mound morphology were detected based on the bathymetric depth-difference comparisons, indicating that the storm event did not have a significant impact on the seafloor. Erosional surfaces caused by resuspension of sediment during the October storm event were not evident in the side-scan sonar mosaic or individual survey lanes.

- The presence of a shell lag deposit at numerous stations over the mound is consistent with previous findings for the Seawolf Mound and indicates small-scale winnowing of the surface sediments may have occurred over some areas of the Seawolf Mound. However, the occurrence of advanced successional seres, well-developed RPD depths, and the presence of numerous biogenic surface features (e.g., worm tubes, burrows, etc.) over the Seawolf Mound provide evidence that there was minimal disturbance of the surface sediments as a result of the recent storm event.

- The detection of thin sand layers over finer-grained sediments is common at stations over the Seawolf Mound, as well as much of the area surrounding NLDS, as sand in the eastern Long Island Sound region is gradually redistributed via bedload transport. The presence of coarse-grained sediment and large shells at the sediment-water interface represents an appreciable change in surface sediment conditions for some stations along the flanks of the mound (Stations 300S, 300SE, and 300WSW) relative to the results of previous surveys. It is possible that these coarse surface deposits are indicative of small-scale, localized winnowing of fine-grained material, and/or transport of coarse material (e.g., shells) over the flanks of the mound from surrounding areas, resulting from the October 2002 storm event. There is no evidence supporting the occurrence of substantial erosion or redistribution of cap material over the surface of the Seawolf Mound, and therefore, observed changes at these stations appear to represent small-scale, highly localized transport and distribution of this coarse material.

- An advanced successional status was present at all but two REMOTS® stations sampled over the Seawolf Mound, with Stage II and Stage III organisms represented in the surficial sediment layers. OSI values were generally indicative of undisturbed benthic conditions (overall OSI value of +7.8), due to the presence of higher successional seres in conjunction with moderately deep RPD depths.

- Benthic habitat conditions over the Seawolf Mound, as indicated by median OSI values, were slightly above those observed at the NLDS reference areas, primarily due to a higher occurrence of Stage III organisms at stations over the Seawolf Mound. Results were comparable to the previous, pre-storm surveys, indicating no evidence of storm-related disturbance to the benthic community.

6.0 REFERENCES

Carey, D.A. 1998. Long Island Sound Dredged Material Management Approach. A study report prepared for the State of Connecticut, Department of Environmental Protection, Office of Long Island Sound Programs, Hartford, CT. 189p, Separate Appendices.

Fredette, T. J. 1994. Disposal site capping management: New Haven Harbor. Reprinted from Dedging'94, Proceedings of the Second International Conference, November 13–16, 1994. U.S. Army Corps of Engineers, New England Division, Waltham, MA.

Germano, J. D.; Rhoads, D. C.; Lunz, J. D. 1994. An integrated, tiered approach to monitoring and management of dredged material disposal sites in the New England region. DAMOS Contribution No. 87 (SAIC Report No. 7575&234). U.S. Army Corps of Engineers, New England Division, Waltham, MA.

Maguire Group, Inc. 1995. Draft Environmental Impact Statement for *Seawolf* class submarine homeporting on east coast of the United States. Submitted to Department of the Navy, U.S. Atlantic Fleet, Norfolk, VA.

Naval Underwater Systems Center (NUSC). 1979. Disposal Area Monitoring System (DAMOS) annual data report-1978. Submitted to U.S. Army Corps of Engineers, New England Division, Waltham, MA.

Rhoads, D. C.; Germano, J. D. 1982. Characterization of organism-sediment relations using sediment-profile imaging: An effective method of Remote Ecological Monitoring of the Seafloor (REMOTS® System). Mar. Ecol. Prog. Ser. 8:115-128.

Rhoads, D. C.; Germano, J. D. 1986. Interpreting long-term changes in community structure: A new protocol. Hydrobiologia 142:291-308.

SAIC. 2001a. Observations of physical oceanographic conditions at the New London Disposal Site, 1997-1998. DAMOS Contribution 130. (SAIC Report No. 453). U.S. Army Corps of Engineers, New England District, Concord, MA.

SAIC. 2001b. Monitoring cruise at the New London Disposal Site, 1992-1998, Volume II; Seawolf Mound. DAMOS Contribution 132. (SAIC Report No. 525). U.S. Army Corps of Engineers, New England District, Concord, MA.

SAIC. 2001c. Monitoring cruise at the New London Disposal Site, August 2000. DAMOS Contribution 133. (SAIC Report No. 512). U.S. Army Corps of Engineers, New England District, Concord. MA.

SAIC. 2002. Monitoring survey at the New London Disposal Site, June 2001. Draft Report submitted to the U.S. Army Corps of Engineers New England District, Concord, MA.

APPENDIX A

Appendix A1

NLDS Seawolf Mound REMOTS® Sediment-Profile Imaging Data from the October 2002 Post Storm Survey

