Dredged Material Management Plan

NOVEMBER 2000 REMOTS® SURVEY AT TWO CANDIDATE DREDGED MATERIAL DISPOSAL SITES IN BUZZARDS BAY

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EXECUTIVE SUMMARY

A comprehensive survey effort was undertaken in November 2000 to characterize baseline physical, chemical, and biological conditions at two candidate dredged material disposal sites in eastern Buzzards Bay and two nearby reference areas. As part of this survey effort, REMOTS® sediment-profile images were collected to characterize existing physical and biological seafloor conditions within candidate Sites 1 and 2 and reference areas REF-NEW and REF-2. Three replicate sediment profile images were collected at each of 81 stations located in and around candidate Site 1, 54 stations located in and around candidate Site 2, and 9 stations located in each of the two reference areas. The sediment-profile images were subsequently analyzed for a suite of standard measurement parameters, including sediment grain size, depth of the redox-potential discontinuity (RPD), successional stage and Organism-Sediment Index (OSI, a measure of overall benthic habitat quality).

The images showed that sediments in the shallower depths (>12 m) along the outer perimeter of Site 1 consisted of muddy fine sand or sandy mud, while the majority of stations in the deeper water (>12 m) within the site boundary had very soft mud. This resulted in the main habitat type within Site 1 being classified as unconsolidated very soft mud. Similar to Site 1, there was a general correlation between water depth and grain size/habitat type at Site 2. Very fine sand and sandy mud were found in the shallower northern half of the site (depths between 7 and 13 m), while very soft, uniform mud was found within the topographic depression (>13 m) comprising the southern half of the site. Habitat types consisting of unconsolidated mud mixed with silt and fine sand were found in the northern half of the site, while unconsolidated very soft mud occurred in the deeper southern half.

Site 1 is located in a broad topographic depression that appears to be a depositional environment favoring the long-term accumulation of fine-grained sediment. Site 2 appears to represent a varied environment with respect to bottom energy regimes. The shallower northern half of Site 2 appears to have the potential for higher bottom energy and net long-term loss of finer-grained sediment fractions, while the deeper southern half appears to favor the long-term net accumulation of fine-grained sediments and is classified as depositional. In general, the deeper areas of Sites 1 and 2 appear to represent better potential containment sites for dredged material than more shallow areas.

Populations of both surface-dwelling, opportunistic polychaetes (Stage I) and deeper-dwelling, subsurface deposit-feeding benthic taxa were widespread across Sites 1 and 2. Numerous burrow openings also were observed throughout the sediment column at many stations in both sites, evidence of the widespread presence of motile burrowers such as lobster, crab and shrimp. Overall, the REMOTS® results indicate that both candidate disposal sites are characterized by relatively abundant and diverse benthic communities. Apparent RPD depths across both sites were highly variable, attributed to temporal and spatial patchiness in sediment organic loading rates typical of estuarine environments like Buzzards Bay that have experienced increased eutrophication in recent decades.

The REMOTS® Organism-Sediment Index (OSI) values indicated that benthic habitat quality in and around Sites 1 and 2 was primarily non-disturbed, reflecting healthy sediment aeration and the presence of a diverse and abundant benthic community comprised of Stage I, II and III organisms. Some stations within each site indicated moderately disturbed benthic habitat quality, attributed primarily to natural physical disturbance by bottom currents in the shallower, sandier areas of each site.

The Ref-New and Ref-2 reference areas are located at depths similar to those existing within the candidate disposal sites. Both reference areas were characterized primarily by unconsolidated soft muddy sediments. In terms of both sediment grain size and benthic habitat types, the conditions at the reference areas were very similar to those existing at the majority of stations within Sites 1 and 2. Both reference areas also had an apparent abundant benthic community comprised of a diverse mixture of surface-dwelling Stage I taxa and subsurface deposit-feeding Stage III organisms. Similar to the candidate disposal sites, both reference areas also showed evidence of extensive burrowing by larger invertebrates. Apparent RPD depths at Ref-2 were well developed, while those at Ref-New were somewhat shallower and more patchy, similar to conditions observed at the candidate disposal sites. Benthic habitat quality at both reference areas was non-disturbed, comparable to conditions at the candidate disposal sites.

Physical and biological seafloor conditions at Ref-2 in November 2000 were largely similar to those previously detected in March 1990. The main difference between the two REMOTS® surveys was in the apparent RPD depths, which were consistently shallower in November 2000. These results were attributed either to the seasonal difference between the two surveys or to a longer-term trend of increasing nutrient inputs to Buzzards Bay (i.e., eutrophication), resulting in system-wide increases in organic loading to the bottom and concomitant decreases in RPD depths. However, the OSI values in both 1990 and 2000 indicated non-disturbed benthic habitat quality at the Ref-2 reference area.

1.0 INTRODUCTION

1.1 Background

In 1995, the Massachusetts Department of Environmental Management (DEM) proposed to designate an open-water dredged material disposal site within the area of the former Cleveland Ledge Disposal Site (CLDS) in eastern Buzzards Bay (Figure 1-1). On 8 March 1995, the DEM filed an Environmental Notification Form (ENF) describing the proposed site, a circular area having a diameter of 500 yards centered at 41° 36.00' N, 70° 41.00'' W, corresponding to the location of the former Buzzards Bay Disposal Site (BBDS) used by U.S. Army Corps of Engineers (Figure 1-2). In the ENF, the DEM indicated that the proposed new BBDS would be designated for the receipt of coarse-grained dredged material only (i.e., silt-clay fraction of 20% or less). Following regulatory response and public comment, the Secretary of Environmental Affairs issued a Certificate on the ENF on May 10, 1995, requiring the preparation of an Environmental Impact Report (EIR) pursuant to the Massachusetts Environmental Policy Act (MEPA). The required scope for the EIR is described in the Certificate (referred to herein as the MEPA Scope).

As part of a larger project to develop a Dredged Material Management Plan (DMMP) for the state of Massachusetts, the Massachusetts Coastal Zone Management Agency (MCZM) has assumed responsibility for addressing the MEPA Scope and preparing the EIR. In March 1998, MCZM filed a Notice of Project Change, proposing to designate the BBDS for all physical categories of dredged material deemed suitable for open ocean disposal (from fine- to coarse-grained), rather than limiting the designation to coarse-grained material only.

In fulfillment of MEPA Scope Item I, MCZM sponsored a Needs Analysis that documented the regional need for a disposal site, estimated the types and quantities of dredged material to be generated, and identified local, regional and state dredged material use and disposal policies (Maguire Group Inc., 1998a). Under MEPA Scope Item II, an Alternatives Analysis was completed to evaluate: 1) the potential environmental benefits and drawbacks of opening an historic disposal site versus identifying a new site, and 2) the feasibility of using the existing Massachusetts Bay Disposal Site (MBDS) or Cape Cod Disposal Site (CCDS; Maguire Group Inc., 1998b).

The Alternatives Analysis concluded that while the CCDS could be used for disposal of material from dredging projects in the northern end of Buzzards Bay, the significant transit distances generally precluded the use of either the CCDS or MBDS as cost-effective options. The Alternatives Analysis also identified several drawbacks to the BBDS as originally proposed by DEM in 1995 (Figure 1-2), including the potential for erosion of fine-grained sediment, limited access by deeper draft hopper dredges, and inadequate long-term capacity. To overcome these drawbacks, it was recommended that deeper and larger areas within and near the historic Cleveland Ledge Disposal Site be considered as potential disposal site locations.

Under MEPA Scope Item III, MCZM is required to collect data to determine the baseline physical and biological characteristics of any proposed disposal site(s), including bathymetry, sediment grain size and chemistry, benthic habitat types and community structure, bottom currents, fisheries, and water column chemistry. Under contract to MCZM, Science Applications International Corporation (SAIC) of Newport, RI conducted a survey in May 1998 involving high-resolution bathymetry and side scan sonar across a relatively large area encompassing the southern half of the historic Cleveland Ledge Disposal Site (Maguire Group Inc., 1998c). The objective of this reconnaissance survey was to gather data on the physical characteristics of the seafloor to facilitate optimal siting of the proposed BBDS.

In general, the May 1998 study identified areas having water depths greater than 12 m as being preferred disposal locations, because such areas have the potential to limit sediment resuspension and maximize long-term capacity while accommodating access by deep draft hopper dredges. The May 1998 bathymetric data revealed two locations in the surveyed area having water depths greater than 12 m: a basin located near the eastern boundary of the historic Cleveland Ledge Disposal Site ("eastern basin") and an area near the southern boundary ("southern basin"; Figure 1-3). SAIC conducted a second bathymetric survey in October 2000 to characterize in greater detail the bottom topography in the vicinity of the southern basin. The two candidate disposal sites selected for further study under MEPA Scope Item III are located over the southern and eastern basins and designated as Sites 1 and 2, respectively (Figures 1-3 and 1-4).

Site 2 is a rectangular area with dimensions 1000 m × 1700 m (Figure 1-4). It is under consideration as a potential disposal site because it appears to be a predominantly depositional seafloor environment, having sufficient water depth and capacity, that has already been affected by past dredged material disposal at the historic Cleveland Ledge Disposal Site. However, this site has the drawback of being close to shallow areas (e.g., Gifford Ledge to the east and the historic Cleveland Ledge "dump top" to the west), which could limit access by deeper draft vessels and potentially represent a hazard to navigation.

The deeper parts of the southern basin occur just outside the southern boundary of the Cleveland Ledge Disposal Site (Figures 1-3 and 1-4). Since deeper areas within Buzzards Bay have the greatest potential to act as containment sites for deposited dredged material, a decision was made to establish candidate Site 1 (a square area measuring 1600 m × 1600 m) over this deeper part of the southern basin.

1.2 Survey Objective

The objective of the November 2000 survey reported here was to use REMOTS® sediment-profile imaging to evaluate the physical and biological characteristics of the seafloor at candidate disposal Sites 1 and 2 and at two nearby reference areas. The REMOTS® results will be used in conjunction with other data to prepare the draft EIR evaluating the potential environmental impacts of any future dredged material disposal at the candidate sites.

2.0 METHODS

2.1 REMOTS® Sediment Profile Imaging

Sediment-profile imaging is a benthic sampling technique in which a specialized camera is used to obtain undisturbed, vertical cross-section photographs (profiles) of the upper 15 to 20 cm of the seafloor. This is a reconnaissance survey technique used for rapid collection, interpretation and mapping of data on physical and biological seafloor characteristics; it has been employed in estuarine, coastal and deep-sea environments worldwide for almost 20 years. Measurements obtained from sediment-profile images are used to characterize sediment types, evaluate benthic habitat quality, map disturbance gradients, and follow ecosystem recovery after disturbance abatement. This technique was first introduced under the name REMOTS® (REmote Ecological Monitoring Of The Seafloor), a registered trademark of Science Applications International Corporation (SAIC). REMOTS® is a formal and standardized technique for sediment-profile imaging and analysis, as described by Rhoads and Germano (1982; 1986). In generic terms, this sampling technique is often referred to as sediment-profile imaging (SPI) or sediment vertical profile imaging (SVPI).

2.2 Sampling Design

The REMOTS® survey at the two candidate disposal sites and nearby reference areas was conducted in November 2000 aboard the M/V *Beavertail*. Sediment-profile images were collected at a total of 81 sampling stations located in and around Site 1, 54 stations located in and around Site 2, and 9 stations located in each of the two reference areas (designated as REF-2 and REF-NEW in Figure 2-1). The stations in and around candidate Sites 1 and 2 were spaced evenly apart in a grid pattern to facilitate mapping of spatial patterns on the seafloor, while cross-shaped station grids were employed in each of the two reference areas (Figure 2-1).

During the field surveys, one- to five-meter vessel positioning accuracy was achieved at each sampling station using a differential-GPS navigation system. The REMOTS® camera was lowered into the sediment multiple times at each sampling station to ensure that at least three replicate sediment-profile images suitable for subsequent analysis were obtained. Color slide film was used and developed soon after the completion of each field day to verify proper equipment operation and image acquisition.

2.3 REMOTS® Image Acquisition

A Benthos Model 3731 Sediment Profile Camera (Benthos, Inc., North Falmouth, MA) was used in this study (Figure 2-2). The camera is designed to obtain *in situ* profile images of the top 20 cm of sediment. Functioning like an inverted periscope, the camera consists of a wedge-shaped prism with a front faceplate and a back mirror mounted at a 45-degree angle to reflect the profile of the sediment-water interface facing the camera. The prism is filled with distilled water, the assembly contains an internal strobe used to illuminate the images, and a 35-mm camera is mounted horizontally on top of the prism. The REMOTS® camera is deployed from a vessel using a winch and overhead boom or A-frame. The prism assembly is moved up and down into the sediments by producing tension or slack on the winch wire. Tension on the wire keeps the prism in the up position, out of the sediments.

The camera frame is lowered to the seafloor at a rate of about 1 m/sec (Figure 2-2). When the frame settles onto the bottom, slack on the winch wire allows the prism to penetrate the seafloor vertically. A passive hydraulic piston ensures that the prism enters the bottom slowly (approximately 6 cm/sec) and does not disturb the sediment-water interface. As the prism starts to penetrate the seafloor, a trigger activates a 13-second time delay on the shutter release to allow maximum penetration before a photo is taken. A Benthos Model 2216 Deep Sea Pinger is attached to the camera and outputs a constant 12 kHz signal of one ping per second; upon discharge of the camera strobe, the ping rate doubles for 10 seconds. Monitoring the signal output on board the survey vessel provides confirmation that a successful image was obtained. Because the sediment photographed is directly against the faceplate, turbidity of the ambient seawater does not affect image quality. When the camera is raised, a wiper blade cleans off the faceplate, the film is advanced by a motor drive, the strobe is recharged, and the camera can be lowered for another image.

2.4 REMOTS® Image Analysis

The REMOTS® images were analyzed with the full-color, SAIC Image Analysis System. This is a PC-based system integrated with a Javelin CCTV video camera and frame grabber. Color slides are digitally recorded as color images on computer disk. The image analysis software is a menu-driven program that incorporates user commands via keyboard and mouse. The system displays each slide on a color monitor while measurements of standard physical and biological parameters are obtained. Proprietary SAIC software allows the measurement and storage of data on up to 21 different variables for each REMOTS® image obtained. Automatic disk storage of all measured parameters allows data from any variables of interest to be compiled, sorted, displayed graphically, contoured, or compared statistically.

All measurements were printed out on individual data sheets for a quality assurance check by an SAIC Senior Scientist before being approved for final data synthesis, statistical analyses, and interpretation. The methods used for computer-based measurement of the key REMOTS® parameters discussed in this report are described in the following sections.

In general, three replicate REMOTS® images were obtained and analyzed at each sampling station. Analysis of three replicate images per station allows for characterization of any variability in benthic habitat conditions that may exist at relatively small spatial scales (i.e., on the order of a few meters between individual camera drops). The measurement results for the individual replicate images are presented in this report in a series of frequency distributions. For mapping purposes, the measured values for the three replicate images at each station were averaged. Mapping of the station average values is useful for characterizing the larger-scale spatial patterns in seafloor conditions existing within each surveyed area.

2.4.1 Sediment Type Determination

The sediment grain-size major mode and range are estimated visually from the REMOTS® images by overlaying a grain size comparator of the same scale. This comparator was prepared by photographing a series of Udden-Wentworth size classes (equal to or less than coarse silt up to granule and larger sizes) through the REMOTS® camera. Seven grain size classes are on this comparator: silt-clay (>4 phi), very fine sand (4 to 3 phi), fine sand (3 to 2 phi), medium sand (2 to 1 phi), coarse sand (1 to 0 phi), very coarse sand (0 to –1 phi), and granules or larger (<-1 phi). Table 2-1 is provided to facilitate conversions between phi units and other commonly employed grain size scales. The lower limit of optical resolution of the photographic system is about 62 microns (4 phi), allowing recognition of grain sizes equal to or greater than coarse silt. The accuracy of this method has been documented by comparing REMOTS® estimates with grain size statistics determined from laboratory sieve analyses.

The major modal grain size that is assigned to an image is the dominant grain size as estimated by area within the imaged sediment column. In images that show distinct stratigraphy (i.e., layering) of sediments having different grain size major modes (e.g., a layer of sand over a layer of mud or vice versa), the dominant major mode assigned to the image depends on how much area of the photograph is represented by one sediment type versus the other. In such cases, the textural assignment may or may not correspond to traditional sieve analyses depending on how closely the vertical sampling intervals are matched between the grab or core sample and the depth of the imaged sediment. Layering is noted as a comment within each REMOTS® image analysis data file, and the thickness of different layers is measured. The presence of different sedimentary layers in REMOTS® images typically indicates that a depositional event has occurred (e.g., a sand cap placed on top of fine-grained dredged material). Changes in the thickness of surface depositional layers over time can be used to estimate deposition rates.

2.4.2 Benthic Habitat Classification

Based on several past sediment-profile imaging surveys conducted in Narragansett Bay, Rhode Island (Diaz 1995; SAIC 1997a and b), five basic benthic habitat types have been identified: AM=*Ampelisca* mat, SH= shell bed, SA=hard sand bottom, HR=hard rock/gravel bottom, and UN=unconsolidated soft bottom (Table 2-2). Several sub-habitat types exist within these major categories (Table 2-2).

The benthic habitat types developed for Narragansett Bay are also applicable to Buzzards Bay. Therefore, each of the sediment profile images obtained in the present study was assigned one of the habitat categories listed in Table 2-2. At most stations, the replicate REMOTS® images showed the same major habitat type to be present, and this habitat type was then assigned to the station for mapping purposes. At a few stations, the replicate images showed two different major habitat types, an indication of small-scale spatial variability in bottom conditions. In such instances, the station was mapped based on the most common or predominant habitat type among the replicate images, but with a special map symbol used to denote “variable” benthic habitat conditions.

2.4.3 Prism Penetration Depth

The optical prism of the REMOTS® sediment-profile camera penetrates the bottom under a static driving force imparted by its own weight. The penetration depth into the bottom depends on the force exerted by the optical prism and the bearing strength of the sediment. If the weight of the camera prism is held constant, the change in penetration depth over a surveyed site will reflect changes in geotechnical properties of the bottom. In this sense, the camera prism acts as a static-load penetrometer. The depth of penetration of the REMOTS® camera prism can be used to map gradients in the bearing strength (hardness) of seafloor sediments. Older, highly bioturbated and/or sediments comprised primarily of silts and clay tend to be soft and allow deeper penetration than sediments with a higher sand content, which tend to create resistance to camera penetration.

2.4.4 Surface Boundary Roughness

Small-scale surface boundary roughness is measured from an image with the computer image analysis system. This vertical measurement is from the highest point at the sediment-water interface to the lowest point. This measurement of vertical relief is made within a horizontal distance of 13 cm (the total width of the optical window). Because the optical window is 20 cm high, the greatest possible roughness value is 20 cm. The source of the roughness is described if known. In most cases this is either biogenic (mounds and depressions formed by bioturbation or foraging activity) or relief formed by physical processes (ripples, scour depressions, rip-ups, mud clasts, etc.).

2.4.5 Infaunal Successional Stages

It is emphasized that the following discussion of REMOTS® infaunal successional stages applies only to soft-bottom habitats, where the REMOTS® camera is able to penetrate into the sediment. In hard bottom environments (i.e., rocky substrates), camera penetration is prevented and the standard suite of REMOTS® measurements cannot be made. In such instances, the infaunal successional stage is considered to be "indeterminate." It is important to note that hard bottom areas can support abundant and diverse epibenthic communities and therefore may represent habitat which is biologically productive or otherwise is of value as refuge or living space for organisms. However, it is stressed that the value of hard bottom habitats is not reflected in the REMOTS® successional stage designation.

The mapping of successional stages is based on the theory that organism-sediment interactions in fine-grained sediments follow a predictable sequence after a major seafloor perturbation (e.g., passage of a storm, disturbance by bottom trawlers, dredged material deposition, hypoxia). The theory states that primary succession results in "the predictable appearance of macrobenthic invertebrates belonging to specific functional types following a benthic disturbance. These invertebrates interact with sediment in specific ways. Because functional types are the biological units of interest, our definition does not demand a sequential appearance of particular invertebrate species or genera" (Rhoads and Boyer 1982). This theory is formally developed in Rhoads and Germano (1982) and Rhoads and Boyer (1982).

The term disturbance is used here to define natural processes, such as seafloor erosion, changes in seafloor chemistry, and foraging disturbances which cause major reorganization of the resident benthos; disturbance also includes anthropogenic impacts, such as dredged material or sewage sludge disposal, thermal effluent from power plants, bottom trawling, pollution impacts from industrial discharge, excessive organic loading, etc. An important aspect of using this successional approach to interpret benthic monitoring results is relating organism-sediment relationships to the dynamical aspects of end-member successional stages (i.e., Stage I, II, or III communities as defined in the following paragraphs). This involves deducing dynamics from structure, a technique pioneered by R. G. Johnson (1972) for marine soft-bottom habitats. The application of this approach to benthic monitoring requires *in situ* measurements of salient structural features of organism-sediment relationships as imaged through REMOTS® technology.

Pioneering assemblages (Stage I assemblages) usually consist of dense aggregations of near-surface living, tube-dwelling polychaetes (Figure 2-3); alternately, opportunistic bivalves may colonize in dense aggregations after a disturbance (Rhoads and Germano 1982, Santos and Simon 1980a). These functional types are usually associated with a shallow redox boundary; bioturbation depths are shallow, particularly in the earliest stages of colonization (Figure 2-3). In the absence of further disturbance, these early successional assemblages are eventually replaced by infaunal deposit feeders; the start of this "infaunalization" process is designated arbitrarily as Stage II. Typical Stage II species are shallow dwelling bivalves or, as is common in New England waters, tubicolous amphipods. In studies of hypoxia-induced benthic defaunation events in Tampa Bay, Florida, ampeliscid amphipods appeared as the second temporal dominant in two of the four recolonization cycles (Santos and Simon 1980a, 1980b).

Stage III taxa, in turn, represent high-order successional stages typically found in low-disturbance regimes. These invertebrates are infaunal, and many feed at depth in a head-down orientation. The localized feeding activity results in distinctive excavations called feeding voids (Figure 2-3). Diagnostic features of these feeding structures include a generally semicircular shape with a flat bottom and arched roof, and a distinct granulometric change in the sediment particles overlying the floor of the structure. This granulometric change is caused by the accumulation of coarse particles that are rejected by the animals feeding selectively on fine-grained material. Other subsurface structures, such as burrows or methane gas bubbles, do not exhibit these characteristics and therefore are quite distinguishable from these distinctive feeding structures. The bioturbational activities of these deposit-feeders are responsible for aerating the sediment and causing the redox horizon to be located several centimeters below the sediment-water interface. In the retrograde transition of Stage III to Stage I, it is sometimes possible to recognize the presence of relict (i.e., collapsed and inactive) feeding voids.

The end-member stages (Stages I and III) are easily recognized in REMOTS® images by the presence of dense assemblages of near-surface polychaetes (Stage I) or the presence of subsurface feeding voids (Stage III; Figure 2-3). The presence of tubicolous amphipods at the sediment surface is indicative of Stage II. It is possible for Stage I polychaetes or Stage II tubicolous amphipods to be present at the sediment surface, while at the same time, Stage III organisms are present at depth within the sediment. In such instances, where two types of assemblages are visible in a REMOTS® image, the image is designated as having either a Stage I on Stage III (I-III) or Stage II on Stage III (II-III) successional state. Additional information on REMOTS® image interpretation can be found in Rhoads and Germano (1982, 1986).

2.4.6 Apparent Redox Potential Discontinuity (RPD) Depth

Aerobic near-surface marine sediments typically have higher reflectance values relative to underlying anoxic sediments. Sand also has higher optical reflectance than mud. These differences in optical reflectance are readily apparent in REMOTS® images; the oxidized surface sediment contains particles coated with ferric hydroxide (an olive color when associated with particles), while reduced and muddy sediments below this oxygenated layer are darker, generally grey to black (Figure 2-3). The boundary between the colored ferric hydroxide surface sediment and underlying grey to black sediment is called the apparent redox potential discontinuity (RPD).

