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13. ABSTRACT
The Tupper Ledge Disposal Site (TLDS) was monitored by Science Applications International Corporation (SAIC) in August 2001 as part of the Disposal Area Monitoring System (DAMOS). The objective of this survey was to document the distribution of dredged material on the seafloor and evaluate the recovery of the benthic community. TLDS, a 500 x 500 m area of seafloor in Union River Bay, near Ellsworth, ME, had received 50,000 m^3 of dredged material from maintenance dredging of the Federal Navigational Channel in the Union River as recently as April 2001. Bathymetric data indicated the formation of a discrete sediment deposit with a maximum height of 3.25 m. A REMOTS® (Remote Ecological Monitoring of the Seafloor) sediment-profile imaging survey indicated a disposal mound of approximately 500 m diameter composed primarily of fine-grained sediment with some wood particles from Union River. The average depth of apparent Redox-Potential Discontinuity (RPD) was relatively shallow over the disposal mound and at the nearby reference areas, indicating poor sediment aeration. Low apparent sediment dissolved oxygen conditions were likely due to decomposition of elevated organic matter from the annual spring runoff event or sporadic phytoplankton blooms within Union River Bay. Benthic recolonization over the disposal mound was slower than expected, with no visible macrofaunal life at some stations. Slow recolonization may be due to the elevated organic content and high sediment oxygen demand associated with decomposition of the wood particles in the dredged material. A more advanced benthic community (Stage III) continued to persist at stations surrounding the mound and at the reference areas, despite evidence of high organic loading in these locations. When all the disposal activity at TLDS is completed, benthic conditions over the mound are likely to gradually improve, as the elevated organic matter undergoes microbial decomposition and direct consumption by benthic organisms. The August 2001 REMOTS® stations should be re-sampled to monitor the progress of benthic habitat recovery in the future. One or more REMOTS® station transects extending from the disposal mound to several km beyond the present reference areas also could be established to determine the extent of the organic enrichment in the area.

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EXECUTIVE SUMMARY

The Disposal Area Monitoring System (DAMOS) Program, managed by the New England District (NAE) of the U.S. Army Corps of Engineers, conducts detailed monitoring studies to detect and minimize any physical, chemical, and biological impacts associated with dredging and dredged material disposal activities in New England. This report presents the results of a DAMOS monitoring survey conducted in August 2001 at the Tupper Ledge Disposal Site (TLDS) near Ellsworth, Maine. The objective of this survey was to document the distribution of dredged material on the seafloor and evaluate the recovery of the benthic community.

Maintenance dredging of the Federal Navigational Channel in the Union River near Ellsworth was performed from January through April 2001. A total estimated barge volume of 50,000 m^3 of dredged material was transported by barge and placed at TLDS, a 500 × 500 m area of seafloor in Union River Bay. This site had been selected based on the results of a previous (March 2000) baseline survey conducted by the DAMOS Program, which confirmed its overall suitability as a seafloor containment site for dredged material.

As part of the August 2001 field effort, a precision bathymetric survey was performed to detect changes in seafloor topography relative to the March 2000 predisposal survey and test the prediction that the dredged material placed at TLDS would form a discrete mound on the seafloor. In addition, a REMOTS® (Remote Ecological Monitoring of the Seafloor) sediment-profile imaging survey was conducted to further delineate the spatial distribution of dredged material on the seafloor and to assess the benthic recolonization status of the disposal site relative to two nearby reference areas.

The comparison of the March 2000 and August 2001 bathymetric data indicated the formation of a discrete sediment deposit on the seafloor at TLDS, consistent with expectations. The thickest layers of dredged material occurred in a semi-circular deposit having a maximum height of 3.25 m, located in the center of TLDS. In addition to detecting the thicker, central portion of the disposal mound, a small depression was observed northeast of TLDS in the August 2001 bathymetric survey. Because of its small size and location, this feature had not been detected during the March 2000 bathymetric survey due to differences in the area covered by the successive 2000 and 2001 surveys.

The REMOTS® results agreed well with the bathymetric depth difference comparison and indicated that the dredged material remained within the confines of the disposal site. The REMOTS® images allowed measurement of relatively thin (i.e., less than 25 cm) dredged material layers that were not detected through the bathymetric depth differencing. The disposal mound as delineated by REMOTS® sediment-profile imaging was roughly circular, with a diameter of approximately 500 m covering most of the area

inside the TLDS boundary. The REMOTS® images further indicated that the dredged material constituting the TLDS disposal mound was mostly fine-grained sediment. Wood particles that had accumulated in the Union River navigation channel from the once-active lumber milling operations in Ellsworth were mixed with the fine-grained dredged material at a number of sampling stations.

The average depth of the apparent Redox-Potential Discontinuity (RPD) was relatively shallow over the disposal mound at TLDS and at the nearby reference areas at the time of the August 2001 survey, indicating poor sediment aeration. The sediment-profile images collected within TLDS and the reference areas showed the presence of distinct bands of black sediment, principally near the sediment-water interface, indicating localized zones of anoxia and sulfide production within the sediment column. The low apparent sediment dissolved oxygen conditions and increased sediment oxygen demand (SOD) were attributed primarily to decomposition of the elevated levels of organic matter present in the sediments. The annual spring runoff event and/or sporadic phytoplankton blooms within Union River Bay likely contribute pulses of organic matter to the sediments within the wider region surrounding TLDS.

Benthic recolonization over the surface of the new disposal mound at TLDS was slower than expected, as azoic conditions (i.e., absence of visible macrofaunal life) were found at a significant number of stations in lieu of the expected early colonizing community (i.e., Stage I). The inhibited recolonization of the mound was attributed to the elevated organic content and high sediment oxygen demand associated with decomposition of the wood particles in the dredged material. A more advanced, well-developed benthic community (i.e., Stage III), similar to that observed in the March 2000 predisposal survey at TLDS, continued to persist at stations surrounding the new disposal mound and at the reference areas, despite evidence of high organic loading in these locations.

Benthic habitat conditions were determined to be highly degraded over the disposal mound at TLDS, due to the widespread anoxic conditions in the sediment and associated poor infaunal recolonization. Benthic habitat conditions in the surrounding area were somewhat better, mainly due to the persistence of the advanced Stage III benthic community despite the elevated organic loading. When all of the disposal activity at TLDS is completed, it is anticipated that benthic conditions at the stations over the mound and in surrounding areas will show gradual improvement, as the elevated organic matter undergoes microbial decomposition and direct consumption by benthic organisms.

The August 2001 REMOTS® stations should be re-sampled to monitor the progress of benthic habitat recovery in the future. One or more REMOTS® station transects extending from the disposal mound to several kilometers beyond the present reference areas also could be established to determine the extent of the organic enrichment in the area.

1.0 INTRODUCTION

In 1977, the New England District (NAE) of the U.S. Army Corps of Engineers established the Disposal Area Monitoring System (DAMOS) to monitor the environmental impacts associated with the subaqueous disposal of sediments dredged from harbors, inlets, and bays in the New England region. The DAMOS Program conducts detailed monitoring studies to detect and minimize any physical, chemical, and biological impacts of dredging and dredged material disposal activities. DAMOS monitoring helps to ensure that any effects of sediment deposition on the marine environment are confined to designated seafloor areas and are of limited duration. A flexible, tiered monitoring protocol is applied in the long-term management of sediment disposal at ten open-water dredged material disposal sites along the coast of New England (Germano et al. 1994).

Maintenance dredging of the Federal Navigational Channel in the Union River near Ellsworth, Maine was performed from January through April 2001. The dredged material was transported by barge and deposited on the seafloor at the Tupper Ledge Disposal Site (TLDS) located in Union River Bay (Figures 1-1 and 1-2). This report presents the results of a DAMOS monitoring survey conducted at TLDS in August 2001 to document the distribution of dredged material on the seafloor and evaluate the recovery of the benthic community.

1.1 Background

The coast of Maine has 5,600 kilometers (3,480 miles) of tidally influenced shoreline, with many small, shallow harbors. These harbors are usually quite close to open water, but protected from heavy seas by large bedrock islands or submerged reefs. At the headwaters of many embayments, there are relatively short, shallow rivers that provide drainage to the coastal mountain range.

The Union River, located in Hancock County, Maine, runs through the town of Ellsworth, and empties into the Atlantic Ocean near Acadia National Park and Mount Desert Island. Runoff from a variety of upland sources carries freshwater and sediment downstream until it encounters the effects of incoming tides from the Gulf of Maine. Similar to other rivers in northern New England, freshwater flow rates within the Union River increase significantly during periods of spring runoff, typically in March or April. The volumes of water discharged by the river transport sediment and other particulates into upper Union River Bay.

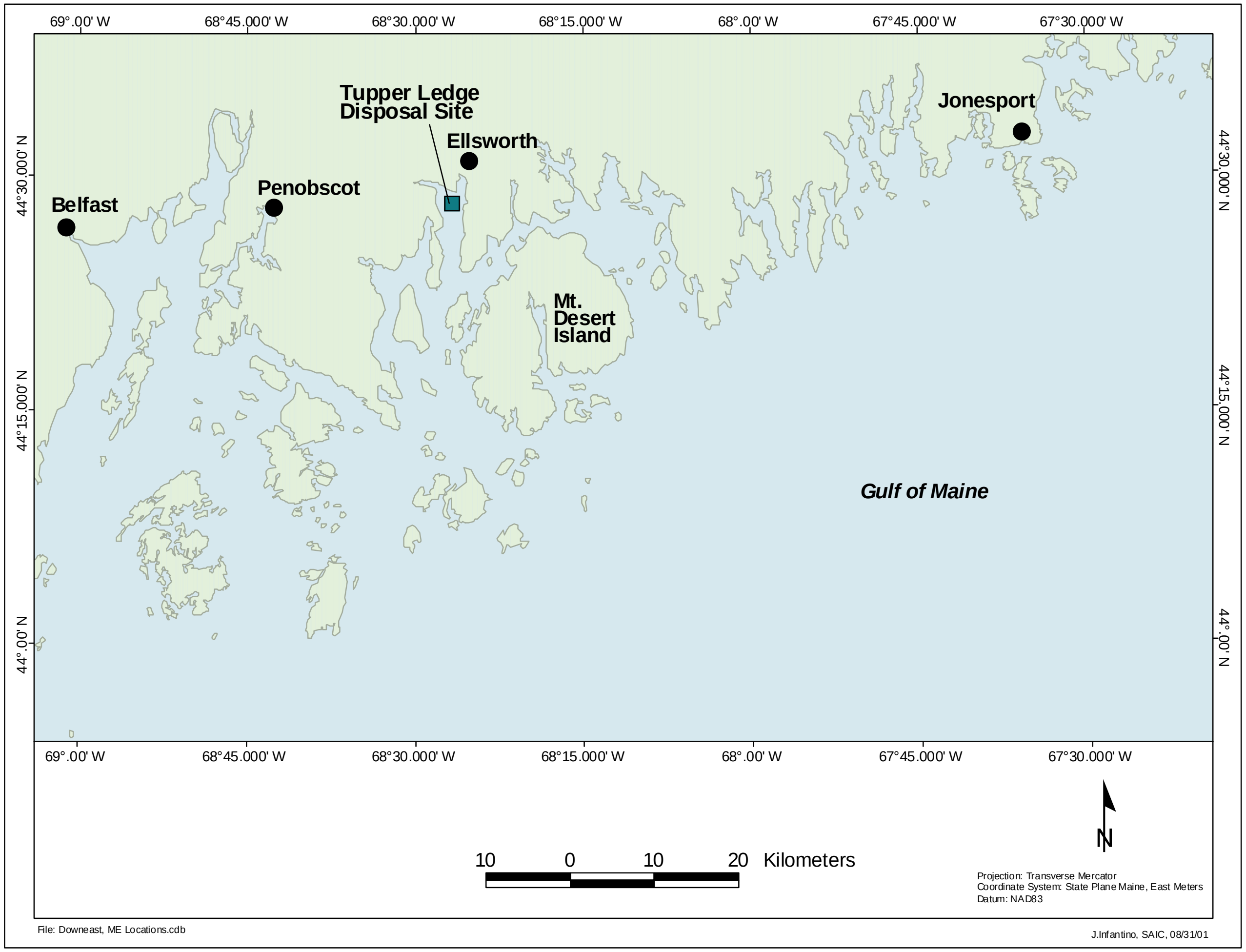

Figure 1-1. Location of the Tupper Ledge Disposal Site relative to the coast of eastern Maine

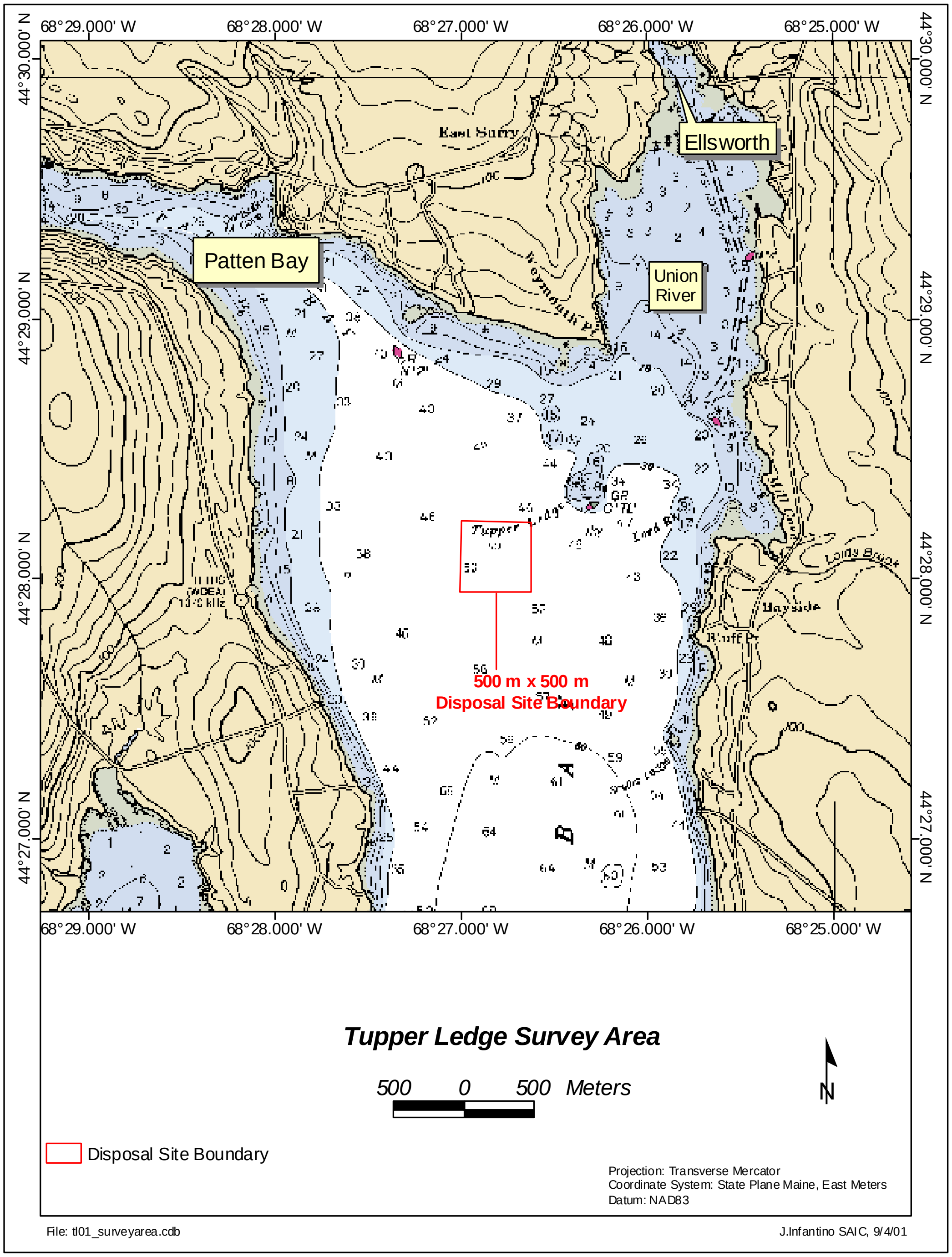

Figure 1-2. Detail of NOAA Chart 13316 showing the location of the Tupper Ledge Disposal Site in Union River Bay

Union River Bay is one of Maine's many estuaries that is tidally influenced by the Gulf of Maine, having a tidal range of 3.5 meters. Circulation patterns in this type of system are influenced by both fresh water inflow from rivers and the tidal influence of salt water from the oceans. Overall, the circulation in the Union River Bay region acts to slow incoming water, allowing for the deposition and accumulation of sediments and organic material and necessitating periodic maintenance dredging of the Union River navigation channel.

In the 1800s, the Union River served as a large lumber shipping port and was home to a number of lumber mills (R. Heckman, Ellsworth Harbormaster, pers. comm.). Positioned on both sides of the Union River, Ellsworth at one time ranked as the second largest lumber shipping port in the world. Although the lumber industry slowed and milling operations ceased in the early part of the 20^{th} century, a significant volume of lumber milling residue (sawdust, wood chips, and wood particles) had been deposited into the Union River. Some of this organically rich material settled out on the bottom of the river, with accumulations of sawdust reaching 5 to 6 feet in some places (R. Heckman, pers. comm.). During natural river transport processes, fine particulates of wood may be transported down the river and deposited into the Union River Bay region.

1.2 Tupper Ledge Disposal Site

The Tupper Ledge Disposal Site is a square area of seafloor (500 × 500 m) situated in the northern portion of the Union River Bay estuary near Ellsworth, Maine (Figures 1-1 and 1-2). This site, centered at 44° 28.256´ N, 68° 26.664´ W, is located approximately 2 km southwest of Weymouth Point (Figure 1-2). On the east side of Weymouth Point, the Union River flows into the Union River Bay from the north. Fresh water runoff from multiple streams also flows in from the northwest through Patten Bay.

In March 2000, an initial baseline study was conducted by the DAMOS program to determine the suitability of a potential disposal site near Tupper Ledge (SAIC 2000). This area was investigated for its potential use for disposal of an estimated 69,000 m^3 of sediments to be dredged from the federally maintained channel in the Union River. The results of the initial baseline study confirmed the depositional nature of this area and its suitability as a seafloor containment site for dredged material (SAIC 2000).

Maintenance dredging of the Union River Federal Navigational Channel was performed from January through April 2001. A total estimated barge volume of 50,000 m^3 of sediment was transported to the center of the newly selected TLDS and deposited on the seafloor (Appendix A). Upon completion of the project, a total of 127 disposal events had been recorded by inspectors on board the disposal barges (Appendix A).

1.3 Survey Objectives and Predictions

In August 2001, the DAMOS Program conducted a postdisposal investigation of TLDS. The specific objectives of the August 2001 postdisposal monitoring survey were to

1) Document the distribution of dredged material (including disposal mound morphology) on the seafloor within TLDS

2) Assess benthic recolonization status within the confines of TLDS relative to existing seafloor conditions at two nearby reference areas

The August 2001 field effort tested the following predictions:

1) The 50,000 m^3 of sediment deposited at TLDS during the winter and spring of 2001 would result in the formation of a discrete dredged material disposal mound on the seafloor; and

2) The recently placed dredged material at TLDS would be supporting a stable Stage I population of recolonizing benthic organisms, with some progression into Stage II or Stage III communities, as predicted by the DAMOS tiered monitoring protocols.

To address the first objective, a precision bathymetric survey was conducted over TLDS, and the results compared to those of the March 2000 baseline (i.e., predisposal) bathymetric survey. In addition, a REMOTS® sediment-profile imaging survey was performed to delineate the distribution of dredged material and assess the benthic recolonization status over the disposal site relative to the nearby reference areas.

2.0 METHODS

Field operations involving precision bathymetry and REMOTS® sediment-profile imaging were conducted at TLDS aboard the M/V *Beavertail* from 5 to 8 August 2001. The methods employed during the field operations and subsequent analyses of the data are described in the following sections.

2.1 Navigation

During the field operations, differentially-corrected Global Positioning System (DGPS) data in conjunction with Coastal Oceanographic's HYPACK® navigation and survey software were used to provide real-time positioning of the survey vessel to an accuracy of +/-5 m. A Trimble DSMPro GPS receiver was used to obtain raw satellite data and provide vessel position information in the horizontal control of North American Datum of 1983 (NAD 83). The GPS receiver has an integrated differential beacon receiver to improve the overall accuracy of the satellite data to the necessary tolerances. The U.S. Coast Guard differential beacon broadcasting from Penobscot, Maine (290 kHz) was utilized for real-time satellite corrections due to its geographic position relative to TLDS.

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

2.2 Bathymetric Data Acquisition and Analysis

2.2.1 Bathymetric Data Acquisition

Bathymetric data were collected over a 1000 × 1000 m area surrounding TLDS to detect any changes in bottom topography resulting from dredged material deposition within the disposal site boundary (Figure 2-1). The bathymetric survey was centered at 44° 28.256´ N, 68° 26.664´ W and consisted of 21 survey lanes, oriented north-south at

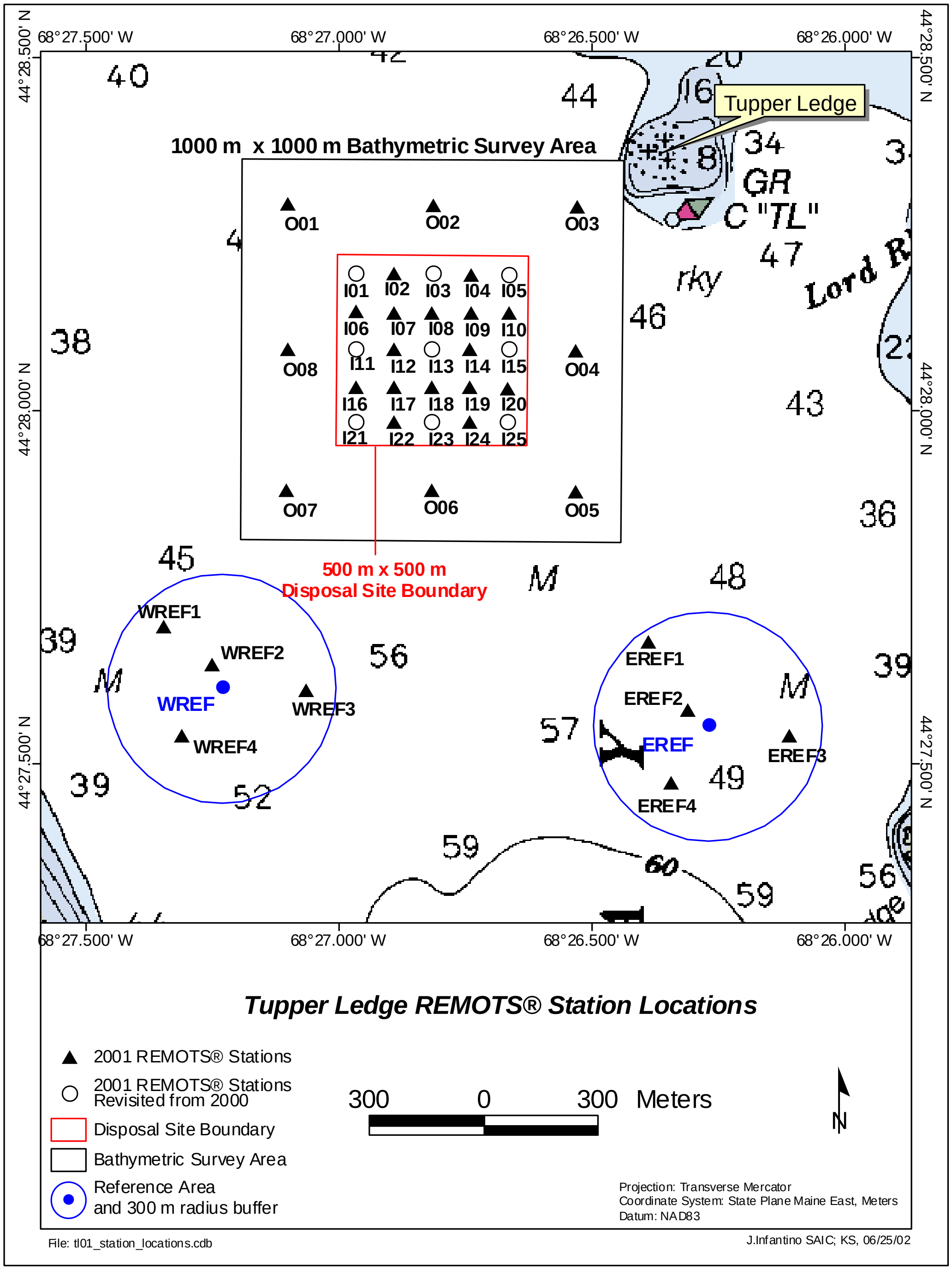

Figure 2-1. Map showing the TLDS boundary, the 1000 x 1000 m bathymetric survey area surrounding TLDS, and the REMOTS® stations occupied at TLDS and nearby reference areas (WREF and EREF)

50 m lane spacing. The individual lanes were the same as those used in the March 2000 baseline (i.e., predisposal) survey to facilitate accurate depth difference comparisons. Along with the north-south lanes, five east-west lanes were established over the survey area for cross-check comparisons. Due to concerns related to shallow water in close proximity to Tupper Ledge, one of the planned 21 north-south survey lanes was not completed.

During the bathymetric survey, HYPACK® was interfaced with an Odom Hydrotrac® survey echosounder, as well as the Trimble DGPS. The Hydrotrac® used a narrow-beam (3°), 208-kHz transducer to make discrete depth measurements and produce a continuous analog record of the seafloor. The Hydrotrac® transmitted approximately 10 digital depth values per second (depending on water depth) to the data acquisition system. Within HYPACK®, the time-tagged position and depth data were merged to create continuous depth records along the actual survey track. These records were viewed in near real-time to ensure adequate coverage of the survey area.