Station	Replicate	Date	Time	Successional Stage	Grain Size (phi) Min	Grain Size (phi) Max	Grain Size (phi) Maj Mode	Mud Clasts Count	Mud Clasts Avg. Diam	Camera Penetration (cm) Min	Camera Penetration (cm) Max	Camera Penetration (cm) Range	Camera Penetration (cm) Mean	Dredged Material Thickness (cm) Min	Dredged Material Thickness (cm) Max	Dredged Material Thickness (cm) Mean	Redox Rebound Thickness (cm) Min	Redox Rebound Thickness (cm) Max	Redox Rebound Thickness (cm) Mean
150E	A	10/21/2002	17:38	ST I	> 4 phi	2 phi	> 4 phi	0	0	12.15	12.81	0.66	12.48	> 12.15	> 12.81	> 12.48	0	0	0
150E	B	10/21/2002	17:41	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	14.38	14.75	0.37	14.57	> 14.38	> 14.75	> 14.57	0	0	0
150E	C	10/21/2002	17:43	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	12.09	13.22	1.13	12.66	> 12.09	> 13.22	> 12.66	0	0	0
150N	A	10/21/2002	18:17	ST II on III	> 4 phi	2 phi	> 4 phi	0	0	11.9	12.68	0.78	12.29	> 11.9	> 12.68	> 12.29	0	0	0
150N	B	10/21/2002	18:18	ST I	> 4 phi	1 phi	> 4 phi	2	0.51	10.16	14.18	4.02	12.17	> 10.16	> 14.18	> 12.17	0	0	0
150N	C	10/21/2002	18:19	ST I on III	> 4 phi	1 phi	> 4 phi	0	0	14.84	15.34	0.5	15.09	> 14.84	> 15.34	> 15.09	0	0	0
150NE	A	10/22/2002	13:46	ST I	> 4 phi	2 phi	> 4 phi	0	0	13	13.75	0.75	13.38	> 13	> 13.75	> 13.38	0	0	0
150NE	B	10/22/2002	13:47	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	14.34	15.2	0.86	14.77	> 14.34	> 15.2	> 14.77	0	0	0
150NE	C	10/22/2002	13:48	ST III	> 4 phi	2 phi	> 4 phi	0	0	14.81	16.56	1.75	15.68	> 14.81	> 16.56	> 15.68	0	0	0
150NW	A	10/21/2002	16:25	ST I on III	> 4 phi	1 phi	> 4 phi	0	0	15.18	16.75	1.57	15.97	> 15.18	> 16.75	> 15.97	0	0	0
150NW	B	10/21/2002	16:29	ST III	> 4 phi	2 phi	> 4 phi	0	0	13.09	14.91	1.82	14	> 13.09	> 14.91	> 14	0	0	0
150NW	C	10/21/2002	16:30	ST I	> 4 phi	2 phi	> 4 phi	0	0	13.09	14.22	1.13	13.66	> 13.09	> 14.22	> 13.66	0	0	0
150S	B	10/22/2002	15:15	ST II on III	> 4 phi	1 phi	> 4 phi	0	0	14.18	14.95	0.77	14.57	> 14.18	> 14.95	> 14.57	0	0	0
150S	D	10/22/2002	19:34	ST I on III	> 4 phi	1 phi	> 4 phi	0	0	13.84	14.61	0.77	14.23	> 13.84	> 14.61	> 14.23	0	0	0
150S	E	10/22/2002	19:40	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	15.24	16.06	0.82	15.65	> 15.24	> 16.06	> 15.65	0	0	0
150SE	A	10/21/2002	17:07	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	15.52	17.25	1.73	16.39	> 15.52	> 17.25	> 16.39	0	0	0
150SE	B	10/21/2002	17:08	ST I	> 4 phi	2 phi	4 to 3 phi	8	0.51	6.54	8.09	1.55	7.32	> 6.54	> 8.09	> 7.32	0	0	0
150SE	C	10/21/2002	17:14	ST I on III	> 4 phi	1 phi	> 4 phi	0	0	13.07	14.15	1.08	13.61	> 13.07	> 14.15	> 13.61	0	0	0
150W	B	10/22/2002	13:58	ST II on III	> 4 phi	2 phi	> 4 phi	2	0.28	14.13	14.41	0.28	14.27	> 14.13	> 14.41	> 14.27	0	0	0
150W	C	10/22/2002	13:59	ST I on III	> 4 phi	3 phi	> 4 phi	0	0	16.25	17.15	0.9	16.7	> 16.25	> 17.15	> 16.7	0	0	0
150W	F	10/22/2002	20:05	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	17.13	17.74	0.61	17.43	> 17.13	> 17.74	> 17.43	0	0	0
150WSW	A	10/22/2002	14:21	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	16.33	17.33	1	16.83	> 16.33	> 17.33	> 16.83	0	0	0
150WSW	B	10/22/2002	14:22	ST II	> 4 phi	1 phi	> 4 phi	0	0	13.43	14.54	1.11	13.99	> 13.43	> 14.54	> 13.99	0	0	0
150WSW	C	10/22/2002	14:23	ST II	> 4 phi	1 phi	> 4 phi	2	0.54	12.7	16.66	3.96	14.68	> 12.7	> 16.66	> 14.68	0	0	0
300E	A	10/21/2002	17:49	ST I	> 4 phi	-1 phi	2 to 1 phi	0	0	2.93	4.11	1.18	3.52	> 2.93	> 4.11	> 3.52	0	0	0
300E	B	10/21/2002	17:50	ST I	> 4 phi	-1 phi	2 to 1 phi	0	0	2	4.72	2.72	3.36	> 2.0	> 4.72	> 3.36	0	0	0
300E	C	10/21/2002	17:51	ST I	> 4 phi	-1 phi	2 to 1 phi	0	0	2.91	4.25	1.34	3.58	> 2.91	> 4.25	> 3.58	0	0	0
300N	A	10/22/2002	13:04	ST I	> 4 phi	2 phi	> 4 phi	0	0	16.15	16.9	0.75	16.52	> 16.15	> 16.9	> 16.52	0	0	0
300N	B	10/22/2002	13:06	ST I	> 4 phi	2 phi	> 4 phi	1	0.68	14.65	15.7	1.05	15.17	> 14.65	> 15.7	> 15.17	0	0	0
300N	C	10/22/2002	13:07	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	15.02	16.59	1.57	15.81	> 15.02	> 16.59	> 15.81	0	0	0
300NE	A	10/22/2002	13:19	ST II on III	> 4 phi	2 phi	> 4 phi	0	0	18.72	19.24	0.52	18.98	> 18.72	> 19.24	> 18.98	0	0	0
300NE	D	10/22/2002	13:41	ST I on III	> 4 phi	2 phi	> 4 phi	2	2.1	14.7	16.15	1.45	15.42	> 14.7	> 16.15	> 15.42	0	0	0
300NE	E	10/22/2002	13:42	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	15.27	16.45	1.18	15.86	> 15.27	> 16.45	> 15.86	0	0	0
300NW	A	10/21/2002	16:16	ST I on III	> 4 phi	2 phi	> 4 phi	6	3.12	16.41	17.91	1.5	17.16	> 16.41	> 17.91	> 17.16	0	0	0
300NW	B	10/21/2002	16:20	ST II on III	> 4 phi	2 phi	> 4 phi	0	0	13.93	14.65	0.72	14.29	> 13.93	> 14.65	> 14.29	0	0	0
300NW	C	10/21/2002	16:20	ST I	> 4 phi	2 phi	> 4 phi	0	0	13.5	14.5	1	14	> 13.5	> 14.5	> 14	0	0	0
300S	C	10/22/2002	15:23	ST I	> 4 phi	2 phi	> 4 phi	0	0	13.99	14.9	0.91	14.44	> 13.99	> 14.9	> 14.44	0	0	0
300S	D	10/22/2002	19:22	INDET	> 4 phi	1 phi	> 4 phi	0	0	14	15	2.82	14.5	> 14	> 15	> 14.5	0	0	0
300S	E	10/22/2002	19:23	ST I	> 4 phi	1 phi	3 to 2 phi	0	0	8.07	10.04	1.97	9.06	> 8.07	> 10.04	> 9.06	0	0	0
300SE	A	10/21/2002	16:58	ST I	> 4 phi	1 phi	> 4 phi	0	0	7.18	11.72	4.54	9.45	> 7.18	> 11.72	> 9.45	0	0	0
300SE	B	10/21/2002	16:59	ST I on III	> 4 phi	2 phi	> 4 phi	1	0.51	9.66	10.57	0.91	10.11	> 9.66	> 10.57	> 10.11	0	0	0
300SE	C	10/21/2002	17:00	ST I on III	> 4 phi	1 phi	4 to 3 phi	0	0	3.88	8.27	4.39	6.08	0	0	0	0	0	0
300W	A	10/22/2002	15:53	ST II	> 4 phi	2 phi	> 4 phi	0	0	7.54	8.47	0.93	8.01	> 7.54	> 8.47	> 8.01	0	0	0
300W	B	10/22/2002	15:54	ST I	> 4 phi	3 phi	> 4 phi	2	0.26	6.93	8.68	1.75	7.81	> 6.93	> 8.68	> 7.81	0	0	0
300W	C	10/22/2002	15:55	ST I	> 4 phi	3 phi	> 4 phi	2	0.38	18.66	19.24	0.58	18.95	> 18.66	> 19.24	> 18.95	0	0	0
300WSW	B	10/22/2002	15:34	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	15.18	15.63	0.45	15.41	> 15.18	> 15.63	> 15.41	0	0	0
300WSW	D	10/22/2002	19:30	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	17.54	17.83	0.29	17.69	> 17.54	> 17.83	> 17.69	0	0	0
300WSW	E	10/22/2002	19:31	ST I on III	> 4 phi	1 phi	> 4 phi	3	0.64	11.34	15.31	3.97	13.33	> 11.34	> 15.31	> 13.33	0	0	0

Appendix A1

NLDS Seawolf Mound REMOTS® Sediment-Profile Imaging Data from the October 2002 Post Storm Survey

