Monitoring Survey at the New London Disposal Site
July/ August 2007

Disposal Area Monitoring System DAMOS

DISPOSAL AREA MONITORING SYSTEM

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13. ABSTRACT

Monitoring surveys were conducted in July and August 2007 at the New London Disposal Site (NLDS) as part of the Disposal Area Monitoring System (DAMOS) Program. The 2007 field effort consisted of bathymetric, sediment-profile imaging, and plan-view imaging surveys designed to characterize the seafloor topography of the disposal site, document the distribution of dredged material around recent and historic disposal locations, and assess the benthic conditions over recently formed and historic disposal mounds.

The August 2007 sediment-profile imaging and plan-view imaging survey was performed at the recently formed NL-06 Mound and the historical mounds, NL-91 and Dow/Stonington (D/S) Mound Complex and the United States Coast Guard Academy (USCGA) Mound. Recolonization at the older mounds (USCGA and NL-91 and D/S Mound Complex) has continued as expected, with mature Stage III communities found at almost every station on both of these older mounds. The infaunal community at each of these mounds is now considered to be fully recovered with habitat conditions similar to those found at the reference stations.

The recent mound, NL-06, has also recovered from disposal-related disturbance. The 2007 NLDS survey was conducted eight months after the last recorded disposal activity at NL-06 which provided ample time for recolonization of the new mound. As expected, the RPD depths at the NL-06 Mound were significantly shallower than reference area values. However, all stations had advanced stages of recolonization with extensive burrowing and feeding voids present.

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EXECUTIVE SUMMARY

Monitoring surveys were conducted in July and August 2007 at the New London Disposal Site (NLDS) as part of the Disposal Area Monitoring System (DAMOS) Program. The 2007 field effort consisted of bathymetric, sediment-profile imaging, and plan-view imaging surveys designed to characterize the seafloor topography of the disposal site, document the distribution of dredged material around recent and historic disposal locations, and assess the benthic conditions over recently formed and historic disposal mounds.

The July 2007 bathymetric survey was performed over a 2100 x 2100 m area encompassing the entire NLDS. Placement of approximately 321,000 m^3 of dredged material at NLDS from 2000 to 2007 resulted in the formation of a mound with a maximum height of approximately 4 m and dimensions of approximately 575 m long by 250 m wide. No other significant bathymetric changes were observed between 1997 and 2007.

The August 2007 sediment-profile imaging and plan-view imaging survey was performed at the recently formed NL-06 Mound and the historical mounds, NL-91 and Dow/Stonington (D/S) Mound Complex and the United States Coast Guard Academy (USCGA) Mound. Recolonization at the older mounds (USCGA and NL-91 and D/S Mound Complex) has continued as expected, with mature Stage III communities found at almost every station on both of these older mounds. The infaunal community at each of these mounds is now considered to be fully recovered with habitat conditions similar to those found at the reference stations.

The recent mound, NL-06, has also recovered from disposal-related disturbance. The 2007 NLDS survey was conducted eight months after the last recorded disposal activity at NL-06 which provided ample time for recolonization of the new mound. As expected, the RPD depths at the NL-06 Mound were significantly shallower than reference area values. However, all stations had advanced stages of recolonization with extensive burrowing and feeding voids present.

While future monitoring surveys at the site should include the NL-06 Mound to document the completion of the recolonization sequence, frequent monitoring of either the NL-91 and D/S Mound Complex or USCGA Mounds is determined to be unnecessary.

1.0 INTRODUCTION

A monitoring survey was conducted at the New London Disposal Site (NLDS) in July and August 2007 as part of the U.S. Army Corps of Engineers (USACE) New England District Disposal Area Monitoring System (DAMOS). DAMOS is a comprehensive monitoring and management program designed and conducted to address environmental concerns associated with use of open-water disposal sites throughout the New England region. An introduction to the DAMOS Program and the New London Disposal Site, including a brief description of previous dredged material disposal activities and previous monitoring surveys, is provided below.

1.1 Overview of the DAMOS Program

For over 30 years, the DAMOS Program has conducted monitoring surveys at open-water disposal sites throughout New England and evaluated the patterns of physical, chemical, and biological responses of seafloor environments to dredged material disposal activity. The DAMOS Program features a tiered disposal site management protocol designed to ensure that any potential adverse environmental impacts associated with dredged material disposal are promptly identified and addressed (Fredette and French 2004; Germano et al. 1994).

DAMOS monitoring surveys are designed to test hypotheses related to expected physical and ecological response patterns following placement of dredged material on the seafloor at established disposal sites. The data collected and evaluated during DAMOS monitoring surveys provide answers to strategic management questions in determining the next step in the disposal site environmental management process.

Two primary goals of DAMOS monitoring surveys are to document the physical location of dredged material placed on the seafloor and to evaluate the environmental impact of placement of the dredged material. Sequential bathymetric measurements are performed to characterize the height and spread of discrete dredged material deposits or mounds created at disposal sites, and sediment-profile imaging (SPI) surveys are performed to support evaluation of seafloor (benthic) habitat conditions and recovery over time. Each type of data collection activity is conducted periodically at disposal sites, and data are evaluated to determine the next step in the disposal site management process. The conditions found after a defined period of disposal activity are compared with the long-term data set at a specific site (Germano et al. 1994). DAMOS monitoring surveys may also feature additional types of data collection activities, such as side-scan sonar, sediment coring, or grab sampling, as deemed appropriate to achieve specific survey objectives.

1.2 Introduction to the New London Disposal Site

The New London Disposal Site (NLDS) is an active open-water dredged material disposal site located 5.38 km (3.1 nmi) south of Eastern Point, Groton, Connecticut (Figure 1-1). NLDS is one of four disposal sites within Long Island Sound. NLDS is centered at 41° 16.306´ N, 72° 04.571´ W (NAD 83) and covers a 3.42 km^2 area of seafloor. Water depths range from 13.4 m to 24.3 m at its deepest point. Two important management boundaries are present at NLDS: a 300-m wide submarine transit corridor, crossing through the center of NLDS from south to north, and the New York-Connecticut state boundary, crossing the southeast corner of the site (Figure 1-1). The submarine corridor was established to minimize conflict between disposal buoy positions and submarine traffic to and from the U.S. Navy Base in Groton, CT. The state boundary affects state regulatory authority under the Coastal Zone Management Act (CZMA) and the issuance of state water quality certification (Clean Water Act, Section 401) for disposal permits (Carey 1998).

Currently, this site is utilized for the unconfined disposal of suitable sediments, as well as subaqueous capping of sediments deemed unsuitable for unconfined open water disposal. There are 12 disposal mounds located within the boundaries of NLDS. Following the creation of the initial NL-RELIC Mound in the late 1970s and early 1980s (NUSC 1979; SAIC et al 1985), disposal has been managed to create broad, flat mounds and to maintain a minimum water depth of 14 m to reduce the potential effects of bottom currents and storm-generated waves and to allow for safe passage of deeper draft vessels transiting through the disposal site. Subsequent surveys (SAIC 2001a) have indicated that the peak of the initial NL-Relic Mound has remained stable at a depth slightly less than 14 m and more recently formed disposal mounds are consistently deeper than 14 m.

In recent years, management objectives have sought to minimize the lateral spread of dredged material during placement at 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 the volume of capping dredged material (CDM) required to completely cover and contain a deposit of unacceptably-contaminated dredged material (UDM) (Fredette 1994). The Seawolf Mound, NL-91 and Dow/Stonington (D/S) Mound Complex, and the United States Coast Guard Academy (USCGA) Mound are examples of capped mounds at NLDS (Figure 1-2). These mounds were formed prior to 1997 and have been monitored at regular intervals by the DAMOS Program.

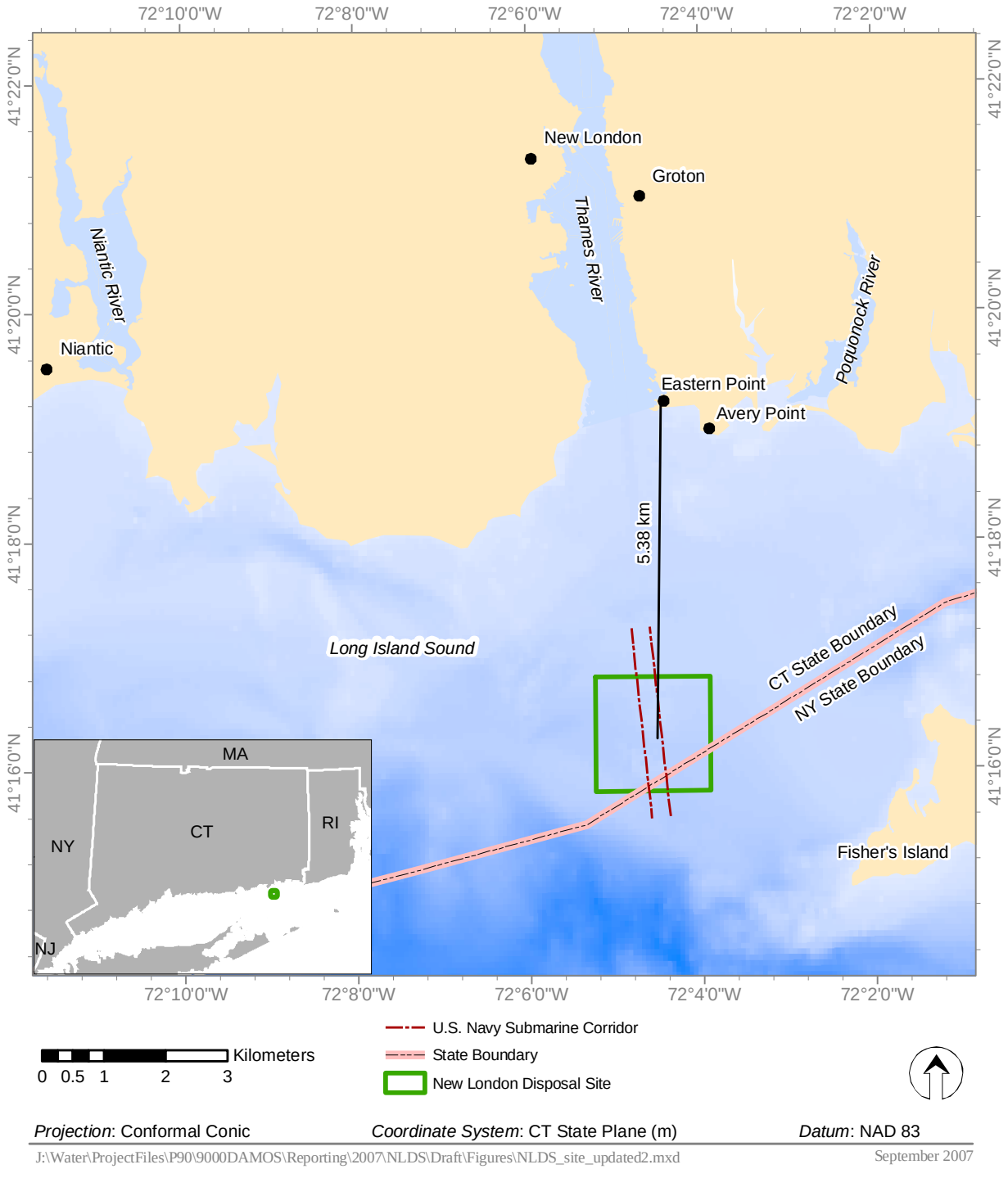

Figure 1-1. Location of the New London Disposal Site

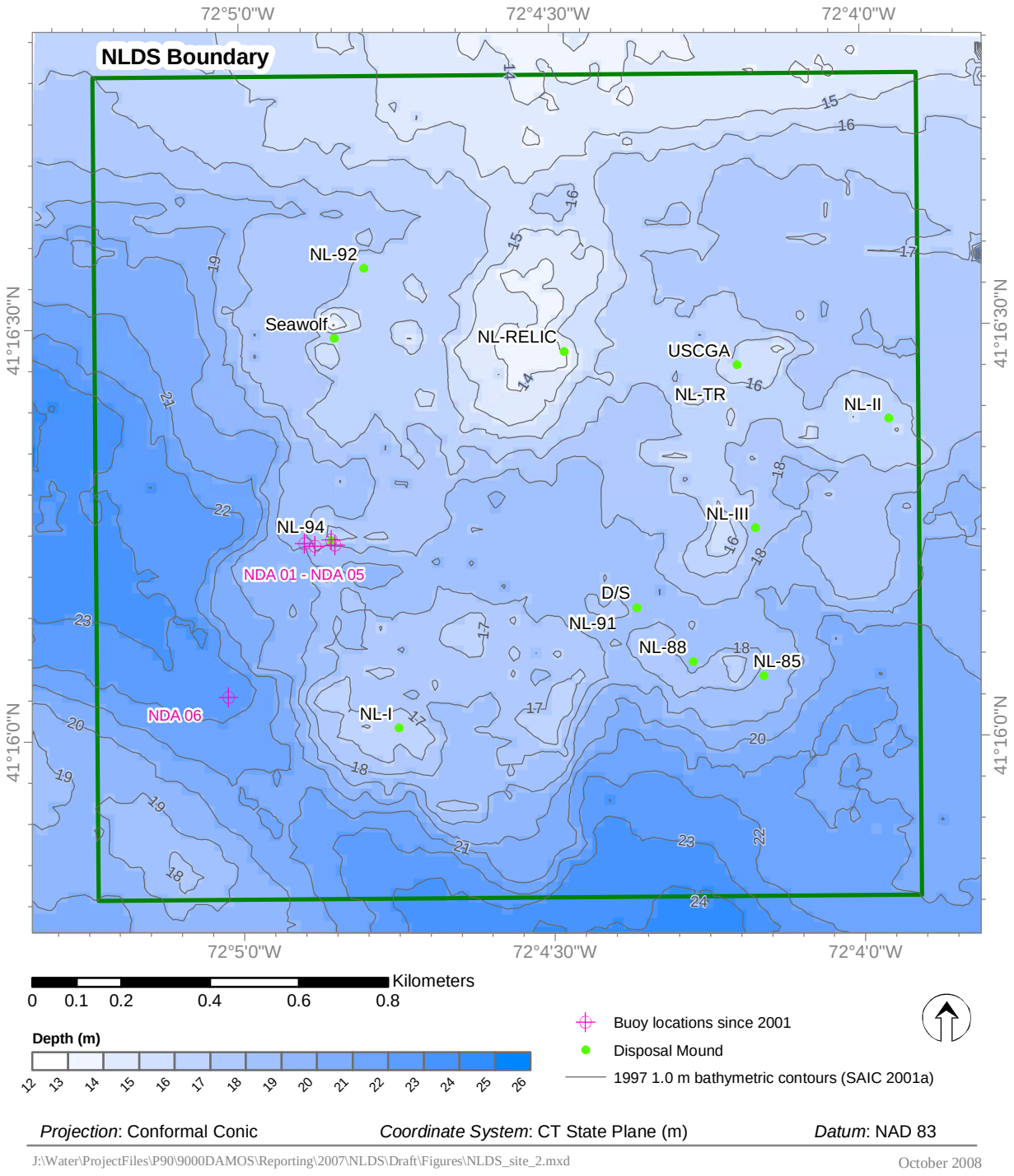

Figure 1-2. Bathymetric contour map of NLDS, September 1997

The disposal site boundaries of NLDS and other New England disposal sites have been established to provide a management objective for placement of dredged material on the seafloor. Barge operators are given specific coordinates (and often visible lighted buoys) within the disposal boundaries to which to navigate and release their cargo of dredged material. In practice, it is expected that disposal will occur in a cluster around the designated disposal location and that some dredged material will be suspended in the water column during release. The Clean Water Act Section 404 (b)(1) provides guidelines for the discharge of dredged material and defines the "discharge point" as the point within the disposal site (the bottom surface area and any overlying volume of water) at which the dredged material is released. The Marine Protection, Research, and Sanctuaries Act Section 102 defines the release zone as a locus of points 100 m around the barge from beginning to end of the discharge. Monitoring surveys are designed with the recognition that the site boundary is a target area for release at the water's surface, and that some dredged material may extend across the boundary on the seafloor during placement and descent.

1.3 Historic NLDS Dredged Material Disposal Activity

While dredging and disposal activities in the New England region have been overseen by the DAMOS Program since its inception in 1977, disposal in the vicinity of New London has taken place since 1955 (SAIC 2001a). Maintenance dredging of New London Harbor and adjacent coastal areas is required to ensure navigable waterways and adequate dockage for deep draft vessels. Currently, the NLDS is utilized for the unconfined disposal of suitable sediments, as well as the subaqueous capping of sediments deemed unsuitable for open-water disposal (SAIC 2004). Material generated from dredging operations in the New London region, including the Lower Thames River and New London Harbor, that is classified as suitable for open-water disposal is typically deposited at NLDS. Since the August 2000 survey, approximately 321,000 m^3 of material has been disposed in the south central portion of the site.

There are 12 discernable disposal mounds located within the boundaries of NLDS: Seawolf, USCGA, NL-Relic, NL-TR, NL-I, NL-II, NL-III, NL-85, NL-88, NL-92, NL-94, and the NL-91 and D/S Mound Complex (Figure 1-2). Development of a thirteenth mound, NL-06, was initiated in 2006 in the southwest corner of NLDS at the location of the NDA 06 disposal buoy (Figure 1-2).

The NL-91 and D/S Mounds, subsequently referred to as the NL-91 and D/S Mound Complex, were formed during the 1991–1992 disposal season from dredging projects in the Mystic and Niantic Rivers, as well as in Stonington Harbor. Approximately 8800 m^3 of dredged material was deposited on the seafloor to form the NL-91 Mound. The D/S Mound was formed in support of a sediment capping project for the Dow Chemical Company. An estimated 12,000 m^3 of UDM from Stonington Harbor and 24,000 m^3 of UDM material from

Dow Chemical Company's Allyn's Point facility were deposited to form the D/S Mound. Approximately 59,300 m^3 of CDM from the Dow Chemical project was used to cap the UDM at the D/S Mound. The placement of cap material was slightly off target causing the coalescence of the NL-91 and D/S Mounds into the NL-91 and D/S Mound Complex. An additional 6,850 m^3 of CDM was directed to the NL-91 and D/S Mound Complex during the 1997–1998 season to ensure the isolation of unsuitable material from the marine environment (SAIC 2001a). During the 1998–1999 disposal season, a total barge volume of 22,210 m^3 CDM was placed in the northern and central regions of the NL-91 and D/S Mound Complex, An additional 1375 m^3 of CDM was deposited over the NL-91 and D/S Mound Complex in May 2000 to continue augmentation of the cap (SAIC 2001b). The topography of the NL-91 and D/S Mound Complex was last surveyed in September 2000 (SAIC 2001c).

The USCGA Mound was developed during the 1994–1995 disposal season as part of a confined aquatic disposal (CAD) project. Approximately 124,000 m^3 of dredged material was placed 180 m west of the historic NL-TR Mound. The USCGA Mound consisted of 43,500 m^3 of UDM subsequently covered by 80,500 m^3 of CDM. The placement of this material on the seafloor resulted in the overlapping of the USCGA Mound with the western flank of the NL-TR Mound. The USCGA Mound is laterally confined by the NL-RELIC Mound to the west and the NL-II Mound to the east (Figure 1-2) (SAIC 2001a).

1.4 Previous NLDS Monitoring Events

Prior to initiation of the DAMOS Program, the U.S. Navy conducted an initial comprehensive study of NLDS in 1973 (SAIC 2001a). Under the DAMOS Program, NLDS has been monitored periodically to assess stability and thickness of dredged material and benthic recolonization status relative to previous survey results and in comparison with nearby references areas. The most recent survey efforts at NLDS have concentrated on the Seawolf Mound. Surveys of the Seawolf Mound were conducted in June/July 2006 (AECOM, in progress), February 2003 (SAIC 2003), June 2001 (SAIC 2004), August 2000 (SAIC 2001c), July 1998 (SAIC 2001b), and September 1997 (SAIC 2001b). Other mounds within NLDS were surveyed in August 1992, August 1995, September 1997, July 1998 (SAIC 2001a), and August 2000 (SAIC 2001c) (Table 1-1).

The August 1992 survey was concentrated over the central region of the disposal site and consisted of bathymetry, sediment-profile imaging, and dissolved oxygen (DO) measurements. Mounds surveyed included the NL-91 Mound and the D/S Mound. The bathymetric survey revealed a minimum depth of 13.0 m over the NL-Relic mound to the north and a maximum depth of 23.5 m along the southern edge of the survey area (SAIC 2001a). A comparison of this survey with the baseline survey of June 1991 (conducted prior to any

Table 1-1.

Overview of Previous Monitoring Surveys at NLDS since 1992

Date	Purpose of Survey	Bathymetry Area (mxm)	No. SPI Stations	No. Sediment Cores	No. Benthic Grabs	Other Studies	Reference
August 1992	Monitoring	1600 x 1600	Site: 41 Ref: 39			DO Sampling	SAIC 2001a
August 1995	Monitoring	1600 x 1600	Site: 31 Ref: 15				SAIC 2001a
October 1995	Baseline (Seawolf)	1000 x 1000					SAIC 2001b
December 1995	Pre-cap (Seawolf)	1000 x 1000					SAIC 2001b
February 1996	Post-cap (Seawolf)	1000 x 1000					SAIC 2001b
September 1997	Monitoring	2100 x 2100 1000 x 1000 (Seawolf)	Site: 68 Ref: 13				SAIC 2001a, SAIC 2001b
July 1998	Monitoring	1000 x 1000 (Seawolf)	Site: 42 Ref: 13	Site: 12 Ref: 1			SAIC 2001a, SAIC 2001b
August 2000	Monitoring	800 x 800 (NL-91 and D/S Mound Complex) 1000 x 1000 (Seawolf)	Site: 55 Ref: 13				SAIC 2001c
June 2001	Monitoring (Seawolf)		Site: 29 Ref: 13	Site: 12 Ref: 1	Site: 6		SAIC 2004
October 2002	Post-storm monitoring (Seawolf)	1000 x 1000	Site: 29 Ref: 13			Side-scan	SAIC 2003
February 2003	Post-storm monitoring (Seawolf)	1000 x 1000					SAIC 2003
July 2006	Monitoring (Seawolf)	2100 x 2100	Site: 13 Ref: 13	Site: 13 Ref: 1	Site: 12 Ref: 6		AECOM, In preparation

placement of either UDM or CDM) resulted in detection of an irregularly shaped mound approximately 500 m in diameter, which was called the NL-91 and D/S Mound Complex.

The August 1995 and September 1997 surveys both involved bathymetry and sediment-profile imaging. Mounds surveyed in 1995 and 1997 included the NL-91 and D/S Mound Complex and the NL-94 Mound. The USCGA Mound was also surveyed in 1995. The 1997 survey was the last complete bathymetric survey of NLDS. Analysis of the 1995 and 1997 bathymetric data showed no significant difference in the size or shape of the NL-91 and D/S Mound Complex since 1992 (SAIC 2001a).

The July 1998 survey involved sediment-profile imaging of the NL-91 and D/S Mound Complex. This survey concluded that the NL-91 and D/S Mound Complex showed strong evidence of benthic community recovery and the continued presence of a stable benthic community (SAIC 2001a).

The August 2000 survey included bathymetry and sediment-profile imaging. The 2000 bathymetric survey covered the NL-91 and D/S Mound Complex as well as the Seawolf Mound but did not cover the area containing the NL-06 Mound (Table 1-1). The 2000 survey confirmed the presence of supplemental CDM over the NL-91 and D/S Mound Complex. The survey also showed that the supplemental CDM had been colonized successfully by Stage II and Stage III organisms. The USCGA Mound continued to be populated by a benthic community consisting of advanced successional stage assemblages.

1.5 Recent Dredged Material Disposal Activity

Since the August 2000 survey, approximately 321,000 m^3 of dredged material has been disposed in the southern portion of NLDS (Figure 1-3 and Table 1-2). Approximately 277,000 m^3 of dredged material was directed to the NL-06 Mound, while smaller amounts of material were directed to the NL-94 Mound and the NL-91 and D/S Mound Complex (Figure 1-3). No further disposal activity has been recorded at NLDS since November 2006. The dredged material deposited during this period originated primarily from maintenance dredging of the Dow Chemical Allyn's Point Plant (84,900 m^3) and the U.S. Navy Excavation CAD Cells (165,400 m^3). A detailed record of barge disposal activity at NLDS for the period August 2000 to July 2007, including the origin of dredged material, the volume deposited, and the disposal location, is provided in Appendix A.

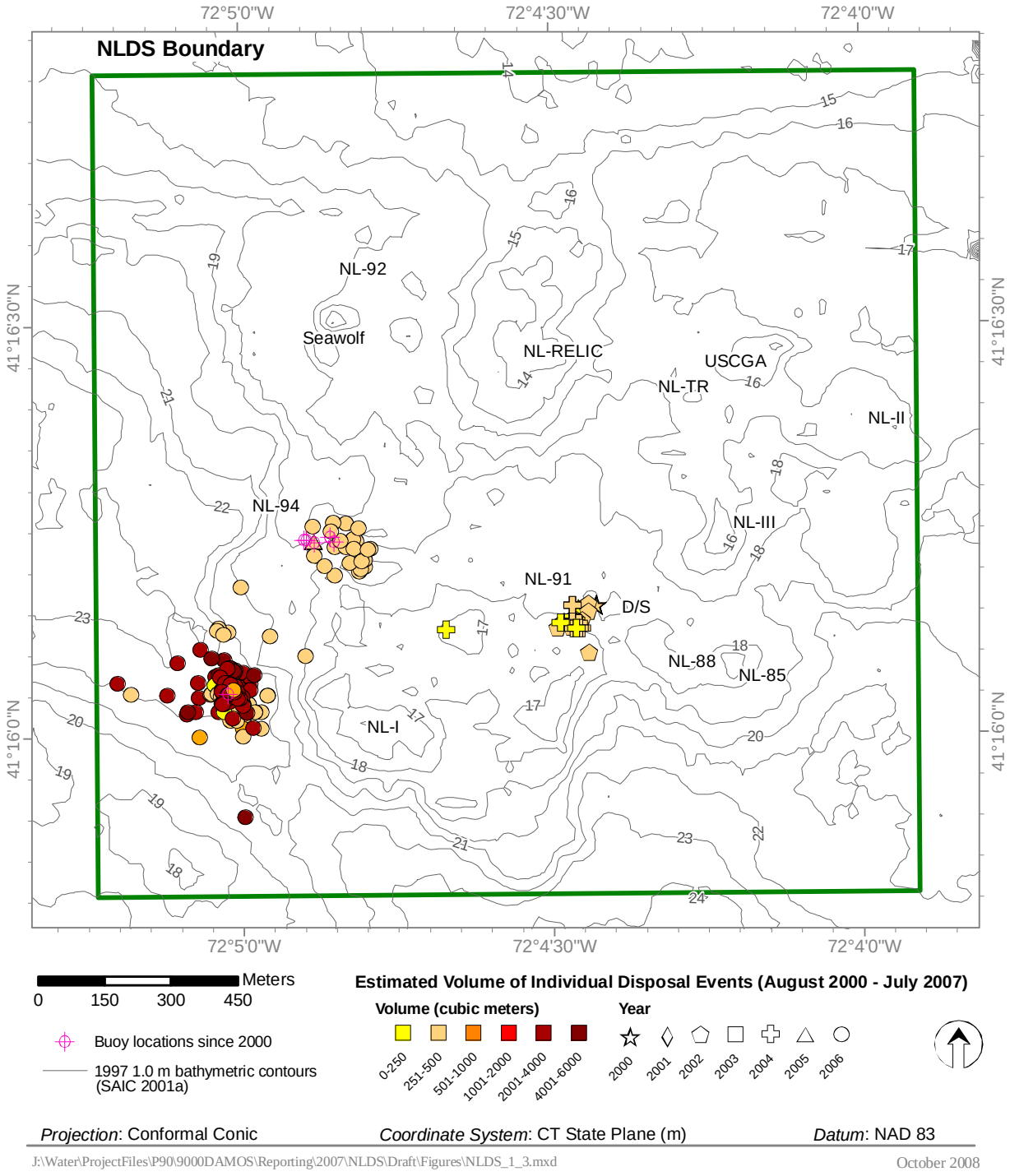

Figure 1-3. NLDS with reported August 2000 through July 2007 dredged material disposal locations indicated

Table 1-2.

Overview of Recent Disposal Activity at NLDS (August 2000–July 2007)

Source Project	Estimated Scow Volume Disposed (m^3)						
	2000	2001	2002	2003	2004	2005	2006
Ragged Rock Marina	2026						
Venetian Harbor		54					
Mumford Cove	--	1472	3498	--	--	--	--
Niantic Bay	--	--	1988	382	--	--	--
Tidal Creek/Hammonasset River	--	--	--	--	--	--	9556
Mystic Shipyard	--	--	841	--	--	--	--
West Cove	--	--	--	3020	6117	6461	--
Gwenmor Marina	--	--	2408	--	--	--	--
U.S. Navy Excavation CAD Cells	--	--	--	--	--	--	165,411
Noank Shipyard	--	--	--	--	--	191	11,621
Allyn's Point Plant	--	--	--	--	--	--	84,865
Harbor One Marina	--	--	--	--	--	--	3058
Pine Island Bay	--	--	--	--	--	--	1758
Mystic River	--	--	--	--	--	--	4893
Spicer's Marina	--	--	--	--	--	--	3326
Thames River, Electric Boat							1651
Thames River, Montville, CT	--	--	--	--	--	--	3192
Stonington Harbor	--	--	--	--	--	--	2829
Total	2026	1526	8735	3402	6117	6652	292,161
Grand Total 2000-2006				320,619			

1.6 Survey Objectives

The July/August 2007 NLDS survey was designed to document the distribution of dredged material (including disposal mound morphology) within NLDS using multibeam bathymetry and assess the benthic recolonization of the NL-06 Mound and two historic mounds (NL-91 and D/S Mound Complex and USCGA) using sediment-profile imaging.

The design of the 2007 survey allowed assessment of the following expectations:

- The placement of approximately 321,000 m^3 of dredged material at the NDA 06 buoy since August 2000 will result in the development of the NL-06 Mound;
- Based on the amount of disposal, the NL-06 Mound is expected to measure approximately 500 to 600 m in diameter with an elevation of 3–4 meters;
- Historical mounds (NL-91 and D/S Mound Complex and USCGA Mound) will show minor consolidation;
- As the NL-91 and D/S Mound Complex and USCGA Mound have not received dredged material in approximately 3 and 13 years, respectively, it is expected that the benthic community will be comprised of mature, equilibrium (Stage III) assemblages and will have conditions comparable to those found at the reference areas; and
- Based on the more recent disposal activity, the NL-06 Mound will display early recolonization assemblages (Stage I and early Stage II).

2.0 METHODS

A team of investigators from AECOM, Germano and Associates, Ocean Surveys Inc. (OSI), and CR Environmental performed the 2007 surveys at NLDS. A multibeam bathymetric survey was conducted 23–26 July 2007 to document the distribution of dredged material within NLDS. A sediment-profile and plan-view imaging survey, combined with sediment grab sampling, were conducted 25–27 August 2007 to assess benthic recolonization of the NL-06 Mound, the NL-91 and D/S Mound Complex, and the USCGA Mound. Field activities are summarized in Table 2-1, and an overview of the methods used to collect, process, and analyze the survey data is provided below.

2.1 Navigation and Data Acquisition

Positional data, comprised of horizontal positioning (x- and y-dimensional data) and time (t-dimensional data), were obtained using a Trimble Differential Global Positioning System (DGPS). Differential corrections were obtained from the U.S. Coast Guard differential beacon transmitter located at Moriches, NY and applied to the raw GPS data resulting in real-time vessel position, typically to submeter accuracy. Positioning system accuracy was confirmed at the beginning and end of each survey day by comparing the observed navigation system coordinates to an established reference point with known coordinates.

The GPS receiver installed on the survey vessel was interfaced to the onboard navigation computer running HYPACK® software providing the field team with the ability to precisely navigate the vessel throughout the survey area and along the pre-selected survey tracklines for the bathymetry survey and to the target stations for the SPI and plan-view imaging survey. HYPACK® hydrographic survey software, developed by HYPACK, Inc. (formerly Coastal Oceanographics, Inc.) was used to acquire, integrate, and store all positional data from the DGPS as well as bathymetric, backscatter, and station data.

2.2 Bathymetry

Bathymetric surveys provide measurements of water depth that, when processed, can be used to map the seafloor topography. The processed data can also be compared with previous surveys to track changes in the size and location of seafloor features. This technique is the primary tool in the DAMOS Program for mapping the distribution of dredged material at disposal sites.

Table 2-1.

2007 NLDS Field Activities Summary

Survey Type	Date	Summary
Multibeam Bathymetry and Acoustic Backscatter	23–26 July 2007	Area: 2100 x 2100 m Lines: 62 Spacing: 25 m
Sediment-Profile and Plan-View Imaging	26–27 August 2007	Stations: 60 Site: 45 Reference: 15
Sediment Grab Sampling	27 August 2007	Stations: 1 (NL-06-15)

2.2.1 Bathymetric Data Collection

The 2007 multibeam bathymetric survey was conducted 23–26 July 2007 aboard the R/V *Able II* and covered a 2100 x 2100 m area of the seafloor (Figure 2-1). A total of 62 survey lines, each approximately 25 m apart and oriented in an east-west direction, were occupied as part of the survey. Additional tie-lines were occupied perpendicular to the main survey lines to assess data quality. In addition to multibeam bathymetric data, acoustic backscatter data were also collected.

The bathymetric and acoustic backscatter data were collected using a Reson 8125 Ultra High Resolution Echosounder outfitted with a 0.5°, 455-kHz transducer. The Applanix POS-MV motion sensor was combined with the GPS to provide accurate heading and measurement of heave, pitch, and roll. The system was calibrated for local water-mass speed of sound by performing conductivity-temperature-density (CTD) casts at frequent intervals throughout the day with a Seabird SBE-19 Seacat CTD profiler.

Water depths over the survey area were recorded in meters and referenced to mean lower low water (MLLW) based on water level data obtained from the National Ocean Service – National Oceanic and Atmospheric Administration (NOS-NOAA) water level gauge at the New London State Pier.

2.2.2 Bathymetric Data Processing

The bathymetric data were processed using the HYPACK® software program and included corrections for tidal conditions, local speed of sound, and spurious data points. Tidal correction consisted of transforming the raw measurements of depth below the transducer to seafloor elevation measurements relative to MLLW using the locally collected tidal elevation data. Heave data supplied by the vessel's motion reference unit (MRU) were incorporated into the raw data to minimize the effects of vessel motion. The bathymetric data were also reviewed for spurious data points (clearly unrealistic measurements resulting from signal interference) and these points were removed. The final data set was averaged into 1.0-m^2 bins. All soundings located within a given bin were averaged, and the average value was assigned to the coordinates at the center of the bin.

2.2.3 Bathymetric Data Analysis

Bathymetric data were analyzed to document the distribution of dredged material in NLDS and evaluate changes in seafloor topography in comparison with previous surveys. The corrected bathymetric data were processed for display using a combination

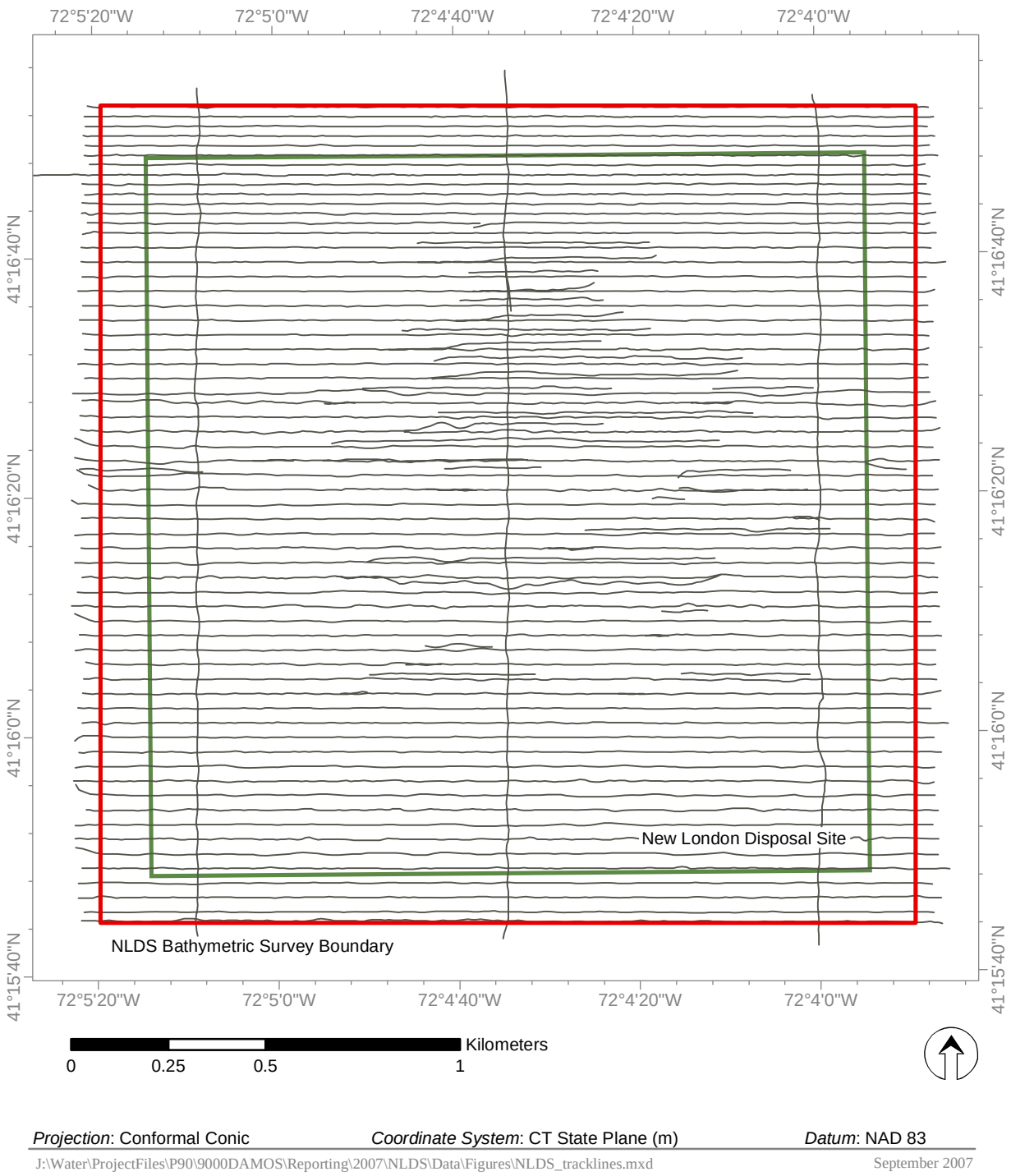

Figure 2-1. NLDS with bathymetry survey boundary and survey lines indicated

of the contouring and surface plotting software program Surfer® 8.0 and the GIS-based software package ArcView® 9.2. The processed bathymetric data were converted into grids using Surfer® and bathymetric contour lines were generated and displayed using ArcView®.

Surfer® was also used to generate a depth-difference grid based on the September 1997 and the July 2007 bathymetric data sets. The depth difference grids were calculated by subtracting the 1997 interpolated depth estimates from the 2007 surveys depth estimates at each point throughout the grid. The resulting depth differences were contoured and displayed using ArcView®.

2.3 Sediment-Profile and Plan-View Imaging

2.3.1 Sediment-Profile Imaging

Sediment-profile imaging (SPI) is a monitoring technique used to provide data on the physical characteristics of the seafloor as well as the status of the benthic biological community. The technique involved deploying an underwater camera system to photograph a cross section of the sediment-water interface. Acquisition of high-resolution sediment-profile images was accomplished using a Nikon D100 digital single-lens reflex camera mounted inside an Ocean Imaging Model 3731 pressure housing system. The pressure housing sat atop a wedge-shaped prism with a front faceplate and a back mirror. The mirror was mounted at a 45° angle to reflect the profile of the sediment-water interface. As the prism penetrated the seafloor, a trigger activated a time-delay circuit that fired an internal strobe to obtain a cross-sectional image of the upper 15–20 cm of the sediment column (Figure 2-2). The camera remained on the seafloor for approximately 20 sec to ensure that a successful image had been obtained.

Test exposures of the Kodak® Color Separation Guide (Publication No. Q-13) were made on deck at the beginning and end of each survey to verify that all internal electronic systems were working to design specifications and to provide a color standard against which final images could be checked for proper color balance. After deployment of the camera at each station, the frame counter was checked to ensure that the requisite number of replicates had been obtained. In addition, a prism-penetration depth indicator on the camera frame was checked to verify that the optical prism had actually penetrated the bottom to a sufficient depth. If images were missed or the penetration depth was insufficient, the camera frame stop collars were adjusted and/or weights were added or removed, and additional replicate images were taken. Changes in prism weight amounts, the presence or absence of mud doors (to limit over-penetration in soft sediments), and frame stop collar positions were recorded for each replicate image.

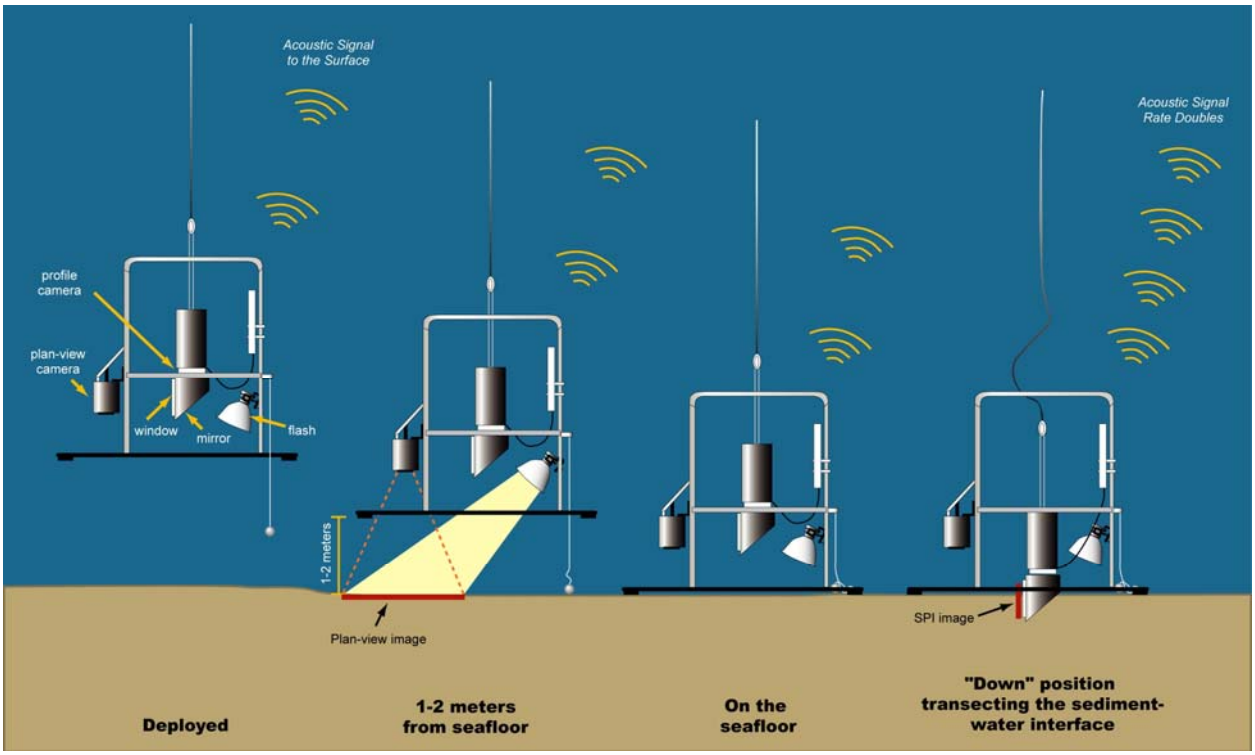

Figure 2-2. Operation of the combined Ocean Imaging Model 3731 sediment-profile and Model DSC-6000 plan-view cameras

Each image was assigned a unique time stamp in the digital file attributes by the camera's data logger and cross-checked with the time stamp in the navigational system's computer data file. In addition, the field crew kept redundant written sample logs. Images were downloaded periodically to verify successful sample acquisition and/or to assess what type of sediment/depositional layer was present at a particular station. Digital image files were re-named with the appropriate station name immediately after downloading as a further quality assurance step.

For a more detailed discussion of SPI methodology, see ENSR 2004.

2.3.2 Plan-View Imaging

Plan-view underwater images were also collected at each station sampled with the sediment-profile camera. An Ocean Imaging Model DSC6000 plan-view underwater camera (PUC) system with two Ocean Imaging Model 400-37 Deep Sea Scaling lasers was attached to the Model 3731 camera frame and used to collect plan-view photographs of the seafloor surface (Figure 2-2). The PUC system consisted of a Nikon D70 camera encased in a titanium housing, a 24 VDC autonomous power pack, a 500W strobe, and a bounce trigger. A weight was attached to the bounce trigger with a stainless steel cable so that the weight hung below the camera frame. The scaling lasers projected two red dots that were separated by a constant distance (26 cm) regardless of the field of view of the PUC, which can be varied by increasing or decreasing the length of the trigger wire. For this survey, the trigger wire length was constant (0.91 m), and the area of seafloor imaged was approximately 0.5 m^2. As the camera apparatus was lowered to the seafloor, the weight attached to the bounce trigger contacted the seafloor prior to the camera frame hitting the bottom and triggered the PUC. Details of the camera settings for each digital image are available in the associated parameters file embedded in each electronic image file; for this survey, the ISO-equivalent was set at 800. The additional camera settings used were as follows: shutter speed was 1/15, f10, white balance set to flash, color mode to Adobe RGB, sharpening to none, noise reduction off, and storage in compressed raw Nikon Electronic Format (NEF) files (approximately 5 MB each). Electronic files were converted to high-resolution jpeg (8-bit) format files (2000 x 3008 pixels) using Nikon Capture4® software (Version 4.4.2).

Prior to field operations, the internal clock in the digital PUC was synchronized with the GPS navigation system and the SPI camera. Each PUC image acquired was assigned a time stamp in the digital file and redundant notations in the field and navigation logs. Throughout the survey, PUC images were downloaded at the same time as the sediment-profile images after collection and evaluated for successful image acquisition and image clarity.

2.3.3 SPI and PUC Data Collection

The sediment-profile and plan-view imaging survey at NLDS was initiated 26 August 2007 and completed 27 August 2007 aboard the F/V *Shanna Rose*. At each station, the vessel was positioned at the target coordinates, and the camera was deployed within a defined station tolerance of 10 m. Three replicate SPI and plan-view images were collected at each of the stations.

The 2007 imaging survey design included the collection of sediment-profile and plan-view images at 60 stations: 45 stations located within NLDS and 15 stations distributed within three reference areas (Table 2-2, Figure 2-3). The 45 stations located within NLDS were distributed as follows: 15 stations at the NL-06 Mound, 15 stations at the NL-91 and D/S Mound Complex, and 15 stations at the USCGA Mound. Stations were randomly located within the area of each of these mounds. Three reference areas, located to the east (NEREF and NLON REF) and west (WREF) of NLDS, were surveyed to provide a basis of comparison between NLDS sediment conditions and the ambient sediment conditions in eastern Long Island Sound. Five reference stations were selected randomly within a 300-m radius of the centers of each of the three reference areas (Table 2-2, Figure 2-3).

2.3.4 SPI and PUC Data Analysis

Computer-aided analysis of the resulting images provided a set of standard measurements that enabled comparison between different locations and different surveys. The DAMOS Program has successfully used this technique for over 25 years to map the distribution of disposed dredged material and to monitor benthic recolonization at disposal sites.

Following completion of data collection, the digital images were analyzed using Bersoft Image Measurement© software version 3.06 (Bersoft, Inc.). Images were first adjusted in Adobe Photoshop® to expand the available pixels to their maximum light and dark threshold range. Linear and area measurements were recorded as number of pixels and converted to scientific units using the Kodak® Color Separation Guide for measurement calibration. Detailed records of all SPI and PUC results are included in Appendices B (SPI) and C (PUC).

Table 2-2.