The depth of the apparent RPD in the sediment column is an important time-integrator of dissolved oxygen conditions within sediment pore waters. In the absence of bioturbating organisms, this high reflectance layer (in muds) will typically reach a thickness of 2 mm (Rhoads 1974). This depth is related to the supply rate of molecular oxygen by diffusion into the bottom and the consumption of that oxygen by the sediment and associated microflora. In sediments that have very high sediment-oxygen demand, the sediment may lack a high reflectance layer even when the overlying water column is aerobic.

In the presence of bioturbating macrofauna, the thickness of the high reflectance layer may be several centimeters. The relationship between the thickness of this high reflectance layer and the presence or absence of free molecular oxygen in the associated pore waters must be made with caution. The boundary (or horizon) which separates the positive Eh region (oxidized) from the underlying negative Eh region (reduced) can only be determined accurately with microelectrodes. For this reason, we describe the optical reflectance boundary, as imaged, as the "apparent" RPD, and it is mapped as a mean value.

The depression of the apparent RPD within the sediment is relatively slow in organic-rich muds (on the order of 200 to 300 micrometers per day); therefore, this parameter has a long time constant (Germano and Rhoads 1984). The rebound in the apparent RPD is also slow (Germano 1983). Measurable changes in the apparent RPD depth using the REMOTS® optical technique can be detected over periods of one or two months. This parameter is used effectively to document changes (or gradients) which develop over a seasonal or yearly cycle related to water temperature effects on bioturbation rates, seasonal hypoxia, sediment oxygen demand, and infaunal recruitment.

Another important characteristic of the apparent RPD is the contrast in reflectance values at this boundary. This contrast is related to the interactions among the degree of organic-loading, bioturbational activity in the sediment, and the levels of bottom-water dissolved oxygen in an area. High inputs of labile organic material increase sediment oxygen demand and, subsequently, sulfate reduction rates (and the abundance of sulfide end-products). This results in more highly reduced (lower reflectance) sediments at depth and higher RPD contrasts. In a region of generally low RPD contrasts, images with high RPD contrasts indicate localized sites of relatively high past inputs of organic-rich material (e.g., organic or phytoplankton detritus, dredged material, sewage sludge, etc.).

2.4.7 Organism-Sediment Index (OSI)

The multi-parameter REMOTS® Organism-Sediment Index (OSI) has been constructed to characterize habitat quality of soft-bottom benthic environments. Habitat quality is defined relative to two end-member standards. The lowest value is given to those bottoms which have low or no dissolved oxygen in the overlying bottom water, no apparent macrofaunal life, and methane gas present in the sediment (see Rhoads and Germano 1982, 1986, for REMOTS® criteria for these conditions). The OSI for such a condition is -10. At the other end of the scale, an aerobic bottom with a deep RPD, evidence of a mature macrofaunal assemblage, and no apparent methane gas bubbles at depth will have an OSI value of +11.

The OSI is a sum of the subset indices shown in Table 2-3. The OSI is calculated automatically by SAIC software after completion of all measurements from each REMOTS® photographic negative. The index has proven to be a useful parameter for mapping disturbance gradients in an area and documenting ecosystem recovery after disturbance (Germano and Rhoads 1984; Revelas et al. 1987; Valente et al. 1992).

The OSI may be subject to seasonal changes because the mean apparent RPD depths vary as a result of temperature-controlled changes in bioturbation rates and sediment oxygen demand. Furthermore, the successional status of a station may change over the course of a season related to recruitment and mortality patterns or the disturbance history of the bottom. The sub-annual change in successional status is generally limited to Stage I (polychaete-dominated) and Stage II (amphipod-dominated) taxa. Stage III communities tend to be maintained over periods of several years unless they are eliminated by increasing organic loading, extended periods of hypoxia, or burial by thick layers of dredged material. The recovery of Stage III communities following abatement of such events may take several years (Rhoads and Germano 1982).

Generally speaking, in the areas sampled, mid-summer (July-August) is considered to be the period of time when ecological responses to pollution exposure are likely to be most severe. During mid-summer, dissolved oxygen concentrations are most likely to approach stressful low levels, and the adverse effects of contaminant exposure are generally greatest at the low dilution flows and high temperatures that occur at this time of year. Because the sampling for the present study occurred during late fall, the resulting OSI values are probably higher than might be found during mid-summer. They are therefore considered to be “conservative” in terms of reflecting higher benthic habitat quality than might be found during the warmest months.

It must be stressed that the REMOTS® Organism-Sediment Index is most useful for characterizing benthic habitat quality and making comparisons among soft-bottom areas, where the REMOTS® camera is able to penetrate into the sediment. In hard bottom environments (i.e., rocky substrates), camera penetration is prevented and the standard suite of REMOTS® measurements cannot be made. In such instances, the OSI is considered to be “indeterminate.” As previously noted, it is important to emphasize that hard bottom areas can support abundant and diverse epibenthic communities and therefore may represent good quality habitat, but this is not typically reflected (either positively or negatively) in the REMOTS® OSI. Other sampling techniques (e.g., photo quadrats) are better suited to characterizing the quality of hard substrate habitats and making comparisons among different areas.

In summary, the Organism-Sediment Index (OSI) is a metric which defines overall benthic habitat quality in soft-bottom environments by reflecting the depth of the apparent redox layer, successional stage of infauna, the presence/absence of methane gas in the sediment, and the presence/absence of reduced (i.e., anaerobic) sediment at the sediment-water interface (Table 2-3). OSI values less than +3 are considered to be indicative of disturbed habitat quality, values between +3 and +6 are considered to be reflective of intermediate quality (i.e., moderately disturbed), and values greater than +6 are considered indicative of non-disturbed benthic habitat quality.

3.0 RESULTS AND DISCUSSION

3.1 REMOTS® Characterization of Site 1

Figure 3-1 presents the numbering scheme used to identify the 81 stations occupied in and around candidate Site 1 during the November 2000 REMOTS® survey. With the exception of station G4, three replicate images were obtained and analyzed at each station for the purpose of preparing the tables and graphs presented below. At station G4, only one image was obtained due to an electronic malfunction of the sediment-profile camera. Therefore, a total of 241 images were analyzed for the Site 1 stations, and the analysis results by image are provided in Appendix Table 1. As previously indicated, the results are presented below in summary form (i.e., station averages), as well as in frequency distributions based on all the images obtained within the site. This type of presentation provides insights into both the small-scale spatial variability at the individual stations and the overall seafloor conditions across the site.

3.1.1 Sediment Grain Size and Benthic Habitat Classification

The majority of the Site 1 stations (67 of 81, or 83%) exhibited surface sediments having a grain size major mode of >4 phi (silt-clay), while sediments at the remainder of the stations (14 of 81, or 17%) had a major mode of 4 to 3 phi (very fine sand; Table 3-1 and Figure 3-2). The frequency distribution mirrors these results: 83% of the images showed silt-clay to be dominant across Site 1, while 17% showed very fine sand (Figure 3-3). Overall, these results indicate there was very little within-station variability in sediment grain size within Site 1, and a somewhat higher degree of among-station variability.

The stations having silt-clay sediments were located most consistently in the deeper areas of Site 1, at depths greater than about 12 m (Figures 3-2 and 3-4). The very fine sand was found at 14 stations located primarily along the northern and western perimeters of the surveyed area, where water depths generally ranged from 8 to 12 m (Figures 3-2 and 3-5). Some of the stations in the shallower perimeter areas exhibited a sand-over-mud stratigraphy, possibly due to winnowing of the fine fraction from the sediment surface by bottom currents (Figure 3-6). One replicate image from station I1 showed a grain size major mode of 2 to 1 phi (medium sand; Figure 3-2). This station is located in the far northeastern corner of the survey grid, in an area of shallower water corresponding to the “dump top” circular mound feature south of the former BBDS.

The primary benthic habitat classification within Site 1 was very soft mud (habitat type UN.SF; Table 3-1 and Figures 3-4, 3-7 and 3-8). The majority of the stations having the UN.SF habitat type were located within the Site 1 boundary (Figure 3-7). A number of stations, located primarily around the perimeter of the site boundary, exhibited either unconsolidated soft sediment which appeared to have a significant silt or fine sand component (habitat types UN.SI and UN.SS as illustrated in Figure 3-6) or hard sand bottom comprised of fine sand (habitat type SA.F as illustrated in Figure 3-5). One station, located in northeast corner of the survey area (station I1), was classified as Hard Rock/Gravel Bottom (habitat type HR). In general, there was a gradient of increasingly softer, finer-grained sediments (UN.SS/SI to UN.SF) moving from the northwest to southeast across the survey grid into deeper water.

The grain size and benthic habitat results generally suggest that, with the exception of the extreme northern and western edges of the site, most of the bottom within the boundary of Site 1 represents a depositional seafloor environment. The depths within the boundary range from about 12 m along the northern edge to greater than 14 m in the southeast quadrant. Site 1 is situated over the northern edge of a broad topographic depression that extends southward, roughly parallel with the Falmouth shoreline, and eventually turns westward as part of the central deep basin of Buzzards Bay. This depression appears to favor the accumulation of very fine-grained, soft sediment, as most of the REMOTS® stations within the site boundary showed silt-clay and the UN.SF habitat type, while stations in shallower depths (above 12 m) on the outer perimeter (including the extreme northern and western edges of the site) had considerably higher sand content. These results are generally consistent with the historical study Moore (1963), who showed that the deeper areas comprising the central axis of Buzzards Bay favored accumulation of fine-grained sediment, while shallower nearshore areas had coarser-textured sediments.

3.1.2 Camera Prism Penetration Depth

The majority of the Site 1 stations had camera penetration depths greater than 10 cm (Table 3-1; Figures 3-9 and 3-10). This relatively deep penetration reflects the soft nature of the unconsolidated fine-grained sediments that characterized most of the site. The deepest penetration values (>15 cm) corresponded consistently with the greater water depths (e.g., Figure 3-4), again reflecting the gradient of increasingly softer, finer-grained sediments moving from northwest to southeast across the surveyed area. A number of stations located along the northern and western perimeter of the survey grid had intermediate mean penetration depths ranging from 5.01 to 10.0 cm, while five stations had low mean camera penetration depths between 0.0 to 5.0 cm (e.g., Figure 3-5). The decrease in camera penetration is attributed to the higher proportion of fine and medium sand present within the sediment at these perimeter stations.

3.1.3 Boundary Roughness

The mean boundary roughness values for the Site 1 stations were predominately in the range 0.0 to 2.0 cm (Table 3-1; Figures 3-11 and 3-12). Values in this range reflect only a small amount of fine-scale surface relief and suggest that neither physical nor biological processes are significantly affecting the sediment surface throughout the site. Five of the stations, located intermittently throughout the survey area, had slightly higher mean boundary roughness values of 2.01 to 4.0 cm. With the exception of stations G7 and G8, the boundary roughness was attributed to physical processes. Stations G7 and G8 each had one replicate image where the boundary roughness was attributed to biological activity (e.g., fecal mounds) and, subsequently, slightly skewed the mean boundary roughness for the station as a whole. Individual replicate images at stations C6, G7, and G8 had boundary roughness >4.01 cm, indicating small-scale spatial (i.e., intra-station) variability in surface relief at these locations.

3.1.4 Infaunal Successional Stage

The majority of the stations located within Site 1 (59 of 81, or 73%) had at least one replicate image that showed the presence of a mature benthic community comprised of Stage III organisms (Table 3-1 and Figure 3-13). Stage III by itself was the highest successional stage observed at 25 of the 81 stations (31%), while Stage III in combination with Stage I (Stage I on III) was the highest successional stage observed at 34 of the 81 stations (42%).

Stage III, alone or in combination with Stage I, was most commonly observed at the stations in deeper water having unconsolidated, soft mud (Figure 3-13). This habitat type is favored by the larger-bodied deposit-feeders comprising the Stage III community. The primary evidence of Stage III in the sediment-profile images was feeding voids observed at depth within the sediment (Figure 3-14). The images throughout Site 1 also showed numerous vertical and horizontal burrow openings within the sediment column, evidence of the widespread presence of motile burrowers such as lobster, crabs, and shrimp (Figures 3-4, 3-15 and 3-16). In addition, the distinct white tubes of the polychaete *Chaetopterus* sp. were observed at the sediment surface at several stations (stations A1, B1, B4, B9, C1, C2, E1, E8, F9, G6, I3, I4, and I8) located in both deep and shallower water (Figures 3-4 and 3-17).

A number of stations (20 of 81, or 25%), primarily located along the periphery of the site boundaries in shallower water, showed only surface-dwelling Stage I organisms to be present (Figures 3-13 and 3-18). These stations generally had a higher sand component and may experience periodic scouring disturbance and winnowing of fines by bottom currents. In Buzzards Bay, it has been demonstrated that sediments comprised primarily of sand or firm mud tend to be dominated by Stage I and II communities consisting of surface-dwelling suspension feeders (Sanders 1958, 1960; Rhoads and Young 1970).

Station B4 had a successional status of Stage I organisms going to Stage II. The Stage I to II designation indicates the presence of both small, opportunistic polychaetes at the sediment surface together with evidence of extensive burrowing just below the sediment surface. This near-surface burrowing is attributed to amphipods and other shallow-dwelling, “Stage II” organisms that become abundant as benthic succession beyond Stage I results in a community living increasingly deeper with the sediment.

The frequency distribution of infaunal successional stages confirms that Stage I, alone or in combination with Stage III, was widespread throughout Site 1 (Figure 3-19). Stage I was observed in 204 of the 241 images (85%). Stage III, alone or in combination with Stage I, also was observed in the majority of images (132 of 241, or 55%) obtained at Site 1. These results, together with the observation of numerous burrow openings in images throughout the site, suggest that the benthic community in and around Site 1 was relatively abundant and diverse, comprised of a mixture of small, surface-dwelling opportunists, deeper-dwelling deposit-feeders, and motile megafauna.

3.1.5 Apparent RPD Depth

The mean RPD depths at each station varied widely throughout Site 1, ranging from 0.8 cm at station E1 to 4.6 cm at station H4 (Table 3-1; Figures 3-20 and 3-21). A little more than half of the stations (48 of 81, or 60%) had a mean RPD depth greater than 2.0 cm, which is indicative of normal or healthy oxygen penetration into the surface sediments. However, a significant number of stations (33 of 81, or 41%) had relatively shallow mean RPD depths ranging from 0 to 2.0 cm (Table 3-1; Figure 3-20). Likewise, the frequency distribution shows that a little over half the replicate images (133 of 241, or 55%) had RPD depths greater than 2 cm, while 40% of the images (97 of 241) had RPD depths less than 2 cm (Figure 3-21). The RPD depth could not be measured in 11 of the 241 images (indeterminate), due mainly to under-penetration of the sediment-profile camera.

In general, there were no consistent spatial patterns in mean RPD depths across the site; the RPD depths varied widely among the individual stations (Figure 3-20). Likewise, the frequency distribution suggests there was significant within-station variability in RPD depths (Figure 3-21). Although the site appears to have an active benthic community capable of extensive bioturbation and hence aeration of the surface sediments, there may also be periodic inputs or “pulses” of organic matter to the sediment. Such pulses are not uncommon in estuaries like Buzzards Bay, and inputs to the sediment can vary widely in both space and time. For example, Anderson and Taylor (2001) observed pulses of nutrients following rainfall events that acted to stimulate phytoplankton production in the surface waters of western Long Island Sound; subsequent sinking of the phytoplankton blooms created pulses of organic matter to the sediment and variability in near-bottom dissolved oxygen concentrations. An additional effect of such variable inputs of organic matter to the bottom is to create localized patches of increased sediment oxygen demand and concomitant variability in RPD depths (Webb 1993; Maughan and Oviatt 1993).

3.1.6 Organism-Sediment Index

The majority of stations throughout Site 1 (52 of 81, or 64%) had OSI values of greater than +6.01, indicative of undisturbed benthic habitat quality (Table 3-1 and Figure 3-22). These high OSI values reflect the well-developed apparent RPD depths at these stations (>2 cm) combined with the presence of an apparent diverse and abundant benthic community consisting of a combination of Stage I and III taxa. A significant number of stations (27 of 81, or 33%), located mainly around the perimeter of Site 1, had OSI values between +3.01 to +6.0 (Figure 3-22). Such values indicate moderately disturbed benthic habitat quality and mainly reflect the dominance of lower-order, opportunistic successional stages at these stations (Stage I or Stage I to II) in combination with mean apparent RPD depths that were generally less than 3 cm. As previously indicated, the “moderate disturbance” at these shallower, sandy stations is most likely natural (i.e., periodic scouring and/or winnowing of fines by bottom currents) as opposed to anthropogenic in nature.

The mean OSI values for stations A4 and E1 were between +0.01 to +3.0, suggesting disturbed benthic habitat quality. The lower OSI at station A4 was due to a relatively shallow RPD depth (1.01-2.0 cm) coupled with a lower-order successional stage (Stage I). The lower OSI at station E1 was primarily due to the shallow apparent RPD depth of 0.0-1.0 cm.

The frequency distribution shows that the majority of images (133 of 241, or 55%) had OSI values greater than +6.01, while a significant number (96 of 241, or 40%) had OSI values less than +6.0 (Figure 3-23). These results suggest that there was considerably more within-station variability in OSI values than indicated by the summary map based on station averages. This is due to both the spatial patchiness in the apparent RPD depths, as well as the uneven distribution of Stage I and III organisms throughout the site. In particular, Stage I was dominant at many of the sandy stations in shallower areas along the northern and western perimeter of the site that may experience periodic physical disturbance (e.g., occasional scouring and winnowing of fines by bottom currents). The dominance of Stage I at these stations is reflected in lower OSI values (see Table 2-30) that in turn indicate this "moderate" natural disturbance. Overall, the OSI values indicate that benthic habitat quality throughout the majority of Site 1 was non-disturbed, particularly in the deeper areas with soft, muddy sediments.

3.2 REMOTS® Characterization of Site 2

Figure 3-24 presents the numbering scheme used to identify the 54 stations occupied in and around candidate Site 2 during the November 2000 REMOTS® survey. With the exception of station O13, three replicate images were obtained and analyzed at each station for the purpose of preparing the tables and graphs presented below. At station O13, only two images were obtained and analyzed because rocks prevented penetration of the sediment-profile camera. Therefore, a total of 161 images were analyzed for the candidate Site 2 stations, and a complete set of the analysis results by image is provided in Appendix Table 2. As in the previous section, summary tables and maps based on station averages, and frequency distributions based on all the images, are used to present the Site 2 results below.

3.2.1 Sediment Grain Size and Benthic Habitat Classification

Silt-clay (>4 phi) was the dominant sediment grain size within Site 2, occurring at 39 of the 54 stations (72%; Table 3-2 and Figure 3-25). The frequency distribution indicates similar results, with 117 of the 161 images (73%) showing silt-clay sediments (Figure 3-26). Very fine sand (4 to 3 phi) was observed at 11 of the 54 stations (20%); these stations were located primarily in shallower water depths on the perimeter of the station grid (Figure 3-25).

Sediments with a higher sand content were found at stations L16, O13 and O16 (Table 3-2; Figure 3-25). Station L16 had a grain size major mode of 3 to 2 phi (fine sand), while the surface sediments at station O16 were comprised predominately of coarse sand (1 to 0 phi). The grain size major mode at station O13 was 0 to –1 phi (very coarse sand). All of these stations are located outside the boundaries of candidate Site 2 and appear to be associated with localized topographic high points (i.e., shallower depths), where winnowing of fines by bottom currents may occur.

The majority of the stations within the Site 2 survey area had a benthic habitat classification of unconsolidated soft bottom (basic habitat type UN), which consisted of silt-clay mixed with varying amounts of silt and sand (subhabitat types UN.SF, UN.SI and UN.SS; Table 3-2). As shown in the frequency distribution (Figure 3-27), the finest grained habitat types UN.SI and UN.SF were most common, followed by sediments with an apparent higher content of fine sand (habitat types SA.F and UN.SS; Figure 3-28).

There was a general correlation between water depth and habitat types, with the apparent amount of sand present in the sediment decreasing with increasing water depth. For example, the habitat type comprised of very fine sand (SA.F) was consistently associated with the shallowest depths of between 7 and 10 m, which occurred in the northern half of the site and along the western and southern edges (Figure 3-29). Habitat types UN.SS and UN.SI, consisting of silt-clay mixed with significant components of silt or very fine sand, were found primarily between depths of 10 to 13 m (Figure 3-29). The UN.SF habitat type, comprised of soft silt-clay, was observed at the stations within the topographic depression feature (>13 m depth) that dominate the southern half of Site 2. Figure 3-28 serves to illustrate the general trend of decreasing sand content and the associated subtle differences in habitat types moving from the shallower north end to the deeper southern end of Site 2.

Overall, the grain size and benthic habitat results indicate that Site 2 represents a varied environment with respect to the inferred seafloor energy regime. The significant sand component present within the sediments in the northern half of the site may be due to slightly higher near-bottom energy levels in this area, resulting in some winnowing of the finer-grained sediment fraction over the long-term (i.e., net long-term erosion of fines). The well-defined topographic depression in the southern half of the site appears to favor the accumulation of fine-grained sediment and is therefore classified as a depositional sedimentary environment.

3.2.2 Camera Prism Penetration Depth

The majority of the stations within the Site 2 boundaries had mean camera penetrations greater than 10 cm (Table 3-2; Figures 3-30 and 3-31). In general, the penetration depths correspond closely with the grain size and benthic habitat classification results (e.g., Figure 3-28). Stations in shallower water depths along the perimeter of the surveyed area had compact, very fine sand and the lowest penetration depths (Figure 3-30). Intermediate penetration depths of between 5 and 15 cm were observed primarily at stations in the northern half of Site 2, where sediments were consisted of silt-clay mixed with very fine sand (Figure 3-30). The deepest camera penetration was found at the stations within the topographic depression in the southern half of the site, where very soft, silt-clay sediments occurred (Figure 3-30).

3.2.3 Boundary Roughness

Almost all the mean boundary roughness values for the Site 2 survey area fell in the range 0 to 2 cm (Table 3-2; Figures 3-32 and 3-33). Similar to the results from Site 1, this indicates a general lack of significant small-scale surface relief within Site 2 due to either physical or biological process.

3.2.4 Infaunal Successional Stage

The majority of the Site 2 stations (31 of 54, or 57%) had at least one replicate image that showed the presence of a mature benthic community comprised of Stage III organisms (Table 3-2 and Figure 3-34). Stage III by itself was the highest successional stage observed at 7 of the 54 stations (13%), while Stage III in combination with Stage I (Stage I on III) was the highest successional stage observed at 24 of the 54 stations (44%).

Stage III, alone or in combination with Stage I, was most commonly observed at the stations in deeper water having unconsolidated, soft mud (Figure 3-34). Lower-order successional stages (i.e., Stage I, Stage I going to II, or Stage II) were observed at 21 of the 54 stations (40%), mainly those located in shallower water where more compact sand or sandy mud was prevalent (Figure 3-34). In the images classified as “Stage I going II” or “Stage II,” it was typically due to the presence of Stage II amphipod tubes (probably *Ampelisca* sp.) present at the sediment surface (Figure 3-35).

Similar to Site 1, the primary evidence of Stage III in the sediment-profile images from Site 2 was feeding voids observed at depth within the sediment (e.g., Figure 3-14). The images throughout Site 2 also showed numerous vertical and horizontal burrow openings within the sediment column, indicating the presence of motile burrowers (Figure 3-36). The distinct white tube ends of the polychaete *Chaetopterus* sp. also were observed at the sediment surface at stations J11, J14, J15, K11, K12, L10, M10, M12, N10, 012 (Figure 3-36).