Station	Replicate	Date	Time	Successional Stage	Apparent RPD Thickness (cm) Min	Max	Mean	Methane Count	Mean	Diam.	OSI	Surface Roughness	Low DO	Comments
150E	A	10/21/2002	17:38	ST I	0.40	3.14	1.63	0	0	0	4	Physical	NO	DM>pen, Brn Sand/gry & blk clay, shell frags, tubes, worm @ z; dm = grey clay cap material
150E	B	10/21/2002	17:41	ST I on III	0.14	2.94	1.49	0	0	0	7	Physical	NO	DM>pen, Brn sand/gry clay, shell frags, voids, tubes, burrows, surf reworking
150E	C	10/21/2002	17:43	ST I on III	0.40	4.51	2.38	0	0	0	9	Physical	NO	DM>pen, Brn sand/gry clay, shell hash, org detritus, lg void, tubes, decaying amps?
150N	A	10/21/2002	18:17	ST II on III	0.40	3.38	1.96	0	0	0	8	Physical	NO	DM>pen, sandy/tan & gry clay, chaotic fabric, reddish-brn patches @z, live & decay amps, voids, tubes, shell bits
150N	B	10/21/2002	18:18	ST I	0.79	3.44	2.54	0	0	0	5	Biogenic	NO	DM>pen, Tan sandy/gry clay, shell hash, red clasts, worm @z, burrow-opening?, hydroid, sm tubes, fecal/flock lyr?
150N	C	10/21/2002	18:19	ST I on III	0.60	2.98	1.95	0	0	0	8	Physical	NO	DM>pen, tan sand/gry clay, shell hash, lg shells @ surf, void, sm tubes, worms @z
150NE	A	10/22/2002	13:46	ST I	0.66	4.04	2.58	0	0	0	5	Physical	NO	DM>pen, Brn sandy/gry clay, chaotic fabric, reddish-brn sed patch@z, pull-away, shell hash & frags, tubes, org detritus-far, surf rework?
150NE	B	10/22/2002	13:47	ST I on III	1.99	4.50	3.34	0	0	0	10	Physical	NO	DM>pen, tan sandy/gry clay, shell hash, lg void or burrow opening, tubes, surf reworking, burrow openings, amps?, shell
150NE	C	10/22/2002	13:48	ST III	0.13	4.50	3.15	0	0	0	10	Physical	NO	DM>pen, brn sandy/gry clay clay, shell frags, shell bed, lg void or burrow opening
150NW	A	10/21/2002	16:25	ST I on III	0.33	4.24	2.51	0	0	0	9	Biogenic	NO	DM>pen, brn sandy/gry&blk clay, reddish brn sed patch @z, shell hash, tubes, burrow-opening or shallow feeding void, fecal lyr, lg shells @surf
150NW	B	10/21/2002	16:29	ST III	0.40	4.57	2.24	0	0	0	8	Physical	NO	DM>pen, brn sandy/gry & blk clay, shell lag, lg shell w/mud, void lwr left, slipper shells=Crepidula
150NW	C	10/21/2002	16:30	ST I	0.46	4.24	1.77	0	0	0	4	Physical	NO	DM>pen, brn sandy/gry clay, shell hash, shells @ surf, tubes, burrow opening, worm @z, org detritus?
150S	B	10/22/2002	15:15	ST II on III	0.26	8.34	3.65	0	0	0	10	Physical	NO	DM>pen, tan sand/gry clay, shell bits, sm tubes, decaying amps?, void, worms @z
150S	D	10/22/2002	19:34	ST I on III	0.13	3.29	2.16	0	0	0	8	Physical	NO	DM>pen, tan sand/gry&blk clay, distinct sed horizons, shell frags, hydroids, void, burrows
150S	E	10/22/2002	19:40	ST I on III	1.81	5.56	3.39	0	0	0	10	Physical	NO	DM>pen, tan sand/gry clay, distinct stratigraphy, tubes, burrow-opening, indistinct voids
150SE	A	10/21/2002	17:07	ST I on III	0.93	6.76	4.01	0	0	0	11	Physical	NO	DM>pen, brn sandy/tan&gry clay, shell lag & hash, shell bed @ surf, lg void, tubes, fecal layer?, bryozoans
150SE	B	10/21/2002	17:08	ST I	0.40	4.64	2.38	0	0	0	5	Physical	NO	DM>pen, tan sandy/gry clay, tubes, red clasts, sm burrows, void?, sm worms @z, shell hash
150SE	C	10/21/2002	17:14	ST I on III	0.40	3.34	1.72	0	0	0	8	Physical	NO	DM>pen, tan sand/gry clay, tubes, lg voids, worms @z, fecal/flock lyr, shell hash
150W	B	10/22/2002	13:58	ST II on III	0.27	2.79	2.05	0	0	0	8	Physical	NO	DM>pen, tan sandy/gry clay, a single amp tube & poly tubes, void, shell bits, ox clasts
150W	C	10/22/2002	13:59	ST I on III	0.53	3.31	2.44	0	0	0	9	Physical	NO	DM>pen, brn sandy/gry&blk clay, shell lag,slipper shell=Crepidula, tubes, voids, burrow, worms @z, shell frags, org detritus
150W	F	10/22/2002	20:05	ST I on III	0.34	5.78	2.74	0	0	0	9	Physical	NO	DM>pen, tan sand/grey clay, tubes, shell frags, void/burrow?, org detritus
150WSW	A	10/22/2002	14:21	ST I on III	0.13	3.51	2.22	0	0	0	8	Physical	NO	DM>pen, sand/gry clay, shell lag, Crepidula shells, void, worm @z, burrow, surf rework
150WSW	B	10/22/2002	14:22	ST II	0.93	2.38	1.96	0	0	0	6	Physical	NO	DM>pen, surface pull-away, sandy/gry clay, shell hash, live or decaying amps, sm worms @z
150WSW	C	10/22/2002	14:23	ST II	0.60	8.14	3.42	0	0	0	8	Physical	NO	DM>pen, brn sand/gry&blk clay, shell lag, a few scattered live amp tubes, mussel shell