2.2.2 Bathymetric Data Processing

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

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

Observed tide data were obtained through the NOAA National Water Level Observation Network. The NOAA 6-minute tide data were downloaded in the MLLW datum and corrected for tidal offsets. SAIC used the water level data available from the operating NOAA tide station in Portland, ME (Station number 8418150). After the bathymetric data were fully edited and reduced to MLLW, cross-check comparisons on overlapping data were performed to verify the proper application of the correctors and to evaluate the consistency of the data set.

2.2.3 Bathymetric Data Analysis

The purpose of the bathymetric data analysis was to identify any unique seafloor features and detect any topographic changes since the March 2000 survey. Because single-beam bathymetric survey data typically cover only a small percentage of the total seafloor area surveyed (approximately 5%), the analysis relies on interpolating between the discrete survey data points to generate a three-dimensional seafloor surface model.

The 2001 TLDS bathymetric survey data were gridded through the ArcGis® ArcInfo software module to generate a depth model for the entire survey area, using a grid cell size of 25 m^2. The same system was used to generate a depth model for the March 2000 bathymetric survey data. The August 2001 and March 2000 models were mathematically compared within ArcGIS®, producing a dataset of calculated depth differences. Using this method, any depth differences are related to changes in seafloor topography between the dates of the compared survey grids.

2.3 REMOTS® Sediment-Profile Imaging

Remote Ecological Monitoring of the Seafloor (REMOTS®) sediment-profile imaging is a benthic sampling technique used to detect and map the distribution of thin (<20 cm) dredged material layers, delineate benthic disturbance gradients, and monitor the process of benthic recolonization following seafloor disturbance. This is a reconnaissance survey technique used for rapid collection, interpretation and mapping of data on physical and biological seafloor characteristics. The DAMOS Program has used this technique for routine disposal site monitoring for over 20 years. The REMOTS® hardware consists of a Benthos Model 3731 sediment-profile camera designed to obtain undisturbed, vertical cross-section photographs (*in situ* profiles) of the upper 15 to 20 cm of the seafloor (Figure 2-2). Computer-aided analysis of each REMOTS® image yields a suite of standard measured parameters, including sediment grain size major mode, camera prism penetration depth (an indirect measure of sediment bearing capacity/density), small-scale surface boundary roughness, depth of the apparent redox potential discontinuity (RPD, a measure of sediment aeration), infaunal successional stage, and Organism-Sediment Index (OSI, a summary parameter reflecting overall benthic habitat quality).

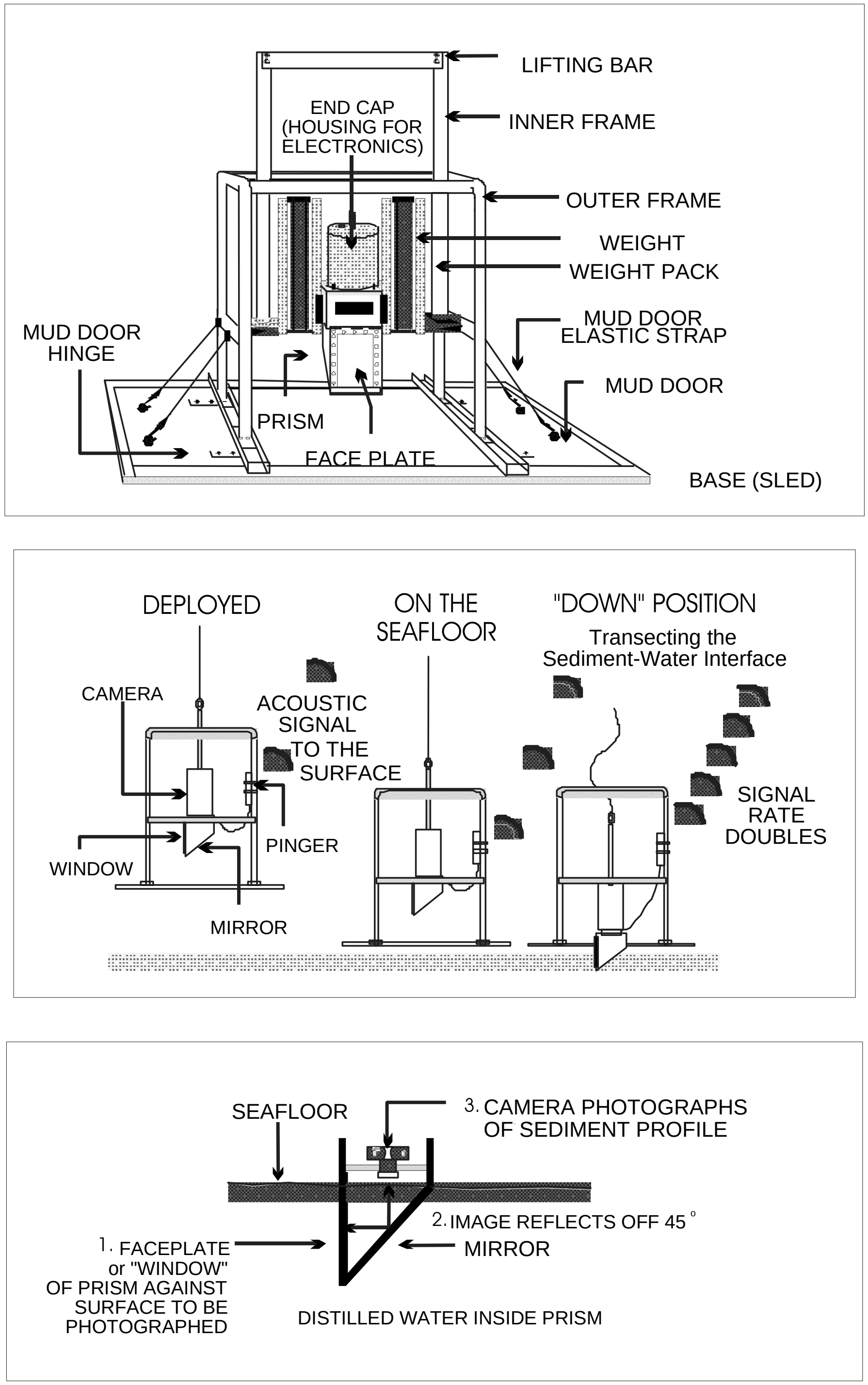

Figure 2-2. Schematic diagram of the Benthos Inc. Model 3731 REMOTS® sediment profile camera and sequence of operation on deployment

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

The REMOTS® survey performed over TLDS consisted of a 25-station square grid within the 500 × 500 m disposal site boundary, plus an additional eight stations distributed outside the disposal site boundary (denoted as inner and outer stations in Figure 2-3 and Table 2-1). The 25 stations within the disposal site boundary included 9 stations that had been sampled previously in the March 2000 baseline survey (Figure 2-1 and Table 2-1). All 33 stations established over TLDS were successfully sampled during the August 2001 survey. Three replicate sediment-profile images were collected at each of the REMOTS® stations. Due to the extremely soft sediment throughout the TLDS survey area, the REMOTS® base frame was outfitted with a set of mud doors (Figure 2-2). This increased surface area distributed the weight of the camera system over the soft sediment and prevented the sediment-water interface from being obscured due to over-penetration of the window.

Reference areas are typically sampled during DAMOS monitoring surveys to provide a comparative assessment of the environmental conditions existing on the ambient seafloor. Two reference areas (WREF and EREF) were established approximately 1 km south of the TLDS study area to provide a basis of comparison of the habitat conditions within the sediment deposited at TLDS with the ambient sediment conditions in Union River Bay (Figure 2-1). Four randomly selected stations were occupied within a 300 m radius of the center of reference area WREF (44° 27.671´ N, 68° 27.233´ W), and an additional four stations were randomly occupied within a 300 m radius of the center of EREF (44° 27.617´ N, 68° 26.271´ W; Figure 2-1; Table 2-2). Three replicate REMOTS® images were collected at each of the reference area stations.

Table 2-1. REMOTS® Station Locations over the TLDS Study Area

Area	Station	Latitude (NAD 83)	Longitude (NAD 83)
INNER GRID	**I01**	**44° 28.257´ N**	**68° 26.967´ W**
	I02	44° 28.257´ N	68° 26.891´ W
	I03	**44° 28.256´ N**	**68° 26.816´ W**
	I04	44° 28.256´ N	68° 26.740´ W
	I05	**44° 28.256´ N**	**68° 26.665´ W**
	I06	44° 28.203´ N	68° 26.967´ W
	I07	44° 28.203´ N	68° 26.892´ W
	I08	44° 28.202´ N	68° 26.816´ W
	I09	44° 28.202´ N	68° 26.741´ W
	I10	44° 28.202´ N	68° 26.665´ W
	I11	**44° 28.151´ N**	**68° 26.968´ W**
	I12	44° 28.150´ N	68° 26.892´ W
	I13	**44° 28.150´ N**	**68° 26.817´ W**
	I14	44° 28.150´ N	68° 26.741´ W
	I15	**44° 28.149´ N**	**68° 26.666´ W**
	I16	44° 28.097´ N	68° 26.968´ W
	I17	44° 28.096´ N	68° 26.893´ W
	I18	44° 28.096´ N	68° 26.817´ W
	I19	44° 28.096´ N	68° 26.742´ W
	I20	44° 28.095´ N	68° 26.666´ W
	I21	**44° 28.048´ N**	**68° 26.969´ W**
	I22	44° 28.048´ N	68° 26.893´ W
	I23	**44° 28.047´ N**	**68° 26.818´ W**
	I24	44° 28.047´ N	68° 26.742´ W
	I25	**44° 28.047´ N**	**68° 26.667´ W**
OUTER GRID	O01	44° 28.356´ N	68° 27.101´ W
	O02	44° 28.354´ N	68° 26.815´ W
	O03	44° 28.353´ N	68° 26.529´ W
	O04	44° 28.149´ N	68° 26.531´ W
	O05	44° 27.949´ N	68° 26.533´ W
	O06	44° 27.950´ N	68° 26.819´ W
	O07	44° 27.952´ N	68° 27.105´ W
	O08	44° 28.151´ N	68° 27.103´ W

* Bold typeface indicates stations that were also occupied in March 2000 TLDS REMOTS® survey

Table 2-2. REMOTS® Station Locations over the TLDS Reference Areas

Area	Station	Latitude (NAD 83)	Longitude (NAD 83)
WEST REF	WREF 1	44° 27.758´ N	68° 27.348´ W
44° 27.671´ N	WREF 2	44° 27.704´ N	68° 27.253´ W
68° 27.233´ W	WREF 3	44° 27.668´ N	68° 27.066´ W
	WREF 4	44° 27.603´ N	68° 27.311´ W
EAST REF	EREF 1	44° 27.736´ N	68° 26.390´ W
44° 27.617´ N	EREF 2	44° 27.639´ N	68° 26.311´ W
68° 26.271´ W	EREF 3	44° 27.602´ N	68° 26.110´ W
	EREF 4	44° 27.536´ N	68° 26.346´ W

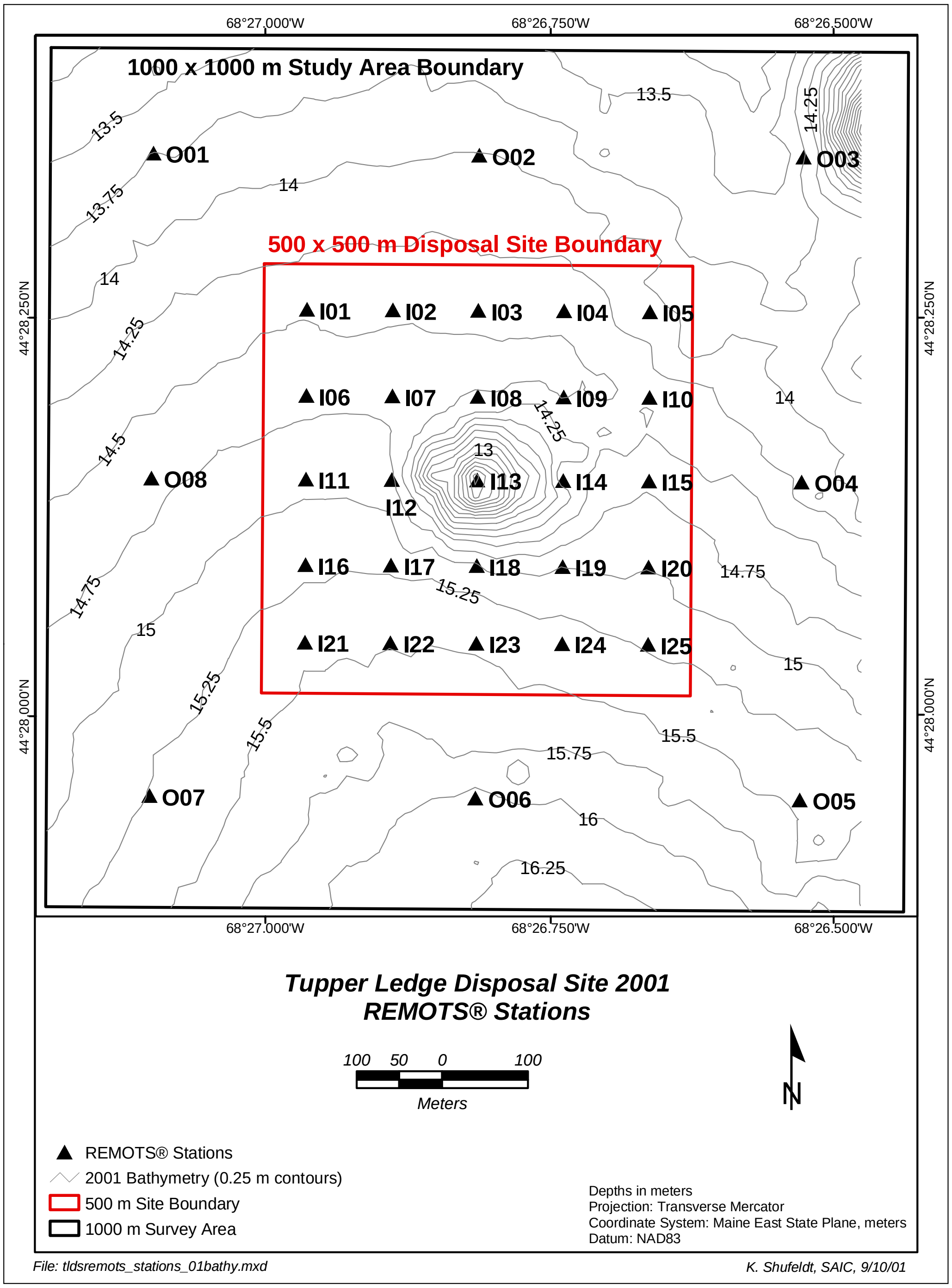

Figure 2-3. Map showing the distribution of inner ("I" prefix) and outer ("O" prefix) REMOTS® sediment-profile imaging stations over the Tupper Ledge study area. Depth contours are from the August 2001 bathymetric survey.

3.0 RESULTS

3.1 Bathymetry

As previously indicated, the extent of the bathymetric survey coverage was reduced slightly from the original plan due to the presence of the extremely shallow Tupper Ledge rock reef along the eastern and northeastern edge of the original 1 km² survey area. The August 2001 survey therefore yielded 20 survey lanes, which encompassed a 950 × 1000 m grid.

The survey area in August 2001 displayed a gently sloping seafloor, with the addition of a topographic high near the center of the disposal site resulting from the recent dredged material placement activity (Figure 3-1). Depths within the 500 × 500 m disposal site ranged from 11.5 m at the apex of the topographic high to 15.5 m along the southern boundary. The extended survey (950 × 1000 m) area also indicated relatively shallow waters to the north, gently sloping into deeper waters in the southern portions of the survey area. The earlier March 2000 dataset had illustrated the same generalized trend of shallower waters to the north, with a gentle slope into deeper water to the south (Figure 3-2). A small, but relatively deep depression was detected in the northeast corner of the surveyed area. Displaying a maximum depth of 17.75 m, the depression is located directly adjacent to the bedrock outcrop known as Tupper Ledge (outside the coverage area) and is likely a naturally occurring feature produced by water flow around the outcrop. This depression is a relatively small feature, which was not covered during the 2000 survey due to a slightly different bathymetric coverage area.

For depth difference comparisons, the August 2001 dataset was reduced to conform to the 850 ×1000 m survey area that was occupied in March 2000. The depth difference comparison between the August 2001 and March 2000 surveys revealed a single, semi-circular deposit of dredged material near the center of the survey area (Figure 3-3). This feature, which represents the thickest layers of dredged material as determined by the acoustic depth soundings, was 3.25 m high at its apex and approximately 225 m wide at its base (Figure 3-3).

In addition, the depth difference comparison displays several small areas of apparent accumulation less than 100 m south of the TLDS boundary. Based on the reported disposal locations included in Appendix A, and the corresponding sediment mound located in the center of the disposal site, these features are likely small-scale survey artifacts and do not represent actual accumulation of dredged material. Survey artifacts are the product of differences in vessel track over a survey lane and subsequent differences

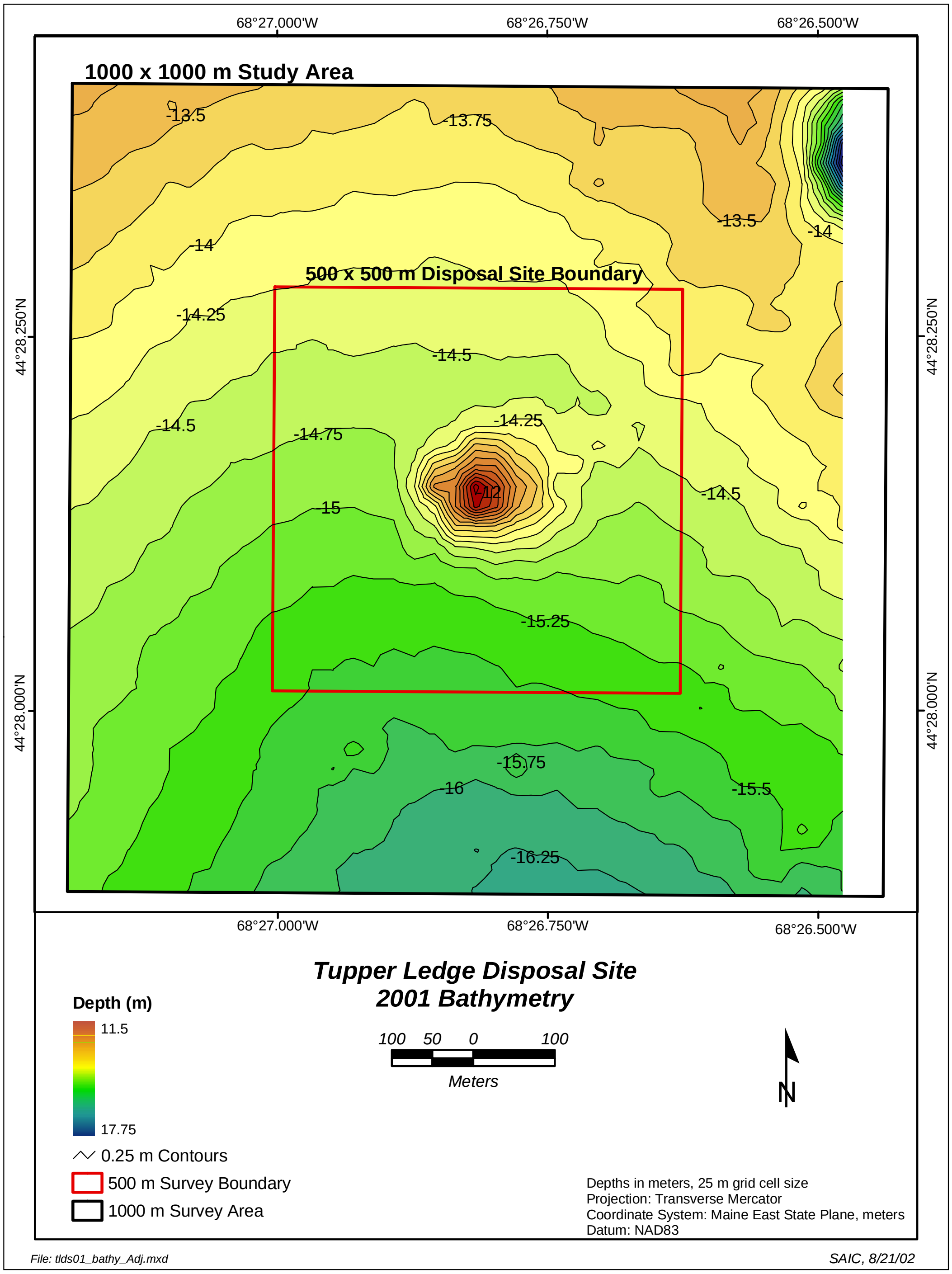

Figure 3-1. Bathymetric chart of the August 2001 survey area over Tupper Ledge Disposal Site, 0.25 m contour interval

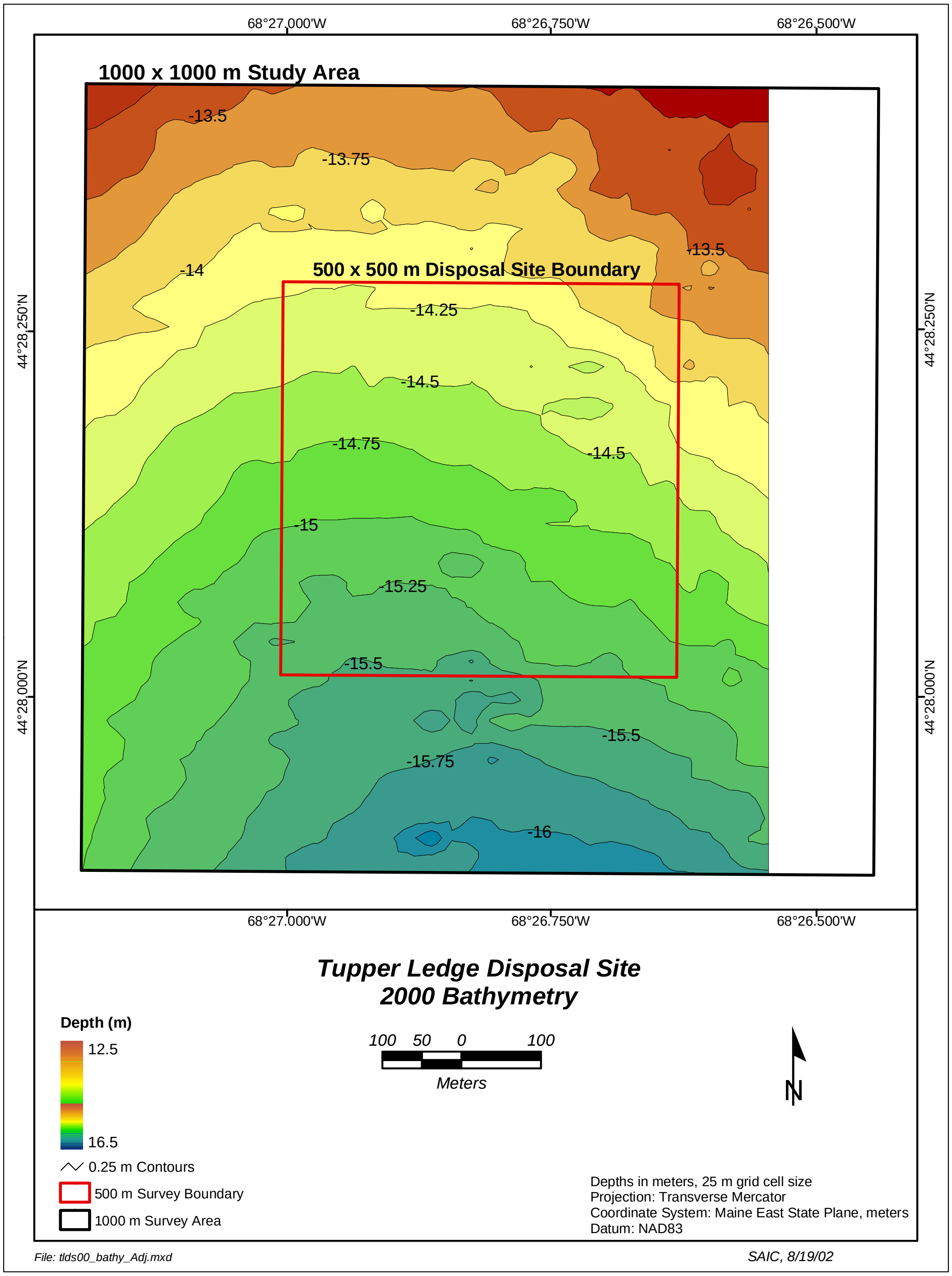

Figure 3-2. Bathymetric chart of the March 2000 survey over the Tupper Ledge Disposal Site, 0.25 m contour interval

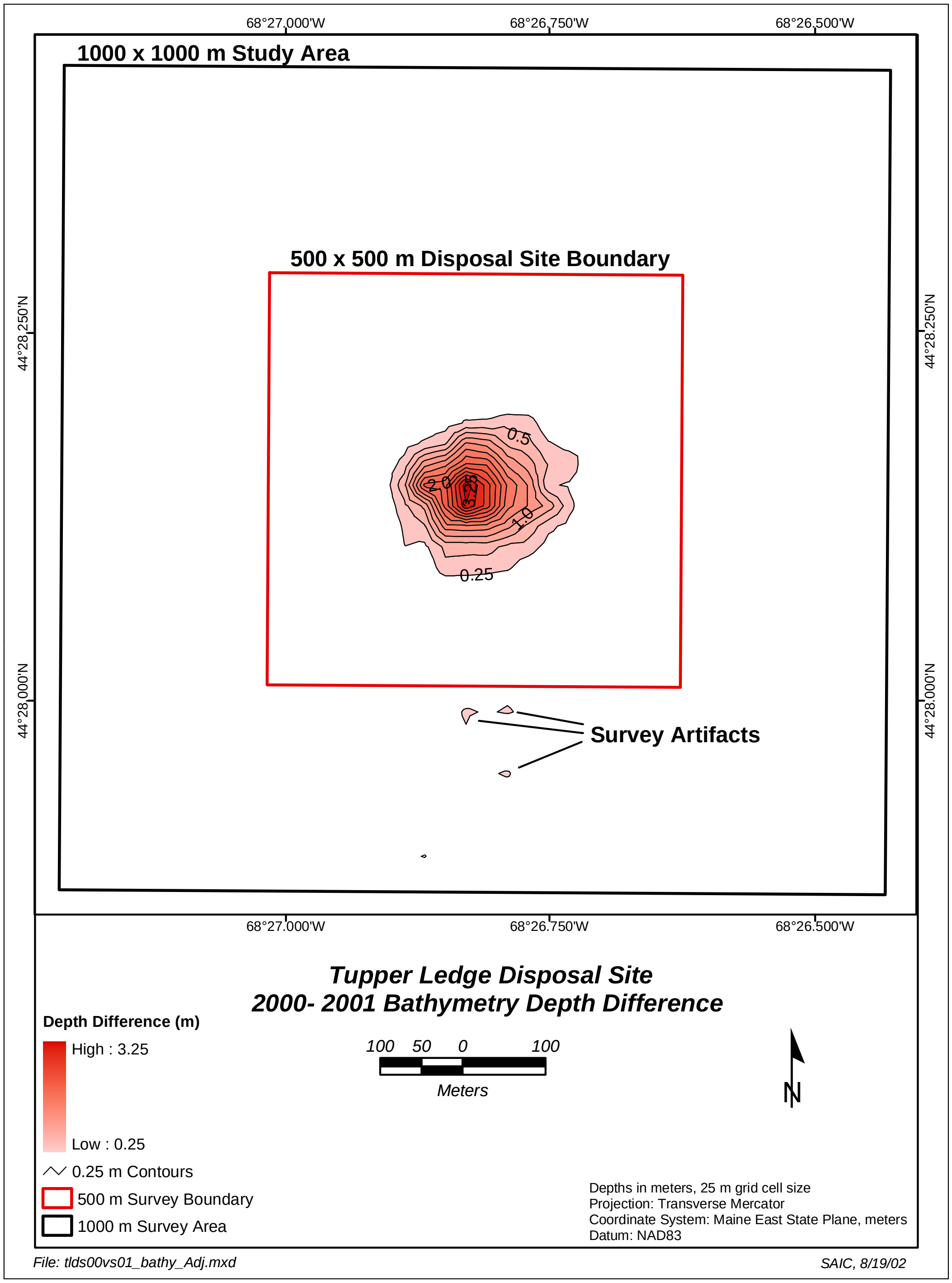

Figure 3-3. Depth difference plot showing the thickest accumulation of dredged material near the center of the Tupper Ledge Disposal Site

in depth measurement during successive bathymetric surveys. As the survey data are processed, gridded, and eventually compared, the differences in depth values along a survey lane appear as false indications of sediment accumulation or consolidation without an actual change in seafloor topography.