The frequency distribution of infaunal successional stages confirms that Stage I, alone or in combination with Stage III, was widespread throughout Site 1 (Figure 3-37). This successional stage was observed in 139 of the 161 images (86%). Stage III, alone or in combination with Stage I, also was observed in a significant number of the images (70 of 161, or 43%) and at the majority of stations within Site 2. These results indicate that Stage I opportunists were ubiquitous and abundant throughout the site, while Stage III organisms were comparatively more sparsely distributed. Overall, the results are similar to those from Site 1 in showing that the benthic community at Site 2 appears to be comprised of a diverse mixture of surface-dwellers, subsurface deposit-feeders, and motile megafauna.

3.2.5 Apparent RPD Depth

The mean apparent RPD depth at 19 of the 54 stations (35%) was greater than 2 cm, while the majority of stations (35 of 54, or 65%) exhibited relatively shallow mean RPD depths of 2 cm or less (Table 3-2 and Figure 3-38). These results are echoed in the frequency distribution, which shows 94 of 161 replicate images (58%) having an RPD less than or equal to 2 cm, and 67 images (42%) having an RPD greater than 2 cm (Figure 3-39).

Apparent RPD depths less than 2 cm are generally considered shallow and may be indicative of sediments that are experiencing high levels of organic loading and/or are colonized by organisms having low levels of bioturbational activity (e.g., Stage I organisms). RPD depths less than 2 cm generally occurred at the sandier stations within the northern half of Site 2 and those on the outer perimeter, where lower-order successional stages were prevalent (Figure 3-38). Apparent RPD depths greater than 2.0 cm are generally indicative of normal or “healthy” oxygen penetration into the surface sediments. The deeper RPD depths at Site 2 were observed most consistently at the stations having soft, muddy sediments within the topographic depression in the southern half of the site (Figure 3-38). Most of these stations had a benthic community comprised of Stage III organisms. These organisms consume excess sediment organic matter and aerate the sediment column through bioturbation, resulting in the observed deeper RPD depths.

3.2.6 Organism-Sediment Index

The mean OSI values at all of the Site 2 stations fell in the range of either +3 to +6 (indicative of moderate disturbance) or +6 to +11 (indicating non-disturbed benthic habitat quality; Table 3-2 and Figure 3-40). The frequency distribution likewise confirms that the majority of images (128 of 161, or 80%) had OSI values greater than +3.0 (Figure 3-41). Most of the stations located in the topographic depression in the southern half of the site had OSI values greater than +6, reflecting the fact that sediments in this area were well-aerated and inhabited by a diverse benthic community consisting Stage I, II and III organisms. It is notable that benthic habitat quality at station L10 located in the center of the former BBDS was non-disturbed. In addition, stations in the area immediately surrounding the former BBDS, where historic dredged material deposits may occur (e.g., stations L15 and L16), had only moderately-disturbed benthic habitat quality comparable to that observed in the wider region (Figure 3-40). These results indicate that the seafloor in this area has fully recovered, as expected, from any negative impacts associated with past dredged material disposal.

The moderately disturbed conditions observed at the sandier stations in the northern half of the site and on the perimeter of the station grid were mainly due to the combination of shallow RPD depths in combination with lower-order successional stages (Figure 3-40). Similar to Site 1, it is possible that the seafloor in the shallower northern part of Site 2 experiences periodic natural physical disturbance (i.e., winnowing of fines by elevated bottom currents during storm events) that is being reflected in the lower OSI values. The frequency distribution (Figure 3-41) shows a number of individual replicate images (23 of 161, or 14%) had OSI values of +0.01 to +3.0 (indicating disturbed benthic habitat quality), which reflects a minor amount of small-scale (i.e., within-station) spatial variability in benthic habitat quality that is not reflected in the mapped station average results. However, the results as a whole indicate that benthic habitat quality across Site 2 was consistently high, falling in the range of either non-disturbed or only moderately disturbed as a result of natural, as opposed to anthropogenic, processes.

3.3 REMOTS® Characterization of Ref-2 and Ref-New

Reference area Ref-2 was located approximately 3500 m to the northwest of the center of Site 1, at a water depth of about 12 m (Figure 2-1). This is the same reference area used by SAIC in a baseline study of the former BBDS conducted in March 1990 (SAIC 1991), allowing historical comparisons to be made in the following sections. Reference area Ref-New was newly established roughly 2200 m to the south of the center of Site 1, at a water depth of about 14 m (Figure 2-1). Thus, water depths within the two reference areas were generally comparable to those within candidate Sites 1 and 2. Nine stations spaced 100 m apart in a cross-shaped pattern were sampled within each of the reference areas (Figure 3-42). Three replicate images were obtained and analyzed at each of the 9 stations in each reference area, for a total of 27 replicate images per area. A complete set of image analysis results is provided in Appendix Table 3. These results are summarized below.

3.3.1 Sediment Grain Size and Benthic Habitat Classification

The grain size major mode at all (100%) of the Ref-2 and Ref-New stations was >4 phi (Table 3-3; Figures 3-43 and 3-44). Consequently, the benthic habitat for all (100%) of the reference stations was classified as unconsolidated, very soft mud (habitat type UN.SF; Table 3-3 and Figures 3-45 and 3-46). A small number of replicate images obtained at Ref-2 were classified as UN.SI, due to the presence of a minor silt/fine sand component mixed with the silt-clay (Figure 3-47).

In 1990, the Ref-2 stations were given the grain size classification ">4 to 3," which indicates that the sediments were largely silt-clay (>4 phi) with a minor component of very fine sand (4 to 3 phi) present (Table 3-4). In the November 2000 survey, the minor component of very fine sand was also present but was not as distinct in the sediment-profile images, resulting in the sediment grain size being classified as >4 phi only (Table 3-4). In general, >4 phi and >4 to 3 phi are considered to be extremely similar grain sizes within the limits of REMOTS® image interpretation, and these results indicate that the basic sediment type has not changed significantly at the Ref-2 area over the 10 year period.

3.3.2 Camera Prism Penetration Depth

The mean camera penetration at 17 of the 18 reference area stations (94%) was greater than 15 cm (Table 3-3; Figure 3-48). In Ref-2, station 200N had a mean camera penetration depth between 10 and 15 cm (Figure 3-48). Only one replicate image in Ref-2 had a mean camera penetration less than 10.01 cm deep, a few replicate images in both areas had penetration depths between 10 and 15 cm (Figure 3-49). Overall, the penetrations depths in both reference areas were relatively deep, attributed to the soft muddy sediments (>4 phi; silt-clay) that characterized both areas (e.g., Figure 3-46).

3.3.3 Boundary Roughness

With exception of Ref-New station 200E, all reference area stations had average boundary roughness values below 2 cm (Table 3-3; Figure 3-50). Ref-New station 200E had a slightly higher mean boundary roughness of 2.2 cm. A small number of replicate images (3) had boundary roughness values between 2.01 and 3.0 cm (Figure 3-51). Overall, these results indicate the sediment surface in both reference was relatively flat, with little small-scale topographic relief.

3.3.4 Infaunal Successional Stage

Stage III, alone or in combination with Stages I or II, was present in at least one image at all of the reference area stations (Table 3-3; Figure 3-52). The majority of the reference area stations (12 of 18, or 67%) had Stage I on III as the highest successional stage (e.g., Figure 3-46), five of the 18 stations (28%) were classified as Stage III only, and one station (Ref-2 station 100E) was classified as Stage II on III due the presence of Stage II tubicolous amphipods at the sediment surface. Only five replicate images obtained in the reference areas showed evidence of Stage I only (Figure 3-53).

Similar to the candidate disposal sites, the images from many stations in both reference areas showed numerous vertical and horizontal burrow openings present within the sediment column, as well as *Chaetopterus* sp. tubes at the sediment surface (e.g., Figure 3-46, left image). Overall, these results indicate that both reference areas were characterized by relatively diverse and abundant benthic communities that appear to be comparable to those at the two candidate disposal sites.

Stage I on III or Stage III was found at all of the Ref-2 stations in both the 1990 and 2000 REMOTS® surveys (Table 3-4). These results suggest there has been little change in biological conditions at this reference area over the 10-year period.

3.3.5 Apparent RPD Depth

With the exception of station 200N, all the Ref-2 stations had mean apparent RPD depths greater than 2 cm, indicating healthy or normal sediment aeration (Table 3-3; Figure 3-54). In contrast, the majority of the Ref-New stations had relatively shallow RPD depths of less than 2 cm (Figure 3-54). These results are reflected in the frequency distributions, which show a greater number of images from Ref-New having shallower RPD depths compared to Ref-2 (Figure 3-55). Ref-New is located south of Site 1, within the same broad topographic depression, while Ref-2 is located in a shallower area having a relatively flat bottom. Based on the silt-clay sediments observed within Site 1 and Ref-New, the topographic depression appears to be a focusing site for fines and associated organic matter. Accumulation of excess organic matter in the sediment creates oxygen demand that can result in the shallower RPD depths observed at Ref-New compared to Ref-2.

Although the RPD depths measured at Ref-2 in November 2000 are considered indicative of healthy sediment aeration, they were consistently shallower than those observed in March 1990 (Table 3-4). These results may simply reflect the difference in the timing of the two surveys, as the depth of the RPD within the sedimentary profile can vary seasonally in estuarine sediments as a function of a variety of factors, including overlying water dissolved oxygen, diffusive flux, temperature, infaunal mixing, advective flux, and the biological and chemical oxygen demand associated with organic matter degradation (Diaz and Rosenberg 1995; Solan et al. 1999).

On the other hand, the results are also consistent with a general, longer-term trend of increasing nutrient and organic inputs (i.e., eutrophication) in northeastern U.S. estuaries like Buzzards Bay (Nixon 1995; Roman et al. 2000; Bricker et al. 1999). Howes and Goehringer (1996) note that over the past 100 years, nutrient and organic discharges to Buzzards Bay waters have led to increased organic delivery to sediments in some areas, resulting in a general scheme of alterations in both benthic communities and sediment oxidation (e.g., decreasing RPD depths). It is difficult to ascertain the degree to which such alterations may be affecting the seafloor in the deeper, central area of Buzzards Bay, where candidate Sites 1 and 2 and the reference areas are located. Compared to other estuaries in the northeast U.S., Buzzards Bay is currently classified as having a low overall human influence, low nitrogen input, and low eutrophic conditions (Bricker et al. 1999). Because the central portion of the Bay has a large volume of water and high flushing rates relative to nitrogen inputs, it is not as affected by nutrient over-enrichment as small embayments (Buzzards Bay Project 1990). With respect to the central Bay, Howes and Goehringer (1996) observe that the challenge for ecologists and managers is to distinguish alterations driven by natural or physical forces from those driven by nutrients and organic matter.

3.3.6 Organism-Sediment Index

The majority of the reference area stations (16 of 18, or 89%) had mean OSI values greater than +6, indicative of non-disturbed benthic habitat quality (Table 3-3; Figure 3-56). Ref-2 station 200N and Ref-New station 200S had slightly lower mean OSI values in the range +3 to +6, indicating only moderately disturbed conditions. The frequency distribution shows that a few replicate images in both areas had OSI values indicative of disturbed conditions, but most of the values were greater than +6 (Figure 3-57). These results again mainly reflect patchiness in the RPD depths, which in turn are attributed to normal spatial variability in the existing inventory and continuing inputs of organic matter to the bottom. Overall, benthic habitat quality at the two reference areas appears to be undisturbed and largely comparable to that at the two candidate disposal sites. Both reference areas have well-established, diverse and abundant benthic communities that are acting to aerate the surface sediments and maintain reasonable well-developed RPD depths.

The average OSI values calculated at the Ref-2 stations in the November 2000 survey were lower than those from March 1990 (Table 3-4). This change is due to the shallower apparent RPD depths observed in 2000, and, as previously indicated, these were attributed either to normal seasonal fluctuation or an overall trend of increasing system eutrophication. The change in the RPD depth was particularly pronounced at station 200N, and this is reflected in the significant change in OSI values, from +11 in 1990 (non-disturbed) to +5 in 2000 (moderately disturbed). At the other stations, the November 2000 OSI values, while lower than in 1990, are still indicative of overall non-disturbed benthic habitat quality.

4.0 SUMMARY

The primary objective of the November 2000 REMOTS® survey was to characterize the existing physical and biological seafloor conditions in and around candidate disposal Sites 1 and 2. The results are summarized as follows:

Physical conditions:

1) Sediments in the shallower depths (>12 m) along the outer perimeter of Site 1 consisted of muddy fine sand or sandy mud, while the majority of stations in the deeper water (> 12 m) within the site boundary had very soft mud (Figure 4-1). This resulted in the main habitat type within Site 1 being classified as UN.SF (unconsolidated very soft mud). Site 1 is situated over a broad topographic depression that appears to favor the long-term accumulation of fine-grained sediment. Based on the REMOTS® survey results, Site 1 is classified as a depositional sedimentary environment.

2) Similar to Site 1, there was a general correlation between water depth and grain size/habitat type at Site 2. Very fine sand and sandy mud were found in the shallower northern half of the site (depths between 7 and 13 m), while very soft, uniform mud was found within the topographic depression (>13 m) comprising the southern half of the site (Figure 4-1). Habitat types consisting of unconsolidated mud mixed with silt and fine sand (UN.SS and UN.SI) were found in the northern half of the site, while unconsolidated very soft mud occurred in the deeper southern half. Site 2 appears to represent a varied environment with respect to bottom energy regimes. The shallower northern half of the site appears to have the potential for higher bottom energy and net long-term loss of finer-grained sediment fractions, while the deeper southern half appears to favor the long-term net accumulation of fine-grained sediments and is classified as depositional.

3) Any new dredged material disposal site in Buzzards Bay would presumably be designated as a containment site, in which the goal is to minimize spreading and loss of deposited material to surrounding areas. Depositional seafloor areas which favor the long-term accumulation of fine-grained sediment represent better potential containment sites for dredged material than higher-energy, more dispersive (i.e., erosional) seafloor environments. Most of candidate Site 1 is located in a broad topographic depression that appears to be a depositional seafloor environment where soft, fine-grained sediment has accumulated over time. Likewise, the deeper southern half of candidate Site 2 appears to be depositional, while the shallower northern half of this site does not appear to favor the long-term accumulation of fine-grained sediment. If the goal is to maximize the *containment* characteristics of any new dredged material disposal site in Buzzards Bay, then the deeper parts of Sites 1 and 2 are the most appropriate seafloor locations.

Biological conditions:

4) Populations of both surface-dwelling, opportunistic polychaetes (Stage I) and deeper-dwelling, subsurface deposit-feeding benthic taxa were widespread across Sites 1 and 2. Numerous burrow openings also were observed throughout the sediment column at many

stations in both sites, evidence of the widespread presence of motile burrowers such as lobster, crab and shrimp. The distal ends of the U-shaped tubes created by the polychaete *Chaetopterus* sp. also were observed commonly in the sediment-profile images from both sites. Overall, the REMOTS® results indicate that both candidate disposal sites are characterized by relatively abundant and diverse benthic communities.

5) Apparent RPD depths across both sites were highly variable, attributed to temporal and spatial patchiness in sediment organic loading rates typical of estuarine environments like Buzzards Bay that have experienced increased eutrophication in recent decades.

6) The REMOTS® Organism-Sediment Index (OSI) values indicated that benthic habitat quality in and around Sites 1 and 2 was primarily non-disturbed, reflecting healthy sediment aeration and the presence of a diverse and abundant benthic community comprised of Stage I, II and III organisms. Some stations within each site indicated moderately disturbed benthic habitat quality, attributed primarily to natural physical disturbance by bottom currents in the shallower, sandier areas of each site.

A second objective of the November 2000 REMOTS® survey was to compare conditions at the two reference areas to those existing at the candidate disposal sites.

7) The Ref-New and Ref-2 reference areas are located at depths similar to those existing within the candidate disposal sites. Both reference areas were characterized primarily by unconsolidated soft muddy sediments (habitat type UN.SF), although the Ref-2 site had some images showing a minor component of silt/very fine sand mixed with the mud (habitat type UN.SI). In terms of both sediment grain size and benthic habitat types, the conditions at the reference areas were very similar to those existing at the majority of stations within Sites 1 and 2.

8) Both reference areas had an apparent abundant benthic community comprised of a diverse mixture of surface-dwelling Stage I taxa and subsurface deposit-feeding Stage III organisms. Similar to the candidate disposal sites, both reference areas also showed evidence of extensive burrowing by larger invertebrates. Apparent RPD depths at Ref-2 were well developed, while those at Ref-New were somewhat shallower and more patchy, similar to conditions observed at the candidate disposal sites. Benthic habitat quality at both reference areas was non-disturbed, comparable to conditions at the candidate disposal sites.

9) Broadly speaking, reference areas used in environmental monitoring studies to detect potential effects at nearby "impact" areas should have similar conditions to the impact areas, prior to the impact. The November 2000 REMOTS® survey indicates that the two selected reference areas appear to be very similar to the two candidate disposal sites in terms of both physical and biological seafloor characteristics. Therefore, it is concluded that these two reference areas are suitable for use in any future monitoring studies designed to detect the impacts of dredged material disposal at either of the two candidate disposal sites.

A final objective of the REMOTS® survey was to compare conditions at reference area Ref-2 to those found in 1990, to detect of any long-term trends in seafloor conditions in this general region of Buzzards Bay.

10) Physical and biological seafloor conditions at Ref-2 in November 2000 were largely similar to those previously detected in March 1990. The main difference between the two REMOTS® surveys was in the apparent RPD depths, which were consistently shallower in November 2000. These results were attributed either to the seasonal difference between the two surveys or to a longer-term trend of increasing nutrient inputs to Buzzards Bay (i.e., eutrophication), resulting in system-wide increases in organic loading to the bottom and concomitant decreases in RPD depths. As a result of the shallower RPD depths in the 2000 survey, the mean OSI values were also lower compared to 1990. However, the OSI values in both years indicated non-disturbed benthic habitat quality at the Ref-2 reference area.

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Tables

Table 2-1

Grain Size Scales for Sediments

ASTM (Unified) Classification[1]	U.S. Std. Sieve[2]	Size in mm	Phi (Φ) Size	Wentworth Classification[3]
Boulder		4096.	-12.0	
		1024.	-10.0	Boulder
	12 in (300 mm)	256.	-8.0	
		128.	-7.0	Large Cobble
Cobble		107.64	-6.75	
		90.51	-6.5	Small Cobble
	3 in (75mm)	76.11	-6.25	
		64.00	-6.0	
		53.82	-5.75	
		45.26	-5.5	
		38.05	-5.25	Very Large Pebble
Coarse Gravel		32.00	-5.0	
		26.91	-4.75	
		22.63	-4.5	
	3/4 in (19 mm)	19.03	-4.25	Large Pebble
		16.00	-4.0	
		13.45	-3.75	
		11.31	-3.5	
		9.51	-3.25	Medium Pebble
Fine Gravel	2.5	8.00	-3.0	
	3	6.73	-2.75	
	3.5	5.66	-2.5	
	4 (4.75 mm)	4.76	-2.25	Small Pebble
	5	4.00	-2.0	
	6	3.36	-1.75	
Coarse Sand	7	2.83	-1.5	
	8	2.38	-1.25	
	10 (2.0 mm)	2.00	-1.0	Granule
	12	1.68	-0.75	
	14	1.41	-0.5	
	16	1.19	-0.25	
	18	1.00	0.0	Very Coarse Sand
	20	0.84	0.25	
Medium Sand	25	0.71	0.5	
	30	0.59	0.75	
	35	0.50	1.0	Coarse Sand
	40 (0.425 mm)	0.420	1.25	
	45	0.354	1.5	
	50	0.297	1.75	
	60	0.250	2.0	Medium Sand
	70	0.210	2.25	
	80	0.177	2.5	
	100	0.149	2.75	
Fine Sand	120	0.125	3.0	
	140	0.105	3.25	Fine Sand
	170	0.088	3.5	
	200 (0.075 mm)	0.074	3.75	
	230	0.0625	4.0	
	270	0.0526	4.25	Very Fine Sand
	325	0.0442	4.5	
Fine-grained Soil:	400	0.0372	4.75	
		0.0312	5.0	
Clay if PI ³ 4 and plot of PI vs. LL		0.0156	6.0	Coarse Silt
is on or above "A" line*		0.0078	7.0	
Silt if PI < 4 and plot of PI vs.		0.0039	8.0	
LL is below "A" line*		0.00195	9.0	Medium Silt
		0.00098	10.0	
		0.00049	11.0	Fine Silt
* and the presence of organic matter		0.00024	12.0	Very Fine Silt
does not influence LL.		0.00012	13.0	Coarse Clay
		0.000061	14.0	Medium Clay
				Fine Clay

1. ASTM Standard D 2487-92. This is the ASTM version of the Unified Soil Classification System. Both systems are similar (from ASTM (1993)).
2. Note that British Standard, French, and German DIN mesh sizes and classifications are different.
3. Wentworth sizes (in inches) cited in Krumbein and Sloss (1963).

Table 2-2.

Benthic habitat categories assigned to sediment-profile images obtained in this study (from Diaz 1995; SAIC 1997).

Habitat AM: *Ampelisca* Mat Uniformly fine-grained (i.e., silty) sediments having well-formed amphipod (*Ampelisca* spp.) tube mats at the sediment-water interface.
Habitat SH: Shell Bed A layer of dead shells and shell fragments at the sediment surface overlying sediment ranging from hard sand to silts. Epifauna (e.g., bryozoans, tube-building polychaetes) commonly found attached to or living among the shells. Two distinct shell bed habitats: **SH.SI: Shell Bed over silty sediment** - shell layer overlying sediments ranging from fine sands to silts to silt-clay. **SH.SA: Shell Bed over sandy sediment** - shell layer overlying sediments ranging from fine to coarse sand.
Habitat SA: Hard Sand Bottom Homogeneous hard sandy sediments, do not appear to be bioturbated, bedforms common, successional stage mostly indeterminate because of low prism penetration. **SA.F: Fine sand** - uniform fine sand sediments (grain size: 4 to 3 phi). **SA.M: Medium sand** - uniform medium sand sediments (grain size: 3 to 2 phi). **SA.G: Medium sand with gravel** - predominately medium to coarse sand with a minor gravel fraction.
Habitat HR: Hard Rock/Gravel Bottom Hard bottom consisting of pebbles, cobbles and/or boulders, resulting in no or minimal penetration of the REMOTS® camera prism. Some images showed pebbles overlying silty-sediments. The hard rock surfaces typically were covered with epifauna (e.g., bryozoans, sponges, tunicates).
Habitat UN: Unconsolidated Soft Bottom Fine-grained sediments ranging from very fine sand to silt-clay, with a complete range of successional stages (I, II and III). Biogenic features were common (e.g., amphipod and polychaete tubes at the sediment surface, small surface pits and mounds, large borrow openings, and feeding voids at depth). Several sub-categories: **UN.SS: Fine Sand/Silty** - very fine sand mixed with silt (grain size range from 4 to 2 phi), with little or no shell hash. **UN.SI: Silty** - homogeneous soft silty sediments (grain size range from >4 to 3 phi), with little or no shell hash. Generally deep prism penetration. **UN.SF: Very Soft Mud** - very soft muddy sediments (>4 phi) of high apparent water content, methane gas bubbles present in some images, deep prism penetration.

Table 2-3.

Calculation of the REMOTS® Organism Sediment Index.

A. CHOOSE ONE VALUE:

Mean RPD Depth	Index Value
0.00 cm	0
>0 - 0.75 cm	1
0.75 - 1.50 cm	2
1.51 - 2.25 cm	3
2.26 - 3.00 cm	4
3.01 - 3.75 cm	5
>3.75 cm	6

B. CHOOSE ONE VALUE:

Successional Stage	Index Value
Azoic	-4
Stage I	1
Stage I on II	2
Stage II	3
Stage II on III	4
Stage III	5
Stage I on III	5
Stage II on III	5

C. CHOOSE ONE OR BOTH IF APPROPRIATE:

Chemical Parameters	Index Value
Methane Present	-2
No/Low Dissolved Oxygen**	-4

REMOTS® ORGANISM-SEDIMENT INDEX = Total of above subset indices (A+B+C)

RANGE: -10 to +11

Note: This is not based on a Winkler or polarigraphic electrode measurement. It is based on the imaged evidence of reduced, low reflectance (i.e., high oxygen demand) sediment at the sediment-water interface.