NLDS Sediment-Profile and Plan-View Image Target Locations

Station	Latitude (N)	Longitude (W)	Station	Latitude (N)	Longitude (W)
NLDS Locations					
USCGA-01	41° 16.457'	72° 04.167'	D/S-01	41° 16.107'	72° 4.501'
USCGA-02	41° 16.484'	72° 04.146'	D/S-02	41° 16.084'	72° 4.426'
USCGA-03	41° 16.440'	72° 04.104'	D/S-03	41° 16.100'	72° 4.393'
USCGA-04	41° 16.476'	72° 04.205'	D/S-04	41° 16.151'	72° 4.516'
USCGA-05	41° 16.438'	72° 04.166'	D/S-05	41° 16.075'	72° 4.380'
USCGA-06	41° 16.397'	72° 04.147'	D/S-06	41° 16.143'	72° 4.503'
USCGA-07	41° 16.492'	72° 04.211'	D/S-07	41° 16.108'	72° 4.449'
USCGA-08	41° 16.449'	72° 04.180'	D/S-08	41° 16.138'	72° 4.386'
USCGA-09	41° 16.452'	72° 04.196'	D/S-09	41° 16.143'	72° 4.486'
USCGA-10	41° 16.460'	72° 04.108'	D/S-10	41° 16.181'	72° 4.404'
USCGA-11	41° 16.475'	72° 04.165'	D/S-11	41° 16.157'	72° 4.447'
USCGA-12	41° 16.484'	72° 04.146'	D/S-12	41° 16.133'	72° 4.481'
USCGA-13	41° 16.466'	72° 04.246'	D/S-13	41° 16.126'	72° 4.506'
USCGA-14	41° 16.383'	72° 04.210'	D/S-14	41° 16.166'	72° 4.401'
USCGA-15	41° 16.434'	72° 04.137'	D/S-15	41° 16.121'	72° 4.422'
NL-06-01	41° 16.101'	72° 05.058'	Reference:		
NL-06-02	41° 16.018'	72° 04.968'	NEREF-01	41° 16.703'	72° 3.333'
NL-06-03	41° 16.059'	72° 04.932'	NEREF-02	41° 16.740'	72° 3.301'
NL-06-04	41° 16.012'	72° 05.086'	NEREF-03	41° 16.692'	72° 3.337'
NL-06-05	41° 16.028'	72° 04.935'	NEREF-04	41° 16.628'	72° 3.413'
NL-06-06	41° 16.050'	72° 04.990'	NEREF-05	41° 16.742'	72° 3.405'
NL-06-07	41° 16.008'	72° 05.016'	WREF-01	41° 16.285'	72° 5.955'
NL-06-08	41° 16.041'	72° 05.069'	WREF-02	41° 16.180'	72° 5.898'
NL-06-09	41° 16.110'	72° 04.984'	WREF-03	41° 16.230'	72° 5.949'
NL-06-10	41° 16.054'	72° 05.123'	WREF-04	41° 16.241'	72° 5.974'
NL-06-11	41° 16.029'	72° 05.038'	WREF-05	41° 16.207'	72° 6.078'
NL-06-12	41° 16.072'	72° 04.950'	NLON REF-01	41° 16.645'	72° 1.963'
NL-06-13	41° 16.118'	72° 05.072'	NLON REF-02	41° 16.588'	72° 1.950'
NL-06-14	41° 16.021'	72° 04.985'	NLON REF-03	41° 16.672'	72° 1.893'
NL-06-15	41° 16.079'	72° 05.011'	NLON REF-04	41° 16.720'	72° 2.040'
			NLON REF-05	41° 16.668'	72° 1.960'

Notes: Coordinate system NAD83
D/S Mound refers to NL-91 and D/S Mound Complex

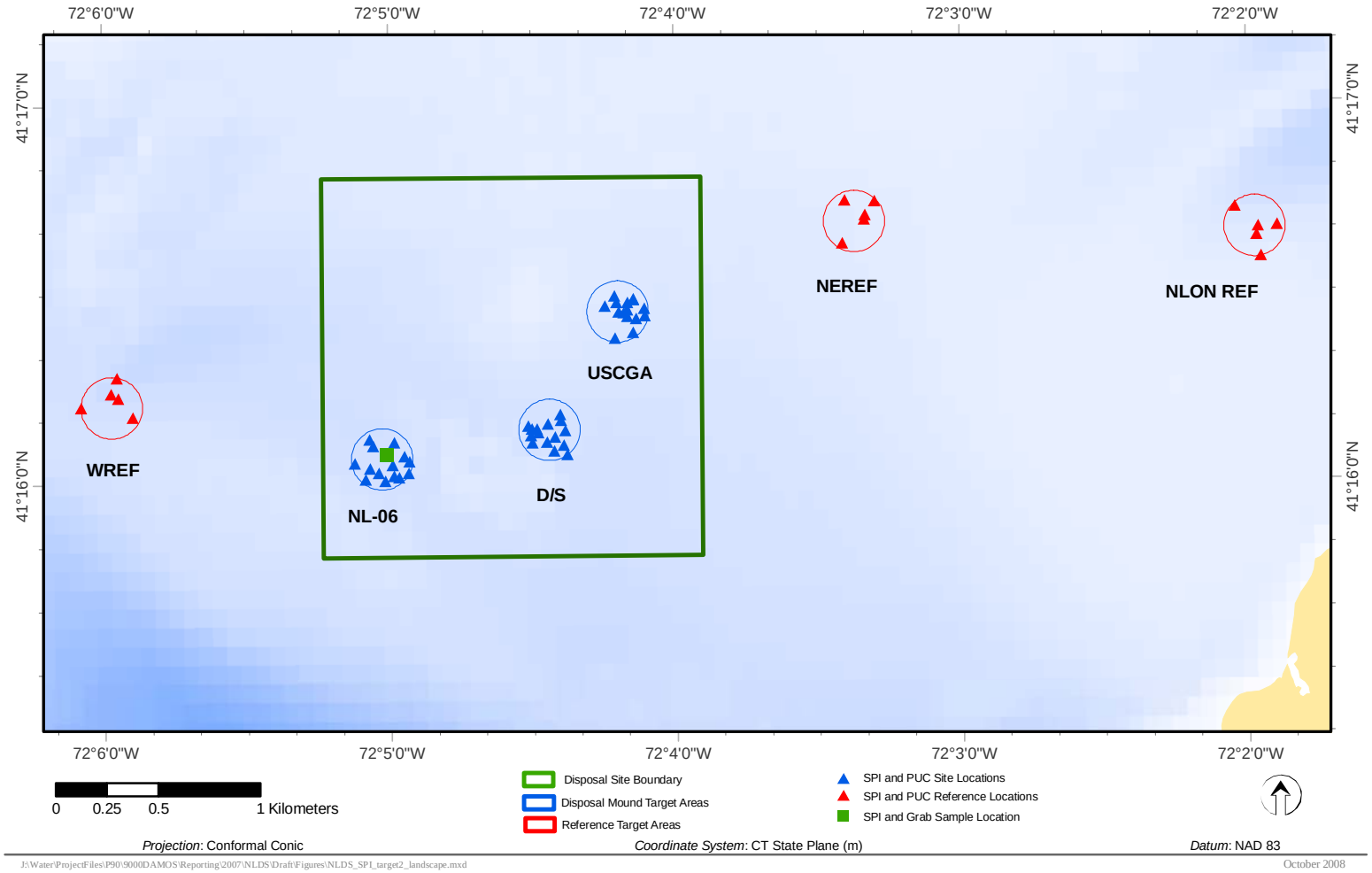

Figure 2-3. NLDS with target sediment-profile, plan-view image, and sediment grab sample locations

2.3.4.1 SPI Data Analysis

Analysis of each SPI image was performed to provide measurement of the following standard set of parameters:

- *Sediment Type*—The sediment grain size major mode and range were estimated visually from the images using a grain-size comparator at a similar scale. Results were reported using the phi scale. Conversion to other grain-size scales is provided in Appendix B. The presence and thickness of disposed dredged material were also assessed by inspection of the images.

- *Penetration Depth*—The depth to which the camera penetrated into the seafloor was measured to provide an indication of the sediment density or bearing capacity. The penetration depth can range from a minimum of 0 cm (i.e., no penetration on hard substrates) to a maximum of 20 cm (full penetration on very soft substrates).

- *Surface Boundary Roughness*—Surface boundary roughness is a measure of the vertical relief of features at the sediment-water interface in the sediment-profile image. Surface boundary roughness was determined by measuring the vertical distance between the highest and lowest points of the sediment-water interface. The surface boundary roughness (sediment surface relief) measured over the width of sediment-profile images typically ranges from 0 to 4 cm, and may be related to physical structures (e.g., ripples, rip-up structures, mud clasts) or biogenic features (e.g., burrow openings, fecal mounds, foraging depressions). Biogenic roughness typically changes seasonally and is related to the interaction of bottom turbulence and bioturbational activities.

- *Apparent Redox Potential Discontinuity (RPD) Depth*— RPD provides a measure of the integrated time history of the balance between near-surface oxygen conditions and biological reworking of sediments. Sediment particles exposed to oxygenated waters oxidize and lighten in color to brown or light grey. As the particles are moved downwards by biological activity or buried, they are exposed to reduced oxygen concentrations in subsurface pore waters and their oxic coating slowly reduces, changing color to dark grey or black. When biological activity is high, the RPD depth increases; when it is low or absent, the RPD depth decreases. The RPD depth was measured by assessing color and reflectance boundaries within the images.

- *Infaunal Successional Stage*—Infaunal successional stage is a measure of the biological community inhabiting the seafloor. Current theory holds that organism-

sediment interactions in fine-grained sediments follow a predictable sequence of development after a major disturbance (such as dredged material disposal), and this sequence has been divided subjectively into three stages (Rhoads and Germano 1982, 1986). Successional stage was assigned by assessing which types of species or organism-related activities were apparent in the images.

Additional components of the SPI analysis included calculation of means and ranges for the parameters listed above and mapping of station-averaged values.

2.3.4.2 PUC Image Data Analysis

Analysis of each PUC image was performed to provide additional information about large-scale sedimentary features, density and patch size of surface fauna, density of infaunal burrowers, and occurrences and density of epifaunal foraging patterns on the seafloor of the disposal site and reference areas.

2.3.5 Statistical Methods

The objective of the SPI and plan-view imaging survey was to assess the benthic recolonization status of the three disposal site mounds relative to reference conditions. Traditionally, the DAMOS Program used point-null hypothesis testing to evaluate this type of objective. This approach postulates the null hypothesis that there is no difference in benthic conditions between the mean values of the reference area and the mean values of the disposal mound; if the p-value is less than the accepted Type I error risk (α = 0.05), it is concluded that the sites are different (e.g., Underwood 1990, 1997; Fairweather 1991). As such, p-values are treated as evidence for or against rejecting the null hypotheses.

As limitations have been identified with this approach (e.g., Carver 1978; Tukey 1991; McBride et al. 1993; Germano 1999; McBride 1999; Nelder 1999; Cole et al. 2001), the DAMOS Program now uses equivalence tests (also known as interval hypothesis tests) to analyze SPI data. Statistical analysis of the 2007 NLDS SPI data included equivalence tests to compare biological conditions at the NLDS mounds with those at the reference stations.

Equivalence tests can examine either 1) the equivalence hypothesis, where the true difference between means is postulated to lie within a prescribed equivalence interval, or 2) the inequivalence hypothesis, in which the true difference between means is postulated to lie beyond that interval. These two approaches provide a framework for demonstrating proof of hazard (equivalence tests), or proof of safety (inequivalence tests). It is the latter

approach that is particularly appropriate for the evaluation of disposal mounds relative to nearby reference areas for the DAMOS Program. In this application of bioequivalence (interval) testing, the null hypothesis chosen was one that presumes the difference between parameter values measured within a disposal site relative to reference areas is great, i.e., an inequivalence hypothesis (e.g., McBride 1999). This is recognized as a 'proof of safety' approach because rejection of this inequivalence null hypothesis requires sufficient proof that the difference is actually small. The null and alternative hypotheses to be tested were:

H_0: $d \leq -\delta$ or $d \geq \delta$ (presumes the difference is great)

H_A: $-\delta < d < \delta$ (requires proof that the difference is small)

Where:

d = the actual difference between reference mean and site mean for a particular parameter, and

δ = the maximum difference expected for that parameter considering background information.

If the null hypothesis is rejected, then it can be concluded that the two means are equivalent to one another within $\pm\delta$ units. The size of δ should be determined from historical data and/or best professional judgment to identify a maximum difference that is within background variability/noise and is therefore not ecologically meaningful. To determine the expected difference (δ) between an undisturbed seafloor (i.e., reference area) and a recently disturbed disposal site (i.e., disposal mound) for RPD and successional stage rank, both the mean and range of values in historical DAMOS SPI monitoring data were considered. Based on these historical data, it was determined that realistic δ for RPD and successional stage rank values would be 1 and 0.5 (on a scale of 0–3), respectively. These difference values were based on the typical spread of RPD and successional stage rank values observed at the reference areas and were representative of a background range.

The test of this interval hypothesis was broken down into two one-sided tests (TOST) (McBride 1999 after Schuirmann 1987) which are based on Student's *t*-distribution. The statistics used to test the interval hypotheses shown here were based on the Central Limit Theorem (CLT) such that the mean of any random variable is normally distributed, and linear combinations of normal random variables are also normal. Hence,

a linear function of means is also normally distributed. As a result, the t-distribution can be used to construct a confidence interval around any linear function of means.

In this sampling design, there are actually six distinct areas, three of which are categorized as reference locations, so the difference equation of interest is defined as the average of the three reference means minus each mound mean, or

$$[(\text{Mean}_{\text{NEREF}} + \text{Mean}_{\text{NLON REF}} + \text{Mean}_{\text{WREF}})/3 - \text{Mean}_{\text{Mound}}]$$

The three reference areas collectively represent ambient conditions and, if appropriate, were pooled into a single reference group. However, if there are mean differences among these three areas, then pooling them into a single reference group would increase the variance beyond true background variability. Differences among the three reference areas were evaluated prior to comparison with the mound data to determine if pooling the reference areas was appropriate.

The difference equations, $\hat{d}$, for the comparisons of interest are:

$$\hat{d}_1 = \tfrac{1}{3}(\text{Mean}_{\text{NEREF}} + \text{Mean}_{\text{NLON REF}} + \text{Mean}_{\text{WREF}}) - \text{Mean}_{\text{NL-06}} \text{ or } \text{Mean}_{\text{Pooled Refs}} - \text{Mean}_{\text{NL-06}}$$

$$\hat{d}_2 = \tfrac{1}{3}(\text{Mean}_{\text{NEREF}} + \text{Mean}_{\text{NLON REF}} + \text{Mean}_{\text{WREF}}) - \text{Mean}_{\text{D/S}} \text{ or } \text{Mean}_{\text{Pooled Refs}} - \text{Mean}_{\text{D/S}}$$

$$\hat{d}_3 = \tfrac{1}{3}(\text{Mean}_{\text{NEREF}} + \text{Mean}_{\text{NLON REF}} + \text{Mean}_{\text{WREF}}) - \text{Mean}_{\text{USCGA}} \text{ or } \text{Mean}_{\text{Pooled Refs}} - \text{Mean}_{\text{USCGA}}$$

The standard error of each difference was calculated from the fact that the variance of a sum is the sum of the variances for independent variables, or:

$$SE(\hat{d}) = \sqrt{\sum_j \left(S_j^2 c_j^2 / n_j\right)}$$

Where:

c_j = coefficients for the j means in the difference equation, $\hat{d}$ (i.e., for the difference equations shown above, the coefficients are 1/3, 1/3, 1/3, and –1 for areas WREF, NEREF, NLON REF, and each disposal mound, respectively; or they would be 1, -1 for Reference and Mound, respectively, if the three reference areas can be pooled).

S_j^2 = variance for the jth area. If equal variances were assumed, a single pooled variance estimate was substituted for each group, equal to the mean square error from an ANOVA.

n_j = number of replicates for the jth area (5, 5, 5, for areas NEREF, NLON REF, and WREF; and 15, 15, 15 for NL-06, NL-91 and D/S Mound Complex, and USCGA).

The inequivalence null hypothesis was rejected (and equivalence was concluded) if the confidence interval on the difference of means, $\hat{d}$, was fully contained within the interval $[-\delta, +\delta]$. Thus the decision rule is to reject H_0 if:

$$D_L = \hat{d} - t_{\alpha,\upsilon} se(\hat{d}) > -\delta \quad \text{and} \quad D_U = \hat{d} + t_{\alpha,\upsilon} se(\hat{d}) < \delta$$

Where:

$\hat{d}$ = observed difference in means between the reference and mound

$t_{\alpha,\upsilon}$ = upper 100α percentile of a Student's t-distribution with υ degrees of freedom

$se(\hat{d})$ = standard error of the difference.

υ = degrees of freedom for the standard error. If a pooled variance estimate was used, the degrees of freedom was equal to the sum of the sample sizes for all groups included in the $\hat{d}$ minus the number of groups; if separate variance estimates were used, degrees of freedom were calculated based on the Brown and Forsythe estimation (Zar 1996).

Equality of the reference areas were graphically evaluated using boxplots and summary statistics. Validity of the normality and equal variance assumptions were tested using Shapiro-Wilk's test for normality on the area residuals ($\alpha = 0.05$) and Levene's test for equality of variances among the four areas ($\alpha = 0.05$). If normality was not rejected but equality of variances was rejected, then the variance for the difference equation was based on separate variances for each group. If systematic deviations from normality were identified, then the data were transformed to approximate normality, if possible. Otherwise, a nonparametric bootstrapped interval was used.

2.4 Sediment Grab Sampling

One sediment grab sample was collected at station NL-06-15 on 27 August 2007 for grain size analysis, to supplement analysis of acoustic backscatter data (Table 2-3; Figure 2-3). A 0.0625-m² Gray O'Hara Box corer was used to collect the sediment sample. The vessel was positioned at the target coordinates, and the equipment was

Table 2-3.

NLDS Sediment Grab Sampling Location

Station	Latitude (N)	Longitude (W)
NL-06-15	41° 16.076'	72° 05.013'

Notes: Coordinate system NAD83

deployed within a defined station tolerance of 10 m. Sediment was extracted from approximately the top six inches of the box core using stainless steel utensils and transferred to a plastic Zip-lock bag. The sample was stored on ice and retained under chain of custody for delivery to the laboratory for analysis. The analysis was performed at Geotesting Express (Boxborough, MA). Grain size analysis was performed using the Standard Test Method for Particle-Size Analysis of Soils (ASTM D 422 with Hydrometer). This test method covers the quantitative determination of the distribution of particle sizes in soils.

3.0 RESULTS

3.1 Bathymetry

The overall topography of NLDS slopes from a depth of less than 14 m in the north towards the south where depths reach 24 m. The July 2007 bathymetric survey confirmed the continued presence of broad trough running northwest to southeast in the southwest portion of NLDS (Figure 3-1). The central portion of the trough has been partially filled with dredged material (NL-I Mound) resulting in an irregular topography. The placement of the NDA 06 buoy has resulted in the formation of a small mound approximately 375 m to the west of the NL-I historic mound. This is consistent with the placement of an estimated volume of 277,000 m^3 of dredged material at the NDA 06 buoy between August 2006 and November 2006.

A depth difference map was generated comparing the July 2007 survey results with those of September 1997 (Figure 3-2). The 1997 single-beam bathymetric survey was used for comparison (rather than the more recent 2000 survey) because it was conducted over the same area as the 2007 survey. Depth difference results were plotted at 1.0 m contour intervals. The only large-scale change in bathymetry over this time period was the formation of the NL-06 Mound. The new mound is roughly oblong in shape, with a slope ranging from approximately 2.0% along the north-south axis to 1.5% along the east-west axis. The approximate dimensions of the mound are 575 m long along its northwest-southeast axis by 250 m wide along its northeast-southwest axis and 3.6 m in height.

In the northwest corner of the site, some depth increases were noted on the northeast slope of the Seawolf Mound (Figure 3-2). While significant consolidation was observed one year following capping of the Seawolf Mound (1997), very little consolidation was observed in later surveys (SAIC 2001). The small areas of apparent depth increases and decreases of up to 0.5 m are likely due to measurement and processing artifacts, which are common in areas of steeper slopes, rather than actual bathymetric differences between the two surveys. An additional source of uncertainty, of approximately 0.5–1.0 m, arises from comparison of a single-beam bathymetry data set (1997) against a multi-beam bathymetry data set (2007).

3.2 Sediment-Profile Imaging

The objective of the 2007 SPI survey was to compare the benthic recolonization status of the NL-06 Mound, USCGA Mound, and the NL-91 and D/S Mound Complex,

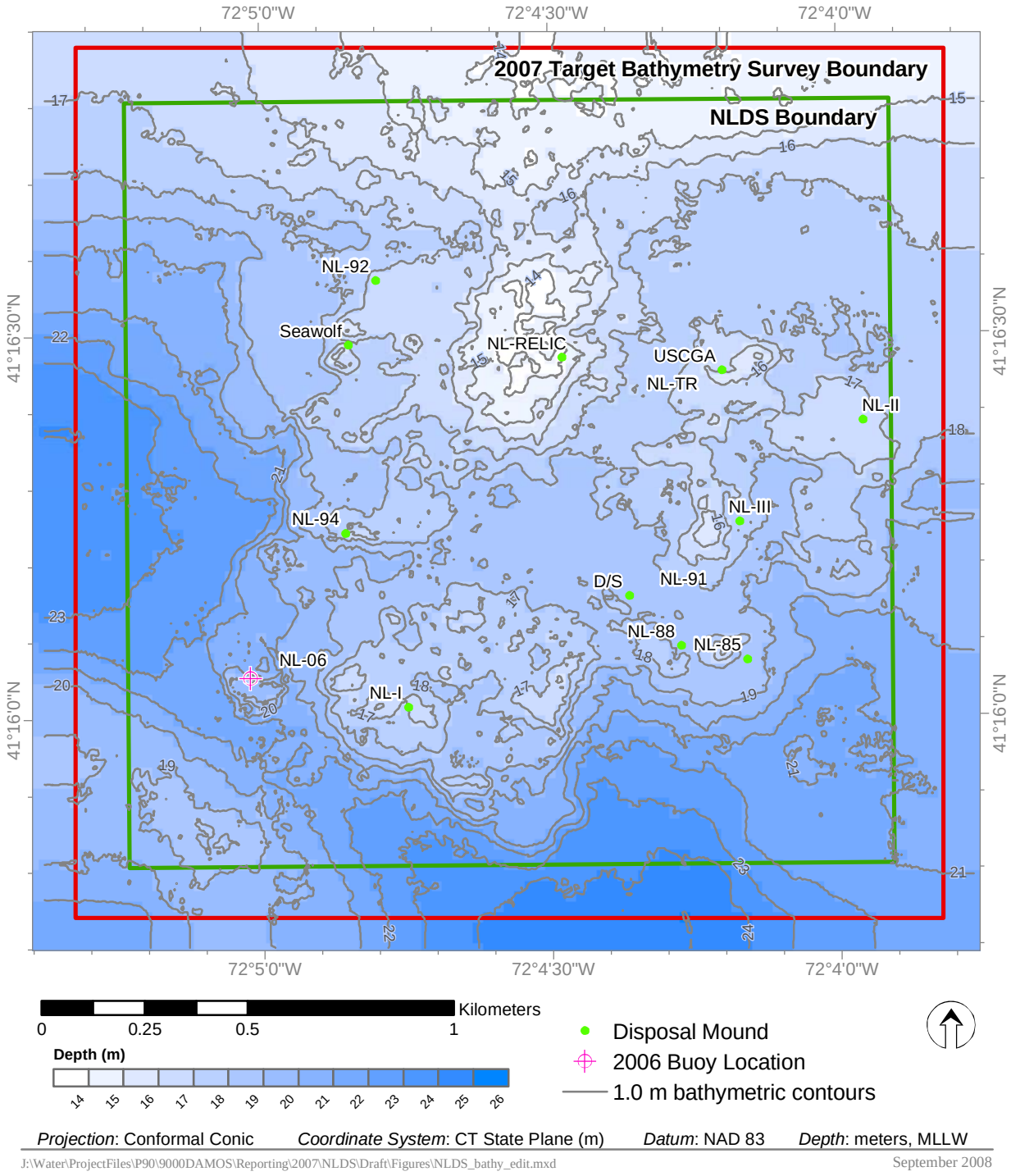

Figure 3-1. Bathymetric contour map of NLDS survey area, July 2007 (1-m contour intervals)

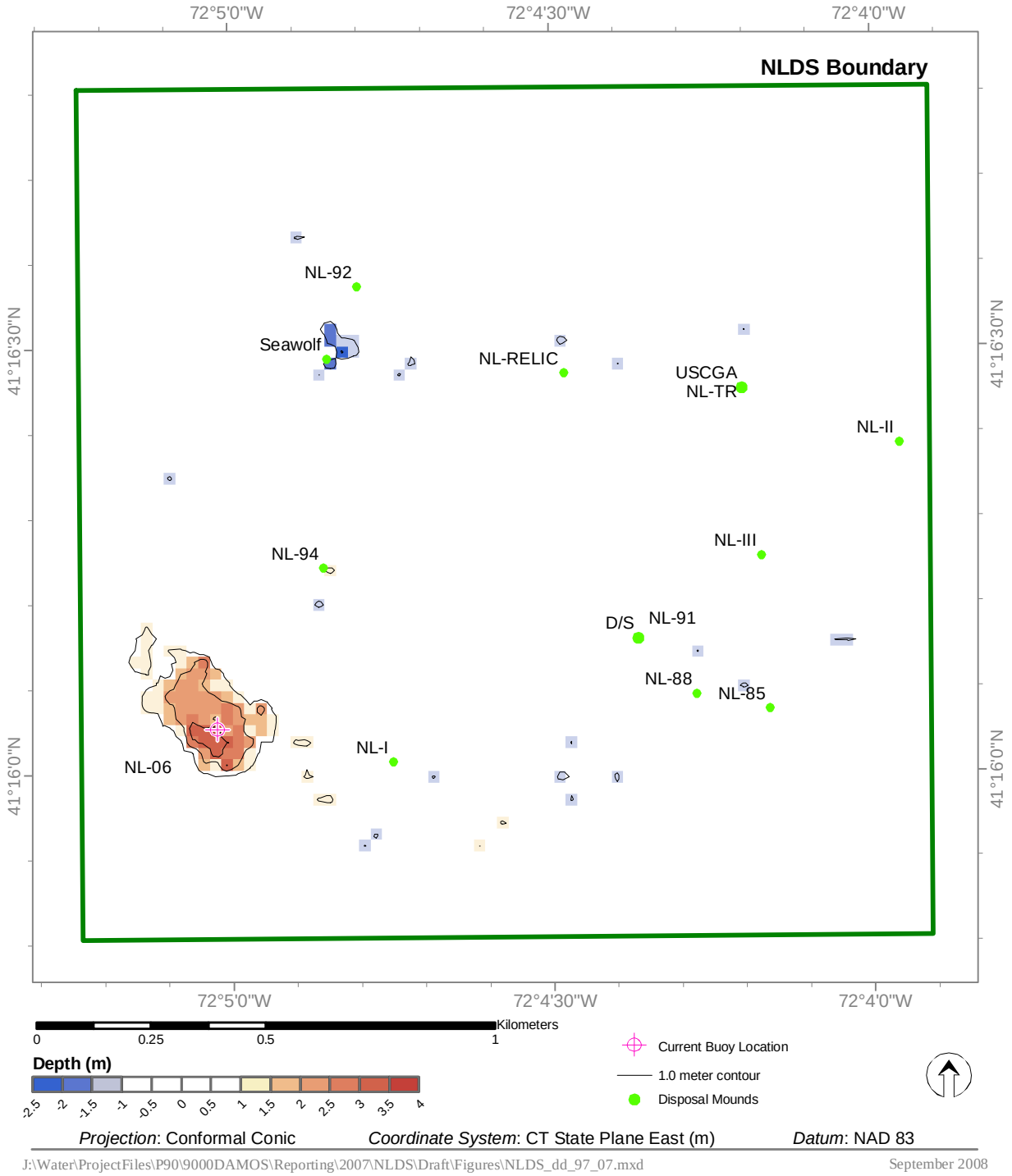

Figure 3-2. Depth difference contour map of NLDS survey area, September 1997 vs. July 2007 survey results (1.0-m contour intervals)

with those at the reference areas. A summary of SPI results from the three disposal mounds (NL-06, NL-91 and D/S Mound Complex, and USCGA) and the three reference areas (NEREF, NLON REF, and WREF) can be found in Tables 3-1 through 3-4, and the complete set of all SPI results can be found in Appendix B.

3.2.1 Reference Areas

Physical Sediment Characteristics

As described in previous monitoring surveys at NLDS (SAIC 2001a, SAIC 2001b, SAIC 2001c, 2004), the sediments at the reference areas were dominated by layers of very fine sand over silt/clay (NEREF), very fine sand (NLON REF), and silt clay with shell fragments (WREF) (Table 3-1, Figure 3-3). This progression of the relative proportion of very fine sand from a thin layer (NEREF) replaced by shell fragments (WREF) to a thicker layer (NLON REF) reflects the nature of the ambient source materials and sediment transport conditions (Figure 3-4).

Average camera prism penetration depth at the reference stations ranged from 0 to 18.4 cm (Figure 3-5), with an overall average of 8.4 cm (Table 3-1). The stop collar settings and number of weights were kept constant (stop collar 16 and 5 weights; Appendix B) so the camera penetration was a good measure of the sediment shear strength within the reference areas (Figure 3-4). The variability in apparent shear strength of reference area sediments reflected the grain size distribution within each reference area (Table 3-1). NEREF had an average penetration of 11.5 cm; WREF had an average penetration of 7.6 cm; and NLON REF had an average penetration of 6.0 cm.

Small-scale boundary roughness values at the reference stations ranged from 0.4 to 3.2 cm, with an overall average value of 1.0 cm (Figure 3-6). The majority of the small-scale surface roughness elements were physical in origin, caused by sand ripples and shells.

Biological Conditions and Benthic Recolonization

The average depth of the apparent RPD at the reference stations ranged from 1.2 to 3.8 cm (Figure 3-7), with an overall average of 2.3 cm (Table 3-1).

All of the reference area stations showed benthic assemblages in the late stages of colonization (Stage II or III) with evidence of deposit feeding activity (Figure 3-8). The average depth of subsurface feeding voids (when present) ranged from 0.6 to 8.5 cm

Table 3-1.

Summary of SPI Results for NLDS Reference Stations, August 2007

Station	Grain Size Major Mode (phi)	Mean Prism Penetration Depth (cm)	Mean RPD Depth (cm)	Mean Boundary Roughness (cm)	Mean DM Thickness (cm)	Mean Void Depth (cm)	Successional Stages present (no. of replicates)
NEREF-01	4 to 3/>4	11.6	2.6	1.0	0.0	6.2	I on III (3)
NEREF-02	4 to 3/>4	12.4	2.5	0.9	0.0	5.4	I on III (2), II (1)
NEREF-03	4 to 3/>4	11.3	2.6	0.9	0.0	8.5	I on III (3)
NEREF-04	4 to 3/>4	10.7	2.8	0.9	0.0	4.7	I on III (2), II (1)
NEREF-05	4 to 3/>4	11.3	2.1	0.4	0.0	4.7	I on III (3)
NLON REF-01	4 to 3	5.5	2.8	1.5	0.0	0.0	I on III (1), II (2)
NLON REF-02	4 to 3	6.9	2.5	0.7	0.0	0.0	I on III (1), II (2)
NLON REF-03	4 to 3	6.3	3.0	0.8	0.0	0.6	I on III (1), II (2)
NLON REF-04	>4 to 3	6.1	1.7	2.2	0.0	0.0	II (3)
NLON REF-05	4 to 3	5.5	2.4	0.8	0.0	0.0	I (1), II (2)
WREF-01	4 to 3	7.5	2.2	0.6	0.0	0.0	II (3)
WREF-02	>4	8.2	1.8	1.8	0.0	4.8	I on III (2), II (1)
WREF-03	>4	7.6	1.7	0.9	0.0	0.0	II (2), III (1)
WREF-04	>4	7.4	2.0	1.4	0.0	0.0	II (3)
WREF-05	>4 to 3	7.2	2.1	0.9	0.0	2.0	I on III (2), II-III (1)
Average		8.4	2.3	1.0	0.0	2.5	
Median		7.5	2.4	0.9	0.0	0.6	
Minimum		5.5	1.7	0.4	0.0	0.0	
Maximum		12.4	3.0	2.2	0.0	8.5	

Table 3-2.

Summary of SPI Results for NL-06 Stations, August 2007

Station	Grain Size Major Mode (phi)	Mean Prism Penetration Depth (cm)	Mean RPD Depth (cm)	Mean Boundary Roughness (cm)	Mean DM Thickness (cm)	Mean Void Depth (cm)	Successional Stages present (no. of replicates)
NL-06-01	3 to 2/>4	12.9	1.3	1.7	12.9	3.2	III (2), I-III (1)
NL-06-02	3 to 2/>4	16.5	2.0	1.0	16.5	3.9	I-II (1), I on III (2)
NL-06-03	3 to 2/>4	15.6	1.8	1.1	15.6	3.1	I on III (3)
NL-06-04	3 to 2/>4	13.7	1.3	1.0	13.7	5.8	I (1), I on III (1), II-III (1)
NL-06-05	3 to 2/>4	16.2	0.7	1.2	16.2	0.0	II (2), I on III (1)
NL-06-06	>4	15.0	1.0	1.2	15.0	2.9	I-II (2), I on III (1)
NL-06-07	3 to 2/>4	12.1	1.3	1.5	12.1	4.8	I-II (1), I on III (2)
NL-06-08	3 to 2/>4	15.7	1.9	1.2	15.7	9.6	I on III (2), II-III (1)
NL-06-09	>4	16.3	1.3	1.2	16.3	5.0	II (1), III (2)
NL-06-10	3 to 2/>4	14.3	2.2	1.0	14.3	4.6	I on III (3)
NL-06-11	>4	12.2	1.0	0.9	12.2	4.4	I on III (1), II (1), II-III (1)
NL-06-12	>4	14.3	1.7	1.8	14.3	4.2	I on III (2), II-III (1)
NL-06-13	>4	13.3	1.9	1.4	13.3	3.5	I on III (1), II (1), III (1)
NL-06-14	>4	13.4	1.6	1.6	13.4	3.5	I on III (3)
NL-06-15	>4	14.5	2.2	1.6	14.5	3.2	I on III (2), II-III (1)
Average		14.4	1.5	1.3	14.4	4.1	
Median		14.3	1.6	1.2	14.3	3.9	
Minimum		12.1	0.7	0.9	12.1	0.0	
Maximum		16.5	2.2	1.8	16.5	9.6	

Table 3-3.

Summary of SPI Results for USCGA Stations, August 2007

Station	Grain Size Major Mode (phi)	Mean Prism Penetration Depth (cm)	Mean RPD Depth (cm)	Mean Boundary Roughness (cm)	Mean DM Thickness (cm)	Mean Void Depth (cm)	Successional Stages present (no. of replicates)
USCGA-01	3 to 2/>4	9.4	1.2	1.7	9.4	0.0	I on III (2), II-III (1)
USCGA-02	3 to 2/>4	10.8	2.7	1.3	10.8	0.0	I-II (1), II (2)
USCGA-03	3 to 2/>4	10.0	2.4	0.6	10.0	5.8	I on III (2), II-III (1)
USCGA-04	3 to 2/>4	15.5	1.9	0.6	15.5	5.0	I on III (3)
USCGA-05	3 to 2/>4	15.5	2.0	1.6	15.5	3.9	I on III (3)
USCGA-06	3 to 2/>4	15.3	2.1	1.5	15.3	4.8	I on III (3)
USCGA-07	3 to 2/>4	10.7	2.2	1.1	10.7	2.0	I on III (2), II-III (1)
USCGA-08	>4	9.9	0.6	1.4	9.9	4.2	I on III (2), II (1)
USCGA-09	3 to 2/>4	13.7	2.2	2.1	13.7	7.7	I on III (3)
USCGA-10	3 to 2/>4	10.4	2.4	1.4	10.4	1.2	I on III (2), II (1)
USCGA-11	3 to 2/>4	6.8	2.4	0.9	6.8	0.0	II (3)
USCGA-12	3 to 2/>4	9.9	3.0	0.9	9.9	0.0	I on III (1), II (2)
USCGA-13	>4	15.0	2.4	2.2	15.0	11.2	I on III (3)
USCGA-14	3 to 2/>4	14.3	1.3	2.1	14.3	3.7	I on III (3)
USCGA-15	>4 to 3	11.7	1.4	2.7	11.7	2.4	I on III (1), II (1), III (1)
Average		11.9	2.0	1.5	11.9	3.5	
Median		10.8	2.2	1.4	10.8	3.7	
Minimum		6.8	0.6	0.6	6.8	0.0	
Maximum		15.5	3.0	2.7	15.5	11.2	

Table 3-4.

Summary of SPI Results for NL-91 and D/S Mound Complex Stations, August 2007

Station	Grain Size Major Mode (phi)	Mean Prism Penetration Depth (cm)	Mean RPD Depth (cm)	Mean Boundary Roughness (cm)	Mean DM Thickness (cm)	Mean Void Depth (cm)	Successional Stages present (no. of replicates)
D/S-01	3 to 2/>4	8.1	2.0	2.0	8.1	0.0	II (2), II-III (1)
D/S-02	3 to 2	8.2	3.3	0.9	8.2	0.0	II (2), II-III (1)
D/S-03	3 to 2/>4	10.1	1.8	0.4	10.1	7.9	I-II (1), I on III (1), III (1)
D/S-04	>4	12.0	2.0	1.2	12.0	10.3	I on III (3)
D/S-05	3 to 2/>4	9.2	3.3	1.7	9.2	0.0	II (3)
D/S-06	3 to 2	5.3	2.2	2.0	5.3	5.1	II (1), II-III (1), IND (1)
D/S-07	3 to 2	7.7	2.5	2.0	7.7	0.0	II (1), II-III (1), IND (1)
D/S-08	3 to 2/>4	13.3	1.8	1.8	13.3	8.5	I on III (3)
D/S-09	3 to 2/>4	11.5	2.3	1.9	11.5	0.0	I on III (1), II (1), II-III (1)
D/S-10	3 to 2/>4	9.6	3.5	3.3	9.6	9.3	II (1), II on III (1), IND (1)
D/S-11	3 to 2/>4	14.0	2.9	1.5	14.0	8.1	I on III (3)
D/S-12	>4	14.6	1.2	1.6	14.6	6.2	II (2), I on III (1)
D/S-13	3 to 2	7.1	1.0	2.7	7.1	4.4	I on III (1), II-III (1), IND (1)
D/S-14	3 to 2/>4	8.7	2.3	2.1	8.7	8.7	I on III (2), II (1)
D/S-15	3 to 2/>4	12.7	2.4	1.4	12.7	9.5	II (2), I on III (1)
Average		10.1	2.3	1.8	10.1	5.2	
Median		9.6	2.3	1.8	9.6	6.2	
Minimum		5.3	1.0	0.4	5.3	0.0	
Maximum		14.6	3.5	3.3	14.6	10.3	

Notes:
IND - Indeterminate

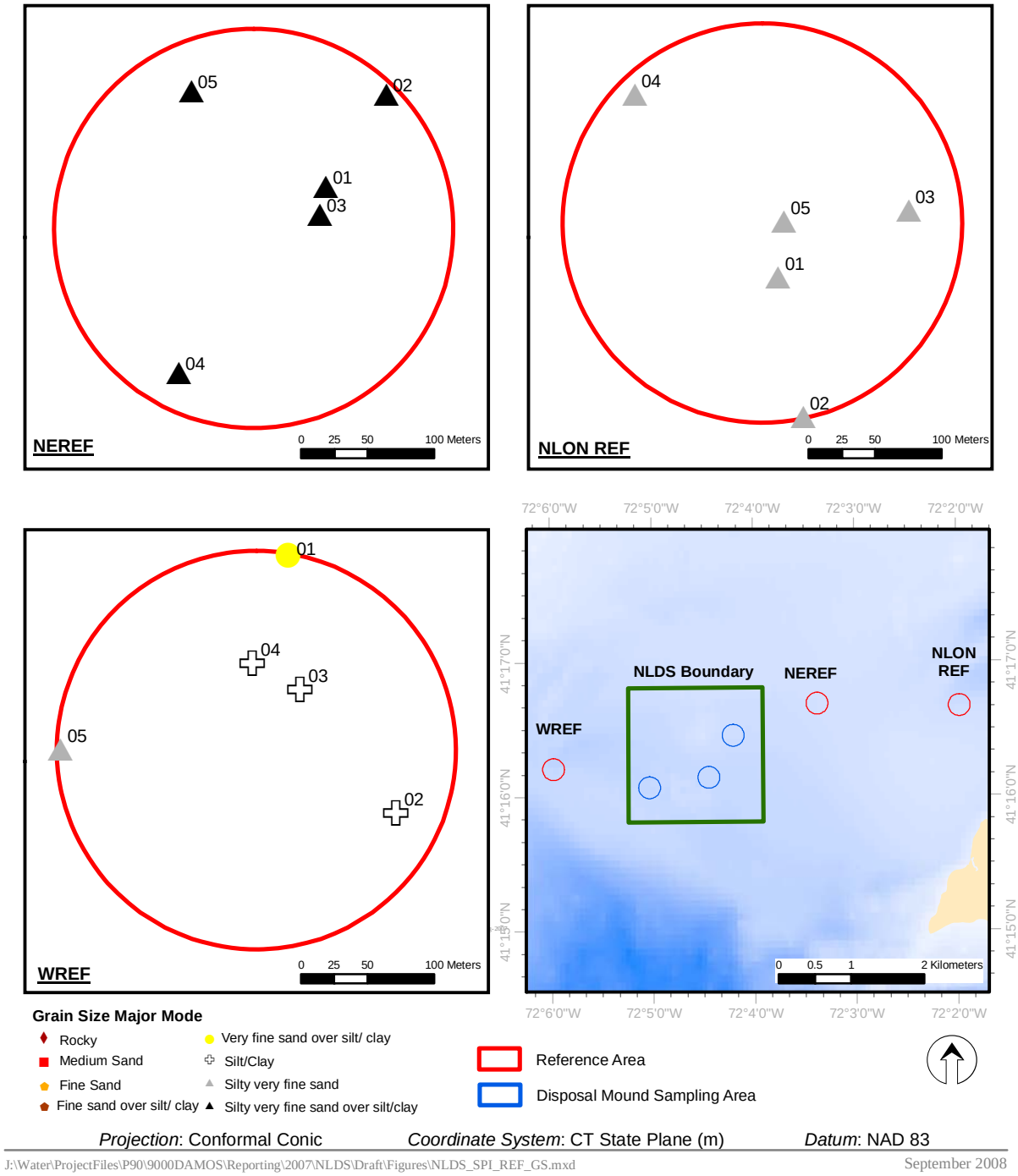

Figure 3-3. Distribution of sediment grain-size major-mode (phi units) found at NLDS reference areas

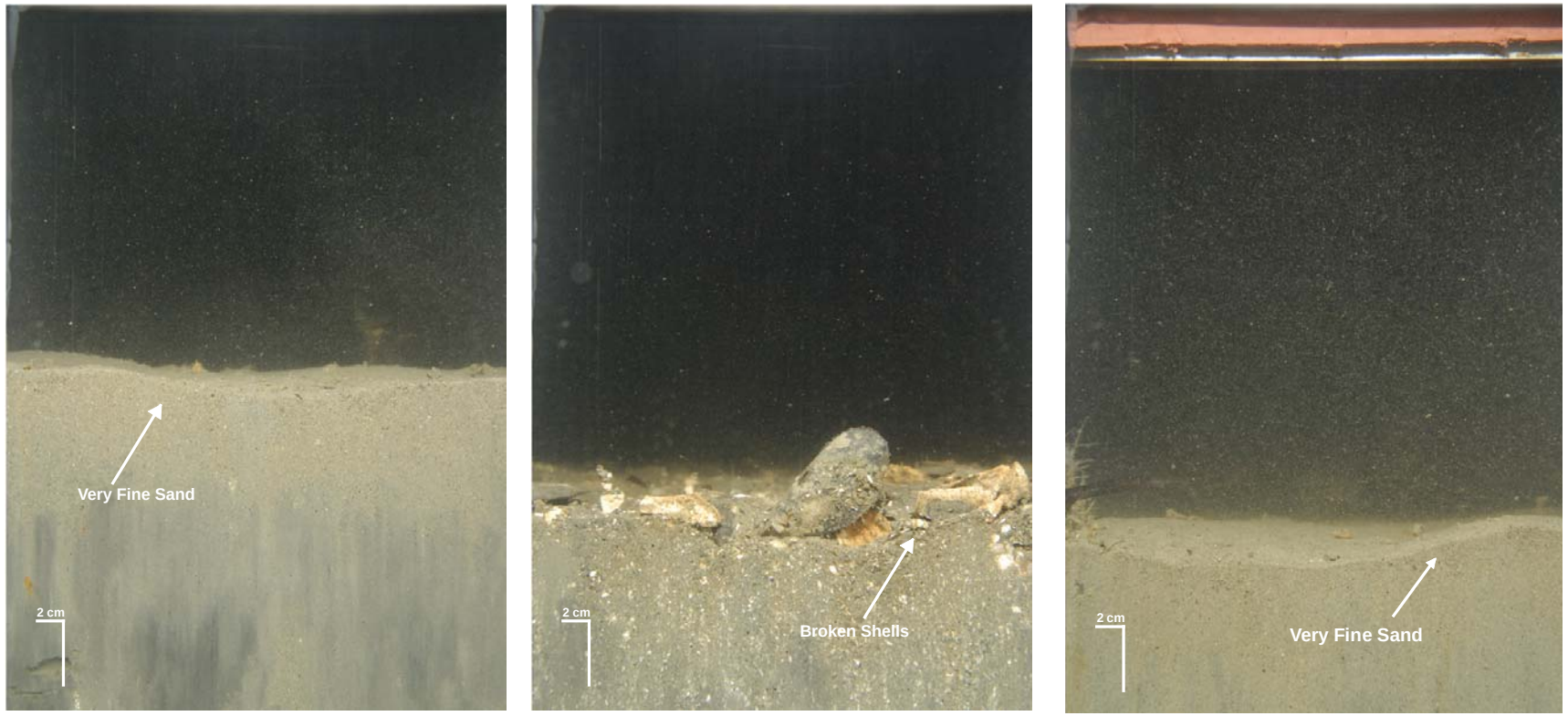

Figure 3-4. Each reference area had a distinctive grain size distribution as shown in these representative images. NEREF-01 (left) had a very fine sand layer over silt/clay; WREF-03 (center) had extensive shell fragments and broken shells on the surface of a silt/clay horizon; NLON REF-05 (right) had a very fine sand layer.