3.2 REMOTS® Sediment-Profile Imaging

The complete set of REMOTS® image analysis results for the TLDS and reference area sampling stations is provided in Appendix B; these results are summarized in Tables 3-1 through 3-3.

3.2.1 Dredged Material Distribution and Physical Sediment Characteristics

The sediment observed in the REMOTS® images at 21 of the 25 inner stations was considered to be dredged material, which generally occurred in layers that exceeded the penetration depth of the REMOTS® camera (i.e., dredged material layer thickness greater than prism penetration; Figure 3-4). The dredged material was predominantly fine-grained, composed mainly of tan silt over dark, clayey silt (grain size major mode of >4 phi; Table 3-1). The REMOTS® camera is able to detect dredged material layers on the apron of the mound that are too thin to be detected by the acoustic depth soundings used in the bathymetric survey. Therefore, the roughly circular dredged material deposit as delineated by REMOTS® extended to the TLDS boundary and had a diameter of approximately 500 m (Figure 3-4).

There was variability in the appearance and thickness of the dredged material. In some images, the dredged material consisted mainly of fine-grained sediment (i.e., silt-clay) having alternating bands of light and dark coloring (Figure 3-5, left image). Other images showed significant amounts of wood particles and/or small wood chips mixed with the silt-clay (Figure 3-5, middle image). Relatively thin, discrete, surface layers of dredged material over ambient sediment were observed at Stations I15, I19, I20 and I21 on the apron of the disposal mound (Figures 3-4 and 3-5, right image). These dredged material layers ranged in thickness from 0.3 cm at Station I21 to 3.0 cm at Station I19 (Table 3-1). One of the sediment-profile images obtained at Station I14 showed multiple dredged material layers, with a surface layer of silt-clay overlying silt-clay mixed with wood particles at depth (Figure 3-6).

Table 3-1. REMOTS® Sediment-Profile Imaging Results Summary for the Inner Survey Stations at TLDS August 2001

Station	Camera Penetration Mean (cm)	Dredged Material Thickness Mean (cm)	Number of Reps w/ Dredged Material	RPD Mean (cm)	Successional Stages Present	Highest Stage Present	Grain Size Major Mode (phi)	Methane Present	Low DO	OSI Mean	OSI Median	Boundary Roughness Mean (cm)
INNER												
I01	11.17	0	0	0.93	I,III	ST_I_ON_III	>4	NO	NO	4.00	3	1.91
I02	11.45	>11.45	3	0.00	I	ST_I	>4	NO	YES	-1.00	-1	1.21
I03	18.63	0	0	1.13	I	ST_I	>4	NO	NO	3.00	3	1.15
I04	17.69	0	0	1.61	I,III	ST_I_ON_III	>4	NO	NO	7.50	7.5	2.05
I05	6.30	>6.30	3	0.60	AZOIC,I	ST_I	>4	NO	NO	0.33	2	2.83
I06	8.34	>8.34	3	0.00	I,III	ST_I_ON_III	>4	NO	YES	-1.67	-3	1.18
I07	5.11	>5.11	3	0.00	AZOIC,I	ST_I	>4	NO	YES	-5.50	-5.5	3.26
I08	9.43	>9.43	3	1.24	I,III	ST_I_ON_III	>4	NO	NO	4.33	4	1.60
I09	8.49	>8.49	3	0.17	AZOIC,I	ST_I	>4	NO	YES	-4.67	-8	2.27
I10	4.39	>4.39	3	0.49	AZOIC,I	ST_I	>4	NO	NO	-1.33	-2	2.98
I11	11.29	>11.29	3	0.13	AZOIC,I	ST_I	>4	NO	YES	-2.67	-2	2.48
I12	7.35	>7.35	3	1.50	I,III	ST_I_ON_III	>4	NO	NO	6.33	7	0.70
I13	3.82	>3.82	3	0.00	I	ST_I	>4	NO	NO	1.00	1	1.77
I14	13.32	>13.32	3	0.57	I	ST_I	>4	NO	YES	0.67	2	1.05
I15	6.96	2.67	3	0.00	AZOIC	AZOIC	>4	NO	YES	-6.67	-8	1.98
I16	8.82	>8.82	3	0.20	AZOIC,I	ST_I	>4	NO	YES	-4.33	-3	1.64
I17	9.40	>9.40	3	0.00	AZOIC,I	ST_I	>4	NO	YES	-4.67	-3	2.55
I18	12.44	>12.44	3	1.19	I	ST_I	>4	NO	NO	3.00	3	1.82
I19	9.90	3	3	0.50	I	ST_I	>4	NO	YES	0.33	1	2.40
I20	9.05	1.17	3	0.50	AZOIC,I	ST_I	>4	NO	NO	-1.00	2	3.01
I21	11.31	0.33	1	0.46	I,III	ST_I_ON_III	>4	NO	YES	2.00	2	1.98
I22	8.02	>8.02	3	0.10	I	ST_I	>4	NO	YES	-2.67	-3	1.89
I23	10.91	>10.91	3	0.00	I	ST_I	>4	NO	YES	-3.00	-3	1.67
I24	10.03	0	0	1.24	AZOIC,I	ST_I	>4	NO	NO	1.33	4	3.42
I25	6.41	>6.41	3	0.00	AZOIC,I	ST_I	>4	NO	YES	-8.00	-8	2.65
AVG	9.60		2.44	0.50						-0.53	-0.32	2.06
MAX	18.63	>13.32	3	1.61						7.50	7.5	3.42
MIN	3.82	0	0	0.00						-8.00	-8	0.70

Table 3-2. REMOTS® Sediment-Profile Imaging Results Summary for the Outer Survey Stations at TLDS August 2001

Station	Camera Penetration Mean (cm)	Dredged Material Thickness Mean (cm)	Number of Reps w/ Dredged Material	RPD Mean (cm)	Successional Stages Present	Highest Stage Present	Grain Size Major Mode (phi)	Methane Present	Low DO	OSI Mean	OSI Median	Boundary Roughness Mean (cm)
OUTER												
O01	11.47	0	0	0.52	I,III	ST_I_ON_III	>4	NO	NO	3.33	1	1.67
O02	10.70	0	0	0.00	I,III	ST_I_ON_III	>4	NO	YES	1.00	1	2.75
O03	11.42	0	0	1.34	I,III	ST_I_ON_III	>4	NO	NO	3.50	3.5	2.38
O04	8.82	0	0	0.48	AZOIC,I,III	ST_I_ON_III	>4	NO	YES	1.33	5	1.93
O05	13.29	0	0	1.19	I	ST_I	>4	NO	NO	3.00	3	1.76
O06	12.93	0	0	0.87	I,III	ST_I_ON_III	>4	NO	NO	6.33	7	2.19
O07	13.81	0	0	1.81	I,III	ST_I_ON_III	>4	NO	NO	8.00	8	2.75
O08	12.30	0	0	0.92	I,III	ST_I_ON_III	>4	NO	NO	4.00	3	1.35
AVG	11.84	0	0	0.89						3.81	3.94	2.10
MAX	13.81	0	0	1.81						8.00	8	2.75
MIN	8.82	0	0	0.00						1.00	1	1.35

Table 3-3. REMOTS® Sediment-Profile Imaging Results Summary from the TLDS Reference Areas August 2001

Station	Camera Penetration Mean (cm)	Dredged Material Thickness Mean (cm)	Number of Reps w/ Dredged Material	RPD Mean (cm)	Successional Stages Present	Highest Stage Present	Grain Size Major Mode (phi)	Methane Present	Low DO	OSI Mean	OSI Median	Boundary Roughness Mean (cm)
EREF												
EREF1	11.45	0.00	0.00	0.69	I	ST_I	>4	NO	NO	2.00	2	2.45
EREF2	10.19	0.00	0.00	1.47	I,III	ST_I_ON_III	>4	NO	NO	7.33	7	2.15
EREF3	12.94	0.00	0.00	1.19	I,III	ST_III	>4	NO	NO	7.00	7	2.02
EREF4	11.98	0.00	0.00	0.59	I,III	ST_I_ON_III	>4	NO	YES	0.67	1	2.31
WREF												
WREF1	15.80	0.00	0.00	1.56	I,III	ST_I_ON_III	>4	NO	NO	6.00	7	3.39
WREF2	14.07	0.00	0.00	1.44	I,III	ST_III	>4	NO	NO	4.67	4	1.88
WREF3	14.97	0.00	0.00	1.48	I,III	ST_I_ON_III	>4	NO	NO	6.33	7	2.88
WREF4	15.14	0.00	0.00	1.32	I,III	ST_I_ON_III	>4	NO	NO	7.33	7	1.01
AVG	13.32	0.00	0.00	1.22						5.17	5.25	2.26
MAX	15.80	0.00	0.00	1.56						7.33	7	3.39
MIN	10.19	0.00	0.00	0.59						0.67	1	1.01

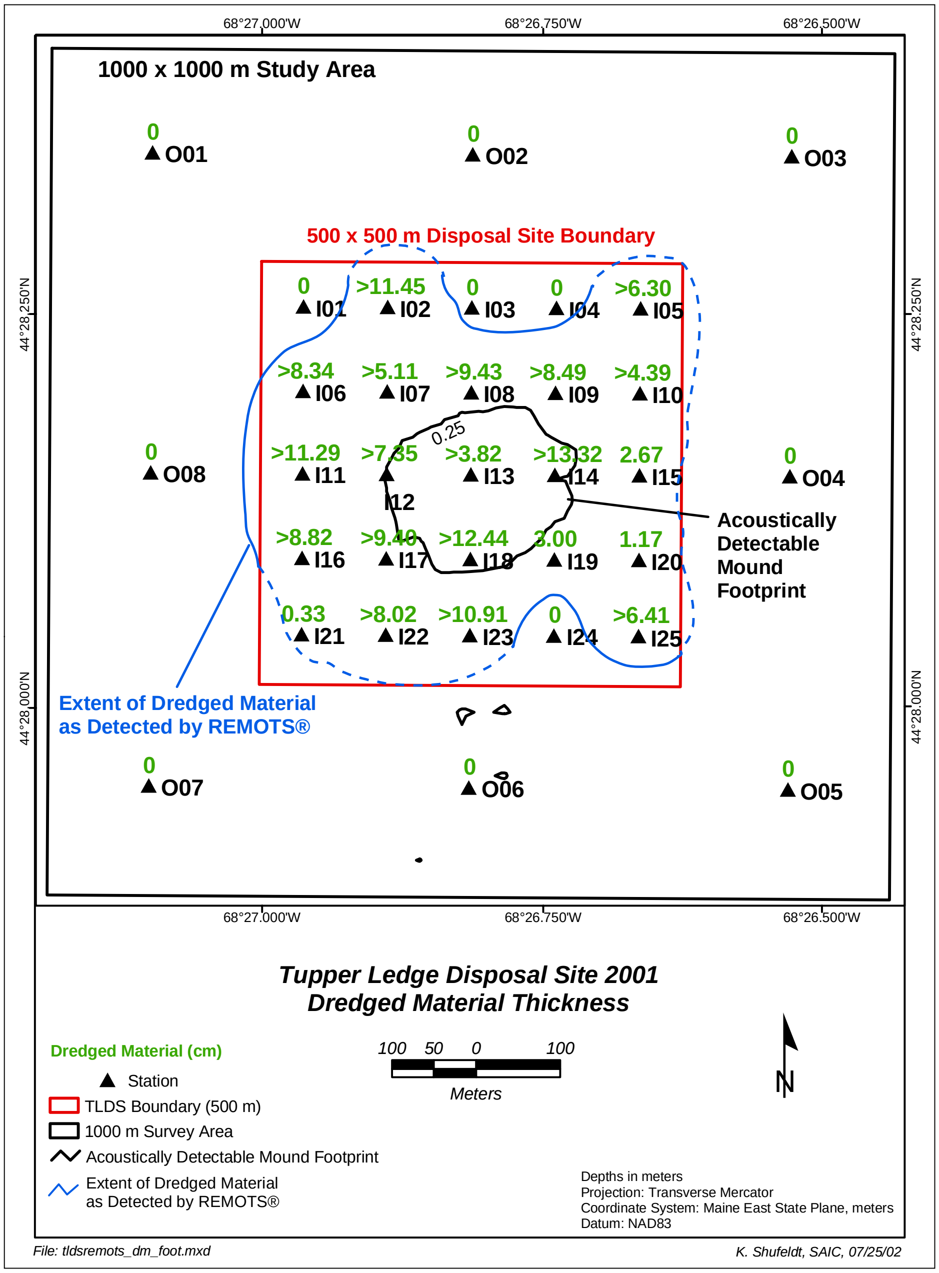

Figure 3-4. Map of replicate averaged dredged material thickness over the Tupper Ledge Disposal Site, relative to the acoustically detectable mound footprint. A greater than sign indicates stations where the measured thickness of the surface dredged material layer exceeded the penetration depth of the sediment-profile camera.

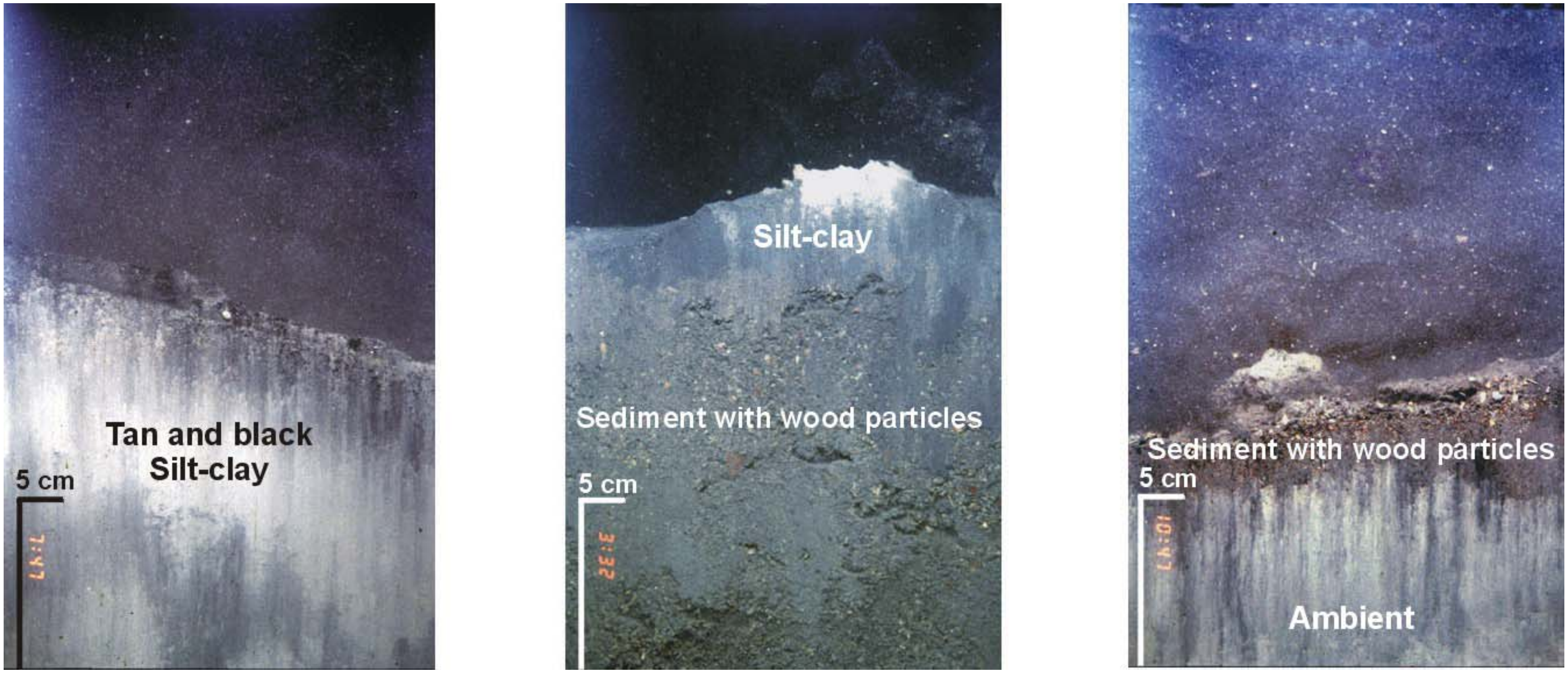

Figure 3-5. REMOTS® images from inner disposal site stations displaying variability in the dredged material. The image on the left from Station I11 shows tan and black silt-clay dredged material greater than camera penetration. Station I08 (middle) has a silt-clay dredged material layer over silt-clay mixed with wood particles. The image from Station I15 (right) displays a discrete dredged material layer of particles and sediment over ambient silt-clay.

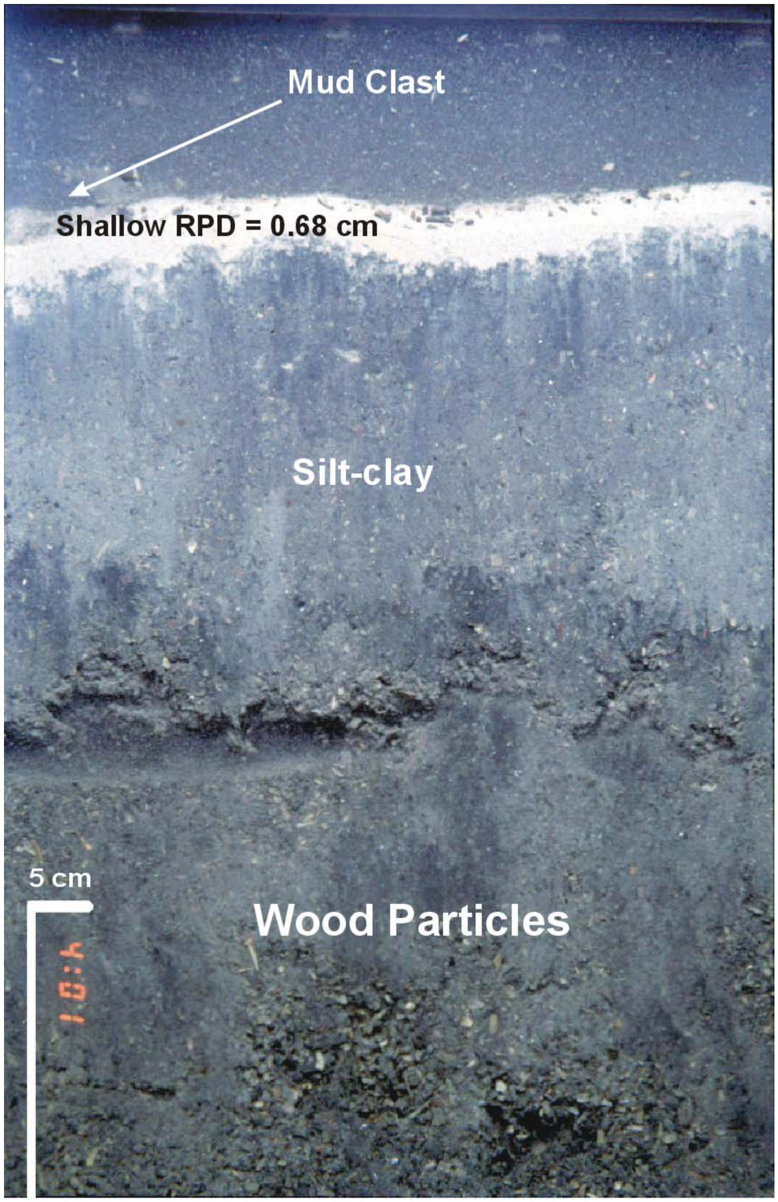

Figure 3-6. REMOTS® image obtained at Station I14 illustrating multiple dredged material layers, with a layer of silt-clay visible over a layer containing a significant proportion of wood particles. Note the thin veneer of oxidized sediment at the surface (shallow RPD) over black (anoxic) sediment below.

Ambient sediment consisting of tan and black silt-clay (e.g., Figure 3-7) was evident at several of the northernmost inner stations at TLDS (Stations I01, I03, I04), as well as at southern station I24 and in two replicate images at Station I21 (Figure 3-4). There was no dredged material detected at any of the outer stations surrounding the disposal site (Figure 3-4; Table 3-2). Likewise, ambient sediment was observed at all of the reference area stations. The ambient sediment at the reference area stations was also fine-grained, comprised of tan and black silt and clay, having a major modal grain size of >4 phi (Table 3-3 and Figure 3-7, right image).

The penetration depth of the camera usually serves as a measure of sediment density or compaction by indicating the relative sediment water content. However, the sediment within the study area was soft enough to prompt the use of "mud doors" to prevent over-penetration of the sediment-profile camera. Mean camera penetration measurements for the inner stations varied from a shallow 3.8 cm at center Station I13 to 18.6 cm at Station I03 (average of 9.6 cm; Table 3-1). Outer station mean camera penetration measurements were slightly higher, ranging from 8.8 cm at Station O04 to 13.8 cm at Station O07, with an overall average of 11.8 cm indicating relatively soft sediment (Table 3-2). Mean camera penetration depths at the reference area stations were moderately higher than those at the TLDS inner and outer stations, ranging from 10.2 to 15.8 cm (overall average 13.3 cm; Table 3-3). High water content is normally characteristic of a recent dredged material deposit. Although cohesive mud clumps at the sediment surface often limited penetration of the sediment-profile camera, the sediment within the confines of TLDS and the surrounding outer and reference area station areas was relatively soft and had high apparent water content. Over- or under-penetration of the REMOTS® camera prevented the analysis of key parameters (e.g., RPD, successional status, surface roughness, and OSI) in 3 of the 123 total images obtained in the August 2001 REMOTS® survey.

Replicate-averaged small-scale boundary roughness values for the inner REMOTS® stations over TLDS ranged from 0.7 cm to 3.4 cm (average of 2.1 cm), which was comparable to both the outer station and the reference area averages of 2.1 cm and 2.3 cm, respectively (Tables 3-1 through 3-3). Outer station replicate-averaged boundary roughness values varied from 1.4 cm to 2.8 cm (Table 3-2). There was no obvious spatial pattern to these relatively high boundary roughness values at the inner, outer, and reference area stations. At all of the stations, the surface roughness was predominately due to the presence of cohesive mud and mud clasts at the sediment surface (Figure 3-8).