300E	A	10/21/2002	17:49	ST I	0.34	4.11	2.76	0	0	0	5	Physical	NO	DM>pen = D/S CDM, brn/gry muddy fine-medium sand w/pebbles, poorly sorted sand, shell frags, org detritus
300E	B	10/21/2002	17:50	ST I	0.20	4.08	2.57	0	0	0	5	Physical	NO	DM>pen = D/S CDM, brn sand/gry muddy medium sand, poorly sorted, pebbles&rocks, shell frags, tubes, org detritus, sm worm @z
300E	C	10/21/2002	17:51	ST I	0.66	4.83	3.71	0	0	0	6	Physical	NO	DM>pen = D/S CDM, muddy, poorly sorted medim sand with pebbles & rocks, shell hash, tubes
300N	A	10/22/2002	13:04	ST I	0.53	4.84	3.10	0	0	0	6	Physical	NO	DM>pen, Tan sandy mud/gry & blk silt, shell hash, tubes, red sed @z
300N	B	10/22/2002	13:06	ST I	0.20	3.44	1.88	0	0	0	4	Physical	NO	DM>pen, tan sandy m/gry clay, shell hash, fecal lyr, surf reworking, wht clay chips @z, sm worms @z
300N	C	10/22/2002	13:07	ST I on III	0.99	4.17	2.73	0	0	0	9	Physical	NO	DM>pen, Tan sandy m/gry silt, shell frags, tubes, decaying amps?, shallow void/burrow, sm worms @z
300NE	A	10/22/2002	13:19	ST II on III	0.13	9.34	6.40	0	0	0	11	Biogenic	NO	DM>pen, tan sand/gry clay, a few scattered amp & poly tubes, lg void, vertical burrow-opening, biogenic mound, worms @z, shell frags
300NE	D	10/22/2002	13:41	ST I on III	0.07	3.18	2.07	0	0	0	8	Physical	NO	DM>pen, tan sand/gry clay, shell frags, lg void, tubes, red clasts
300NE	E	10/22/2002	13:42	ST I on III	0.07	4.97	2.48	0	0	0	9	Physical	NO	DM>pen, brn sand/gry clay, shell lag, tubes, sm void?, fecal lyr, surf rework, sm worms @z
300NW	A	10/21/2002	16:16	ST I on III	0.26	4.04	2.12	0	0	0	8	Physical	NO	DM>pen, tan sandy/gry clay, voids, red clasts, sm tubes, shell hash, burrow
300NW	B	10/21/2002	16:20	ST II on III	0.60	2.65	1.62	0	0	0	8	Physical	NO	DM>pen, tan sandy/gry clay, a few scattered poly & amp tubes, void, shell hash, surf reworking
300NW	C	10/21/2002	16:20	ST I	0.13	3.38	1.56	0	0	0	4	Biogenic	NO	DM>pen, tan sand/gry clay, tubes, shell frags, fecal mound/lyr, burrow opening, org detritus
300S	C	10/22/2002	15:23	ST I	0.33	3.94	2.17	0	0	0	4	Physical	NO	DM>pen, thin brn surface sand and shell hash lyr/gry & blk clay, shell lag, tubes, bryozoans, opening @z due to clay over sand - not biological
300S	D	10/22/2002	19:22	INDET	-99.00	-99.00	-99.00	0	0	0	99	Physical	NO	DM>pen, pull-away, medium sand over grey clay cap material, rocks & pebbles, shell hash
300S	E	10/22/2002	19:23	ST I	1.27	4.49	2.38	0	0	0	5	Physical	NO	DM>pen,illustrates variability in Seawolf DM=mostly grey clay mixed with some fine sand; Tan fine sand w/gry clay, shell hash, flock lyr, mussel shells-far
300SE	A	10/21/2002	16:58	ST I	0.46	3.78	2.71	0	0	0	5	Physical	NO	DM>pen,thin tan sand layer/gry clay, shell hash, rocks & pebbles, org detritus, burrow-opening, surf rework
300SE	B	10/21/2002	16:59	ST I on III	0.13	4.11	1.89	0	0	0	8	Physical	NO	DM>pen, brn sand surf layer/gry clay, shell hash, lg shell @ surf, lg void, tubes
300SE	C	10/21/2002	17:00	ST I on III	0.27	5.17	2.65	0	0	0	9	Physical	NO	Ambient poorly sorted muddy fine sand with pebbles, shell hash, hydroid, tubes, void, burrows-opening
300W	A	10/22/2002	15:53	ST II	0.07	2.14	0.71	0	0	0	4	Biogenic	NO	DM? Tan/blk sandy m, shell frags, pull-away, tubes, amp tubes?, red sed @z, possible ambient - station may be right on edge of the cap
300W	B	10/22/2002	15:54	ST I	0.07	6.67	1.65	0	0	0	4	Physical	NO	DM>pen, tan/gry & blk sandy m, tubes, shell bits, ox & red clasts, might be ambient sed
300W	C	10/22/2002	15:55	ST I	0.40	5.16	2.55	0	0	0	5	Physical	NO	DM>pen, brn sandy m/gry clay, shell hash, tubes, red clasts, Crepidula shell clearly grey cap material = different from other two reps @ this station
300WSW	B	10/22/2002	15:34	ST I on III	0.20	4.77	3.35	0	0	0	10	Physical	NO	DM>pen, thin tan sand layer/gry &blk clay, void, tubes
300WSW	D	10/22/2002	19:30	ST I on III	0.20	3.96	2.43	0	0	0	9	Physical	NO	DM>pen, thin tan surf layer/gry clay, shell bits, tubes, voids, org detritus, sm worms @z
300WSW	E	10/22/2002	19:31	ST I on III	0.60	5.37	3.18	0	0	0	10	Physical	NO	DM>pen, brn sand/gry&blk clay (S/M), shell lag, voids, tubes, red clasts, bryozoans