Table 3-1
Summary of REMOTS® results for the stations in and around candidate site 1.

STATION	GRAIN SIZE MAJOR MODE (phi)	MEAN CAMERA PENETRATION (cm)	MEAN BOUNDARY ROUGHNESS (cm)	SUCCESSIONAL STAGES PRESENT (# of replicates)	MEAN APPARENT RPD THICKNESS (cm)	BENTHIC HABITAT (# of replicates)	MEAN OSI
A1	>4	13.1	1.0	ST_I_ON_III (2), ST_I (1)	2.4	UN.SI (3)	7.3
A2	>4	8.1	1.2	ST_I (3)	1.8	UN.SS (3)	4.0
A3	>4	14.1	1.5	ST_I_ON_III (2), ST_I (1)	3.5	UN.SI (3)	8.3
A4	>4	8.6	1.7	ST_I (3)	1.4	UN.SS (3)	3.0
A5	>4	11.4	0.8	ST_I (2), ST_I_ON_III (1)	2.8	UN.SS (3)	6.7
A6	>4	7.6	1.8	INDET (1), ST_I_ON_III (1), ST_I (1)	1.8	UN.SS (2), SA.F (1)	7.5
A7	4 to 3	8.0	1.1	ST_I_ON_III (2), ST_I (1)	2.4	SA.F (3)	7.3
A8	>4	6.9	0.6	ST_I (3)	1.7	UN.SS (3)	3.7
A9	>4	11.1	0.9	ST_I_ON_III (3)	1.7	UN.SI (3)	7.7
B1	4 to 3	3.6	1.0	ST_I (3)	1.1	SA.F (3)	4.0
B2	4 to 3	7.9	0.9	ST_I (3)	1.9	SA.F (3)	4.0
B3	>4	9.0	1.0	ST_I (2), ST_I_ON_III (1)	2.1	UN.SS (3)	5.7
B4	>4	11.2	1.1	ST_I (2), ST_I_TO_II (1)	2.9	UN.SI (3)	5.7
B5	4 to 3	5.6	0.8	ST_I (3)	1.6	SA.F (3)	4.0
B6	4 to 3	7.6	1.2	ST_I (3)	1.5	SA.F (3)	3.3
B7	>4	10.2	1.3	ST_I (3)	1.8	UN.SS (3)	4.0
B8	>4	16.4	0.8	ST_I_ON_III (2), ST_I (1)	2.5	UN.SI (3)	7.7
B9	>4	9.9	2.2	ST_III (1), ST_I_ON_III (1), ST_I (1)	2.4	UN.SS (3)	7.3
C1	>4	9.5	1.1	ST_III (1), ST_I_ON_III (1), ST_I (1)	2.4	UN.SS (3)	7.3
C2	>4	12.4	1.0	ST_I_ON_III (2), ST_III (1)	2.1	UN.SI (3)	8.7
C3	>4	16.9	1.1	ST_I_ON_III (3)	3.5	UN.SF (2), UN.SI (1)	9.7
C4	>4	18.8	2.2	ST_I_ON_III (2), ST_III (1)	2.4	UN.SF (3)	9.0
C5	>4	19.6	0.9	ST_I_ON_III (2), ST_III (1)	2.4	UN.SF (3)	8.7
C6	>4	18.4	2.6	ST_III (1), ST_I_ON_III (1), ST_I (1)	1.0	UN.SF (3)	5.5
C7	>4	19.7	1.4	ST_I_ON_III (2), ST_I (1)	3.0	UN.SF (3)	8.0
C8	4 to 3	6.1	0.6	ST_I (3)	2.3	SA.F (3)	4.7
C9	4 to 3	5.9	1.2	ST_I (3)	1.4	SA.F (3)	3.3

Table 3-1 (continued)

STATION	GRAIN SIZE MAJOR MODE (phi)	MEAN CAMERA PENETRATION (cm)	MEAN BOUNDARY ROUGHNESS (cm)	SUCCESSIONAL STAGES PRESENT (# of replicates)	MEAN APPARENT RPD THICKNESS (cm)	BENTHIC HABITAT (# of replicates)	MEAN OSI
D1	>4	9.1	1.1	ST_I (2), ST_I_ON_III (1)	2.3	UN.SI (2), UN.SS (1)	6.0
D2	>4	12.4	1.6	ST_III (1), ST_I_ON_III (1), ST_I (1)	1.6	UN.SI (3)	6.0
D3	>4	14.9	1.0	ST_I_ON_III (2), ST_I (1)	2.2	UN.SI (3)	7.0
D4	>4	16.7	0.7	ST_III (1), ST_I_ON_III (1), ST_I_TO_II (1)	3.0	UN.SF (3)	8.7
D5	>4	20.4	0.7	ST_I_ON_III (2), ST_I (1)	2.9	UN.SF (3)	7.7
D6	>4	16.6	1.8	ST_I_ON_III (3)	3.9	UN.SF (3)	10.7
D7	>4	19.0	0.7	ST_I_ON_III (2), ST_I (1)	3.0	UN.SF (3)	8.0
D8	>4	12.1	0.5	ST_I_ON_III (2), ST_I (1)	0.9	UN.SF (3)	5.5
D9	>4	19.1	1.0	ST_III (1), ST_I_ON_III (1), ST_I (1)	2.8	UN.SF (3)	7.7
E1	4 to 3	2.6	1.4	ST_I (2), ST_I_ON_III (1)	0.8	SA.F (3)	3.0
E2	4 to 3	5.9	0.7	ST_I (2), ST_I_ON_III (1)	2.4	SA.F (3)	6.3
E3	>4	15.6	0.7	ST_I_ON_III (2), ST_I (1)	2.1	UN.SF (3)	7.0
E4	>4	18.1	1.9	ST_I_ON_III (2), ST_III (1)	2.4	UN.SF (3)	8.7
E5	>4	16.2	1.9	ST_I_ON_III (2), ST_I (1)	1.8	UN.SF (3)	6.7
E6	>4	18.7	1.5	ST_III (1), ST_I_ON_III (1), ST_I (1)	4.2	UN.SF (3)	9.3
E7	>4	19.2	1.0	ST_I_ON_III (2), ST_I (1)	3.0	UN.SF (3)	9.0
E8	>4	18.1	1.7	ST_I_ON_III (3)	2.0	UN.SF (3)	8.0
E9	>4	17.3	1.6	ST_I_ON_III (2), ST_III (1)	3.2	UN.SF (3)	9.3
F1	4 to 3	6.3	1.4	ST_I (3)	1.9	SA.F (2), UN.SI (1)	3.7
F2	>4	14.8	0.9	ST_III (1), ST_II_ON_III (1), ST_I (1)	2.4	UN.SI (2), UN.SF (1)	7.3
F3	>4	12.5	1.6	ST_I_ON_III (2), ST_III (1)	2.4	UN.SI (2), UN.SF (1)	8.7
F4	>4	18.4	1.1	ST_I_ON_III (2), ST_I (1)	2.5	UN.SF (3)	7.7
F5	>4	17.6	1.4	ST_I (2), ST_III (1)	3.8	UN.SF (3)	7.0
F6	>4	18.9	1.2	ST_III (2), ST_I_ON_III (1)	1.9	UN.SF (3)	8.0
F7	>4	17.4	1.4	ST_I_ON_III (3)	3.3	UN.SF (3)	9.7
F8	>4	19.5	0.9	ST_I_ON_III (2), ST_I (1)	1.2	UN.SF (3)	8.0
F9	>4	16.5	1.0	ST_III (2), ST_I_ON_III (1)	1.7	UN.SF (3)	9.0

Table 3-1 (continued)

STATION	GRAIN SIZE MAJOR MODE (phi)	MEAN CAMERA PENETRATION (cm)	MEAN BOUNDARY ROUGHNESS (cm)	SUCCESSIONAL STAGES PRESENT (# of replicates)	MEAN APPARENT RPD THICKNESS (cm)	BENTHIC HABITAT (# of replicates)	MEAN OSI
G1	>4	11.0	2.0	ST_I_ON_III (2), ST_I (1)	2.8	UN.SI (2), UN.SF (1)	7.7
G2	>4	12.1	1.8	ST_III (1), ST_I_ON_III (1), ST_I (1)	2.4	UN.SF (2), UN.SS (1)	7.3
G3	>4	15.8	0.6	ST_I_ON_III (3)	2.5	UN.SF (3)	9.0
G4	>4	15.7	0.9	ST_I (1)	3.4	UN.SF (1)	6.0
G5	>4	17.4	1.1	ST_I_ON_III (2), ST_III (1)	4.5	UN.SF (3)	10.7
G6	>4	16.8	1.0	ST_I_ON_III (2), ST_I (1)	3.2	UN.SF (3)	8.7
G7	>4	17.2	2.4	ST_I_ON_III (2), ST_III (1)	2.2	UN.SF (3)	8.3
G8	>4	18.3	2.4	ST_I (2), ST_I_ON_III (1)	1.3	UN.SF (3)	4.0
G9	>4	19.8	0.8	ST_III (2), ST_I_ON_III (1)	1.7	UN.SF (3)	7.7
H1	>4	11.9	0.7	ST_I (3)	1.8	UN.SI (3)	4.0
H2	4 to 3	3.7	0.6	ST_I (3)	0.9	SA.F (3)	3.5
H3	>4	16.0	0.8	ST_I_ON_III (2), ST_I (1)	3.8	UN.SF (2), UN.SI (1)	9.0
H4	>4	18.4	0.8	ST_I_ON_III (3)	4.6	UN.SF (3)	10.3
H5	>4	13.7	0.9	ST_I_ON_III (2), ST_I (1)	3.0	UN.SI (2), UN.SF (1)	8.0
H6	>4	15.5	1.0	ST_I_ON_III (3)	1.9	UN.SI (3)	8.3
H7	>4	18.5	0.6	ST_III (1), ST_I_ON_III (1), ST_I (1)	2.1	UN.SF (3)	7.0
H8	>4	15.5	1.1	ST_III (2), ST_I_ON_III (1)	2.2	UN.SI (3)	8.3
H9	>4	17.0	1.2	ST_III (1), ST_I_ON_III (1), ST_I (1)	1.8	UN.SF (3)	6.3
I1	4 to 3	1.8	0.8	INDET (2), ST_I (1)	0.8	HR (2), SA.M (1)	52.0
I2	4 to 3	4.5	1.0	ST_I (3)	2.0	SA.F (3)	4.3
I3	4 to 3	6.7	0.5	ST_I (3)	1.8	SA.F (2), UN.SS (1)	3.7
I4	>4	17.8	1.2	ST_III (2), ST_I_ON_III (1)	2.3	UN.SF (3)	8.7
I5	>4	6.8	0.8	ST_I (3)	1.8	UN.SS (2), SA.F (1)	3.7
I6	>4	10.7	1.0	ST_I (3)	1.9	UN.SI (3)	4.0
I7	>4	15.9	1.1	ST_I (3)	2.9	UN.SI (3)	5.0
I8	>4	16.0	0.9	ST_I_ON_III (3)	3.1	UN.SI (3)	9.3
I9	>4	13.8	1.2	ST_I (2), ST_III (1)	1.7	UN.SI (3)	5.3

Table 3-2
Summary of REMOTS® results for the stations in and around candidate site 2.

STATION	GRAIN SIZE MAJOR MODE (phi)	MEAN CAMERA PENETRATION (cm)	MEAN BOUNDARY ROUGHNESS (cm)	SUCCESSIONAL STAGES PRESENT (# of replicates)	MEAN APPARENT RPD THICKNESS (cm)	BENTHIC HABITAT (# of replicates)
J10	>4	13.1	2.1	ST_I_ON_III (2), ST_I (1)	1.6	UN.SI (3)
J11	>4	9.8	1.2	ST_I_ON_III (2), ST_I_TO_II (1)	1.5	UN.SI (3)
J12	>4	16.6	1.0	ST_I (3)	2.1	UN.SF (3)
J13	>4	6.4	0.9	ST_I (2), ST_I_ON_III (1)	1.5	UN.SI (2), UN.SS (1)
J14	>4	17.0	0.7	ST_I_ON_III (3)	2.2	UN.SF (3)
J15	>4	18.0	1.1	ST_I_ON_III (2), ST_III (1)	2.3	UN.SF (3)
J16	>4	17.4	1.2	ST_I_ON_III (2), ST_III (1)	2.8	UN.SI (3)
J17	>4	18.4	1.2	ST_I_ON_III (3)	3.3	UN.SI (3)
J18	4 to 3	3.4	1.0	ST_I (2), INDET (1)	1.3	SA.F (3)
K10	>4	10.0	1.3	ST_I (2), ST_I_ON_III (1)	2.0	UN.SI (2), SA.F (1)
K11	>4	8.5	1.5	ST_III (1), ST_I_ON_III (1), ST_I (1)	2.4	UN.SS (3)
K12	>4	5.6	1.3	ST_I (2), ST_I_TO_II (1)	1.9	UN.SS (3)
K13	>4	7.0	0.9	ST_I (3)	1.7	UN.SS (2), UN.SI (1)
K14	>4	12.9	1.2	ST_I_ON_III (2), ST_I (1)	1.6	UN.SF (3)
K15	>4	16.8	0.9	ST_I (2), ST_I_ON_III (1)	2.4	UN.SF (3)
K16	>4	11.2	1.6	ST_I_ON_III (3)	1.6	UN.SS (3)
K17	>4	13.4	0.9	ST_I_ON_III (2), ST_I (1)	2.1	UN.SI (3)
K18	4 to 3	2.9	1.2	ST_I (3)	1.3	SA.F (3)
L10	>4	9.7	0.6	ST_I_ON_III (3)	1.7	UN.SS (3)
L11	>4	9.0	1.1	ST_I (3)	1.8	UN.SS (2), SA.F(1)
L12	4 to 3	5.6	0.8	ST_I (3)	1.9	SA.F (3)
L13	4 to 3	5.9	1.1	ST_I (3)	2.0	SA.F (3)
L14	>4	8.8	0.6	ST_I (3)	1.9	UN.SS (2), SA.F (1)
L15	4 to 3	3.9	1.1	ST_I (2), INDET (1)	1.8	SA.F (2), SA.M (1)
L16	3 to 2	2.6	1.1	ST_I (3)	2.3	SA.F (3)
L17	>4	11.3	0.7	ST_I_ON_III (2), ST_I (1)	2.3	UN.SI (3)
L18	>4	6.5	0.7	ST_I (2), ST_I_TO_II (1)	1.6	UN.SI (2), SA.F (1)

Table 3-2 (continued)

STATION	GRAIN SIZE MAJOR MODE (phi)	MEAN CAMERA PENETRATION (cm)	MEAN BOUNDARY ROUGHNESS (cm)	SUCCESSIONAL STAGES PRESENT (# of replicates)	MEAN APPARENT RPD THICKNESS (cm)	BENTHIC HABITAT (# of replicates)
M10	>4	10.3	1.0	ST_I_ON_III (2), ST_I (1)	1.5	UN.SI (3)
M11	>4	9.2	0.7	ST_I (3)	1.4	UN.SI (3)
M12	>4	13.3	0.8	ST_III (1), ST_I_ON_III (1), ST_I(1)	1.7	UN.SI (3)
M13	>4	14.2	1.1	ST_I_ON_III (2), ST_I (1)	1.8	UN.SI (2), UN.SF (1)
M14	>4	16.2	0.7	ST_I_ON_III (3)	2.6	UN.SF (3)
M15	>4	17.0	1.3	ST_I_ON_III (2), ST_I (1)	1.8	UN.SF (3)
M16	>4	16.2	1.0	ST_III (1), ST_I_ON_III (1), ST_I (1)	2.3	UN.SF (3)
M17	>4	18.1	1.1	ST_I_ON_III (3)	2.0	UN.SF (3)
M18	4 to 3	4.3	0.9	ST_I (3)	1.6	SA.F (3)
N10	>4	17.7	1.2	ST_I_ON_III (3)	3.0	UN.SF (3)
N11	4 to 3	5.5	1.1	ST_I (3)	1.4	SA.F (3)
N12	4 to 3	4.6	1.1	ST_I (3)	1.3	SA.F (3)
N13	4 to 3	6.6	2.3	ST_I (3)	2.2	SA.F (3)
N14	>4	18.9	1.3	ST_I_ON_III (3)	2.8	UN.SF (3)
N15	>4	18.5	1.3	ST_I_ON_III (3)	2.2	UN.SF (3)
N16	>4	9.4	1.2	ST_I_ON_III (2), ST_I (1)	1.6	UN.SI (3)
N17	>4	5.2	0.7	ST_I_ON_III (1), ST_I (1), INDET (1)	1.3	UN.SI (2), HR (1)
N18	4 to 3	3.7	0.5	ST_I (2), ST_I_TO_II (1)	1.6	SA.F (3)
O10	>4	8.4	0.4	ST_II (2), ST_I (1)	1.2	UN.SI (3)
O11	>4	8.7	1.2	ST_I_ON_III (2), ST_I (1)	1.0	UN.SI (3)
O12	4 to 3	4.9	0.9	ST_III (1), ST_II (1), ST_I (1)	1.4	SA.F (3)
O13	0 to -1	0.1	0.0	INDET (2)	0.0	HR (2)
O14	>4	17.7	0.9	ST_I_ON_III (3)	2.5	UN.SF (3)
O15	>4	17.8	1.2	ST_I_ON_III (2), ST_III (1)	2.3	UN.SF (3)
O16	1 to 0	0.1	0.0	INDET (3)	0.0	HR (3)
O17	4 to 3	4.8	0.6	ST_I (3)	1.8	SA.F (3)
O18	>4	15.0	0.9	ST_I (3)	3.0	UN.SF (3)

Table 3-3
Summary of REMOTS® results for the stations at the Ref-2 and Ref-New reference areas.

STATION	GRAIN SIZE MAJOR MODE (phi)	MEAN CAMERA PENETRATION (cm)	MEAN BOUNDARY ROUGHNESS (cm)	SUCCESSIONAL STAGES PRESENT (# of replicates)	MEAN APPARENT RPD THICKNESS (cm)	BENTHIC HABITAT (# of replicates)	MEAN OSI
Ref 2							
R2100E	>4	18.1	0.9	ST_II_ON_III (2), ST_I_ON_III (1)	3.5	UN.SF (3)	10.3
R2100N	>4	17.9	0.8	ST_III (2), ST_I_ON_III (1)	2.5	UN.SF (3)	9.0
R2100S	>4	18.3	1.5	ST_I_ON_III (2), ST_III (1)	2.9	UN.SF (3)	9.3
R2100W	>4	17.9	0.7	ST_I_ON_III (3)	3.3	UN.SF (3)	9.3
R2200E	>4	17.4	0.6	ST_I_ON_III (3)	3.4	UN.SF (3)	10.0
R2200N	>4	11.7	0.9	ST_III (1), ST_I_ON_III (1), ST_I (1)	0.9	UN.SI (3)	5.3
R2200S	>4	17.3	0.6	ST_I_ON_III (3)	3.3	UN.SF (3)	10.0
R2200W	>4	17.0	1.7	ST_I_ON_III (2), ST_I (1)	2.9	UN.SF (3)	8.0
R2CTR	>4	19.2	1.0	ST_I_ON_III (1), ST_I_TO_II (1), ST_I (1)	3.2	UN.SF (3)	7.0
Ref New							
RN100E	>4	15.4	0.9	ST_I_ON_III (3)	1.8	UN.SF (3)	8.0
RN100N	>4	16.8	0.8	ST_I_ON_III (3)	1.8	UN.SF (3)	8.0
RN100S	>4	16.8	1.0	ST_I_ON_III (3)	2.5	UN.SF (3)	9.0
RN100W	>4	18.7	1.0	ST_I_ON_III (3)	1.9	UN.SF (3)	8.0
RN200E	>4	16.5	2.2	ST_I_ON_III (3)	2.3	UN.SF (3)	8.7
RN200N	>4	19.3	1.0	ST_I_ON_III (2), ST_III (1)	1.6	UN.SF (3)	7.7
RN200S	>4	15.4	1.1	ST_I (2), ST_I_ON_III (1)	1.4	UN.SF (3)	4.7
RN200W	>4	17.7	0.8	ST_I_ON_III (3)	2.8	UN.SF (3)	9.0
RNCTR	>4	18.3	1.1	ST_I_ON_III (2), ST_III (1)	0.3	UN.SF (3)	9.0

Table 3-4
Comparison between 1990 and 2000 REMOTS® results at the Ref-2 reference area.

Station	Grain Size		Successional Stage		RPD		OSI	
	1990	2000	1990	2000	1990	2000	1990	2000
CTR	>4 to 3	>4	ST III and/or I on III	ST I on III	5.8	3.2	11	7
100S	>4 to 3	>4	ST III and/or I on III	ST I on III	4.5	2.9	11	9
200S	>4 to 3	>4	ST III and/or I on III	ST I on III	5.3	3.3	11	10
100N	>4	>4	ST III and/or I on III	ST III	5.6	2.5	11	9
200N	NA	>4	ST III and/or I on III	ST III	6.2	0.9	11	5
100E	>4 to 3	>4	ST III and/or I on III	ST II on III	3.2	3.5	11	10
200E	>4 to 3	>4	ST III and/or I on III	ST I on III	5.6	3.4	11	10
100W	>4	>4	ST III and/or I on III	ST I on III	4.5	3.3	11	8
200W	>4 to 3	>4	ST III and/or I on III	ST I on III	4.7	2.9	11	9

Figures

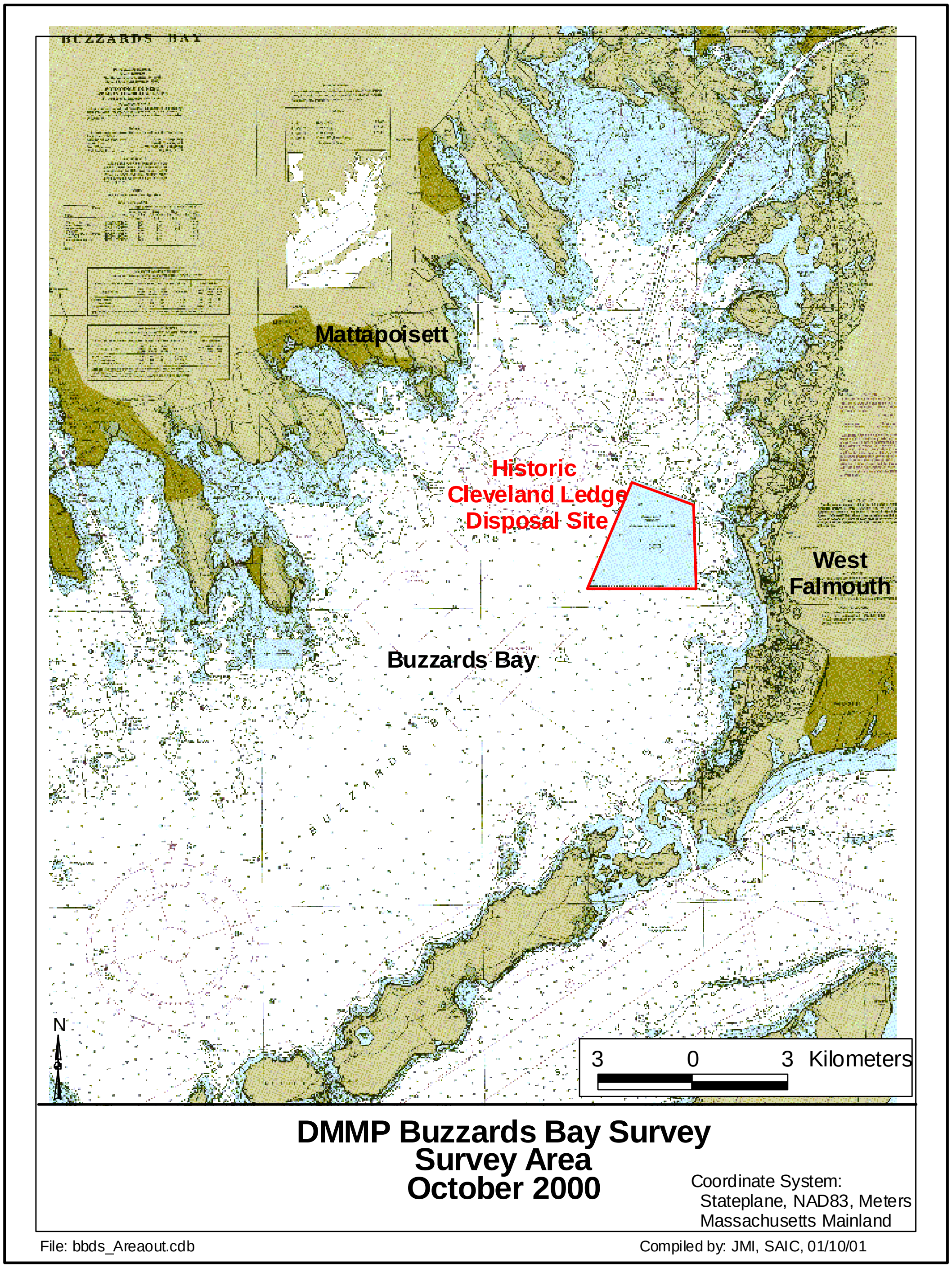


Figure 1-1. General location map showing the boundary of the historic Cleveland Ledge Disposal Site on the eastern side of Buzzards Bay, off of West Falmouth (from NOAA Nautical Chart 13229).