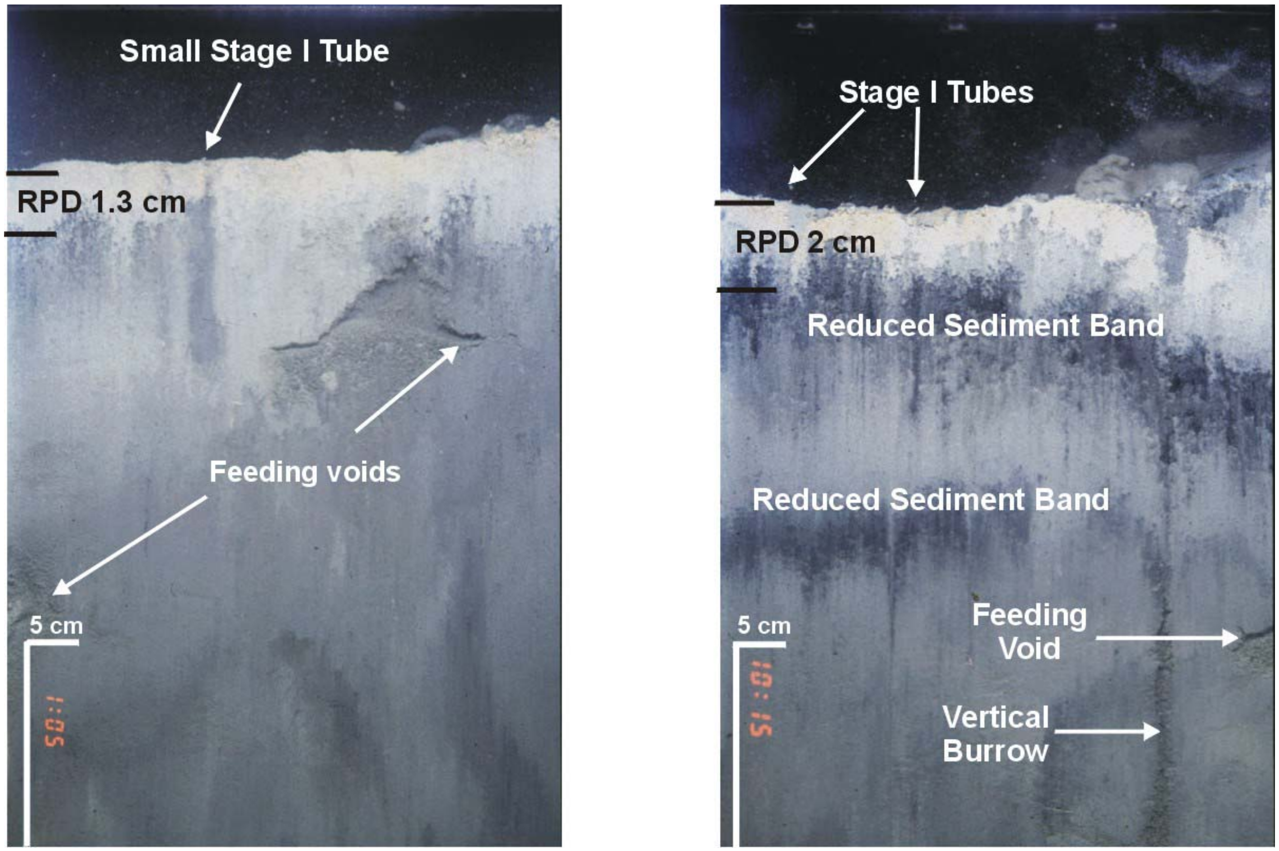

Figure 3-7. REMOTS® images from outer Station O06 (left) and reference area WREF4 (right) showing ambient sediment. Stage I on III successional status was detected in both images. Bands of black sulfidic sediment ("reduced sediment bands") were evident at Station WREF4.

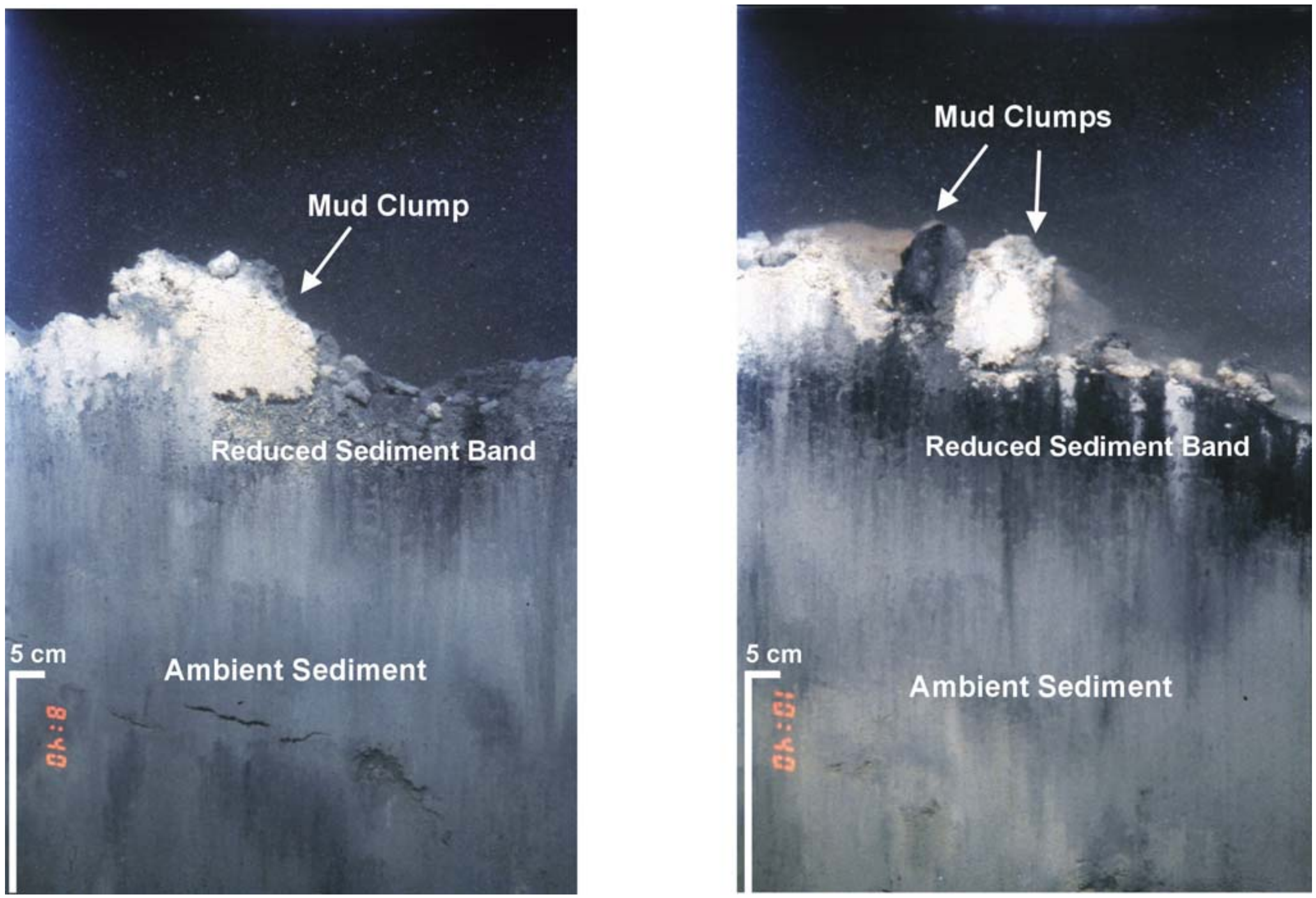

Figure 3-8. REMOTS® image from outer station O04 (left) and TLDS reference area station WREF3 (right) displaying cohesive mud clumps at the sediment surface. Horizontal bands of black, sulfidic sediment are also visible near the sediment surface.

3.2.2 Biological Conditions and Benthic Recolonization

Three parameters were used to assess the benthic recolonization status and overall benthic habitat conditions of the disposal site relative to the reference areas: apparent Redox Potential Discontinuity (RPD) depth, Organism-Sediment Index (OSI), and infaunal successional status. The redox potential discontinuity (RPD) measured in each image provided an estimate of the apparent depth of oxygen penetration into the sediment surface. The replicate-averaged RPD measurements for the inner TLDS stations were quite low, ranging from 0.0 cm at Stations I02, I06, I07, I13, I15, I17, I23, and I25 to 1.6 cm at Station I04, with an overall average of 0.5 cm indicative of poorly aerated surface sediments (Figure 3-9; Table 3-1). The outer stations displayed only slightly deeper RPD depths, with replicate-averaged values ranging from 0.0 cm at Station O02 to 1.8 cm at Station O07 (average of 0.9 cm; Figure 3-9; Table 3-2). The reference areas displayed a similar range of RPD values, from 0.59 cm to 1.56 cm; however, more replicates had RPD depths at the higher end of that range, yielding a composite average RPD value of 1.2 cm that was somewhat higher than the averages for the inner and outer TLDS stations (Table 3-3).

Black, anoxic sediment was visible at or near the sediment-water interface in many images from throughout the surveyed area (Figures 3-8 and 3-10). Low apparent sediment dissolved oxygen conditions were prevalent at the inner stations (14 of the 25 stations); however, they were also observed at two outer stations and one reference area station (Figure 3-10; Tables 3-1 through 3-3). Stations where wood particles were present in the sediment frequently had very shallow or no RPD (Figures 3-6 and 3-10). When present, the RPD appeared as a thin, tan iron oxide layer over black sulfidic mud or as small patchy oxidized mud clumps in the presence of reduced sediment (Figures 3-6 and 3-8).

Although no evidence of redox rebound intervals was noted in the surficial sediment, relic RPDs (an indicator of sediment layering) were detected in eight inner stations and two outer stations. Relic RPDs usually occur when a relatively thin layer of dredged material is placed over an older deposit or ambient sediments, and represent the depth of oxygenation in the underlying material prior to being covered by the fresh deposit. A new RPD will be formed at the sediment surface as oxygen is incorporated into the surficial sediments via the bioturbational activity of benthic infauna. In addition, layering of dredged material is often detected due to different textures or composition of the sediment comprising the layers (e.g., Figure 3-6).

Although sediment methane was not detected in any of the REMOTS® images obtained in August 2001, the majority of images from the inner and outer disposal site and

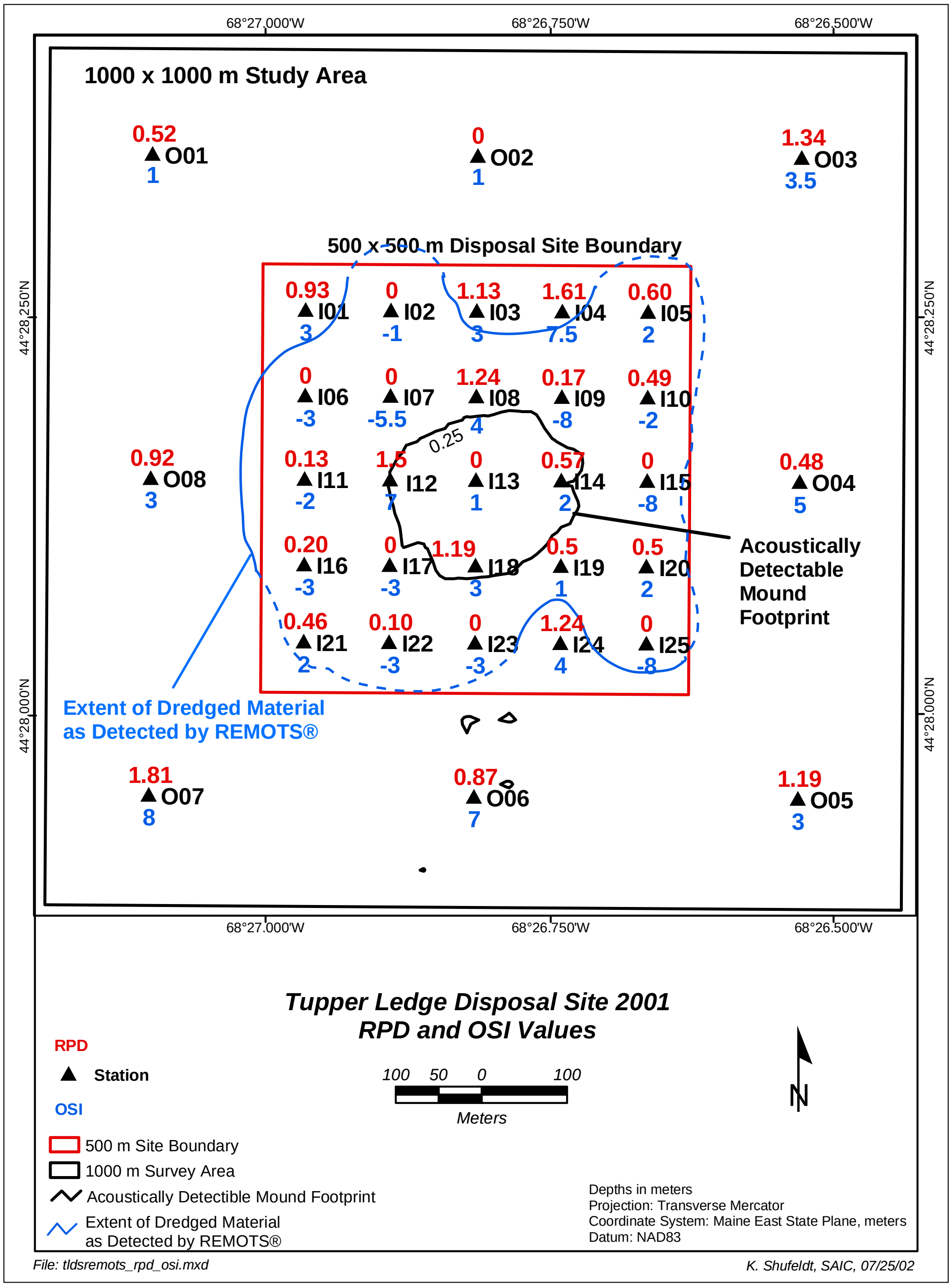

Figure 3-9. Map of replicate averaged RPD depths (red, in centimeters) and median OSI values (blue) detected within TLDS relative to the acoustically detectable dredged material footprint

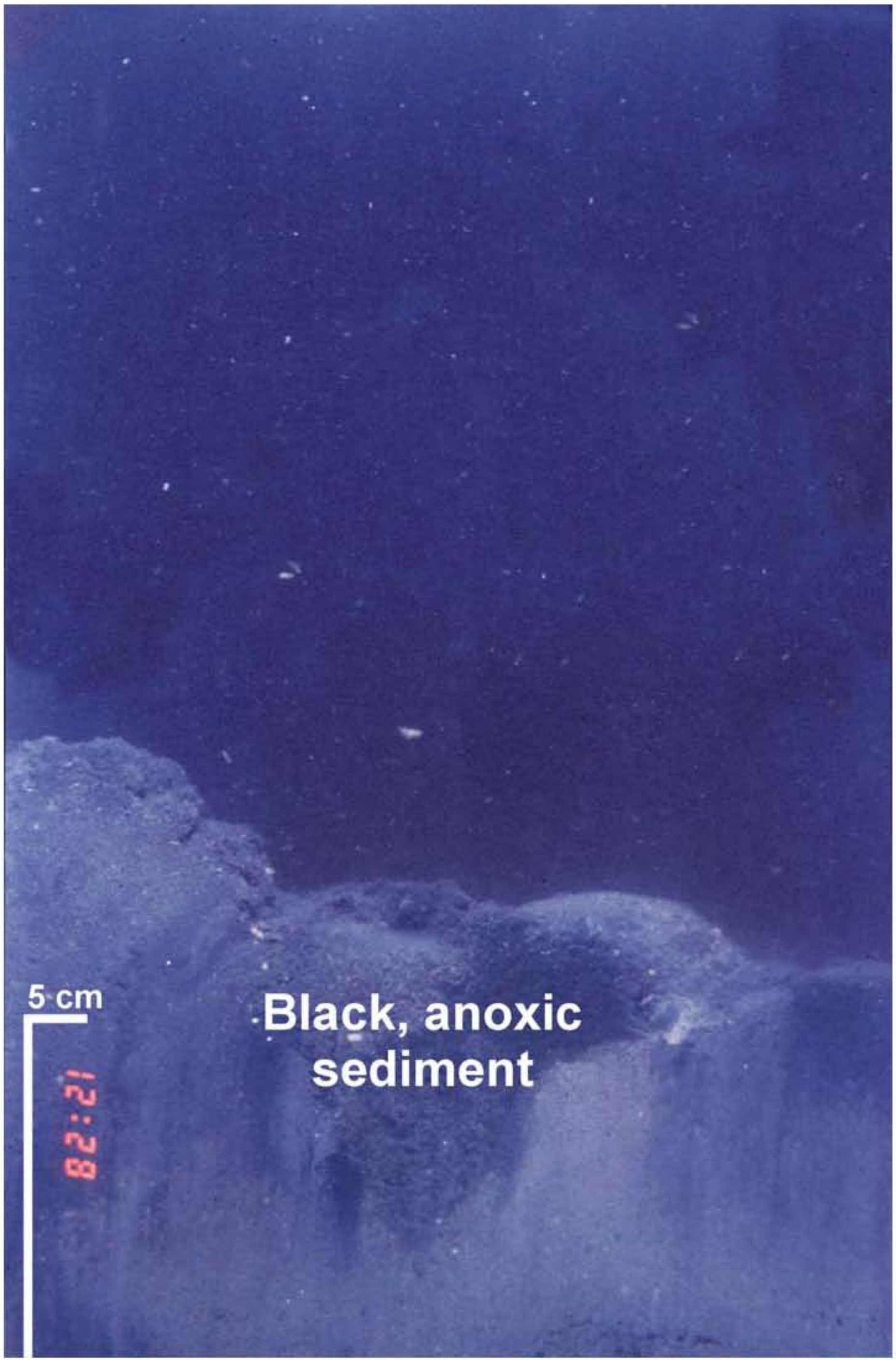

Figure 3-10. REMOTS® image collected from Station I17 showing anoxic sediment with no apparent RPD and lacking visible macrofauna (azoic), resulting in an OSI value of –8

nearby reference area stations displayed distinct horizons or "bands" of black, sulfidic sediment at or just below the sediment surface. Such horizons of reduced sediment were frequently present over and/or under layers of oxidized sediment (Figures 3-7, 3-8, and 3-11). While wood particles were identifiable in the inner TLDS images, no wood particles were evident in conjunction with the reduced sediment layers in the images from the outer disposal site and reference areas.

Considering the relatively short amount of time between the 2001 disposal activity and the August 2001 monitoring event, it was anticipated that the benthic community would be in an early stage of recolonization. The successional stage recolonization status for the inner disposal site stations included azoic conditions (i.e., no visible macrofaunal life), Stage I pioneering polychaetes at the sediment surface and Stage III taxa (Figure 3-12; Table 3-1). Azoic conditions were observed at 11 of the 25 inner stations and at one outer station (Figures 3-10 and 3-12; Tables 3-1 and 3-2). Stage III activity, evidenced by active feeding voids produced by head-down, deposit-feeding infauna, was detected at stations located primarily to the north and west of the disposal mound (Figure 3-12).

Stage I pioneering polychaetes and Stage III taxa characterized the successional stage recolonization status at the outer stations, with one station exhibiting azoic benthic conditions. Stage III occurred in 11 of the 24 replicate images obtained at the outer stations (46%), compared to 10 of the 75 replicate images (13%) at the inner stations. The reference area stations exhibited relatively advanced successional status, with both Stage I and Stage III present (Table 3-3). Stage III occurred in 14 of the 24 replicate images (58%) obtained at the reference areas. Overall, the dominance of low-order seres (azoic or Stage I) at the inner disposal site stations indicated that benthic recolonization over the dredged material deposit was still in a very early stage at the time of the survey.

Replicate-averaged median OSI values for the inner disposal site stations ranged from -8 at Stations I09, I15, and I25 to +7.5 at Station I04 (overall average of –0.3; Figure 3-9; Table 3-1). Negative OSI values are indicative of highly degraded benthic habitat conditions. Relatively higher OSI values were calculated for the outer stations, which ranged from +1 at Stations O01 and O02 to +8 at Station O07 (overall average of +3.9; Figure 3-9; Table 3-2). The degraded benthic habitat designation at many of the inner stations around the disposal mound was due to shallow RPD depths or the total lack of an apparent RPD, azoic or Stage I successional status, and the presence of apparent low sediment dissolved oxygen conditions in many station replicates (Figure 3-10). Likewise, shallow or non-existent RPD depths coupled with azoic or Stage I successional stages, and low apparent sediment dissolved oxygen conditions, served to diminish the median OSI values at the outer stations to values reflecting moderately degraded benthic habitat

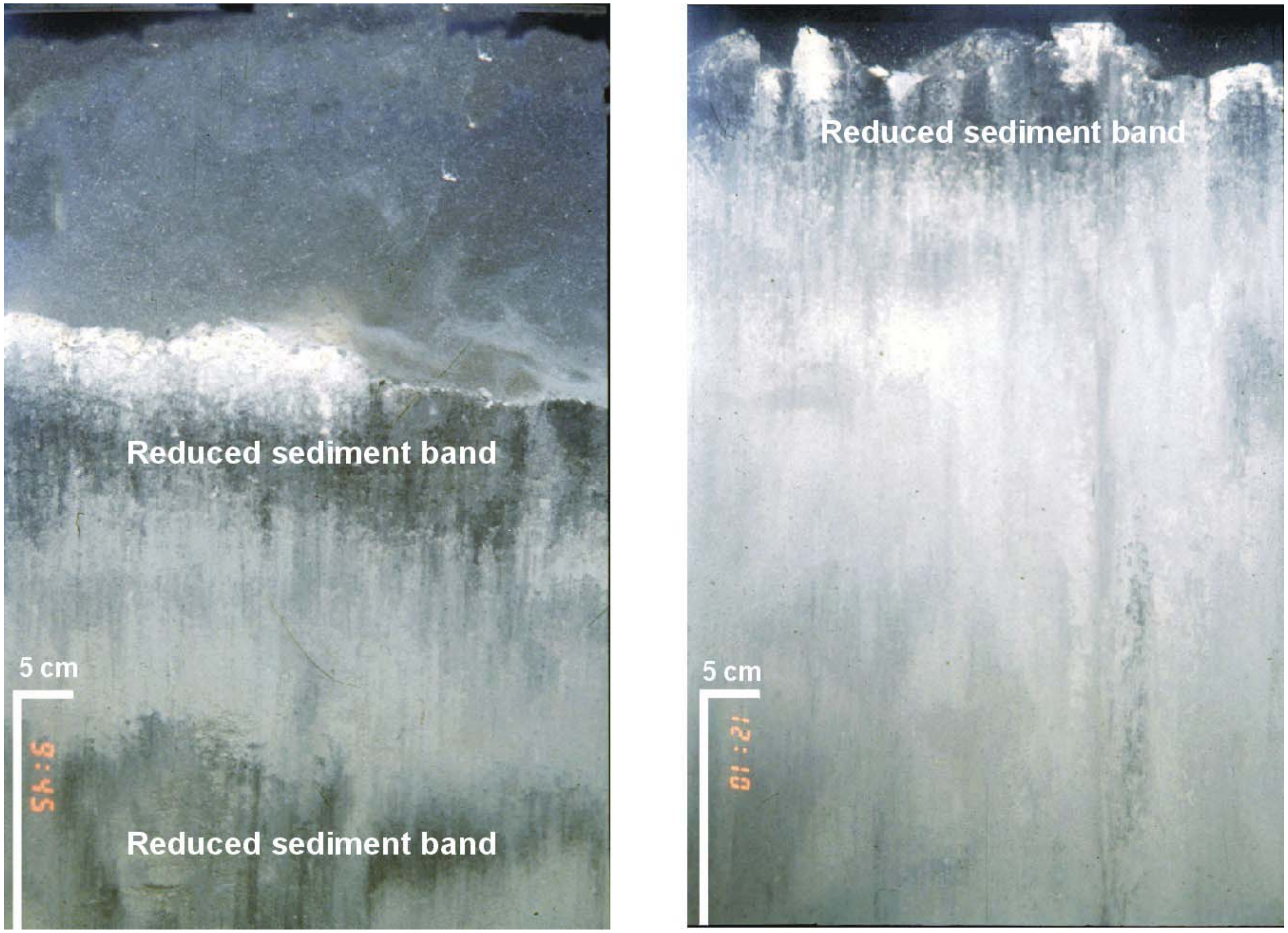

Figure 3-11. REMOTS® image from inner Station I01 (left) and outer Station O05 (right) displaying the reduced sediment banding observed just below the sediment-water interface and at depth in the ambient sediment

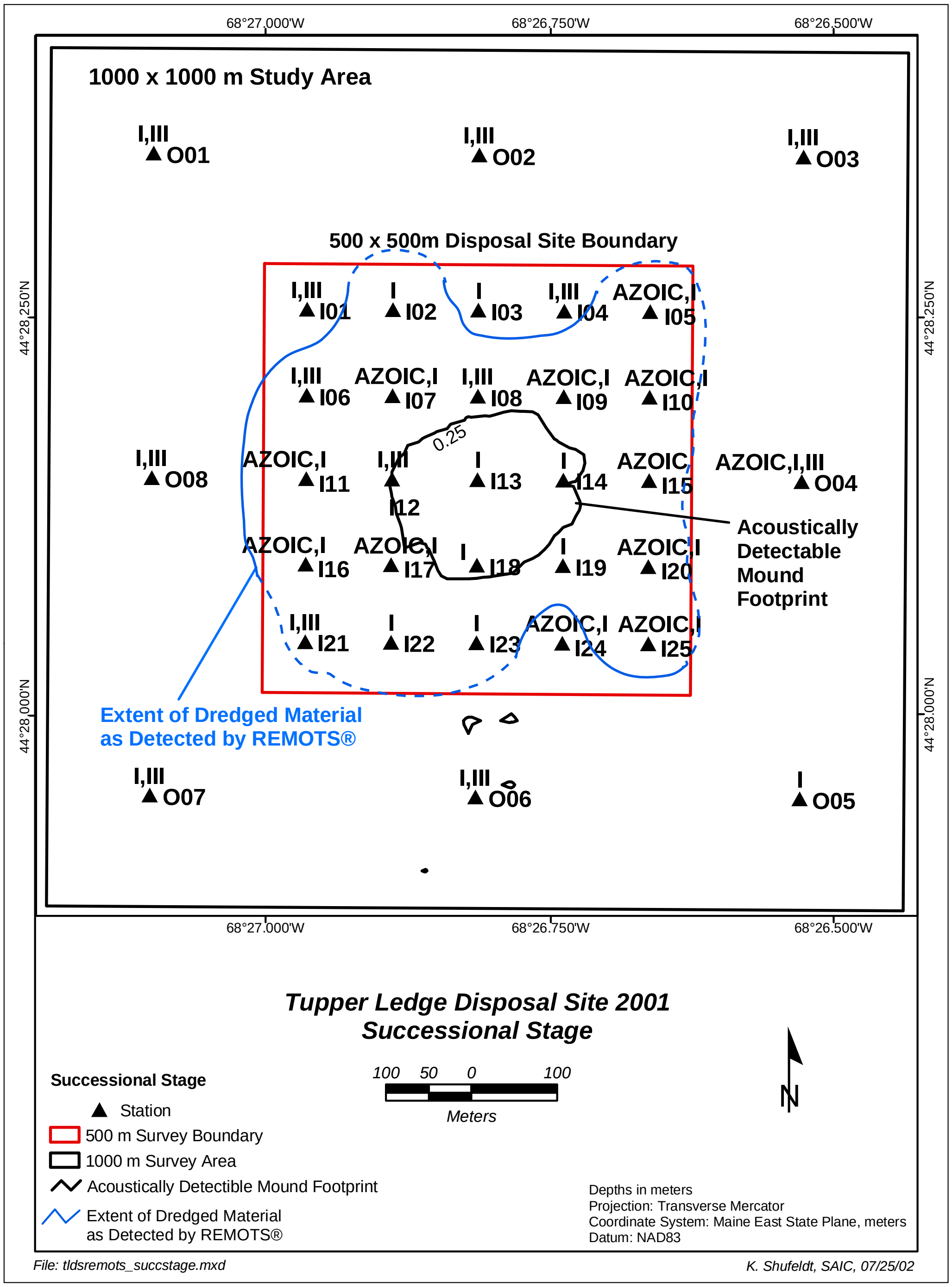

Figure 3-12. Map of successional stage status for the REMOTS® stations established within the TLDS Study Area relative to the acoustically detectable dredged material footprint

conditions. There was some spatial variability in benthic habitat conditions over the disposal mound, with stations such as I04 and I12 exhibiting deeper mean RPD depths, Stage III activity, and relatively well-aerated surface sediment that resulted in higher OSI values (Figure 3-9). In images from one outer and one inner station, Stage III feeding voids were visible at depth in sediment with no RPD and apparent low dissolved oxygen conditions (Figure 3-13).