Appendix A1

NLDS Seawolf Mound REMOTS® Sediment-Profile Imaging Data from the October 2002 Post Storm Survey

Station	Replicate	Date	Time	Successional Stage	Grain Size (phi)			Mud Clasts		Camera Penetration (cm)				Dredged Material Thickness (cm)			Redox Rebound Thickness (cm)		
					Min	Max	Maj Mode	Count	Avg. Diam	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean
450N	A	10/22/2002	12:59	ST I on III	> 4 phi	1 phi	> 4 phi	0	0	10.97	12.82	1.85	11.9	0	0	0	0	0	0
450N	B	10/22/2002	13:00	ST I	> 4 phi	2 phi	4 to 3 phi	0	0	6.31	8.07	1.76	7.19	0	0	0	0	0	0
450N	C	10/22/2002	13:01	ST I on III	> 4 phi	2 phi	4 to 3 phi	0	0	7.32	7.9	0.58	7.61	0	0	0	0	0	0
450NE	A	10/22/2002	13:13	ST II on III	> 4 phi	2 phi	> 4 phi	0	0	12.18	13.41	1.23	12.8	> 12.18	> 13.41	> 12.8	0	0	0
450NE	B	10/22/2002	13:14	ST I	> 4 phi	2 phi	> 4 phi	0	0	9.77	10.2	0.43	9.99	> 9.77	> 10.2	> 9.99	0	0	0
450NE	C	10/22/2002	13:15	ST I on III	> 4 phi	2 phi	4 to 3 phi	0	0	10.02	11.54	1.52	10.78	0	0	0	0	0	0
450NW	A	10/21/2002	16:11	ST II on III	> 4 phi	1 phi	4 to 3 phi	0	0	9.24	11.75	2.51	10.49	0	0	0	0	0	0
450NW	B	10/21/2002	16:12	ST I on III	> 4 phi	2 phi	4 to 3 phi	3	0.55	11.13	12.41	1.28	11.77	0	0	0	0	0	0
450NW	C	10/21/2002	16:13	ST I on III	> 4 phi	1 phi	4 to 3 phi	0	0	11.27	12.75	1.48	12.01	0	0	0	0	0	0
450WSW	A	10/22/2002	15:46	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	14.54	15.34	0.8	14.94	> 14.54	> 15.34	> 14.94	0	0	0
450WSW	B	10/22/2002	15:47	ST II	> 4 phi	2 phi	> 4 phi	1	0.28	18.58	19.27	0.69	18.92	> 18.58	> 19.27	> 18.92	0	0	0
450WSW	C	10/22/2002	15:48	ST I	> 4 phi	1 phi	> 4 phi	0	0	14.86	16.86	2	15.86	> 14.86	> 16.86	> 15.86	0	0	0
75E	A	10/21/2002	17:57	ST I	> 4 phi	2 phi	> 4 phi	0	0	14.04	16.65	2.61	15.34	> 14.04	> 16.65	> 15.34	0	0	0
75E	B	10/21/2002	17:58	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	11.86	12.36	0.5	12.11	> 11.86	> 12.36	> 12.11	0	0	0
75E	C	10/21/2002	17:59	ST I on III	> 4 phi	2 phi	> 4 phi	3	0.33	14.75	15.5	0.75	15.12	> 14.75	> 15.5	> 15.12	0	0	0
75N	A	10/21/2002	18:10	ST I	> 4 phi	2 phi	> 4 phi	0	0	12.84	14.25	1.41	13.55	> 12.84	> 14.25	> 13.55	0	0	0
75N	B	10/21/2002	18:11	ST I	> 4 phi	2 phi	> 4 phi	0	0	10.75	13.38	2.63	12.07	> 10.75	> 13.38	> 12.07	0	0	0
75N	C	10/21/2002	18:12	ST II	> 4 phi	2 phi	> 4 phi	0	0	8.9	13.32	4.42	11.11	> 8.9	> 13.32	> 11.11	0	0	0
75NE	A	10/21/2002	18:03	ST I	> 4 phi	2 phi	> 4 phi	0	0	12.43	13.15	0.72	12.79	> 12.43	> 13.15	> 12.79	0	0	0
75NE	B	10/21/2002	18:03	ST I	> 4 phi	2 phi	> 4 phi	4	0.22	14.2	14.88	0.68	14.54	> 14.2	> 14.88	> 14.54	0	0	0
75NE	D	10/21/2002	18:06	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	12.25	12.7	0.45	12.48	> 12.25	> 12.7	> 12.48	0	0	0
75NW	A	10/21/2002	16:32	INDET	> 4 phi	2 phi	> 4 phi	0	0	12	12	1.11	12	> 12	> 12	> 12	0	0	0
75NW	B	10/21/2002	16:35	ST I	> 4 phi	2 phi	> 4 phi	0	0	12.91	13.63	0.72	13.27	> 12.91	> 13.63	> 13.27	0	0	0
75NW	C	10/21/2002	16:35	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	14.63	15.45	0.82	15.04	> 14.63	> 15.45	> 15.04	0	0	0
75S	C	10/22/2002	15:09	ST II on III	> 4 phi	2 phi	> 4 phi	0	0	17.33	17.97	0.64	17.65	> 17.33	> 17.97	> 17.65	0	0	0
75S	D	10/22/2002	19:44	ST II on III	> 4 phi	2 phi	> 4 phi	0	0	13.66	14.38	0.72	14.02	> 13.66	> 14.38	> 14.02	0	0	0
75S	F	10/22/2002	19:47	ST I to II	> 4 phi	2 phi	> 4 phi	0	0	16.22	16.95	0.73	16.58	> 16.22	> 16.95	> 16.58	0	0	0
75SE	A	10/21/2002	17:19	ST II on III	> 4 phi	2 phi	> 4 phi	0	0	14.41	15.38	0.97	14.9	> 14.41	> 15.38	> 14.9	0	0	0
75SE	B	10/21/2002	17:20	ST I	> 4 phi	2 phi	> 4 phi	1	0.84	13.56	14.72	1.16	14.14	> 13.56	> 14.72	> 14.14	0	0	0
75SE	C	10/21/2002	17:24	ST II on III	> 4 phi	2 phi	> 4 phi	1	1.29	12.09	13.38	1.29	12.74	> 12.09	> 13.38	> 12.74	0	0	0
75W	E	10/22/2002	14:10	ST I on III	> 4 phi	2 phi	> 4 phi	5	0.12	14.13	15.88	1.75	15.01	> 14.13	> 15.88	> 15.01	0	0	0
75W	H	10/22/2002	19:56	ST I	> 4 phi	2 phi	> 4 phi	0	0	16.11	16.86	0.75	16.49	> 16.11	> 16.86	> 16.49	0	0	0
75W	I	10/22/2002	20:00	ST I on III	> 4 phi	2 phi	> 4 phi	3	0.44	16.63	17.52	0.89	17.08	> 16.63	> 17.52	> 17.08	0	0	0
75WSW	A	10/22/2002	14:11	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	17.24	18.02	0.78	17.63	> 17.24	> 18.02	> 17.63	0	0	0
75WSW	B	10/22/2002	14:12	ST I to II	> 4 phi	2 phi	> 4 phi	0	0	17.54	18.49	0.95	18.01	> 17.54	> 18.49	> 18.01	0	0	0
75WSW	C	10/22/2002	14:12	ST I on III	> 4 phi	2 phi	> 4 phi	0	0	16.58	17.38	0.8	16.98	> 16.58	> 17.38	> 16.98	0	0	0
CTR	A	10/21/2002	17:30	ST II	> 4 phi	3 phi	> 4 phi	0	0	11.49	14.88	3.39	13.18	> 11.49	> 14.88	> 13.18	0	0	0
CTR	B	10/21/2002	17:31	ST III	> 4 phi	-1 phi	> 4 phi	1	0.26	11.77	13.81	2.04	12.79	> 11.77	> 13.81	> 12.79	0	0	0
CTR	C	10/21/2002	17:32	ST I on III	> 4 phi	2 phi	> 4 phi	2	0.37	11.95	12.59	0.64	12.27	> 11.95	> 12.59	> 12.27	0	0	0

Appendix A1

NLDS Seawolf Mound REMOTS® Sediment-Profile Imaging Data from the October 2002 Post Storm Survey