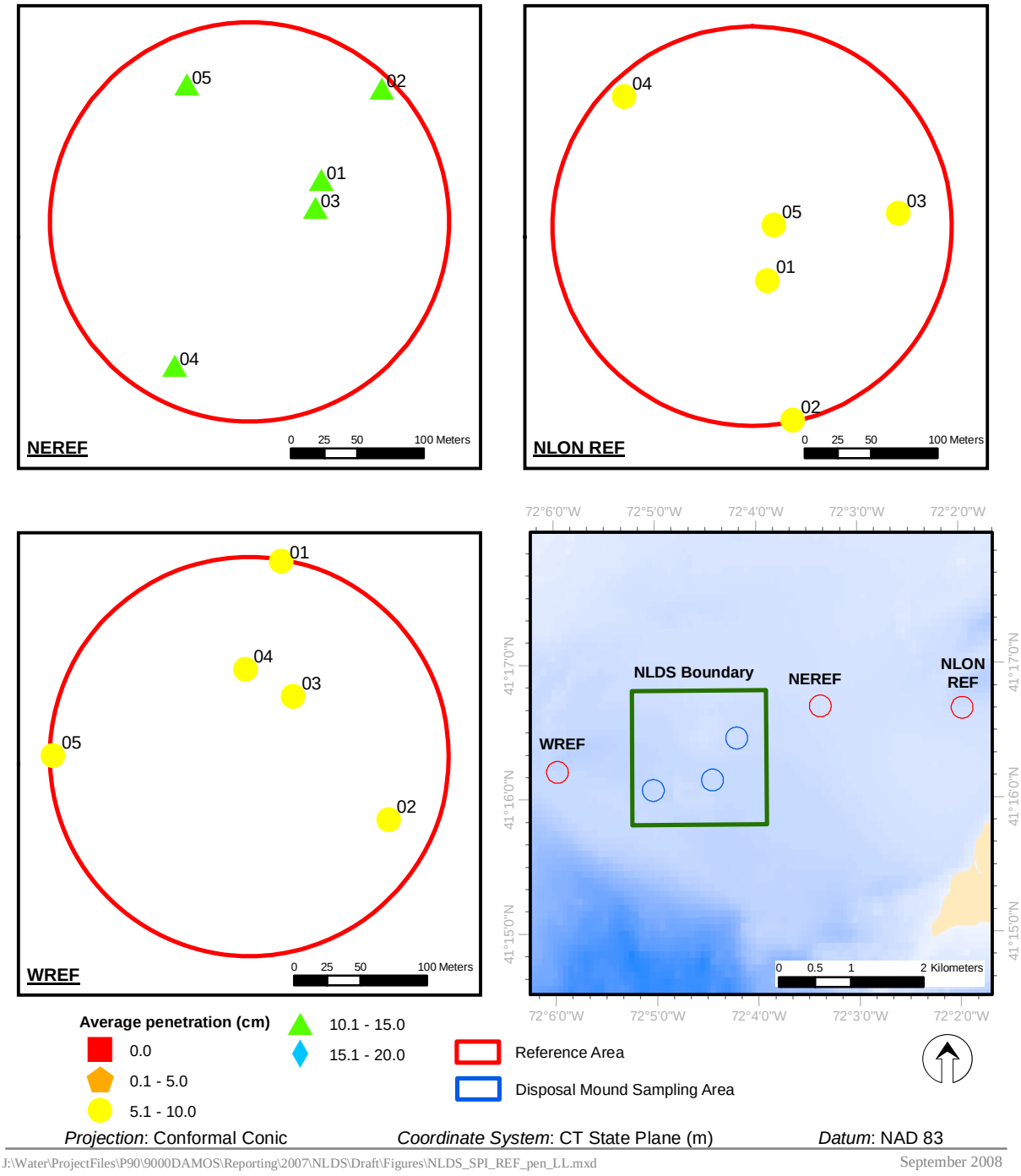

Figure 3-5. Spatial distribution of station-averaged camera prism penetration depth (cm) at NLDS reference areas

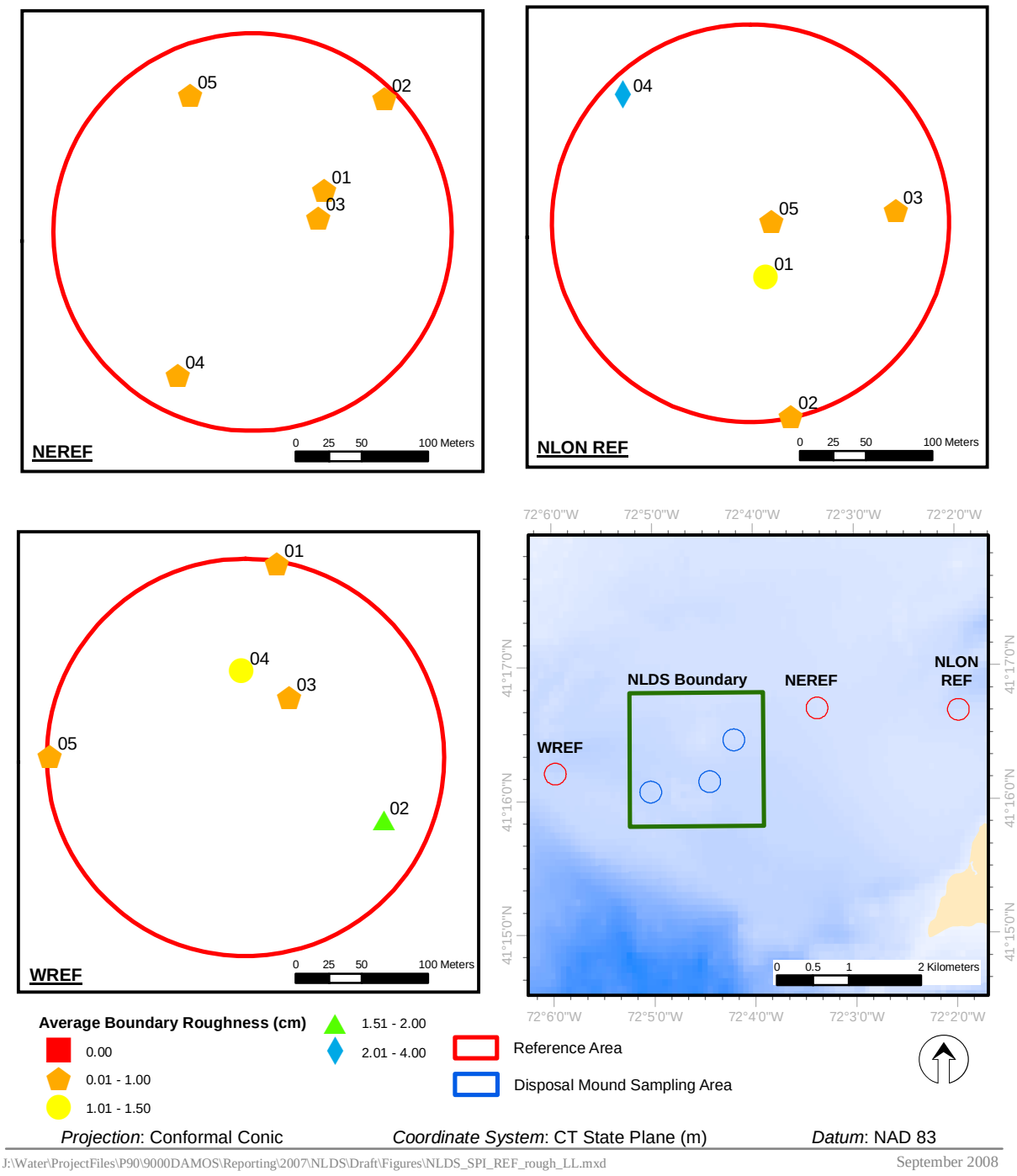

Figure 3-6. Spatial distribution of station-averaged surface boundary roughness (cm) at NLDS reference areas

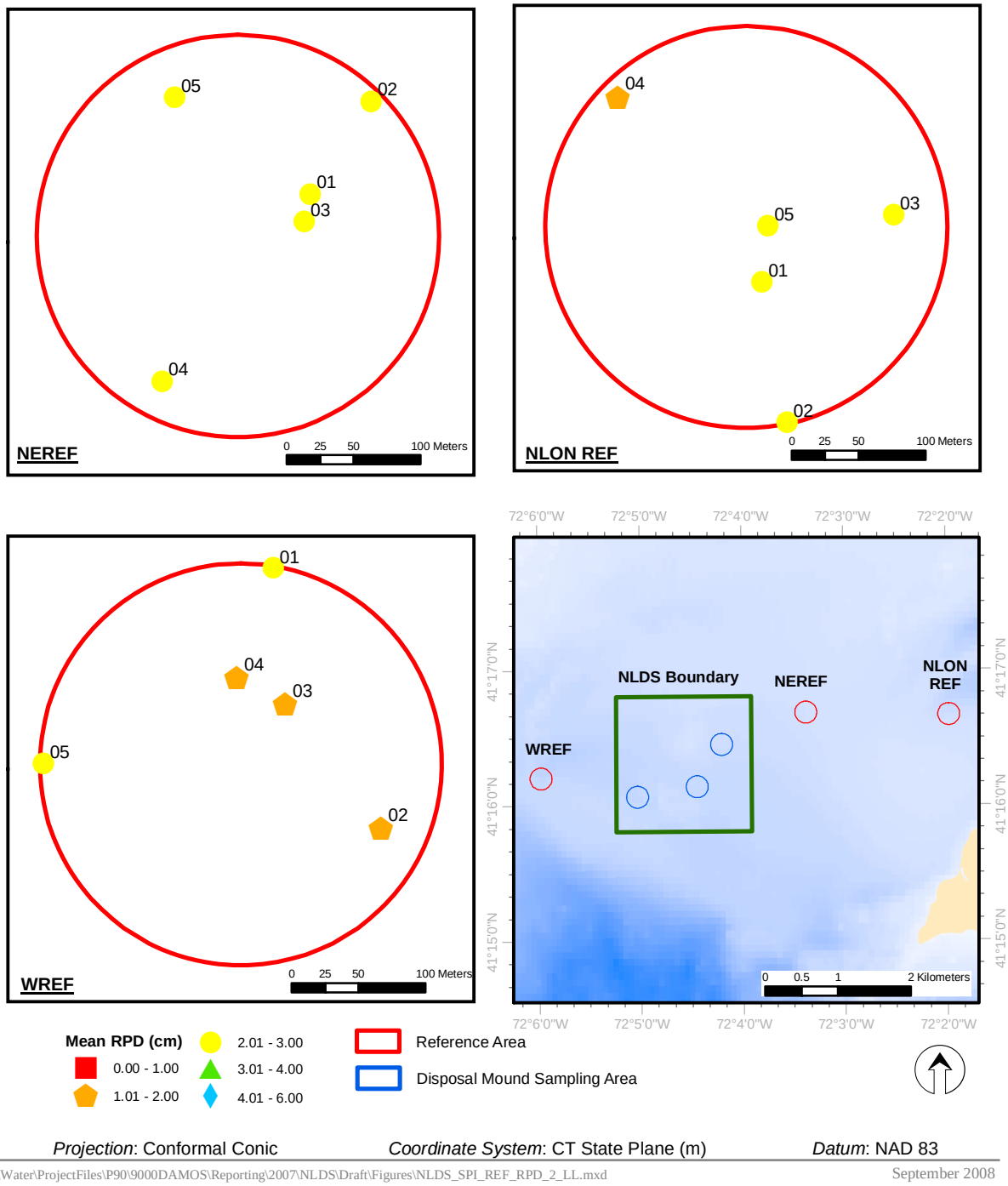

Figure 3-7. Spatial distribution of station-averaged apparent RPD depths (cm) at NLDS reference areas

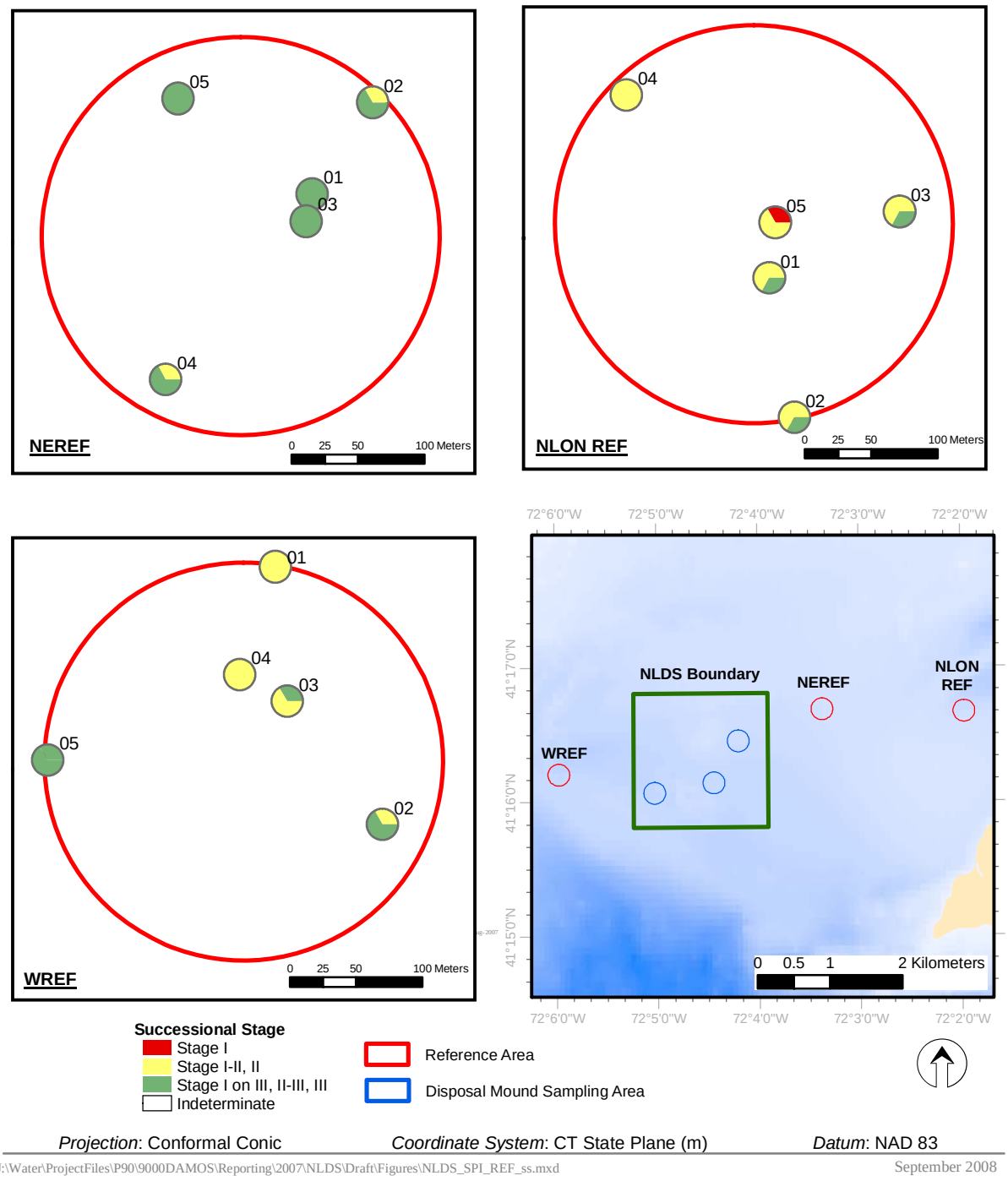

Figure 3-8. Spatial distribution of infaunal successional stages found at NLDS reference areas

below the sediment surface (Table 3-1). Many of the stations showed evidence of surface disturbance (Stage I on III); the disturbance was clearly visible as thin, mobile sand layers or mussel clumps (Figure 3-4).

3.2.2 NL-06 Mound

Physical Sediment Characteristics

Between August 2000 and November 2006, approximately 277,000 m^3 of dredged material was directed to the NL-06 Mound. The sediments on this disposal mound displayed two dominant sediment grain sizes: fine sand with shell debris (3 to 2/>4 phi) and consolidated silt-clay (> 4 phi) (Table 3-2; Figure 3-9), reflecting the source material from the recent disposal operations. All stations displayed the typical chaotic cross-sectional fabric of recently disposed sediment ranging from consolidated clay clumps (Figure 3-10) to surface sand layers mixed with shells over mud (Figure 3-11).

Camera prism penetration ranged from 8.9 to 17.6 cm (Figure 3-12); with an overall average penetration depth of 14.4 cm (Table 3-2). The stop collars and weights were the same for all 45 replicate images collected on this mound (see Appendix B), so the variation in camera prism penetration depth was an excellent indicator of relative sediment shear strength. Even though all the stations sampled on this mound showed dredged material thickness in excess of the prism penetration depth, there was no evidence of organic enrichment, low oxygen concentrations in the overlying water, or presence of subsurface methane gas in any of the images collected on the NL-06 mound (Table 3-2).

Small-scale boundary roughness values ranged from 0.5 to 3.0 cm over the disposal mound, with an overall average of 1.5 cm (Table 3-2; Figure 3-13). The small-scale topographic roughness elements at the NL-06 Mound were generally physical in origin (Appendix B), i.e., caused by surface ripples, clay clumps, or shells at the sediment surface (Figure 3-14), but 15 out of the 45 replicate images displayed biological boundary roughness elements (burrows, bioturbation).

Biological Conditions and Benthic Recolonization

Infaunal density and bioturbational activity was moderate at this recently formed mound, and quite typical for the response one year after cessation of disposal. The depth of the apparent RPD ranged from 0.1 – 2.8 cm over the NL-06 Mound (Table 3-2, Figure 3-15), with an overall average RPD depth for the mound of 1.9 cm (Table 3-2).

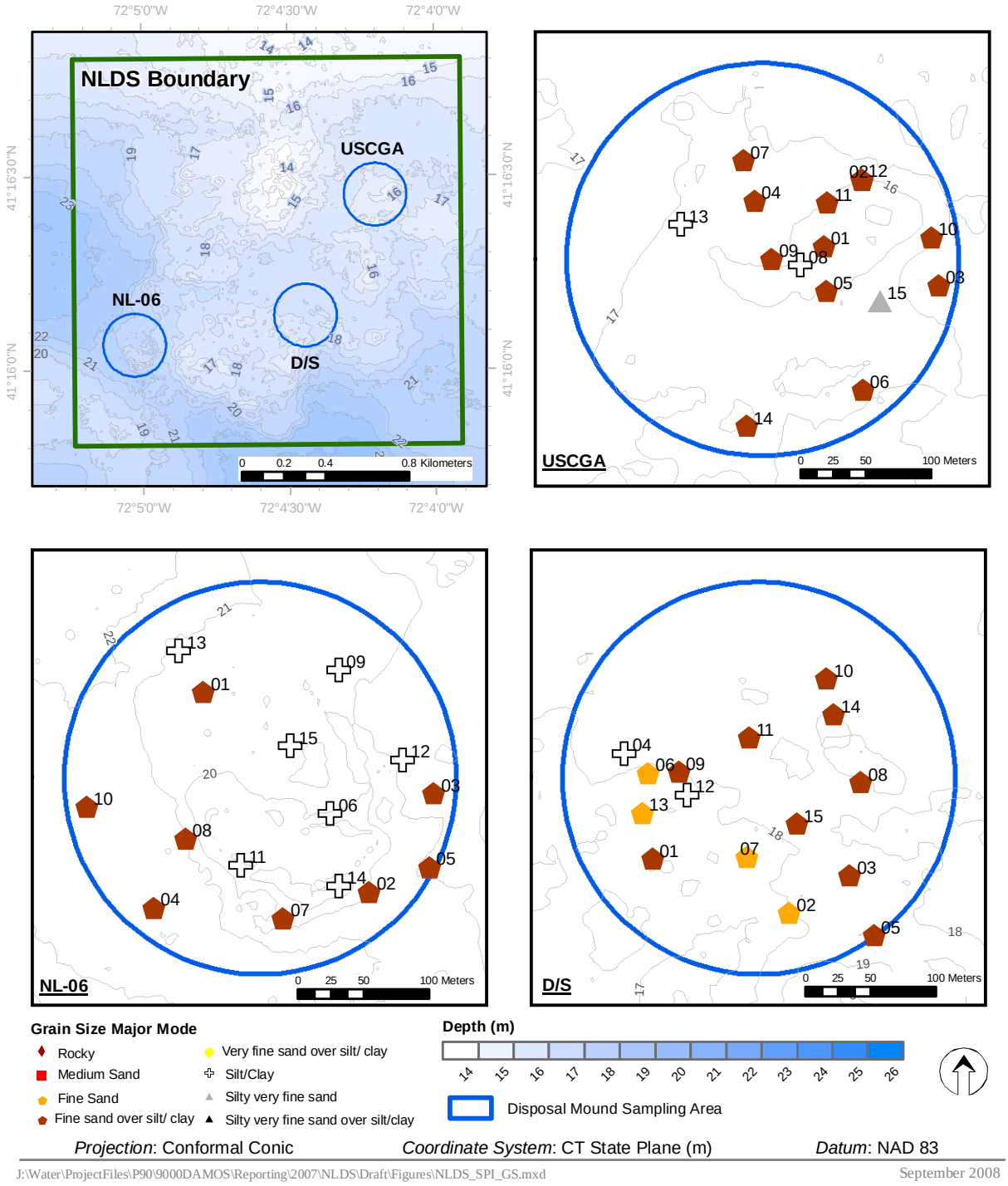

Figure 3-9. Distribution of sediment grain size major mode found at NLDS

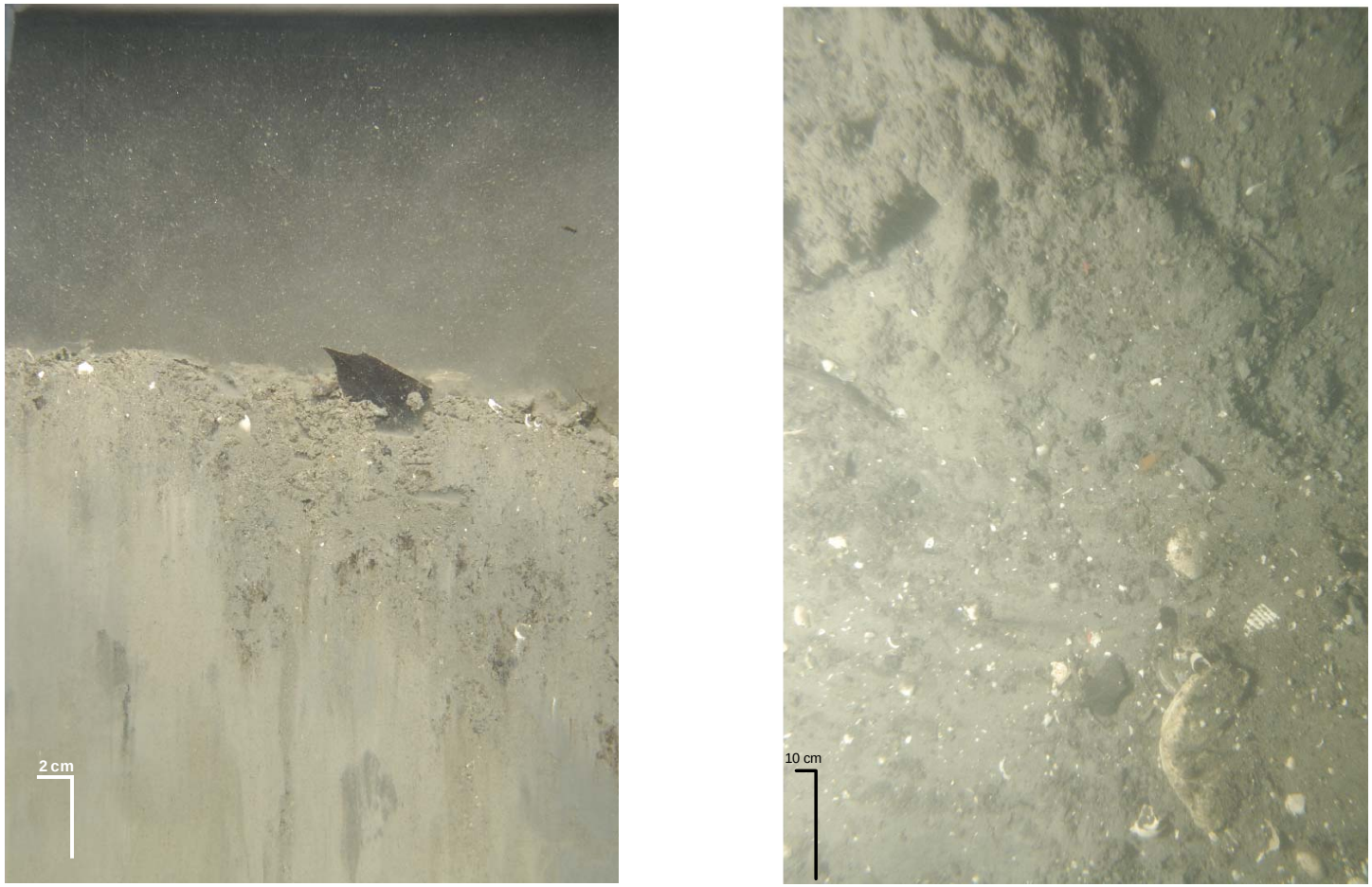

Figure 3-10. The consolidated clay clumps seen at the sediment surface in this profile (left) and plan-view (right) image from Station NL-06-12 are characteristic of recently disposed fine-grained material dredged by a clamshell operation.

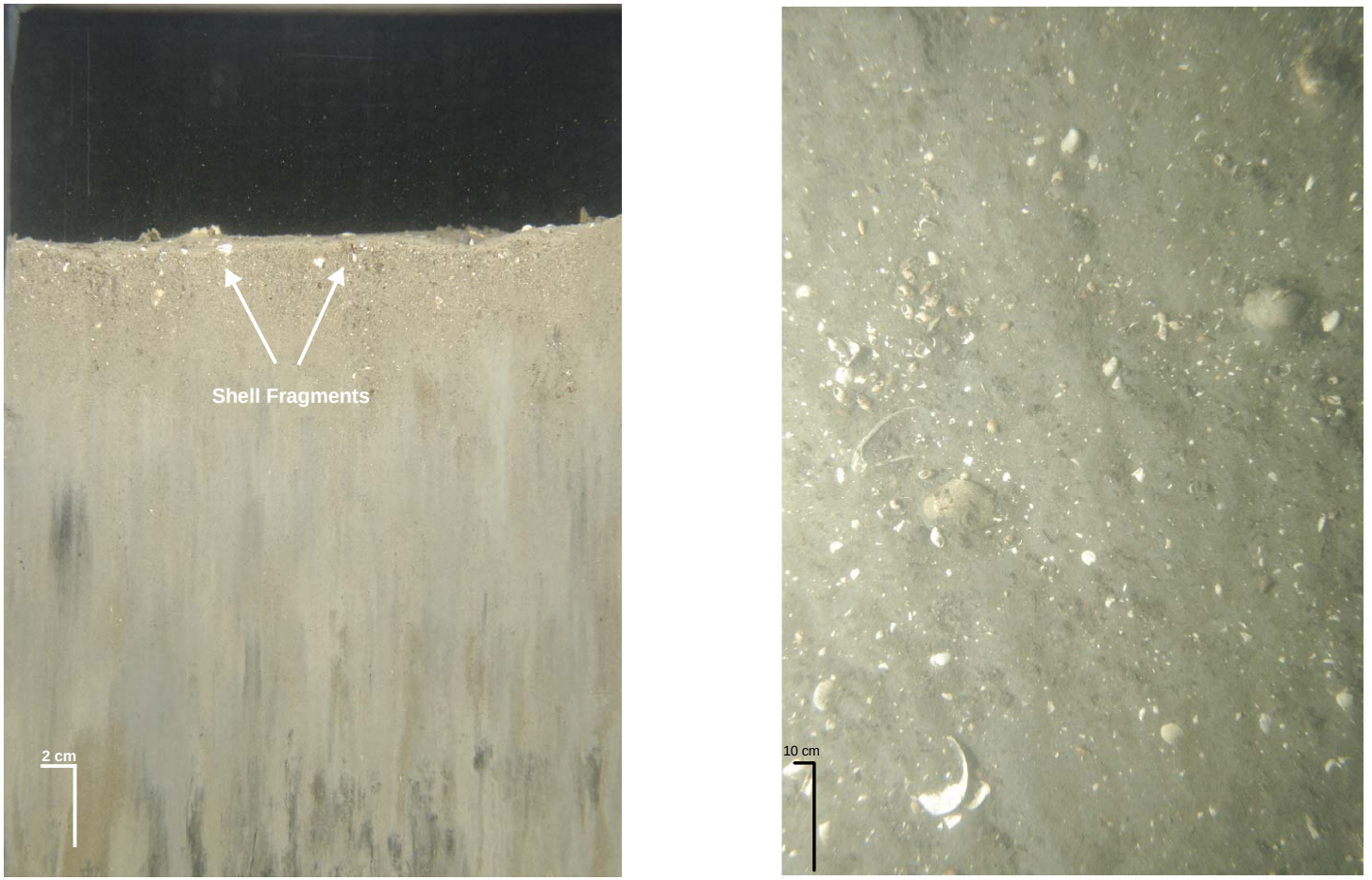

Figure 3-11. The surface layer of sand seen in this profile image from Station NL-06-02 (left) is mixed with shell fragments and clay clumps, as evidenced by the shells and patches of mud seen on the sediment surface in the larger-scale corresponding plan-view image (right).

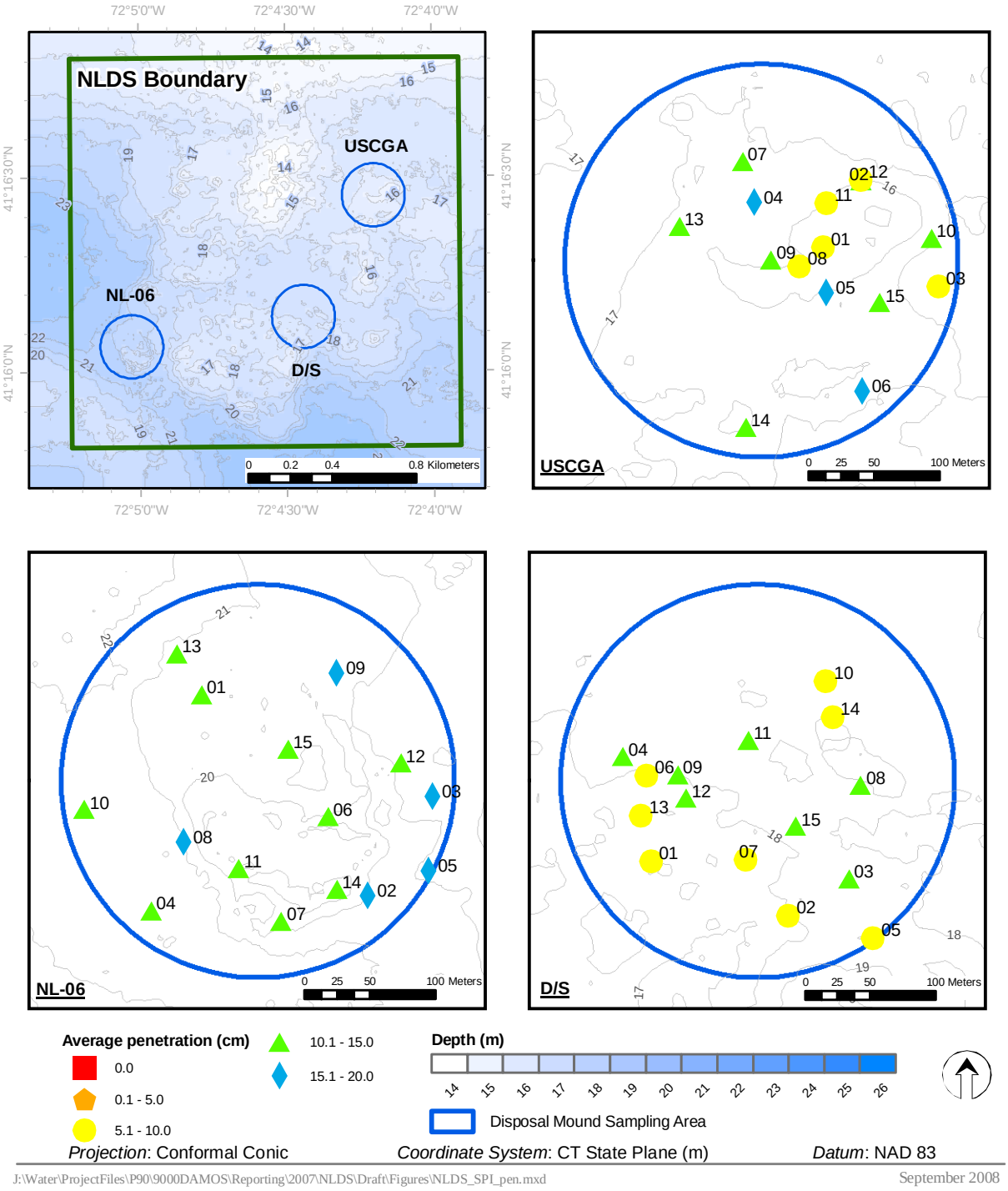

Figure 3-12. Spatial distribution of station-averaged camera prism penetration depth (cm) at NLDS

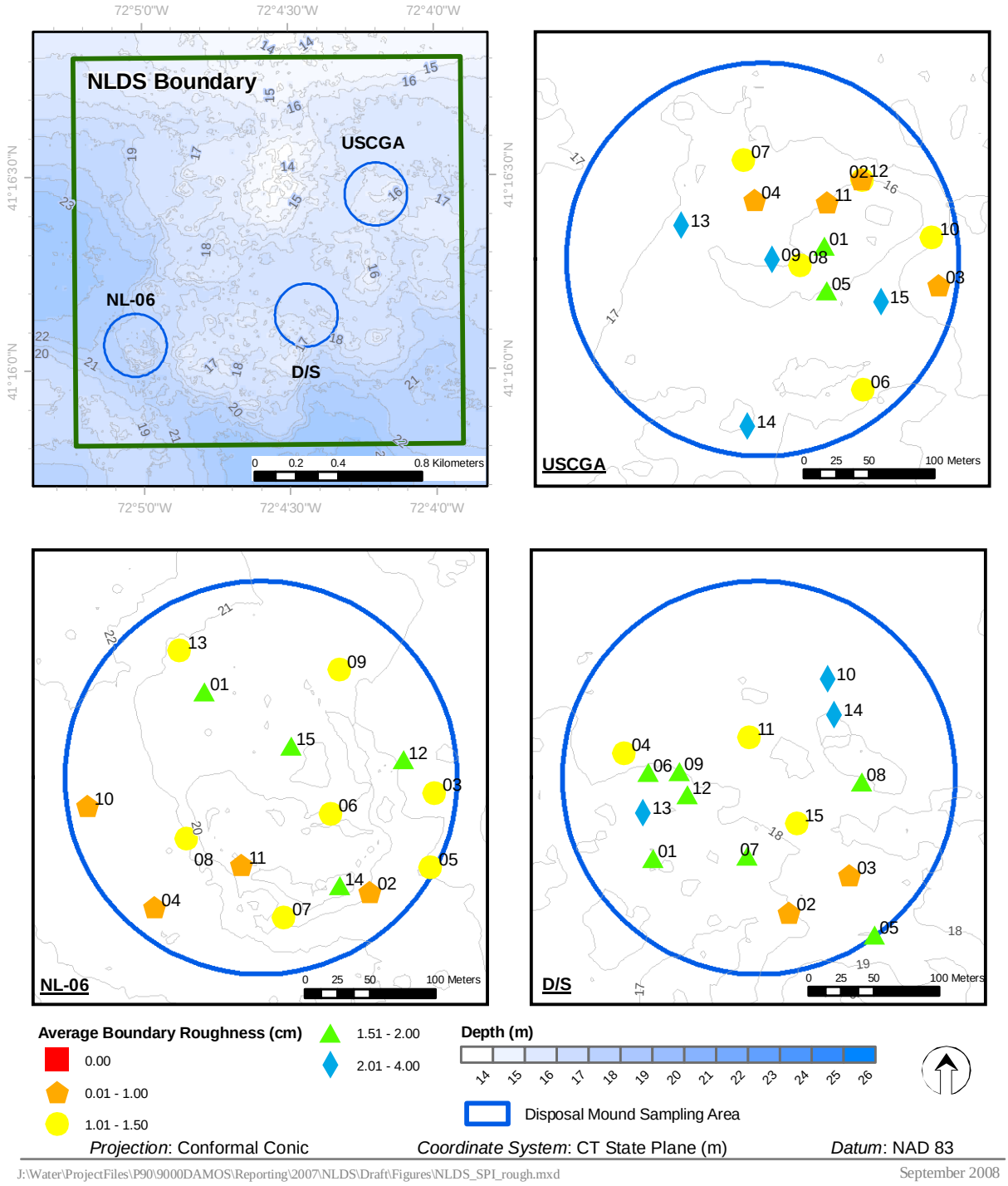

Figure 3-13. Spatial distribution of station-averaged surface boundary roughness (cm) at NLDS

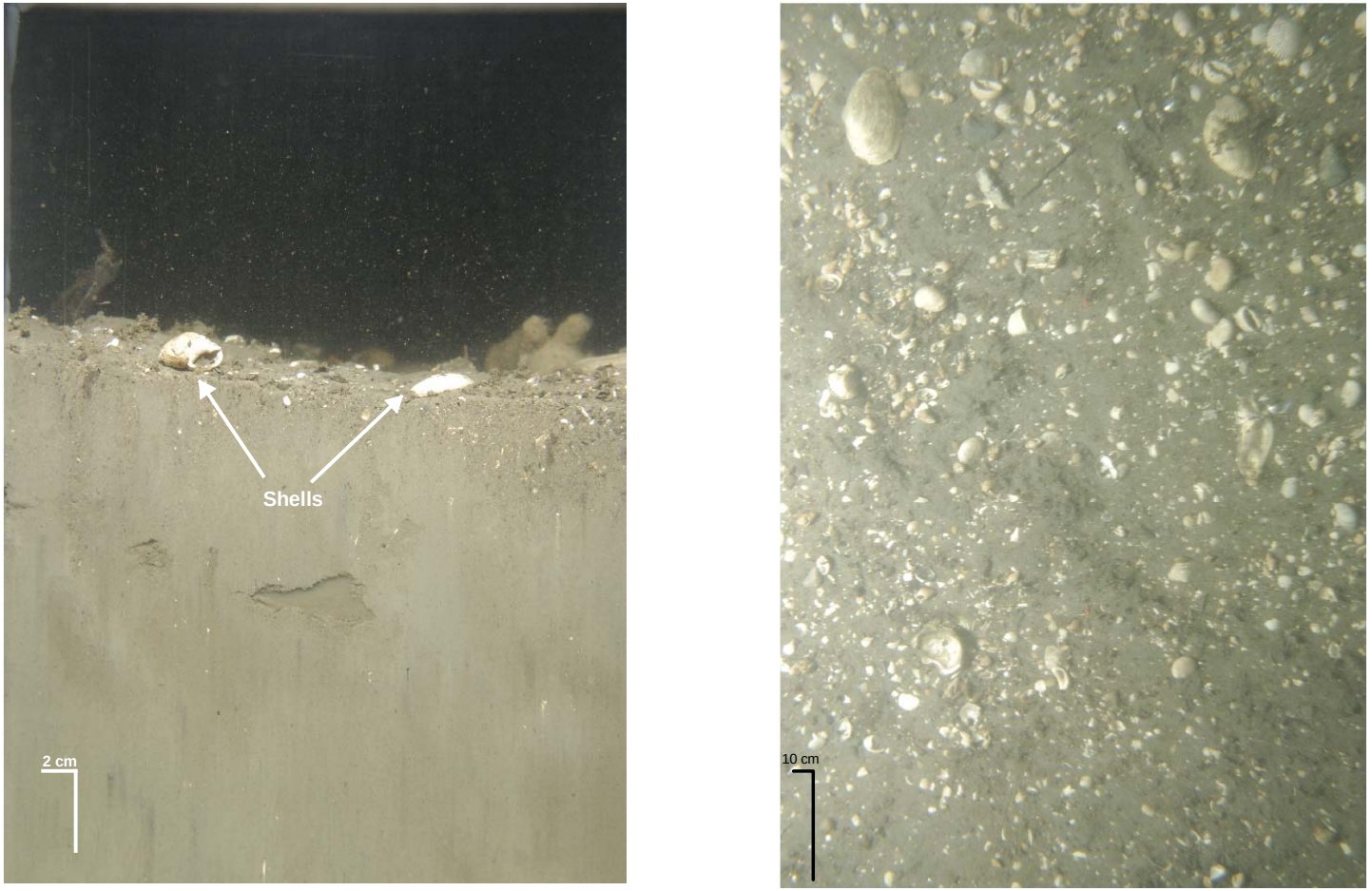

Figure 3-14. The small-scale surface boundary roughness elements seen in this profile image from the NL-06-14 (left) were of physical origin, caused by the presence of shells and surface ripples. The plan-view image (right) contains a dense covering of shells with some algal growth and a ridge of consolidated clay.

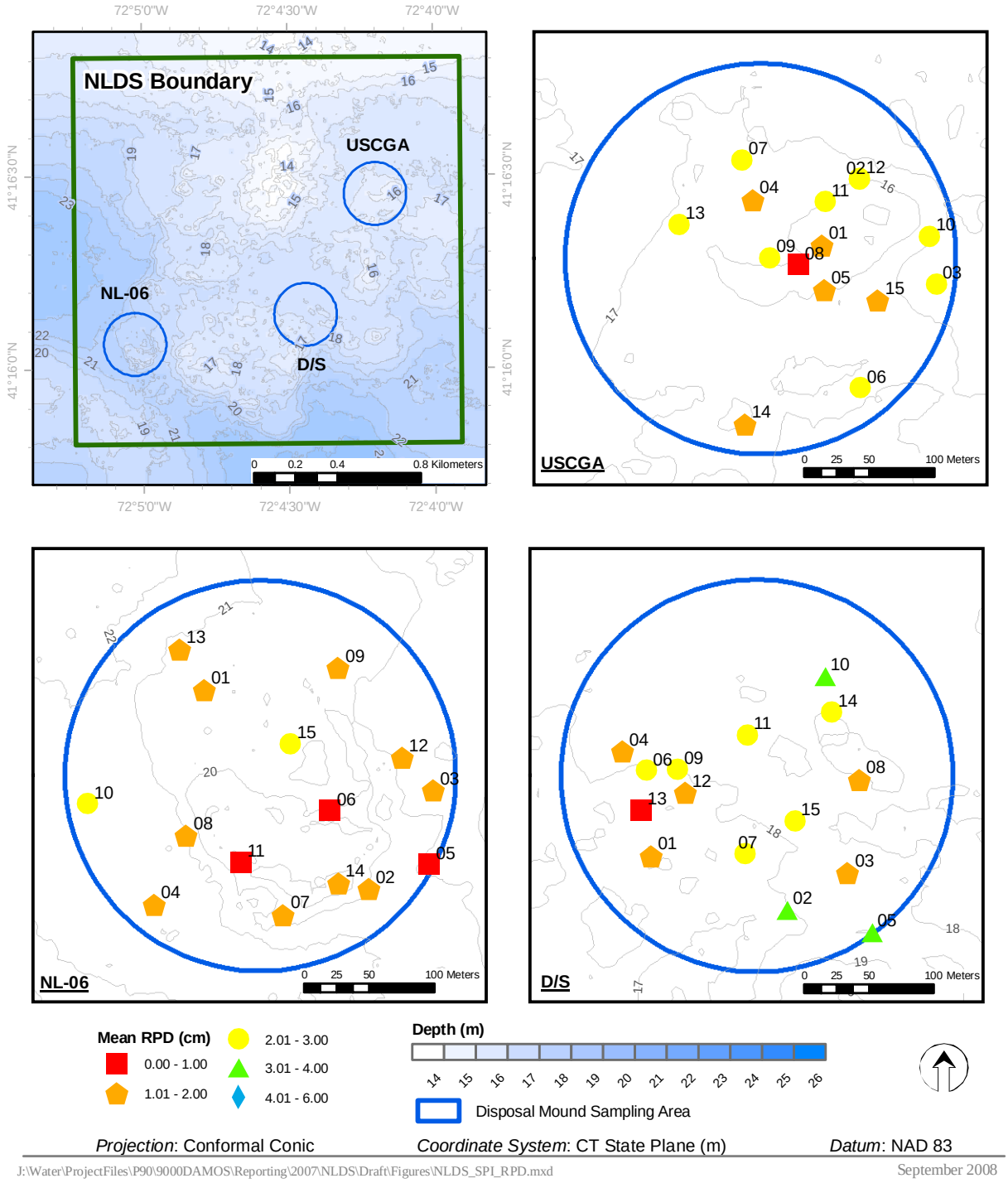

Figure 3-15. Spatial distribution of station-averaged apparent RPD depths (cm) at NLDS

The majority of stations showed benthic assemblages in the late stages of recolonization (Stage II or III) with evidence of deposit feeding activity and surface disturbance (Stage I on III; Table 3-2; Figures 3-16 and 3-17). Only one replicate image (NL06-04 B) lacked clear evidence of Stage II or III infauna presence (Figure 3-17). The average depth of subsurface feeding voids ranged from 0.0 to 10.3 cm below the sediment surface (Table 3-2).

3.2.3 USCGA Mound

Physical Sediment Characteristics

The 15 locations sampled on this historical mound had complex variations in sediment grain size major modes and ranges, with the majority of stations dominated by layers of fine sand over silt-clay and a few stations with predominantly silt-clay (Table 3-3; Figure 3-9). Despite the apparent evenness of the major modes, small-scale variation in grain size was apparent in many images (Figure 3-18), largely due to the presence of clumps of adult mussels.

Camera prism penetration ranged from 5.8 to 18.1 cm (Figure 3-12), with an overall average penetration depth of 11.9 cm (Table 3-3). Stop collar settings varied less than 1.5 cm among stations, but the number of weights per carriage ranged from 2 to 5 (see Appendix B). Even though all stations sampled on this mound showed dredged material thickness in excess of the prism penetration depth (Table 3-3), there was no evidence of organic enrichment, low oxygen concentrations in the overlying water, or presence of subsurface methane gas in any of the images collected.

Small-scale boundary roughness ranged from 0.3 to 4.3 cm over this disposal mound, with an overall average of 1.5 cm (Figure 3-13 and Table 3-3). The majority of the surface roughness elements were of biogenic origin and were due to the presence of burrow openings, live mussel clumps, feeding pits, or fecal mounds at the sediment-water interface; 20 of the 45 replicates had physical surface roughness elements consisting of ripples, mud clasts, or shells at the sediment surface.

Biological Conditions and Benthic Recolonization

The average depth of the apparent RPD measured at the stations surveyed on the USCGA Mound ranged from 1.4 to 3.5 cm (Figure 3-15), with an overall mound average of 2.5 cm (Table 3-3). All stations showed benthic assemblages in the late stages of colonization (Stage II or III), with evidence of deposit feeding activity (Figure 3-16).