While the range of OSI values at the reference areas (+0.7 to +7.3) was comparable to those at the inner and outer TLDS stations, the median OSI values at the reference areas were consistently higher than those at the inner or outer stations, with an overall average of +5.3 (Table 3-3). Such a value is indicative of moderately degraded benthic habitat quality, mainly related to relatively shallow RPD depths at the reference area stations (Figure 3-14). Reduced sediment layers or bands were common at the sediment-water interface and at depth in many replicates for both the EREF and WREF reference areas (Figures 3-7, right image, and 3-14).

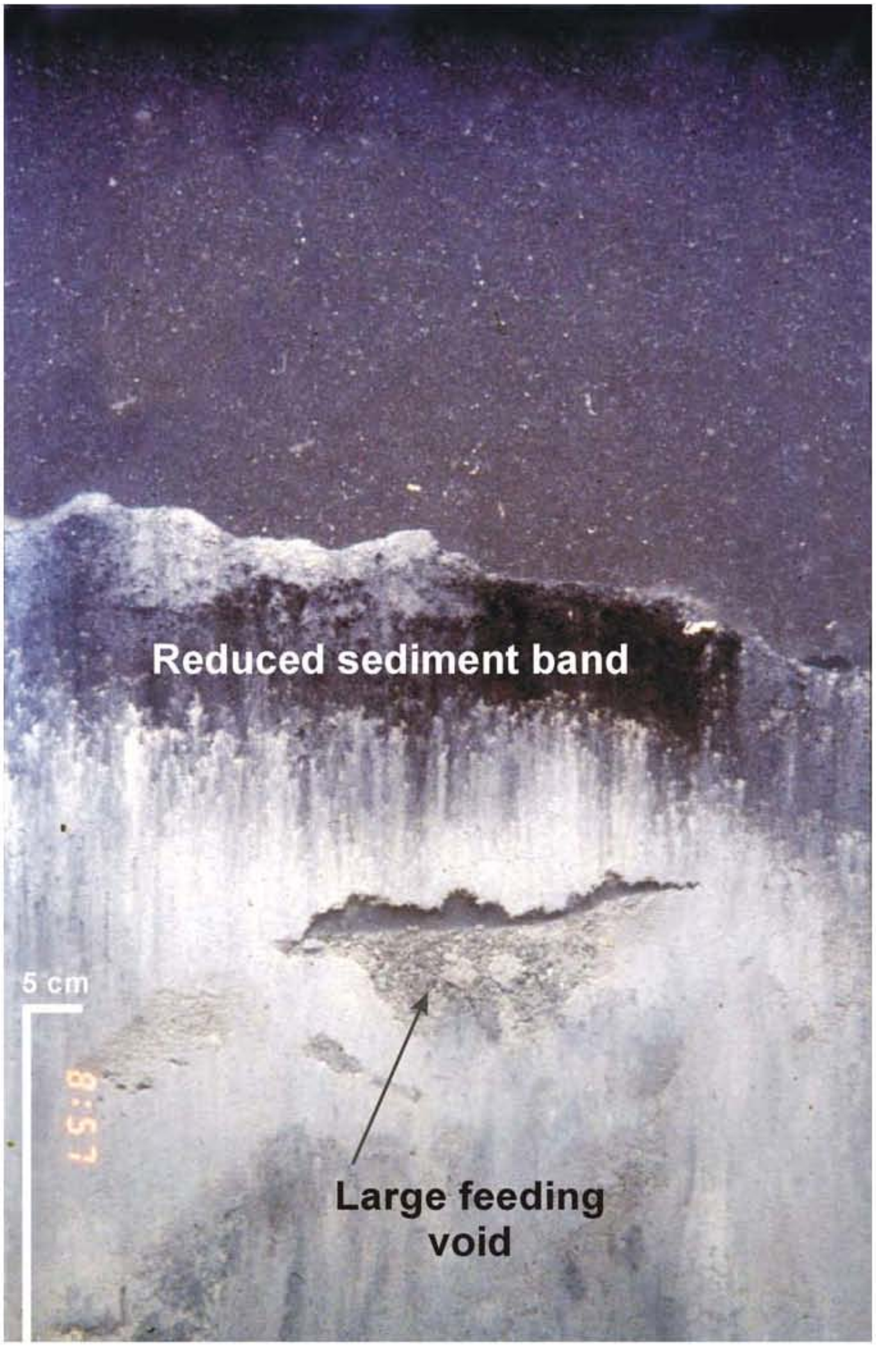

Figure 3-13. REMOTS® image from outer Station O02 showing a large Stage III feeding void in ambient sediment with low dissolved oxygen conditions and no apparent RPD

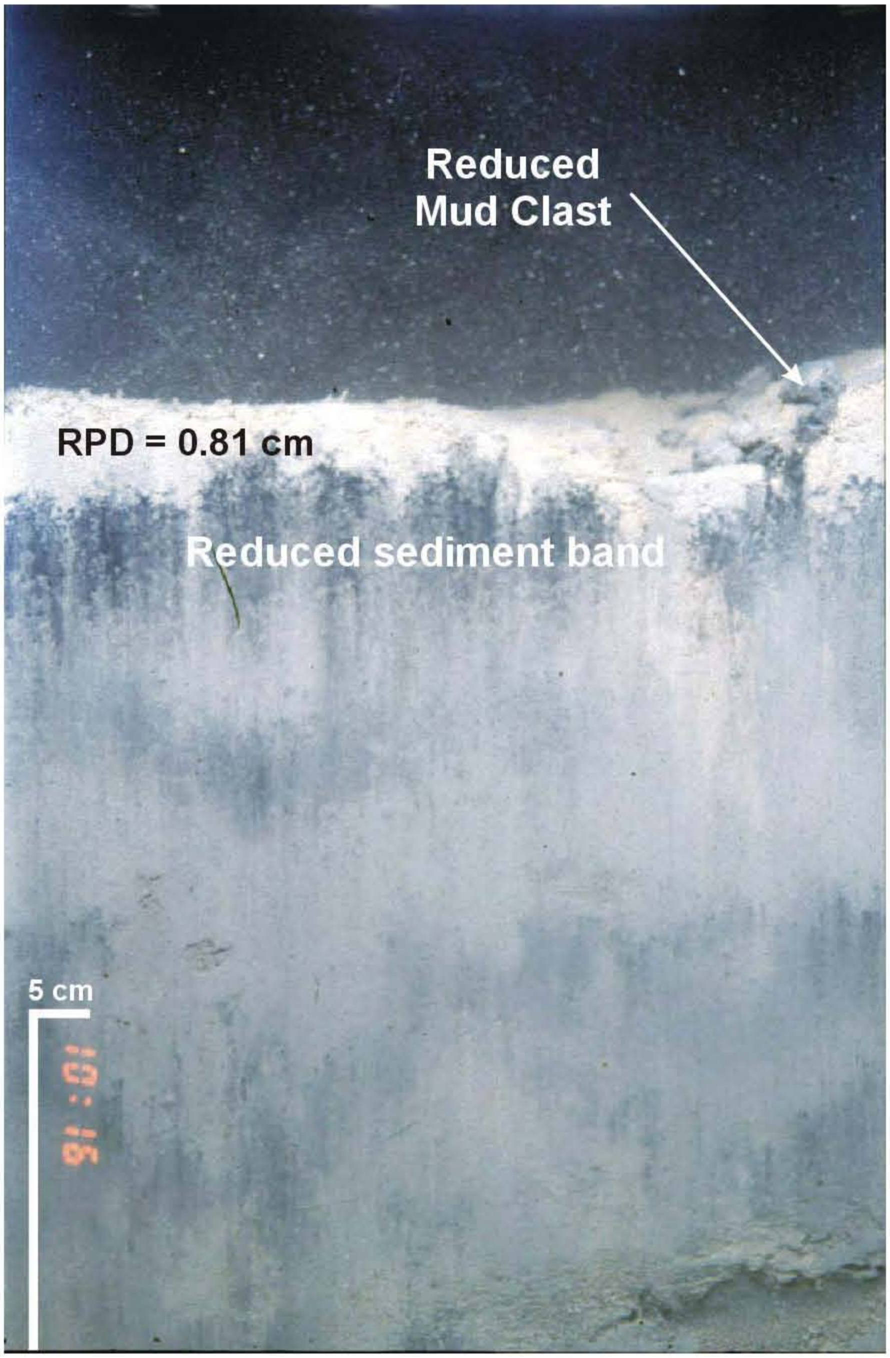

Figure 3-14. REMOTS® image from Station WREF 4 illustrating a reduced sediment band near the sediment surface under a relatively thin oxidized sediment layer with reduced mud clasts. Note the Stage III void at the bottom right of the image.

4.0 DISCUSSION

4.1 Dredged Material Distribution

One objective of the August 2001 survey over TLDS was to document changes in seafloor topography resulting from the placement of approximately 50,000 m^3 of dredged material from the Union River Federal Navigation Channel. The comparison of the March 2000 (predisposal) and August 2001 (postdisposal) bathymetric data indicated that the thickest layers of dredged material formed a semi-circular deposit on the seafloor in the center of the disposal site (Figure 3-3). At the center of this deposit (i.e., the apex of the disposal mound), the dredged material had a thickness of 3.25 m (Figure 3-3). Moving away from the mound apex, thickness decreased steadily in all directions, with the thickness contours forming a series of concentric rings. The 0.25 m thickness contour, representing the resolution limit of the bathymetric depth differencing technique, formed a circular feature having a diameter of roughly 225 m (Figure 3-3).

In addition to detecting the thicker, central portion of the disposal mound, a minor depression was observed northeast of TLDS in the August 2001 bathymetric survey (Figure 3-1). Because of its size and location, this feature was not detected during the March 2000 bathymetric survey and is attributed to differences in the coverage areas between the successive 2000 and 2001 surveys. With the exception of the new disposal mound and the discovery of the small depression, there were no other significant changes in seafloor topography over the remainder of the survey area. The bathymetric depth difference results therefore indicated that the thickest layers of the dredged material deposit were centered within the 500 × 500 m disposal site boundary.

The REMOTS® results agreed well with the depth difference comparison and indicated that the dredged material was centered within the confines of the disposal site. Sediment-profile imaging allowed measurement of relatively thin (i.e., less than about 20 cm) dredged material layers that were not reliably detected through bathymetric depth differencing. As a result, the spatial distribution or "footprint" of the dredged material deposit, as determined by REMOTS®, extended beyond the acoustically detected footprint (Figure 3-4). The measured average thickness of the dredged material layer at stations on the apron of the mound at TLDS generally exceeded the penetration depth of the sediment-profile camera. Discrete dredged material layers between 0.33 cm and 3.00 cm thick were observed at Stations I15, I19, I20, and I21 on the outer apron, while only ambient sediment (i.e., no dredged material) occurred at Stations I01, I03, I04, and I24 (Figure 3-4). Overall, the disposal mound as delineated by REMOTS® sediment-profile imaging had a diameter of approximately 500 m. Furthermore, the lack of dredged material detected at

Station O06 confirms that the small-scale features detected in the depth difference comparison were survey artifacts.

The REMOTS® images indicated that the dredged material constituting the TLDS disposal mound was mostly fine-grained sediment (i.e., silt-clay). However, wood particles mixed with the silt-clay (e.g., Figures 3-5 and 3-6) were observed in at least one sediment-profile image at 9 of the 25 disposal site stations (36%). The wood particles originated from the once active lumber milling industry in Ellsworth. Over the years, residual wood material from cut and processed lumber (e.g., wood chips, very fine wood particles and/or fibers) was discharged and eventually settled to the bottom of the Union River. During the maintenance dredging of the Federal Navigation Channel, the historic, deep layers of wood and wood particles were exposed and subsequently deposited at TLDS along with the fine-grained sediment.

The presence of cohesive mud clumps at the sediment-water interface (e.g., Figure 3-8) was the primary cause of high small-scale surface relief (boundary roughness) at TLDS. These mud clumps were not previously detected during the March 2000 baseline survey, when the average small-scale boundary roughness at the TLDS stations was 1.7 cm compared to average values of >2.0 cm at the inner, outer and reference area stations in the present survey (SAIC 2000). Such angular mud clumps or clasts are frequently observed at the surface of recent dredged material deposits, as a result of muddy, cohesive sediment being dredged by mechanical methods (e.g., using a clamshell bucket) and remaining in a consolidated state during transport and disposal. Therefore, the mud clumps and associated high boundary roughness at the inner stations are most readily attributed to the recent disposal activities. However, the presence of mud clumps and relatively high boundary roughness at the outer and reference area stations (Figure 3-8) is not readily explained by dredged material disposal and suggests a more widespread, regional source of physical disturbance at the sediment surface.

One possible explanation for the mud clumps at the outer disposal site and reference area stations is disturbance of the bottom from the passage of fishing gear. According to information provided by the local harbormaster, Union River Bay supports a scallop fishery (R. Heckman, Ellsworth Harbor Master, pers. comm.). Local residents report witnessing scallop fishing vessels dragging in the bay throughout the winter, primarily when offshore weather conditions are unfavorable. Dragging a weighted net or scallop dredge along the seafloor can act to break up muddy, cohesive surface sediments into the discrete clumps or clasts observed in the sediment-profile images obtained in August 2001 (Messieh et al. 1991; Thrush et al. 1995).

The 2001 disposal operations at TLDS took place in winter and early spring, at the same time fishing is generally at its peak in Union River Bay. Although fishing in the tidal waters of the bay is restricted from April 15 to August 1, it is possible that the effects of trawling disturbance were still visible at the sediment surface during the August 2001 monitoring survey. Because the dredged material disposal and fishing activities may have occurred around the same time, it is not certain that the mud clumps observed at the disposal site were directly related to the disposal activity, although it is a reasonable assumption. The fishing influence is a possible explanation for the presence of sediment clumping outside of the disposal area.

In further monitoring of TLDS, it may be beneficial to conduct a side-scan sonar survey over the areas of interest, including the reference areas. The side-scan sonar data could be used to characterize sediment distribution throughout TLDS and to provide a rough estimate of the spatial extent of the disposal mound. The data could also be used to document scours on the seafloor produced as a result of towing fishing gear along the bottom. Most importantly, the side-scan imagery would compliment other existing and future data sets, such as bathymetry and REMOTS®, by providing a means to verify large-scale seafloor features.

4.2 Sediment Dissolved Oxygen Levels

The RPD as measured in sediment-profile images provides an indication of the apparent depth of oxidation in the sediment column. It represents an important time-integrator of dissolved oxygen conditions within sediment pore waters and is also a useful indicator for assessing the condition of a benthic ecosystem. Overall, apparent RPD depths at the inner and outer disposal site stations, as well as at the nearby reference area stations, were relatively shallow at the time of the August 2001 survey, indicating poor sediment aeration throughout the region. The inner disposal site stations consistently had the shallowest RPD depths, with an overall average of 0.5 cm and a significant number of stations (8 of 25, or 32%) where the RPD was 0 cm (i.e., low apparent sediment dissolved oxygen as illustrated in Figure 3-10). The overall mean RPD depths at the outer disposal site (0.9 cm) and reference area stations (1.2 cm) were likewise substantially shallower than the mean value of 2.7 cm measured at TLDS in the March 2000 baseline survey.

The extremely shallow RPD depths at the inner disposal site stations are most readily attributed to the elevated levels of organic carbon associated with the presence of wood particles. In general, sediments dredged from river channels and inner harbor areas often contain elevated levels of organic matter relative to ambient conditions on the seafloor surrounding an open-water disposal site. Wood particles contain a particularly high organic carbon content that can add to the already elevated levels associated with fine-grained dredged material. Decomposition of this organic matter acts to consume oxygen within the sediment. Dredged material containing decomposing wood particles therefore tends to have very high sediment oxygen demand (SOD), and the consumption of available oxygen in the sediment pore water is reflected in shallow or non-existent RPD depths.

The presence of wood particles in the dredged material at the inner TLDS stations represents a case of very high organic loading. As a result, the level of oxidation observed within the surface sediments comprising the disposal mound was not consistent with normal patterns of recovery for a 4-month-old dredged material deposit. At DAMOS monitored dredged material mounds in Long Island Sound, for example, apparent RPD depths of greater than 1 or 2 cm typically develop within several months of disposal, as a result of both molecular diffusion and active downward mixing of oxygen from overlying waters by benthic organisms (bioturbation and burrow aeration). Accumulation of wood particles in sediments has been shown to cause shallow or non-existent RPD depths and low apparent sediment dissolved oxygen conditions in other regions (SAIC 1999; Pearson and Rosenberg 1978).

While poor sediment aeration over the disposal mound at TLDS is readily attributed to decomposing wood particles and associated high SOD in the dredged material, relatively shallow RPD depths were also observed at both the outer disposal site and reference area stations located away from the mound. In addition to the shallow RPD depths, distinct horizontal bands of black, reduced sediment were observed in nearly half of the replicate images (58 of the total 123 replicates) obtained from all locations during the August 2001 survey. Numerous other images from all locations displayed less defined patches of black, reduced sediment near the sediment surface and at depth. In general, these black patches indicate localized zones of elevated sulfide production in the sediment, resulting from the anaerobic decomposition of organic matter. The distinct bands of sulfidic sediment at or just below the sediment-water interface in the REMOTS® images suggest there was a relatively recent and significant input (i.e., a "pulse") of organic matter to the seafloor in and surrounding TLDS. Such a strong organic matter pulse could have several possible origins, but with patches of black, sulfidic sediments detected in close proximity to the disposal site, as well as the TLDS reference area stations (see Figures 3-7, 3-8, 3-11, and 3-13) the impacts appear to be on a regional scale.

The possibility of organic enrichment related to dredging and disposal activities in the Union River warrants investigation. Evidence of wood particles and reduced material in the disposal mound provides evidence that substantial organic matter input was associated with the disposal of dredged material at TLDS. However, the August 2001 monitoring serves to confirm that most of the dredged sediment and associated wood particles formed a discrete mound on the seafloor within the confines of the disposal site. Additionally, wood particles were not evident in the REMOTS® images from the outer TLDS and the reference areas. Therefore, there is no evidence that the less-dense wood particles in the dredged material were entrained in the water column during dredging and/or disposal activities and transported by currents to areas surrounding TLDS.

A more likely explanation for the widespread presence of sulfidic sediments at or near the sediment-water interface throughout the entire survey area (inner and outer TLDS stations and reference areas) is related to natural processes within the upper portions of the Union River Bay estuary. The pulse of organic carbon within the sediment may have been due to seasonal events such as spring runoff or phytoplankton blooms from the overlying water. Seasonal events like the spring runoff or sporadic phytoplankton blooms have the potential to add significant amounts of organic material to the sediment in a relatively short period of time. Once this material has settled to the seafloor, it becomes subject to decomposition. The resultant depletion of oxygen causes an anoxic zone to develop near the sediment-water interface; such a zone can become marked by the distinct horizontal "bands" of sulfidic sediment present in the August 2001 images. In the March 2000 baseline survey, a greenish tint was noted at the sediment surface in several REMOTS® images, possibly representing a depositional layer of algal detritus from the overlying water column (Figure 4-1). Although such algal layers were not observed in any of the sediment-profile images collected in the August 2001 survey, the observed black bands may represent a record of the decomposition of past blooms within the sediment column.

The March 2000 baseline survey also showed that total organic carbon (TOC) levels were relatively high in surface sediments at TLDS. Specifically, an average TOC concentration of 3.7% was found, compared to concentrations of 1.3% near the Rockland Disposal Site in Penobscot Bay, and 2.3% at a site in Frenchman's Bay (SAIC 2000). These results are considered indicative of the strongly depositional nature of the seafloor at TLDS; this area may be a focusing site for fine-grained sediment and organic matter transported downstream by the Union River and/or produced locally within the Union River Bay estuary. High TOC levels may be augmented by historic dredged material disposal at this location, from past dredging of the Union River navigation channel. However, organic enrichment of the surface sediments can be more readily attributed to more recent depositional events. The disposal of dredged material within the confines of TLDS containing significant amounts of wood material in the year 2001 added to the existing high sediment inventories of organic matter at TLDS, increasing the potential for elevated sediment oxygen demand and sulfide production.