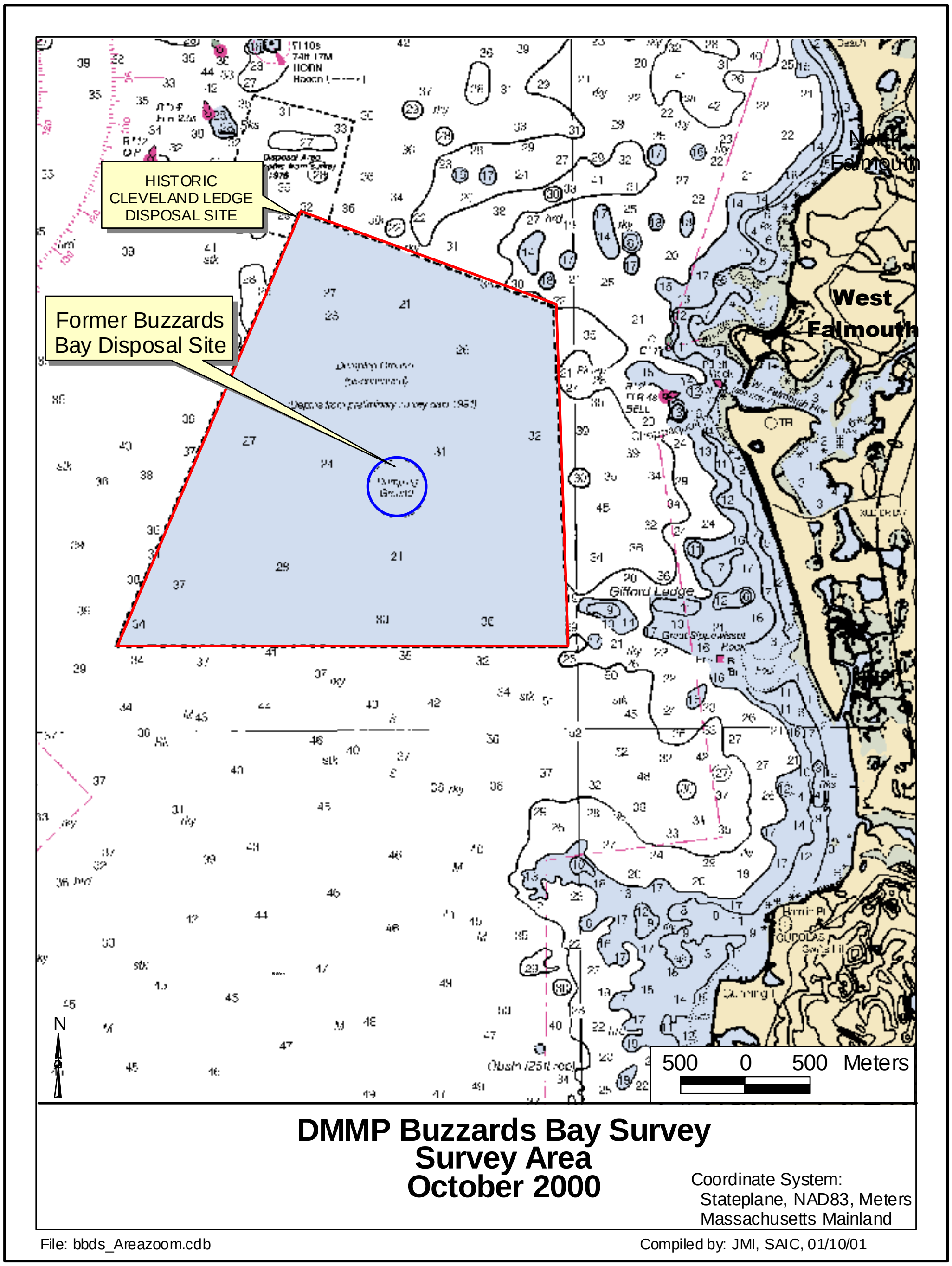


Figure 1-2. Map of the historic Cleveland Ledge Disposal Site showing the location of the former Buzzards Bay Disposal Site (BBDS). In 1995, Massachusetts DEM proposed the designation of a new BBDS in the same location.

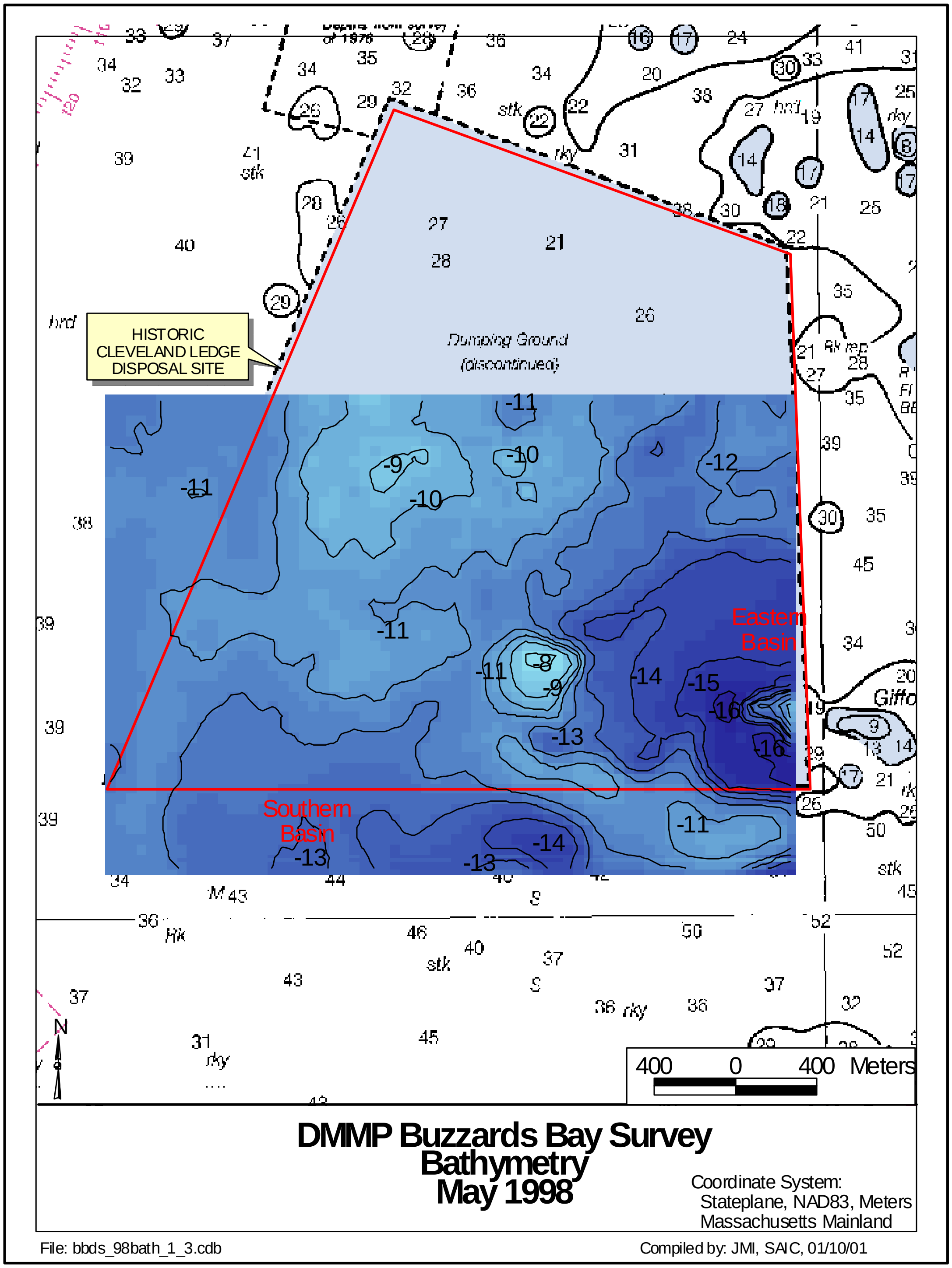


Figure 1-3. Results of the high-resolution bathymetric survey conducted across the southern half of the Cleveland Ledge Disposal Site in May 1998, superimposed on NOAA Nautical Chart 13229. Depths from the bathymetric survey are in meters; nautical chart depth soundings are in feet.

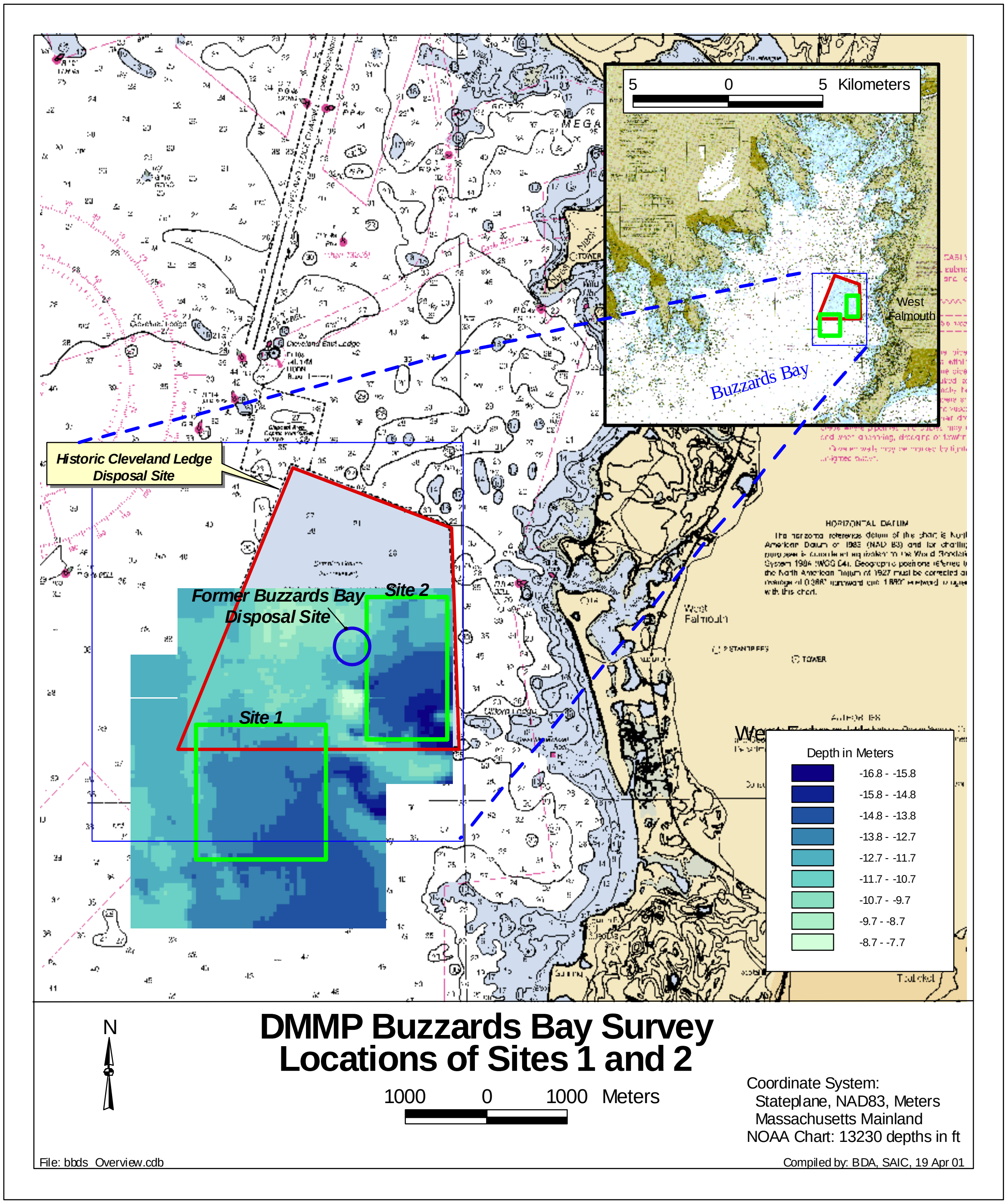


Figure 1-4. Map showing the general location of candidate disposal Sites 1 and 2 within Buzzards Bay and in relation to the historic Cleveland Ledge Disposal Site. Depth contours (in meters) underlying Sites 1 and 2 are from SAIC surveys conducted in May 1998 and October 2000.

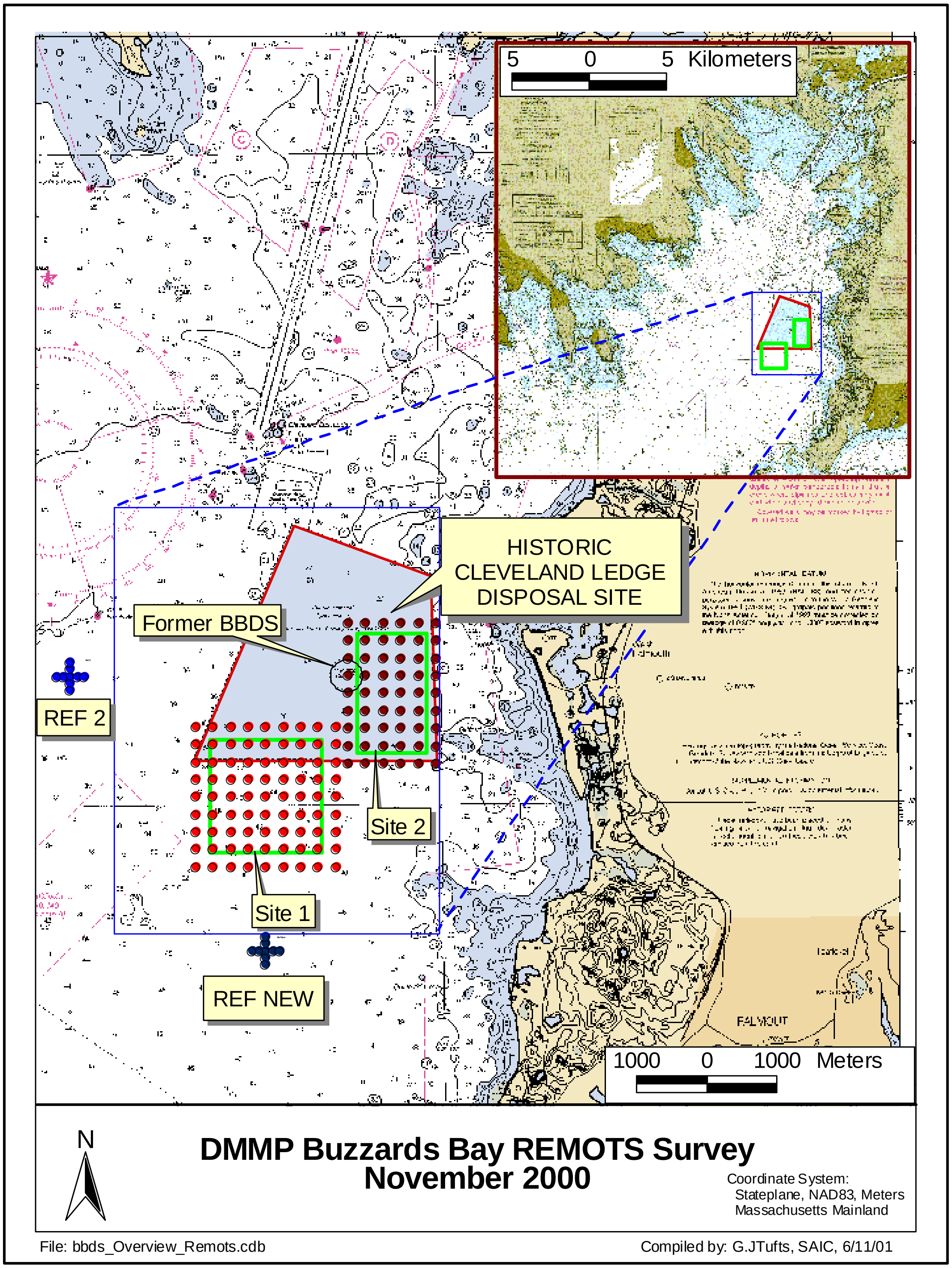


Figure 2-1. General location map showing station grids employed at candidate Sites 1 and 2 and the two reference areas.

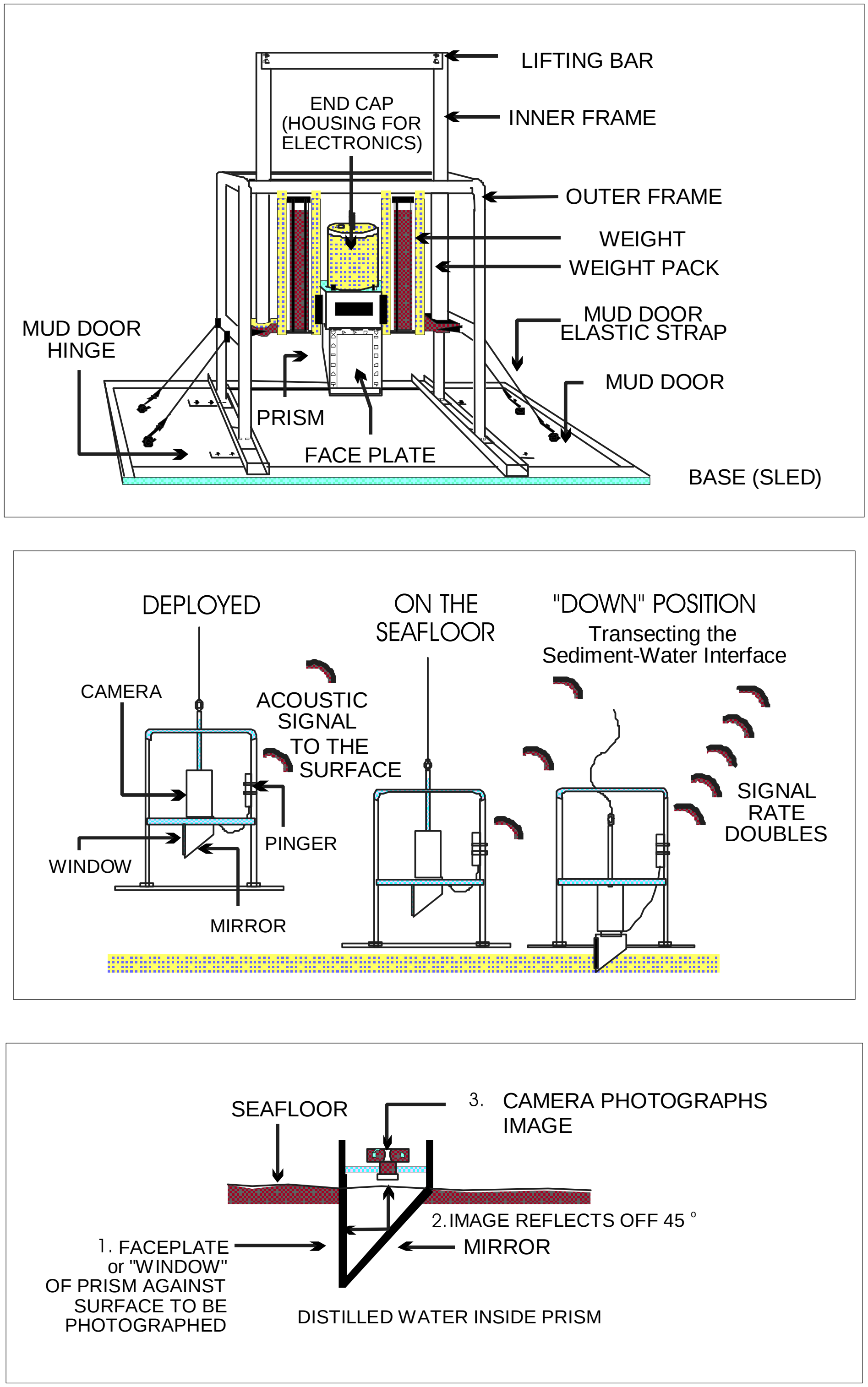


Figure 2-2. Schematic diagram of Benthos, Inc. Model 3731 sediment-profile camera and sequence of operation on deployment.