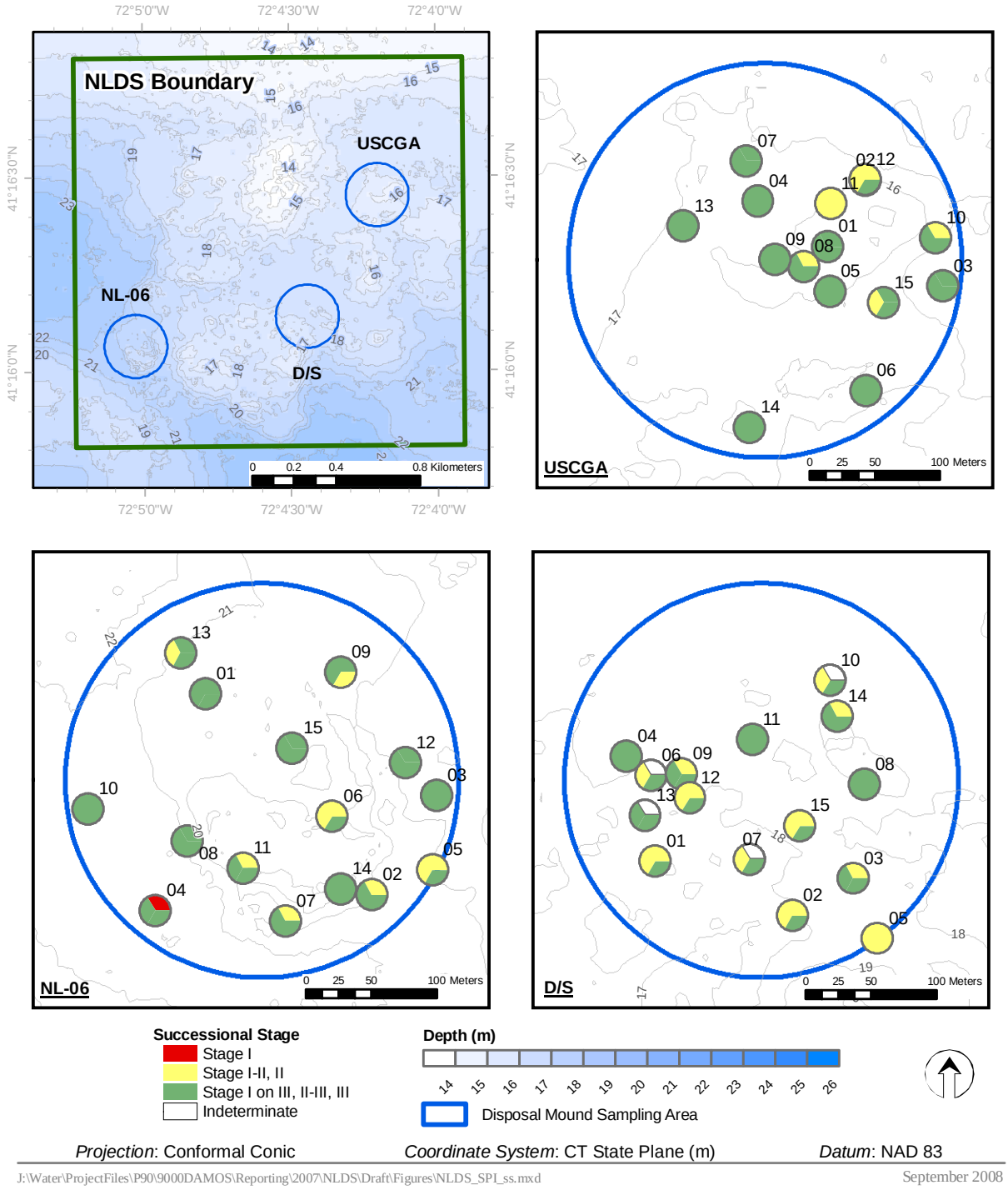

Figure 3-16. Distribution of infaunal successional stages found at NLDS

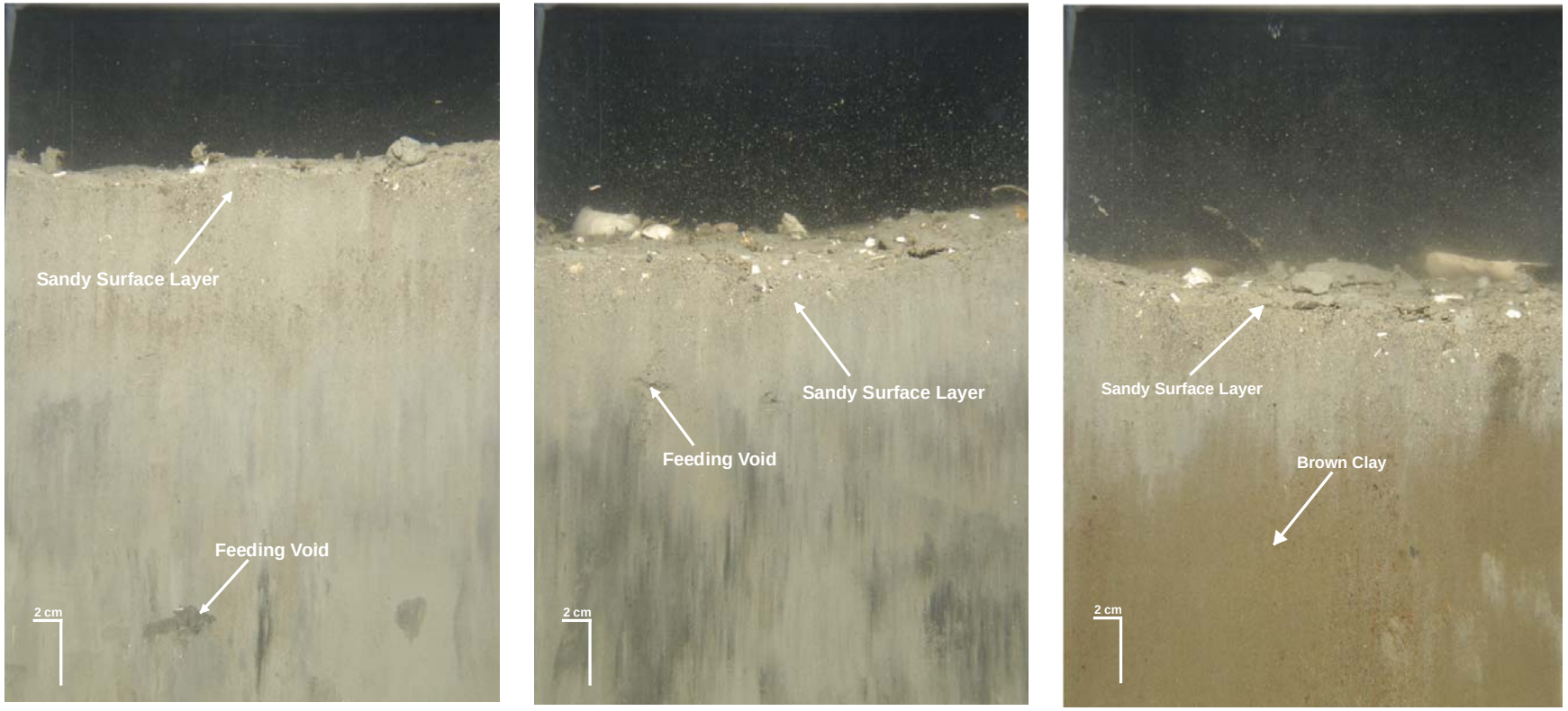

Figure 3-17. The biological conditions at the NL-06 Mound represented clear evidence of sustained recovery despite physical disturbance of the surface layers. The image from NL-06-02 (left) shows Stage III burrows and feedings voids below a sand layer with Stage I organisms. The image from NL-06-13 (center) shows Stage III burrows and feeding voids beneath a lag deposit of sand and shells mixed with clay. The only exception was one replicate from NL-06-04 (right) that contained distinctive brown clay and a sandy surface layer with Stage I organisms.

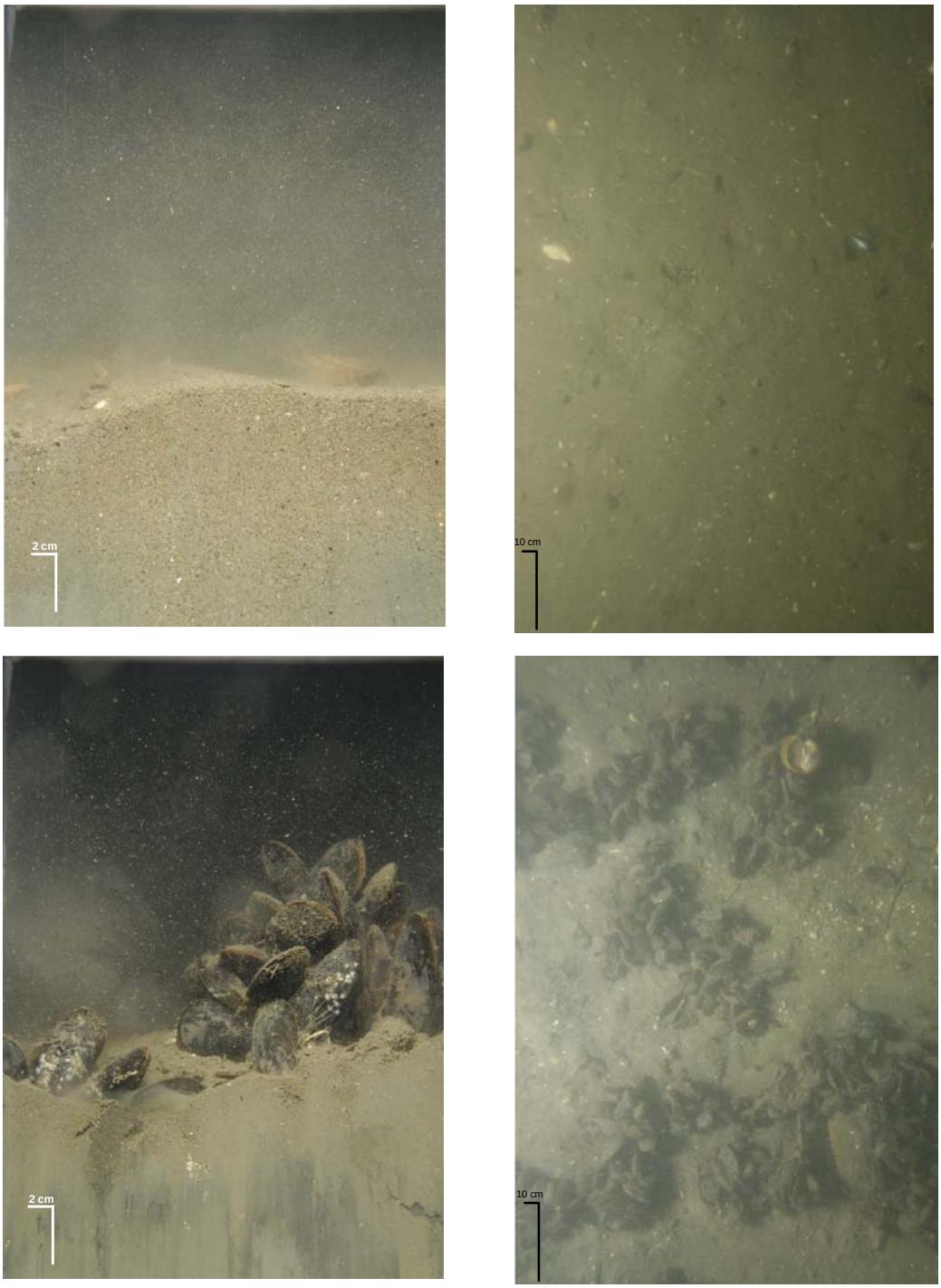

Figure 3-18. The rippled well-sorted sand at USCGA-02 (top) and clumps of adult mussels at USCGA-13 (bottom) are indicative of surface disturbance seen at many of the stations on the USCGA Mound.

The average depth of subsurface feeding voids ranged from 0.0 to 11.2 cm below the sediment surface (Table 3-3). Many of the stations showed evidence of surface disturbance (Stage I on II or Stage I on III); the disturbance was clearly visible as thin, mobile sand layers or mussel clumps (Figure 3-18). In the 13 years since the last disposal event at this mound, it has been completely recolonized by a mature, equilibrium, deposit-feeding community with subsurface sediments that have been extensively bioturbated. There is also evidence of frequent disturbance of the sediment-water interface (Figure 3-19).

3.2.4 New London-91 (NL-91) and Dow Stonington (D/S) Mound Complex

Physical Sediment Characteristics

The sediment at the NL-91 and D/S Mound Complex was dominated by surface layers of fine sand, somewhat similar to that found at the USCGA Mound; all but two stations had a sediment grain-size major mode of either 3 to 2/>4 phi (fine sand layer over silt-clay) or 3 to 2 phi (fine sand) (Figure 3-9). The two stations dominated by silt-clay were in an area with live adult mussel clumps but also had thin layers of sand at the surface (D/S-04 and D/S-12, Figure 3-9). Consolidated clay clumps were seen at the sediment surface in some of the replicate images (Figure 3-20). Even though more than three years have passed since disposal operations ceased at the NL-91 and D/S Mound Complex, evidence of the dredged material signature was still present in the cross-sectional profiles (Figure 3-21). All stations sampled on this mound showed dredged material thickness in excess of the prism penetration depth (Table 3-4). There was also evidence of organically enriched sulfidic sediments and the presence of subsurface methane gas in one replicate image at D/S-03 (Figure 3-22).

Camera prism penetration ranged from 1.7 to 15.5 cm (Table 3-4), with an overall average penetration depth of 10.1 cm (Figure 3-12). The stop collars and weight settings were changed at different stations on this mound, making it difficult to evaluate the actual shear strength of the sediment; however, on a relative scale among the three disposal mounds, the sediment shear strength on this mound was high compared to the USCGA (intermediate) and NL-06 (lowest) Mounds.

Small-scale boundary roughness values ranged from 0.7 to 2.4 cm (Table 3-4), with an overall average value of 1.8 cm (Figure 3-13). The majority of the surface roughness elements were of physical origin and due to the presence of sand ripples, shells, and gravel at the sediment-water interface (Figure 3-23).

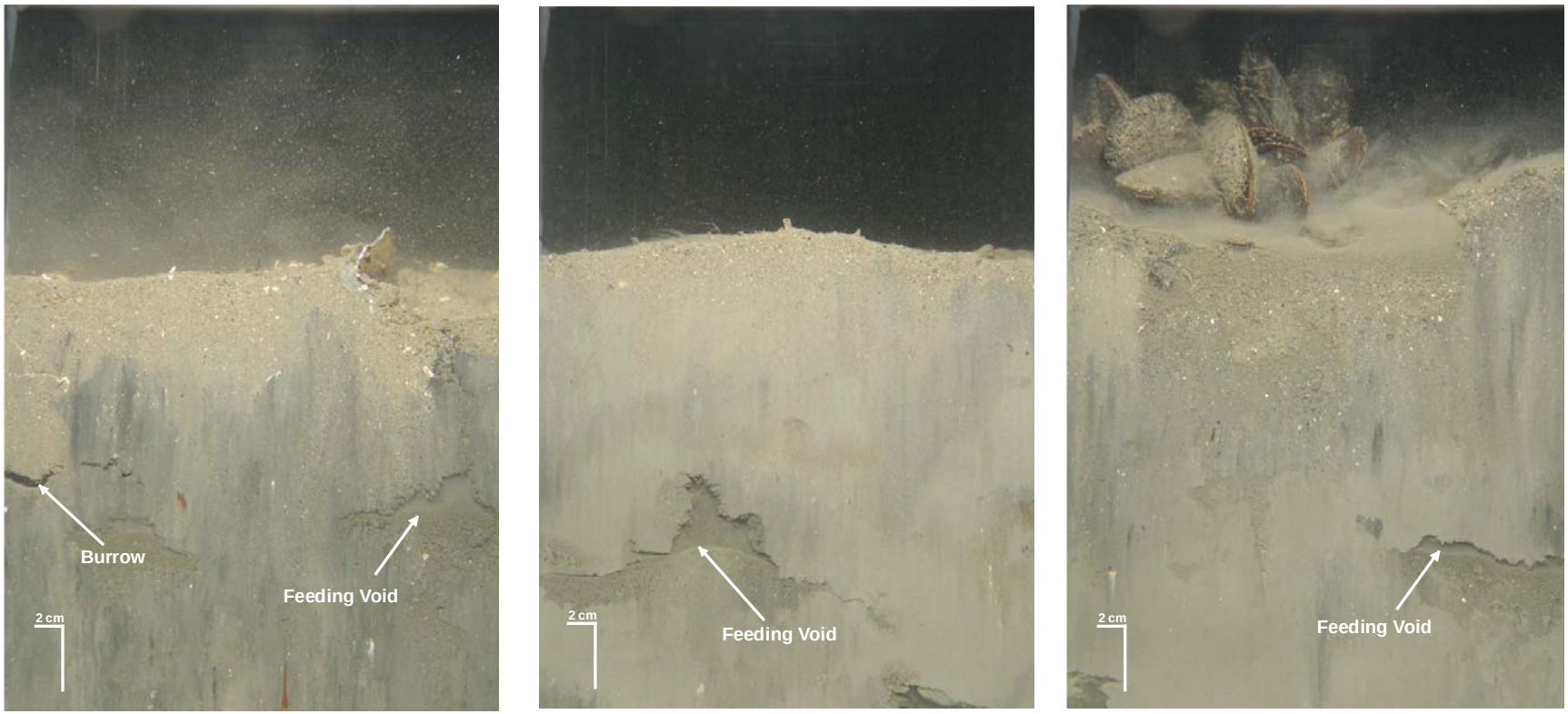

Figure 3-19. Sediment-profile images from the USCGA Mound show the degree to which the subsurface sediments have been reworked by infaunal burrowing and deposit-feeding activities (voids and burrows highlighted by arrows on the images) and surface sediments subject to physical disturbance: USCGA-07 (left); USCGA-09 (center); USCGA-13 (right).

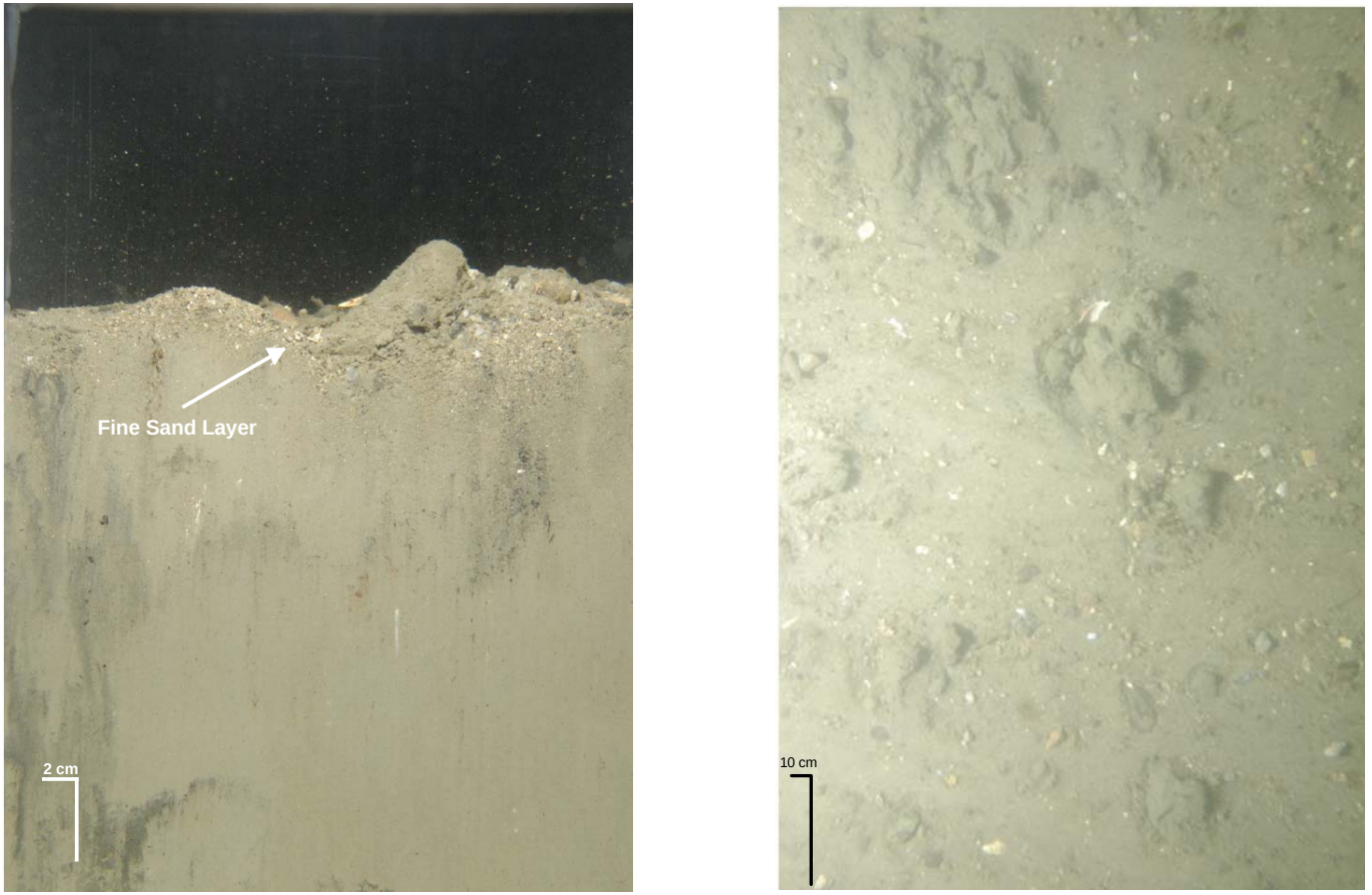

Figure 3-20. Consolidated clay is visible on the surface at several NL-91 and D/S Mound Complex stations. The sediment-profile image (left) and corresponding plan-view image (right) from D/S-12 show a thin layer of poorly sorted gravelly fine sand with exposed eroded clay clumps overlying a silt/clay horizon of dredged material.

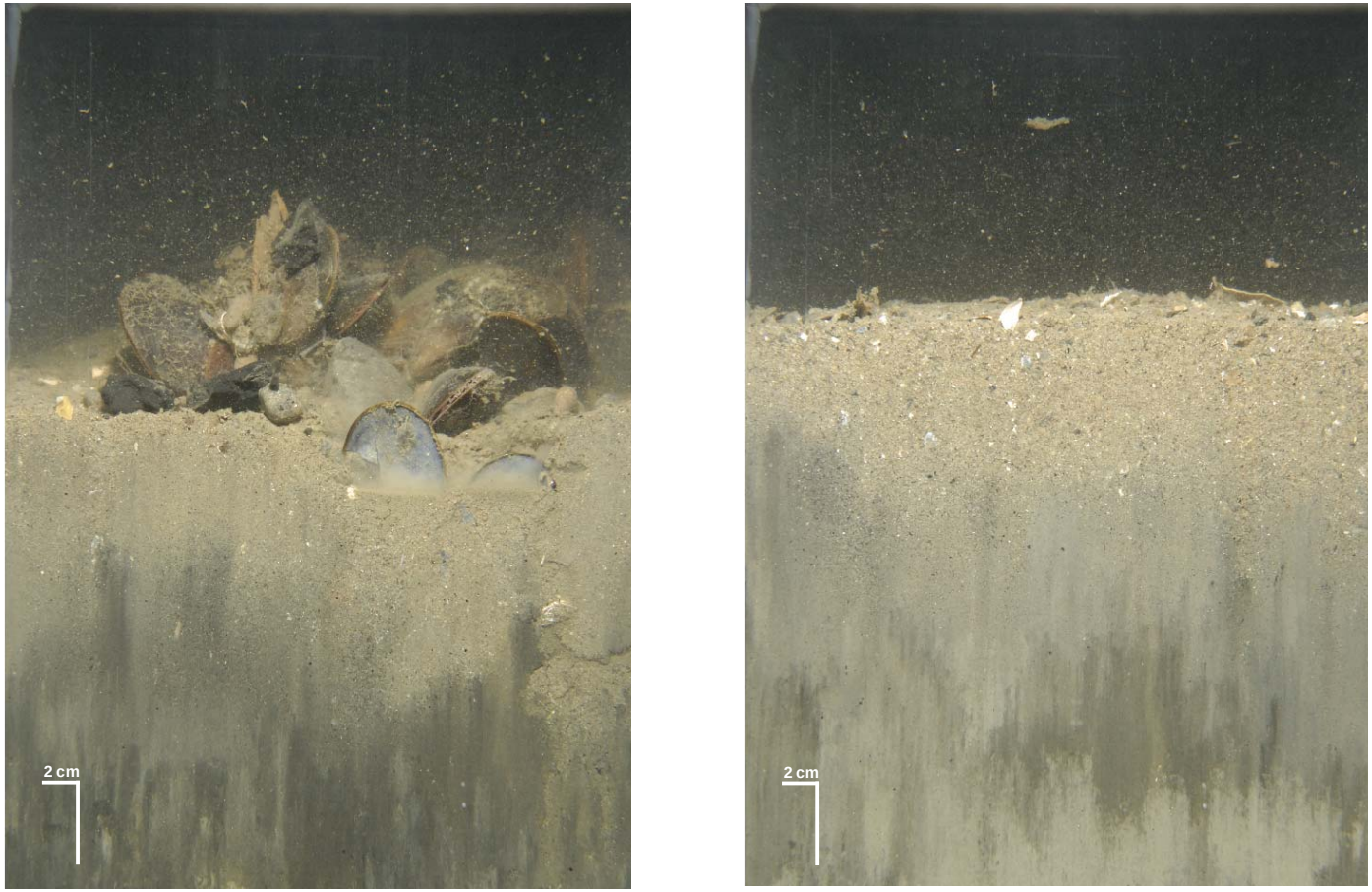

Figure 3-21. Evidence of dredged material can still be seen in the profile images from Stations D/S-08 (left) and D/S-10 (right) despite the extensive recolonization and subsurface reworking by benthic infauna.

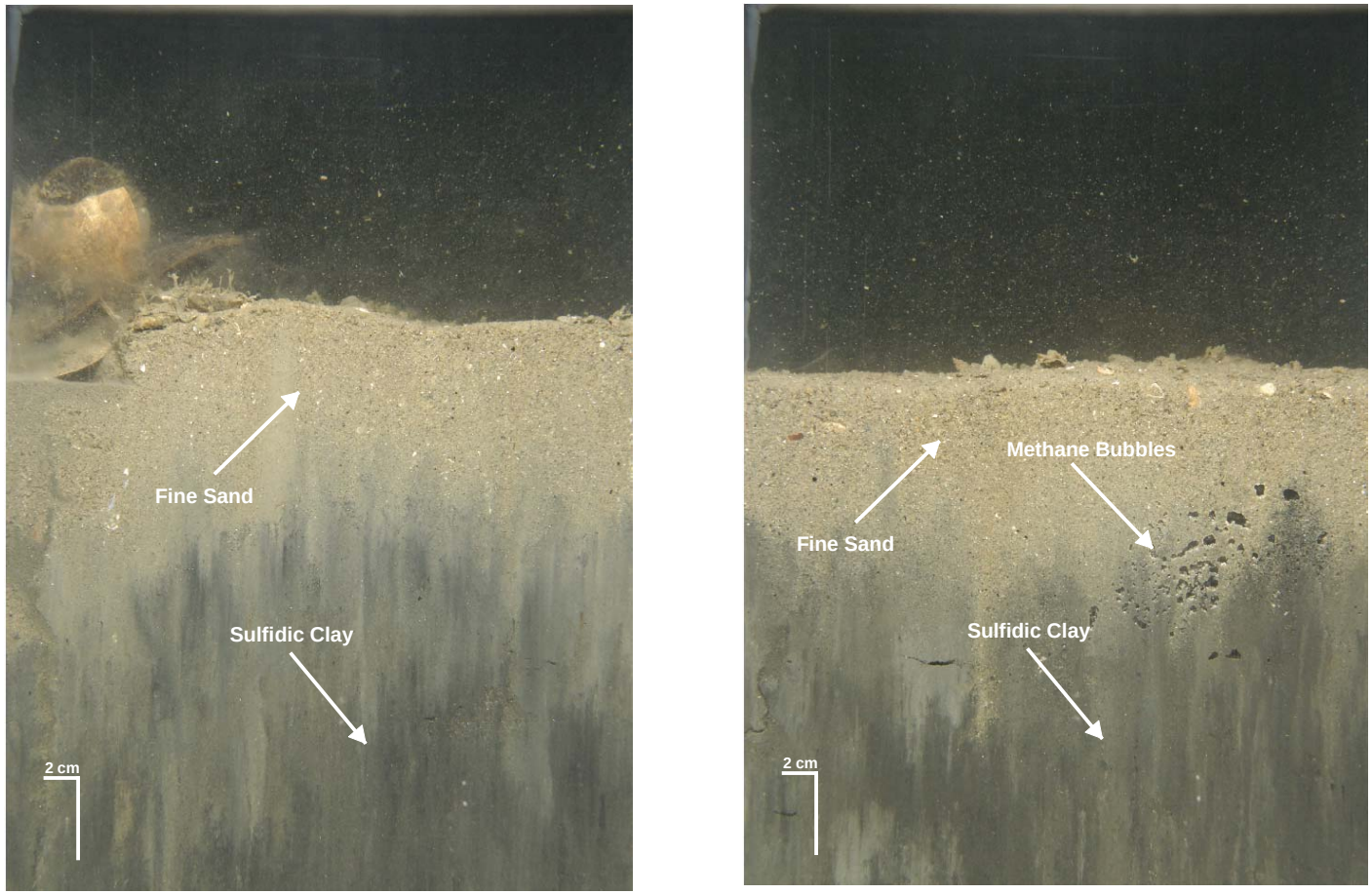

Figure 3-22. Organically enriched dredged material was present near the surface at several stations. Station D/S-11 (left) had a layer of fine sand over dark sulfidic clay with shell fragments on the surface. Station D/S-03 (right) also had a fine sand layer over sulfidic clay with methane bubbles at the interface between the sand and the clay.

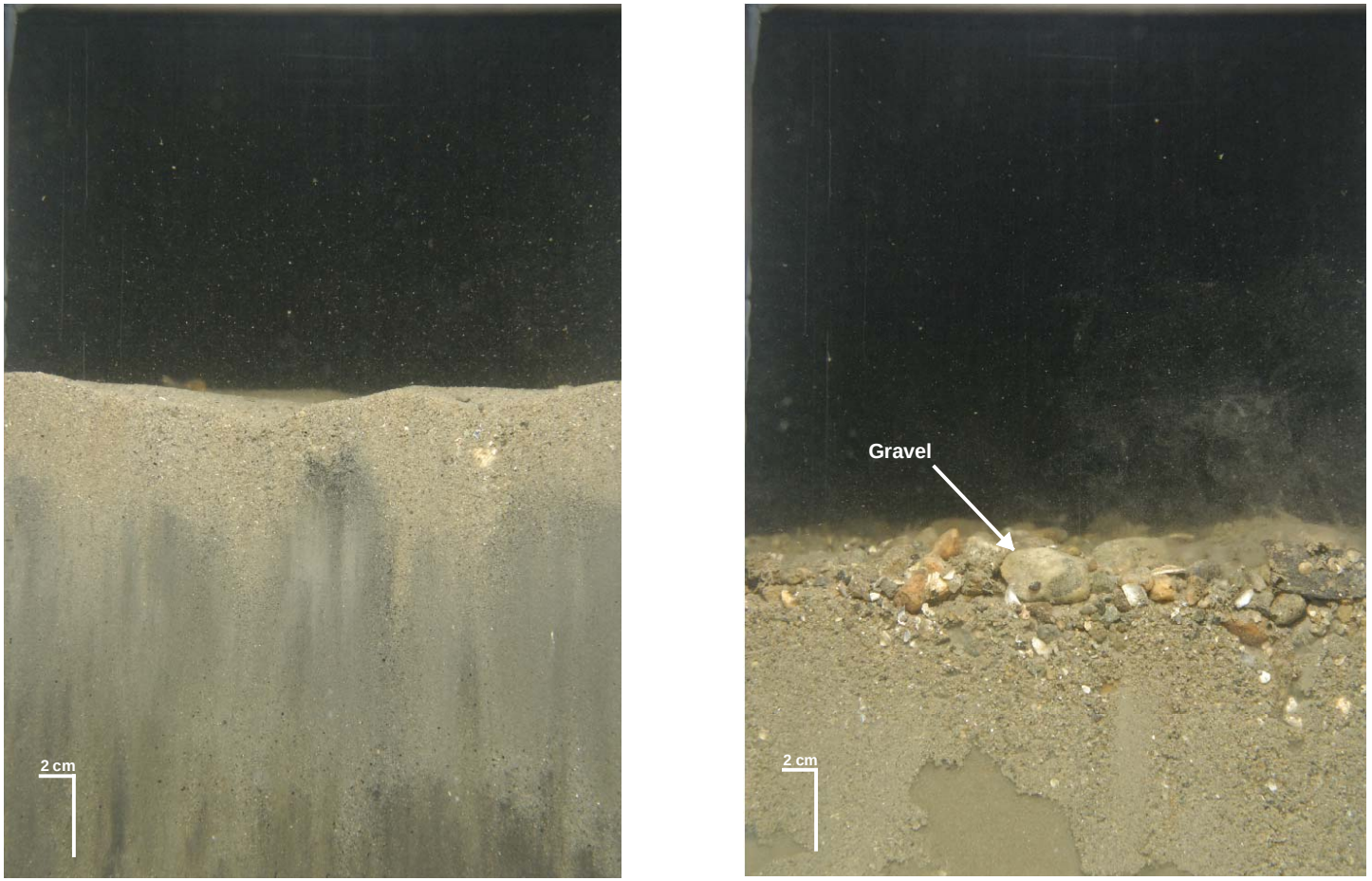

Figure 3-23. The presence of sand ripples and lag deposits indicated active sediment transport has occurred over the surface of the NL-91 and D/S Mound Complex. Stations D/S-15 and D/S-09 have sand ripples (left) and reverse graded gravel (right), respectively.

Biological Conditions and Benthic Recolonization

The average depth of the apparent RPD at the stations surveyed on the NL-91 and D/S Mound Complex ranged from 0.0 to 4.2 cm (Figure 3-15), with an overall average of 2.3 cm (Table 3-4). As with the other historical mound surveyed (USCGA Mound), all stations had benthic assemblages in the late stages of colonization (Stage II or III) with evidence of deposit-feeding activity (Figure 3-16). The average depth of subsurface feeding voids (when present) ranged from 4.0 to 11.3 cm below the sediment surface (Table 3-4). In the three years since the last disposal event at this mound, it was completely recolonized by a mature, equilibrium, deposit-feeding community and had subsurface sediments that have been extensively bioturbated; however, frequent disturbance of the sediment-water interface was also evident (Figure 3-21).

3.2.5 Comparison of NLDS Mounds to Reference Area Conditions

The objective of the SPI and plan-view imaging survey was to assess the benthic recolonization status of the three disposal site mounds relative to reference conditions. The dataset used in the statistical comparison consisted of five stations at each of the three reference areas (NLON REF, NEREF, WREF) and 15 stations at each of the three disposal mounds (NL-06, USCGA, NL-91 and D/S Mound Complex). At each station, the results for three replicate drops of the SPI camera were combined to get one value per station: the average of replicates was used for the station RPD and the maximum stage among replicates was used as the successional stage rank for the station. Successional stage ranks have possible values between 0 (no fauna present) and 3 (Stage III); half-ranks are also possible for the "in-between" stages (e.g., Stage I->II has value 1.5). A summary of the mean RPD and successional stage rank values for each station are shown in Table 3-5 and Figure 3-24.

Mean RPD Variable

The three reference areas showed some differences in RPD (Table 3-5 and Figure 3-24) with WREF having slightly lower RPD values than the other two reference areas. Because pooling stations across all reference areas will increase the estimate of residual variability beyond what is probably the true within-group variance, the three reference areas were maintained as separate locations in the following analysis. The grand mean of the three reference areas was used for comparison to each mound mean and the variance estimate was calculated based on the residual variability within the six separate reference and mound locations.

Table 3-5.

Summary of Station Means by Sampling Location

Area	N	Mean RPD (cm) Mean	Mean RPD (cm) Standard deviation	Successional Stage Rank Mean	Successional Stage Rank Standard deviation
Reference Locations					
NLON REF	5	2.5	0.50	2.6	0.55
NEREF	5	2.5	0.24	3.0	0
WREF	5	2.0	0.22	2.6	0.55
Mean		2.3		2.7	
Disposal Mounds					
NL-06	15	1.5	0.47	3.0	0
USCGA	15	2.0	0.63	2.9	0.35
NL-91/ D/S	15	2.3	0.73	2.8	0.32

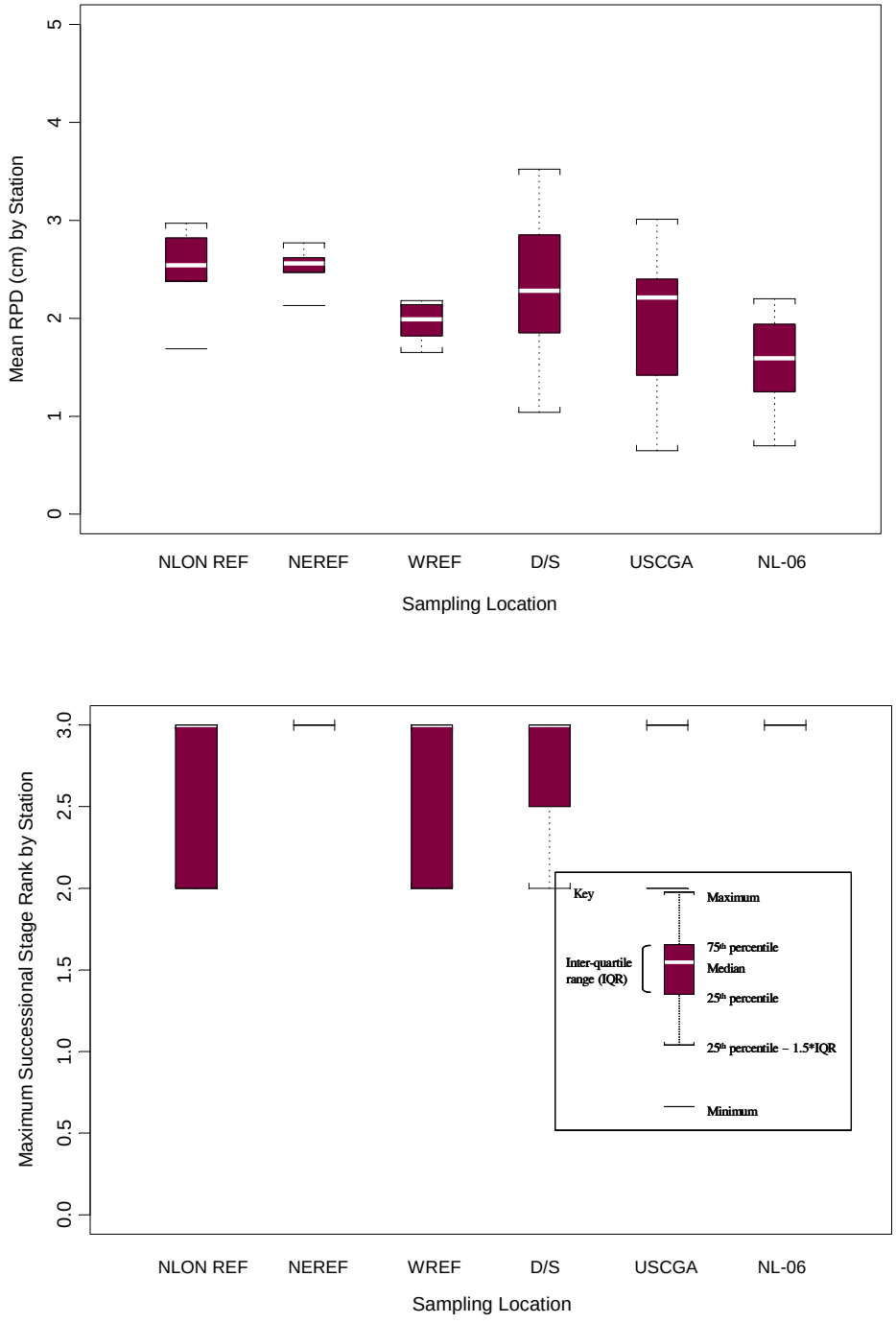

Figure 3-24. Boxplots showing distribution of station mean RPD and successional stage rank values for 2007 NLDS survey

The assumption of normality was not rejected by the Shapiro-Wilk's test on area residuals (i.e., each observation minus the area mean) (Shapiro-Wilk's test p-value = 0.51), and the assumption of equal variances was not rejected by Levene's test ($p=0.15$), so a pooled residual variance estimate was used to compute the variance for the difference equations (Table 3-6).

The specified δ values of ±1 for RPD were outside the 95% lower and upper confidence bounds for the shaded comparisons (Table 3-6). The RPD depths at the USCGA Mound and NL-91 and D/S Mound Complex were not different from the reference areas within the predetermined definition of what is "ecologically meaningful" for apparent mean RPD depths (i.e., < 1cm difference). The RPD depths at the NL-06 Mound were found to be different from the reference areas.

Successional Stage Rank Variable

The mean successional stage rank for each of the three mounds exceeded the mean of the reference areas (Table 3-5 and Figure 3-24). The NL-06 Mound had zero variance with all 15 stations showing Stage III succession; on the USCGA Mound, 13 of the 15 stations were at Stage III. Only the older NL-91 and D/S Mound Complex showed stations with assemblages in transition to Stage III (10 stations in Stage III, 4 in transition between Stage II and III, and 1 in Stage II). Statistical comparisons of these data were not necessary to illustrate that the disposal mounds had successional stages that were at least as advanced as the reference areas.

3.3 Plan-View Imaging

The plan-view images taken in conjunction with the sediment-profile images provided valuable additional information about large-scale sedimentary features (bedforms, lag deposits), density/patch size of surface fauna, density of infaunal burrowers, and occurrence and density of epifaunal foraging patterns both on the disposal mounds and at the reference areas. Detailed comments and results of the plan-view image analysis can be found in Appendix C.

3.3.1 Physical Sediment Characteristics

The sediment surface on the most recent disposal mound (NL-06) was notably different from that at the other two mounds or the reference areas. Irregular topography from consolidated clay clumps or shells was quite common, with thin layers of fine sand at NL-06. The NL-91 and D/S Mound Complex and USCGA Mounds and reference

Table 3-6.

Summary Statistics and Results of Bioequivalence Testing for RPD Values

Difference Equation	Observed Difference ($\hat{d}$)	SE($\hat{d}$)	Degrees of Freedom for SE($\hat{d}$)	95% Lower Confidence Bound	95% Upper Confidence Bound
REF – NL-06	0.78	0.208	54	0.43	1.13
REF – USCGA	0.29	0.208	54	-0.05	0.64
REF – D/S	0.006	0.208	54	-0.34	0.35

Note: Shading indicates two groups are statistically equivalent

areas had abundant shells, but these were either live or recently deceased mussel shells (see below) or highly weathered shell fragments and gravel. The older mounds and reference areas also had thicker layers of brown sand with clear sand ripples and winnowing around larger shells (Figures 3-25 and 3-26).

3.3.2 Biological Conditions

While occasional crabs, snails, and starfish could be seen in the plan-view images (Figure 3-27; Appendix C) tracks, trails, and burrows were difficult to see except in the stations with the finest surface sediments. The dominant epifauna were clumps of adult mussels; at some stations the majority of the mussels were dead and the shells were still articulated (Figure 3-28).

An unusual occurrence was the presence of an aggregation of slipper limpets (*Crepidula fornicata*) in three replicates of one station in the NLON REF area (Figure 3-29). Slipper limpets are commonly found in soft substrates attached to mussels or oysters and in chains of up to 12 animals. When found in dense aggregations, they can deposit mud through filter feeding and pseudofeces production. Another interesting observation was the moon snail, *Neverita (Polynices) duplicata*, which was visible in the plan-view image as well as the SPI image from one replicate at Station USCGA-11 (Figure 3-29).

3.4 Sediment Grab

An individual grab sample was collected for grain size analysis, to supplement potential future analysis of acoustic backscatter data. The grab sample collected at Station NL-06-15 (Figure 2-3) consisted of sediment that was firm in texture with an olive-brown colored surface overlaying dark gray material. Small shell fragments were visible on the surface. The sample was comprised of approximately 80% silt and clay. The results (Appendix D) confirm that the sediment classification made via analysis of the SPI images was representative of what was measured in the sample (clay with sand) (Table 3-7).

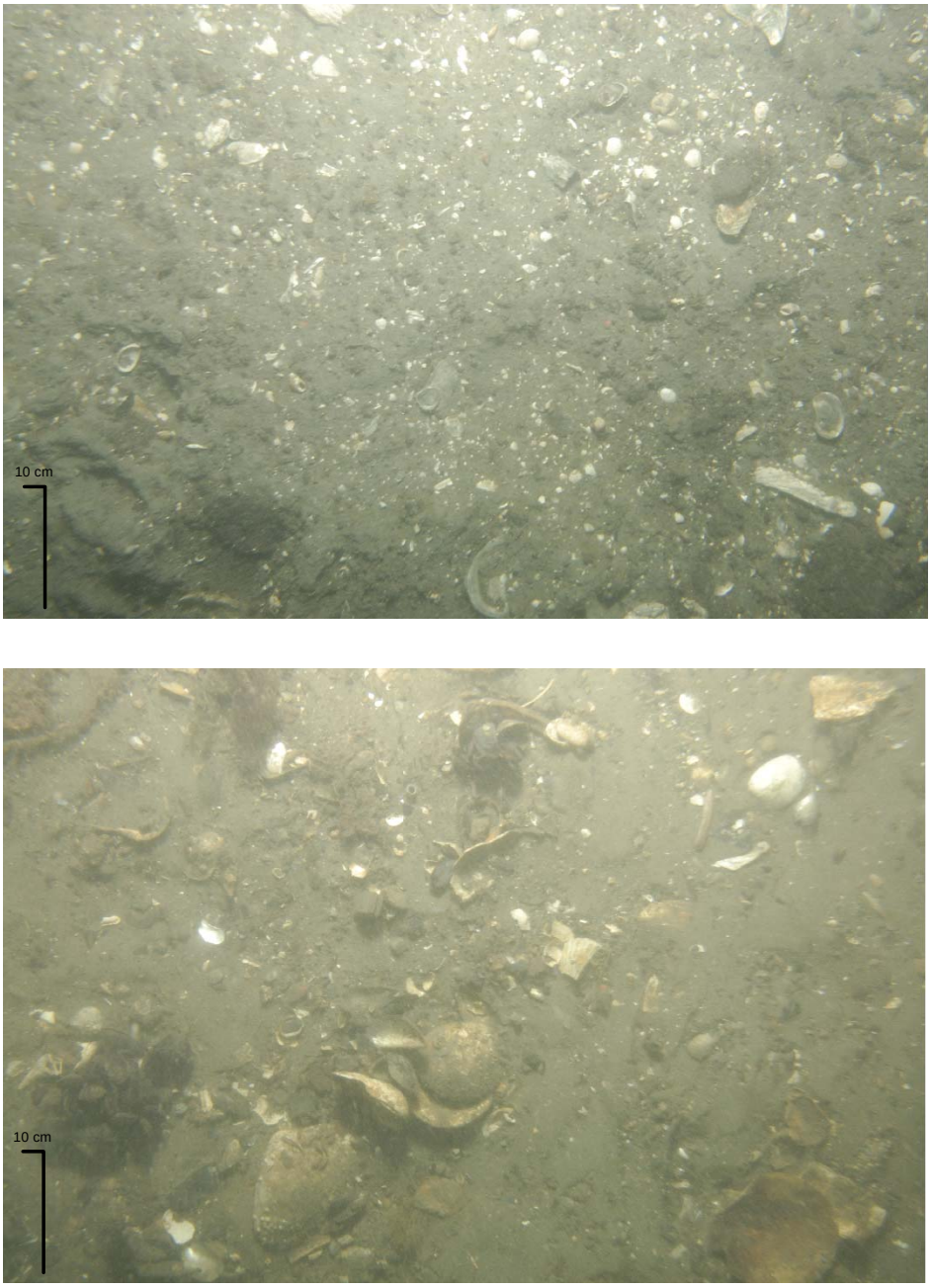

Figure 3-25. Plan-view images from the NL-06 Mound and the NL-91 and D/S Mound Complex show the characteristic sediment types and topographies found at each location. Consolidated clay, thin sand, shell hash, and white shell fragments can be seen on the surface at NL-06-11 (top). Brown sand, weathered shells, and both live and dead mussels can be seen on the surface at D/S-10 (bottom).

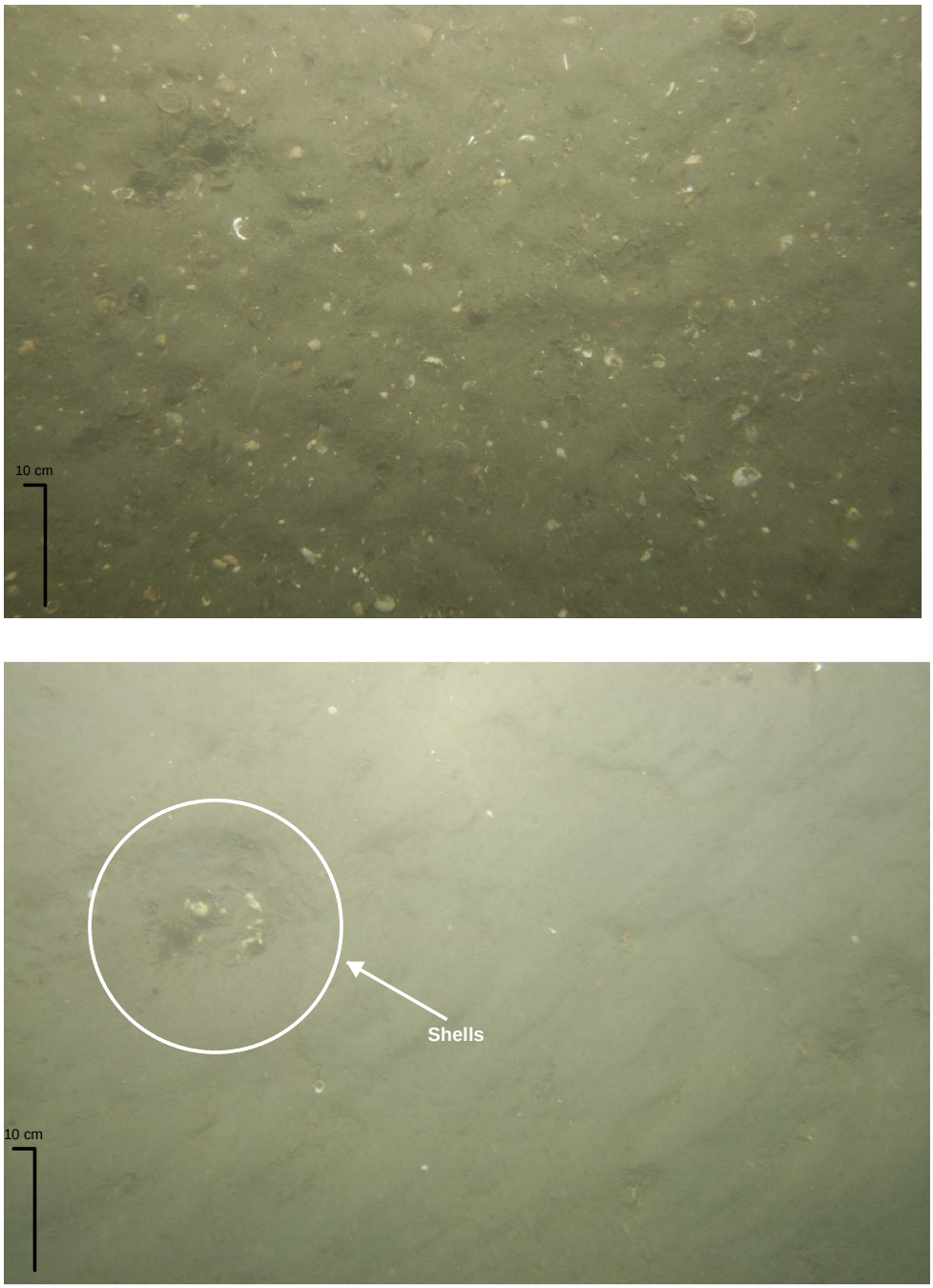

Figure 3-26. Plan-view images from the USCGA Mound and the NEREF area show the characteristic sediment types and topographies found on each sampling location. Brown sand in small ripples and shell fragments were seen on the surface at USCGA-03 (top). Brown sand in small ripples and winnowing around a patch of shells are seen from the surface at NEREF-02 (bottom).