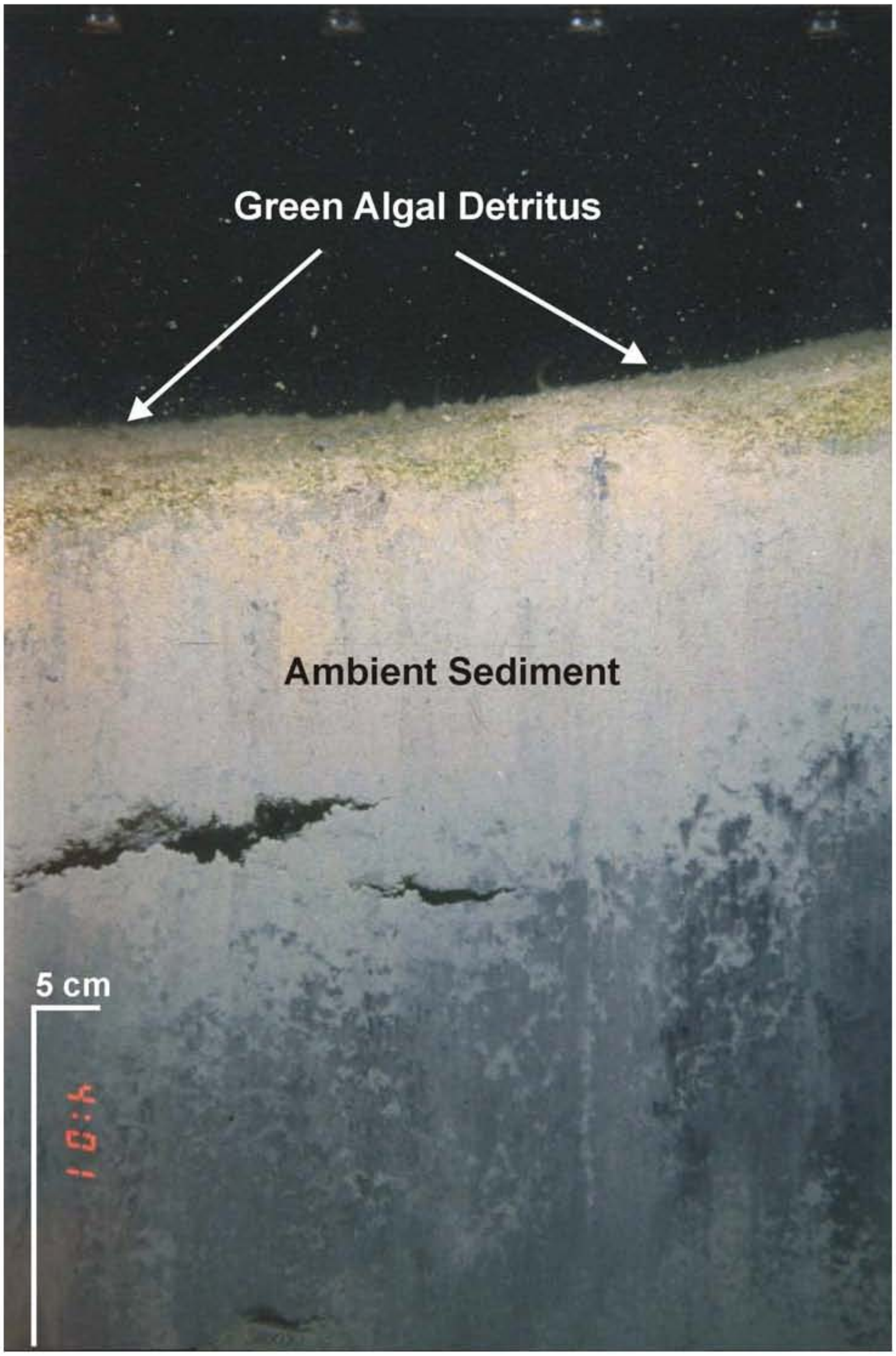

Figure 4-1. REMOTS® image obtained at Station I01 in the March 2000 baseline survey showing a greenish tint at the sediment surface, possibly indicating a recent depositional layer of algal detritus

4.3 Benthic Recolonization and Benthic Habitat Conditions

The August 2001 monitoring survey was conducted approximately four months following the cessation of the January-to-April disposal activities. According to the DAMOS tiered monitoring approach, a disposal mound experiencing normal benthic recolonization is expected to support a widespread and abundant Stage I community four months following disposal, with perhaps some progression into more advanced Stage II or III assemblages (Germano et al. 1994). In the August 2001 monitoring survey, the inner disposal site stations were dominated by low-order successional stages (azoic and Stage I) that showed significant spatial variability. The observation of azoic conditions instead of Stage I at a significant number of the inner stations (11 of 25, or 44%) indicates slower-than-expected recolonization over the surface of the mound. The inhibited recolonization is attributed to the elevated organic content and high SOD associated with decomposition of the wood particles in the dredged material. Anoxic sediment conditions and elevated levels of sulfides, which are toxic to many benthic organisms (Wang and Chapman 1999), created an unfavorable environment for recolonization.

Advanced Stage III assemblages were detected at only 6 of the 25 inner stations (24%), primarily those to the north and west of the disposal mound apex. With the exception of Station I03, Stage III activity was present at all nine stations sampled in the March 2000 baseline survey. Of these nine baseline stations, successional status of three stations located on the periphery of the survey boundary (I01, I03, and I21) remained unchanged during the August 2001 survey (Table 3-1). The successional status of the remaining March 2000 baseline stations declined considerably in the August 2001 survey, from Stage I on III communities to azoic or Stage I.

Despite evidence of an organic loading pulse at the outer disposal site and reference area stations, advanced Stage III activity was widespread (e.g., Figures 3-13 and 3-14). Stage III was present at all but one outer disposal site and one reference area station, where only Stage I was present. Azoic conditions were evident in one replicate image obtained at outer station O04. In general, successional status appeared to be more advanced at the reference area stations than the disposal site stations, with no azoic conditions observed.

The OSI provides a summary measure of overall benthic habitat quality. The disposal site stations showed variable benthic habitat conditions, with median OSI values ranging from highly degraded (OSI less than zero) to non-degraded (OSI $< +6$). With the exception of station I12, the higher OSI values occurred on the outer apron of the disposal mound or at the outer stations where no dredged material was observed. A total of 23 of the 25 inner stations (92%) displayed OSI values below $+6$, and 12 of these stations (48%)

displayed OSI values less than zero. The overall OSI of –0.3, indicating highly degraded benthic habitat quality, reflects the shallow or non-existent RPD depths, a lack of benthic infauna or early stages of infaunal colonization, low sediment dissolved oxygen conditions and high SOD observed over most of the disposal mound.

The overall average median OSI value calculated for the TLDS mound stations was much lower than that observed during the March 2000 baseline survey (–0.3 in August 2001 versus +6 in March 2000). The value of +6 in the 2000 baseline survey reflected some existing, moderate degradation of benthic habitat quality attributed to the effects of high background levels of sediment organic carbon in the region. A decline in OSI values is normally expected as a result of the physical seafloor disturbance associated with dredged material disposal. The observed decline from +6 to –0.3 is greater than expected due to the combination of physical disturbance and low apparent sediment dissolved oxygen associated with the unusually high levels of organic matter in the deposited material.

Although the median OSI values at the outer and reference area stations (+3.9 and +5.3, respectively) were higher than at the inner stations, such values are nonetheless indicative of disturbed or degraded benthic habitat conditions. These conditions were mainly a function of shallow RPD depths and low apparent sediment dissolved oxygen related to the pulse input of organic matter to the sediment surface. This input was apparently not of sufficient magnitude or duration at the outer or reference area stations to create unfavorable conditions for the existing Stage III community. Moderate inputs of organic matter experienced at sufficient distance from an organic loading point source can actually have a stimulatory effect on benthic production (Pearson and Rosenberg 1978; Grizzle and Penniman 1991; Simboura et al. 1995; Maurer et al. 1993).

The disposal of dredged material at TLDS represented a significant input of organic matter, and the August 2001 REMOTS® results indicated the existence of regional organic enrichment as well (i.e., at the outer and reference area stations). When all of the disposal activity at TLDS is completed, it is anticipated that benthic conditions at the stations over the mound will show gradual improvement, as the elevated organic matter undergoes microbial decomposition and direct consumption by benthic organisms.

Relatively little information is available regarding the dynamics of upper Union River Bay. As a result, the poor benthic habitat conditions detected at the inner, outer and reference area stations might be attributable to a variety of factors, including both anthropogenic and natural causes. Future monitoring of this site is recommended to verify benthic habitat quality improves over time. The August 2001 REMOTS® stations should be re-sampled to monitor the progress of recovery in the future. It is also recommended that one or more station transects be established to determine the extent of organic enrichment in the area. These transects should extend from the disposal mound to some distance beyond the present reference areas (perhaps several kilometers).

5.0 SUMMARY AND RECOMMENDATIONS

- Following the disposal of dredged material from the Union River navigation channel during the winter and spring of 2001, the August 2001 bathymetric survey indicated the formation of a discrete sediment deposit on the seafloor at TLDS. The thickest layers of dredged material occurred in a semi-circular deposit having a maximum height of 3.25 m, located in the center of TLDS. The disposal mound as delineated by REMOTS® sediment-profile imaging was roughly circular, with a diameter of about 500 m covering most of the area inside the TLDS boundary.

- The REMOTS® images indicated that the dredged material constituting the TLDS disposal mound was mostly fine-grained sediment. Wood particles that had accumulated in the Union River navigation channel from the once-active lumber milling operations in Ellsworth were mixed with the fine-grained dredged material at a number of sampling stations.

- Cohesive mud clumps or clasts were observed at the sediment surface at both the disposal mound and reference area stations, due to either dredged material disposal or a more widespread, regional source of physical seafloor disturbance such as trawling. A side-scan sonar survey over TLDS and the surrounding area might help to determine the possible cause(s) of the increased small-scale surface roughness observed in the August 2001 REMOTS® survey.

- Apparent RPD depths over the disposal mound at TLDS and in the surrounding area were shallow at the time of the August 2001 survey, indicating poor sediment aeration. Distinct bands of black sediment indicating localized zones of anoxia and sulfide production were visible within the sediment column, principally near the sediment-water interface. The low apparent dissolved oxygen conditions and increased sediment oxygen demand were attributed primarily to decomposition of the elevated levels of organic matter (wood particles) present in the dredged material. The annual spring run-off event and/or sporadic phytoplankton blooms may also contribute pulses of organic matter to the sediments within and around TLDS.

- Benthic recolonization over the surface of the new disposal mound at TLDS was slower than expected, as azoic conditions instead of Stage I were found at a significant number of sampling stations. The inhibited recolonization of the mound was attributed to the elevated organic content and high sediment oxygen demand associated with decomposition of the wood particles in the dredged material.

Advanced Stage III activity, similar to that observed in the March 2000 baseline survey at TLDS, continued to persist at the outer disposal site and reference area stations, despite evidence of high organic loading.

- Benthic habitat conditions were determined to be highly degraded over the disposal mound at TLDS, due to the widespread anoxic conditions in the sediment and associated poor infaunal recolonization. Benthic habitat quality in the surrounding area was somewhat better, mainly due to the persistence of the Stage III community despite evidence of organic loading. Overall, the August 2001 REMOTS® results indicated the existence of substantial organic enrichment at the disposal mound (inner stations) and lesser levels of enrichment at the outer and reference area stations.

- When all of the disposal activity at TLDS is completed, it is anticipated that benthic conditions at the stations over the mound will show gradual improvement, as the elevated organic matter undergoes microbial decomposition and direct consumption by benthic organisms.

- It is recommended that the August 2001 REMOTS® stations be re-sampled to monitor the progress of benthic habitat recovery in the future. One or more REMOTS® station transects extending from the disposal mound to several kilometers beyond the present reference areas could be established to determine the extent of organic enrichment in the area.

6.0 REFERENCES

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

Grizzle, R. E. and C. A. Penniman. 1991. Effects of organic enrichment on estuarine macrofaunal benthos: a comparison of sediment profile imaging and traditional methods. Mar. Ecol. Prog. Ser. 74:249-262.

Maurer, D., G. Robertson, and T. Gerlinger. 1993. San Pedro Shelf California: Testing the Pearson-Rosenberg Model (PRM). Mar. Environ. Res. 35:303-321.

Messieh, S. N., T. W. Rowell, D. L. Peer and P. J. Cranford. 1991. The effects of trawling, dredging and ocean dumping on the eastern Canadian continental shelf seabed. Continental Shelf Research 11:1237-63.

Pearson, T. H. and R. Rosenberg. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr. Mar. Biol. Ann. Rev. 16:229-311.

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

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

SAIC. 1999. Port Angeles Harbor Wood Waste Study, Port Angeles, Washington. Prepared for Washington State Department of Ecology, Olympia, WA, 40 pp. + figures, tables and appendices.

SAIC. 2000. Survey of a Proposed Disposal Site near Tupper Ledge in Union River Bay, Maine. SAIC Report No. 490. Final report submitted to the US Army Corps of Engineers, New England District, Concord, MA.

SAIC. 2001. Monitoring at the New London Disposal Site, 1992-1998, Volume I. DAMOS Contribution No. 128 (SAIC Report No. 515). U.S. Army Corps of Engineers, New England District, Concord, MA.

Simboura, N., A. Zenetos, P. Panayotidis, and A. Makra. 1995. Changes in benthic community structure along an environmental pollution gradient. Marine Pollution Bulletin 30:470-474.

Thrush, S. F., J. E. Hewitt, V. J. Cummings and P. K. Dayton. 1995. The impact of habitat disturbance by scallop dredging on marine benthic communities: what can be predicted from the results of experiments? Marine Ecology Progress Series 129:141-150.

Wang, F. and P. M. Chapman. 1999. Biological implications of sulfide in sediment – a review focusing on sediment toxicity. Environmental Toxicology and Chemistry 18:2526-2532.

Appendix A
Disposal Logs

Appendix A, Scow Inspector Disposal Logs

2000-2001 **TLDS**
Project: UNION RIVER
Permit 2000C0015 **Permittee** COE-ELLSWORTH ME

Buoy	Departure	Disposal	Return	Latitude	Longitude	Buoy's Vector		Volume (cy)
TLDA	1/8/2001	1/8/2001	1/8/2001	44.47133	-68.44617	30ft	S	600
TLDA	1/8/2001	1/8/2001	1/8/2001	44.47133	-68.44617	25ft	S	600
TLDA	1/9/2001	1/9/2001	1/9/2001	44.47117	-68.44617	20ft	E	600
TLDA	1/9/2001	1/9/2001	1/9/2001	44.4705	-68.44633	50ft	SE	600
TLDA	1/10/2001	1/10/2001	1/10/2001	44.47133	-68.446	20ft	S	600
TLDA	1/10/2001	1/10/2001	1/10/2001	44.47183	-68.44434	20ft	SE	600
TLDA	1/10/2001	1/10/2001	1/10/2001	44.47117	-68.44583	5ft	E	600
TLDA	1/11/2001	1/11/2001	1/11/2001	44.47183	-68.446	30ft	NE	600
TLDA	1/11/2001	1/11/2001	1/11/2001	44.4715	-68.44583	5ft	S	600
TLDA	1/11/2001	1/11/2001	1/11/2001	44.4715	-68.44566	10ft	S	600
TLDA	1/12/2001	1/12/2001	1/12/2001	44.47167	-68.44517	10ft	SE	600
TLDA	1/12/2001	1/12/2001	1/12/2001	44.47183	-68.44583	20ft	SE	600
TLDA	1/13/2001	1/13/2001	1/13/2001	44.472	-68.44566	40ft	NE	600
TLDA	1/13/2001	1/13/2001	1/13/2001	44.4715	-68.44566	5ft	S	600
TLDA	1/14/2001	1/14/2001	1/14/2001	44.47167	-68.4465	5ft	N	600
TLDA	1/14/2001	1/14/2001	1/14/2001	44.4705	-68.44583	30ft	NE	600
TLDA	1/14/2001	1/14/2001	1/14/2001	44.47017	-68.44566	20ft	S	600
TLDA	1/15/2001	1/15/2001	1/15/2001	44.47167	-68.44566	20ft	N	600
TLDA	1/15/2001	1/15/2001	1/15/2001	44.47183	-68.44617	20ft	N	600
TLDA	1/16/2001	1/16/2001	1/16/2001	44.47133	-68.44583	50ft	SW	600
TLDA	1/16/2001	1/16/2001	1/16/2001	44.46928	-68.44676	10ft	S	600
TLDA	1/16/2001	1/16/2001	1/16/2001	44.4715	-68.44518	30ft	SE	600
TLDA	1/17/2001	1/17/2001	1/17/2001	44.471	-68.44534	20ft	NE	600
TLDA	1/17/2001	1/17/2001	1/17/2001	44.46903	-68.44697	40ft	S	600
TLDA	1/17/2001	1/17/2001	1/17/2001	44.46903	-68.44677	30ft	S	600
TLDA	1/18/2001	1/18/2001	1/18/2001	44.4692	-68.4467	5ft	S	600
TLDA	1/18/2001	1/18/2001	1/18/2001	44.46912	-68.44704	10ft	SW	600
TLDA	1/18/2001	1/18/2001	1/18/2001	44.46917	-68.44693	10ft	N	600
TLDA	1/18/2001	1/18/2001	1/18/2001	44.46915	-68.44688	10ft	N	450
TLDA	1/19/2001	1/19/2001	1/19/2001	44.46915	-68.44688	8ft	S	600
TLDA	1/19/2001	1/19/2001	1/19/2001	44.46905	-68.44693	15ft	NE	320
TLDA	1/22/2001	1/22/2001	1/22/2001	44.46903	-68.44693	75ft	S	397
TLDA	1/23/2001	1/23/2001	1/23/2001	44.4692	-68.44688	20ft	E	405
TLDA	1/23/2001	1/23/2001	1/23/2001	44.46912	-68.44698	4ft	S	373
TLDA	1/24/2001	1/24/2001	1/24/2001	44.46922	-68.44701	3ft	N	325
TLDA	1/24/2001	1/24/2001	1/24/2001	44.46925	-68.44693	76ft	SE	325
TLDA	1/24/2001	1/24/2001	1/24/2001	44.46913	-68.44685	31ft	S	301
TLDA	1/25/2001	1/25/2001	1/25/2001	44.46922	-68.44701	1ft	N	345
TLDA	1/25/2001	1/25/2001	1/25/2001	44.46917	-68.44701	1ft	N	325
TLDA	1/25/2001	1/25/2001	1/25/2001	44.4691	-68.44691	60ft	S	325
TLDA	1/26/2001	1/26/2001	1/26/2001	44.4693	-68.44705	45ft	N	325
TLDA	1/27/2001	1/27/2001	1/27/2001	44.4693	-68.44653	20ft	N	325

Project: UNION RIVER
Permit 2000C0015 **Permittee** COE-ELLSWORTH ME

Buoy	Departure	Disposal	Return	Latitude	Longitude	Buoy's Vector		Volume (cy)
TLDA	1/28/2001	1/28/2001	1/28/2001	44.46923	-68.4469	25ft	N	373
TLDA	1/28/2001	1/28/2001	1/28/2001	44.46926	-68.4465	5ft	E	325
TLDA	1/29/2001	1/29/2001	1/29/2001	44.46965	-68.44633	1ft	E	373
TLDA	1/29/2001	1/29/2001	1/29/2001	44.4694	-68.44646	20FT	SE	325
TLDA	1/29/2001	1/29/2001	1/29/2001	44.46922	-68.44693	7ft	E	325
TLDA	1/30/2001	1/30/2001	1/30/2001	44.46928	-68.44676	140ft	E	349
TLDA	1/30/2001	1/30/2001	1/30/2001	44.46938	-68.44677	20ft	N	325
TLDA	2/5/2001	2/5/2001	2/5/2001	44.4695	-68.44593	1 ft	E	600
TLDA	2/5/2001	2/5/2001	2/5/2001	44.46853	-68.44562	60	NE	600
TLDA	2/7/2001	2/7/2001	2/7/2001	44.4695	-68.44569	3	NE	600
TLDA	2/7/2001	2/7/2001	2/7/2001	44.46918	-68.44592	15	NE	600
TLDA	2/8/2001	2/8/2001	2/8/2001	44.46898	-68.44633	50	SE	600
TLDA	2/8/2001	2/8/2001	2/8/2001	44.46895	-68.44656	20	S	600
TLDA	2/9/2001	2/9/2001	2/9/2001	44.46928	-68.4467	1	E	600
TLDA	2/12/2001	2/12/2001	2/12/2001	44.46915	-68.44642	20	S	600
TLDA	2/12/2001	2/12/2001	2/12/2001	44.46932	-68.44642	1	E	600
TLDA	2/13/2001	2/13/2001	2/13/2001	44.4691	-68.44669	20	SE	600
TLDA	2/13/2001	2/13/2001	2/13/2001	44.46926	-68.44632	20	S	600
TLDA	2/13/2001	2/13/2001	2/13/2001	44.46903	-68.44633	40	SW	600
TLDA	2/15/2001	2/15/2001	2/15/2001	44.46932	-68.44645	20	SW	600
TLDA	2/16/2001	2/16/2001	2/16/2001	44.46905	-68.44635	98	SE	600
TLDA	2/16/2001	2/16/2001	2/16/2001	44.46945	-68.44663	10	NW	600
TLDA	2/16/2001	2/16/2001	2/16/2001	44.46933	-68.4465	30	NE	400
TLDA	2/17/2001	2/17/2001	2/17/2001	44.46885	-68.44659	50	SE	600
TLDA	2/17/2001	2/17/2001	2/17/2001	44.4692	-68.44614	5	E	450
TLDA	2/20/2001	2/20/2001	2/20/2001	44.46958	-68.44622	6	N	400
TLDA	2/22/2001	2/22/2001	2/22/2001	44.46988	-68.4446	300	NE	450
TLDA	2/27/2001	2/27/2001	2/27/2001	44.46898	-68.44638	70	SW	600
TLDA	2/28/2001	2/28/2001	2/28/2001	44.46852	-68.44598	150	S	625
TLDA	3/2/2001	3/2/2001	3/2/2001	44.46923	-68.44592	1	E	500
TLDA	3/3/2001	3/3/2001	3/3/2001	44.46926	-68.44677	10	S	550
TLDA	3/4/2001	3/4/2001	3/4/2001	44.46973	-68.44677	20	NW	600
TLDA	3/5/2001	3/5/2001	3/5/2001	44.4696	-68.44666	20	N	500
TLDA	3/7/2001	3/7/2001	3/7/2001	44.46943	-68.44617	10	N	550
TLDA	3/8/2001	3/8/2001	3/8/2001	44.46942	-68.44685	15	N	375
TLDA	3/8/2001	3/8/2001	3/8/2001	44.46972	-68.44624	15	N	500
TLDA	3/9/2001	3/9/2001	3/9/2001	44.46942	-68.44665	10	NE	400
TLDA	3/10/2001	3/10/2001	3/10/2001	44.4688	-68.34675	10	SW	500
TLDA	3/10/2001	3/11/2001	3/11/2001	44.46945	-68.4465	20	NE	400
TLDA	3/11/2001	3/11/2001	3/11/2001	44.46953	-68.44666	40	N	475
TLDA	3/12/2001	3/12/2001	3/12/2001	44.46948	-68.44665	40	NE	400
TLDA	3/13/2001	3/13/2001	3/13/2001	44.46957	-68.44691	40	W	400
TLDA	3/14/2001	3/14/2001	3/14/2001	44.46945	-68.44678	40	N	600
TLDA	3/15/2001	3/15/2001	3/15/2001	44.46958	-68.44598	20	E	525
TLDA	3/15/2001	3/15/2001	3/15/2001	44.46937	-68.4462	30	E	400

Project: UNION RIVER

Permit 2000C0015 **Permittee** COE-ELLSWORTH ME

Buoy	Departure	Disposal	Return	Latitude	Longitude	Buoy's Vector		Volume (cy)
TLDA	3/16/2001	3/16/2001	3/16/2001	44.46898	-68.44627	25	SW	500
TLDA	3/18/2001	3/18/2001	3/18/2001	44.46922	-68.44646	5	S	600
TLDA	3/19/2001	3/19/2001	3/19/2001	44.4692	-68.44632	10	SW	600
TLDA	3/20/2001	3/20/2001	3/20/2001	44.4693	-68.44592	10	SE	400
TLDA	3/20/2001	3/20/2001	3/20/2001	44.46973	-68.44645	30	W	600
TLDA	3/21/2001	3/21/2001	3/21/2001	44.46942	-68.44665	15	W	600
TLDA	3/21/2001	3/21/2001	3/21/2001	44.46947	-68.44672	20	nw	600
TLDA	3/22/2001	3/22/2001	3/22/2001	44.46958	-68.44646	20	nw	400
TLDA	3/23/2001	3/23/2001	3/23/2001	44.46937	-68.44673	30	nw	600
TLDA	3/23/2001	3/23/2001	3/23/2001	44.46947	-68.44646	75	w	550
TLDA	3/24/2001	3/24/2001	3/24/2001	44.46928	-68.44637	20	se	600
TLDA	3/25/2001	3/25/2001	3/25/2001	44.46918	-68.44648	3	N	600
TLDA	3/25/2001	3/25/2001	3/26/2001	44.46935	-68.44633	10	NE	350
TLDA	3/26/2001	3/26/2001	3/26/2001	44.46942	-68.44652	10	NE	600
TLDA	3/26/2001	3/26/2001	3/27/2001	44.46958	-68.44672	40	NE	600
TLDA	3/27/2001	3/27/2001	3/27/2001	44.46912	-68.44628	25	S	600
TLDA	3/27/2001	3/28/2001	3/28/2001	44.46937	-68.44645	5	SE	600
TLDA	3/28/2001	3/28/2001	3/28/2001	44.46928	-68.44622	10	S	500
TLDA	3/29/2001	3/29/2001	3/29/2001	44.46918	-68.44637	10	S	300
TLDA	3/29/2001	3/29/2001	3/29/2001	44.46962	-68.44673	20	NW	600
TLDA	3/30/2001	3/30/2001	3/30/2001	44.46935	-68.44662	20	e	300
TLDA	3/30/2001	3/30/2001	3/30/2001	44.4691	-68.44642	10	se	400
TLDA	3/31/2001	3/31/2001	3/31/2001	44.46915	-68.44646	15	S	600
TLDA	4/2/2001	4/2/2001	4/2/2001	44.46933	-68.44646	10	E	550
TLDA	4/3/2001	4/3/2001	4/3/2001	44.46928	-68.44672	0		550
TLDA	4/4/2001	4/4/2001	4/4/2001	44.46948	-68.447	30	N	200
TLDA	4/4/2001	4/4/2001	4/4/2001	44.46957	-68.44645	30	NE	550
TLDA	4/5/2001	4/5/2001	4/5/2001	44.46947	-68.44653	10	NE	350
TLDA	4/5/2001	4/5/2001	4/5/2001	44.46947	-68.44677	15	N	550
TLDA	4/6/2001	4/6/2001	4/6/2001	44.46943	-68.44663	40	NW	575
TLDA	4/6/2001	4/6/2001	4/7/2001	44.46952	-68.44656	25	NE	550
TLDA	4/7/2001	4/7/2001	4/7/2001	44.46928	-68.44645	20	SE	325
TLDA	4/8/2001	4/8/2001	4/8/2001	44.46945	-68.44662	40	NW	500
TLDA	4/9/2001	4/9/2001	4/9/2001	44.46903	-68.44645	30	S	525
TLDA	4/10/2001	4/10/2001	4/10/2001	44.46915	-68.44659	20	SE	600
TLDA	4/11/2001	4/11/2001	4/11/2001	44.46935	-68.44685	10	NW	325
TLDA	4/11/2001	4/11/2001	4/11/2001	44.46947	-68.4468	10	N	600
TLDA	4/12/2001	4/12/2001	4/12/2001	44.4694	-68.44675	6	N	600
TLDA	4/13/2001	4/13/2001	4/13/2001	44.46918	-68.44691	20	SW	400
TLDA	4/13/2001	4/13/2001	4/13/2001	44.46945	-68.44675	20	N	600