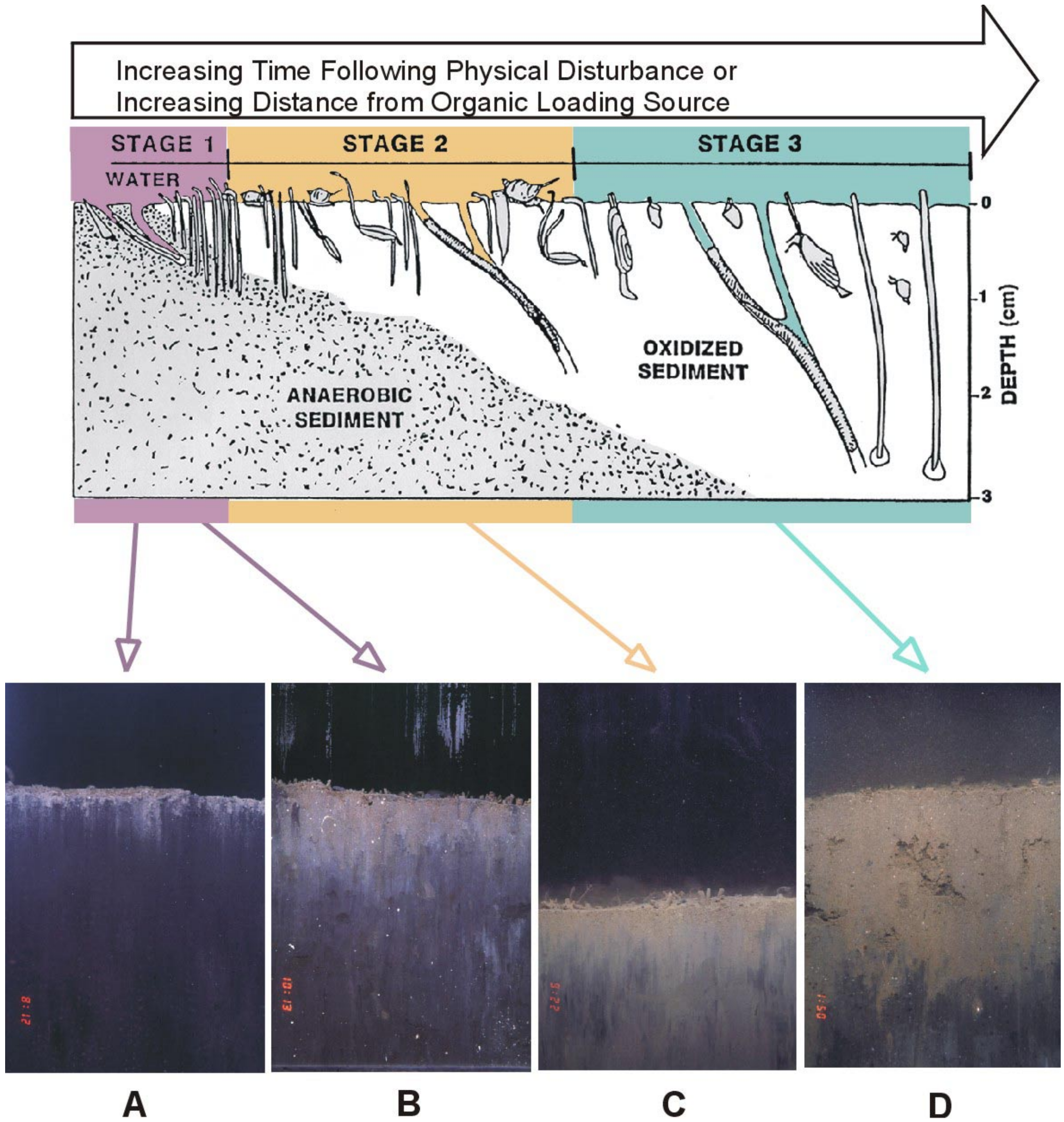


Figure 2-3. The drawing at the top illustrates the development of infaunal successional stages over time following a physical disturbance or with distance from an organic loading source (from Rhoads and Germano 1986). The REMOTS® images below the drawing provide examples of the different successional stages. Image A shows highly reduced sediment with a very shallow redox layer (contrast between light colored surface sediments and dark underlying sediments) and little evidence of infauna. Numerous small polychaete tubes are visible at the sediment surface in image B (Stage I), and the redox depth is deeper than in image A. A mixture of polychaete and amphipod tubes occurs at the sediment surface in image C (Stage II). Image D shows numerous burrow openings and feeding pockets (voids) at depth within the sediment; these are evidence of deposit-feeding, Stage III infauna. Note the RPD is relatively deep in this image, as bioturbation by the Stage III organisms has resulted in increased sediment aeration.

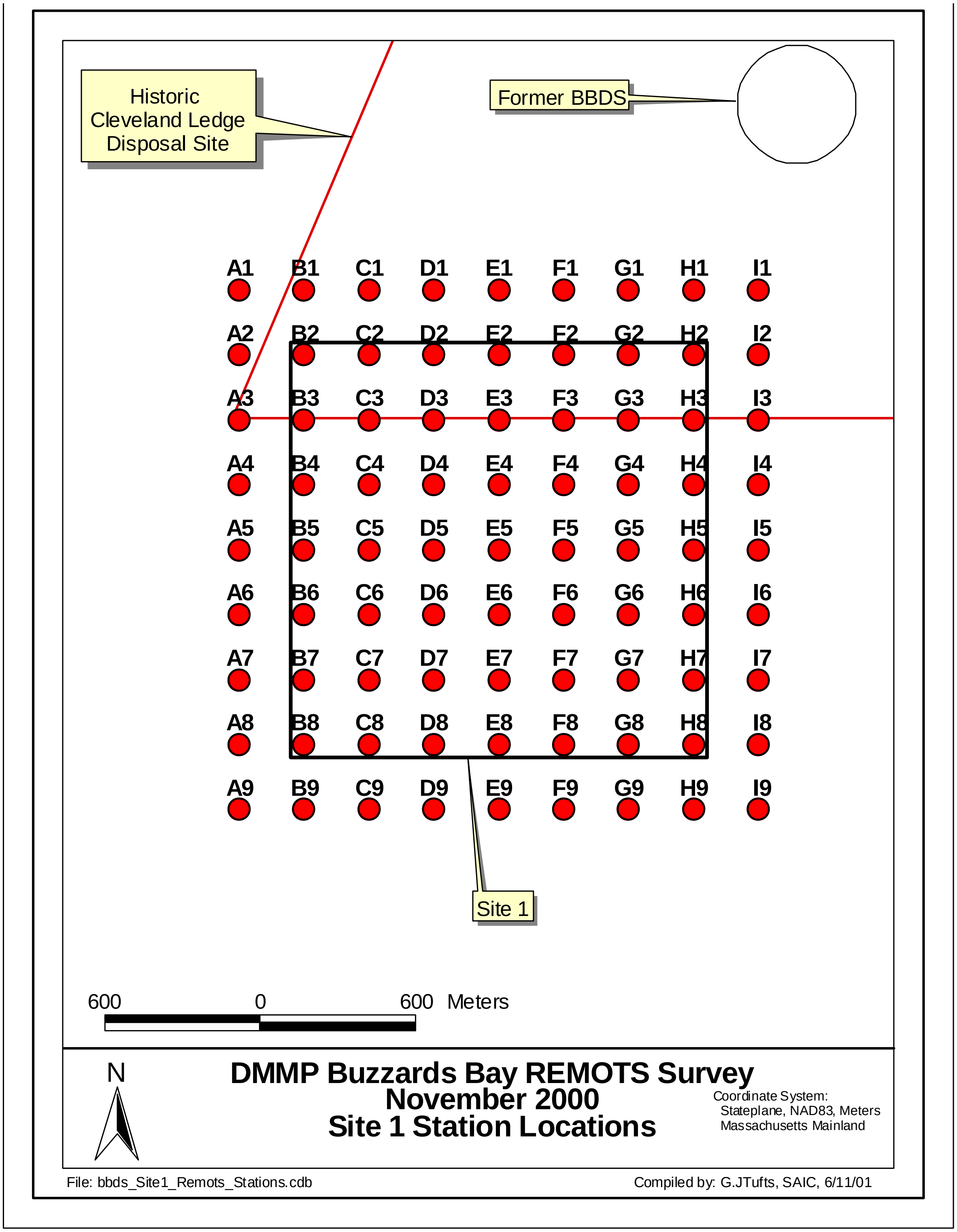


Figure 3-1. REMOTS® sampling stations in and around candidate disposal Site 1.

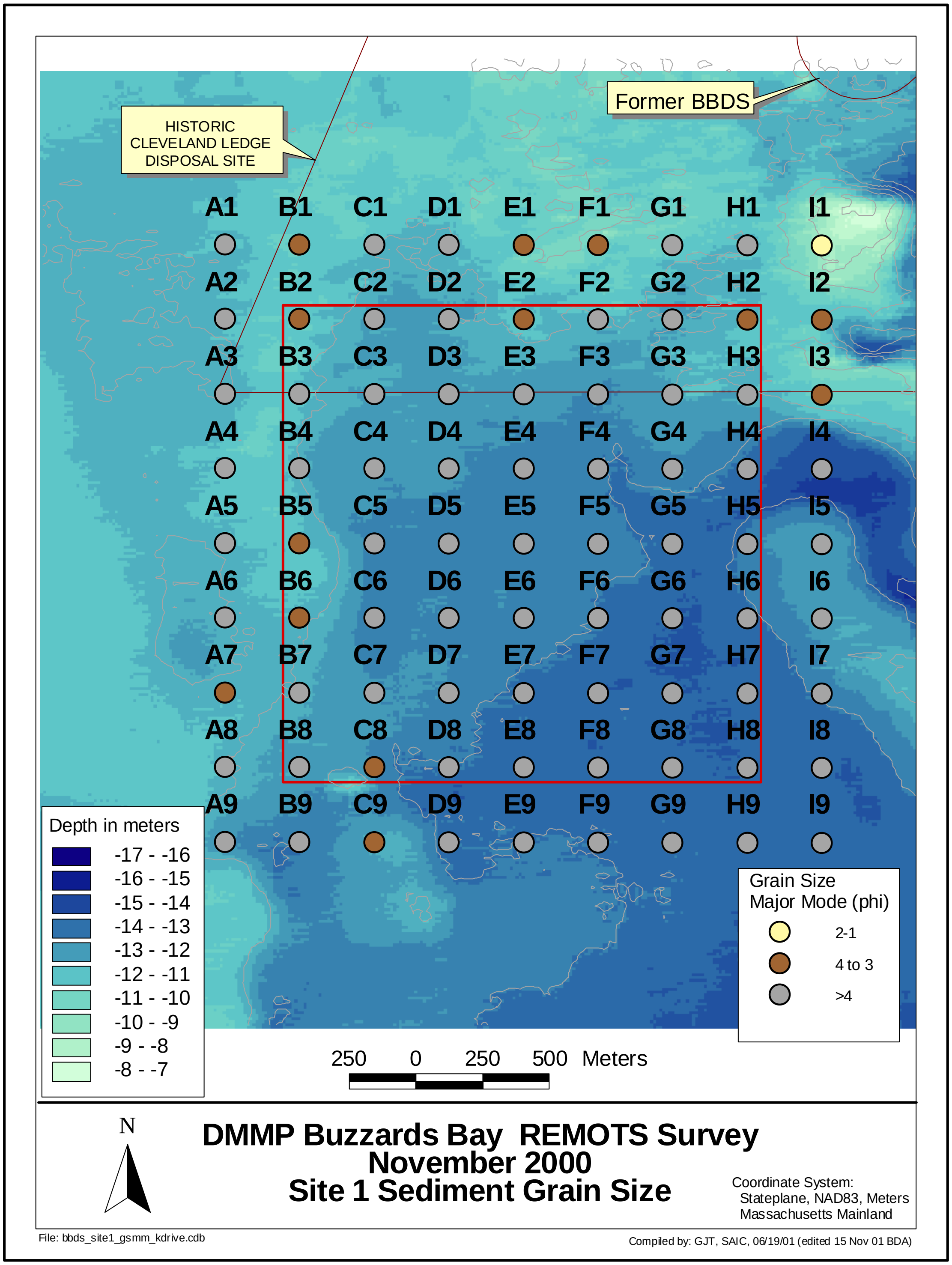


Figure 3-2. Map of grain size major mode at the Site 1 sampling stations. Bathymetric contours are from an SAIC survey conducted in October 2000.

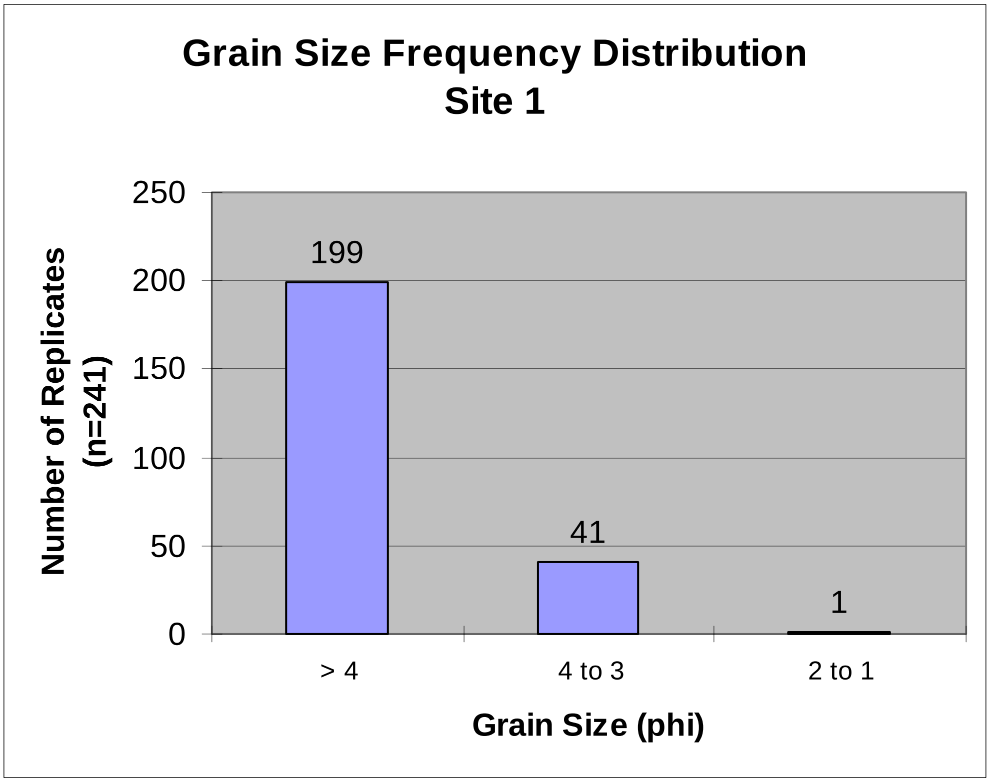
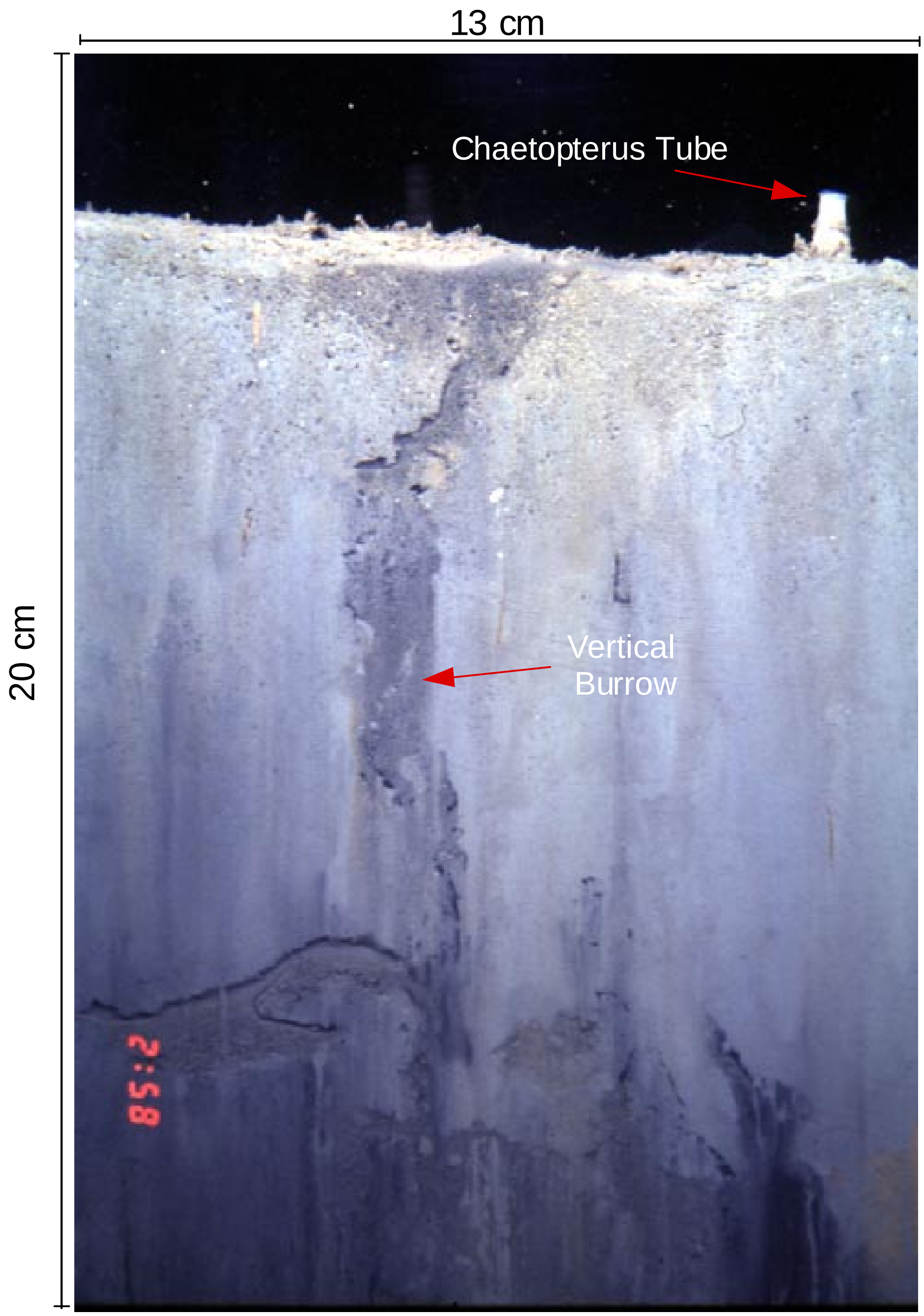
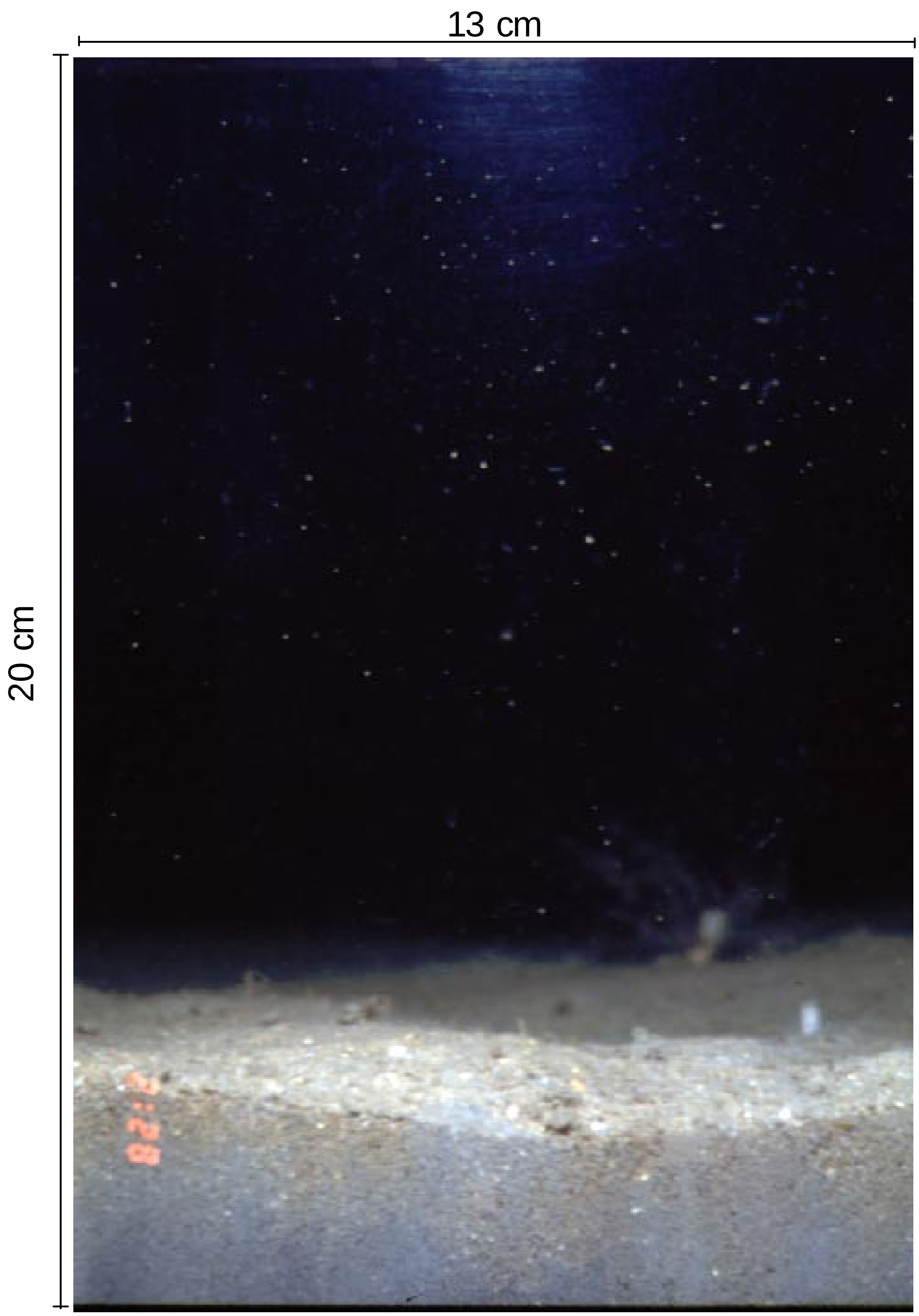


Figure 3-3. Frequency distribution showing the number of replicate images having a particular grain size major mode.



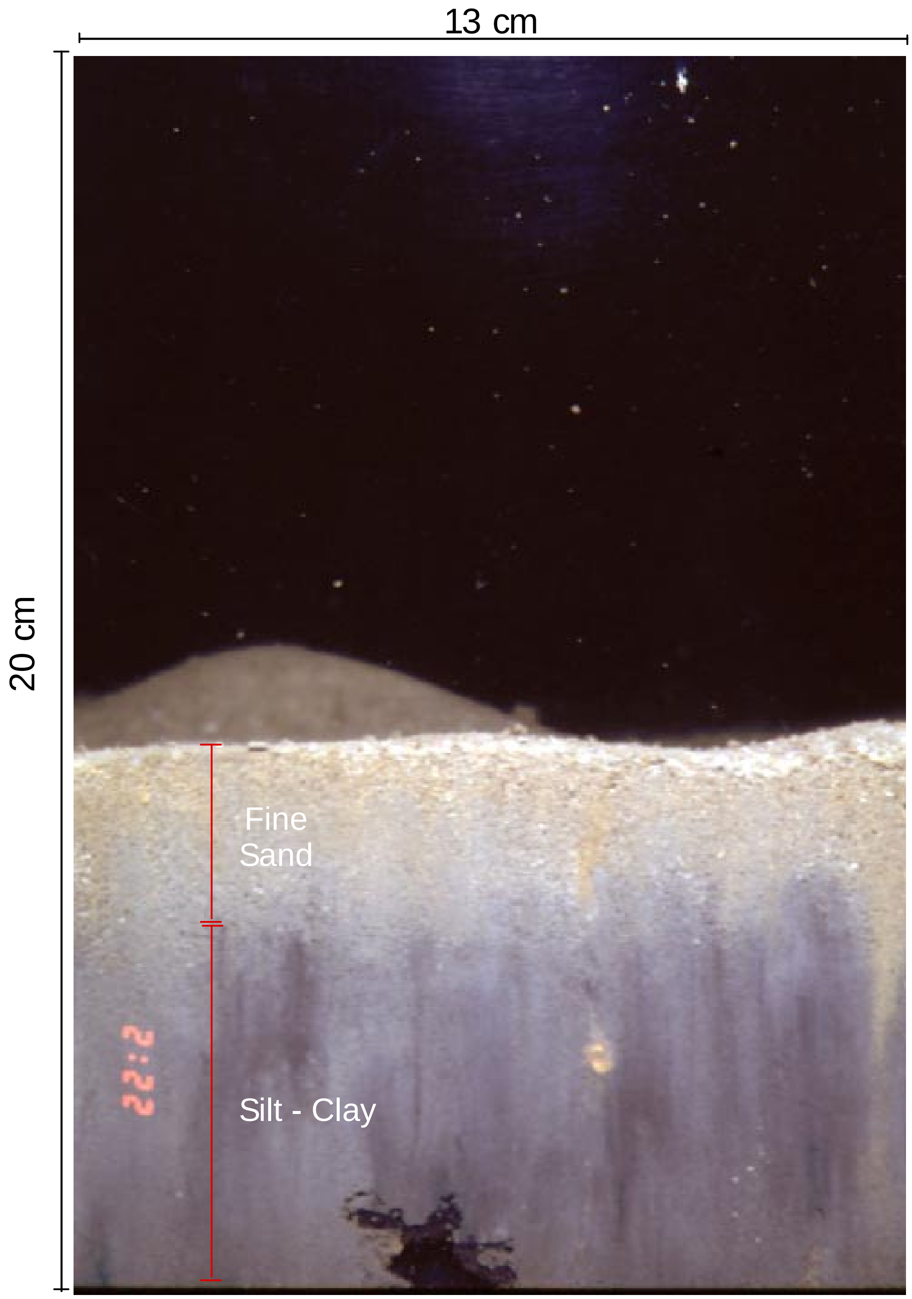
File: Remots_Fig3_4

Figure 3-4. REMOTS® image from station F7 illustrating the fine-grained surface sediment (>4 phi) which was found throughout the deeper part of candidate Site 1. The penetration of the REMOTS® camera prism is relatively deep in this image (18 cm), reflecting the unconsolidated, soft nature of this silt-clay sediment. This is an example of the UN.SF benthic habitat type. A vertical burrow structure and a surface tube of the polychaete *Chaetopterus* sp. also are visible in this image.