Station	Replicate	Date	Time	Successional Stage	Apparent RPD Thickness (cm) Min	Apparent RPD Thickness (cm) Max	Apparent RPD Thickness (cm) Mean	Methane Count	Methane Mean	Methane Diam.	OSI	Surface Roughness	Low DO	Comments
450N	A	10/22/2002	12:59	ST I on III	1.79	4.04	3.13	0	0	0	10	Physical	NO	Ambient brn sand/blk sandy m, void, worm @z, tubes, burrows, shell bits, red sed @ z, mussel shells and hydroids, living mussels
450N	B	10/22/2002	13:00	ST I	1.06	4.17	2.22	0	0	0	4	Physical	NO	Ambient brn muddy sand/blk sandy m, shells, sm worms @z, shell frags
450N	C	10/22/2002	13:01	ST I on III	0.26	3.84	2.20	0	0	0	8	Physical	NO	Ambient brn sand/blk sandy m, shell lag, tubes, voids, lg worms @z, wht clay chip@z, red sed @z, slipper shells (Crepidula)
450NE	A	10/22/2002	13:13	ST II on III	0.79	5.03	2.50	0	0	0	9	Physical	NO	DM>pen, brn sandy/gry&blk clay, sandy shell lag, shell hash, org detrtius, decaying amps, sm voids, sm worms @z, sm tubes
450NE	B	10/22/2002	13:14	ST I	0.73	3.91	2.55	0	0	0	5	Physical	NO	DM>pen = cap material, Brn muddy sand/gry clay, wiper clasts, sandy shell lag, shell @ surf, surf reworking, sm burrows-openings, sm worms @z, sm tubes
450NE	C	10/22/2002	13:15	ST I on III	0.26	5.63	1.62	0	0	0	8	Physical	NO	Ambient brn sand/blk sandy m, shell lag, org detritus, voids, lg burrowing worm or anemone, poly tubes, red sed @z, shell hash station is right on edge on cap deposit= 2 reps cap material and one rep (this one) ambient
450NW	A	10/21/2002	16:11	ST II on III	-99.00	-99.00	-99.00	0	0	0	99	Biogenic	NO	Ambient muddy sand>pen, Tan sandy/gry sandy m, pull away, scattered amp and poly tubes, void, shell frags
450NW	B	10/21/2002	16:12	ST I on III	0.93	4.24	2.10	0	0	0	8	Physical	NO	Ambient muddy sand>pen, brn sand/gry&blk sandy m, shell hash, org det, wht clay chips@z, yellow material@z=?, lg void/burrow, sm worms@z, red clsts,sm tubes
450NW	C	10/21/2002	16:13	ST I on III	0.46	5.10	3.18	0	0	0	10	Biogenic	NO	Ambient muddy sand>pen, brn sandy/gry sandy m, shell lag, org detritus, voids, burrows-openings, tubes
450WSW	A	10/22/2002	15:46	ST I on III	0.73	4.18	1.87	0	0	0	8	Physical	NO	DM>pen, tan sand/gry clay, tubes, shell frags, voids, worms @z
450WSW	B	10/22/2002	15:47	ST II	0.68	2.23	1.46	0	0	0	5	Physical	NO	DM>pen, tan sandy/gry&blk clay, amp & poly tubes, ox clast, org detritus, shell bits
450WSW	C	10/22/2002	15:48	ST I	1.35	5.35	3.94	0	0	0	7	Physical	NO	DM>pen, brn sandy/gry sandy m &clay, shell lag, burrows-openings, tubes, surf rework
75E	A	10/21/2002	17:57	ST I	0.26	5.43	1.75	0	0	0	4	Biogenic	NO	DM>pen, tan sandy/gry clay, shell hash, tubes, burrow opening?, patchy RPD, org detritus
75E	B	10/21/2002	17:58	ST I on III	0.07	4.77	1.77	0	0	0	8	Biogenic	NO	DM>pen, brn sandy/gry clay, shell frags, void, biogenic mound, fecal lyr, tubes, hydroid?
75E	C	10/21/2002	17:59	ST I on III	0.20	3.84	1.21	0	0	0	7	Physical	NO	DM>pen, tan sandy/gry clay, shell frags, tubes, void, red clasts, burrow
75N	A	10/21/2002	18:10	ST I	0.13	3.51	1.15	0	0	0	3	Physical	NO	DM>pen, tan sand/gry&blk clay, chaotic fabric, reddish-brn mottled sed, tubes, red sed @z, shell frags, patchy RPD, burrow-opening
75N	B	10/21/2002	18:11	ST I	0.13	7.68	4.23	0	0	0	7	Physical	NO	DM>pen, brn sandy m/gry clay, shell hash, burrow openings, tubes
75N	C	10/21/2002	18:12	ST II	0.13	5.23	2.34	0	0	0	7	Physical	NO	DM>pen, tan sandy m/gry clay, thin sandy surf layer, m clumps @ surf, irreg topo, shell frags, tubes, a few isolated amp tubes, sm burrow opening, mussel shell
75NE	A	10/21/2002	18:03	ST I	0.20	3.24	2.14	0	0	0	4	Physical	NO	DM>pen, tan sandy/gry & blk clay, red sed patches @z, shell frags, tubes
75NE	B	10/21/2002	18:03	ST I	0.66	4.24	3.34	0	0	0	6	Physical	NO	DM>pen, thin surface sand lyr/gry clay, shell frags, tubes, lg shell @surf
75NE	D	10/21/2002	18:06	ST I on III	0.79	3.84	2.39	0	0	0	9	Physical	NO	DM>pen, thin surface sand lyr/gry clay, shell lag, tubes, org detritus, Chaetopterus tube in farfield=Stage III
75NW	A	10/21/2002	16:32	INDET	-99.00	-99.00	-99.00	0	0	0	99	Indeterminate	NO	DM>pen, dist surf, pull-away, sandy/gry clay, shell frags, m clumps-far, sm worm @zimage is essentially un-analyzable
75NW	B	10/21/2002	16:35	ST I	0.60	4.11	1.82	0	0	0	4	Physical	NO	DM>pen, thin tan sand lyr/gry clay, shell hash, tubes, sm worm @z
75NW	C	10/21/2002	16:35	ST I on III	1.13	5.96	3.94	0	0	0	11	Physical	NO	DM>pen, thin tan sand layer/gry clay, voids, tubes, shell frags, vertical burrow
75S	C	10/22/2002	15:09	ST II on III	2.45	4.91	3.88	0	0	0	11	Physical	NO	DM>pen, thin tan sand layer/gry clay, shell frags, single amp tube, poly tubes, sm void
75S	D	10/22/2002	19:44	ST II on III	2.14	6.03	4.00	0	0	0	11	Physical	NO	DM>pen, tan sand surface layer/gry clay, shell hash, voids, burrows, poly tubes, isolated amp tubes
75S	F	10/22/2002	19:47	ST I to II	0.40	4.17	1.97	0	0	0	5	Physical	NO	DM>pen, thin surface sand layer/gry clay, shell frags, tubes, amp tubes?, worms @z, shell @ surf, surf rework, burrow opening
75SE	A	10/21/2002	17:19	ST II on III	0.40	3.91	2.88	0	0	0	9	Physical	NO	DM>pen,thin surface sand layer/gry clay, shell frags, shallow small void, iolated amp tubes, poly tubes, bryozoans, fecal/flock lyr
75SE	B	10/21/2002	17:20	ST I	0.46	4.10	2.34	0	0	0	5	Physical	NO	DM>pen, thin tan sand surf layer/gry & blk clay, shell frags, red sed patches @z, tubes, red clast
75SE	C	10/21/2002	17:24	ST II on III	0.13	6.37	2.92	0	0	0	9	Biogenic	NO	DM>pen, sandy/gry clay, shell frags, poly tubes, iolated amp tube, void, burrow, surf reworking, ox clast, org @z?
75W	E	10/22/2002	14:10	ST I on III	0.33	4.48	2.35	0	0	0	9	Biogenic	NO	DM>pen, sandy/gry clay, shell frags, tubes, rock@ surf, voids, red clasts
75W	H	10/22/2002	19:56	ST I	0.40	3.28	2.11	0	0	0	4	Physical	NO	DM>pen, thin tan surface sand layer/gry clay, shell frags, tubes, decaying amps?, worm @z
75W	I	10/22/2002	20:00	ST I on III	1.01	2.76	2.23	0	0	0	8	Physical	NO	DM>pen, thin surface sand layer/gry clay, shell hash, ox & red clasts, sm voids, tubes, org detritus, surf rework
75WSW	A	10/22/2002	14:11	ST I on III	0.86	4.10	2.63	0	0	0	9	Biogenic	NO	DM>pen, tan sandy/gry clay, shell hash, poly tubes, lg voids, sm worms @z, shells @surf
75WSW	B	10/22/2002	14:12	ST I to II	0.07	3.77	1.89	0	0	0	5	Physical	NO	DM>pen, tan sand thin surf layer/gry & blk clay, shell bits, tubes, shell @ surf, worms @ z, burrow?, isolated amp tube?
75WSW	C	10/22/2002	14:12	ST I on III	0.20	3.51	2.15	0	0	0	8	Physical	NO	DM>pen, tan sandy/gry clay, shell bits, mussel shells @ surf, tubes, void, surf rework
CTR	A	10/21/2002	17:30	ST II	0.20	3.19	1.94	0	0	0	6	Biogenic	NO	DM>pen, sandy/gry & blk clay, shell frags, live & decaying ampelisca, vertical burrow-opening left?, sm void?, burrows
CTR	B	10/21/2002	17:31	ST III	0.13	3.34	1.97	0	0	0	8	Physical	NO	DM>pen, tan sandy/gry clay, shell lag-armoring?, lg rock-far, mussels shells, lg void or burrow
CTR	C	10/21/2002	17:32	ST I on III	0.13	3.87	2.18	0	0	0	8	Physical	NO	DM>pen, tan sandy/gry & blk clay, shell hash, tubes, red clsts, lg voids, burrow-opening, chaotic fabric, lg shell-far, red sed patches@z

Appendix A2

NLDS Reference Area REMOTS® Sediment-Profile Imaging Data from the October 2002 Post Storm Survey