Project Total Volume:	**49,688**	**CM**	**64,986**	**CY**
Buoy Total Volume:	**49,688**	**CM**	**64,986**	**CY**
Report Total Volume:	**49,688**	**CM**	**64,986**	**CY**

Appendix B
REMOTS® Results

Appendix B1
Inner Station TLDS REMOTS® Sediment-Profile Photography Data from the 2001 Survey

Station	Replicate	Date	Time	Successional Stage	Grain Size (phi)			Mud Clasts		Camera Penetration (cm)				Dredged Material Thickness (cm)			Redox Rebound Thickness (cm)			Apparent RPD Thickness (cm)		
					Min	Max	Maj Mode	Count	Avg. Diam	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
INNER																						
I01	F	8/6/2001	9:27	ST_I	>4	4	>4	0	0	6.47	8.56	2.09	7.51	0	0	0	0	0	0	0.21	1.66	1
I01	G	8/6/2001	9:45	ST_I_ON_III	>4	3	>4	15	0.29	12.3	14.44	2.14	13.37	0	0	0	0	0	0	0.53	1.5	1.05
I01	H	8/6/2001	9:50	ST_I	>4	3	>4	8	0.64	11.87	13.37	1.5	12.62	0	0	0	0	0	0	0.75	1.66	0.75
I02	B	8/5/2001	14:39	INDET	>4	3	>4	0	0	20.81	20.81	0	20.81	20.81	20.81	>20.81	0	0	0	NA	NA	NA
I02	D	8/7/2001	12:13	ST_I	>4	4	>4	0	0	4.27	6.54	2.27	5.41	4.27	6.54	>5.41	0	0	0	0	0	0
I02	F	8/7/2001	12:14	ST_I	>4	4	>4	0	0	7.46	8.81	1.35	8.14	7.46	8.81	>8.14	0	0	0	0	0	0
I03	A	8/5/2001	15:36	ST_I	>4	4	>4	0	0	18.65	19.46	0.81	19.05	0	0	0	0	0	0	0.16	2.43	1.23
I03	B	8/5/2001	15:36	ST_I	>4	4	>4	0	0	19.51	20.32	0.81	19.92	0	0	0	0	0	0	1.03	2.76	1.87
I03	C	8/5/2001	15:37	ST_I	>4	4	>4	2	0.78	16	17.84	1.84	16.92	0	0	0	0	0	0	0	0.5	0.3
I04	A	8/5/2001	16:33	ST_I_ON_III	>4	3	>4	0	0	16.92	18.76	1.84	17.84	0	0	0	0	0	0	NA	NA	NA
I04	B	8/5/2001	16:34	ST_III	>4	3	>4	0	0	13.67	17.02	3.35	15.35	0	0	0	0	0	0	0.59	3.03	1.85
I04	C	8/5/2001	16:35	ST_I_ON_III	>4	3	>4	0	0	19.41	20.37	0.96	19.89	0	0	0	0	0	0	0.48	1.76	1.36
I05	A	8/7/2001	11:00	ST_I	>4	3	>4	20	0.96	7.59	8.61	1.02	8.1	7.59	8.61	>8.1	0	0	0	0.32	1.98	1.29
I05	B	8/7/2001	11:00	ST_I	>4	3	>4	7	0.88	3.26	8.4	5.13	5.83	3.26	8.4	>5.83	0	0	0	0.32	2.51	0.5
I05	C	8/7/2001	11:01	AZOIC	>4	4	>4	0	0	3.8	6.15	2.35	4.97	3.8	6.15	>4.97	0	0	0	0	0	0
I06	K	8/8/2001	7:40	ST_I	>4	3	>4	3	1.1	6.74	7.22	0.48	6.98	6.74	7.22	>6.98	0	0	0	0	0	0
I06	L	8/8/2001	7:41	ST_I_ON_III	>4	4	>4	4	0.22	7.97	9.04	1.07	8.5	7.97	9.04	>8.5	0	0	0	0	0	0
I06	M	8/8/2001	7:41	ST_I	>4	3	>4	6	0.45	8.56	10.53	1.98	9.55	8.56	10.53	>9.55	0	0	0	0	0	0
I07	D	8/7/2001	12:17	ST_I	>4	3	>4	0	0	4.27	9.73	5.46	7	4.27	9.73	>7	0	0	0	0	0	0
I07	E	8/7/2001	12:18	AZOIC	>4	3	>4	0	0	5.46	7.08	1.62	6.27	5.46	7.08	>6.27	0	0	0	0	0	0
I07	F	8/7/2001	12:19	INDET	>4	4	>4	0	0	0.7	3.41	2.7	2.05	0.7	3.41	>2.05	0	0	0	NA	NA	NA
I08	D	8/5/2001	15:32	ST_I	>4	3	>4	0	0	13.68	15.89	2.22	14.78	13.68	15.89	>14.78	0	0	0	0	0.5	0.2
I08	J	8/8/2001	7:35	ST_I	>4	3	>4	0	0	5.24	6.97	1.73	6.11	5.24	6.97	>6.11	0	0	0	0.16	5.03	2.1
I08	K	8/8/2001	7:35	ST_I_ON_III	>4	3	>4	0	0	6.97	7.84	0.86	7.41	6.97	7.84	>7.41	0	0	0	0.16	2	1.42
I09	F	8/7/2001	11:29	AZOIC	>4	3	>4	0	0	5.62	6.76	1.14	6.19	5.62	6.76	>6.19	0	0	0	0	0	0
I09	H	8/7/2001	11:30	AZOIC	>4	3	>4	0	0	5.03	8.7	3.68	6.86	5.03	8.7	>6.86	0	0	0	0	0	0
I09	I	8/7/2001	11:31	ST_I	>4	3	>4	0	0	11.41	13.41	2	12.41	11.41	13.41	>12.41	0	0	0	0.27	2.16	0.5
I10	A	8/7/2001	10:51	AZOIC	>4	4	>4	0	0	2.94	5.88	2.94	4.41	2.94	5.88	>4.41	0	0	0	0.05	2.83	1.26
I10	B	8/7/2001	10:51	AZOIC	>4	3	>4	0	0	3.58	6.1	2.51	4.84	3.58	6.1	>4.84	0	0	0	0	0	0
I10	C	8/7/2001	10:52	ST_I	>4	3	>4	4	0.25	2.19	5.67	3.48	3.93	2.19	5.67	>3.93	0	0	0	0	0	0.2
I11	I	8/8/2001	7:47	ST_I	>4	3	>4	20	0.57	9.47	10.21	0.75	9.84	9.47	10.21	>9.84	0	0	0	0.05	1.39	0.2
I11	J	8/8/2001	7:47	AZOIC	>4	4	>4	1	0.3	9.36	12.89	3.53	11.12	9.36	12.89	>11.12	0	0	0	0	0	0
I11	K	8/8/2001	7:48	ST_I	>4	3	>4	0	0	11.34	14.49	3.16	12.91	11.34	14.49	>12.91	0	0	0	0	0	0.2
I12	F	8/7/2001	12:24	ST_I	>4	3	>4	0	0	6.45	7.04	0.59	6.75	6.45	7.04	>6.75	0	0	0	0.22	2.31	1.64
I12	H	8/8/2001	7:56	ST_I_ON_III	>4	3	>4	0	0	6.32	7.08	0.76	6.7	6.32	7.08	>6.7	0	0	0	0.05	2.11	1.19
I12	I	8/8/2001	7:57	ST_I_ON_III	>4	3	>4	0	0	8.23	8.98	0.75	8.6	8.23	8.98	>8.6	0	0	0	0.43	2.47	1.68
I13	A	8/5/2001	15:21	ST_I	>4	4	>4	0	0	4.43	7.24	2.81	5.84	4.43	7.24	>5.84	0	0	0	0	0	0
I13	H	8/8/2001	8:02	ST_I	>4	3	>4	0	0	3.73	5.3	1.57	4.51	3.73	5.3	>4.51	0	0	0	NA	NA	NA
I13	I	8/8/2001	8:03	ST_I	>4	3	>4	0	0	0.65	1.57	0.92	1.11	0.65	1.57	>1.11	0	0	0	NA	NA	NA
I14	C	8/5/2001	16:01	ST_I	>4	3	>4	30	0.2	16.86	18.05	1.19	17.46	16.86	18.05	>17.46	0	0	0	0.22	1.41	0.68
I14	F	8/5/2001	16:08	ST_I	>4	3	>4	40	0.38	15.51	16.16	0.65	15.84	15.51	16.16	>15.84	0	0	0	0.38	2.11	1.03
I14	H	8/7/2001	11:24	ST_I	>4	3	>4	0	0	6	7.3	1.3	6.65	6	7.3	>6.65	0	0	0	0	0	0
I15	A	8/7/2001	10:46	AZOIC	>4	4	>4	7	0.21	4.81	6.84	2.03	5.83	0	0	0.50	0	0	0	0	0	0
I15	B	8/7/2001	10:47	AZOIC	>4	3	>4	0	0	6.63	9.3	2.67	7.97	0	0	2.50	0	0	0	0	0	0
I15	C	8/7/2001	10:48	AZOIC	>4	3	>4	10	0.29	6.47	7.7	1.23	7.09	0	0	5.0	0	0	0	0	0	0
I16	H	8/8/2001	8:09	ST_I	>4	4	>4	0	0	10.11	11.12	1.02	10.61	10.11	11.12	>10.61	0	0	0	0	0	0
I16	J	8/8/2001	8:10	AZOIC	>4	4	>4	0	0	7.27	8.5	1.23	7.89	7.27	8.5	>7.89	0	0	0	0	0	0
I16	K	8/8/2001	8:11	ST_I	>4	3	>4	12	0.5	6.63	9.3	2.67	7.97	6.63	9.3	>7.97	0	0	0	0.05	1.39	0.61
I17	D	8/7/2001	12:27	ST_I	>4	3	>4	0	0	10.32	12.62	2.3	11.47	10.32	12.62	>11.47	0	0	0	0	0	0
I17	E	8/7/2001	12:28	AZOIC	>4	3	>4	0	0	6.15	9.79	3.64	7.97	6.15	9.79	>7.97	0	0	0	0	0	0
I17	F	8/7/2001	12:28	ST_I	>4	3	>4	0	0	7.9	9.62	1.72	8.76	7.9	9.62	>8.76	0	0	0	0	0	0
I18	F	8/7/2001	9:32	ST_I	>4	3	>4	12	0.23	11.08	13.19	2.11	12.14	11.08	13.19	>12.14	0	0	0	0.65	1.3	0.94
I18	G	8/7/2001	9:33	ST_I	>4	3	>4	0	0	12.65	15.19	2.54	13.92	12.65	15.19	>13.92	0	0	0	0.11	2.05	1.45
I18	H	8/7/2001	9:34	ST_I	>4	3	>4	0	0	10.86	11.68	0.81	11.27	10.86	11.68	>11.27	0	0	0	0.22	1.84	1.17
I19	C	8/5/2001	15:56	ST_I	>4	3	>4	0	0	14.7	16	1.3	15.35	0	0	4.0	0	0	0	0	0	0
I19	E	8/7/2001	11:19	ST_I	>4	3	>4	0	0	7.62	9.73	2.11	8.68	0	0	2.0	0	0	0	0.49	2.11	1.5
I19	F	8/7/2001	11:19	ST_I	>4	3	>4	4	0.38	3.78	7.57	3.78	5.68	0	0	3.0	0	0	0	0	0	0
I20	C	8/7/2001	10:43	ST_I	>4	3	>4	0	0	7.65	10.64	2.99	9.14	0	0	1.0	0	0	0	0	0	0.5
I20	E	8/8/2001	8:24	ST_I	>4	3	>4	10	0.84	7.33	10.75	3.42	9.04	0	0	1.5	0	0	0	0.37	1.98	1.01
I20	F	8/8/2001	8:25	AZOIC	>4	3	>4	6	0.45	7.65	10.27	2.62	8.96	0	0	1.0	0	0	0	0	0	0
I21	D	8/6/2001	9:59	ST_I_ON_III	>4	3	>4	12	0.6	11.07	12.46	1.39	11.76	0	0	1	0	0	0	0.75	1.66	0.2
I21	E	8/6/2001	10:00	ST_I_ON_III	>4	3	>4	0	0	11.12	12.62	1.5	11.87	0	0	0	0	0	0	0	0	0
I21	F	8/6/2001	10:01	ST_I	>4	4	>4	12	0.21	8.77	11.82	3.05	10.29	0	0	0	0	0	0	0.05	2.09	1.17
I22	E	8/7/2001	12:32	ST_I	>4	3	>4	0	0	6.63	8.66	2.03	7.65	6.63	8.66	>7.65	0	0	0	0	0	0
I22	F	8/7/2001	12:33	ST_I	>4	3	>4	0	0	6.26	7.54	1.28	6.9	6.26	7.54	>6.9	0	0	0	0	0	0.3
I22	G	8/7/2001	12:34	ST_I	>4	3	>4	2	0.5	8.34	10.7	2.35	9.52	8.34	10.7	>9.52	0	0	0	0	0	0
I23	G	8/8/2001	8:17	ST_I	>4	3	>4	1	0.25	11.14	13.19	2.05	12.16	11.14	13.19	>12.16	0	0	0	0	0	0
I23	H	8/8/2001	8:17	ST_I	>4	3	>4	0	0	11.73	12.81	1.08	12.27	11.73	12.81	>12.27	0	0	0	0	0	0
I23	I	8/8/2001	8:18	ST_I	3	3	>4	0	0	7.35	9.24	1.89	8.3	7.35	9.24	>8.3	0	0	0	0	0	0
I24	B	8/5/2001	15:47	ST_I	>4	3	>4	6	0	13.62	17.41	3.78	15.51	0	0	0	0	0	0	0.11	3.46	1.58
I24	D	8/7/2001	11:09	ST_I	>4	3	>4	0	0	6.27	8.22	1.95	7.24	0	0	0	0	0	0	0.7	2.86	2.15
I24	E	8/7/2001	11:09	AZOIC	>4	3	>4	0	0	5.08	9.62	4.54	7.35	0	0	0	0	0	0	0	0	0
I25	A	8/7/2001	10:37	AZOIC	>4	3	>4	0	0	5.94	8.4	2.46	7.17	5.94	8.4	>7.17	0	0	0	0	0	0
I25	B	8/7/2001	10:37	ST_I	>4	3	>4	6	0.54	5.72	9.63	3.9	7.67	5.72	9.63	>7.67	0	0	0	NA	NA	NA
I25	C	8/7/2001	10:38	AZOIC	>4	4	>4	15	0.75	3.58	5.19	1.6	4.39	3.58	5.19	>4.39	0	0	0	0	0	0

Appendix B1 (continued)

Station	Replicate	Date	Time	Methane			OSI	Surface Roughness	Low DO	Comments
				Min	Max	Mean				
INNER										
I01	F	8/6/2001	9:27	0	0	0	3	PHYSICAL	NO	AMBIENT TAN SILT/TAN&BLK CLAYEY SILT, MUD CLASTS-FARFIELD, RED SED
I01	G	8/6/2001	9:45	0	0	0	7	PHYSICAL	NO	AMBIENT TAN SILT/TAN&BLK CLAYEY SILT,BANDED RED SED, RELIC RPD,TUBES,VOID,CLSTS
I01	H	8/6/2001	9:50	0	0	0	2	PHYSICAL	NO	AMBIENT TAN/TAN&BLK CLAYEY SILT, RED SED BAND, OX&RED CLSTS,LG CLUMPS,WOOD
I02	B	8/5/2001	14:39	0	0	0	99	INDETERMINATE	NO	DM>P, BRNISH GRY MOTTLED M, OVERPEN, RED SED, LG BURROW SYSTEM,SM WORMS @TOP
I02	D	8/7/2001	12:13	0	0	0	1	PHYSICAL	NO	DM>P, BRNISH GRY M, RED SED, LG MUD CLUMPS, IRREG TOPO, TUBES?,NO RPD
I02	F	8/7/2001	12:14	0	0	0	-3	PHYSICAL	YES	DM>P, TAN&BLK SULFIDIC CLAYEY SILT, LOW DO?, V SM TUBES?,RED SED BAND
I03	A	8/5/2001	15:36	0	0	0	3	PHYSICAL	NO	AMBIENT TAN/BLK&GRY CLAYEY SILT, RED SED BAND, SM TUBES
I03	B	8/5/2001	15:36	0	0	0	4	PHYSICAL	NO	AMBIENT TAN/BLK&GRY CLAYEY SILT, WIPER CLST, RED SED BAND, TUBES, WORM@Z
I03	C	8/5/2001	15:37	0	0	0	2	PHYSICAL	NO	AMBIENT TAN&GRY CLAYEY SILT,RED SED BAND,RED SED@SURF,OX CLSTS,SM PATCHY RPD
I04	A	8/5/2001	16:33	0	0	0	99	PHYSICAL	NO	AMBIENT TAN&GRY M, VOIDS,SM TUBES, RED SED@SURF, RPD?,THIN SURF DEPOSIT OF ORG MATTER
I04	B	8/5/2001	16:34	0	0	0	8	BIOGENIC	NO	AMBIENT TAN&GRY CLAYEY SILT, FLOCK LAYER, BURROW-OPENING,VOID?,SLOPING TOPO
I04	C	8/5/2001	16:35	0	0	0	7	PHYSICAL	NO	AMBIENT TAN/TAN&BLK CLAYEY SILT,RED SED BAND, VOIDS,SM TUBES,WORM@Z,M CLUMPS
I05	A	8/7/2001	11:00	0	0	0	3	PHYSICAL	NO	DM>P, LAYERING, TAN OX LYR/BLK CLAYEY SILT,RED SED, OX&RED CLSTS,WIP CLST,TUBES
I05	B	8/7/2001	11:00	0	0	0	2	PHYSICAL	NO	DM>P,TAN OX LYR/BLK&TAN CLAYEY SILT, IRG TOPO,WOOD, RED CLSTS,R.SED BAND
I05	C	8/7/2001	11:01	0	0	0	-4	PHYSICAL	NO	DM>P, BLK&TAN CLAYEY SILT>P, NO RPD, WOOD, MUD CLUMPS-FAR, RED SED
I06	K	8/8/2001	7:40	0	0	0	-3	PHYSICAL	YES	DM>P, TAN&BLK SULFIDIC M, LG OX MUD CLUMP, RPD?, RED SED BAND, CLSTS, TUBES
I06	L	8/8/2001	7:41	0	0	0	1	PHYSICAL	YES	DM>P, TAN&BLK SULFIDIC M, RELIC RPD, NO RPD, OX&RED CLSTS, VOIDS,TUBES,WORM?
I06	M	8/8/2001	7:41	0	0	0	-3	PHYSICAL	YES	DM>P, TAN&BLK CLAYEY SILT, TUBES, OX CLASTS, NO RPD, RED SED BAND
I07	D	8/7/2001	12:17	0	0	0	-3	PHYSICAL	YES	DM>P, BRN&BLK M, LG OX&RED MUD CLUMP, TUBES, SM WOOD CHIPS, IRREG TOPO
I07	E	8/7/2001	12:18	0	0	0	-8	PHYSICAL	YES	DM>P, BRN&BLK SULFIDIC MOTTLED M, PULP SED, AZOIC, RED SED BAND
I07	F	8/7/2001	12:19	0	0	0	99	INDETERMINATE	NO	DM>P, BRN&BLK SULFIDIC M, UPEN, WOOD DOOR IN VIEW, FLOCK LAYER,TUBES
I08	D	8/5/2001	15:32	0	0	0	2	PHYSICAL	NO	DM>P,BLK&BRN M, PULP SED,OX PATCH=RPD, SM TUBES?,RED SED BAND,WORMS@Z
I08	J	8/8/2001	7:35	0	0	0	4	PHYSICAL	NO	DM>P, IRON OXIDE/BLK SULF M, UNDERPEN,PULP SED, WOOD CHIPS, RED SED@SURFACE
I08	K	8/8/2001	7:35	0	0	0	7	PHYSICAL	NO	DM>P, IRON OX LYR/BLK SULFIDIC M, PULP SED, RED SED BAND, VOIDS,TUBES,RELIC RPD
I09	F	8/7/2001	11:29	0	0	0	-8	PHYSICAL	YES	DM>P, GRY&BLK SULFIDIC M, LOW DO, LG MUD CLUMP, PULP SED
I09	H	8/7/2001	11:30	0	0	0	-8	PHYSICAL	YES	DM>P, BRN&BLK SULFIDIC M, PULP SED, WOOD CHIPS, IRREG TOPO
I09	I	8/7/2001	11:31	0	0	0	2	PHYSICAL	NO	DM>P, TAN/BROWNISH GREY M, PULP SED, TUBES, MUD CLUMPS, REDUCED SED @SURF
I10	A	8/7/2001	10:51	0	0	0	-2	PHYSICAL	NO	DM>P, BLK&TAN CLAYEY SILT>P, RPD MEASURABLE?, M CLUMPS, UNDERPEN, RED SED
I10	B	8/7/2001	10:51	0	0	0	-4	PHYSICAL	NO	DM>P, BLK&TAN CLAYEY SILT>P, V.RED SED@SURF,IRREG TOPO-M CLUMPS, NO RPD
I10	C	8/7/2001	10:52	0	0	0	2	PHYSICAL	NO	DM>P, TAN&GRY CLAYEY SILT,UNDERPEN, SM&PATCHY RPD, RED CLSTS,WOOD CHIPS?
I11	I	8/8/2001	7:47	0	0	0	-2	PHYSICAL	YES	DM>P, TAN&BLK SULFIDIC CLAYEY SILT, RED SED BAND,SM RPD,CLST LYR, TUBES,WORMS?
I11	J	8/8/2001	7:47	0	0	0	-8	PHYSICAL	YES	DM>P, TAN&BLK CLAYEY SILT, RED SED BAND,RELIC RPD,LOW DO,WIPER&OX CLST,SLOPING
I11	K	8/8/2001	7:48	0	0	0	2	PHYSICAL	YES	DM>P, TAN&BLK SULFIDIC CLAYEY SILT,LOW DO,WIPR CLST,FLUID CLST LYR,RED SED BAND
I12	F	8/7/2001	12:24	0	0	0	4	PHYSICAL	NO	DM>P, TAN IRON OXIDE LAYER/BLACK CLAYEY SILT, TUBES
I12	H	8/8/2001	7:56	0	0	0	7	PHYSICAL	NO	DM>P, TAN IRON OXIDE/BLK SULFIDIC CLAYEY SILT,TUBES, VOIDS,IRON OXIDE LYR=RPD
I12	I	8/8/2001	7:57	0	0	0	8	PHYSICAL	NO	DM>P, TAN IRON OXIDE LYR/BLK SULFIDIC CLAYEY SILT, TUBES, VOIDS
I13	A	8/5/2001	15:21	0	0	0	1	BIOGENIC	NO	DM>P, TAN&GRY CLAYEY SILT, TUBES, BURROW-W/TUBES, NO RPD,SURF REWORK
I13	H	8/8/2001	8:02	0	0	0	99	INDETERMINATE	NO	DM>P,TAN&GRY CLAYEY SILT, DIST SURF,TUBES, 1 CM RPD?,SURF REWORK,BURROW
I13	I	8/8/2001	8:03	0	0	0	99	PHYSICAL	NO	DM>P,BRN&BLK M, UNDERPEN,.5 CM RPD?,TUBES, WHITE CLAY CHIPS,WOOD DOOR,M CLUMP
I14	C	8/5/2001	16:01	0	0	0	2	PHYSICAL	NO	DM>P,TAN/BRN&BLK SULFIDIC M, PULP SED, OX&RED CLASTS
I14	F	8/5/2001	16:08	0	0	0	3	PHYSICAL	NO	DM>P,TAN/BRN&BLK M-PULP SED, CLAST LAYER, ORG DETRITUS?
I14	H	8/7/2001	11:24	0	0	0	-3	PHYSICAL	YES	DM>P, BRN&BLK CLAYEY SILT, NO RPD, PULP SED@SURF, RED SED,TUBES
I15	A	8/7/2001	10:46	0	0	0	-4	PHYSICAL	NO	V.THIN DM/AMB, BLK&TAN CLAYEY SILT>P, NO RPD, OX&RED CLASTS, RED SED@SURF
I15	B	8/7/2001	10:47	0	0	0	-8	PHYSICAL	YES	THIN DM LYR/AMB, BLK&GRY CLAYEY SILT>P, PULP SED-WOOD CHIPS, LOW DO, M CLUMPS
I15	C	8/7/2001	10:48	0	0	0	-8	PHYSICAL	YES	SURF DM LYR/AMB, BLK&GRY CLAYEY SILT>P, PULP SED,RED SED BAND, NO RPD, CLASTS
I16	H	8/8/2001	8:09	0	0	0	-3	PHYSICAL	YES	DM>P, TAN&SULFIDIC BLK CLAYEY SILT, RPD=0 CM,RED SED BAND,IRREG TOPO, TUBES,LO DO
I16	J	8/8/2001	8:10	0	0	0	-8	PHYSICAL	YES	DM>P, GRY & BLK SULFIDIC MOTTLED CLAYEY SILT, LOW DO, AZOIC, WIPER CLAST
I16	K	8/8/2001	8:11	0	0	0	-2	PHYSICAL	YES	DM>P, TAN&BLK SULF.CLAYEY SILT, LOW DO,PATCHY RPD,BURROW,CLSTS,TUBES,IRG TOPO
I17	D	8/7/2001	12:27	0	0	0	-3	PHYSICAL	YES	DM>P, TAN&GRY CLAYEY SILT, PULP SED, TUBES, IRREG TOPO, WOOD CHIPS
I17	E	8/7/2001	12:28	0	0	0	-8	PHYSICAL	YES	DM>P, TAN&BLK SULFIDIC M, IRREG TOPO, RED SED, RPD=O, PULP SED,WOOD CHIPS
I17	F	8/7/2001	12:28	0	0	0	-3	PHYSICAL	YES	DM>P, BRN&GRY M W/PULP SED, SM WOOD CHIPS, SM TUBES, LG MUD CLUMP, NO RPD
I18	F	8/7/2001	9:32	0	0	0	3	PHYSICAL	NO	DM>P, IRON OXIDE LAYER/BLK&BRN M, PULP SED, RED CLASTS, TUBES
I18	G	8/7/2001	9:33	0	0	0	3	PHYSICAL	NO	DM>P, IRON OX LYR/BLK&BRN M-PULP SED,WIP CLSTS,TUBES, RED SED BAND,RELIC RPD
I18	H	8/7/2001	9:34	0	0	0	3	PHYSICAL	NO	DM>P, TAN/BLK&BRN SULFIDIC M, PULP SED, RED SED BAND,RELIC RPD,TUBES,WOOD CHIPS
I19	C	8/5/2001	15:56	0	0	0	1	INDETERMINATE	NO	DM, PULP/AMB BRNISH GRY M, WOOD CHIPS,RED SED BAND, WIP BLADE,0 RPD,RELIC RPD
I19	E	8/7/2001	11:19	0	0	0	3	PHYSICAL	NO	DM, PULP/AMBIENT GREYISH BROWN M, REDUCED SED, SM TUBES
I19	F	8/7/2001	11:19	0	0	0	-3	PHYSICAL	YES	DM, PULP/AMB GRY&BLK CLAYEY SILT,RED CLST,IRREG TOPO, LOW DO,RED SED BAND
I20	C	8/7/2001	10:43	0	0	0	2	PHYSICAL	NO	THIN LYR DM/AMBIENT,BLK&TAN CLAYEY SILT>P,RED SED BAND@SURF,PATCHY RPD,SLOP TOPO,TUBES
I20	E	8/8/2001	8:24	0	0	0	3	PHYSICAL	NO	THIN LYR DM/AMB,TAN/BLK&GRY CLAYEY SILT,IRREG TOPO,OX&RED CLSTS,BLK SULF. M,SM TUBES
I20	F	8/8/2001	8:25	0	0	0	-8	PHYSICAL	YES	THIN LYR DM, BLK&TAN CLAYEY SILT>P, RED SED@SURF,LOW DO?, OX&RED CLSTS,M CLUMP
I21	D	8/6/2001	9:59	0	0	0	2	PHYSICAL	YES	SURF CLST LYR=DM, TAN&BLK CLAYEY SILT, SM RPD, RED SED BANDS, VOID,TUBES,BURROW,RED SED@SURF
I21	E	8/6/2001	10:00	0	0	0	1	PHYSICAL	YES	DM?, TAN&BLK CLAYEY SILT,FLOCK LAYR=DM,VOIDS, RED SED, RELIC RPD, SM WOOD CHIPS?
I21	F	8/6/2001	10:01	0	0	0	3	PHYSICAL	NO	AMBIENT M>P, TAN/TAN&BLK CLAYEY SILT, RED SED BAND, SM VOID, OX&RED CLSTS
I22	E	8/7/2001	12:32	0	0	0	-3	PHYSICAL	YES	DM>P, TAN&BLK SULF.M, TUBES, NO RPD, MUD CLUMPS @SURF, RED SED BAND
I22	F	8/7/2001	12:33	0	0	0	-2	PHYSICAL	YES	DM>P, TAN&BLK CLAYEY SILT, SM TUBES, RELIC RPD,SM RPD, RED SED BAND
I22	G	8/7/2001	12:34	0	0	0	-3	PHYSICAL	YES	DM>P, TAN&BLK CLAYEY SILT, RPD?, OX CLSTS, SM TUBES, WORM@SURF, RELIC RPD
I23	G	8/8/2001	8:17	0	0	0	-3	PHYSICAL	YES	DM>P, BLK&GRY SULFIDIC M, LOW DO, RELIC RPD?, TUBES, IRREG TOPO, RED M CLUMPS
I23	H	8/8/2001	8:17	0	0	0	-3	PHYSICAL	YES	DM>P, BLK&GRY SULFIDIC M, LOW DO, RELIC RPD, RED SED BAND,OX SED PATCH, BURROW
I23	I	8/8/2001	8:18	0	0	0	-3	PHYSICAL	YES	DM>P, BLK&GRY SULFIDIC M, RELIC RPD, LOW DO, TUBES?, SM OX SED CLUMPS-FARFIELD
I24	B	8/5/2001	15:47	0	0	0	4	PHYSICAL	NO	AMIBENT TAN/BLK&TAN CLAYEY SILT, WIPER BLADE, OX&RED CLSTS, BURROW, RED SED
I24	D	8/7/2001	11:09	0	0	0	4	PHYSICAL	NO	AMBIENT TAN/BLK SULFIDIC CLAYEY SILT, REDUCED SED BAND
I24	E	8/7/2001	11:09	0	0	0	-4	PHYSICAL	NO	AMBIENT TAN/BLK SULFIDIC M OR DM CLUMP>P, IRREG TOPO, BURROW OPNING,M CLUMPS,NO RPD
I25	A	8/7/2001	10:37	0	0	0	-8	PHYSICAL	YES	DM>P, BLK&TAN CLAYEY SILT, LOW DO, AZOIC, RED SED BAND, MUD CLUMPS
I25	B	8/7/2001	10:37	0	0	0	99	PHYSICAL	NO	DM>P, TAN&GRY CLAYEY SILT>P, RPD?,LG M CLUMPS, OX&RED CLSTS,VOID?,FLOCK LYR
I25	C	8/7/2001	10:38	0	0	0	-8	PHYSICAL	YES	DM>P, BLK&TAN CLAYEY SILT>P, LOW DO,RED SED,NO RPD, OX&RED CLSTS,UPEN,M CLUMPS