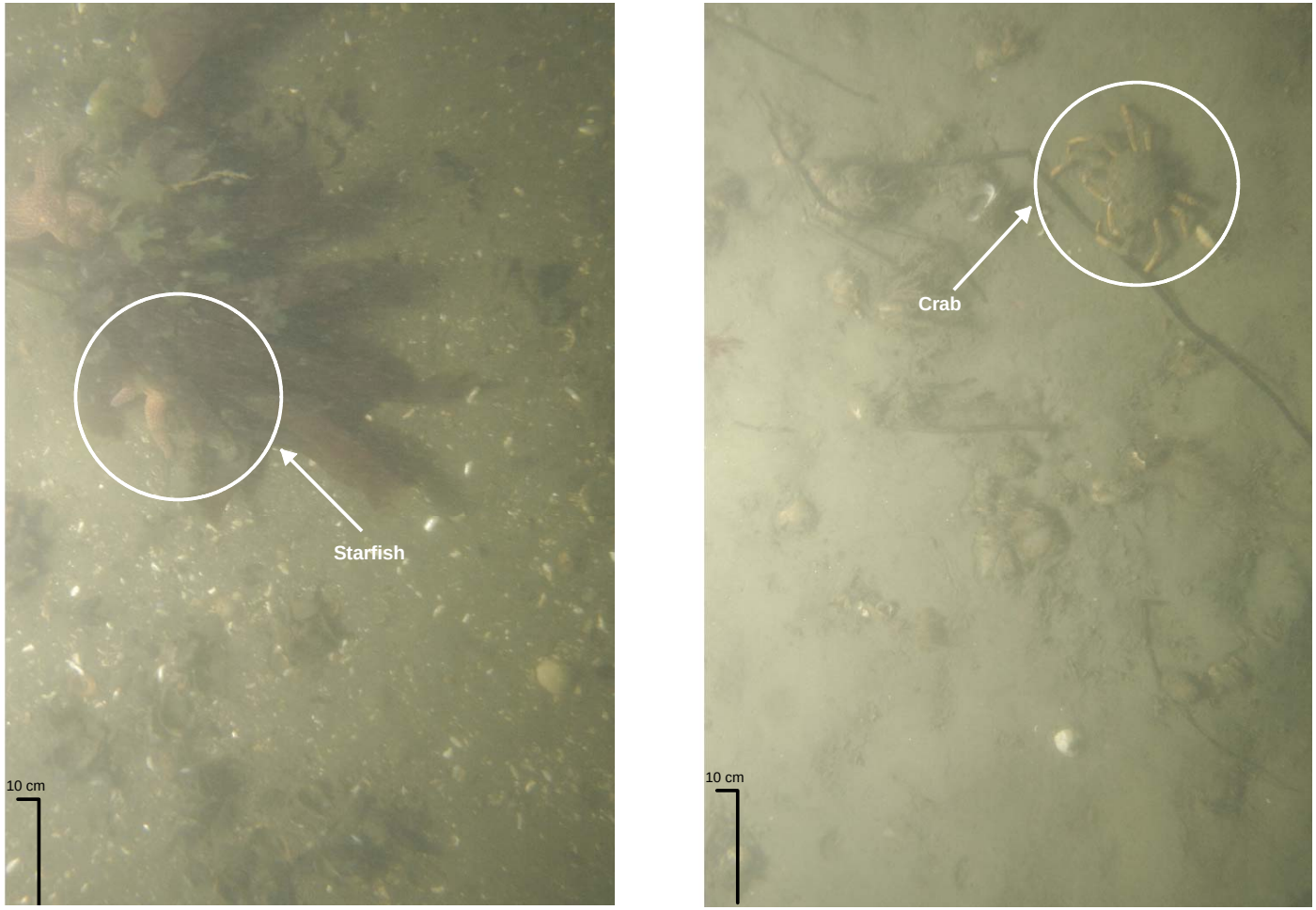

Figure 3-27. Epifaunal organisms such as starfish, snails, and crabs were visible in plan-view images as illustrated in these images from WREF-05 (left) and NLON REF-01 (right).

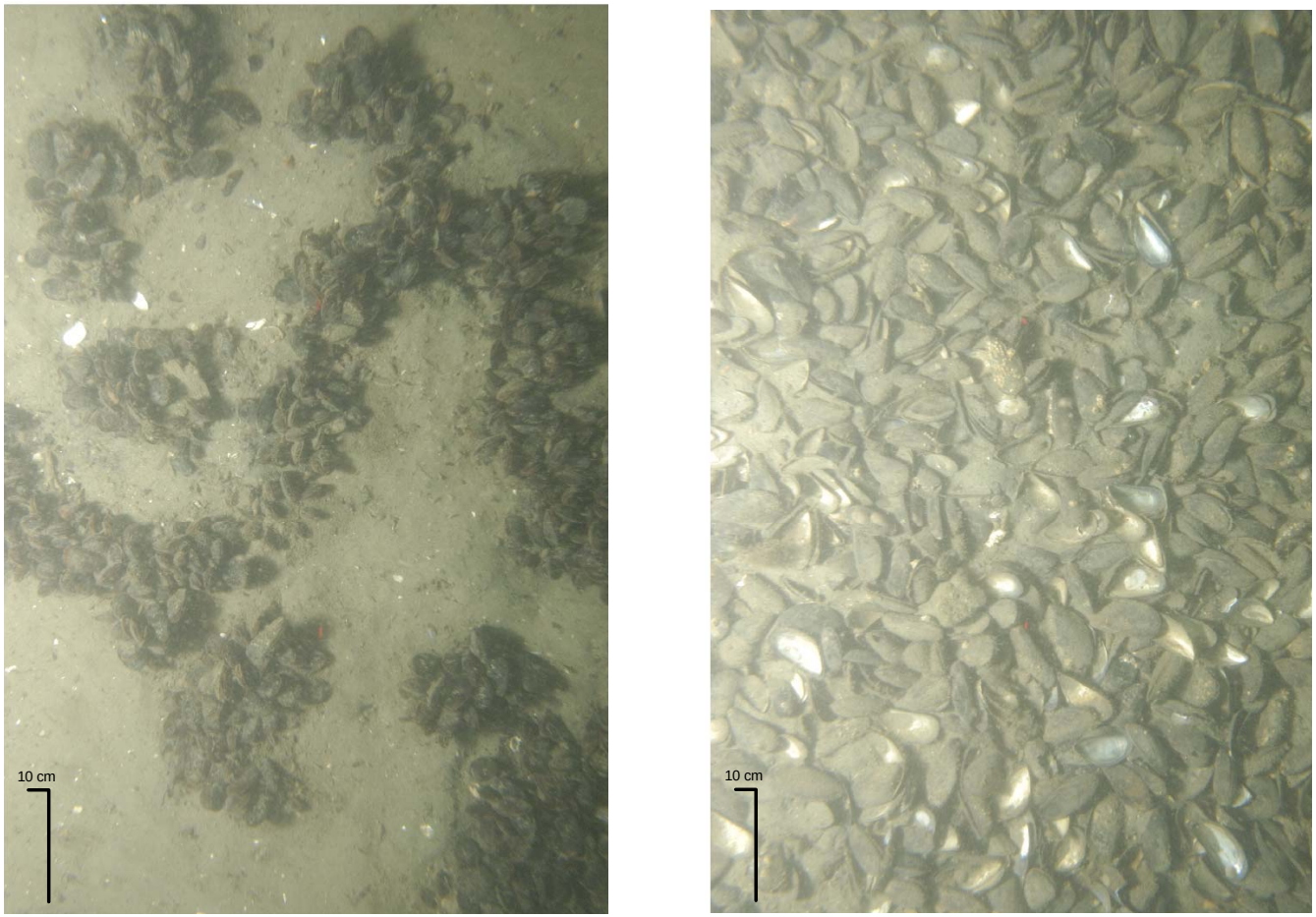

Figure 3-28. Dense clumps of adult mussels (*Mytilus* sp.) were seen at the USCGA Mound and NL-91 and D/S Mound Complex and all reference areas. Live clumps are visible in this image from D/S-08 (left), while an assemblage of mostly dead mussels is visible in this image from D/S-06 (right).

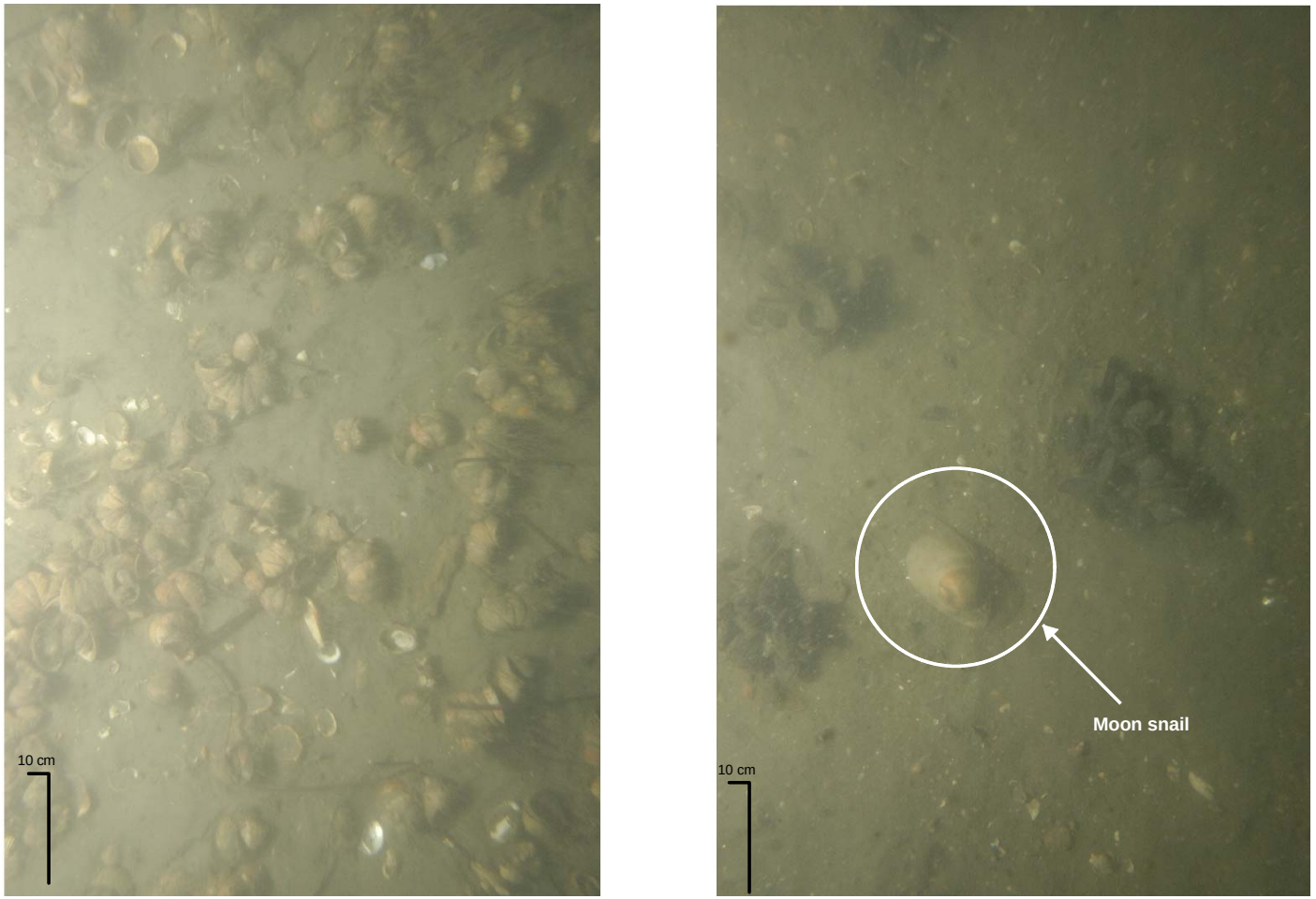

Figure 3-29. An aggregation of slipper limpets, *Crepidula fornicata*, was observed at NLON REF-04 (left); an active predatory moon snail, *Neverita (Polynices) duplicata*, was observed at USCGA-11 (right).

Table 3-7.

Sediment Composition of NLDS Grab Sample

Station	Sediment	Percentage
NL-06-15	Cobble	0.0%
	Gravel	1.5%
	Sand	19.2%
	Silt and Clay	79.3%

4.0 DISCUSSION

The objectives of the 2007 NLDS survey were to document the distribution of dredged material within NLDS and to assess the recolonization status and benthic habitat characteristics of three disposal mounds relative to the reference areas. These objectives were accomplished using bathymetric, SPI, and PUC survey techniques.

4.1 Dredged Material Distribution

The July/August 2007 bathymetric survey at NLDS was intended to assess the seafloor topography of the disposal site and evaluate the distribution of dredged material. Between August 2000 and July 2007, approximately 277,000 m^3 of dredged material was directed to the NDA 06 buoy location. Smaller amounts of material were directed to the NL-94 and NL-91 and D/S Mound Complex (Figure 1-3). Changes in bathymetry detected between the 1997 and 2007 surveys showed the thickest accumulations of dredged material occurred in the area immediately adjacent to the 2006 marker buoy (Figure 3-2), coincident with the recorded disposal locations (Figure 1-3). The bathymetric data revealed an oblong mound with a maximum height of approximately 4 m and dimensions of approximately 575 m long by 250 m wide. These measured dimensions are similar to the predicted dimensions of 3–4 m in height and 500–600 m in diameter based on the amount of dredged material disposal. The measured mound was slightly narrower than predicted. No other large-scale bathymetric changes were observed between 1997 and 2007.

4.2 Biological Conditions and Benthic Recolonization

The results of the 2007 SPI and PUC survey confirmed the predictions made at the outset of the survey for the three disposal mounds:

- The NL-91 and D/S Mound Complex and USCGA Mound are expected to have benthic communities comprised of mature, equilibrium (Stage III) assemblages and will have conditions comparable to those found at the reference areas; and

- The NL-06 Mound will display early recolonization assemblages (Stage I and early Stage II).

Recolonization at the older mounds (USCGA and NL-91 and D/S Mound Complex) has continued as expected, with mature Stage III communities found at almost every station on both of these older mounds. Infaunal burrowers and deposit feeders

were evident in the SPI images from these two older mounds, and both mounds continued to have habitat conditions similar to those found at the reference stations.

The USCGA Mound has had no direct disposal activity since January 1995 when a capped mound was created with approximately 43,500 m³ of fine-grained UDM and 80,500 m³ of fine-grained CDM from berthing areas at the Coast Guard Academy. The mound was surveyed shortly after it was created in 1995, and was revisited in 2000. The USCGA Mound showed evidence of rapid recolonization eight months following the last disposal (SAIC 2001a), with numerous amphipod mats visible in the images. In 2000, the USCGA Mound had advanced recolonization with abundant amphipod tubes (active and decayed), relatively deep RPDs, and a grain size major mode of >4 phi at all stations.

In 2007, the USCGA Mound had a thin layer of well-sorted sand over silt-clay and no amphipod tubes. There was ample evidence of sediment transport and winnowing as well as clumps of mussels (Figure 3-18). The sediments on the USCGA Mound were firmer than the sediments at the NL-06 Mound, and the conditions were quite similar to the reference areas, particularly NEREF. Although the original cap material was largely fine grained, sediment transport processes and winnowing have left a surface layer of fine sand and scattered gravel and shells. This layer was a few centimeters thick and resembled the layers on the surface at the NLON REF and NEREF reference areas.

The NL-91 and D/S Mound Complex was originally formed during the 1991–1992 disposal season and received over 30,000 m³ of additional capping material between 1997 and 2000 (SAIC 2001c). More recently, the NL-91 and D/S Mound Complex received approximately 21,700 m^3 between 2000 and 2004. All stations surveyed in 2000 had a grain size major mode of >4 phi (silt/clay) with many replicates displaying a distinct layer of poorly sorted fine or medium sandy dredged material (SAIC 2001c). Most stations had active or decayed amphipod tubes on the surface in 2000. In contrast, the mound surface sediments imaged in 2007 had a grain size major mode of 3–2/>4 (fine sand layer over silt-clay) and lacked amphipod tubes. The surface sediments in 2007 contained a much higher proportion of coarse material (gravel and shells) and displayed evidence of winnowing in both plan-view and SPI images (Figures 3-20 and 3-23). Adult mussels were present in many plan-view images (Appendix C) and these mussel beds had clearly contributed dead shells to the surface sediments. In some replicates on the NL-91 and D/S Mound Complex the sand layer was relatively thin, with either exposed clay clumps (Figure 3-20) or reduced organic-rich silt near the surface and subsurface methane gas (Figure 3-22). In general, the surface features at the NL-91 and D/S Mound Complex in 2007 showed extensive reworking of the new material, winnowing, lag

deposits, as well as accumulation of shell debris and fine sediment around clumps of mussels. This was consistent with conditions at the USCGA Mound and reference areas in 2007.

The recent mound, NL-06, has also recovered from disposal-related disturbance. The 2007 NLDS survey was conducted eight months after the last recorded disposal activity at NL-06 which provided ample time for recolonization of the new mound. All stations had advanced stages of recolonization with extensive burrowing and feeding voids present (Figure 3-17).

The surface of the NL-06 Mound was noticeably different from the historical mounds or reference areas. The material disposed at this mound likely contained a significant number of dead bivalves that have now winnowed out onto the surface and are relatively intact compared to those at WREF (Figures 3-11 and 3-14). There was a very thin layer of sand (thinner than at NEREF) over silt/clay and the grain size major mode was >4 phi at every station. At many stations the consolidated clay was exposed at the surface (Figure 3-10). As expected, the RPD depths at the NL-06 Mound were significantly shallower than reference area values (Tables 3-1 and 3-2). However, the successional stage conditions were actually more advanced, on average, than reference conditions or conditions at the other mounds (Figure 3-16),

Notably, the two historical mounds and the reference areas had dense assemblages of adult mussels and no tube-building amphipods. A previous survey in 2001 found a large settlement of juvenile mussels across the disposal site (SAIC 2004). The creation of the NL-06 Mound in 2005–2006 buried the sessile animals in this area and no successful settlement has occurred since then. Previous surveys have also noted strong cyclical development and senescence of tube-building amphipods at NLDS (SAIC 2001a). The dominance of mussel clumps on the surface seven years after this high settlement is not surprising and may explain the absence of tube-building amphipods.

The pattern of biological community structure can be highly variable from season to season and year to year (Rhoads and Germano 1982). The presence or absence of juvenile mussels (Family Mytilidae) or tube-building amphipods (*Ampelisca* spp.) may represent a relatively ephemeral stage in the continual colonization, maturation, and death of individual populations of benthic animals. The most important consequence of their presence on the disposal mound is the effect on sediment transport and accumulation of fine material (between tubes and shells) and shell material on the surface. After these populations senesce, their tubes and shells decay and contribute to the surface material.

5.0 CONCLUSIONS

The July/August 2007 survey provided a means to assess changes in seafloor topography across NLDS and the benthic recolonization status of two historic capped mounds and one recently formed mound following placement of nearly 321,000 m^3 of sediment between August 2000 and November 2006.

The 2007 survey was designed to assess the following expectations:

- The placement of approximately 321,000 m^3 of dredged material (277,000 m^3 at the NDA 06 buoy location) since the 2000 DAMOS survey will result in the development of the NL-06 Mound;
- The NL-06 Mound is expected to measure approximately 500–600 m in diameter with an elevation of 3–4 m, based on the amount of disposal;
- Historical mounds (NL-91 and D/S Mound Complex and USCGA Mound) will show minor consolidation;
- As the NL-91 and D/S Mound Complex and USCGA Mound have not received dredged material in approximately three and 13, years respectively, it is expected that the benthic community will be comprised of mature, equilibrium (Stage III) assemblages and will have conditions comparable to those found at the reference areas; and
- The NL-06 Mound will display early recolonization assemblages (Stage I and early Stage II).

The NL-06 Mound was approximately 4 m in height, similar to the predicted height; but the overall footprint (575 m long x 250 m wide) was somewhat smaller than the predicted mound diameter of 500–600 m. There was no evidence of consolidation of the NL-91 and D/S Mound Complex and the USCGA Mound apparent in the 2007 bathymetric dataset.

Recolonization of the NL-91 and D/S Mound Complex and the USCGA Mound has continued as expected, with mature, Stage III communities found at almost every station on both mounds. The recent mound, NL-06, has also recovered from disposal-related disturbance with Stage III communities at every station and habitat conditions comparable to the reference stations.

Based on the findings of the 2007 NLDS survey, the following recommendations are proposed:

R1) Periodic bathymetric surveys should be conducted (as necessary) to monitor the morphology and stability of historical mounds and the formation of future mounds; and

R2) Periodic SPI/plan-view surveys should be conducted (as necessary) to monitor the recolonization of the NL-06 Mound and any future mounds based on future disposal activities at the site.

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Appendix A

Disposal Barge Log Summary for NLDS
August 2000 to August 2007

Project Name: CONNECTICUT RIVER
Permittee: RAGGED ROCK MARINA
Permit Number: 199802068

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
12/5/2000	350	268	41.26930	-72.07380	500	N
12/6/2000	350	268	41.26930	-72.07380	500	N
12/7/2000	350	268	41.26930	-72.07380	500	N
12/11/2000	300	229	41.26930	-72.07380	200	NE
12/13/2000	300	229	41.26930	-72.07380	200	NE
12/18/2000	300	229	41.26930	-72.07380	500	S
12/19/2000	350	268	41.26930	-72.07380	300	S
12/21/2000	350	268	41.26930	-72.07380	300	S
Total Dredged Material Volume	2,650	2,026				

Project Name: MUMFORD COVE
Permittee: MUMFORD COVE ASSOC
Permit Number: 199902434

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
1/12/2001	200	153	41.26920	-72.07428	NA	NA
1/14/2001	250	191	41.26920	-72.07428	NA	NA
1/15/2001	250	191	41.26920	-72.07428	NA	NA
1/18/2001	225	172	41.26920	-72.07428	NA	NA
1/19/2001	250	191	41.26920	-72.07428	NA	NA
1/22/2001	250	191	41.26920	-72.07428	NA	NA
1/23/2001	250	191	41.26920	-72.07428	NA	NA
1/24/2001	250	191	41.26920	-72.07428	NA	NA
1/29/2002	425	325	41.26897	-72.07442	NA	NA
1/29/2002	300	229	41.26897	-72.07442	NA	NA
1/30/2002	425	325	41.26897	-72.07442	NA	NA
1/31/2002	425	325	41.26897	-72.07442	NA	NA
2/1/2002	425	325	41.26897	-72.07442	NA	NA
2/1/2002	425	325	41.26897	-72.07442	NA	NA
2/3/2002	375	287	41.26885	-72.07446	NA	NA
2/8/2002	400	306	41.26897	-72.07442	NA	NA
2/8/2002	375	287	41.26897	-72.07442	NA	NA
2/9/2002	375	287	41.26897	-72.07442	NA	NA
2/9/2002	375	287	41.26897	-72.07442	NA	NA
2/10/2002	250	191	41.26897	-72.07442	NA	NA
Total Dredged Material Volume	6,500	4,970				

Project Name: NIANTIC BAY
Permittee: NIANTIC BAY YACHT CLUB
Permit Number: 199902732

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
4/8/2002	450	344	41.26883	-72.07484	NA	NA
4/9/2002	500	382	41.26833	-72.07400	NA	NA
4/10/2002	450	344	41.26933	-72.07400	NA	NA
4/10/2002	400	306	41.26917	-72.07400	NA	NA
4/11/2002	500	382	41.26900	-72.07417	NA	NA
4/11/2002	300	229	41.26900	-72.07433	NA	NA
3/10/2003	175	134	41.26897	-72.07442	NA	NA
3/11/2003	325	248	41.26897	-72.07446	NA	NA
Total Dredged Material Volume	3,100	2,370				

Project Name: TIDAL CREEK/HAMMONASSET RIVER
Permittee: RIVERSIDE BASIN MARINA
Permit Number: 200000248

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
4/17/2006	350	268	41.27050	-72.08082	1	NW
4/20/2006	425	325	41.27098	-72.08053	15	W
4/21/2006	375	287	41.27092	-72.08142	25	NW
4/25/2006	475	363	41.27100	-72.08087	5	N
4/26/2006	400	306	41.27033	-72.08137	5	W
4/28/2006	475	363	41.26993	-72.08083	20	SW
4/30/2006	550	421	41.27012	-72.08110	10	W
5/2/2006	550	421	41.27063	-72.08025	20	E
5/3/2006	550	421	41.27028	-72.08005	5	E
5/5/2006	500	382	41.27008	-72.08008	10	SE
5/6/2006	525	401	41.27010	-72.08003	15	E
5/7/2006	550	421	41.27000	-72.08017	20	SE
5/10/2006	575	440	41.27050	-72.08053	20	E
5/11/2006	525	401	41.27025	-72.08003	20	E
5/14/2006	575	440	41.27017	-72.08020	15	SE
5/15/2006	525	401	41.27067	-72.08033	25	E
5/18/2006	525	401	41.27005	-72.08013	20	SE
5/20/2006	525	401	41.27063	-72.08067	5	NE
5/24/2006	525	401	41.27047	-72.08032	30	E
5/26/2006	600	459	41.27088	-72.08018	5	N
5/27/2006	525	401	41.27018	-72.08043	5	E
5/28/2006	525	401	41.27022	-72.08010	5	E
5/29/2006	400	306	41.27047	-72.07988	5	NE
5/30/2006	375	287	41.27045	-72.07993	5	E
5/31/2006	575	440	41.27083	-72.08092	10	W
Total Dredged Material Volume	12,500	9,558				

Project Name: VENETIAN HARBOR
Permittee: STEPHEN BECKER
Permit Number: 200002193

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
1/27/2001	70	54	41.26920	-72.07428	0	NA
Total Dredged Material Volume	70	54				

Project Name: MYSTIC SHIPYARD
Permittee: MYSTIC SHIPYARD
Permit Number: 200100427

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/17/2002	200	153	41.26898	-72.07449	0	NA
10/18/2002	200	153	41.26897	-72.07442	0	NA
10/21/2002	200	153	41.26897	-72.07442	0	NA
10/22/2002	200	153	41.26897	-72.07442	0	NA
10/23/2002	150	115	41.26897	-72.07442	0	NA
10/24/2002	150	115	41.26897	-72.07442	0	NA
Total Dredged Material Volume	1,100	841				

Project Name: WEST COVE
Permittee: SPICERS MARINA LLC
Permit Number: 200100467

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
2/20/2003	400	306	41.26897	-72.07442	0	
2/21/2003	400	306	41.26897	-72.07442	0	
2/24/2003	350	268	41.26897	-72.07442	0	
2/26/2003	400	306	41.26897	-72.07442	0	
2/27/2003	400	306	41.26897	-72.07442	0	
3/4/2003	400	306	41.26897	-72.07442	0	
3/5/2003	400	306	41.26897	-72.07442	0	
3/6/2003	400	306	41.26897	-72.07442	0	
3/7/2003	400	306	41.26897	-72.07442	0	
3/8/2003	400	306	41.26897	-72.07442	0	
4/8/2004	400	306	41.26897	-72.07442		
4/9/2004	400	306	41.26897	-72.07442		
4/10/2004	400	306	41.26897	-72.07442		
4/12/2004	400	306	41.26897	-72.07442		
4/16/2004	400	306	41.26897	-72.07442		
4/20/2004	400	306	41.26897	-72.07442		
4/21/2004	400	306	41.26897	-72.07442		
4/23/2004	400	306	41.26897	-72.07442		
4/26/2004	400	306	41.26930	-72.07442		
4/27/2004	400	306	41.26930	-72.07442		
4/29/2004	400	306	41.26930	-72.07442		
5/4/2004	400	306	41.26897	-72.07442		
5/5/2004	400	306	41.26888	-72.07425		
5/6/2004	400	306	41.26883	-72.07417		
5/7/2004	400	306	41.26883	-72.07442		
5/10/2004	400	306	41.26893	-72.07425		
5/11/2004	400	306	41.26883	-72.07425		
5/12/2004	400	306	41.26883	-72.07425		
5/24/2004	200	153	41.26883	-72.07433	0	
5/25/2004	200	153	41.26882	-72.07783		
5/28/2004	200	153	41.26895	-72.07475		
5/31/2004	200	153	41.26883	-72.07433	0	
4/5/2005	350	268	41.27062	-72.08138	100	
4/6/2005	450	344	41.27062	-72.08138	50	S
4/7/2005	450	344	41.27062	-72.08138	100	S
4/11/2005	400	306	41.27062	-72.08138	50	S
4/12/2005	450	344	41.27062	-72.08138	100	S
4/13/2005	400	306	41.27062	-72.08138	50	S
4/14/2005	400	306	41.27062	-72.08138	100	S
4/19/2005	300	229	41.27062	-72.08138	30	S
4/26/2005	400	306	41.27062	-72.08138	25	S
4/27/2005	350	268	41.27062	-72.08138	50	S
4/28/2005	400	306	41.27062	-72.08138	75	S
4/29/2005	300	229	41.27062	-72.08138	75	S
5/3/2005	350	268	41.27062	-72.08138	50	N
5/3/2005	400	306	41.27062	-72.08138	50	S
5/4/2005	400	306	41.27062	-72.08138	75	S
5/10/2005	400	306	41.27062	-72.08138	25	N
5/11/2005	400	306	41.27062	-72.08138	25	N
5/13/2005	400	306	41.27062	-72.08138	50	N
5/16/2005	400	306	41.27062	-72.08138	50	N
5/18/2005	400	306	41.27062	-72.08138	25	N
5/19/2005	300	229	41.27062	-72.08138	25	N
5/31/2005	350	268	41.27062	-72.08138	50	N
Total Dredged Material Volume	20,400	15,598				

Project Name: GWENMOR MARINA
Permittee: GWENMOR MARINA
Permit Number: 200100530

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/1/2002	150	115	41.26897	-72.07442	0	NA
10/2/2002	150	115	41.26897	-72.07442	0	NA
10/3/2002	150	115	41.26897	-72.07442	0	NA
10/4/2002	150	115	41.26897	-72.07442	0	NA
10/5/2002	150	115	41.26902	-72.07442	0	NA
10/7/2002	150	115	41.26897	-72.07442	0	NA
10/8/2002	150	115	41.26897	-72.07467	0	NA
10/9/2002	150	115	41.26897	-72.07442	0	NA
10/10/2002	150	115	41.26897	-72.07442	0	NA
10/11/2002	150	115	41.26897	-72.07442	0	NA
10/13/2002	150	115	41.26897	-72.07442	0	NA
10/14/2002	150	115	41.26897	-72.07442	0	NA
10/15/2002	150	115	41.26897	-72.07442	0	NA
10/25/2002	150	115	41.26897	-72.07442	0	NA
10/27/2002	150	115	41.26897	-72.07442	0	NA
10/28/2002	150	115	41.26897	-72.07442	0	NA
10/30/2002	150	115	41.26897	-72.07442	0	NA
10/31/2002	150	115	41.26897	-72.07442	0	NA
11/4/2002	150	115	41.26897	-72.07442	0	NA
11/5/2002	150	115	41.26897	-72.07442	0	NA
11/9/2002	150	115	41.26897	-72.07442	0	NA
Total Dredged Material Volume	3,150	2,408				

Project Name: EXCAVATION CAD CELLS
Permittee: US DEPARTMENT OF THE NAVY
Permit Number: NAE20043047

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/18/2006	7,000	5,352	41.26505	-72.08327	95	N
10/18/2006	4,000	3,058	41.26757	-72.08350	100	N
10/18/2006	5,300	4,052	41.26715	-72.08322	100	N
10/19/2006	4,200	3,211	41.26685	-72.08305	100	N
10/19/2006	5,200	3,976	41.26770	-72.08368	100	N
10/19/2006	4,000	3,058	41.26807	-72.08368	see notes	N
10/19/2006	7,000	5,352	41.26798	-72.08355	see notes	N
10/20/2006	4,000	3,058	41.26775	-72.08312	see notes	N
10/20/2006	5,600	4,282	41.26800	-72.08357	see notes	
10/21/2006	6,000	4,588	41.26755	-72.08343	see notes	N
10/22/2006	4,100	3,135	41.26805	-72.08373	see notes	
10/22/2006	5,600	4,282	41.26750	-72.08380	see notes	N
10/22/2006	4,200	3,211	41.26777	-72.08453	see notes	NE
10/23/2006	7,000	5,352	41.26793	-72.08302	see notes	N
10/23/2006	4,000	3,058	41.26788	-72.08393	see notes	N
10/24/2006	4,000	3,058	41.26735	-72.08390	see notes	
10/24/2006	5,500	4,205	41.26762	-72.08320	see notes	N
10/24/2006	4,100	3,135	41.26763	-72.08390	see notes	N
10/25/2006	7,000	5,352	41.26763	-72.08360		N
10/25/2006	4,150	3,173	41.26777	-72.08670		N
10/26/2006	5,000	3,823	41.26777	-72.08372		N
10/26/2006	4,000	3,058	41.26769	-72.08345		N
10/26/2006	4,800	3,670	41.26777	-72.08380		N
10/26/2006	4,300	3,288	41.26770	-72.08353		N
10/26/2006	4,600	3,517	41.26760	-72.08372		N
10/27/2006	4,200	3,211	41.26765	-72.08365		N
10/27/2006	4,500	3,441	41.26738	-72.08367		N
10/27/2006	3,700	2,829	41.26750	-72.08383		N
10/30/2006	3,800	2,905	41.26705	-72.08360		N
10/30/2006	4,600	3,517	41.26773	-72.08365		N
10/30/2006	3,700	2,829	41.26762	-72.08313		N
10/30/2006	5,000	3,823	41.26752	-72.08355		N
10/31/2006	3,800	2,905	41.26748	-72.08362		NE
10/31/2006	4,400	3,364	41.26748	-72.08333		N
10/31/2006	3,700	2,829	41.26753	-72.08353		N
10/31/2006	4,600	3,517	41.26730	-72.08333		N
11/1/2006	3,800	2,905	41.26752	-72.08368		N
11/1/2006	4,600	3,517	41.26740	-72.08380		N
11/1/2006	3,700	2,829	41.26757	-72.08347		N
11/2/2006	4,600	3,517	41.26760	-72.08390		
11/2/2006	4,600	3,517	41.26758	-72.08360		
11/2/2006	3,600	2,753	41.26752	-72.08375		
11/3/2006	4,300	3,288	41.26745	-72.08340		N
11/3/2006	3,500	2,676	41.26745	-72.08347		NE
11/3/2006	4,400	3,364	41.26752	-72.08372		N
11/4/2006	3,400	2,600	41.26757	-72.08355		N
11/4/2006	4,400	3,364	41.26733	-72.08387		N
11/4/2006	800	612	41.26762	-72.08357		N
Total Dredged Material Volume	216,350	165,421				

Project Name: MARINA
Permittee: NOANK SHIPYARD
Permit Number: NAE20043061

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
8/26/2005	250	191	41.26755	-72.08370	50	S
8/21/2006	250	191	41.26755	-72.08370	50	S
8/21/2006	250	191	41.26755	-72.08370	25	S
8/22/2006	250	191	41.26755	-72.08370	25	S
8/23/2006	250	191	41.26755	-72.08370	50	S
8/23/2006	250	191	41.26755	-72.08370	25	S
8/24/2006	250	191	41.26755	-72.08370	25	S
8/24/2006	250	191	41.26755	-72.08370	25	S
8/25/2006	250	191	41.26755	-72.08370	25	S
8/29/2006	250	191	41.26755	-72.08370	50	S
8/30/2006	500	382	41.26717	-72.08333	30	SE
8/30/2006	250	191	41.26755	-72.08370	50	S
8/31/2006	250	191	41.26755	-72.08370	75	SE
8/31/2006	450	344	41.26700	-72.08367	10	S
9/1/2006	450	344	41.26717	-72.08350	60	ENE
9/1/2006	250	191	41.26755	-72.08370	150	SE
9/5/2006	250	191	41.26755	-72.08370	25	S
9/5/2006	400	306	41.26750	-72.08333	30	SSE
9/6/2006	250	191	41.26755	-72.08370	50	S
9/6/2006	400	306	41.26717	-72.08333	30	SE
9/7/2006	250	191	41.26755	-72.08370	50	S
9/7/2006	450	344	41.26733	-72.08367	25	SE
9/9/2006	250	191	41.26755	-72.08370	50	S
9/10/2006	400	306	41.26700	-72.08333	60	SE
9/11/2006	450	344	41.26733	-72.08333	70	SE
9/12/2006	250	191	41.26755	-72.08370	50	S
9/13/2006	400	306	41.26717	-72.08333	40	SSE
9/13/2006	250	191	41.26755	-72.08370	25	S
9/14/2006	400	306	41.26733	-72.08333	60	ESE
9/14/2006	250	191	41.26755	-72.08370	50	S
9/15/2006	400	306	41.26733	-72.08333	40	S
9/15/2006	250	191	41.26755	-72.08370	50	S
9/15/2006	450	344	41.26767	-72.08333	30	NE
9/16/2006	250	191	41.26755	-72.08370	15	S
9/17/2006	400	306	41.26733	-72.08333	20	SE
9/17/2006	200	153	41.26755	-72.08370	50	SE
9/18/2006	250	191	41.26755	-72.08370	50	S
9/19/2006	450	344	41.26717	-72.08333	30	ESE
9/19/2006	250	191	41.26755	-72.08370	50	S
9/19/2006	400	306	41.26750	-72.08267	40	ESE
9/20/2006	250	191	41.26755	-72.08370	50	S
9/21/2006	450	344	41.26717	-72.08300	30	SE
9/21/2006	250	191	41.26755	-72.08370	50	S
9/22/2006	400	306	41.26717	-72.08283	25	S
9/22/2006	250	191	41.26755	-72.08370	25	S
9/23/2006	350	268	41.26750	-72.08267	30	NE
9/25/2006	250	191	41.26755	-72.08370	50	S
9/25/2006	400	306	41.26683	-72.08283	50	SSE
9/26/2006	250	191	41.26755	-72.08370	25	S
Total Dredged Material Volume	15,450	11,813				

Project Name: ALLYN'S POINT PLANT
Permittee: DOW CHEMICAL CO.
Permit Number: NAE2004307

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/5/2006	5500	4,205	41.26753	-72.08373	50	W
10/5/2006	3500	2,676	41.26747	-72.08450	75	W
10/6/2006	6000	4,588	41.26753	-72.08418	25	E
10/6/2006	4000	3,058	41.26845	-72.08445	5	E
10/6/2006	3500	2,676	41.26752	-72.08535	7	W
10/7/2006	3500	2,676	41.28290	-72.08367	1	E
10/7/2006	3600	2,753	41.26817	-72.08507	1	
10/7/2006	5300	4,052	41.26823	-72.08382	20	
10/8/2006	5300	4,052	41.26762	-72.08370		
10/8/2006	3700	2,829	41.26805	-72.08363		
10/9/2006	5600	4,282	41.26725	-72.08372		
10/9/2006	3800	2,905	41.26807	-72.08368	0	
10/9/2006	4500	3,441	41.26790	-72.08405	0	
10/10/2006	3500	2,676	41.26788	-72.09958	0	
10/10/2006	5500	4,205	41.26793	-72.08397	3	E
10/10/2006	3700	2,829	41.26798	-72.08332	no buoy	
10/10/2006	4700	3,594	41.26713	-72.08483	no buoy	
10/11/2006	4000	3,058	41.26765	-72.08330	no buoy	
10/11/2006	5500	4,205	41.26827	-72.08417	no buoy	
10/11/2006	3700	2,829	41.26792	-72.08378	no buoy	
10/11/2006	5300	4,052	41.26757	-72.08412	no buoy	
10/12/2006	3500	2,676	41.26717	-72.08398	no buoy	
10/12/2006	5200	3,976	41.26803	-72.08353	no buoy	
10/12/2006	3200	2,447	41.26718	-72.08460	0	
10/13/2006	5400	4,129	41.26718	-72.08480	0	
Total Dredged Material Volume	111,000	84,871				

Project Name: MARINA
Permittee: HARBOR ONE MARINA
Permit Number: NAE20044113

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/3/2006	300	229.38	41.26748	-72.08367	30	
10/4/2006	350	267.61	41.26755	-72.08363	25	
10/5/2006	500	382.3	41.26755	-72.08367	30	
10/6/2006	500	382.3	41.26755	-72.08363	25	
10/9/2006	500	382.3	41.26755	-72.08392	0	
10/10/2006	500	382.3	41.26755	-72.08400	0	
10/12/2006	500	382.3	41.26755	-72.08367	0	
10/13/2006	450	344.07	41.26755	-72.08633	0	
10/14/2006	400	305.84	41.26755	-72.08362	0	
Total Dredged Material Volume	4,000	3,058				

Project Name: PINE ISLAND BAY
Permittee: SHENNECOSETT YACHT CLUB
Permit Number: NAE2004744

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/17/2006	450	344	41.26755	-72.08417	0	NA
10/18/2006	500	382	41.26755	-72.08400	0	NA
10/19/2006	400	306	41.26750	-72.08392	0	NA
10/19/2006	500	382	41.26758	-72.08383	0	NA
10/19/2006	450	344	41.26755	-72.08363	0	NA
Total Dredged Material Volume	2,300	1,759				

Project Name: MYSTIC RIVER
Permittee: LIGNUM VITAE LLC/SCHOONER WHARF
Permit Number: NAE20051661

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
9/27/2006	450	344	41.26717	-72.08333	40	SSE
9/28/2006	400	306	41.26717	-72.08367	30	SSW
9/29/2006	500	382	41.26717	-72.08300	30	SSE
10/2/2006	450	344	41.26700	-72.08333	50	SSE
10/3/2006	400	306	41.26717	-72.08333	30	SE
10/4/2006	500	382	41.26733	-72.08317	30	SE
10/5/2006	450	344	41.26717	-72.08300	30	ESE
10/6/2006	450	344	41.26667	-72.08333	40	S
10/8/2006	450	344	41.26733	-72.08333	NA	
10/9/2006	500	382	41.26733	-72.08333	NA	
10/10/2006	450	344	41.26700	-72.08350	NA	
10/11/2006	450	344	41.26767	-72.08333	NA	
10/12/2006	500	382	41.26767	-72.08333	NA	
10/13/2006	450	344	41.26717	-72.08367	NA	
Total Dredged Material Volume	6,400	4,893				

Project Name: MARINA
Permittee: SPICER'S MARINA
Permit Number: NAE20052676

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/2/2006	300	229	41.26755	-72.08370	25 ft	S
10/3/2006	350	268	41.26755	-72.08370	25 ft	S
10/4/2006	350	268	41.26755	-72.08370	25 ft	S
10/5/2006	350	268	41.26755	-72.08370	25 ft	S
10/8/2006	300	229	41.26755	-72.08370	No buoy	
10/9/2006	300	229	41.26755	-72.08370	No buoy	
10/10/2006	300	229	41.26755	-72.08370	No buoy	
10/12/2006	300	229	41.26755	-72.08370	No buoy	
10/13/2006	350	268	41.26755	-72.08370	No buoy	
10/16/2006	350	268	41.26755	-72.08370	No buoy	
10/18/2006	350	268	41.26755	-72.08370	No buoy	
10/19/2006	400	306	41.26755	-72.08370	No buoy	
10/27/2006	350	268	41.26755	-72.08370	No buoy	
Total Dredged Material Volume	4,350	3,326				

Project Name: THAMES RIVER, MONTVILLE CT
Permittee: WATERFRONT REALTY INC.
Permit Number: NAE20053589

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/2/2006	600	459	41.26880	-72.08370	165	NW
10/3/2006	600	459	41.26887	-72.08397	90	NW
10/5/2006	550	421	41.26970	-72.08337	90	N
10/7/2006	400	306	41.26870	-72.08258	75	NE
10/10/2006	500	382	41.26830	-72.08163	120	N
10/15/2006	600	459	41.26883	-72.08400		
10/17/2006	325	248	41.26772	-72.08408	105	N
10/18/2006	600	459	41.26875	-72.08383	90	NE
Total Dredged Material Volume	4,175	3,192				

Project Name: THAMES RIVER
Permittee: GENERAL DYNAMICS/ELECTRIC BOAT
Permit Number: NAE20061673

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/2/2006	1,160	887	41.26667	-72.08450	220	*
10/5/2006	1,000	765	41.26683	-72.08333	250	*
Total Dredged Material Volume	2,160	1,652				

Project Name: STONINGTON HARBOR
Permittee: DODSON BOAT YARD
Permit Number: NAE20063246

Disposal Date	Volume (yd^3)	Volume (m^3)	Disposal Latitude (degrees)	Disposal Longitude (degrees)	Approximate Distance from Buoy (ft)	Approximate Direction from Buoy
10/16/2006	650	497	41.26767	-72.08333	NA	
10/16/2006	400	306			NA	
10/17/2006	400	306	41.26767	-72.08367	NA	
10/18/2006	450	344	41.26750	-72.08333	NA	
10/19/2006	300	229	41.26767	-72.08333	NA	
10/20/2006	300	229	41.26750	-72.08333	NA	
10/21/2006	300	229	41.26767	-72.08383	NA	
10/22/2006	300	229	41.26750	-72.08383	NA	
10/25/2006	300	229	41.26717	-72.08383	NA	
10/26/2006	300	229	41.26733	-72.08383	NA	
Total Dredged Material Volume	3,700	2,829				

Appendix B

Sediment-Profile Image Results for NLDS
August 2007 Survey

Appendix B-1
Grain Size Scale for Sediments

Phi (Φ) size	Size range (mm)	Size class (Wentworth class)
< -1	> 2	Gravel
0 to –1	1 to 2	Very coarse sand
1 to 0	0.5 to 1	Coarse sand
2 to 1	0.25 to 0.5	Medium sand
3 to 2	0.125 to 0.25	Fine sand
4 to 3	0.0625 to 0.125	Very fine sand
> 4	< 0.0625	Silt/clay