Station	Replicate	Date	Time	Successional Stage	Grain Size (phi)			Mud Clasts		Camera Penetration (cm)				Dredged Material Thickness (cm)			Redox Rebound Thickness (cm)			Apparent RPD Thickness (cm)			Methane		
					Min	Max	Maj Mode	Count	Avg. Diam	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Count	Mean	Diam.
NE-REF																									
1	A	10/22/2002	16:27	ST II	> 4 phi	3 phi	> 4 phi	0	0	10.5	11.15	0.65	10.82	0	0	0	0	0	0	1.39	6.23	3.02	0	0	0
1	B	10/22/2002	16:29	ST II	> 4 phi	2 phi	> 4 phi	0	0	9.88	10.38	0.5	10.13	0	0	0	0	0	0	2.06	6.84	3.24	0	0	0
1	C	10/22/2002	16:30	ST II to III	> 4 phi	3 phi	> 4 phi	0	0	7.93	8.59	0.66	8.26	0	0	0	0	0	0	0.67	3.74	2.30	0	0	0
2	A	10/22/2002	16:35	ST II	> 4 phi	3 phi	> 4 phi	0	0	9.54	10.18	0.64	9.86	0	0	0	0	0	0	0.46	1.72	1.33	0	0	0
2	B	10/22/2002	16:36	ST II	> 4 phi	3 phi	> 4 phi	0	0	8.77	9.66	0.89	9.22	0	0	0	0	0	0	0.20	5.90	3.49	0	0	0
2	C	10/22/2002	16:37	ST II	> 4 phi	3 phi	> 4 phi	0	0	7.82	8.25	0.43	8.03	0	0	0	0	0	0	1.59	3.11	2.55	0	0	0
3	A	10/22/2002	16:12	ST II on III	> 4 phi	3 phi	> 4 phi	0	0	11.09	11.99	0.9	11.54	0	0	0	0	0	0	1.26	5.72	3.56	0	0	0
3	B	10/22/2002	16:13	ST II	> 4 phi	3 phi	> 4 phi	0	0	8.57	9.45	0.88	9.01	0	0	0	0	0	0	0.53	5.30	2.84	0	0	0
3	C	10/22/2002	16:14	ST II on III	> 4 phi	3 phi	> 4 phi	3	1.07	9.63	10.36	0.73	9.99	0	0	0	0	0	0	1.86	5.10	3.16	0	0	0
4	A	10/22/2002	16:18	ST II	> 4 phi	3 phi	> 4 phi	3	0.41	8.86	9.52	0.66	9.19	0	0	0	0	0	0	0.79	5.89	3.61	0	0	0
4	C	10/22/2002	16:22	ST II	> 4 phi	3 phi	> 4 phi	0	0	9.02	9.43	0.41	9.23	0	0	0	0	0	0	0.86	4.90	2.78	0	0	0
4	D	10/22/2002	16:23	ST II	> 4 phi	3 phi	> 4 phi	1	0.4	9.36	9.74	0.38	9.55	0	0	0	0	0	0	0.53	4.44	3.18	0	0	0
NLON-REF																									
1	A	10/22/2002	16:57	INDET	> 4 phi	3 phi	> 4 phi	0	0	6.95	10.31	3.36	8.63	0	0	0	0	0	0	-99.00	-99.00	-99.00	0	0	0
1	B	10/22/2002	16:58	ST I	> 4 phi	2 phi	4 to 3 phi	0	0	2.84	3.47	0.63	3.15	0	0	0	0	0	0	0.20	3.18	1.55	0	0	0
1	C	10/22/2002	16:59	ST I	> 4 phi	2 phi	4 to 3 phi	0	0	2.72	3.06	0.34	2.89	0	0	0	0	0	0	0.99	3.98	2.46	0	0	0
2	A	10/22/2002	17:39	ST II on III	> 4 phi	3 phi	4 to 3 phi	0	0	7.04	7.4	0.36	7.22	0	0	0	0	0	0	1.33	4.25	2.66	0	0	0
2	B	10/22/2002	17:40	ST II	> 4 phi	3 phi	4 to 3 phi	0	0	5.95	6.56	0.61	6.26	0	0	0	0	0	0	0.13	4.15	1.65	0	0	0
2	C	10/22/2002	17:41	ST II	> 4 phi	3 phi	4 to 3 phi	1	0.48	7.63	8.18	0.55	7.91	0	0	0	0	0	0	0.99	3.18	2.16	0	0	0
3	A	10/22/2002	17:25	INDET	> 4 phi	3 phi	4 to 3 phi	3	1.75	1.13	4.24	3.11	2.68	0	0	0	0	0	0	-99.00	-99.00	-99.00	0	0	0
3	B	10/22/2002	17:27	ST II	> 4 phi	2 phi	4 to 3 phi	0	0	1.74	2.52	0.78	2.13	0	0	0	0	0	0	0.86	2.72	2.29	0	0	0
3	C	10/22/2002	17:28	ST II	> 4 phi	2 phi	4 to 3 phi	0	0	5.61	5.97	0.36	5.79	0	0	0	0	0	0	2.12	5.63	3.87	0	0	0
4	A	10/22/2002	17:33	ST II on III	> 4 phi	2 phi	4 to 3 phi	0	0	3.31	4.16	0.85	3.73	0	0	0	0	0	0	0.07	4.11	2.51	0	0	0
4	B	10/22/2002	17:34	ST II	> 4 phi	2 phi	4 to 3 phi	0	0	5.93	6.5	0.57	6.22	0	0	0	0	0	0	0.33	4.24	2.80	0	0	0
4	C	10/22/2002	17:35	ST II	> 4 phi	2 phi	4 to 3 phi	0	0	1.95	2.68	0.73	2.32	0	0	0	0	0	0	0.73	2.46	1.67	0	0	0
WEST-REF																									
1	B	10/21/2002	15:24	ST II on III	> 4 phi	2 phi	4 to 3 phi	0	0	6.34	7.45	1.11	6.89	0	0	0	0	0	0	0.99	3.64	2.54	0	0	0
1	C	10/21/2002	15:25	ST I	> 4 phi	2 phi	4 to 3 phi	0	0	6.4	7.27	0.87	6.84	0	0	0	0	0	0	0.13	3.44	2.03	0	0	0
1	D	10/21/2002	15:26	ST I	> 4 phi	2 phi	> 4 phi	0	0	9.32	10.52	1.2	9.92	0	0	0	0	0	0	0.07	4.90	2.37	0	0	0
2	B	10/21/2002	15:49	ST I on III	> 4 phi	2 phi	4 to 3 phi	0	0	3.68	4.93	1.25	4.3	0	0	0	0	0	0	0.60	3.97	1.96	0	0	0
2	C	10/21/2002	15:49	ST I	> 4 phi	2 phi	4 to 3 phi	0	0	3.63	5.06	1.43	4.35	0	0	0	0	0	0	0.46	4.37	2.46	0	0	0
2	D	10/21/2002	15:50	ST I	> 4 phi	2 phi	4 to 3 phi	0	0	4.49	5.38	0.89	4.93	0	0	0	0	0	0	0.73	2.58	1.95	0	0	0
3	A	10/21/2002	15:55	INDET	> 4 phi	1 phi	3 to 2 phi	0	0	-0.53	0.77	1.3	0.12	0	0	0	0	0	0	-99.00	-99.00	-99.00	0	0	0
3	B	10/21/2002	15:56	ST I	> 4 phi	2 phi	3 to 2 phi	0	0	0.95	2.31	1.36	1.63	0	0	0	0	0	0	0.13	2.87	2.12	0	0	0
3	D	10/21/2002	15:58	ST I	> 4 phi	2 phi	4 to 3 phi	1	0.21	9.49	10.06	0.57	9.77	0	0	0	0	0	0	0.60	3.38	2.28	0	0	0
4	A	10/21/2002	15:36	ST I	> 4 phi	1 phi	3 to 2 phi	0	0	4.02	4.91	0.89	4.47	0	0	0	0	0	0	0.33	2.91	1.73	0	0	0
4	B	10/21/2002	15:37	ST I	> 4 phi	1 phi	3 to 2 phi	0	0	3.65	4.45	0.8	4.05	0	0	0	0	0	0	0.20	3.64	2.59	0	0	0
4	D	10/21/2002	15:39	ST I	> 4 phi	2 phi	3 to 2 phi	5	0.36	4.11	5.54	1.43	4.82	0	0	0	0	0	0	0.40	3.18	2.07	0	0	0
5	A	10/21/2002	15:30	ST I	> 4 phi	1 phi	3 to 2 phi	0	0	6.95	7.56	0.61	7.26	0	0	0	0	0	0	0.93	4.31	2.93	0	0	0
5	B	10/21/2002	15:31	ST II	> 4 phi	1 phi	3 to 2 phi	0	0	6.82	8.36	1.54	7.59	0	0	0	0	0	0	0.20	3.57	1.79	0	0	0
5	D	10/21/2002	15:32	ST II on III	> 4 phi	1 phi	3 to 2 phi	0	0	8.99	9.79	0.8	9.39	0	0	0	0	0	0	0.13	2.92	1.86	0	0	0