File: Remots_Fig3_5

Figure 3-5. REMOTS® image from station B1 illustrating very fine sand (4 to 3 phi) found in the shallower areas in and around candidate Site 1. The relatively shallow penetration of the REMOTS® camera prism (4 cm) suggests that the sand is relatively compact. This is an example of the SA.F benthic habitat type.



File: Remots_Fig3_6

Figure 3-6. REMOTS® image from station C1 illustrating predominantly silt-clay sediment (>4 phi) which appears to have a significant component of very fine sand present near the sediment surface (e.g., sand over mud stratigraphy). This stratigraphy could be the result of bottom currents carrying away (winnowing) the finer grained sediment fractions (i.e., silts and clay) from the near surface sediments, leaving behind the fine sand. This is an example of unconsolidated soft bottom comprised on silt-clay with a significant fine sand component (habitat type UN.SS).

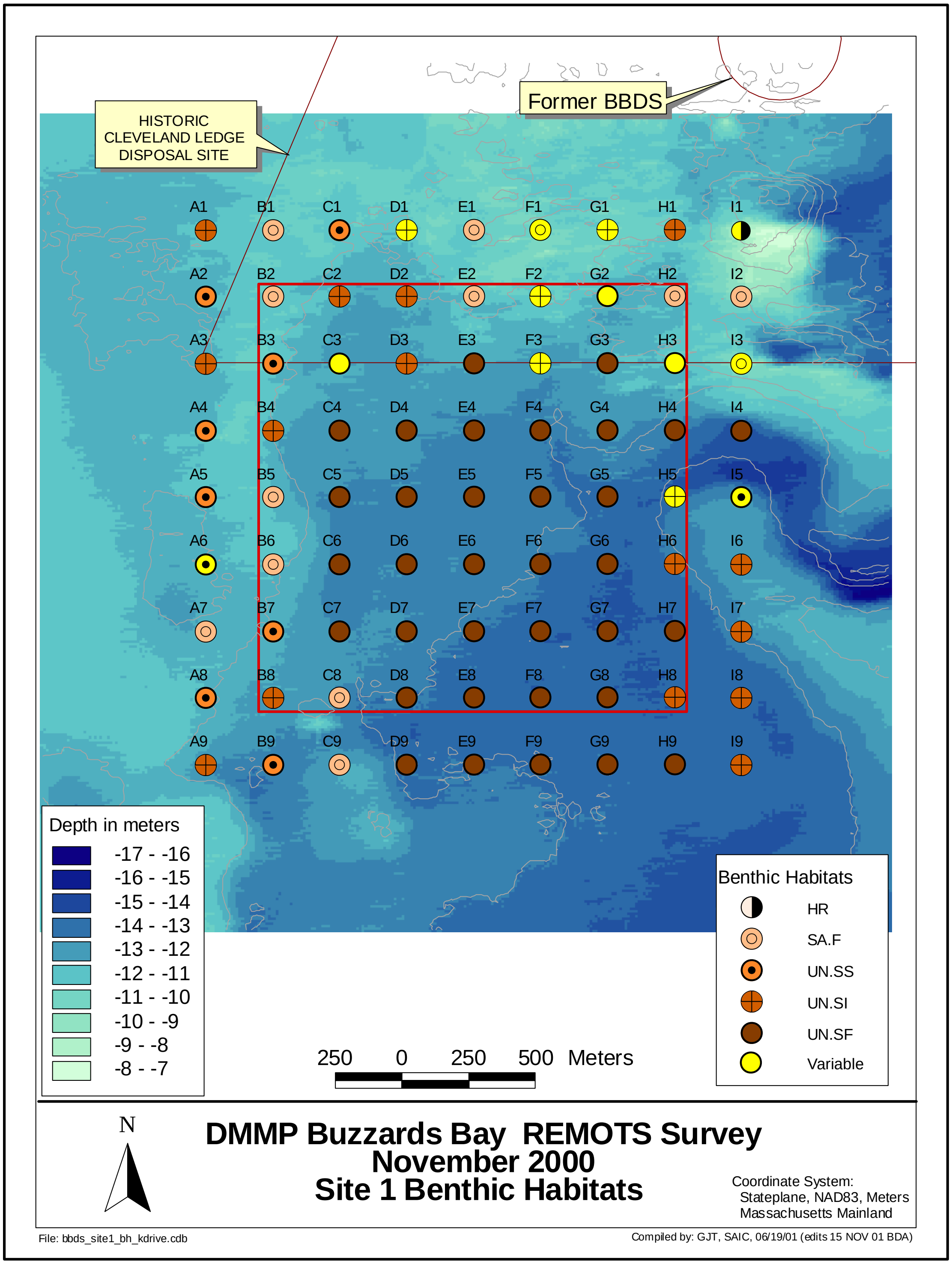


Figure 3-7. Map of benthic habitat types at the Site 1 sampling stations. Stations having more than one habitat type present are shown at "variable," with the most common or predominant habitat type at such stations depicted on the map (see Table 3-1).

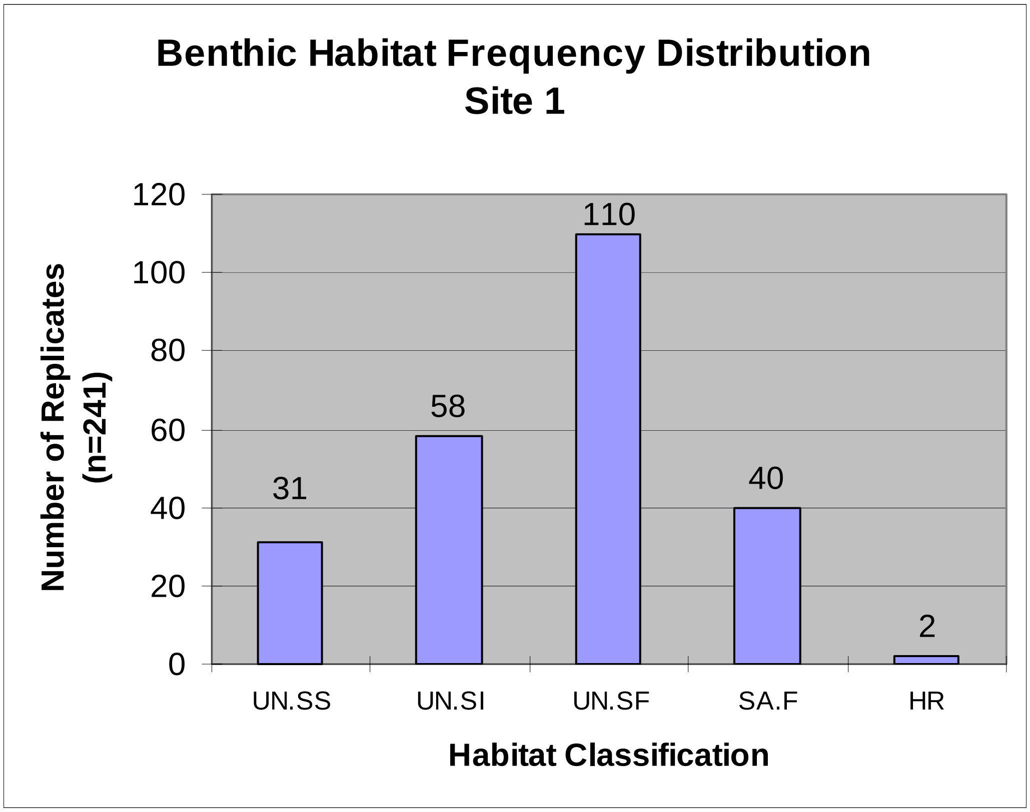


Figure 3-8. Frequency distribution showing the number of replicate images having a particular benthic habitat type classification.

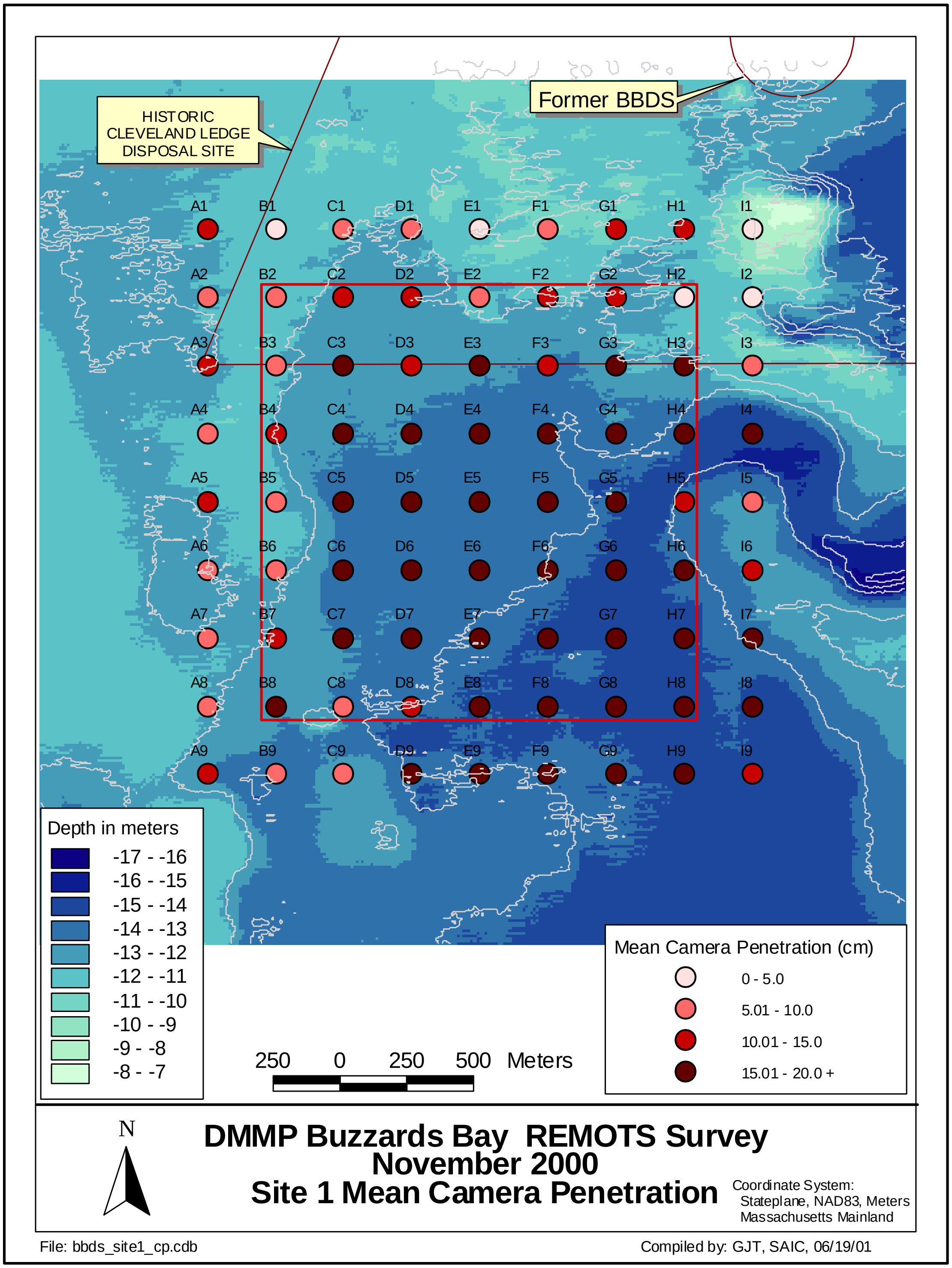


Figure 3-9. Map of mean camera prism penetration depths at the Site 1 sampling stations.

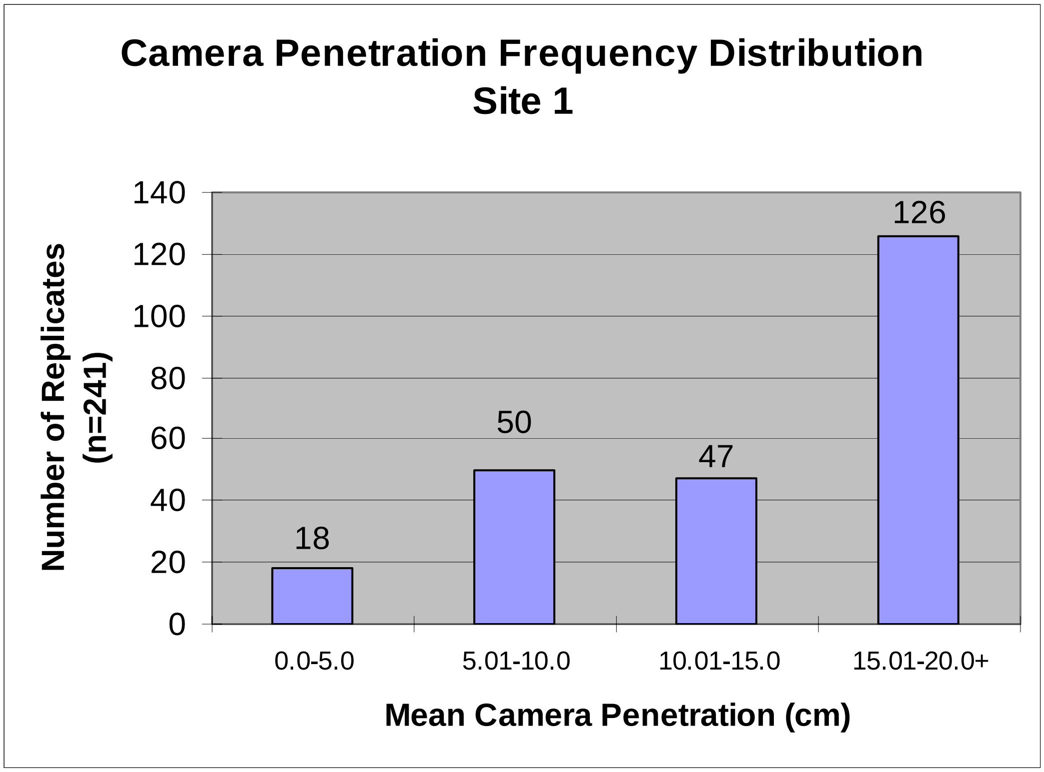


Figure 3-10. Frequency distribution of mean camera prism penetrations depths for the images obtained in Site 1.

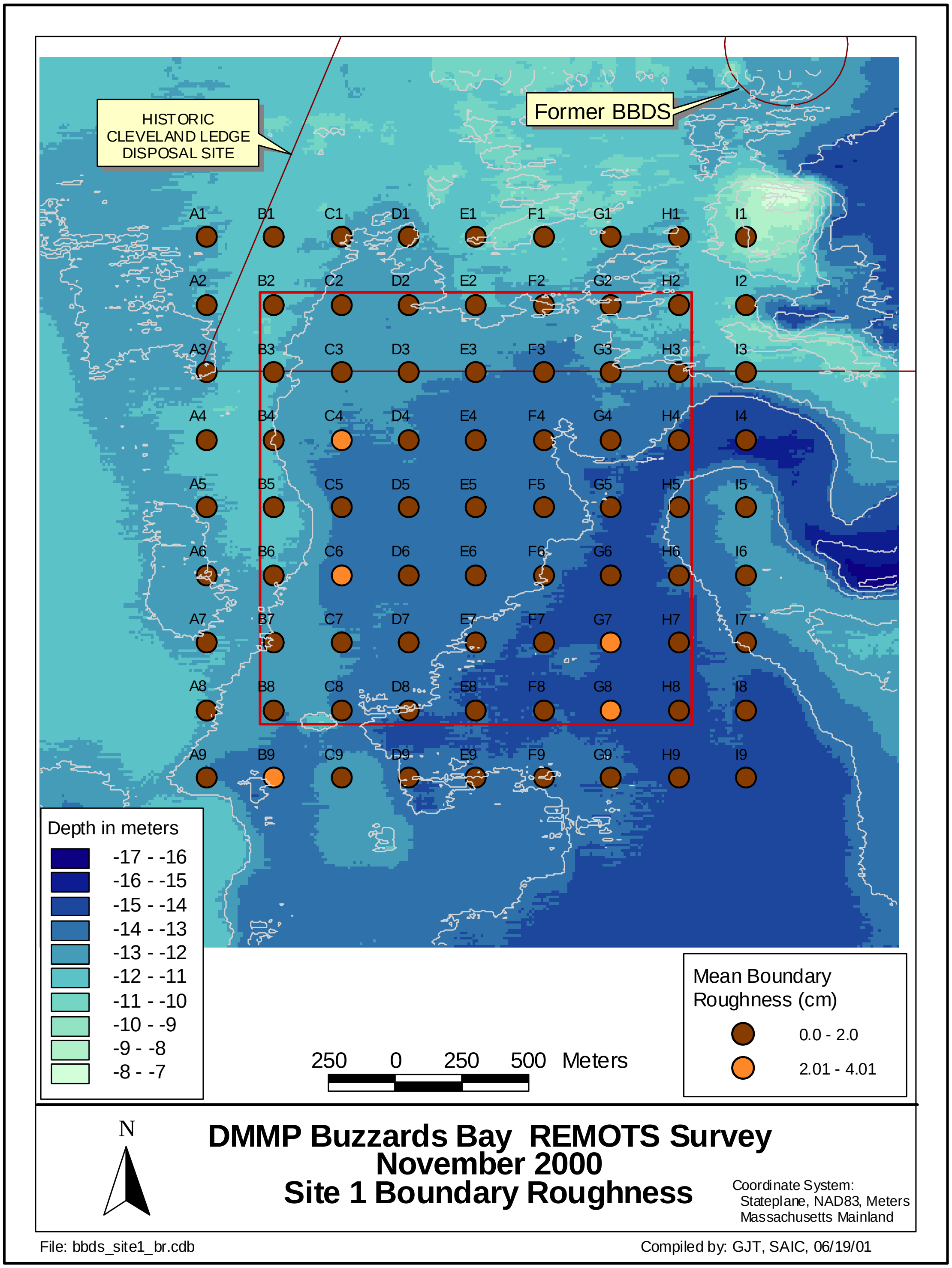


Figure 3-11. Map of mean boundary roughness values at the Site 1 sampling stations.

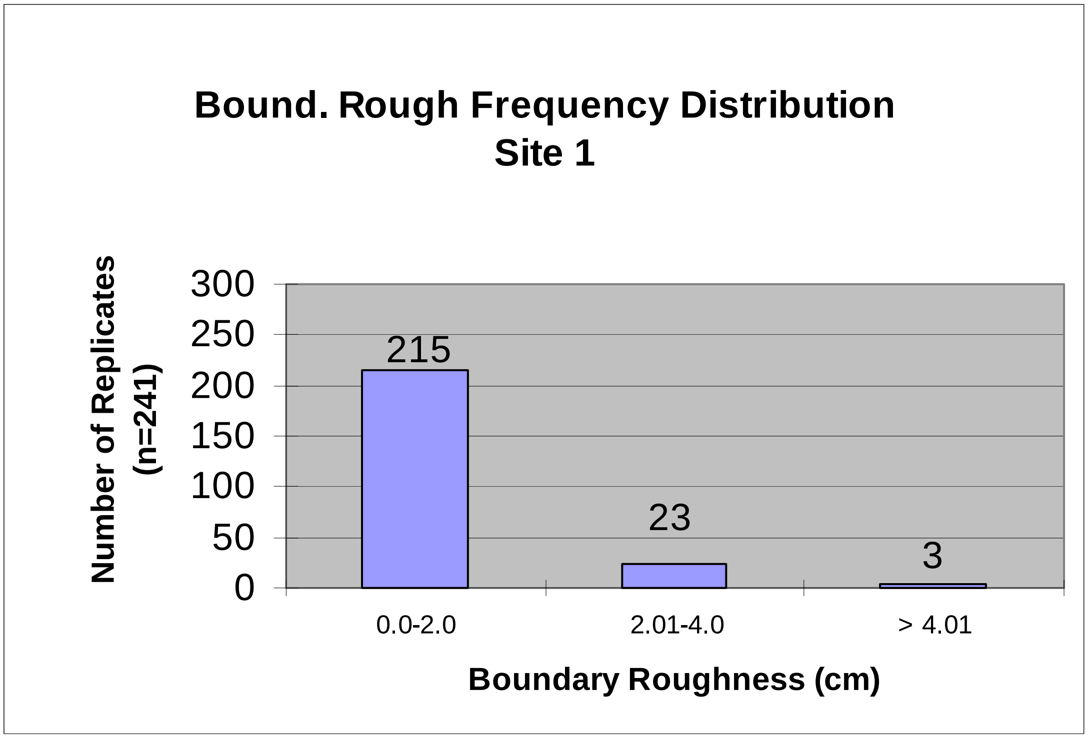


Figure 3-12. Frequency distribution of boundary roughness values for the images obtained in Site 1.