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area		Total DM Mean		Total DM Min		Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
NL06-01	A	8/26/2007	4:20	14.0	2	14.46	3 to 2/>4	0	>4	>4 to 0	184.22	12.7	12.4	13.2	0.9	Physical	13.23	0.9	0		No	184.22	>	12.7	>	12.4	>	13.2	No	n	3	2.5	4.9	3.7	3	DM>pen; Sand/clay=thin surf lyr of shell frags+fine sand over light brown clay; shell-sand lag deposit?; low contrast/difficult rpd; brown streaks in DM
NL06-01	B	8/26/2007	4:21	14.0	2	14.44	>4	2	>4	>4 to 2	191.27	13.2	12.0	15.0	3.0	Physical	10.95	0.8	0		No	191.27	>	13.2	>	12.0	>	15.0	No	n	1	2.3	2.3	2.3	2 -> 3	DM>pen; Light brown-grayish cohesive clay w/ homogenous texture; hummocky surface; brown patches@depth=red clay or organic matter; low contrast rpd; 1 few shell frags; 1 small/partial void
NL06-01	C	8/26/2007	4:22	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	185.14	12.8	12.4	13.7	1.3	Physical	30.22	2.1	7	o	No	185.14	>	12.8	>	12.4	>	13.7	No	n	1	3.4	3.7	3.6	3	DM>pen; Surf lyr/veneer of shells+sand over light brown cohesive clay; shell-sand lag deposit; low rpd contrast; several small voids/burrows with brown patches@depth
NL06-02	A	8/26/2007	3:47	14.0	2	14.44	3 to 2/>4	-1	>4	>4 to -1	234.06	16.2	15.8	16.8	1.0	Physical	37.18	2.6	0		No	234.06	>	16.2	>	15.8	>	16.8	No	n	0				1 -> 2	DM>pen; S/M layering=upper 2-3 cm is fine sand w/ shell frags over cohesive brown-grey clay DM; winnowed surface; low contrast rpd; not much evidence of bio. activity
NL06-02	B	8/26/2007	3:48	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	238.61	16.5	16.0	17.1	1.2	Biological	26.71	1.8	3	o	No	238.61	>	16.5	>	16.0	>	17.1	No	n	1	3.8	4.0	3.9	1 on 3	DM>pen; S/M layering=3-4 cm is fine sand w/ shell hash over brown-grey cohesive clay DM; slight lag deposit; light RPD contrast (low organics), evidence of burrows and some subsurface worms against faceplate
NL06-02	C	8/26/2007	3:49	14.0	2	14.46	4 to 3 />4	-1	>4	>4 to -1	241.97	16.7	16.5	17.3	0.8	Biological	23.03	1.6	1	o	No	241.97	>	16.7	>	16.5	>	17.3	No	n	0				1 on 3	DM>pen; faint layer-cake layering=multiple dm lyrs; low rpd contrast; significant sand in upper 2-4 cm, edge of voids and burrows transected at depth
NL06-03	A	8/26/2007	4:34	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	233.68	16.2	15.7	16.6	0.9	Biological	33.3	2.3	0		No	233.68	>	16.2	>	15.7	>	16.6	No	n	3	1.8	3.7	2.7	1 on 3	DM>pen; S/M layering=upper 2-3 cm is fine sand w/ shell frags over brown-grey clay DM; shallow voids/burrows; low contrast rpd
NL06-03	B	8/26/2007	4:34	14.0	2	14.46	4 to 3 />4	-1	>4	>4 to -1	224.59	15.5	14.8	16.1	1.4	Biological	27.35	1.9	0		No	224.59	>	15.5	>	14.8	>	16.1	No	n	2	1.7	2.5	2.1	1 on 3	DM>pen; at least 2 DM layers; S/M layering=upper 2 cm is fine sand w/ shell frags over cohesive clay DM; shallow voids; low/indistinct rpd contrast; wood frag@swi
NL06-03	C	8/26/2007	4:35	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	220.08	15.2	14.6	15.5	1.0	Physical	18.35	1.3	0		No	220.08	>	15.2	>	14.6	>	15.5	No	n	2	4.0	5.2	4.6	1 on 3	DM>pen; S/M layering=upper 2-3 cm is fine sand w/ shell frags over brown-grey clay; indistinct rpd w/ low contrast; shallow voids; brown patches
NL06-04	A	8/26/2007	4:04	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	239.62	16.6	16.1	16.8	0.7	Biological	27.61	1.9	0		No	239.62	>	16.6	>	16.1	>	16.8	No	n	2	4.2	7.3	5.8	1 on 3	DM>pen; S/M=upper 2-3 cm is silty fine sand w/ shell frags over cohesive brown-tan clay DM; numerous surf tubes; weak+indistinct rpd contrast; shallow voids
NL06-04	B	8/26/2007	4:05	14.0	2	14.46	3 to 2/>4	<-1	>4	>4 to <-1	190.28	13.2	12.7	14.0	1.3	Physical	10.64	0.7	10	o	No	190.28	>	13.2	>	12.7	>	14.0	No	n	0				1	DM>pen; S/M upper 2-4 is fine sand w/ silt+shell frags over unique reddish-brown silt-clay DM; reddish-brown w/ wood or plant fiber; wiper clasts on surface (artifacts)
NL06-04	C	8/26/2007	4:06	14.0	2	14.46	3 to 2/>4	<-1	>4	>4 to <-1	162.91	11.3	10.7	11.6	0.9	Physical	16.22	1.1	7	o+r	No	162.91	>	11.3	>	10.7	>	11.6	No	n	0				2 -> 3	DM>pen; thin surface veneer of fine sand+shell frags over tan+black clayey DM; shell+sand lag deposit; streaky dm.
NL06-05	A	8/26/2007	4:39	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	223.2	15.4	13.9	16.4	2.5	Biological	11.36	0.8	0		No	223.2	>	15.4	>	13.9	>	16.4	No	n	0				1 on 3	DM>pen; S/M=sed surf+upper 2-4 fine sand grading into clayey DM; DM is reduced@depth; vertical burrow opening; surf tubes; shell+sand lag deposit.
NL06-05	B	8/26/2007	4:40	14.0	2	14.44	3 to 2/>4	-1	>4	>4 to -1	234.02	16.2	16.1	16.6	0.5	Physical	7.47	0.5	0		No	234.02	>	16.2	>	16.1	>	16.6	No	n	0				2	DM>pen; S/M=upper 2-4 cm is fine sand over tan=grey clayey DM; shell+sand lag deposit; reduced patches@depth
NL06-05	C	8/26/2007	4:41	14.0	2	14.46	3 to 2/>4	0	>4	>4 to 0	247.16	17.1	16.7	17.3	0.6	Physical	11.64	0.8	0		No	247.16	>	17.1	>	16.7	>	17.3	No	n	0				2	DM>pen; multiple DM layers/horizons; S/M=upper 2-4 cm is fine sand W/ shells over silt-clay dm; reduced/black@depth; shell+sand lag deposit; shallow burrowing worms visible in 3-6 cm subsurface range
NL06-06	A	8/26/2007	4:43	14.0	2	14.46	>4	0	>4	>4 to 0	201.35	13.9	13.4	14.3	0.9	Physical	8.37	0.6	1	r	No	201.35	>	13.9	>	13.4	>	14.3	No	n	0				1 -> 2	DM>pen; multi-colored consolidated clay=brown+grey+tan+dark patches; sed surface looks sand w/ shells=lag deposit; a few tubes@swi and some small worms at depth
NL06-06	B	8/26/2007	4:44	14.0	2	14.46	>4	<-1	>4	>4 to <-1	192.72	13.3	12.8	14.5	1.7	Physical	7.8	0.5	9	r	No	192.72	>	13.3	>	12.8	>	14.5	No	n	2	2.3	3.5	2.9	1 on 3	DM>pen; S/M=surf layer of sand+dense shell frags over light tan clay DM; 2 shallow voids; shell+sand lag deposit
NL06-06	C	8/26/2007	4:45	14.0	2	14.45	>4	0	>4	>4 to 0	254.37	17.6	17.4	18.3	0.9	Physical	25.88	1.8	0		No	254.37	>	17.6	>	17.4	>	18.3	No	n	0				1 -> 2	DM>pen; S/M=surf layer of sand+shell frags grading into light grey clay DM; patch of reddish sed@depth; surf tubes and some shallow subsurface worms
NL06-07	A	8/26/2007	3:51	14.0	2	14.45	3 to 2/>4	-1	>4	>4 to -1	182.06	12.6	12.1	13.1	0.9	Biological	13.26	0.9	1	r	No	182.06	>	12.6	>	12.1	>	13.1	No	n	0				1 -> 2	DM>pen; S/M=upper 2-3 is fine sand/sandy w/ shell frags over uniform tan cohesive clay DM; shell+sand lag deposit; surf tubes; edge of void chamber transected on right

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area	Total DM Mean	Total DM Min	Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
NL06-07	B	8/26/2007	3:52	14.0	2	14.45	3 to 2/>4	-1	>4	>4 to -1	206.29	14.3	13.6	15.0	1.5	Biological	21.39	1.5	0		No	206.29	> 14.3	> 13.6	> 15.0	No	n	3	1.6	12.7	7.2	1 on 3	DM>pen; S/M=upper 2-4 cm is fine sand w/ shell frags grading into consolidated light grey clay@depth; 1 shallow+2 deep voids; slight surface shell+sand lag deposit
NL06-07	C	8/26/2007	3:53	14.0	2	14.45	>4	2	>4	>4 to 2	137.03	9.5	8.7	10.8	2.2	Physical	20.17	1.4	0		No	137.03	> 9.5	> 8.7	> 10.8	No	n	3	1.0	3.8	2.4	1 on 3	DM>pen; uniform light tan cohesive clay DM>pen (no surface sand or shells); sparse Ampelisca tubes+worm tubes+3 shallow voids; wood twig@swi left
NL06-08	A	8/26/2007	4:00	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	253.11	17.5	17.2	17.9	0.7	Biological	31.52	2.2	0		No	253.11	> 17.5	> 17.2	> 17.9	No	n	2	3.5	15.7	9.6	1 on 3	DM>pen; distinct S/M layering=6 cm surface layer of fine sand DM over tan cohesive clay DM w/ reduced patches; 1 shallow void in sand and one deep void lwr left corner.
NL06-08	B	8/26/2007	4:01	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	222.69	15.4	14.8	15.9	1.1	Biological	18.11	1.3	0		No	222.69	> 15.4	> 14.8	> 15.9	No	n	0				1 on 3	DM>pen; S/M=upper 2-4 cm is fine sand w/ shell frags over grey-tan-black cohesive clay DM; shell-sand lag deposit ; reduced sed horizon@depth; edge of burrow transected at depth
NL06-08	C	8/26/2007	4:01	14.0	2	14.46	>4	-1	>4	>4 to -1	205.45	14.2	13.1	14.9	1.8	Biological	34.66	2.4	15	o+r	No	205.45	> 14.2	> 13.1	> 14.9	No	n	0				2 -> 3	DM>pen; sed surf is somewhat sandy but not continuous layer; mostly grey/black cohesive clay DM; sulfidic black band@depth; vertical "burrow" is dragdown artifact; a few Ampelisca tubes, transected burrow on left
NL06-09	A	8/26/2007	4:24	14.0	2	14.46	3 to 2/>4	0	>4	>4 to 0	233.67	16.2	15.9	16.7	0.9	Biological	26.17	1.8	2	o	No	233.67	> 16.2	> 15.9	> 16.7	No	n	1	4.6	4.6	4.6	3	DM>pen; S/M=upper 1-2 cm is sandy (silty fine sand w/ shells) grading into homogenous cohesive tan clay DM; 1 small/indistinct void; a few Ampelisca tubes@surf; shell+sand @swi
NL06-09	B	8/26/2007	4:25	14.0	2	14.46	>4	0	>4	>4 to 0	228.72	15.8	15.3	17.0	1.7	Physical	23.95	1.7	10	o	No	228.72	> 15.8	> 15.3	> 17.0	No	n	2	4.9	5.7	5.3	3	DM>pen=tan-brown-grey cohesive clay DM; sed surf has some fine sand and shells; collapsed Ampelisca tubes@surf; vertical burrow@far left+2 voids
NL06-09	C	8/26/2007	4:26	14.0	2	14.46	>4	1	>4	>4 to 1	244.05	16.9	16.4	17.3	1.0	Physical	4.96	0.3	1	o	No	244.05	> 16.9	> 16.4	> 17.3	No	n	0				2	DM>pen; cohesive clay=black/sulfidic patches+tan/grey patches; a few shell frags@surf; small/short Ampelisca tubes in farfield. Transected burrowns and small worms in subsurface against faceplate
NL06-10	A	8/26/2007	4:11	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	225.94	15.6	15.4	16.1	0.7	Physical	27.92	1.9	0		No	225.94	> 15.6	> 15.4	> 16.1	No	n	1	4.4	4.7	4.6	1 on 3	DM>pen; S/M=upper 2-3 cm is fine sand w/ shells grading into reduced cohesive clay; shell+sand lag deposit; large-bodied red organism@subsurface left=Stg 3
NL06-10	B	8/26/2007	4:11	14.0	2	14.46	3 to 2/>4	0	>4	>4 to 0	196.08	13.6	12.9	14.0	1.1	Physical	32.6	2.3	0		No	196.08	> 13.6	> 12.9	> 14.0	No	n	0				1 on 3	DM>pen; S/M=upper 2-4 cm is fine sand w/ shells grading into reduced cohesive clay; shell+sand lag ; stg 3 poly@depth; strong rpd contrast
NL06-10	C	8/26/2007	4:12	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	196.77	13.6	13.0	14.1	1.1	Physical	34.96	2.4	0		No	196.77	> 13.6	> 13.0	> 14.1	No	n					1 on 3	DM>pen; S/M=upper 2-4 cm is fine sand w/ shells grading into reduced cohesive black-tan clay; multiple depositional layers; shell+sand lag ; transected burrow on left
NL06-11	A	8/26/2007	3:56	14.0	2	14.46	>4	<-1	>4	>4 to <-1	200.84	13.9	13.6	14.4	0.8	Physical	14.2	1.0	0		No	200.84	> 13.9	> 13.6	> 14.4	No	n	1	4.2	4.6	4.4	1 on 3	DM>pen; DM is light grey cohesive clay w/ small brown patches; sed surface is fine sand armored w/ shells ; 1 indistinct void and several transected burrow edges
NL06-11	B	8/26/2007	3:56	14.0	2	14.46	>4	<-1	>4	>4 to <-1	128.49	8.9	8.4	9.3	0.9	Physical	9.65	0.7	0		No	128.49	> 8.9	> 8.4	> 9.3	No	n	0				2	DM>pen; S/M=sed surface+upper 1-2 cm is fine sand w/ abundant shells+hash+gravel over tan/grey clay w/ reddish-brown patches; woody twig@swi; armored surface.
NL06-11	C	8/26/2007	3:57	14.0	2	14.46	>4	<-1	>4	>4 to <-1	199.4	13.8	13.3	14.3	1.0	Physical	20.5	1.4	0		No	199.4	> 13.8	> 13.3	> 14.3	No	n	0				2 -> 3	DM>pen; sed surf is thin veneer of fine sand+shells over grey/tan cohesive clay w/ brown patches; some small worms at depth, burrow edge appears transected in lower right quadrant
NL06-12	A	8/26/2007	4:30	14.0	2	14.46	>4	1	>4	>4 to 1	206.53	14.3	13.7	14.7	1.0	Biological	31.26	2.2	1	o	No	206.53	> 14.3	> 13.7	> 14.7	No	n	1	4.8	5.6	5.2	1 on 3	DM>pen; light tan cohesive clay w/ a few brown+dark patches; shell@swi+slightly sandy; low rpd contrast; prominent stg 3 feeding void+scattered surf tubes
NL06-12	B	8/26/2007	4:31	14.0	2	14.46	>4	1	>4	>4 to 1	227.42	15.7	14.6	16.5	1.8	Physical	ind	ind	0		No	227.42	> 15.7	> 14.6	> 16.5	No	n	2	4.7	6.4	5.6	1 on 3	DM>pen; grey-light brown cohesive clay w/ some dark/sulfidic patches; shells@swi; 2 void-like openings, sediment disturbed by dragdown of shells, disrupting RPD and preventing measurement
NL06-12	C	8/26/2007	4:31	14.0	2	14.46	>4	1	>4	>4 to 1	184.33	12.7	11.2	13.8	2.6	Physical	17.32	1.2	5	o	No	184.33	> 12.7	> 11.2	> 13.8	No	n	1	1.4	2.3	1.9	2 -> 3	DM>pen; tan-brown somewhat sandy cohesive clay w/ brown patches; shell frags+decayed leaf@swi; shallow feeding void below leaf; low rpd contrast; larval fish@swi@left

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area	Total DM Mean	Total DM Min	Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
NL06-13	A	8/26/2007	4:16	14.0	2	14.46	>4	1	>4	>4 to 1	171.94	11.9	11.3	12.7	1.3	Physical	25.07	1.7	10	o	No	171.94	> 11.9	> 11.3	> 12.7	No	n	0				2	DM > pen; tan-grey cohesive clay w/ black/sulfidic patches; surface veneer of sand+numerous shells+cohesive clay clasts@swi=lag deposit; low rpd contrast
NL06-13	B	8/26/2007	4:17	14.0	2	14.46	>4	-1	>4	>4 to -1	207.12	14.3	13.8	15.2	1.4	Physical	27.16	1.9	0		No	207.12	> 14.3	> 13.8	> 15.2	No	n	2	3.3	4.0	3.6	3	DM > pen; S/M=surface veneer of fine sand+shells@swi over tan-grey cohesive clay w/ black patches; low rpd contrast; 2 subsurface feeding voids; sand+shell lag deposit
NL06-13	C	8/26/2007	4:17	14.0	2	14.46	3 to 2/>4	-1	>4	>4 to -1	199.2	13.8	13.2	14.6	1.4	Biological	30.55	2.1	0		No	199.2	> 13.8	> 13.2	> 14.6	No	n	1	3.2	3.4	3.3	1 on 3	DM > pen; S/M=surface veneer+upper 1-3 cm is fine sand+shells tan-grey cohesive clay w/ faint black/sulfidic horizons; 1 wiper clast; low rpd contrast; shell+sand lag deposit; 1 subsurface void
NL06-14	A	8/26/2007	3:38	14.0	2	14.46	>4	<-1	>4	>4 to -1	157.53	10.9	10.1	11.9	1.7	Biological	1.53	0.1	0		No	157.53	> 10.9	> 10.1	> 11.9	No	n	3	2.7	3.7	3.2	1 on 3	DM > pen; sed surface is sandy w/ numerous shell frags+small detritus-covered tubes over cohesive tan clay; clay=uniform color with thin veneer of low contrast oxidized sediment on surface (recent winnowing of fines). Several feeding voids & transected burrows
NL06-14	B	8/26/2007	3:39	14.0	2	14.46	>4	<-1	>4	>4 to <-1	186.61	12.9	12.5	13.9	1.4	Physical	26.49	1.8	0		No	186.61	> 12.9	> 12.5	> 13.9	No	n	4	2.7	5.0	3.8	1 on 3	DM > pen; light tan-grey consolidated clay w/ uniform color+texture; swi is sandy w/ shells+tubes=lag deposit; low rpd contrast; prominent subsurface voids
NL06-14	C	8/26/2007	3:40	14.0	2	14.46	>4	0	>4	>4 to 0	238.55	16.5	15.4	17.0	1.6	Physical	40.75	2.8	0		No	238.55	> 16.5	> 15.4	> 17.0	No	n	0				1 on 3	DM > pen; uniform light tan-grey consolidated silt-clay; dragdown of a few small shell frags; wiper clasts; edge of oxygenated burrow halos at depth
NL06-15	A	8/26/2007	4:47	14.0	2	14.46	>4	1	>4	>4 to 1	228.01	15.8	14.9	16.7	1.8	Physical	34.96	2.4	0		No	228.01	> 15.8	> 14.9	> 16.7	No	n	2	1.2	2.8	2.0	1 on 3	DM > pen; light tan/grey consolidated silt-clay; sand patch@surf+sandy/shelly swi=lag deposit; 2 indistinct shallow voids and transected burrows at depth
NL06-15	B	8/26/2007	4:48	14.0	2	14.46	>4	<-1	>4	>4 to -1	212.59	14.7	14.4	15.1	0.7	Physical	35.2	2.4	1	o	No	212.59	> 14.7	> 14.4	> 15.1	No	n	1	5.2	5.5	5.3	1 on 3	DM > pen; light tan/grey uniform consolidated clay; veneer of sand+shells+large consolidated clay clast@swi=lag deposit; large vertical burrow is dragdown artifact+1 distinct feeding void.
NL06-15	C	8/26/2007	4:49	14.0	2	14.46	>4	<-1	>4	>4 to <-1	189.48	13.1	12.3	14.4	2.1	Physical	24.06	1.7	0		No	189.48	> 13.1	> 12.3	> 14.4	No	n	1	2.0	2.3	2.2	2 -> 3	DM > pen; light tan/grey uniform consolidated clay w/ brown-reddish patches; shell+sand@swi=lag deposit; 1 shallow indistinct void.
DS-01	B	8/26/2007	1:52	15.0	4	14.46	3 to 2	<-1	>4	>4 to <-1	83.27	5.8	5.0	6.5	1.5	Physical	31.72	2.2	0		No	83.27	> 5.8	> 5.0	> 6.5	No	2-3 dead shells	0				2	DM > pen; poorly sorted mix of fine to medium sand w/ grey silt-clay patches+gravel@swi; mussel shells+gravel@swi=lag deposit; encrusting epifuana on shells/gravel.
DS-01	E	8/26/2007	3:13	17.0	5	14.44	3 to 2/>4	<-1	>4	>4 to <-1	151.06	10.5	9.9	11.4	1.6	Physical	18.87	1.3	0		No	151.06	> 10.5	> 9.9	> 11.4	No	1 dead shell	0				2 -> 3	DM > pen; indistinct S/M layering=mix of fine-to-medium sand w/ shell frags grading into grey silt-clay; epifauna-encrusted shells+gravel@swi over sand.
DS-01	F	8/26/2007	3:13	17.0	5	14.46	2 to 1	<-1	>4	>4 to <-1	114.73	7.9	6.3	9.2	2.9	Physical	37.01	2.6	0		No	114.73	> 7.9	> 6.3	> 9.2	No	n	0(?)				2	DM > pen; poorly sorted mix of fine-to-medium w/ gravel+subsurface patches of grey silt-clay; 1 void in silt under sand surface layer; sed surface armored by shell frags, medium sand, and gravel; low contrast rpd
DS-02	B	8/26/2007	1:06	14.0	3	14.46	3 to 2	<-1	>4	>4 to <-1	129.45	9.0	8.3	9.5	1.2	Physical	50.23	3.5	0		No	129.45	> 9.0	> 8.3	> 9.5	No	1 dead shell	0				2	DM > pen; mostly fine sand mixed w/ grey silt-clay@depth; swi has lag deposit of sand, gravel and shell frags; low rpd contrast; encrusting epifauna on gravel+shells
DS-02	C	8/26/2007	1:08	14.0	3	14.46	3 to 2	-1	>4	>4 to -1	114.51	7.9	7.3	8.1	0.7	Physical	42.88	3.0	0		No	114.51	> 7.9	> 7.3	> 8.1	No	n	0				2	DM > pen; mostly fine to medium sand mixed with grey silt-clay@depth; S/M stratigraphy; scattered gravel w/ attached hyroids@swi; moderate rpd contrast
DS-02	D	8/26/2007	3:06	17.0	5	14.49	3 to 2	<-1	>4	>4 to <-1	110.79	7.6	7.1	8.0	0.9	Physical	52.23	3.6	0		No	110.79	> 7.6	> 7.1	> 8.0	No	n	0				2 -> 3	DM > pen; mostly fine to medium sand w/ gravel+patches of grey silt-clay@depth; shell frags+gravel+sand@swi; poorly sorted sandy DM
DS-03	C	8/26/2007	12:51	14.0	3	14.46	3 to 2/>4	<-1	>4	>4 to <-1	188.05	13.0	12.7	13.1	0.4	Physical	39.33	2.7	0		Yes	188.05	> 13.0	> 12.7	> 13.1	No	n	3	6.1	9.8	7.9	3	DM > pen; distinct S/M layering=upper 4-5 cm is clean fine sand over black/sulfidic silt-clay; pocket of methane bubbles; infaunal burrow at left, a few tubes@swi; strong rpd contrast
DS-03	D	8/26/2007	12:52	14.0	3	14.44	3 to 2/>4	<-1	>4	>4 to <-1	96.45	6.7	6.4	6.7	0.4	Physical	10.91	0.8	0		No	96.45	> 6.7	> 6.4	> 6.7	No	n	0				1 -> 2	DM > pen; distinct S/M layering=upper 2-3 cm is light-colored fine sand w/ some gravel over black/sulfidic silt-clay; sand+gravel@swi=lag deposit; thin rpd w/ strong contrast
DS-03	G	8/26/2007	3:03	17.0	5	14.46	3 to 2/>4	-1	>4	>4 to -1	151.42	10.5	10.3	10.7	0.3	Physical	29.99	2.1	0		No	151.42	> 10.5	> 10.3	> 10.7	No	n	0				1 on 3	DM > pen; distinct S/M layering=upper 2-3 cm is light-colored fine sand w/ some gravel+shells over black/sulfidic silt-clay; 2 subsurface Stg 3 worms lower left; strong rpd contrast
DS-04	A	8/26/2007	2:22	15.0	4	14.46	3 to 2/>4	0	>4	>4 to 0	209.17	14.5	14.0	15.2	1.2	Physical	25.68	1.8	0		No	209.17	> 14.5	> 14.0	> 15.2	No	5 dead shells	2	9.5	11.8	10.6	1 on 3	DM > pen; S/M layering=variable 1-2 cm surface layer of fine sand over patchy grey silt-clay mixed with fine sand; dead mussel shells@swi; epifauna on shells.

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area	Total DM Mean	Total DM Min	Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
DS-04	B	8/26/2007	2:23	15.0	4	14.46	>4	-1	>4	>4 to -1	145.07	10.0	9.1	10.6	1.5	Biological	29.13	2.0	0		No	145.07	> 10.0	> 9.1	> 10.6	No	>15 dead shells	2	9.2	10.9	10.0	1 on 3	DM > pen; dense mussel shell bed over sandy sed surface over dark-grey silt-clay; vertical burrow@left+2 indistinct voids in lower corners.
DS-04	C	8/26/2007	2:24	15.0	4	14.49	>4	-1	>4	>4 to -1	165.29	11.4	11.2	12.1	0.9	Biological	31.41	2.2	0		No	165.29	> 11.4	> 11.2	> 12.1	No	>7 dead shells	0				1 on 3	DM > pen; dense mussel shell bed over sandy sed surfaced over dark-grey silt-clay; shallow/variable rpd w/ red sed@surf=shell bed smothering; drag-down of surface sand, burrows at depth in lower right
DS-05	A	8/26/2007	12:57	14.0	3	14.46	3 to 2/>4	<-1	>4	>4 to <-1	126.86	8.8	8.5	9.3	0.7	Physical	52.06	3.6	0		No	126.86?	> 8.8	> 8.5	> 9.3	No	clusters of living mussels	0				2	DM (or ambient sed?) > pen; mostly fine to medium light-colored sand grading into grey silt-clay@depth; gravel+living mussel clusters w/ attached hydroids@swi; no clear DM signature
DS-05	E	8/26/2007	2:57	17.0	5	14.46	3 to 2/>4	1	>4	>4 to 1	153.7	10.6	10.4	10.9	0.6	Physical	49.12	3.4	0		No	153.7?	> 10.6	> 10.4	> 10.9	No	n	0				2	DM (or ambient sed?) > pen; S/M layering=light-colored fine sand grading into patches of grey clay@depth; a few surf tubes; low-to-moderate rpd contrast; no clear DM signature
DS-05	F	8/26/2007	2:58	17.0	5	14.46	3 to 2/>4	<-1	>4	>4 to <-1	118.76	8.2	5.9	9.6	3.7	Physical	42.36	2.9	0		No	118.76?	> 8.2	> 5.9	> 9.6	No	>6 living mussels in cluster	0				2	DM (or ambient sed?) > pen; mostly light-colored fine sand w/ shell frags w/ discontinous patches of grey silt-clay@depth; cluster of living mussels@swi; low-to-moderate rpd contrast; no clear DM signature
DS-06	A	8/26/2007	2:16	15.0	4	14.44	3 to 2	0	>4	>4 to 0	66.16	4.6	3.2	5.2	2.0	Physical	37.55	2.6	0		No	66.16	> 4.6	> 3.2	> 5.2	No	7 dead shells	0				2	DM > pen; light-colored fine sand w/ dense dead mussel shell layer@swi; low rpd contrast; no clear DM signature
DS-06	B	8/26/2007	2:17	15.0	4	14.44	2 to 1	<-1	>4	>4 to <-1	57.99	4.0	3.3	4.8	1.4	Physical	ind	ind	0		No	57.99	> 4.0	> 3.3	> 4.8	No	n	0				Indetermina	DM > pen; low pen=firm sed; sed surface is poorly sorted mix of sand+gravel (mostly graules/pebbles) overlying silty fine sand; some attached epifauna@swi; no clear rpd contrast
DS-06	C	8/26/2007	2:18	15.0	4	14.46	>4 to 3	0	>4	>4 to 0	106.9	7.4	6.1	8.6	2.5	Physical	26.75	1.8	0		No	106.9	> 7.4	> 6.1	> 8.6	No	dense dead shells	2	4.7	5.5	5.1	2 -> 3	DM > pen; shell bed (dense continuous cover of mussel shells - see planview) over silty-clayey very fine sand; low rpd contrast; 2-3 shallow voids or burrows
DS-07	A	8/26/2007	1:43	15.0	4	14.46	3 to 2/>4	<-1	>4	>4 to <-1	203.75	14.1	13.8	14.5	0.7	Physical	41.65	2.9	0		No	203.75	> 14.1	> 13.8	> 14.5	No	n	0				2 -> 3	DM > pen; distinct S/M layering=upper 4-6 cm is fine sand grading into grey silt-clay@depth; gravel+shells@swi (planview shows mussel shells)
DS-07	B	8/26/2007	1:45	15.0	4	14.46	3 to 2	<-1	>4	>4 to <-1	25.08	1.7	0.0	4.3	4.3	Physical	ind	ind	0		No	25.08	> 1.7	> 0.0	> 4.3	No	mix of live+dead shells	0				Indetermina	DM > pen; low penetration due to dense living mussel clusters+dead mussel shells+gravel@swi overlying silty fine sand; shell drag-down has obscured subsurface features
DS-07	C	8/26/2007	1:46	15.0	4	14.44	3 to 2	<-1	>4	>4 to <-1	104.71	7.3	6.6	7.5	0.9	Physical	30.73	2.1	0		No	104.71	> 7.3	> 6.6	> 7.5	No	n	0				2	DM > pen; sed surface is dense gravel+shells+sand (lag) overlying muddy/silty fine sand; some epifauna on gravel/shells
DS-08	A	8/26/2007	12:32	14.0	3	14.46	3 to 2/>4	0	>4	>4 to 0	181.81	12.6	12.0	12.9	0.9	Physical	29.84	2.1	0		No	181.81	> 12.6	> 12.0	> 12.9	No	1 cluster of living mussels	4	1.9	9.5	5.7	1 on 3	DM > pen; S/M layering=2-3 cm surface layer of light-colored fine sand grading into black-sulfidic silt-clay; distinct subsurface feeding voids+2 large-bodied worm-like orgs; planview shows dense mussel clusters
DS-08	B	8/26/2007	12:33	14.0	3	14.46	>4	0	>4	>4 to 0	224.58	15.5	14.0	16.7	2.7	Physical	20.89	1.4	0		No	224.58	> 15.5	> 14.0	> 16.7	No	2-3 live mussels@swi	1	11.3	11.4	11.3	1 on 3	DM > pen; mostly black-sulfidic silt-clay > pen; sandy in upper sed column; 1 small void+2 wormlike Stg 3 orgs@depth; gastropod+live mussels@swi; thin+patchy rpd
DS-08	C	8/26/2007	12:33	14.0	3	14.46	3 to 2/>4	<-1	>4	>4 to <-1	169.93	11.8	10.7	12.5	1.9	Biological	27.44	1.9	0		No	169.93	> 11.8	> 10.7	> 12.5	No	cluster of live mussels	0				1 on 3	DM > pen; S/M layering=upper 3-4 cm is light-colored fine sand over dark/sulfidic streaky silt-clay; gravel+cluster of living mussels@swi; epifaunal growth on mussels, horizontal burrow/gallery at right & worm at depth
DS-09	A	8/26/2007	2:12	15.0	4	14.46	3 to 2/>4	<-1	>4	>4 to <-1	157.85	10.9	10.6	11.2	0.6	Physical	36.78	2.5	0		No	157.85	> 10.9	> 10.6	> 11.2	No	n	0				1 on 3	DM > pen; dense mixed gravel@swi overlying mostly fine to medium sand; grading into silty-clayey sand@depth; epifauna on gravel; subsurface burrow
DS-09	D	8/26/2007	3:17	17.0	5	14.46	3 to 2/>4	<-1	>4	>4 to <-1	158.85	11.0	9.7	13.5	3.8	Physical	40.98	2.8	0		No	158.85	> 11.0	> 9.7	> 13.5	No	a few dead shells	0				2 -> 3	DM > pen; a few mussel shells+gravel+shell frags@swi overlying fine to medium sand; increasing silt-clay with depth; low rpd contrast; epifauna on mussel shells
DS-09	E	8/26/2007	3:18	17.0	5	14.46	3 to 2/>4	<-1	>4	>4 to <-1	180.15	12.5	11.8	12.9	1.1	Physical	21.68	1.5	0		No	180.15	> 12.5	> 11.8	> 12.9	No	1 dead shell	0				2	DM > pen; S/M layering=mix of shells+gravel@swi over fine muddy sand w/ shell hash grading into brown-grey silt-clay@depth; epifauna growing on shells; heavily armored surface
DS-10	A	8/26/2007	12:06	14.0	3	14.44	3 to 2/>4	<-1	>4	>4 to <-1	209.83	14.5	14.3	14.7	0.4	Physical	40.95	2.8	0		No	209.83	> 14.5	> 14.3	> 14.7	No	n	0				2	DM > pen; distinct S/M layering=upper 4-5 cm is fine sand w/ shell hash overlying brown/grey cohesive clay; moderate rpd contrast; small subsurface worms at depth

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area		Total DM Mean		Total DM Min		Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
DS-10	B	8/26/2007	12:06	14.0	3	14.46	3 to 2/>4	<-1	>4	>4 to <-1	154.86	10.7	10.3	11.0	0.7	Physical	60.92	4.2	0		No	154.86	>	10.7	>	10.3	>	11.0	No	1 dead shell	2	8.2	10.5	9.3	1 on 3	DM>pen; S/M layering=upper 7-9 cm is fine sand w/ shell hash over brown-grey clay@depth; feeding voids/burrows; mussel+other large shells@sed surf; deep rpd w/ moderate contrast
DS-10	C	8/26/2007	12:07	14.0	3	14.46	3 to 2/>4	<-1	>4	>4 to <-1	53.55	3.7	0.7	9.4	8.7	Physical	ind	ind	0		No	53.55	>	3.7	>	0.7	>	9.4	No	several dead shells	ind				Indetermina	DM>pen; profile is disturbed by dragdown of large shell or debris; planview shows dense shells+mussel clusters@swi
DS-11	A	8/26/2007	12:26	14.0	3	14.46	3 to 2/>4	0	>4	>4 to 0	206.33	14.3	13.1	15.0	1.9	Physical	48.75	3.4	0		No	206.33	>	14.3	>	13.1	>	15.0	No	2-3 dead shells	2	7.7	8.9	8.3	1 on 3	DM>pen; S/M layering=upper 4-5 cm layer of light-colored fine sand over dark/sulfidic silt-clay; scattered shells@sed surf 2-3 indistinct voids+subsurface worm-like orgs.
DS-11	B	8/26/2007	12:27	14.0	3	14.46	3 to 2/>4	1	>4	>4 to 1	221.25	15.3	14.9	15.7	0.9	Physical	33.39	2.3	6	r	No	221.25	>	15.3	>	14.9	>	15.7	No	n	4	5.9	9.6	7.7	1 on 3	DM>pen; indistinct S/M layering=upper 2-4 cm is light-colored sand grading into dark/sulfidic clay@depth; smearing of rpd ignored during measurement; mudclasts in farfield are real (see planview); voids+stg 3 worm@depth
DS-11	C	8/26/2007	12:28	14.0	3	14.46	3 to 2/>4	-1	>4	>4 to -1	181.42	12.5	11.7	13.3	1.7	Physical	41.55	2.9	0		No	181.42	>	12.5	>	11.7	>	13.3	No	n	2	5.9	10.8	8.4	1 on 3	DM>pen; distinct S/M layering=upper 3-5 cm is light-colored fine sand overlying dark grey/black/sulfidic silt-clay@depth; 2-3 mud snails@swi; 2 prominent voids/void complexes. Sand is transported layer, as with all of the images from this site
DS-12	A	8/26/2007	2:07	15.0	4	14.46	3 to 2/>4	<-1	>4	>4 to <-1	219.47	15.2	13.2	16.0	2.8	Physical	50.78	3.5	0		No	219.47	>	15.2	>	13.2	>	16.0	No	cluster of 6-7 live mussels	2	4.6	7.8	6.2	1 on 3	DM>pen; S/M layering=upper 3-4 cm layer of light-colored fine sand+shell hash over brown cohesive silt-clay; clusters of live mussels@swi; 2 prominent feeding voids; surf tube farfield.
DS-12	B	8/26/2007	2:08	15.0	4	14.46	>4	0	>4	>4 to 0	209.8	14.5	13.8	15.2	1.4	Physical	0	0	1	o	No	209.8	>	14.5	>	13.8	>	15.2	No	n	0				2	DM>pen; light brown-tan silt-clay w/ patches of black+reddish brown; thin surface veneer of oxidized fine sand; plan view looks like recent winnowing around dump clasts, no apparent RPD
DS-12	C	8/26/2007	2:09	15.0	4	14.46	>4	<-1	>4	>4 to <-1	204.14	14.1	13.8	14.4	0.7	Physical	0	0	0		No	204.14	>	14.1	>	13.8	>	14.4	No	n	0				2	DM>pen; small wiper clasts@swi; dm is mostly light tan silt-clay w/ dark patches; thin surface veneer of fine sand+shell has; no clear rpd
DS-13	A	8/26/2007	2:00	15.0	4	14.46	3 to 2	<-1	>4	>4 to <-1	45.5	3.1	1.6	6.3	4.6	Physical	ind	ind	0		No	45.5	>	3.1	>	1.6	>	6.3	No	many dead shells	0				Indetermina	DM>pen; low pen due to dense shells@swi; surface lyr of dense shells+gravel over silty-muddy fine sand; encrusting epifauna on shells, profile disturbed by shell drag-down, no RPD or successional stage determination possible
DS-13	B	8/26/2007	2:01	15.0	4	14.46	3 to 2	<-1	>4	>4 to <-1	89.19	6.2	5.1	7.0	1.9	Physical	ind	ind	0		No	89.19	>	6.2	>	5.1	>	7.0	No	many dead shells	2	1.9	6.1	4.0	2 - >3	DM>pen; poorly sorted mix of gravel, shells, coarse sand+muddy fine sand; several voids caused by shell/gravel displacement during prism penetration; shells+gravel@swi=lag deposit; no clear rpd contrast
DS-13	C	8/26/2007	2:02	15.0	4	14.46	3 to 2/>4	<-1	>4	>4 to <-1	175.39	12.1	11.4	13.1	1.7	Physical	15	1.0	0		No	175.39	>	12.1	>	11.4	>	13.1	No	both living & dead	1	4.5	5.0	4.7	1 on 3	DM>pen; S/M layering=upper 2-4 cm is fine sand w/ shell hash over brown-grey silt-clay; dense shells@swi; several subsurface worm-like orgs+1 burrow/feeding void; low rpd contrast
DS-14	A	8/26/2007	12:18	14.0	3	14.46	4 to 3	<-1	>4	>4 to <-1	62.2	4.3	3.6	5.0	1.4	Physical	23.16	1.6	0		No	62.2	>	4.3	>	3.6	>	5.0	No	dead shells	0				2	DM>pen; low penetration in firm, silty, brown fine sand w/ shell hash; scattered epifauna-encrusted shell frags+gravel@swi; low rpd contrast; shallow subsurface burrowing evident
DS-14	B	8/26/2007	12:19	14.0	3	14.46	3 to 2/>4	0	>4	>4 to 0	153.04	10.6	8.1	11.8	3.7	Physical	34.11	2.4	0		No	153.04	>	10.6	>	8.1	>	11.8	No	a few dead shells in planview	1	5.7	10.4	8.1	1 on 3	DM>pen; S/M layering=light-colored fine sand over dark grey silt-clay; clay is patchy not continuous; large subsurface burrow; shell frags@sed surf
DS-14	C	8/26/2007	12:21	14.0	3	14.46	3 to 2/>4	<-1	>4	>4 to <-1	163.67	11.3	10.8	12.1	1.2	Physical	41.85	2.9	0		No	163.67	>	11.3	>	10.8	>	12.1	No	n	2	8.6	10.2	9.4	1 on 3	DM>pen; S/M layering=upper 4-5 cm is light-colored fine sand w/ shell frags over grey-brown silt-clay; subsurface burrow/voids; a few shell frags@swi; moderate rpd contrast
DS-15	A	8/26/2007	12:38	14.0	3	14.46	3 to 2/>4	<-1	>4	>4 to <-1	188.77	13.1	11.9	13.8	1.9	Physical	37.76	2.6	0		No	188.77	>	13.1	>	11.9	>	13.8	No	dense clusters of living mussels	0				2	DM>pen; S/M layering=upper 4-7 layer of light-colored fine sand w/ shell frags over grey silt-clay w/ black streaks; dead shells+cluster of living mussels@swi; moderate rpd contrast
DS-15	B	8/26/2007	12:40	14.0	3	14.46	3 to 2/>4	<-1	>4	>4 to <-1	176.51	12.2	11.4	12.7	1.3	Biological	37.44	2.6	0		No	176.51	>	12.2	>	11.4	>	12.7	No	living mussels clusters in planview	6	7.3	11.7	9.5	1 on 3	DM>pen; S/M layering=upper 4-6 cm layer of light-colored fine sand w/ shell frags over grey silt-clay; numerous subsurface feeding voids; gravel+epifauna-encrusted shells@swi; moderate rpd contrast
DS-15	C	8/26/2007	12:41	14.0	3	14.44	3 to 2/>4	0	>4	>4 to 0	184.22	12.8	12.2	13.3	1.1	Physical	30.54	2.1	0		No	184.22	>	12.8	>	12.2	>	13.3	No	n	0				2	DM>pen; S/M w/ multiple layers=upper 3-4 cm of light-colored fine sand over grey clay mixed w/ sand over brown silt-clay; a few shell frags@surf; moderate rpd contrast

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area		Total DM Mean		Total DM Min		Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
USCGA-01	A	8/26/2007	10:43	14.5	4	14.46	3 to 2/>4	<-1	>4	>4 to <-1	117.77	8.1	7.6	8.49	0.9	Biological	22.79	1.6	0		No	117.77	>	8.1	>	7.6	> 8.5	No	cluster of live mussels	0			0.00	1 on 3	DM>pen; S/M=upper 1 cm is light-colored fine sand w/ shells+shell frags overlying grey silt-clay w/ black patches@depth; cluster of live mussel shells+other shells@swi; 2 larger worm-like orgs in sed=Stg 3
USCGA-01	B	8/26/2007	10:44	14.5	4	14.46	3 to 2/>4	<-1	>4	>4 to <-1	131.4	9.1	7.17	10.26	3.1	Physical	11.78	0.8	0		No	131.4	>	9.1	>	7.2	> 10	No	2 dead shells (live clusters in planview)	0			0.00	1 on 3	DM>pen; S/M=thin surface layer (0.5 to 1 cm) of light-colored fine sand w/ shells over light grey/dark grey silt-clay; 1 larger-bodied worm@depth=Stg 3; moderate rpd contrast; abundant shells@swi
USCGA-01	C	8/26/2007	10:45	14.5	4	14.46	3 to 2/>4	0	>4	>4 to 0	159.02	11.0	10.23	11.4	1.2	Biological	16.44	1.1	2	r	No	159.02	>	###	>	10	> 11	No	2 dead shells (live clusters in planview)	0			0.00	2 -> 3	DM>pen; S/M w/ possible multiple layers=upper 2-4 cm is light-colored fine sand w/ shells over dark grey over light grey silt-clay; rpd=sand layer; shells+sand@surf
USCGA-02	A	8/26/2007	9:26	14.5	2	14.46	3 to 2/>4	<-1	>4	>4 to <-1	128.93	8.9	7.68	9.56	1.9	Physical	55.64	3.8	0		No	128.93	>	8.9	>	7.7	> 9.6	No	n	0			0.00	2	DM>pen; S/M layering=upper 8-10 cm is light-colored fine sand over light grey clay@depth; scattered gravel/shells@sed surf; sand has transgressed over finer muds
USCGA-02	B	8/26/2007	9:27	14.5	2	14.46	3 to 2/>4	-1	>4	>4 to -1	166.72	11.5	10.93	11.96	1.0	Physical	28.09	1.9	0		No	166.72	>	###	>	11	> 12	No	n	0			0.00	1 -> 2	DM>pen; S/M layering=upper 4-5 cm is light-colored clean fine sand w/ a few shell frags over light-grey homogenous silt-clay.
USCGA-02	C	8/26/2007	9:27	14.5	2	14.46	3 to 2/>4	-1	>4	>4 to -1	174.38	12.1	11.6	12.45	0.9	Physical	31.82	2.2	0		No	174.38	>	###	>	12	> 12	No	n	0			0.00	2	DM>pen; distinct S/M layering=upper 3 cm is light-colored clean fine sand w/ a few shell frags over light-grey homogenous silt-clay; rpd=sand layer which is part of bedload transport; physically dominated system
USCGA-03	D	8/26/2007	11:20	16.0	5	14.44	3 to 2/>4	0	>4	>4 to 0	137.47	9.5	9.32	10.12	0.8	Physical	33.87	2.3	0		No	137.47	>	9.5	>	9.3	> 10	No	n	2	5.24	8.67	6.96	1 on 3	DM>pen; S/M layering=upper 3-4 cm is light-colored clean fine sand grading into grey silt-clay w/ dark grey streaks@depth; shell frags@sed surf; large prominent void/burrow+small voids lwr right.
USCGA-03	E	8/26/2007	11:21	16.0	5	14.44	3 to 2/>4	0	>4	>4 to 0	94.78	6.6	6.34	6.92	0.6	Physical	35.15	2.4	0		No	94.78	>	6.6	>	6.3	> 6.9	No	n	0			0.00	2 -> 3	DM>pen; S/M=upper 2-5 cm is light-colored clean fine sand w/ abundanct shell frags over grey silt-clay; shells@sed surf; small bivalves at depth, some evidence of deeper burrowing
USCGA-03	F	8/26/2007	11:22	16.0	5	14.46	3 to 2/>4	-1	>4	>4 to -1	202.99	14.0	13.84	14.17	0.3	Biological	33.29	2.3	0		No	202.99	>	###	>	14	> 14	No	n	3	7.44	13.17	10.31	1 on 3	DM>pen; S/M layering=upper 2-5 cm is light-colored clean fine sand w/ shell frags over grey silt-clay over distinct reddish-brown DM; reddish-brown=old plant material; vertical burrow left+voids.
USCGA-04	A	8/26/2007	9:14	14.5	2	14.46	3 to 2/>4	-1	>4	>4 to -1	181.01	12.5	12.27	12.67	0.4	Biological	17.73	1.2	0		No	181.01	>	###	>	12	> 13	No	n (but live mussel clusters in planview)	1	8.69	9.18	8.94	1 on 3	DM>pen; S/M layering=upper 2 cm is light-colored clean fine sand w./ shell frags over homogenous light/dark grey silt-clay; prominent feeding void; sand=rpd; shell frags@swi
USCGA-O4	D	8/26/2007	11:42	16.0	5	14.46	3 to 2/>4	-1	>4	>4 to -1	261.87	18.1	17.66	18.54	0.9	Biological	32.91	2.3	0		No	261.87	>	###	>	18	> 19	No	n	0			0.00	1 on 3	DM>pen; S/M layering=upper 2 cm is light-colored clean fine sand w/ shell frags over homogenous light/dark grey silt-clay; reddish-brown patch in lwr right corner; 1 subsurface Stg 3 worm; 2 Ampelisca tubes@swi
USCGA-O4	E	8/26/2007	11:42	16.0	5	14.46	3 to 2/>4	-1	>4	>4 to -1	228.67	15.8	15.61	16.1	0.5	Biological	33.6	2.3	0		No	228.67	>	###	>	16	> 16	No	n	1	5.87	6.09	5.98	1 on 3	DM>pen; S/M layering=upper 1-2 cm is light-colored fine sand w/ shell frags over light grey homogenous silt-clay; surf tubes+1 feeding void; dark patches@depth.
USCGA-05	A	8/26/2007	10:30	14.5	4	14.46	3 to 2/>4	-1	>4	>4 to -1	214.83	14.9	14.42	15.29	0.9	Biological	31.14	2.2	0		No	214.83	>	###	>	14	> 15	No	n (live mussel clusters in planview)	3	5.2	7.86	6.53	1 on 3	DM>pen; S/M layering=upper 3-4 cm is light-colored fine sand w/ abundant shell frags over light grey silt-clay w/ dark streaks; 3 prominent feeding voids; shells@sed surf
USCGA-05	B	8/26/2007	10:31	14.5	4	14.46	3 to 2/>4	-1	>4	>4 to -1	235.8	16.3	16.1	16.57	0.5	Biological	27.91	1.9	0		No	235.8	>	###	>	16	> 17	No	n	0			0.00	1 on 3	DM>pen; S/M=3-4 cm is light-colored fine sand w/ shell frags grading into grey silt-clay; vertical burrow@left edge of image=Stg 3; shell frags@sed surf
USCGA-05	C	8/26/2007	10:31	14.5	4	14.46	3 to 2/>4	-1	>4	>4 to -1	222.93	15.4	13.5	16.95	3.5	Biological	28.54	2.0	0		No	222.93	>	###	>	14	> 17	No	live mussel clusters in farfield	2	4.01	6.3	5.16	1 on 3	DM>pen; thin surface veneer (<1 cm) of fine sand w/ shell frags over homogenous grey silt-clay w/ dark streaks; 2 distinct feeding voids; mussel shells farfield; large burrow in right half of image is an artifact from shell dragdown by prism
USCGA-06	A	8/26/2007	10:13	14.5	4	14.44	3 to 2/>4	<-1	>4	>4 to <-1	188.8	13.1	11.87	13.43	1.6	Biological	27.81	1.9	0		No	188.8	>	###	>	12	> 13	No	1 live shell farfield (and live clusters in planview)	3	6.32	11.17	8.75	1 on 3	DM>pen; multiple layers w/ S/M=upper 3-4 cm is light-colored fine sand w/ shell frags over 2 layers of grey silt-clay; shells@swi; 1 distinct subsurface feeding void+2 indistinct voids; moderate rpd contrast