Appendix A2

NLDS Reference Area REMOTS® Sediment-Profile Imaging Data from the October 2002 Post Storm Survey

Station	Replicate	Date	Time	OSI	Surface Roughness	Low DO	Comments
NE-REF							
1	A	10/22/2002	16:27	8	Biogenic	NO	Ambient tan/gry & blk sandy m, dense amp tube mat, worm @ z
1	B	10/22/2002	16:29	8	Biogenic	NO	Ambient tan/blk sandy m, dense juvenile amp tube mat
1	C	10/22/2002	16:30	8	Biogenic	NO	Ambient tan/gry&blk sandy m, dense juvenile ampelisca, chaetopterus tube-far, worms @z
2	A	10/22/2002	16:35	5	Biogenic	NO	Ambient tan/gry & blk sandy m, pull-away, dense amp tube mat, red sed @z
2	B	10/22/2002	16:36	8	Biogenic	NO	Ambient tan/blk sandy m, dense juvenile ampelisca, wiper clast
2	C	10/22/2002	16:37	7	Biogenic	NO	Ambient tan/blk sandy m, dense juvenile ampelisca, wiper clast, poly tubes
3	A	10/22/2002	16:12	10	Biogenic	NO	Ambient tan/blk sandy m, dense amp tube mat, voids, poly tubes, worms @ z, burrows
3	B	10/22/2002	16:13	7	Biogenic	NO	Ambient tan/gry & blk sandy m, dense amp tubes, shell @ surf?, poly tubes
3	C	10/22/2002	16:14	10	Biogenic	NO	Ambient tan/gry & blk sandy m, dense amp tubes, red clasts, poly tubes, void, wiper clast
4	A	10/22/2002	16:18	8	Biogenic	NO	Ambient tan/gry&blk sandy m, dense amp tube mat, red clasts, sm worms @z
4	C	10/22/2002	16:22	7	Biogenic	NO	Ambient tan/gry &blk sandy m, dense juvenile ampelisca, poly tubes
4	D	10/22/2002	16:23	8	Biogenic	NO	Ambient tan/gry sandy m, dense juvenile ampelisca, poly tubes, ox clast
NLON-REF							
1	A	10/22/2002	16:57	99	Indeterminate	NO	Ambient gry sandy m, pull-away, dist surf, shell frags, hydroids, sponge?, poly & amp tubes
1	B	10/22/2002	16:58	4	Physical	NO	Ambient tan/gry & blk muddy fine sand, shell frags=crepidula, rock, hydroids/bryozoans, wht clay clast @ surf
1	C	10/22/2002	16:59	5	Physical	NO	Ambient tan/gry muddy sand, shell bits, poly tubes, red sed @z
2	A	10/22/2002	17:39	9	Biogenic	NO	Ambient tan/gry & blk muddy sand, dense juvenile ampelisca, burrow, void
2	B	10/22/2002	17:40	6	Biogenic	NO	Ambient tan/blk sandy m, dense juvenile ampelisca, poly tubes, sm worm @z, red sed @z, iron oxide streaks
2	C	10/22/2002	17:41	6	Biogenic	NO	Ambient tan/gry & blk muddy fine sand, dense juvenile ampelisca, red clast, wht clay chips @z
3	A	10/22/2002	17:25	99	Indeterminate	NO	Ambient gry muddy fine sand, dist surf, underpen, shell, poly tubes, red clasts, flock lyr, red sed @z
3	B	10/22/2002	17:27	7	Biogenic	NO	Ambient tan/gry muddy fine sand, dense juvenile ampelisca, shell bits, org detritus, worms @z
3	C	10/22/2002	17:28	9	Physical	NO	Ambient tan/gry sandy m, dense juvenile ampelisca, shell bits, red sed @z
4	A	10/22/2002	17:33	9	Biogenic	NO	Ambient tan/gry & blk muddy fine sand, dense juvenile ampelisca, poly tubes, burrow, void, expelled sed @ surf=fecal lyr
4	B	10/22/2002	17:34	7	Biogenic	NO	Ambient tan/gry sandy m, juvenile amps, poly tubes, wiper clasts, iron oxide streaks, sm void?
4	C	10/22/2002	17:35	6	Biogenic	NO	Ambient tan/gry muddy sand, dense juvenile ampelisca, shell frags, poly tubes
WEST-REF							
1	B	10/21/2002	15:24	9	Physical	NO	Ambient brn/blk sandy m, shell hash, poly & amp tubes, sm voids, red sed @z, shell frags @ surf, org detritus
1	C	10/21/2002	15:25	4	Physical	NO	Ambient brn/blk muddy fine sand, sulfidic m @ z, shell hash, wht clay chips @ z, tubes
1	D	10/21/2002	15:26	5	Physical	NO	Ambient brn/blk sandy m, sulfidic m @z, shell hash, tubes, wht clay chip @z, fecal lyr
2	B	10/21/2002	15:49	8	Physical	NO	Ambient brn/blk sandy m, shell hash, shells & rocks-far, burrow opening, void, wht clay chips @z, tubes
2	C	10/21/2002	15:49	5	Physical	NO	Ambient brn/blk muddy fine sand, shell hash, lg shells @ surf, tubes, gastropod-far?
2	D	10/21/2002	15:50	4	Physical	NO	Ambient brn/gry & blk muddy fine sand, shell hash, tubes, shells @surf, red sed @z
3	A	10/21/2002	15:55	99	Physical	NO	Ambient gry muddy sand, underpen, shell hash, dist surf, tubes, lg rock or m clump, macro algae w/gastropods, org detritus
3	B	10/21/2002	15:56	4	Physical	NO	Ambient brn/gry muddy fine sand, shell hash, underpen, tubes, biogenic mound?
3	D	10/21/2002	15:58	5	Physical	NO	Ambient brn/gry & blk sandy m, shell hash, lg shell @ surf, tubes, red sed @ z, wht clay chips @z, burrow
4	A	10/21/2002	15:36	4	Physical	NO	Ambient brn/gry & blk sandy m, shell lag, org detritus, tubes, wht clay @z, burrow-opening
4	B	10/21/2002	15:37	5	Physical	NO	Ambient brn/blk muddy sand, shell hash, shell lag, tubes, wht clay @z, red sed @z, m clump or rock=far
4	D	10/21/2002	15:39	4	Physical	NO	Ambient brn/blk muddy fine sand, shell hash, wht clay @ z, shells @ surf, tubes
5	A	10/21/2002	15:30	5	Physical	NO	Ambient brn/blk muddy fine sand w/ shell hash, red sed @z, wht clay chips @z, tubes
5	B	10/21/2002	15:31	6	Biogenic	NO	Ambient brn/blk sulfidic muddy sand, shell hash, lg shell @ surf, amp tubes, fecal lyr, wht clay chips @z, poly tubes
5	D	10/21/2002	15:32	8	Physical	NO	Ambient brn/blk muddy fine sand w/ shell hash, lg shell@ surf, org detritus, red sed@z, voids, live & decaying amps?, wiper clst, patchy RPD

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