Appendix B2
Outer Station TLDS REMOTS® Sediment-Profile Photography Data from the 2001 Survey

Station	Replicate	Date	Time	Successional Stage	Grain Size (phi)			Mud Clasts		Camera Penetration (cm)				Dredged Material Thickness (cm)			Redox Rebound Thickness (cm)			Apparent RPD Thickness (cm)		
					Min	Max	Maj Mode	Count	Avg. Diam	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
OUTER																						
O01	E	8/7/2001	9:08	ST_I	>4	3	>4	0	0	9.52	11.38	1.86	10.45	0	0	0	0	0	0	0	0	0
O01	F	8/7/2001	9:08	ST_I	>4	3	>4	14	0.55	11.6	13.09	1.49	12.34	0	0	0	0	0	0	0	0	0
O01	G	8/7/2001	9:09	ST_I_ON_III	>4	3	>4	2	0.79	10.8	12.45	1.65	11.62	0	0	0	0	0	0	0.96	2.18	1.55
O02	E	8/7/2001	8:57	ST_I_ON_III	>4	3	>4	0	0	10.32	13.35	3.03	11.84	0	0	0	0	0	0	0	0	0
O02	F	8/7/2001	8:58	ST_I	>4	3	>4	0	0	9.36	11.81	2.45	10.59	0	0	0	0	0	0	0	0	0
O02	G	8/7/2001	8:59	ST_I	>4	3	>4	0	0	8.3	11.06	2.77	9.68	0	0	0	0	0	0	NA	NA	NA
O03	B	8/6/2001	12:22	ST_I	>4	3	>4	12	0.29	16.86	17.77	0.9	17.31	0	0	0	0	0	0	0.74	1.54	1.13
O03	E	8/7/2001	8:48	ST_I_ON_III	>4	3	>4	0	0	6.6	9.52	2.93	8.06	0	0	0	0	0	0	NA	NA	NA
O03	F	8/7/2001	8:49	ST_I	>4	4	>4	4	0.35	7.23	10.53	3.3	8.88	0	0	0	0	0	0	0.05	2.29	1.55
O04	D	8/7/2001	8:39	AZOIC	>4	3	>4	0	0	7.77	9.26	1.49	8.51	0	0	0	0	0	0	0	0	0
O04	E	8/7/2001	8:40	ST_I_ON_III	>4	3	>4	12	0.57	11.97	14.89	2.93	13.43	0	0	0	0	0	0	0.69	2.23	1.43
O04	F	8/7/2001	8:41	ST_I_ON_III	>4	3	>4	5	1.04	3.83	5.21	1.38	4.52	0	0	0	0	0	0	0	0	0
O05	I	8/6/2001	12:10	ST_I	>4	4	>4	0	0	18.99	20.27	1.28	19.63	0	0	0	0	0	0	0.11	1.44	0.5
O05	L	8/7/2001	8:32	ST_I	>4	3	>4	0	0	10.21	11.97	1.76	11.09	0	0	0	0	0	0	NA	NA	NA
O05	M	8/7/2001	8:33	ST_I	>4	4	>4	0	0	8.03	10.27	2.23	9.15	0	0	0	0	0	0	0.48	2.55	1.88
O06	C	8/6/2001	13:05	ST_I_ON_III	>4	3	>4	2	0.67	17.11	18.4	1.28	17.75	0	0	0	0	0	0	0.75	2.09	1.26
O06	D	8/7/2001	10:25	ST_I_ON_III	>4	3	>4	5	0.21	8.13	10.16	2.03	9.14	0	0	0	0	0	0	0.32	2.14	1.35
O06	E	8/7/2001	10:30	ST_I_ON_III	>4	3	>4	0	0	10.27	13.53	3.26	11.9	0	0	0	0	0	0	0	0	0
O07	D	8/7/2001	9:24	ST_I_ON_III	>4	3	>4	15	0.17	13.19	14.15	0.96	13.67	0	0	0	0	0	0	0.11	2.77	1.81
O07	E	8/7/2001	9:24	ST_I	>4	3	>4	0	0	10.48	16.38	5.9	13.43	0	0	0	0	0	0	NA	NA	NA
O07	F	8/7/2001	9:25	ST_I_ON_III	>4	3	>4	0	0	13.64	15.03	1.39	14.33	0	0	0	0	0	0	NA	NA	NA
O08	D	8/7/2001	9:15	ST_I_ON_III	>4	3	>4	0	0	12.93	14.26	1.33	13.59	0	0	0	0	0	0	1.00	2.00	1.5
O08	E	8/7/2001	9:16	ST_I	>4	4	>4	0	0	11.28	12.61	1.33	11.94	0	0	0	0	0	0	0	0	0.3
O08	F	8/7/2001	9:16	ST_I	>4	3	>4	0	0	10.69	12.07	1.38	11.38	0	0	0	0	0	0	0.16	1.65	0.96

Appendix B2 (continued)

Station	Replicate	Date	Time	Methane Min	Methane Max	Methane Mean	OSI	Surface Roughness	Low DO	Comments
OUTER										
O01	E	8/7/2001	9:08	0	0	0	1	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BAND, RELIC RPD, SM TUBES, NO RPD
O01	F	8/7/2001	9:08	0	0	0	1	PHYSICAL	NO	AMBIENT TAN&BLK M>P,RED SED BANDS,OX&RED CLSTS,M CLUMPS@SURF,TUBES, NO RPD
O01	G	8/7/2001	9:09	0	0	0	8	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BAND,VOIDS,TUBES,BURROW-SED REWORK,FLOCK LYR,CLST
O02	E	8/7/2001	8:57	0	0	0	1	PHYSICAL	YES	AMBIENT BLK/TAN M>P,RED SED BAND@SURF, NO RPD, VOIDS,TUBES, RELIC RPD
O02	F	8/7/2001	8:58	0	0	0	1	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BANDS, NO RPD,MUD CLUMPS, SM TUBES, RELIC RPD
O02	G	8/7/2001	8:59	0	0	0	99	PHYSICAL	NO	AMBIENT TAN M>P, RED SED@SURF,FLOCK LYR,VOID?,SED REWORK-BURROW,SUSPENDED M
O03	B	8/6/2001	12:22	0	0	0	3	PHYSICAL	NO	AMBIENT TAN M>P, RED SED @Z, TUBES, OX&RED CLASTS
O03	E	8/7/2001	8:48	0	0	0	99	PHYSICAL	NO	AMBIENT TAN&GRY M>P, RPD?, BURROW, VOIDS, IRREG TOPO-M CLUMPS, SM TUBES
O03	F	8/7/2001	8:49	0	0	0	4	PHYSICAL	NO	AMBIENT TAN/GRY&BLK M>P, RED SED@Z, TUBES, RED CLASTS
O04	D	8/7/2001	8:39	0	0	0	-8	PHYSICAL	YES	AMBIENT BLK&GRY SULFIDIC M>P, RED SED BAND@SURF, LG M CLUMPS,SM TUBES,LOW DO
O04	E	8/7/2001	8:40	0	0	0	7	PHYSICAL	NO	AMBIENT TAN&BLK M>P,RED SED BAND, VOIDS,TUBES, OX&RED CLSTS,LG OX M CLUMP-RPD
O04	F	8/7/2001	8:41	0	0	0	5	PHYSICAL	NO	AMBIENT BRNISH GRY M>P,NO RPD,VOIDS, M CLUMPS @SURF, LOW DO?,SM TUBES,UPEN
O05	I	8/6/2001	12:10	0	0	0	2	PHYSICAL	NO	AMBIENT TAN&BLK M>P, SM&PATCHY RPD, RED SED BAND@SURF,SM TUBES,IRREG TOPO
O05	L	8/7/2001	8:32	0	0	0	99	PHYSICAL	NO	AMBIENT TAN&BLK M>P,LG V.RED SED PATCH@SURF,SM TUBES, RPD?,LG M CLUMPS
O05	M	8/7/2001	8:33	0	0	0	4	PHYSICAL	NO	AMBIENT TAN M>P, SM RED SED PATCH @SURF, TUBES, SM MUD CLUMPS@SURF
O06	C	8/6/2001	13:05	0	0	0	7	PHYSICAL	NO	AMBIENT TAN&GRY M>P, SM TUBES, VOIDS, BURROW, RED CLASTS, RED SED BAND
O06	D	8/7/2001	10:25	0	0	0	7	PHYSICAL	NO	AMBIENT M>P, SM TUBES, RED CLASTS,VOIDS, BURROWING WORMS @Z, WORM@SURF,M CLUMP
O06	E	8/7/2001	10:30	0	0	0	5	PHYSICAL	NO	AMBIENT SULFIDIC BLK&TAN M>P, V.RED SED@SURF, LOW DO?,VOID, SM TUBES
O07	D	8/7/2001	9:24	0	0	0	8	PHYSICAL	NO	AMBIENT TAN&BLK M>P, V. RED SED@SURF,SM VOID, OX&RED CLSTS,M CLUMPS
O07	E	8/7/2001	9:24	0	0	0	99	PHYSICAL	NO	AMBIENT TAN/GRY M>P, RPD?,TUBES,IRREG TOPO-SLOPING,M CLUMPS,BURROW OPNING
O07	F	8/7/2001	9:25	0	0	0	99	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RPD?-CLAY, FLOCK LYR, VOIDS, RED SED BAND
O08	D	8/7/2001	9:15	0	0	0	7	PHYSICAL	NO	AMBIENT TAN&BLK M>P, V. RED SED@SURF, RPD?, VOIDS, MUD CLUMPS
O08	E	8/7/2001	9:16	0	0	0	2	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BAND, TUBES, MUD CLUMPS, SM&PATCHY RPD
O08	F	8/7/2001	9:16	0	0	0	3	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BAND,BURROW, DIST SURF,TUBES, M CLUMPS,RELIC RPD

Appendix B3
TLDS Reference Area REMOTS® Sediment-Profile Photography Data from the 2001 Survey

Station	Replicate	Date	Time	Successional Stage	Grain Size (phi)			Mud Clasts		Camera Penetration (cm)				Dredged Material Thickness (cm)			Redox Rebound Thickness (cm)			Apparent RPD Thickness (cm)		
					Min	Max	Maj Mode	Count	Avg. Diam	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
EREF																						
EREF1	A	8/6/2001	11:21	ST_I	>4	4	>4	0	0	9.36	10.96	1.6	10.16	0	0	0	0	0	0	0.16	2.13	1.38
EREF1	E	8/7/2001	8:06	ST_I	>4	3	>4	5	1.08	12.93	15.85	2.93	14.39	0	0	0	0	0	0	NA	NA	NA
EREF1	F	8/7/2001	8:07	ST_I	>4	3	>4	7	0.52	8.4	11.22	2.82	9.81	0	0	0	0	0	0	0	0	0
EREF2	B	8/6/2001	11:13	ST_I_ON_III	>4	3	>4	9	0.48	9.15	11.76	2.61	10.45	0	0	0	0	0	0	0.53	1.44	1.08
EREF2	C	8/6/2001	11:13	ST_I_ON_III	>4	3	>4	20	0.16	11.38	13.51	2.13	12.45	0	0	0	0	0	0	2.07	3.88	2.84
EREF2	D	8/6/2001	11:14	ST_I_ON_III	>4	3	>4	0	0	6.81	8.51	1.7	7.66	0	0	0	0	0	0	0.27	3.03	0.5
EREF3	B	8/6/2001	11:02	ST_III	>4	3	>4	0	0	14.57	16.01	1.44	15.29	0	0	0	0	0	0	0	0	0.75
EREF3	C	8/6/2001	11:03	ST_III	>4	3	>4	8	0.55	9.1	11.81	2.71	10.45	0	0	0	0	0	0	0.53	2.82	1.62
EREF3	D	8/6/2001	11:04	ST_I	>4	3	>4	0	0	12.13	14.04	1.92	13.09	0	0	0	0	0	0	NA	NA	NA
EREF4	F	8/7/2001	8:21	ST_I	>4	3	>4	4	0.43	16.1	18.24	2.14	17.17	0	0	0	0	0	0	0.43	3.32	1.78
EREF4	G	8/7/2001	8:22	ST_I	>4	4	>4	6	0.21	7.55	10.59	3.03	9.07	0	0	0	0	0	0	0	0	0
EREF4	H	8/7/2001	8:22	ST_I_ON_III	>4	3	>4	5	0.05	8.83	10.59	1.76	9.71	0	0	0	0	0	0	0	0	0
WREF																						
WREF1	A	8/6/2001	10:28	ST_I	>4	3	>4	0	0	15.41	19.95	4.54	17.68	0	0	0	0	0	0	0.43	1.35	1.09
WREF1	B	8/6/2001	10:29	ST_I_ON_III	>4	3	>4	8	0.27	16.27	20.16	3.89	18.22	0	0	0	0	0	0	0.92	2.27	1.5
WREF1	C	8/6/2001	10:29	ST_I_ON_III	>4	3	>4	10	0.28	10.65	12.38	1.73	11.51	0	0	0	0	0	0	0.11	2.76	2.08
WREF2	A	8/6/2001	10:22	ST_III	>4	3	>4	5	2.76	11.73	13.14	1.41	12.43	0	0	0	0	0	0	0.54	2.27	1.57
WREF2	B	8/6/2001	10:22	ST_I	>4	3	>4	20	0.43	11.3	13.51	2.22	12.41	0	0	0	0	0	0	0.65	2.11	2.00
WREF2	C	8/6/2001	10:23	ST_I	>4	3	>4	10	0.72	16.38	18.38	2	17.38	0	0	0	0	0	0	0.65	2.11	0.75
WREF3	A	8/6/2001	10:39	ST_I_ON_III	>4	3	>4	0	0	13.46	15.3	1.84	14.38	0	0	0	0	0	0	0.05	1.41	0.9
WREF3	B	8/6/2001	10:40	ST_I	>4	3	>4	5	0.38	15.89	18.76	2.86	17.32	0	0	0	0	0	0	0.7	2.81	1.97
WREF3	C	8/6/2001	10:40	ST_I_ON_III	>4	3	>4	10	0.4	11.24	15.19	3.95	13.22	0	0	0	0	0	0	0.43	2.11	1.58
WREF4	A	8/6/2001	10:15	ST_I_ON_III	>4	3	>4	7	0.42	15.9	16.49	0.59	16.2	0	0	0	0	0	0	0.59	2.5	2.00
WREF4	B	8/6/2001	10:16	ST_I_ON_III	>4	3	>4	6	0.5	13.62	14.89	1.28	14.26	0	0	0	0	0	0	0.11	1.49	0.81
WREF4	C	8/6/2001	10:17	ST_I_ON_III	>4	3	>4	0	0	14.36	15.53	1.17	14.95	0	0	0	0	0	0	0.37	1.81	1.16

Appendix B3 (continued)

Station	Replicate	Date	Time	Methane			OSI	Surface Roughness	Low DO	Comments
				Min	Max	Mean				
EREF										
EREF1	A	8/6/2001	11:21	0	0	0	3	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BANDS,RELIC RPD,FILM CHEMS,M CLUMPS-FAR
EREF1	E	8/7/2001	8:06	0	0	0	99	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED@SURF&@Z, TUBES,IRREG TOPO,M CLUMPS,RPD?
EREF1	F	8/7/2001	8:07	0	0	0	1	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED@SURF, IRREG TOPO-M CLUMPS, NO RPD,TUBES,FLOCK LYR
EREF2	B	8/6/2001	11:13	0	0	0	7	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED@SURF, VOIDS, OX&RED CLSTS, WIPER BLADE
EREF2	C	8/6/2001	11:13	0	0	0	9	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BAND, RELIC RPD, RPD,VOID,CLASTS
EREF2	D	8/6/2001	11:14	0	0	0	6	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BAND@SURF, PATCHY RPD,VOIDS, M CLUMPS
EREF3	B	8/6/2001	11:02	0	0	0	6	PHYSICAL	NO	AMBIENT TAN&V.BLK M>P,V.RED SED BAND@SURF, VOIDS,FLOCK LYR,BURROW
EREF3	C	8/6/2001	11:03	0	0	0	8	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BANDS,RELIC RPD?,VOIDS, M CLUMPS&CLSTS
EREF3	D	8/6/2001	11:04	0	0	0	99	INDETERMINATE	NO	AMBIENT TAN&BLK M>P, RED SED BAND@SURF, RPD?, DIST SURF, FLOCK LYR
EREF4	F	8/7/2001	8:21	0	0	0	4	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BANDS, RED CLSTS,IRREG TOPO-M CLUMPS
EREF4	G	8/7/2001	8:22	0	0	0	-3	PHYSICAL	YES	AMBIENT TAN&BLK M>P, RED SED, OX&RED CLSTS, SM VOID?, IRREG TOPO-M CLUMPS
EREF4	H	8/7/2001	8:22	0	0	0	1	PHYSICAL	YES	AMBIENT TAN&V.BLK M>P,V.BLK RED SED BAND@SURF,RPD?,SM VOIDS,OX CLSTS
WREF										
WREF1	A	8/6/2001	10:28	0	0	0	3	PHYSICAL	NO	AMBIENT TAN&GRY M>P,RED SED BAND,LG M CLUMPS, TUBES,BURROW-OPNING
WREF1	B	8/6/2001	10:29	0	0	0	7	PHYSICAL	NO	AMBIENT TAN&GRY M>P, RED SED BAND, RED CLSTS,IRREG TOPO,SM VOIDS, WORM@Z,TUBE
WREF1	C	8/6/2001	10:29	0	0	0	8	PHYSICAL	NO	AMBIENT TAN&BLK M>P,V.RED SED@SURF,LG RED BURROW, OX&RED CLSTS,VOIDS
WREF2	A	8/6/2001	10:22	0	0	0	8	PHYSICAL	NO	AMBIENT TAN&GRY M>P,LG OX&RED M CLUMPS,V.BLK RED SED @SURF &@Z,VOIDS
WREF2	B	8/6/2001	10:22	0	0	0	4	PHYSICAL	NO	AMBIENT TAN&GRY M>P, REDUCED SED BAND, OX&RED CLASTS, TUBES
WREF2	C	8/6/2001	10:23	0	0	0	2	PHYSICAL	NO	AMBIENT TAN&GRY M>P, TUBES, MUD CLUMPS & CLSTS, SM VOID?, PATCHY RPD
WREF3	A	8/6/2001	10:39	0	0	0	7	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BAND, SM VOIDS, LG MUD CLUMPS, TUBES
WREF3	B	8/6/2001	10:40	0	0	0	4	PHYSICAL	NO	AMBIENT TAN&BLK M>P, RED SED BAND, RED CLASTS, IRREG TOPO
WREF3	C	8/6/2001	10:40	0	0	0	8	PHYSICAL	NO	AMBIENT TAN&BLK M>P, V RED SED BAND,VOIDS,IRREG TOPO,M CLUMPS/CLST,PATCHY RPD
WREF4	A	8/6/2001	10:15	0	0	0	8	PHYSICAL	NO	AMBIENT M>P,RED SED BANDS,IRON OX LYR=RPD, VOIDS,TUBES, BURROW
WREF4	B	8/6/2001	10:16	0	0	0	7	PHYSICAL	NO	AMBIENT M>P, RED SED BAND, TUBES, RED CLASTS, VOIDS, BURROW
WREF4	C	8/6/2001	10:17	0	0	0	7	PHYSICAL	NO	AMBIENT M>P, RED SED BAND, LG MUD CLUMP, VOIDS

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