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area	Total DM Mean	Total DM Min	Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
USCGA-06	B	8/26/2007	10:14	14.5	4	14.45	3 to 2/>4	0	>4	>4 to 0	245.44	17.0	16.07	18.19	2.1	Biological	21.74	1.5	0		No	245.44	> ###	> 16	> 18	No	cluster of live mussels	0			0.00	1 on 3	DM>pen; S/M layering=upper 1-2 m is mostly silty fine sand w/ shell hash grading into tan/grey silt-clay; live mussel cluster@swi; weak rpd contrast; burrows transected at depth and in lower right corner (deposit feeders present)
USCGA-06	C	8/26/2007	10:15	14.5	4	14.45	3 to 2/>4	<-1	>4	>4 to <-1	230.96	16.0	15.69	16.38	0.7	Biological	39.59	2.7	0		No	230.96	> ###	> 16	> 16	No	n	3	3.44	8.1	5.77	1 on 3	DM>pen; S/M layering=upper 2-3 cm is light-colored fine sand w/ shell frags over tan-grey homogenous silt-clay; 2 small voids+1 indistinct burrow.
USCGA-07	A	8/26/2007	8:59	14.5	2	14.45	3 to 2/>4	0	>4	>4 to 0	197.82	13.7	12.67	14.28	1.6	Biological	37.62	2.6	0		No	197.82	> ###	> 13	> 14	No	n (live clusters in planview)	3	5.07	6.79	5.93	1 on 3	DM>pen; S/M layering=upper 4-5 cm is light-colored fine sand w/ abundant shell frags over grey silt-clay; several distinct feeding voids+burrows; moderate rpd contrast; subsurface red worms
USCGA-07	B	8/26/2007	9:00	14.5	2	14.45	3 to 2/>4	0	>4	>4 to 0	136.12	9.4	9.13	9.65	0.5	Physical	33.52	2.3	0		No	136.12	> 9.4	> 9.1	> 9.7	No	n (live clusters in planview)	0			0.00	1 on 3	DM>pen; distinct S/M layering=upper 2-3 cm is light-colored fine sand w/ abundant shell frags over grey silt-clay; 2 larger-bodied red worms@depth=Stg 3.
USCGA-07	C	8/26/2007	9:00	14.5	2	14.45	3 to 2/>4	0	>4	>4 to 0	131.5	9.1	8.5	9.77	1.3	Physical	24.59	1.7	0		No	131.5	> 9.1	> 8.5	> 9.8	No	live clusters	0			0.00	2 ->3	DM>pen; subtle S/M layering=upper 1-2 cm is light-colored fine sand w/ shell frags over streak black-grey silt-clay; live mussel cluster@swi; moderate rpd contrast.
USCGA-08	A	8/26/2007	10:36	14.5	4	14.46	3 to 2/>4	0	>4	>4 to 0	151.93	10.5	9.88	11.17	1.3	Biological	10.28	0.7	0		No	151.93	> ###	> 9.9	> 11	No	cluster of live mussels	3	5.41	7.21	6.31	1 on 3	DM>pen; S/M=thin veneer (1 cm) of light-colored fine sand w/ shell frags over grey silt-clay; cluster of live mussels; subsurface feeding voids.
USCGA-08	B	8/26/2007	10:37	14.5	4	14.46	>4	2	>4	>4 to 2	134.03	9.3	8.76	10.28	1.5	Biological	ind	ind	0		No	134.03	> 9.3	> 8.8	> 10	No	dense clusters of live mussels	1	6.12	6.74	6.43	1 on 3	DM>pen; swi disturbed/floccy due to disruption of surface from prism slicing through dense clusters of live mussels; indistinct feeding voids@center; rpd not measureable from sampling disturbance
USCGA-08	C	8/26/2007	10:38	14.5	4	14.44	>4	-1	>4	>4 to -1	143.39	9.9	9.38	10.68	1.3	Biological	8.48	0.6	0		No	143.39	> 9.9	> 9.4	> 11	No	1 live mussel@swi	0			0.00	2	DM>pen; sed surf is somewhat sandy w/ shells+shell hash over grey silt-clay; appears to be dead Ampelisca tubes @ swi on right
USCGA-09	A	8/26/2007	10:50	14.5	4	14.46	3 to 2/>4	1	>4	>4 to 1	221.8	15.3	13.44	16.19	2.8	Biological	31.31	2.2	0		No	221.8	> ###	> 13	> 16	No	1 dead mussel shell (live clusters in planview)	3	4.37	13.95	9.16	1 on 3	DM>pen; S/M=upper 2-3 cm is light-colored fine sand w/ shell frags over grey-brown silt-clay; several prominent feeding voids/burrows; 1 subsurface orange worm; moderate rpd contrast
USCGA-09	B	8/26/2007	10:51	14.5	4	14.44	3 to 2/>4	0	>4	>4 to 0	213.18	14.8	14.33	15.22	0.9	Biological	32.28	2.2	0		No	213.18	> ###	> 14	> 15	No	n	3	5.42	14.49	9.96	1 on 3	DM>pen; S/M=upper 1-2 cm is light-colored fine sand w/ shell hash over grey silt-clay; reddish-brown patch; prominent voids/burrows; several surf tubes.
USCGA-09	C	8/26/2007	10:51	14.5	4	14.46	>4	<-1	>4	>4 to <-1	158.29	10.9	9.68	12.27	2.6	Biological	33.93	2.3	0		No	158.29	> ###	> 9.7	> 12	No	2 dead shells (live clusters in planview)	2	3.09	4.95	4.02	1 on 3	DM>pen; sed surf is silty/muddy fine sand w/ shell hash over grey silt-clay w/ black/tan patches; 2 voids/burrows+1 orange worm-like org; encrusted rock or shell@swi; live mussels in planview
USCGA-10	D	8/26/2007	11:26	16.0	5	14.46	3 to 2/>4	0	>4	>4 to 0	163.38	11.3	10.73	11.69	1.0	Physical	31.85	2.2	0		No	163.38	> ###	> 11	> 12	No	1-2 dead shells	0			0.00	1 on 3	DM>pen; S/M layering=upper 3-5 cm is light-colored fine sand w/ shells+shell frags grading into grey silt-clay; 2 subsurface worms=Stg 3; surface tubes.
USCGA-10	E	8/26/2007	11:27	16.0	5	14.46	3 to 2/>4	0	>4	>4 to 0	160.94	11.1	10.88	11.6	0.7	Physical	39.46	2.7	0		No	160.94	> ###	> 11	> 12	No	n (live clusters in planview)	0			0.00	2	DM>pen; S/M=upper 3-4 cm is light-colored fine sand w/ surface shell frags over grey silt-clay; a few surface tubes; evidence of shallow subsurface burrows
USCGA-10	F	8/26/2007	11:28	16.0	5	14.46	>4 to 3	1	>4	>4 to 1	127.6	8.8	7.39	9.79	2.4	Biological	32.94	2.3	0		No	127.6	> 8.8	> 7.4	> 9.8	No	n (live clusters in planview)	1	3.54	3.86	3.70	1 on 3	DM>pen; muddy brown fine to very fine sand w/ shell hash+surface shell frags; vertical burrow is most likely artifact from shell dragdown;1 feeding void+subsurface worm@left.
USCGA-11	D	8/26/2007	11:33	16.0	5	14.46	3 to 2/>4	<-1	>4	>4 to <-1	108.24	7.5	6.99	7.91	0.9	Physical	33.54	2.3	0		No	108.24	> 7.5	> 7	> 7.9	No	n (live clusters in planview)	0			0.00	2	DM>pen; S/M=mostly light-colored fine to medium sand w/ some gravel+shells@surf - looks like grey silt-clay@depth; sand layer due to bedload transport
USCGA-11	E	8/26/2007	11:35	16.0	5	14.46	3 to 2/>4	<-1	>4	>4 to <-1	103.94	7.2	6.7	8.04	1.3	Physical	28.8	2.0	0		No	103.94	> 7.2	> 6.7	> 8	No	1 dead shell (live clusters in planview)	0			0.00	2	DM>pen; S/M=mostly light-colored fine to medium sand w/ gravel+shells@surf - looks like grey silt-clay@depth; edge of transected burrows in image show shallow subsurface deposit feeders present
USCGA-11	F	8/26/2007	11:37	16.0	5	14.46	3 to 2	0	>4	>4 to 0	83.19	5.8	5.56	5.94	0.4	Physical	41.8	2.9	0		No	83.19	> 5.8	> 5.6	> 5.9	No	1 dead shell (live cluster in planview)	0			0.00	2	DM>pen; profile shows light-colored fine to medium sand w/ dense shell frags@surface; hint of possible grey clay@depth.
USCGA-12	A	8/26/2007	9:28	14.5	2	14.46	3 to 2/>4	<-1	>4	>4 to <-1	213.77	14.8	14.31	15.14	0.8	Physical	40.21	2.8	0		No	213.77	> ###	> 14	> 15	No	n	0			0.00	1 on 3	DM>pen; distinct S/M layering=upper 6-7 cm is light-colored clean fine sand w/ shells+a few pebbles@surf over light-grey clay; 1 Stg 3 org@depth (polychaete).
USCGA-12	B	8/26/2007	9:30	14.5	2	14.46	3 to 2	-1	>4	>4 to -1	96.28	6.7	6.18	7.01	0.8	Physical	45.44	3.1	0		No	96.28	> 6.7	> 6.2	> 7	No	n	0			0.00	2	DM>pen; light-colored fine to medium sand w/ shell frags@surface; hint of possible underlying grey clay but insufficient pen; surf tubes.

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area	Total DM Mean	Total DM Min	Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
USCGA-12	C	8/26/2007	9:30	14.5	2	14.46	3 to 2/>4	-1	>4	>4 to -1	118.8	8.2	7.77	8.76	1.0	Physical	44.8	3.1	0		No	118.8	> 8.2	> 7.8	> 8.8	No	1 dead shell	0			0.00	2	DM>pen; indistinct S/M layering=upper 5-7 cm is light-colored fine sand w/ surface shell frags over light grey silt-clay. Bivalves and burrows evident in subsurface
USCGA-13	D	8/26/2007	8:41	14.5	2	14.46	>4	0	>4	>4 to 0	228.74	15.8	13.97	16.52	2.6	Biological	32.87	2.3	0		No	228.74	> ###	> 14	> 17	No	cluster of live mussels	2	9.85	14	11.93	1 on 3	DM>pen; brown-grey relatively soft silt-clay; multiple layers?; 2 worms@depth+2 burrows/voids; somewhat sandy in upper 2-3 cm.
USCGA-13	E	8/26/2007	8:41	14.5	2	14.46	>4	0	>4	>4 to 0	223.32	15.4	14.73	17.26	2.5	Biological	31.51	2.2	0		No	223.32	> ###	> 15	> 17	No	cluster of live mussels	2	10.6	14.6	12.60	1 on 3	DM>pen; mostly brown-grey relatively soft silt-clay; some shell hash+sand near surface; swi disturbed due to mussels; reduced sed@surf
USCGA-13	F	8/26/2007	8:42	14.5	2	14.46	>4	-1	>4	>4 to -1	200.21	13.8	12.99	14.58	1.6	Physical	41.27	2.9	0		No	200.21	> ###	> 13	> 15	No	n (live clusters in planview)	3	6.07	11.87	8.97	1 on 3	DM>pen; S/M layering in upper 6-8 cm is fine sand w/ shell hash+shells@surf over grey silt-clay; several feeding voids/burrows; stg 1 surf tubes
USCGA-14	A	8/26/2007	10:21	14.5	4	14.46	>4	-1	>4	>4 to -1	240.43	16.6	15.98	16.99	1.0	Physical	13.71	0.9	0		No	240.43	> ###	> 16	> 17	No	n (live clusters in planview)	3	3.59	9.97	6.78	1 on 3	DM>pen; primarily streaky grey relatively soft silt-clay; possibly 2 separate DM layers; somewhat sandy in upper 2-3 cm; shells@surf; distinct voids/burrows; thin rpd w/ moderate contrast
USCGA-14	B	8/26/2007	10:22	14.5	4	14.44	3 to 2/>4	-1	>4	>4 to -1	184.46	12.8	11.71	13.3	1.6	Biological	25.94	1.8	0		No	184.46	> ###	> 12	> 13	No	n (live clusters in planview)	0			0.00	1 on 3	DM>pen; S/M layering=upper 3-4 cm is muddy fine sand w/ shells@surf grading into grey silt-clay; edge of void transected and evidence of subsurface worms against faceplate
USCGA-14	D	8/26/2007	10:24	14.5	4	14.46	3 to 2/>4	<-1	>4	>4 to <-1	194.73	13.5	11	14.64	3.6	Physical	ind	1.2	1	r	No	194.73	> ###	> 11	> 15	No	cluster of live mussels	2	4.15	4.55	4.35	1 on 3	DM>pen; indistinct S/M layering=discontinuous 1-2 cm surf lyr of fine sand w/ shells@surf over tan-grey soft silt-clay; 2 small voids; mud-clast dragdown+swi camera disturbance; rpd from average linear measurement in left half of image
USCGA-15	A	8/26/2007	10:05	14.5	4	14.45	>4	1	>4	>4 to 1	222.88	15.4	12.52	16.84	4.3	Biological	29.86	2.1	0		No	222.88	> ###	> 13	> 17	No	cluster of live mussels	0			0.00	3	DM>pen=tan-dark grey soft silt-clay; slight disturbance of swi+rpd by camera; live mussel cluster; moderate rpd contrast; reduced DM; edges of burrows transected at depth
USCGA-15	B	8/26/2007	10:06	14.5	4	14.46	3 to 2	<-1	>4	>4 to <-1	116.82	8.1	7.7	8.58	0.9	Physical	14.72	1.0	0		No	116.82	> 8.1	> 7.7	> 8.6	No	cluster of live mussels	0			0.00	2	DM>pen; firm muddy fine to medium sand w/ patches of grey clay; dense shells@sed surf; thin rpd w/ low contrast; live mussel cluster
USCGA-15	C	8/26/2007	10:07	14.5	4	14.47	>4 to 3	-1	>4	>4 to -1	165.67	11.4	10.48	13.48	3.0	Biological	17.19	1.2	0		No	165.67	> ###	> 10	> 13	No	dense cluster of live mussels	1	6	8.24	7.12	1 on 3	DM>pen; silty-muddy very fine to fine sand>pen; 1 distinct feeding void; dense live mussels+shells@sed surf; thin rpd w/ low contrast
NEREF-01	A	8/27/2007	8:12	16.0	5	14.46	4 to 3/>4	0	>4	>4 to 0	180.22	12.5	11.49	12.85	1.4	Biological	35.67	2.5	0		No					No	n	2	4.8	9.16	6.98	1 on 3	Ambient sed>pen; subtle S/M layering=upper 3-4 cm is tan very fine to fine sand over slightly reduced (dark) grey silt-clay; prominent voids/burrows; moderate rpd contrast
NEREF-01	B	8/27/2007	8:13	16.0	5	14.46	4 to 3/>4	0	>4	>4 to 0	163.25	11.3	10.68	11.37	0.7	Physical	36.58	2.5	0		No					No	n	1	3.09	3.23	3.16	1 on 3	Ambient sed>pen; S/M=upper 3-4 cm is tan light-colored very fine sand over dark grey silt-clay; 1 very small void; a few surf tubes; small reduced wiper clasts
NEREF-01	C	8/27/2007	8:14	16.0	5	14.46	4 to 3/>4	0	>4	>4 to 0	159.42	11.0	10.52	11.42	0.9	Physical	38.62	2.7	0		No					No	n	1	8.06	9.09	8.58	1 on 3	Ambient sed>pen; S/M=upper 3 cm is tan light-colored very fine sand over dark grey silt-clay; 1 subsurface void+2 orange-red orgs; a few small surf tubes; moderate rpd contrast
NEREF-02	A	8/27/2007	8:08	16.0	5	14.44	4 to 3/>4	1	>4	>4 to 1	195.03	13.5	13.23	13.68	0.4	Biological	35.47	2.5	0		No					No	n	2	6.76	12.92	9.84	1 on 3	Ambient sed>pen; S/M=upper 2-3 cm is tan light-colored very fine sand over darker grey silt-clay; 2 subsurface voids+1 very long worm-like org; surf tubes look like small/short Ampelisca
NEREF-02	B	8/27/2007	8:09	16.0	5	14.44	4 to 3/>4	1	>4	>4 to 1	158.21	11.0	10.73	11.13	0.4	Physical	40.26	2.8	0		No					No	n	0			0.00	2	Ambient sed>pen; S/M=upper 3-4 cm is tan light-colored very fine sand over darker grey silt-clay; evidence of shallow subsurface worms +a few surf tubes
NEREF-02	C	8/27/2007	8:10	16.0	5	14.46	4 to 3/>4	1	>4	>4 to 1	184.54	12.8	11.73	13.48	1.8	Physical	31.42	2.2	0		No					No	n	1	6.32	6.47	6.40	1 on 3	Ambient sed>pen; S/M=upper 2-3 cm is tan light-colored very fine sand over darker grey silt-clay; 1 subsurface void+reddish smear of organism.
NEREF-03	A	8/27/2007	8:16	16.0	5	14.49	4 to 3/>4	1	>4	>4 to 1	180.7	12.5	12.09	12.9	0.8	Biological	42.67	2.9	0		No					No	n	1	10.99	12.63	11.81	1 on 3	Ambient sed>pen; S/M=upper 4-6 cm is tan light-colored very fine sand over darker grey silt-clay; void/burrow lwr right corner; biogenic mound; numerous short fat tubes appear to be juvenile Ampelisca
NEREF-03	B	8/27/2007	8:16	16.0	5	14.46	4 to 3/>4	1	>4	>4 to 1	169.96	11.8	11.15	12.11	1.0	Physical	36.43	2.5	0		No					No	n	3	7.5	9.59	8.55	1 on 3	Ambient sed>pen; S/M=upper 3-4 cm is tan light-colored very fine sand over dark grey silt-clay; numerous small surf tubes (Ampelisca); subsurface voids.

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area	Total DM Mean	Total DM Min	Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
NEREF-03	C	8/27/2007	8:17	16.0	5	14.46	4 to 3/>4	1	>4	>4 to 1	138.94	9.6	9.34	10.12	0.8	Physical	34.75	2.4	0		No					No	n	1	5.04	5.2	5.12	1 on 3	Ambient sed>pen; S/M=upper 3-4 cm is dark very fine to fine sand over darker silt-clay; sand looks reduced w/ thin or zero rpd; layer of detritus@swi and decaying Ampelisca tubes; one small void@left
NEREF-04	A	8/27/2007	7:55	16.0	5	14.46	4 to 3/>4	1	>4	>4 to 1	144.77	10.0	9.34	10.46	1.1	Physical	41.9	2.9	0		No					No	n	0	0		0.00	2	Ambient sed>pen; S/M=upper 3-5 cm is light-colored very fine sand over dark grey silt clay; organic detritus@sed surf=decaying Amp tubes
NEREF-04	B	8/27/2007	7:56	16.0	5	14.46	4 to 3/>4	1	>4	>4 to 1	142.84	9.9	9.65	10.5	0.9	Physical	39.3	2.7	0		No					No	n	4	6.01	7.04	6.53	1 on 3	Ambient sed>pen; S/M=upper 3-4 cm is light-colored very fine sand over dark grey silt-clay; 4 voids (2 are verys small); small surface worm tubes.
NEREF-04	C	8/27/2007	7:57	16.0	5	14.44	4 to 3/>4	1	>4	>4 to 1	177.83	12.3	12.02	12.65	0.6	Biological	38.77	2.7	0		No					No	n	2	6.66	8.62	7.64	1 on 3	Ambient sed>pen; subtle S/M layering=upper 5-6 cm is light-colored very fine sand over dark silt-clay w/ sand patches; 2-3 indistinct voids/burrows; a few surf tubes; low to moderate rpd contrast
NEREF-05	A	8/27/2007	8:02	16.0	5	14.46	4 to 3/>4	1	>4	>4 to 1	161.94	11.2	11.2	11.62	0.4	Physical	34.19	2.4	0		No					No	n	0			0.00	1 on 3	Ambient sed>pen; S/M=upper 3-4 cm is light-colored very fine sand over grey to dark-grey silt-clay; numerous small Ampelisca tubes@swi; 1 larger-bodied worm-like org@depth
NEREF-05	B	8/27/2007	8:03	16.0	5	14.46	4 to 3/>4	1	>4	>4 to 1	183.28	12.7	12.49	12.87	0.4	Physical	37	2.6	0		No					No	n	2	6.76	9.05	7.91	1 on 3	Ambient sed>pen; S/M=upper 3-5 cm is light-colored very fine sand over grey silt-clay; small stg 1 surf tubes+2-3 subsurface voids/burrows+1 larger-bodied worm (partial).
NEREF-05	C	8/27/2007	8:04	16.0	5	14.46	4 to 3/>4	0	>4	>4 to 0	146.86	10.2	9.92	10.39	0.5	Physical	21.08	1.5	0		No					No	n	1	5.36	7.03	6.20	1 on 3	Ambient sed>pen; indistinct S/M=upper 2 cm is silty very fine sand over grey silt-clay; 1-2 voids/burrows+2 subsurface worm-like orgs; a few surf short Ampelisca tubes.
NLON-REF-01	A	8/27/2007	7:19	16.0	5	14.49	4 to 3	1	>4	>4 to 1	86.31	6.0	5.13	6.38	1.3	Physical	35.46	2.4	0		No					No	n	0			0.00	2	Ambient sed>pen=very fine clean light-colored sand; reduced/black patches@depth=low rpd contrast; shells+a few tubes@sed surf; most likely Stage 3 present but can't see in SPI because of shallow penetration (burrow openings visible in plan view)
NLON-REF-01	B	8/27/2007	7:20	16.0	5	14.46	4 to 3	1	>4	>4 to 1	68.42	4.7	3.07	5.4	2.3	Biological	54.82	3.8	0		No					No	n	0			0.00	1 on 3	Ambient sed>pen=very fine clean light-colored sand; detritus/decayed tubes@surf; burrow opening=Stg 3; worm tubes and Ampelisca tubes at SWI
NLON-REF-01	C	8/27/2007	7:20	16.0	5	14.46	4 to 3	1	>4	>4 to 1	82.4	5.7	5.33	6.16	0.8	Physical	32.33	2.2	0		No					No	n	0			0.00	2	Ambient sed>pen=very fine clean light-colored sand; most likely Stage 3 present but lack of prism penetration prevents definitive determination
NLON-REF-02	A	8/27/2007	7:30	16.0	5	14.46	4 to 3	1	>4	>4 to 1	73.36	5.1	4.77	5.26	0.5	Physical	33.77	2.3	0		No					No	n	0			0.00	2	Ambient sed>pen=very fine clean light-colored sand; most likely Stage 3 present but lack of prism penetration prevents definitive determination
NLON-REF-02	B	8/27/2007	7:30	16.0	5	14.46	4 to 3/>4	1	>4	>4 to 1	123.78	8.6	7.95	9	1.1	Physical	43.63	3.0	0		No					No	n	0			0.00	2	Ambient sed>pen=very fine clean light-colored sand; indistinct S/M=grey silt-clay@depth; evidence of shallow subsurface burrowing; most likely Stage 3 present but not definitive
NLON-REF-02	C	8/27/2007	7:31	16.0	5	14.44	4 to 3	1	>4	>4 to 1	102.06	7.1	6.77	7.39	0.6	Physical	32.68	2.3	0		No					No	n	0			0.00	1 on 3	Ambient sed>pen=very fine light-colored sand w/ patches of dark grey clay@depth; burrow with reduced pseudofeces at surface, Stage 3 present
NLON-REF-03	A	8/27/2007	7:24	16.0	5	14.46	4 to 3	1	>4	>4 to 1	96.93	6.7	6.29	7.06	0.8	Physical	38.53	2.7	0		No					No	n	0			0.00	2	Ambient sed>pen=very fine light-colored clean sand; reduced/dark grey patches@depth; short tubes@swi; Ampelisca tubes at SWI; hydroids in farfield; Stage 3 most likely present but inadequate penetration to determine.
NLON-REF-03	B	8/27/2007	7:25	16.0	5	14.46	4 to 3/>4	1	>4	>4 to 1	122.32	8.5	8.22	8.76	0.5	Physical	38.58	2.7	1	r	No					No	n	1	1.64	2.12	1.88	1 on 3	Ambient sed>pen; S/M=upper 5-6 cm is light-colored clean very fine sand overlying dark grey silt-clay; 1 void in sand@left.
NLON-REF-03	C	8/27/2007	7:26	16.0	5	14.46	4 to 3	1	>4	>4 to 1	51.88	3.6	2.83	3.99	1.2	Physical	51.88	3.6	0		No					No	n	0			0.00	2	Ambient sed>pen=very fine clean light-colored sand; low pen=firm sand; aRPD greater than penetration; succ.stage is 2 at a minimum
NLON-REF-04	A	8/27/2007	7:08	16.0	5	14.44	4 to 3	1	>4	>4 to 1	89.53	6.2	5.4	6.76	1.4	Biological	34.93	2.4	0		No					No	n	0			0.00	2	Ambient sed>pen=muddy very fine sand w/ grey clay patches@depth; dense Crepidula shell bed in planview+Crepidula shell in farfield; shells@sed surf, evidence of subsurface burrows
NLON-REF-04	B	8/27/2007	7:08	16.0	5	14.46	>4 to 3	1	>4	>4 to 1	96.27	6.7	5.18	7.1	1.9	Biological	17.84	1.2	0		No					No	n	0			0.00	2	Ambient sed>pen=muddy very fine sand or mud w/ very fine sand; dense shells@swi, mixture of Crepidula and mussels (plan view); most likely Stage 3 present but in low density (burrow openings visible in plan view)

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area	Total DM Mean	Total DM Min	Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
NLON-REF-04	C	8/27/2007	7:09	16.0	5	14.46	>4 to 3	1	>4	>4 to 1	76.68	5.3	3.59	6.77	3.2	Physical	20.57	1.4	0		No					No	n	0			0.00	2	Ambient sed>pen=muddy very fine sand or mud w/ very fine sand; dense shells@swi=Crepidula shell bed; vertical opening due to shell dragdown; Stage 3 likely present but inadequate penetration to determine
NLON-REF-05	A	8/27/2007	7:15	16.0	5	14.46	4 to 3	1	>4	>4 to 1	91.05	6.3	5.8	7.03	1.2	Physical	35.89	2.5	0		No					No	n	0			0.00	2	Ambient sed>pen=very fine clean light-colored sand; subtle darker patches@depth=low rpd contrast; hydroid@left; shallow void@left; Ampelisca tubes, Stage 3 likely present but inadequate penetration to determine
NLON-REF-05	B	8/27/2007	7:15	16.0	5	14.46	4 to 3	1	>4	>4 to 1	68.01	4.7	4.41	5.06	0.6	Physical	29.89	2.1	0		No					No	n	0			0.00	1	Ambient sed>pen=very fine clean light-colored sand; subtle darker patches@depth=low rpd contrast; piece of eelgrass@sed surf; tan-yellowish "tube-like" pieces of detritus; a few shell frags@sed surf
NLON-REF-05	C	8/27/2007	7:16	16.0	5	14.46	4 to 3	1	>4	>4 to 1	77.58	5.4	5.04	5.65	0.6	Physical	37.58	2.6	0		No					No	n	0			0.00	2	Ambient sed>pen=very fine clean light-colored sand; subtle darker patches@depth=low rpd contrast; piece of eelgrass@sed surf; shell frags@sed surf
WREF-01	A	8/27/2007	8:43	16.0	5	14.46	4 to 3	<-1	>4	>4 to <-1	107.97	7.5	7.37	7.77	0.4	Physical	35.53	2.5	0		No					No	n	0			0.00	2	Ambient sed>pen=brown fine sand w/ abundant shell hash+patches of grey clay@depth; dense shells+shell frags@sed surf; small burrows transected at depth
WREF-01	B	8/27/2007	8:44	16.0	5	14.46	4 to 3	<-1	>4	>4 to <-1	103.56	7.2	6.65	7.5	0.9	Physical	30.37	2.1	0		No					No	n	0			0.00	2	Ambient sed>pen=brown fine sand w/ abundant shell hash+patches of grey clay@depth; dense shells+shell frags@sed surf; small burrows transected at depth
WREF-01	C	8/27/2007	8:45	16.0	5	14.46	4 to 3	<-1	>4	>4 to <-1	112.73	7.8	7.37	8.04	0.7	Physical	28.6	2.0	0		No					No	1 dead shell	0			0.00	2	Ambient sed>pen=brown fine sand w/ abundant shell hash+patches of grey clay@depth; dense shells+shell frags@sed surf; small burrows transected at depth
WREF-02	A	8/27/2007	9:08	16.0	5	14.46	>4	-1	>4	>4 to -1	144.07	10.0	8.69	10.64	2.0	Physical	20.83	1.4	0		No					No	1 cluster of live mussels in SPI (dense clusters in planview)	1	6.95	7.04	7.00	1 on 3	Ambient sed>pen=brown sandy silt-clay w/ abundant shell hash throughout; live mussel cluster@swi; 1 feeding void; patchy rpd w/ low contrast.
WREF-02	B	8/27/2007	9:09	16.0	5	14.46	>4	-1	>4	>4 to -1	91.8	6.3	5.15	7.53	2.4	Biological	27.37	1.9	0		No					No	1 cluster of live mussels in SPI (dense clusters in planview)	0			0.00	2	Ambient sed>pen=brown sandy silt-clay w/ abundant shell hash throughout; live mussel cluster@swi; 1 feeding void; patchy rpd w/ low contrast.
WREF-02	C	8/27/2007	9:10	16.0	5	14.44	>4	-1	>4	>4 to -1	119.94	8.3	7.86	8.94	1.1	Biological	30.86	2.1	0		No					No	1 cluster of live mussels in SPI (dense clusters in planview)	3	6.66	8.42	7.54	1 on 3	Ambient sed>pen=brown sandy silt-clay w/ abundant shell hash throughout; shells and live mussel cluster@swi; low contrast rpd; small fecal coil@swi, transected burrows at depth
WREF-03	A	8/27/2007	8:54	16.0	5	14.46	>4	<-1	>4	>4 to <-1	98.82	6.8	6.27	7.28	1.0	Physical	16.99	1.2	0		No					No	a few dead mussel shells	0			0.00	2	Ambient sed>pen=brown sandy silt-clay w/ abundant shell hash throughout; dense shells@swi; shallow but low contrast rpd; 1 surface worm tube encrusted w/ shell frags
WREF-03	B	8/27/2007	8:55	16.0	5	14.46	>4	<-1	>4	>4 to <-1	121.81	8.4	7.86	8.96	1.1	Physical	30.41	2.1	0		No					No	a few dead mussel shells	0			0.00	2	Ambient sed>pen=brown muddy fine sand over grey silt-clay w/ abundant shell hash throughout; dense shells@sed surf; low rpd contrast
WREF-03	C	8/27/2007	8:56	16.0	5	14.44	>4	<-1	>4	>4 to <-1	110.91	7.7	7.35	7.93	0.6	Biological	24.24	1.7	0		No					No	a few dead mussel shells	0			0.00	3	Ambient sed>pen=brown muddy fine sand over grey silt-clay w/ abundant shell hash throughout; dense shells@sed surf; low rpd contrast; biogenic mound in nearfield, large tube @ SWI in center
WREF-04	A	8/27/2007	8:48	16.0	5	14.46	>4	<-1	>4	>4 to <-1	103.78	7.2	6	8	2.0	Physical	30.43	2.1	0		No					No	some dead mussel shells	0			0.00	2	Ambient sed>pen=brown muddy fine sand over grey silt-clay w/ abundant shell hash throughout; dense shells@sed surf; low rpd contrast
WREF-04	B	8/27/2007	8:49	16.0	5	14.46	>4	-1	>4	>4 to -1	111.65	7.7	7.32	8.02	0.7	Physical	30.75	2.1	0		No					No	some dead mussel shells	0			0.00	2	Ambient sed>pen=brown muddy fine sand over grey silt-clay w/ abundant shell hash throughout; dense shells+shell frags@sed surf; hydroids+epifauna on shells.
WREF-04	C	8/27/2007	8:50	16.0	5	14.46	>4 to 3	<-1	>4	>4 to <-1	105.55	7.3	6.48	7.86	1.4	Physical	24.95	1.7	0		No					No	some dead mussel shells	0			0.00	2	Ambient sed>pen=brown muddy fine sand over grey silt-clay w/ abundant shell hash throughout; dense shells+shell frags@sed surf; hydroids+epifauna on shells; dark/reduced patches@depth

Appendix B-2
Sediment-Profile Image Results for NLDS
July/August 2007

Station	Rep	Date	Time	Stop Collar Setting (in)	# of Lead Weights per Carriage	Calibration Constant	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	GrnSize Range	Penetration Area (sq.cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	Boundary Roughness Type	RPD Area (sq.cm)	Mean RPD (cm)	Mud Clast Number	Mud Clast State	Methane	Total DM Area	Total DM Mean	Total DM Min	Total DM Max	Low DO?	Mussels?	Feeding Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Successional Stage	COMMENT
WREF-05	A	8/27/2007	9:01	16.0	5	14.46	>4	<-1	>4	>4 to <-1	107.68	7.4	7.17	7.77	0.6	Physical	23.63	1.6	0		No					No	dead shells (live clusters in planview)	5.94	6.05		6.05	1 on 3	Ambient sed>pen=brown muddy fine sand over grey silt-clay w/ dense shell hash throughout; dense shells+shell frags@sed surf; hydroids+epifauna on shells; 1 void lwr left corner+1 partial orange worm-like org=Stg 3
WREF-05	B	8/27/2007	9:02	16.0	5	14.46	>4 to 3	<-1	>4	>4 to <-1	115.89	8.0	7.21	8.73	1.5	Physical	38.44	2.7	0		No					No	dead shells and live clusters in SPI farfield+plan view	0			0.00	1 on 3	Ambient sed>pen=brown muddy fine sand over grey silt-clay w/ dense shell hash throughout; dense shells+shell frags+shell clusters+live mussel clusters@sed surf; hydroids+epifauna on shells; transected burrow at depth
WREF-05	C	8/27/2007	9:03	16.0	5	14.46	>4 to 3	<-1	>4	>4 to <-1	90.56	6.3	5.94	6.52	0.6	Physical	30.97	2.1	0		No					No	dead shells (live clusters in planview)	0			0.00	2 -> 3	Ambient sed>pen=brown muddy fine sand over grey silt-clay w/ dense shell hash throughout; dense shells+shell frags+shell clusters@sed surf; hydroids+epifauna on shells.

Appendix C

Plan View Results for NLDS
August 2007 Survey

Appendix C
Plan-View Image Results for NLDS

Station	Rep	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m2)	Sediment Type	Bedforms	Infauna	Burrows	Tubes	Tracks	Epifauna	Mudclasts	Debris	Comment
NL06-01	A	8/26/2007	4:19 PM	79.7	52.94	0.42	Silt or fine sand w/ shells	n	n	n	n	n	y	n	shell	Silty or sandy bottom w/ dense shells and shell frags; small rocks (gravel) visible among shells; encrusting epifauna on shells/rocks
NL06-01	C	8/26/2007	4:20 PM	ind	ind	ind	Silt or fine sand w/ shells	n	n	n	n	n	y	n	shell	Lasers not visible; Silty or sandy bottom w/ dense shells and shell frags; small rocks (gravel) visible among shells; encrusting epifauna on shells/rocks
NL06-02	A	8/26/2007	3:46 PM	75.59	50.1	0.38	Silt or fine sand w/ shells	n	n	n	n	n	y	n	shells+floccy detritus	Silty/sandy bottom w/ dense shells+shell frags; pockets of floccy greenish organic detritus on sed surf
NL06-03	A	8/26/2007	4:32 PM	79.99	53.13	0.42	Silt or fine sand w/ shell frags	n	y	n	n	n	n	n	shells+floccy detritus	Silty/sandy bottom w/ dense shells+shell frags; sed surface slightly hummocky=weathered clay clumps?; pockets of floccy greenish organic detritus on sed surf
NL06-03	B	8/26/2007	4:34 PM	80.31	53.34	0.43	Silt or fine sand w/ shell frag	n	n	y	n	y	n	n	shells+floccy greenish detritus	Silty/sandy bottom w/ dense shells+shell frags; accumulations of floccy greenish detritus in shallow pockets; burrow opening upper left corner
NL06-04	A	8/26/2007	4:03 PM	78.14	51.89	0.41	Silt or fine sand w/ shells	n	n	n	n	y	n	n	shells+floccy greenish detritus	Silty/sandy bottom w/ dense shells+shell frags; greenish detritus (algae?) @ sed surface; dense shells+shell frags
NL06-04	B	8/26/2007	4:03 PM	ind	ind	ind	Silt or fine sand w/ shells	n	n	ind	n	ind	ind	n	shells	Image partially obscured by turbidity cloud; silt-sandy bottom w/ dense shells visible
NL06-04	C	8/26/2007	4:04 PM	76.44	50.77	0.39	Silt or fine sand w/ shells	n	n	n	n	n	n	n	shells	Image partially obscured by turbidity; silt-sandy bottom w/ dense shells visible
NL06-05	A	8/26/2007	4:38 PM	72.8	48.35	0.35	Silt or fine sand w/ shells	y	y	y	n	n	y	n	shells	Silt/sandy bottom w/ shells+shell frags; very small/subtle bedforms (assymetrical sand waves); 1 or 2 burrow openings
NL06-06	A	8/26/2007	4:43 PM	74.27	49.14	0.36	Silt or fine sand w/ dense shel	n	n	n	n	n	n	y	dense shells	Silty/sandy bottom w/ very dense shells (shell bed); some darker mud clasts or small rocks among shells
NL06-06	B	8/26/2007	4:43 PM	89.73	59.62	0.53	Silt or fine sand w/ dense shel	n	n	n	n	n	n	n	dense shells	Silty/sandy bottom w/ dense shells; some floccy detritus or greenish algal growth on sed surface(?)
NL06-07	A	8/26/2007	3:50 PM	78.49	52.21	0.41	Silt or fine sand w/ dense shel	n	y	y	n	n	n	y	dense shells	Silty/sandy bottom w/ dense shells; 1 burrow opening w/ mud clasts and 2 other mud clast mounds among shells
NL06-07	C	8/26/2007	3:51 PM	ind	ind	ind	Compact clay w/ shells	n	n	y	n	n	n	y	a few shells	Lasers not visible due to turbidity; left side of image show small hummocky mound of consolidated clay (weathered dm?); right side is silty mud w/ shells
NL06-08	A	8/26/2007	3:58 PM	79.91	53.07	0.42	Silt or fine sand w/ some shel	n	n	y	n	n	y	n	a few shell frags	Silt-sandy bottom w/ some shell frags; mud snails=mobile epifauna; some floccy detritus; small burrow openings
NL06-08	B	8/26/2007	3:59 PM	69.31	45.94	0.32	Silt or fine sand w/ some shel	n	y	n	n	n	y	n	some shells+shell frags	Silt-sandy bottom w/ some shell frags; small "bands" or "wind-rows" of floccy detritus
NL06-08	C	8/26/2007	4:00 PM	67.64	44.94	0.30	Silt or fine sand w/ shell frags	n	y	n	n	n	y	n	shells+shell frags	Silt-sandy bottom w/ shells+shell frags; significant accumulations of brown floccy organic detritus@sed surf; mud snails=mobile epifauna
NL06-09	A	8/26/2007	4:23 PM	77.91	51.75	0.40	Silt or fine sand w/ shell frags	n	n	n	n	n	n	y	shells+shell frags	Silt-sandy bottom w/ shells+shell frags; knobby surface=weathered consolidated clay clasts? some floccy detritus
NL06-10	A	8/26/2007	4:10 PM	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	Sed surface not visible due to turbidity cloud
NL06-11	A	8/26/2007	3:54 PM	81.76	54.31	0.44	Silty cohesive clay w/ dense s	n	n	n	n	n	y	y	dense shells and shell frags	Silty consolidated clay bottom w/ some cohesive clasts visible (weathered dm?) and dense shells/shell frags
NL06-11	B	8/26/2007	3:55 PM	59.59	39.64	0.24	Silt or fine sand w/ dense shel	n	n	n	n	n	n	n	dense shells+shell frags	Silty/sandy bottom w/ dense shells+shell frags; slightly fuzzy due to turbidity; a few small wood fragments
NL06-11	C	8/26/2007	3:56 PM	85.75	56.95	0.49	Silt or fine sand w/ dense shel	n	n	n	n	n	y	y	dense shells+shell frags	Silty/sandy bottom w/ dense shells+shell frags; 1 large mud clast
NL06-12	A	8/26/2007	4:29 PM	74.54	49.52	0.37	Silt or fine sand w/ dense shel	n	n	n	n	n	y	n	dense shells	Silty/sand bottom w/ dense shells+shell frags; some floccy brown detritus or epifaunal growth among shells
NL06-12	B	8/26/2007	4:29 PM	55.42	36.81	0.20	Silty cohesive clay w/ shells	n	n	n	n	n	y	y	some shells	Silty consolidated clay bottom w/ rocks+consolidated clay clasts (weathered dm?); epifauna (hydroids/bryozoans) on shells+rocks

Appendix C
Plan-View Image Results for NLDS

Station	Rep	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m2)	Sediment Type	Bedforms	Infauna	Burrows	Tubes	Tracks	Epifauna	Mudclasts	Debris	Comment
NL06-12	C	8/26/2007	4:30 PM	63.86	42.32	0.27	Silty/sandy cohesive clay w/ s	n	n	n	n	n	n	y	shells, leaves, wood	Silty-sandy consolidated clay bottom w/ some shells+shell frags; bumpy surface of consolidated clay=weathered dm; small leaves, crab claw, shells, wood
NL06-13	A	8/26/2007	4:15 PM	72.51	48.12	0.35	Silt/sand-covered cohesive cla	n	n	n	n	n	y	y	dense shells+shell frags	Silty-sandy consolidated clay w/ dense shells+shell frags (weathered dm); some floccy detritus or algal growth@sed surf
NL06-13	B	8/26/2007	4:15 PM	69.49	46.25	0.32	Silt/sand-covered cohesive cla	n	y	y	y	n	y	n	shells+shell frags	Silt/sand covered consolidated clay w/ moderately dense shells+shell frags (weathered dm); a few mud snails+1-2 burrow openings; surface tubes; floccy organic detritus
NL06-13	C	8/26/2007	4:16 PM	73.46	48.6	0.36	Silt/sand-covered cohesive cla	n	y	y	n	n	n	y	shells+shell frags	Silt/sand covered consolidated clay w/ mod dense shells+shell frags (weathered dm); a few burrow openings+mudclasts/rocks
NL06-14	A	8/26/2007	3:37 PM	78.33	52.1	0.41	Silt/sand covered cohesive cla	n	y	y	n	n	y	n	dense shells+shell frags	Silt/sand-covered consolidated clay w/ dense shells+shell frags=weathered dm; some floccy detritus@sed surf; small burrow openings; snails=mobile epifauna
NL06-14	B	8/26/2007	3:37 PM	76.89	50.95	0.39	Silt/sand covered cohesive cla	n	y	y	y	n	y	y	dense shells+shell frags	Silt/sand-covered consolidated clay w/ dense shells+shell frags=weathered dm; some floccy detritus@sed surf; small burrow openings
NL06-14	C	8/26/2007	3:38 PM	84.29	55.95	0.47	Silt/sand covered cohesive cla	n	y	y	y	n	y	y	shells+shell frags	Silt/sand-covered consolidated clay w/ shells+shell frags=weathered dm; some floccy detritus@sed surf; small burrow openings; mud snails/hermit crabs=mobile epifauna
NL06-15	A	8/26/2007	4:46 PM	79.13	52.45	0.42	Silt/sand covered cohesive cla	n	n	n	n	n	y	y	shells+shell frags	Silt/sand-covered consolidated clay w/ shells+shell frags=weathered dm; some floccy detritus@sed surf; mud snails/hermit crabs=mobile epifauna; hydroids/bryozoans@center
NL06-15	B	8/26/2007	4:47 PM	ind	ind	ind	Silt/sand covered cohesive cla	n	ind	ind	ind	n	ind	ind	dense shells+shell frags	Fuzzy image; lloks like silt/sand-covered consolidated clay w/ shells+shell frags=weathered dm; 1 strand of eelgrass (detritus not living)
NL-DS-01	A	8/26/2007	1:50 PM	82.6	54.76	0.45	Mixed sand/gravel w/ dense n	n	n	n	n	n	y	n	dense mussel shells	Fine to medium muddy sand w/ gravel and dense dead mussel shell=weathered dm; some epifaunal growth on mussel shells
NL-DS-01	B	8/26/2007	1:51 PM	81.93	54.2	0.44	Mixed sand/gravel w/ scattere	n	n	n	n	n	y	n	scattered mussel shells	Fine to medium muddy sand w/ assorted gravel and clusters of dead mussel shell=weathered dm; seastar+fish in upper left corner; hydroids/bryozoans growing on rocks/mussel shells
NL-DS-01	C	8/26/2007	1:53 AM	73.21	48.62	0.36	Mixed sand/gravel w/ scattere	n	n	n	n	n	y	n	wood+scattered mussel shells	Fine to medium muddy sand w/ assorted gravel and clusters of dead mussel shell=weathered dm; orange sponge in upper part of image; numerous hydroids/bryozoans growing on rocks/mussel shells; small retangular piece of wood
NL-DS-02	A	8/26/2007	1:04 PM	81.6	54.08	0.44	Muddy sand w/ some gravel+	n	y	y	n	n	y	n	a few dead mussel shells	Muddy fine sand w/ scattered small rocks (mostly granules/pebbles); 1 dense cluster of living mussels; a few dead mussel shells; hydroids on shells/rocks; 1 burrow opening
NL-DS-02	B	8/26/2007	1:05 PM	88.15	58.63	0.52	Muddy sand w/ gravel+shells	n	n	n	n	n	y	n	a few dead mussel shells	Muddy fine sand w/ small rocks (granules/pebbles); 1 cluster of dead mussel shells (possibly a few live mussels?); hyroids on rocks/mussels
NL-DS-02	C	8/26/2007	1:06 PM	80.76	53.6	0.43	Muddy sand w/ gravel+shells	n	n	n	n	n	y	n	some shells	Muddy fine sand w/ small rocks (granules/pebbles); 2 small clusters of live mussels; hyroids on rocks/mussels
NL-DS-03	A	8/26/2007	12:47 PM	66.36	44.09	0.29	Muddy sand w/ gravel+shells	n	n	n	n	y	y	n	some shells	Muddy fine sand w/ small rocks (granules/pebbles); 2 small clusters of live mussels; hyroids on rocks/mussels; tracks+many mud snails/hermit crabs; sed surf looks slightly scoured (small scour depressions around pebbles)

Appendix C
Plan-View Image Results for NLDS

Station	Rep	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m2)	Sediment Type	Bedforms	Infauna	Burrows	Tubes	Tracks	Epifauna	Mudclasts	Debris	Comment
NL-DS-03	C	8/26/2007	12:49 PM	71.58	47.54	0.34	Muddy sand w/ gravel+shells	n	n	n	n	n	y	n	some shells	Muddy fine sand w/ some small rocks (granules/pebbles); 1 small clusters of 2-3 live mussels; mud snails/hermit crabs
NL-DS-03	D	8/26/2007	12:51 PM	80.15	53.12	0.43	Muddy sand w/ gravel+shells	n	n	n	n	n	y	n	shells, shell frags, wood	Muddy fine sand w/ some small rocks (granules/pebbles); 1 clusters of live mussels; mud snails/hermit crabs; 1 piece of wood (branch); 1 piece of eelgrass
NL-DS-04	A	8/26/2007	2:21 PM	71.02	47.07	0.33	Gravel w/ shells+fine sand	n	n	n	n	n	n	n	some shells	Tightly-packed gravel (mostly granules/pebbles) w/ muddy sand and various shells (dead mussel shells+others);
NL-DS-04	B	8/26/2007	2:21 AM	71.9	47.76	0.34	Mussel shell bed over sandy s	n	n	n	n	n	n	n	very dense dead mussel shells	Shell bed of dead mussel shells overlying sandy silt-clay DM (from SPI image); little epifaunal growth on mussel shells=relatively recent transport?
NL-DS-04	C	8/26/2007	2:22 AM	83.8	55.54	0.47	Mussel shell bed over sandy s	n	n	n	n	n	n	n	very dense dead mussel shells	Shell bed of dead mussel shells overlying sandy silt-clay DM (from SPI image); little epifaunal growth on mussel shells=relatively recent transport? shells partially covered by silt in upper right corner
NL-DS-05	A	8/26/2007	12:56 PM	78.04	51.89	0.40	Muddy sand w/ some gravel	n	n	n	n	y	y	n	some shells	Sand w/ some gravel+several clusters of live mussels; hyroids on rocks/mussels; round divots in sed in upper part of image=possible foraging pits or former crab burrows
NL-DS-05	B	8/26/2007	12:57 PM	76.98	51.06	0.39	Muddy sand w/ shell frags	n	y	y	n	y	y	n	some small shell frags	Muddy sand w/ mostly small shell frags+1 dead mussel shell; a few small burrow openings(?); a few hermit crabs
NL-DS-05	C	8/26/2007	12:58 PM	84.56	56.12	0.47	Muddy sand w/ shell frags	y	y	y	n	n	y	n	some small shell frags	Muddy sand w/ some small shell frags+1 dead mussel shell; a few small burrow openings(?); a few hermit crabs; small assymetric ripples (indistinct bedforms)
NL-DS-06	A	8/26/2007	2:15 PM	79.99	53.12	0.42	Mussel shell bed w/ gravel	n	n	n	n	n	n	n	dense dead mussel shells	Most of image shows dense dead mussel shells over sandy gravel; part of image is just gravel; very little epifaunal growth on shells
NL-DS-06	B	8/26/2007	2:16 PM	83.8	55.66	0.47	Gravel (granules/pebbles)	n	n	n	n	n	y	n	1 or 2 dead mussel shells	Granule- to pebble-size gravel w/ some encrusting epifauna (hydroids) overlying sand (from SPI); a few white shell frags+1 dead mussel shell
NL-DS-06	C	8/26/2007	2:17 PM	80.2	53.12	0.43	Mussel shell bed over silty fin	n	n	n	n	n	n	n	very dense dead mussel shells	Shell bed of dead mussel shells overlying silty fine sand (from SPI image); little epifaunal growth on mussel shells
NL-DS-07	A	8/26/2007	1:42 PM	79.52	52.52	0.42	Sandy gravel w/ some shells	n	n	n	n	n	y	n	clusters of live mussels	Mixed gravel (mostly granules+pebbles) with silty brown sand, shell frags, and several clusters of live mussels; hydroids attached to some rocks/shells
NL-DS-07	B	8/26/2007	1:44 PM	78.21	52.05	0.41	Sandy gravel w/ some shells	n	n	n	n	n	y	n	several clusters of live mussels	Mixed gravel (mostly granules+pebbles) with silty brown sand, shell frags, and several clusters of live mussels; hydroids attached to some rocks/shells
NL-DS-08	A	8/26/2007	12:30 PM	74.93	49.84	0.37	Silty sand w/ some shells	n	n	n	y	n	y	n	dense clusters of live mussels	Silty brown sand w/ some small white shell frags and dense,
NL-DS-08	B	8/26/2007	12:31 PM	86.46	57.38	0.50	Silty sand w/ some shells	n	y	n	y	y	y	n	1 cluster of live mussels	Silty brown sand w/ shell frags+1 cluster of live mussels; 3 prominent white "soda straw" tubes@bottom of frame; tracks near mussel cluster
NL-DS-08	C	8/26/2007	12:32 PM	78.97	52.45	0.41	Silty sand w/ some white shell	n	n	n	y	y	y	n	many dense clusters of live mussels	Silty brown sand w/ several dense clusters of live mussels; hydroids on some mussels; a few snails+tubes; line in sed from camera base
NL-DS-09	A	8/26/2007	2:11 PM	86.2	57.13	0.49	Gravel (granules/pebbles) w/ a	n	n	n	n	n	y	n	a few dead mussel shells and other shells	Mixed gravel (mostly granules+pebbles) over silty brown sand (from SPI), some shell frags+dead mussel shells; hydroids attached to some rocks/shells
NL-DS-09	B	8/26/2007	2:12 PM	82.18	54.36	0.45	Gravel (granules/pebbles) w/ a	n	n	n	n	n	y	n	a few dead mussel shells and other shells	Mixed gravel (mostly granules+pebbles) over silty brown sand (from SPI), some shell frags+dead mussel shells; hydroids attached to some rocks/shells

Appendix C
Plan-View Image Results for NLDS

Station	Rep	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m2)	Sediment Type	Bedforms	Infauna	Burrows	Tubes	Tracks	Epifauna	Mudclasts	Debris	Comment
NL-DS-09	C	8/26/2007	2:13 PM	79.82	52.96	0.42	Gravel (granules/pebbles) w/ a	n	n	n	n	n	y	n	a few dead mussel shells+1 clam shell	Mixed gravel (mostly granules+pebbles) over silty brown sand (from SPI); dead mussel/clamshells; hydroids; outer tip of a seastar arm at lower edge of image
NL-DS-10	A	8/26/2007	12:04 PM	77.84	51.5	0.40	Sand w/ some gravel+shell fr	n	n	n	n	n	y	n	some shell frags	Brown sand w/ some gravel and shell frags; hydroids growing on some of the rocks/shells
NL-DS-10	B	8/26/2007	12:05 PM	87.42	58.17	0.51	Sand w/ some gravel+dense a	n	n	n	n	n	y	n	dense assorted shells+shell frags	Brown sand w/ some gravel and relatively dense shells+shell frags; hydroids growing on some of the rocks/shells; a few hermit crabs
NL-DS-10	C	8/26/2007	12:06 PM	82.85	55.04	0.46	Sand w/ some gravel+dense a	n	y	n	y	n	y	n	dense assorted shells+shell frags	Brown sand w/ some gravel and relatively dense shells+shell frags; 2 small clusters of live mussels; hydroids on some rocks/shells; 1 white "soda straw" tube@bottom of image
NL-DS-11	A	8/26/2007	12:24 PM	84.68	56.23	0.48	Sand w/ some gravel	n	n	n	n	n	y	n	clusters of live mussels	Brown sand w/ very little gravel+shells; a few clusters of live mussels
NL-DS-11	B	8/26/2007	12:25 PM	72.65	48.21	0.35	Sand w/ cohesive weathered c	n	n	n	n	n	y	y	a few shells/shell frags	Sand w/ chunks and clasts of cohesive dark clay; 1 cluster of live mussels; shell frags; a few hermit crabs
NL-DS-11	C	8/26/2007	12:27 PM	73.07	48.34	0.35	Sand w/ some shells	n	y	y	y	n	y	n	shells, shell frags and brown kelp-like algae	Sand w/ a few small clusters of live mussels+shells; scour depressions around shells=moderately high energy; a few mud snails/hermit crabs; brown kelp/algae
NL-DS-12	A	8/26/2007	2:06 PM	82.66	54.75	0.45	Sand w/ some shell and grave	n	n	n	n	n	y	y	a few shells+shell frags	Sand w/ some gravel+shell frags and dense clusters of live mussels; intact mud clasts
NL-DS-12	B	8/26/2007	2:06 PM	80.2	53.36	0.43	Sand w/ some shell and grave	n	y	y	n	n	y	y	a few shell frags	Sand w/ some gravel+shell frags and several large intact mud clast; mud snails/hermit crabs; small burrow openings
NL-DS-12	C	8/26/2007	2:07 PM	76.73	50.86	0.39	Sand w/ some gravel+shell	n	n	n	n	n	y	y	a few shells+shell frags	Sand w/ some gravel+shells and several intact mud clast "mounds"; 3 clusters of live mussels; indentation from camera base
NL-DS-13	A	8/26/2007	1:59 PM	82.77	54.97	0.45	Mixed sandy gravel w/ many	n	n	n	n	n	y	n	many dead mussel shells+other shells+1-2 strands of dead eelgrass	Mixed gravel (mostly graunules/pebbles) with sand+many dead shells (mostly mussel shells); a few hydroids+mud snails/hermit crabs
NL-DS-13	B	8/26/2007	2:00 PM	90.04	59.68	0.54	Mixed sandy gravel w/ many	n	n	n	n	n	y	n	many shells (mostly mussels)	Mixed gravel (mostly graunules/pebbles) with sand+many dead shells (mostly mussel shells); a few hydroids+mud snails/hermit crabs
NL-DS-13	C	8/26/2007	2:01 PM	78.9	52.41	0.41	Sandy gravel/gravelly sand w/	n	n	n	n	n	y	n	many shells+1-2 pieces wood branches	Gravelly fine sand (or fine sand w/ significant gravel); many dead shells, mostly mussels; 1-2 pieces wood debris; a few hydroids
NL-DS-14	A	8/26/2007	12:16 PM	84.94	56.3	0.48	Brown fine sand w/ some grav	n	y	y	n	n	y	n	a few shells	Fine brown sand w/ some gravel (mostly granules/pebbles) and a few cobble-size rocks w/ encrusting hydroids; a few mussel shells
NL-DS-14	B	8/26/2007	12:18 PM	68.96	45.8	0.32	Fine sand w/ gravel+shells	n	n	n	y	n	y	n	shells	Fine sand w/ embedded gravel (granules to cobbles) and many shells/shell frags; hydroids growing on some shells
NL-DS-14	C	8/26/2007	12:19 PM	70.5	46.87	0.33	Fine sand w/ some gravel+sh	n	n	n	n	n	y	n	some shells/shell frags+1 piece of string/rope	Fine sand w/ some mixed gravel (mostly granules)+shells; 1 orange sponge and a few hydroids
NL-DS-15	A	8/26/2007	12:37 PM	82.32	54.63	0.45	Fine sand w/ some gravel/shel	n	y	n	y	y	y	n	some shells/shell frags+1 piece green Ulva	Fine sand w/ some gravel/shells+many clusters of live mussels; 1-2 mud snails/hermit crabs; small tubes; faint tracks; hydroids+1 piece Ulva
NL-DS-15	B	8/26/2007	12:38 PM	ind	ind	ind	Fine sand w/ some gravel/shel	n	y	n	y	n	y	n	some shells/shell frags	One laser not visible=half of image obscured by turbidity=assume similar to previous rep=Fine sand w/ some gravel/shells+many clusters of live mussels
NL-DS-15	C	8/26/2007	12:39 PM	88.36	58.57	0.52	Fine sand w/ some gravel+sh	y	y	n	y	n	y	n	some shells/shell frags	Somewhat rippled fine sand (ripples small +assymetrical) w/ some minor gravel+shells (several dead mussel shells); hermit crabs/mud snails; tubes(?)
NLON-REF-01	A	8/27/2007	7:18 AM	78.14	51.91	0.41	Fine sand w/ large shells	n	y	n	y	y	y	n	clusters+individual dead shells (mostly Crepidula?); eelgrass fragments	Muddy fine sand w/ shells - individual and shell clusters; hydroids growing on shells; long eelgrass fragments; one decapod

Appendix C
Plan-View Image Results for NLDS

Station	Rep	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m2)	Sediment Type	Bedforms	Infauna	Burrows	Tubes	Tracks	Epifauna	Mudclasts	Debris	Comment
NLON-REF-01	B	8/27/2007	7:18 AM	ind	ind	ind	Fine sand w/ large shells	n	y	n	y	y	y	n	dead shells+shell clusters (mostly Crepidula?)	Lasers not visible due to turbidity; assume similar to previous rep=sand w/ shell, hydroids, pieces of eelgrass or other plant debris
NLON-REF-01	C	8/27/2007	7:19 AM	82.51	54.69	0.45	Muddy fine sand w/ a few lar	n	y	n	y	y	y	n	a few dead shells+shell clusters (some Crepidula shells)	Muddy fine sand w/ a few shells; shells have epifaunal growth=hydroids/ red algae?; some mud snails/hermit crabs
NLON-REF-02	A	8/27/2007	7:28 AM	79.91	52.86	0.42	Muddy fine sand	y?	y	y	y	n	y	n	a few strands of dead eelgrass	Muddy fine sand w/ small divots (biogenic feeding pits or scour depressions superimposed on shallow bedforms); several tubes+burrow; a few mud snails
NLON-REF-02	B	8/27/2007	7:29 AM	79.05	52.5	0.42	Muddy fine sand	y?	y	y	y	n	y	n	n	Muddy fine sand w/ small divots (biogenic feeding pits or scour depressions superimposed on shallow bedforms); several tubes+burrow; a few hermit crabs
NLON-REF-02	C	8/27/2007	7:30 AM	78.06	51.85	0.40	Muddy fine sand	y?	y	y	y	n	y	n	n	Muddy fine sand w/ small divots (biogenic feeding pits superimposed on shallow bedforms); several tubes+burrow; a few hermit crabs/mud snails
NLON-REF-03	A	8/27/2007	7:23 AM	74.86	49.69	0.37	Muddy fine sand	n	y	y	y	y	y	n	several strands of dead eelgrass	Muddy fine sand w/ just a few shells; small burrows; feeding pits/excavations in sed; hydroids/bryzoans; several strands of dead eelgrass
NLON-REF-03	B	8/27/2007	7:24 AM	73.46	48.8	0.36	Muddy fine sand	y	y	y	y	n	y	n	a few shells	Muddy fine sand w/ just a few shells; small burrows+some tubes; subtle bedforms=assymetrical ripples; mud snails/hermit crabs
NLON-REF-03	C	8/27/2007	7:25 AM	ind	ind	ind	Muddy fine sand	n	y	y	y	n	y	n	a few shells; hydroids; red algae?	Lasers not visible due to turbidity; muddy fine sand w/ a few shells, hyroids, algae(?); mud snails/hermit crabs
NLON-REF-04	A	8/27/2007	7:06 AM	78.11	51.94	0.41	Muddy fine sand w/ dense she	n	n	n	n	n	y	n	dense Crepidula shells+dead eelgrass	Muddy fine sand w/ dense Crepidula shells+pieces of dead eelgrass
NLON-REF-04	B	8/27/2007	7:07 AM	79.37	52.72	0.42	Muddy fine sand w/ dense she	n	y	n	y	n	y	n	dense Crepidula shells+dead eelgrass	Muddy fine sand w/ dense Crepidula shells+pieces of dead eelgrass; clumps of red algae and other macrophytes
NLON-REF-04	C	8/27/2007	7:08 AM	ind	ind	ind	Muddy fine sand w/ dense she	n	n	y	y	n	y	n	dense Crepidula shells+dead eelgrass	Muddy fine sand w/ dense Crepidula shells+pieces of dead eelgrass; red algae
NLON-REF-05	A	8/27/2007	7:13 AM	76.99	51.2	0.39	Muddy fine sand w/ a few she	n	y	y	y	n	y	n	a few shells+1-2 strands of eelgrass	Muddy fine sand w/ a few shells; hydroids on shells; a few strands of dead eelgrass; a few mud snails/hermit crabs
NLON-REF-05	B	8/27/2007	7:14 AM	76.8	51.01	0.39	Muddy fine sand w/ some she	n	y	n	y	n	y	n	a few shells+1-2 strands of eelgrass+red algae?	Muddy fine sand w/ a few shells; some hydroid+a few strands of dead eelgrass+a few mud snails/hermit crabs+1 orange sponge+red algae+several white tubes (Chaetopterus-like)
NL-USCGA-01	A	8/26/2007	10:41 AM	76.48	50.88	0.39	Muddy fine sand w/ many she	n	y	n	y	n	y	n	many shells+a few live mussel clusters	Muddy fine sand w/ various sized shells+shell frags+a few live mussel clusters
NL-USCGA-01	B	8/26/2007	10:42 AM	75.2	50.02	0.38	Muddy fine sand w/ dense she	n	y	y	n	n	y	n	dense shells of different sizes+2 live mussel clusters	Muddy fine sand w/ various sized shells+shell frags+a few live mussel clusters
NL-USCGA-01	C	8/26/2007	10:44 AM	76.06	50.58	0.38	Muddy fine sand w/ dense she	n	y	y	y	n	y	n	dense shells of different sizes+several clusters of live mussels	Muddy fine sand w/ various sized shells+shell frags+several clusters of live mussels
NL-USCGA-02	A	8/26/2007	9:25 AM	84.73	56.24	0.48	Muddy fine sand w/ some she	n	y	y	y	n	y	n	some shells+shell frags of different sizes	Muddy fine sand w/ moderate numbers of shells+shell frags; a few small burrow openings, worm tubes, and mobile epifauna (a few mud snails/hermit crabs)
NL-USCGA-02	B	8/26/2007	9:25 AM	78.26	51.73	0.40	Muddy fine sand	n	y	y	y	n	y	n	small number of shells/shell frags	Muddy fine sand w/ small numbers of shells+shell frags; 2 live mussels lower left corner; small burrow openings
NL-USCGA-03	A	8/26/2007	9:38 AM	74.69	49.53	0.37	Muddy fine sand w/ shell frag	n	y	y	y	n	y	n	many shell frags	Muddy fine sand w/ many shell frags; a few small burrow openings, tubes, and mud snails/hermit crabs
NL-USCGA-03	D	8/26/2007	11:19 AM	82.4	54.69	0.45	Muddy fine sand w/ shell frag	n	y	y	y	n	y	y	many shell frags	Muddy fine sand w/ many shell frags; a few small burrow openings, tubes, and mud snails/hermit crabs
NL-USCGA-03	F	8/26/2007	11:20 AM	74.34	48.87	0.36	Muddy fine sand w/ dense she	n	y	y	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ dense shells+shell frags; a few small burrow openings, tubes, and mud snails/hermit crabs; 2 "soda straw" tubes

Appendix C
Plan-View Image Results for NLDS

Station	Rep	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m2)	Sediment Type	Bedforms	Infauna	Burrows	Tubes	Tracks	Epifauna	Mudclasts	Debris	Comment
NL-USCGA-04	A	8/26/2007	9:13 AM	78.41	52.04	0.41	Muddy fine sand w/ shells+sl	n	y	n	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ dense shells+shell frags; several clusters of live mussels; a few tubes+mud snails/hermit crabs; school of small fish
NL-USCGA-O4	D	8/26/2007	11:40 AM	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	Visibility obscured by high turbidity; assume similar to previous rep=muddy fine sand w/ shells+clusters of live mussels
NL-USCGA-05	A	8/26/2007	10:28 AM	82.35	54.58	0.45	Muddy fnie sand w/ abundant	n	y	n	y	y	y	n	shells+shell frags	Muddy fine sand w/ dense shells+shell frags; several clusters of live mussels; tubes, tracks, and a few hermit crabs
NL-USCGA-05	C	8/26/2007	10:30 AM	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	Visibility obscured by high turbidity; assume similar to previous rep=muddy fine sand w/ shells+clusters of live mussels
NL-USCGA-06	A	8/26/2007	10:12 AM	81.68	54.14	0.44	Muddy fine sand w/ abundant	n	y	n	y	y	y	n	shells+shell frags	Muddy fine sand w/ dense shells+shell frags; many small clusters of live mussels; tubes, many tracks, and a few hermit crabs
NL-USCGA-06	B	8/26/2007	10:13 AM	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	Visibility obscured by high turbidity; assume similar to previous rep=muddy fine sand w/ shells+clusters of live mussels (live mussel cluster in SPI image)
NL-USCGA-06	C	8/26/2007	10:14 AM	85.81	56.96	0.49	Muddy fine sand w/ some she	ind	y	n	y	y	y	n	some shells+shell frags	Muddy fine sand w/ dense shells+shell frags; several clusters of many live mussels; tubes, some faint tracks, and a few hermit crabs/mud snails
NL-USCGA-07	A	8/26/2007	8:57 AM	78.87	52.5	0.41	Muddy fine sand w/ dense she	n	y	n	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ dense shells+shell frags; 1 cluster of a few live mussels; some tubes and a few hermit crabs/mud snails
NL-USCGA-07	B	8/26/2007	8:58 AM	77.36	51.27	0.40	Muddy fine sand w/ dense she	n	y	n	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ very dense shells+shell frags; several clusters of live mussels; many dead mussel shells.
NL-USCGA-07	C	8/26/2007	8:59 AM	ind	ind	ind	Muddy fine sand w/ dense she	n	y	n	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ very dense shells+shell frags; several clusters of live mussels; some dead mussel shells.
NL-USCGA-08	A	8/26/2007	10:35 AM	75.8	50.35	0.38	Muddy fine sand w/ shells+sl	n	y	n	y	y	n	n	shells and shell frags	Muddy fine sand w/ shells+shell frags; many clusters of live mussels - mussels are very dense, almost continuous
NL-USCGA-08	B	8/26/2007	10:36 AM	76.88	50.95	0.39	Muddy fine sand w/ gravel+d	n	y	n	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ mixed gravel, shells+shell frags; many dead mussel shells; several clusters of live mussels.
NL-USCGA-08	C	8/26/2007	10:37 AM	77.24	51.32	0.40	Muddy fine sand w/ gravel+d	n	n	n	n	n	y	n	dense shells+shell frags	Muddy fine sand w/ mixed gravel+shells/shell frags; many dead mussel shells: a few clusters of live mussels; a few rope-like or wood-like encrusted objects
NL-USCGA-09	A	8/26/2007	10:48 AM	77.02	51.16	0.39	Muddy fine sand w/ shells+sl	n	y	n	y	n	y	n	many shells+shell frags	Muddy fine sand w/ shells+shell frags; several large clusters of live mussels
NL-USCGA-09	B	8/26/2007	10:49 AM	78.52	52.15	0.41	Muddy fine sand w/ shells+sl	n	y	y	y	n	y	n	many shells+shell frags	Muddy fine sand w/ shells+shell frags; 1-2 clusters of live mussels; small burrow openings; large rock@upper part of image
NL-USCGA-09	C	8/26/2007	10:50 AM	ind	ind	ind	Muddy fine sand w/ shells+sl	n	y	y	ind	ind	y	n	some shells+shell frags+1 piece of wood	Image partially obscured by turbidity - lasers not visible; muddy fine sand w/ shells+shell frags; several large clusters of live mussels; 1 piece of wood debris
NL-USCGA-10	D	8/26/2007	11:25 AM	86.09	57.25	0.49	Muddy fine sand w/ dense she	n	y	n	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ dense shells+shell frags; several large clusters of live mussels; a few hyroids on mussels
NL-USCGA-10	E	8/26/2007	11:26 AM	85.38	56.49	0.48	Muddy fine sand w/ dense she	n	y	y	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ dense shells+shell frags; 2-3 small clusters of live mussels; small burrow openings; some hydroids growing on mussels
NL-USCGA-10	F	8/26/2007	11:27 AM	ind	ind	ind	Muddy fine sand w/ dense she	n	y	y	y	n	y	n	dense shells+shell frags	Image partially obscured by turbidity - only 1 laser visible; Muddy fine sand w/ very dense shells+shell frags; several medium clusters of live mussels
NL-USCGA-11	D	8/26/2007	11:32 AM	79.75	52.87	0.42	Muddy fine sand w/ dense she	n	y	y	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ dense shells+shell frags; 1 small cluster of live mussels; small burrows, several worm tubes, hermit crab

Appendix C
Plan-View Image Results for NLDS

Station	Rep	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m2)	Sediment Type	Bedforms	Infauna	Burrows	Tubes	Tracks	Epifauna	Mudclasts	Debris	Comment
NL-USCGA-11	E	8/26/2007	11:34 AM	83.6	55.37	0.46	Muddy fine sand w/ dense she	n	y	n	y	n	y	n	very dense shells+shell frags	Muddy fine sand w/ very dense shells+shell frags; several small clusters of live mussels; small tubes
NL-USCGA-11	F	8/26/2007	11:35 AM	80.78	53.65	0.43	Muddy fine sand w/ dense she	n	y	y	y	n	y	n	dense shells+shell frags	Muddy fine sand w/ dense shells+shell frags; 1 small cluster of live mussels; indentation from camera base; small tubes+a few small burrow openings
NL-USCGA-12	A	8/26/2007	9:27 AM	84.05	55.83	0.47	Muddy fine sand w/ small nur	n	y	n	y	y	n	n	small number of shell frags	Muddy fine sand w/ small number of shell frags+relatively featureless surface; slight rippling(bedforms); 1 relatively large straight-line indentation
NL-USCGA-12	B	8/26/2007	9:28 AM	81.6	53.97	0.44	Muddy fine sand w/ shells+sl	n	y	n	y	y	y	n	shells+shell frags	Muddy fine sand w/ moderate number of shells+shell frags; several hermit crabs+small faint tracks; small tubes
NL-USCGA-12	C	8/26/2007	9:29 AM	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	ind	Visibility obscured by high turbidity; assume similar to previous rep=muddy fine sand w/ some shells
NL-USCGA-13	D	8/26/2007	8:39 AM	78.19	51.99	0.41	Muddy/silty fine sand w/ dens	n	y	n	y	n	y	n	shells+shell frags	Muddy fine sand w/ shells+shell frags; several large clusters of dense live mussels (one-half of image=mussels); some epifaunal growth on mussel shells
NL-USCGA-13	E	8/26/2007	8:40 AM	72.67	48.26	0.35	Muddy fine sand w/ shells+sl	n	y	n	y	n	y	n	shells+shell frags	Muddy fine sand w/ mostly small shell frags; several big clusters of dense live mussels; crab in mussel cluster@right
NL-USCGA-14	A	8/26/2007	10:20 AM	84.29	55.94	0.47	Muddy fine sand w/ shells+sl	n	y	n	y	y	y	n	shells+shell frags	Muddy fine sand w/ dense shells+shell frags; several big clusters of dense live mussels; faint tracks near middle of image
NL-USCGA-14	B	8/26/2007	10:21 AM	ind	ind	ind	Muddy fine sand w/ shells+sl	n	ind	ind	y	ind	y	ind	shells+shell frags+brown algae (kelp or dead Ulva?)	Image partially obscured by turbidity; assume similar to previous rep=muddy fine sand w/ shells+shell frags: several clusters of live mussels
NL-USCGA-14	C	8/26/2007	10:22 AM	76.34	50.67	0.39	Muddy fine sand w/ shells+sl	n	y	n	y	n	y	n	shells+shell frags	Muddy fine sand w/ shells+shell frags; dense clusters of live mussels; some epifaunal growth on mussels
NL-USCGA-15	A	8/26/2007	10:04 AM	77.99	51.69	0.40	Muddy fine sand w/ some she	n	y	n	y	n	y	n	some shells+shell frags	Muddy fine sand w/ some minor shells+shell frags; very dense clusters of live mussels
NL-USCGA-15	B	8/26/2007	10:05 AM	80.84	53.77	0.43	Muddy fine sand w/ shells+sl	n	y	n	y	n	y	n	shells+shell frags	Muddy fine sand w/ dense shells+shell frags; several clusters of live mussels; a few tubes; 1 brownish bryozoan or hydroid growing on mussel cluster
NL-USCGA-15	C	8/26/2007	10:06 AM	73.63	48.88	0.36	Muddy fine sand w/ dense she	n	y	y	y	y	y	n	shells+shell frags	Muddy fine sand w/ dense shells+shell frags; several large clusters of live mussels; a few small burrow openings; a few worm tubes; 1 set of faint tracks
NLON-NEREF-01	B	8/27/2007	8:13 AM	82.44	54.76	0.45	Muddy fine sand or sandy mu	y	y	y	y	n	n	n	a few shells/shell frags	Muddy fine sand w/ a few shell frags; small scour depressions (bedforms) in sed surface and behind shell frags
NLON-NEREF-01	C	8/27/2007	8:14 AM	80.62	53.45	0.43	Muddy fine sand or sandy mu	y	y	y	y	n	n	n	a few shells/shell frags	Muddy fine sand w/ a few shell frags; small scour depressions (bedforms) in sed surface and behind shell frags
NLON-NEREF-02	A	8/27/2007	8:07 AM	84.85	56.36	0.48	Muddy fine sand or sandy mu	y	y	y	y	n	n	n	a few shells/shell frags	Muddy fine sand w/ a few shell frags; very faint scour depressions (bedforms) in sed surface and behind shell frags
NLON-NEREF-02	B	8/27/2007	8:08 AM	84.94	56.07	0.48	Muddy fine sand/sandy mud w	y	y	y	y	n	n	n	a few shells/shell frags	Muddy fine sand w/ a few shell frags; very faint scour depressions (bedforms) in sed surface and behind shell frags
NLON-NEREF-03	A	8/27/2007	8:15 AM	77.51	51.55	0.40	Muddy fine sand/sandy mud w	y	y	y	y	y	n	n	a few shells/shell frags+some floccy detritus	Muddy fine sand w/ a few shell frags; very faint depressions in sed surface (biogenic pits); some floccy brownish/yellowish detritus@sed surf
NLON-NEREF-03	B	8/27/2007	8:16 AM	78.75	52.29	0.41	Muddy fine sand/sandy mud w	n	y	y	y	y	n	n	some floccy detritus	Muddy fine sand w/ a few shell frags; sed surf has faint hummocky appearance=tracks or biogenic mounds/pits; spider crab@bottom of frame; some floccy brownish/yellowish detritus@sed surf

Appendix C
Plan-View Image Results for NLDS

Station	Rep	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m2)	Sediment Type	Bedforms	Infauna	Burrows	Tubes	Tracks	Epifauna	Mudclasts	Debris	Comment
NLON-NEREF-04	A	8/27/2007	7:54 AM	79.57	52.91	0.42	Muddy fine sand/sandy mud w	y	y	n	y	y	n	n	a few shell frags+some floccy detritus	Muddy fine sand w/ very few shell frags; slightly hummocky appearance suggestive of small bedforms (from gentle current scouring of sed surf); faint tracks?
NLON-NEREF-04	B	8/27/2007	7:55 AM	85.09	56.48	0.48	Muddy fine sand w/ a few she	y	y	y	y	y	n	n	a few shell frags	Muddy fine sand w/ very few shell frags; slightly hummocky sed surface (gentle current scouring of fine sand surface).
NLON-NEREF-04	C	8/27/2007	7:56 AM	83.88	55.5	0.47	Muddy fine sand w/ a few she	y	y	y	y	y	n	y	a few shell frags+some floccy detritus	Muddy fine sand w/ very few shell frags; slightly hummocky sed surface (gentle current scouring of fine sand surface); mud clasts@left
NLON-NEREF-05	A	8/27/2007	8:01 AM	78.11	51.95	0.41	Muddy fine sand w/ a few she	y	y	y	y	y	n	n	a few shell frags+some floccy detritus	Muddy fine sand w/ very few shell frags; sed surf has slightly hummocky or "washed" appearance (gentle current scouring of fine sand surface); 1-2 white tubes; a few small burrow openings
NLON-NEREF-05	B	8/27/2007	8:01 AM	85.18	56.65	0.48	Muddy fine sand w/ a few she	y	y	y	y	y	n	n	a few shell frags+some floccy detritus	Muddy fine sand w/ very few shell frags; sed surf has slightly "washed" appearance (e.g., scour depression around shell cluster in upper part of image); a few small burrow openings
NLON-NEREF-05	C	8/27/2007	8:02 AM	84.14	55.65	0.47	Muddy fine sand w/ a few she	n	y	y	y	y	n	n	a few shell frags	Muddy fine sand w/ very few shell frags; base frame indentation in lwr left corner; 2 \white tubes near upper part of image; sed surface has slightly scoured appearance
NLON-WREF-01	A	8/27/2007	8:42 AM	82.35	54.69	0.45	Fine to medium sand w/ shell	n	y	n	n	n	y	n	many shell frags	Fine to medium sand w/ shell hash+very dense shell frags; hydroids growing on some of the shells
NLON-WREF-01	B	8/27/2007	8:42 AM	76.77	51.06	0.39	Fine/medium sand w/ shell ha	n	y	n	n	n	y	n	many shell frags	Fine to medium sand w/ shell hash+very dense shell frags; hydroids growing on some of the shells
NLON-WREF-01	C	8/27/2007	8:43 AM	80.68	53.55	0.43	Fine/medium sand w/ very de	n	y	n	n	n	y	n	many shell frags	Fine to medium sand w/ very dense shell hash/shell frags; left one-third of image obscured by turbidity
NLON-WREF-02	A	8/27/2007	9:07 AM	70.28	46.58	0.33	Muddy fine sand w/ some she	n	y	n	y	y	y	n	some shell hash	Muddy fine sand w/ minor amount of shell hash; very dense+abundant clusters of live mussels (one-half of image=live mussel clusters); tracks on sed surf among mussel clusters; some tubes?
NLON-WREF-02	B	8/27/2007	9:08 AM	77.17	51.16	0.39	Muddy fine sand/sandy mud w	n	y	y	y	n	y	n	dense shells+shell frags	Muddy fine sand or sandy mud w/ dense shells, shell frags+shell hash; dense clusters of live mussels@left side of image
NLON-WREF-02	C	8/27/2007	9:09 AM	75.06	49.62	0.37	Muddy fine sand w/ dense she	n	y	y	y	n	y	n	dense shell frags+shell hash	Muddy fine sand w/ dense shells hash+shell frags+shells; dense clusters of live mussels; a few small burrow openings
NLON-WREF-03	A	8/27/2007	8:53 AM	69.97	46.4	0.32	Sand (from SPI) w/ dense cov	n	n	n	n	n	y	n	dense shells+shell frags	Almost continuous layer of dead shells+shell frags+shell hash (i.e., shell bed) overlying sandy sed w/ shell hash (from SPI); little evidence of infaunal activity
NLON-WREF-03	B	8/27/2007	8:54 AM	81.75	54.26	0.44	Sand (from SPI) w/ dense cov	n	n	n	n	n	y	n	dense shells+shell frags	Almost continuous layer of dead shells+shell frags+shell hash (i.e., shell bed) overlying sandy sed w/ shell hash (from SPI); little evidence of infaunal activity
NLON-WREF-03	C	8/27/2007	8:55 AM	80.47	53.23	0.43	Sand (from SPI) w/ dense cov	n	n	n	n	n	y	n	dense shells+shell frags	Almost continuous layer of dead shells+shell frags+shell hash (i.e., shell bed) overlying sandy sed w/ shell hash (from SPI); little evidence of infaunal activity
NLON-WREF-04	A	8/27/2007	8:47 AM	73.36	48.59	0.36	Sand (from SPI) w/ dense cov	n	n	n	n	n	y	n	dense shells+shell frags	Almost continuous layer of dead shells+shell frags+shell hash (i.e., shell bed) overlying sandy sed w/ shell hash (from SPI); little evidence of infaunal activity
NLON-WREF-04	B	8/27/2007	8:48 AM	81.93	54.3	0.44	Sand (from SPI) w/ dense cov	n	n	n	n	n	y	n	dense shells+shell frags	Almost continuous layer of dead shells+shell frags+shell hash (i.e., shell bed) overlying sandy sed w/ shell hash (from SPI); little evidence of infaunal activity
NLON-WREF-04	C	8/27/2007	8:49 AM	78.33	52.09	0.41	Sand (from SPI) w/ dense cov	n	n	n	n	n	y	n	dense shells+shell frags	Almost continuous layer of dead shells+shell frags+shell hash (i.e., shell bed) overlying sandy sed w/ shell hash (from SPI); little evidence of infaunal activity

Appendix C
Plan-View Image Results for NLDS

Station	Rep	Date	Time	Image Width (cm)	Image Height (cm)	Field of View imaged (m2)	Sediment Type	Bedforms	Infauna	Burrows	Tubes	Tracks	Epifauna	Mudclasts	Debris	Comment
NLON-WREF-05	A	8/27/2007	9:00 AM	81.6	54.1	0.44	Sand (from SPI) w/ dense she	n	y	n	n	n	y	n	dense shells+shell frags	Muddy sand w/ dense shells+shell hash; many small clusters of shells w/ dense epifaunal growth (hydroids/bryozoans) @ sed surface; a few live mussels
NLON-WREF-05	B	8/27/2007	9:01 AM	87.69	58.14	0.51	Sand (from SPI) w/ dense she	n	y	n	n	n	y	n	dense shells+shell frags+alga	Muddy sand w/ dense shells+shell hash; many small clusters of shells w/ dense epifaunal growth (hydroids/bryozoans/red algae?) @ sed surface; a few live mussels
NLON-WREF-05	C	8/27/2007	9:02 AM	86.39	57.14	0.49	Sand (from SPI) w/ dense she	n	y	n	n	n	y	n	dense shells+shell frags+alga	Muddy sand w/ dense shells+shell hash; 1-2 clusters of shells w/ dense epifaunal growth (hydroids/bryozoans/red+green algae) @ sed surface; 2 seastars w/ algae shell cluster

Appendix D

Grain Size Sample Results

GeoTesting express
a subsidiary of Geocomp Corporation

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

Transmittal

TO:

Mr. Ryan McCarthy
ENSR International
2 Technology Park Drive
Westford, MA 01886

DATE: 1/28/2008	GTX NO: 7980
RE: MBDS Capping Study Phase I Project	

COPIES	DATE	DESCRIPTION
1	1/28/2008	**January 2008 Laboratory Test Reports**

REMARKS:

CC:

SIGNED: Joe Tomei – Laboratory Manager

APPROVED BY: Gary Torosian – Director of Testing Services

GeoTesting express
a subsidiary of Geocomp Corporation

Boston
Atlanta
New York

www.geocomp.com/geotesting

January 28, 2008

Mr. Ryan McCarthy
ENSR International
2 Technology Park Drive
Westford, MA 01886

Re: MBDS Capping Study Phase I Project (GTX-7980)

Dear Mr. McCarthy:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received 13 soil samples from you on January 21, 2008. These samples were labeled as follows:

DEMO-1: Bottom, Middle, Top
DEMO-2: Bottom, Middle, Top
DEMO-3: Bottom, Middle, Top
DEMO-15: Bottom, Middle, Top
NLDS-06-16

GTX performed the following tests on these samples:

13 Grain Size Analyses (ASTM D 422) with Hydrometer
12 Moisture Contents (ASTM D 2216)
12 Atterberg Limits (ASTM D 4318)

A copy of your test request is attached.

The results presented in this report apply only to the items tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of these samples will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

Respectfully yours,

Joe Tomei
Laboratory Manager

GeoTesting express
a subsidiary of Geocomp Corporation

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

Geotechnical Test Report

January 28, 2008

GTX-7980
MBDS Capping Study
Phase I
Project

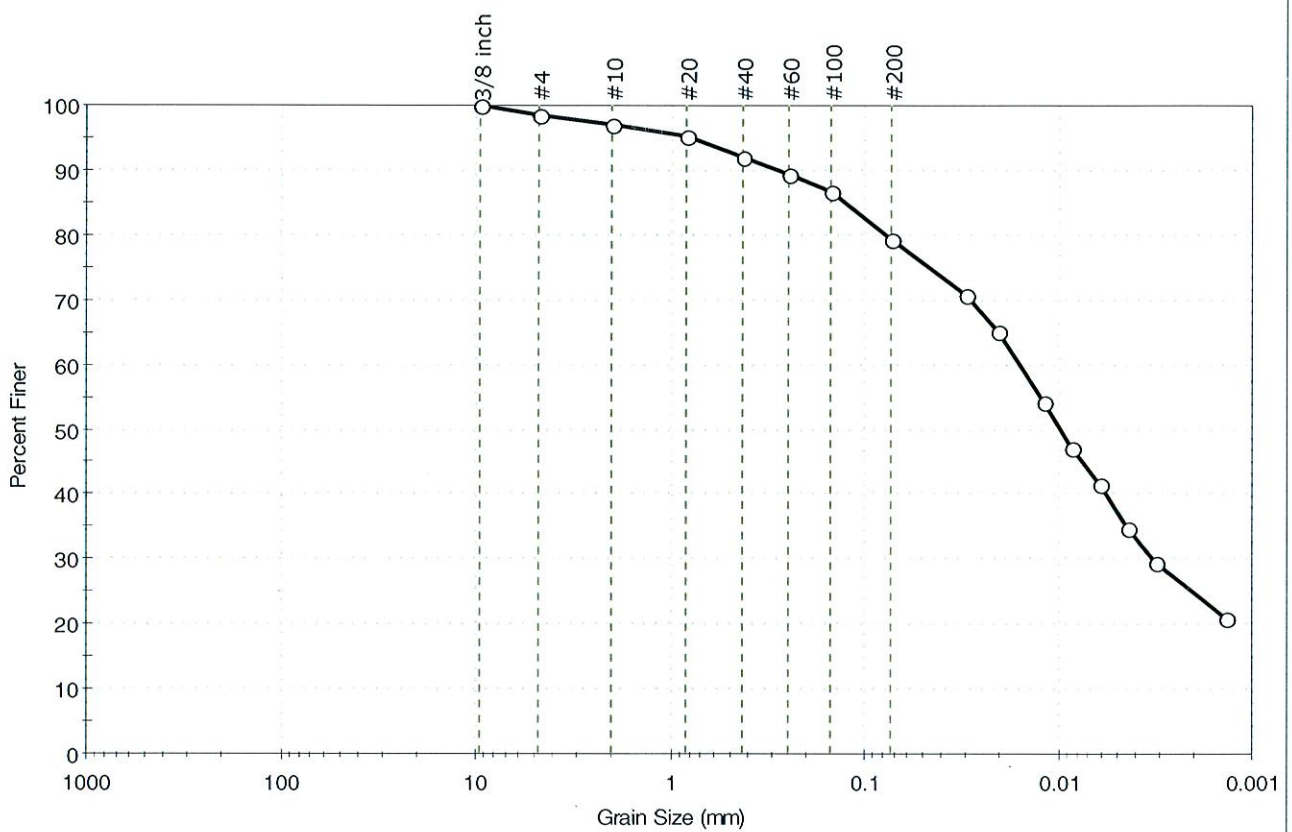
Prepared for:

ENSR INTERNATIONAL

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	ENSR International				
Project:	MBDS Capping Study Phase I				
Location:				Project No:	GTX-7980
Boring ID:	---	Sample Type:	bag	Tested By:	ap
Sample ID:	NLDS-06-16	Test Date:	01/23/08	Checked By:	jdt
Depth :	---	Test Id:	125636		
Test Comment:	---				
Sample Description:	Wet, black clay with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



%Cobble	%Gravel	%Sand	%Silt & Clay Size
---	1.5	19.2	79.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8 inch	9.51	100		
#4	4.75	99		
#10	2.00	97		
#20	0.84	95		
#40	0.42	92		
#60	0.25	89		
#100	0.15	87		
#200	0.074	79		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0306	71		
---	0.0205	65		
---	0.0120	54		
---	0.0086	47		
---	0.0062	42		
---	0.0044	35		
---	0.0032	29		
---	0.0014	21		

Coefficients

D_{85} = 0.1273 mm	D_{30} = 0.0033 mm
D_{60} = 0.0159 mm	D_{15} = N/A
D_{50} = 0.0098 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 1/25/2008 1:02:06 PM

ENSR | AECOM

CHAIN OF CUSTODY RECORD

Client/Project Name: USACE	Project Location: MASS BAY
Project Number: 09000-423-200	Field Logbook No.: 0707A408
Sampler (Print Name)/(Affiliation): RYAN McCARTHY / ENSR	Chain of Custody Tape Nos.:
Signature:	Send Results/Report to: TAT:

Container Type: P – Plastic; A – Amber Glass; G – Clear Glass; V – VOA Vial; O – Other; E – Encore

Preservation: 1 – HCl, 4°; 2 – H2SO4, 4°; 3 – HNO3, 4°; 4 – NaOH, 4°; 5 – NaOH/ZnAc, 4°; 6 – Na2S2O3, 4°; 7 – 4°

Matrix Codes: DW – Drinking Water; WW – Wastewater; GW – Groundwater; SW – Surface Water; ST – Storm Water; W – Water; S – Soil; SL – Sludge; SD – Sediment; SO – Solid; A – Air; L – Liquid; P – Product

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	Analysis Requested: WATER CONTENT / D-2216	Analysis Requested: GRAIN SIZE / HYDROMETER D-422	Analysis Requested: PERMEABILITY / D-4318	Lab I.D.	Remarks
DEMO-1-TOP	8/24/07	~~1450~~		X	P-BAG	SD	4°C	N/A	✓	✓	✓		
DEMO-1-MID		1550		X									
DEMO-1-BOT		"		X									
DEMO-2-TOP		1500		X									
DEMO-2-MID		"		X									
DEMO-2-BOT		"		X									
DEMO-3-TOP	11	1429		X									
DEMO-3-BOT		"		X									
DEMO-3-MID		"		X									
DEMO-15-TOP		1615		X									
DEMO-15-MID		"		X									
DEMO-15-BOT		"		X					↓	↓	↓		
NLDS-06-15	8/27/07	0937		X	"	"	"	"		X			

Relinquished by: (Print Name)/(Affiliation) D Lewis / ENSR Signature:	Date: 8/28/07 Time: 11:10	Received by: (Print Name)/(Affiliation) Stephanie Wilson / ENSR Signature:	Date: 8/29/07 Time: 1110
Relinquished by: (Print Name)/(Affiliation) Stephanie Wilson / ENSR Signature:	Date: 1/21/08 Time: 1120	Received by: (Print Name)/(Affiliation) RYAN McCARTHY / ENSR Signature:	Date: 1/21/08 Time: 1130
Relinquished by: (Print Name)/(Affiliation) RYAN MCCARTHY / ENSR Signature:	Date: 1/21/08 Time: 1200	Received by: (Print Name)/(Affiliation) Richard Lunetta Signature:	Date: 1/21/08 Time: 12:15

Analytical Laboratory (Destination):

Sample Shipped Via: UPS FedEx Courier Other

Temp blank: Yes No

White: Original (to Lab) Yellow: Lab Pink: Sampler

Serial No. 01434

GeoTesting express

a subsidiary of Geocomp Corporation

WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$
B	pore pressure parameter for $\Delta\sigma_3$
CIU	isotropically consolidated undrained triaxial shear test
CR	compression ratio for one dimensional consolidation
C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$
C_u	coefficient of uniformity, D_{60}/D_{10}
C_c	compression index for one dimensional consolidation
C_α	coefficient of secondary compression
c_v	coefficient of consolidation
c	cohesion intercept for total stresses
c'	cohesion intercept for effective stresses
D	diameter of specimen
D_{10}	diameter at which 10% of soil is finer
D_{15}	diameter at which 15% of soil is finer
D_{30}	diameter at which 30% of soil is finer
D_{50}	diameter at which 50% of soil is finer
D_{60}	diameter at which 60% of soil is finer
D_{85}	diameter at which 85% of soil is finer
d_{50}	displacement for 50% consolidation
d_{90}	displacement for 90% consolidation
d_{100}	displacement for 100% consolidation
E	Young's modulus
e	void ratio
e_c	void ratio after consolidation
e_o	initial void ratio
G	shear modulus
G_s	specific gravity of soil particles
H	height of specimen
PI	plasticity index
i	gradient
K_o	lateral stress ratio for one dimensional strain
k	permeability
LI	Liquidity Index
m_v	coefficient of volume change
n	porosity
PI	plasticity index
P_c	preconsolidation pressure
p	$(\sigma_1 + \sigma_3) / 2$, $(\sigma_v + \sigma_h) / 2$
p'	$(\sigma'_1 + \sigma'_3) / 2$, $(\sigma'_v + \sigma'_h) / 2$
p'_c	p' at consolidation
Q	quantity of flow
q	$(\sigma_1 . \sigma_3) / 2$
q_f	q at failure
q_o, q_i	initial q
q_c	q at consolidation
S	degree of saturation
SL	shrinkage limit
s_u	undrained shear strength
T	time factor for consolidation
T	temperature
t	time
U, UC	unconfined compression test
UU, Q	unconsolidated undrained triaxial test
u_a	pore gas pressure
u_e	excess pore water pressure
u, u_w	pore water pressure
V	total volume
V_g	volume of gas
V_s	volume of solids
V_v	volume of voids
V_w	volume of water
V_o	initial volume
v	velocity
W	total weight
W_s	weight of solids
W_w	weight of water
w	water content
w_c	water content at consolidation
w_f	final water content
w_l	liquid limit
w_n	natural water content
w_p	plastic limit
w_s	shrinkage limit
w_o, w_i	initial water content
α	slope of q_f versus p_f
α'	slope of q_f versus p_f'
γ_t	total unit weight
γ_d	dry unit weight
γ_s	unit weight of solids
γ_w	unit weight of water
ε	strain
ε_{vol}	volume strain
ε_h, ε_v	horizontal strain, vertical strain
μ	Poisson's ratio, also viscosity
σ	normal stress
σ'	effective normal stress
σ_c, σ'_c	consolidation stress in isotropic stress system
σ_h, σ'_h	horizontal normal stress
σ_v, σ'_v	vertical normal stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
τ	shear stress
φ	friction angle based on total stresses
φ'	friction angle based on effective stresses
φ'_r	residual friction angle
φ_{ult}	φ for ultimate strength