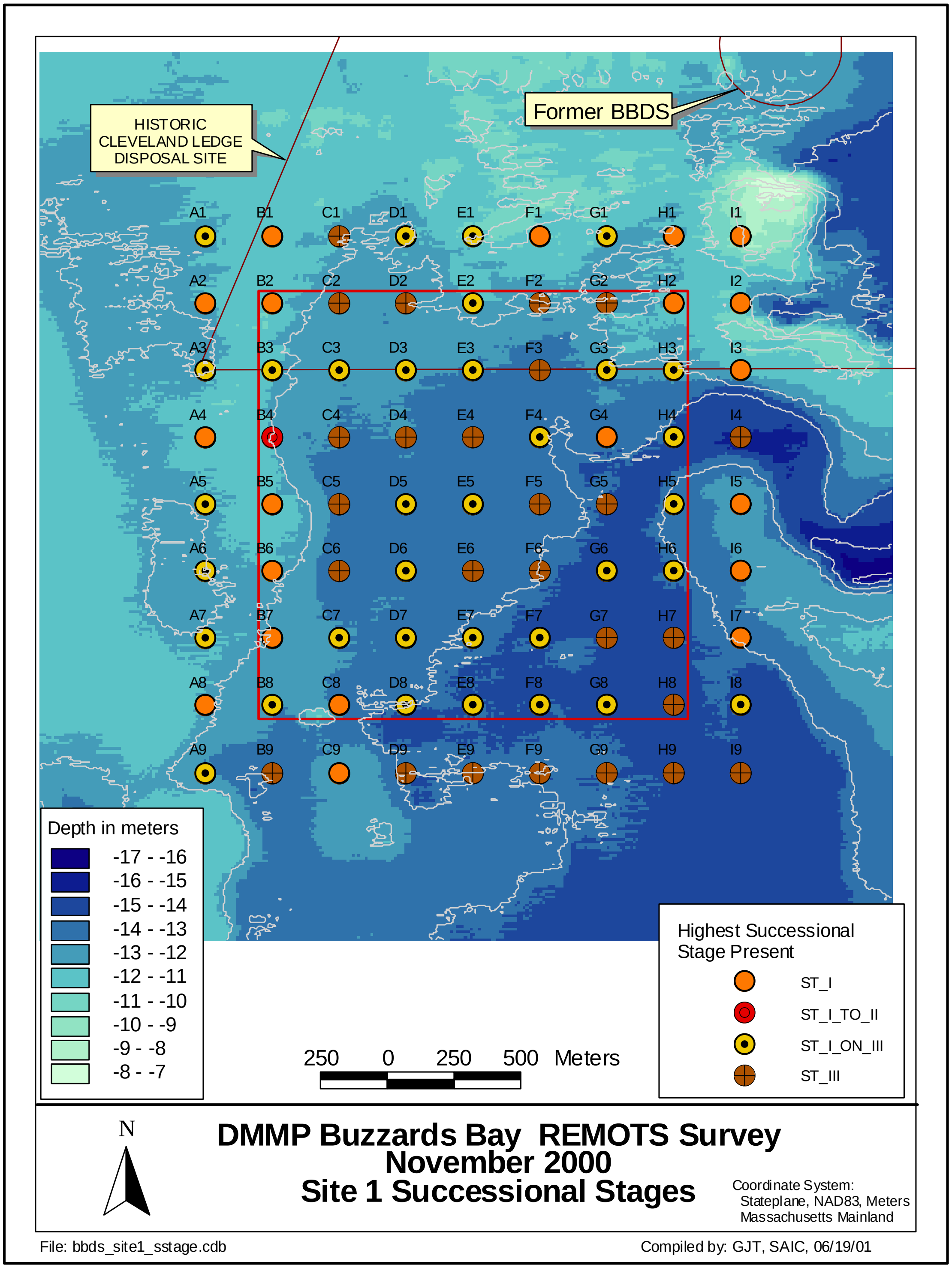
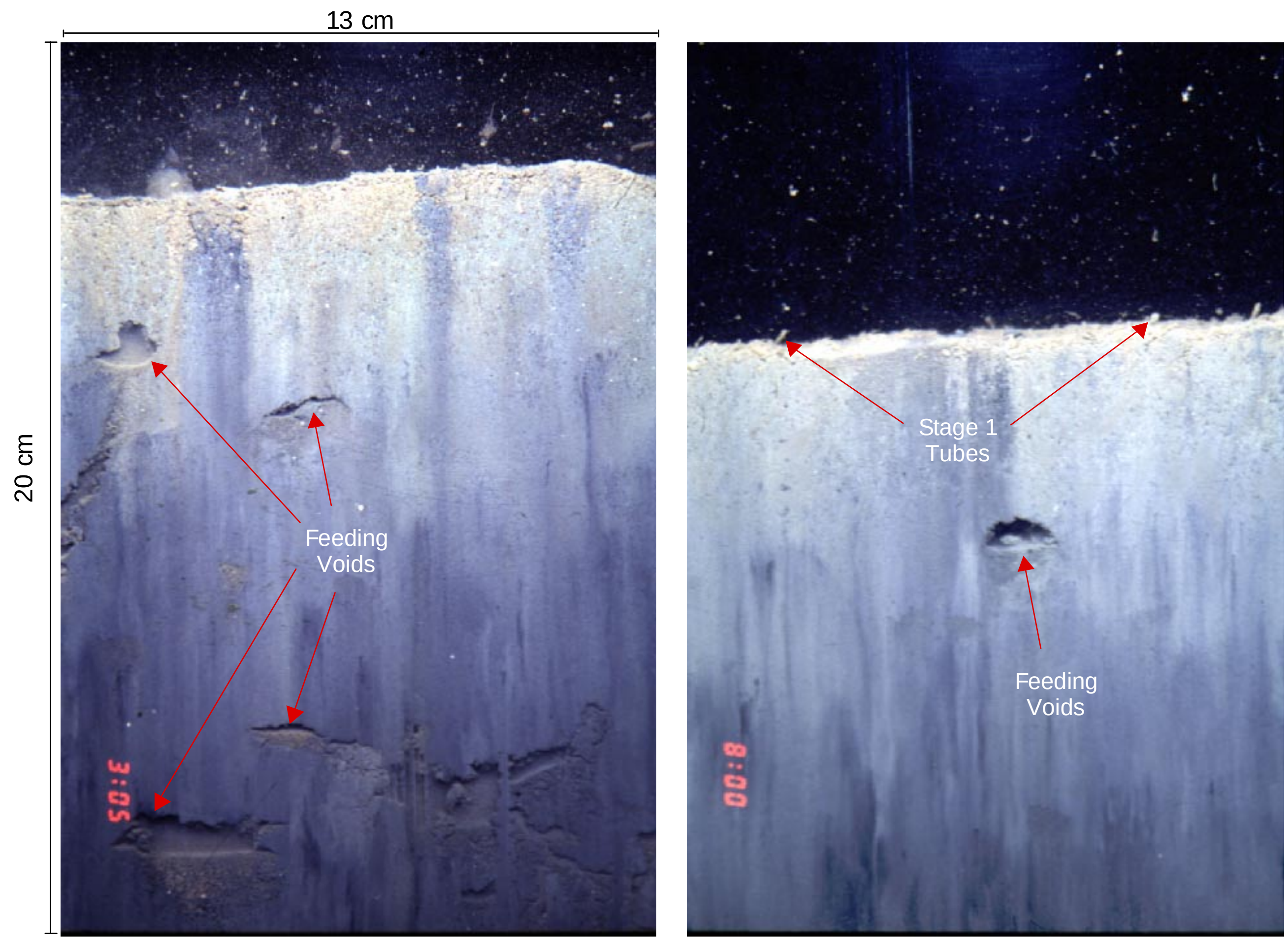
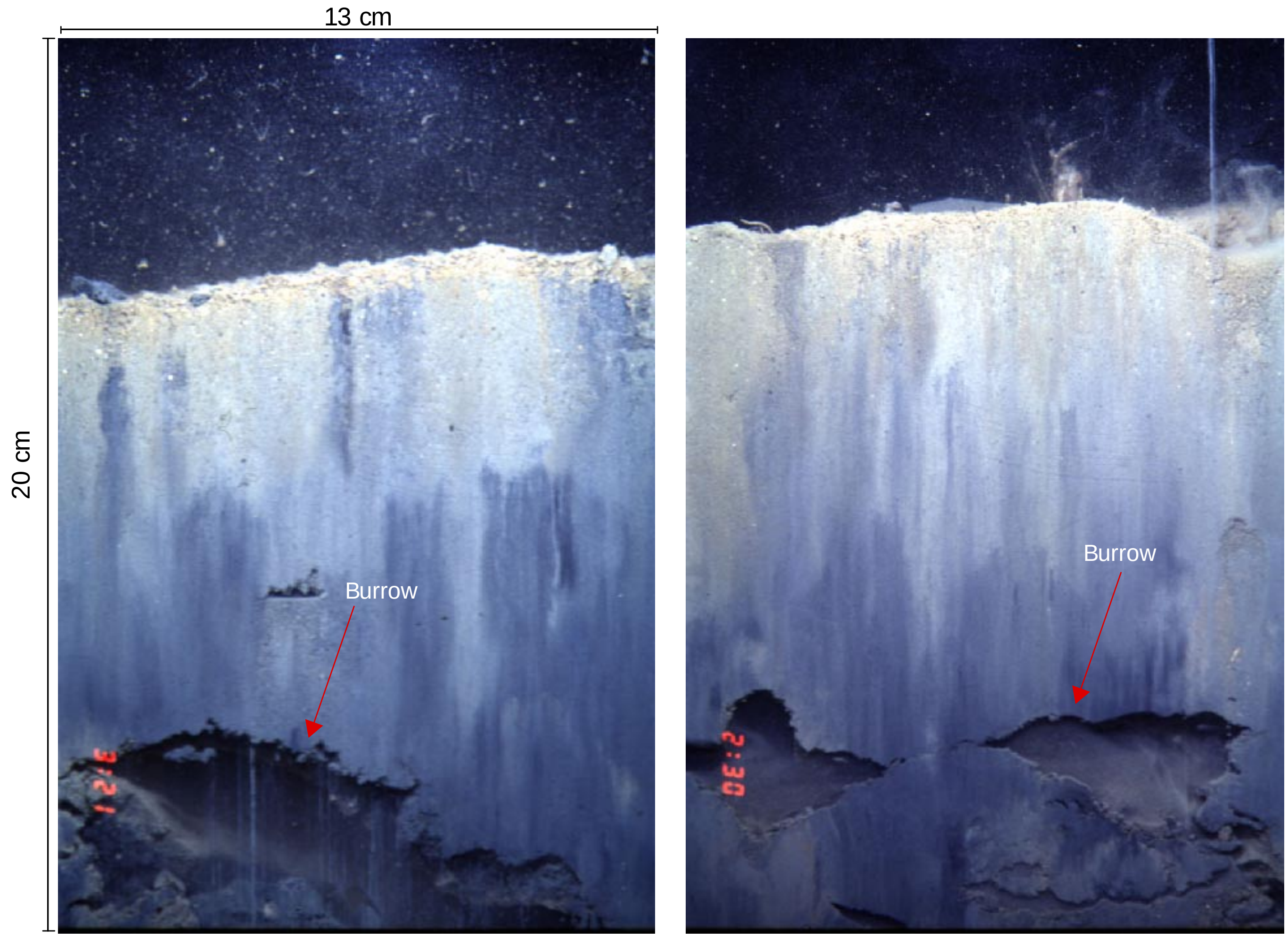


Figure 3-13. Map showing the highest infaunal successional stage observed among the replicate images obtained at each Site 1 sampling station.



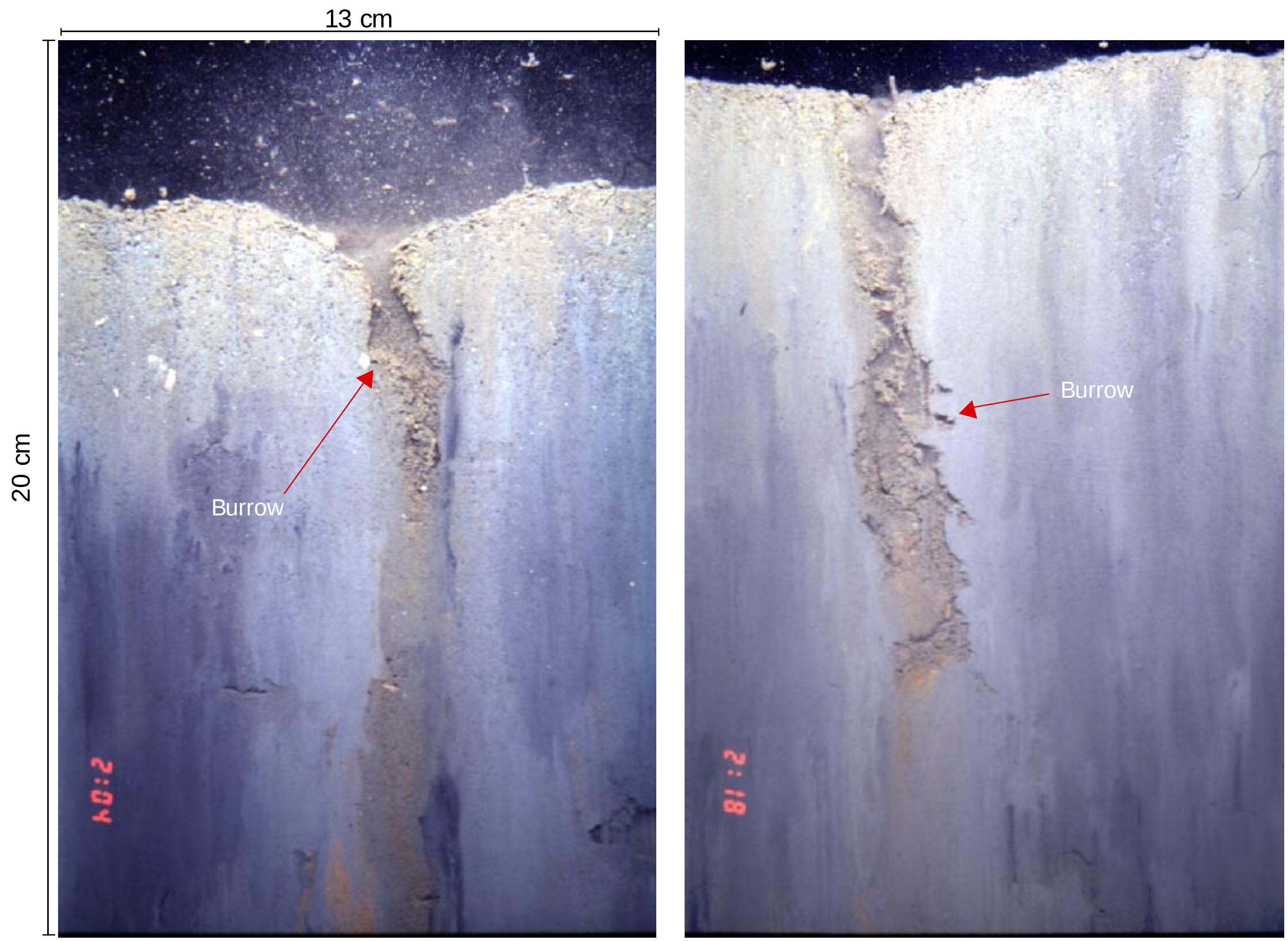
File: Remots_Fig3_14

Figure 3-14. REMOTS® image from station H8 (left) illustrating multiple Stage III feeding voids visible at depth within the unconsolidated, silt-clay sediment (habitat type UN.SF) which characterized the deeper part of Site 1. The image at right from station H5 shows numerous small, Stage I polychaete tubes at the sediment surface and a Stage III feeding void at depth, providing an example of Stage I on III.



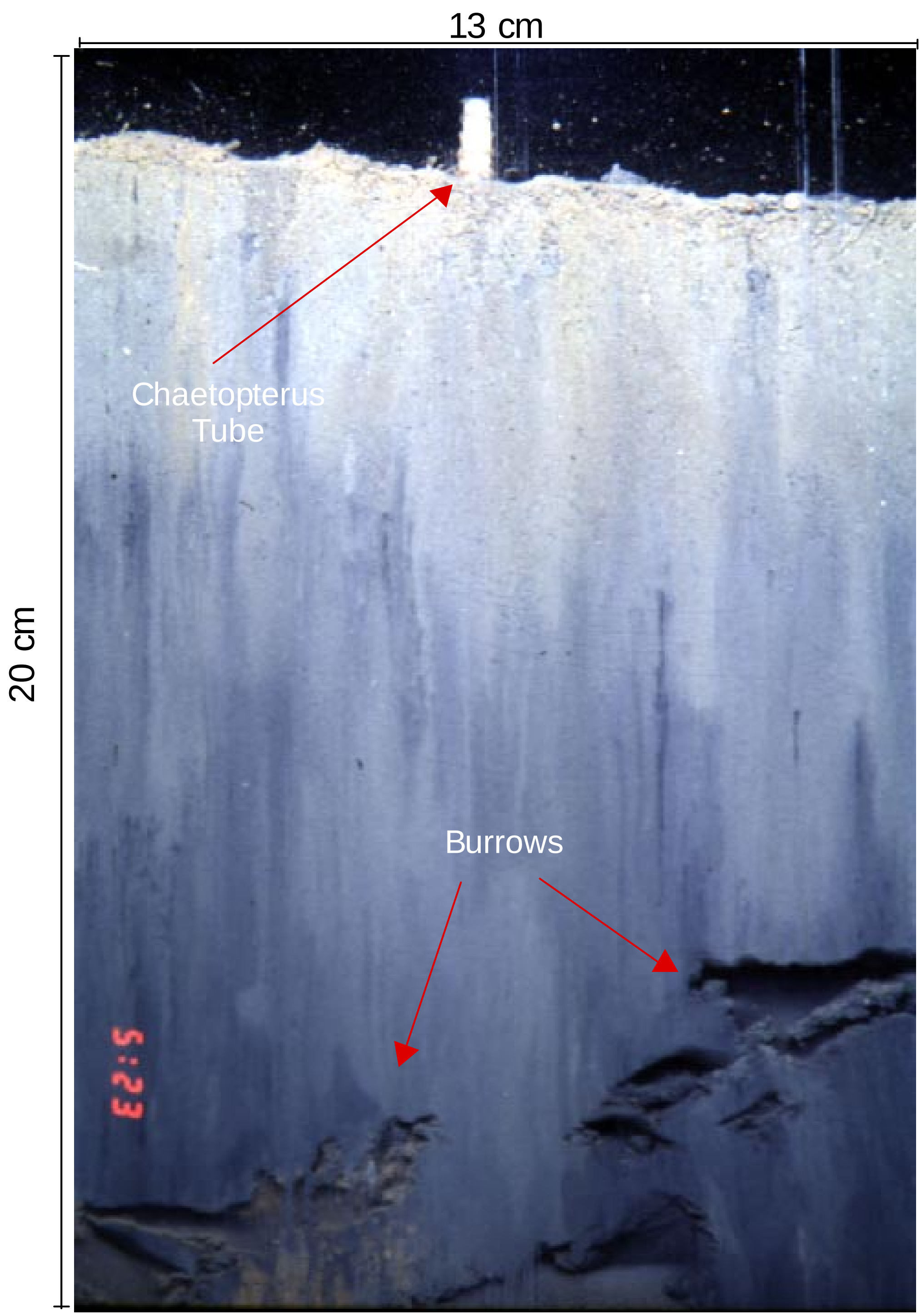
File: Remots_Fig3_15

Figure 3-15. REMOTS® images from stations G2 (left) and G6 (right) showing relatively large horizontal burrow openings at depth within the sediment.



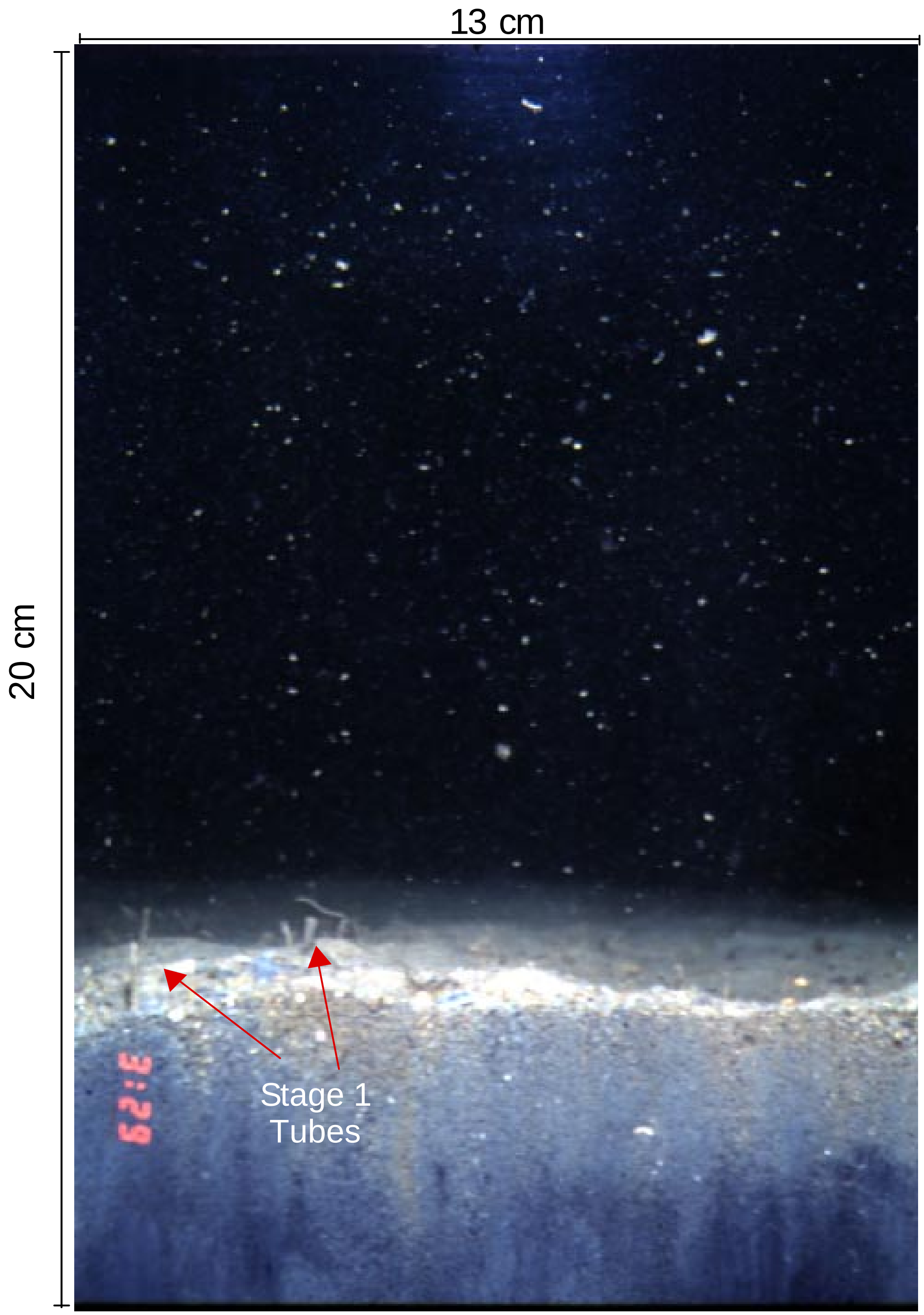
File: Remots_Fig3_16

Figure 3-16. REMOTS® images from stations F7 (left) and C7 (right) showing vertical burrow structures with openings at the sediment surface.



File: Remots_Fig3_17

Figure 3-17. REMOTS® image from station I4 showing a distinct white tube of the polychaete *Chaetopterus* sp. visible at the sediment surface. Horizontal burrow openings also are visible in the sediment near the bottom of this image.



File: Remots_Fig3_18

Figure 3-18. REMOTS® image from station E2 in the shallower portion of Site 1 showing small tubes of opportunistic Stage I polychaetes present at the surface of very fine sand (habitat type SA.F).

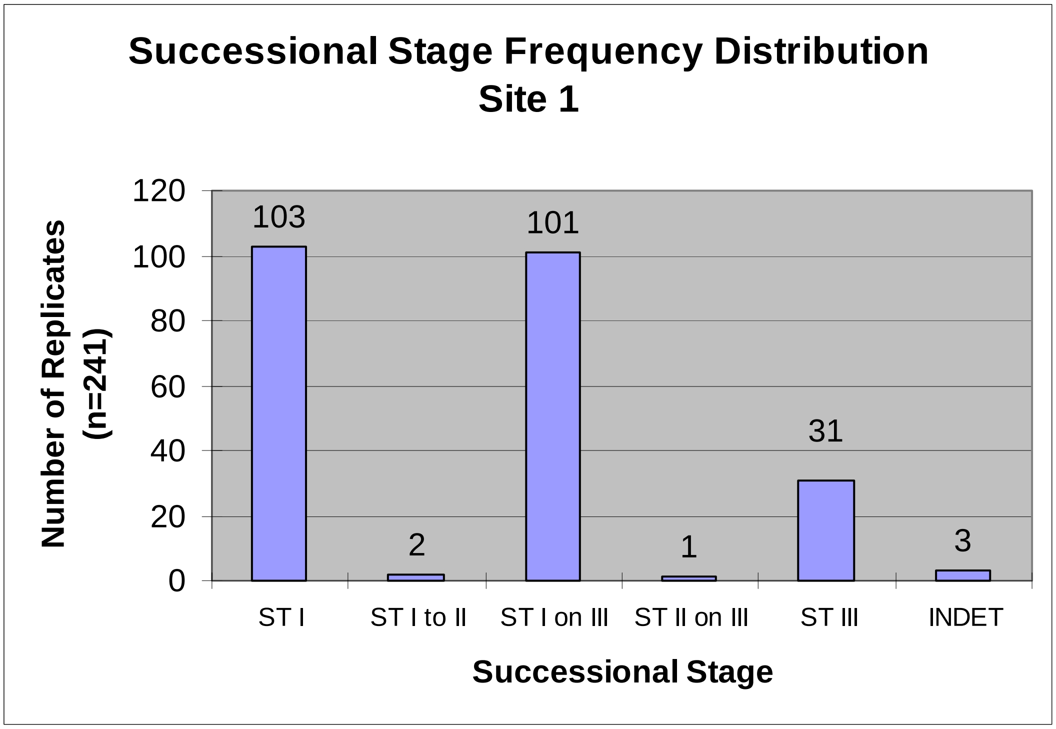


Figure 3-19. Frequency distribution of infaunal successional stages for the images obtained in Site 1.

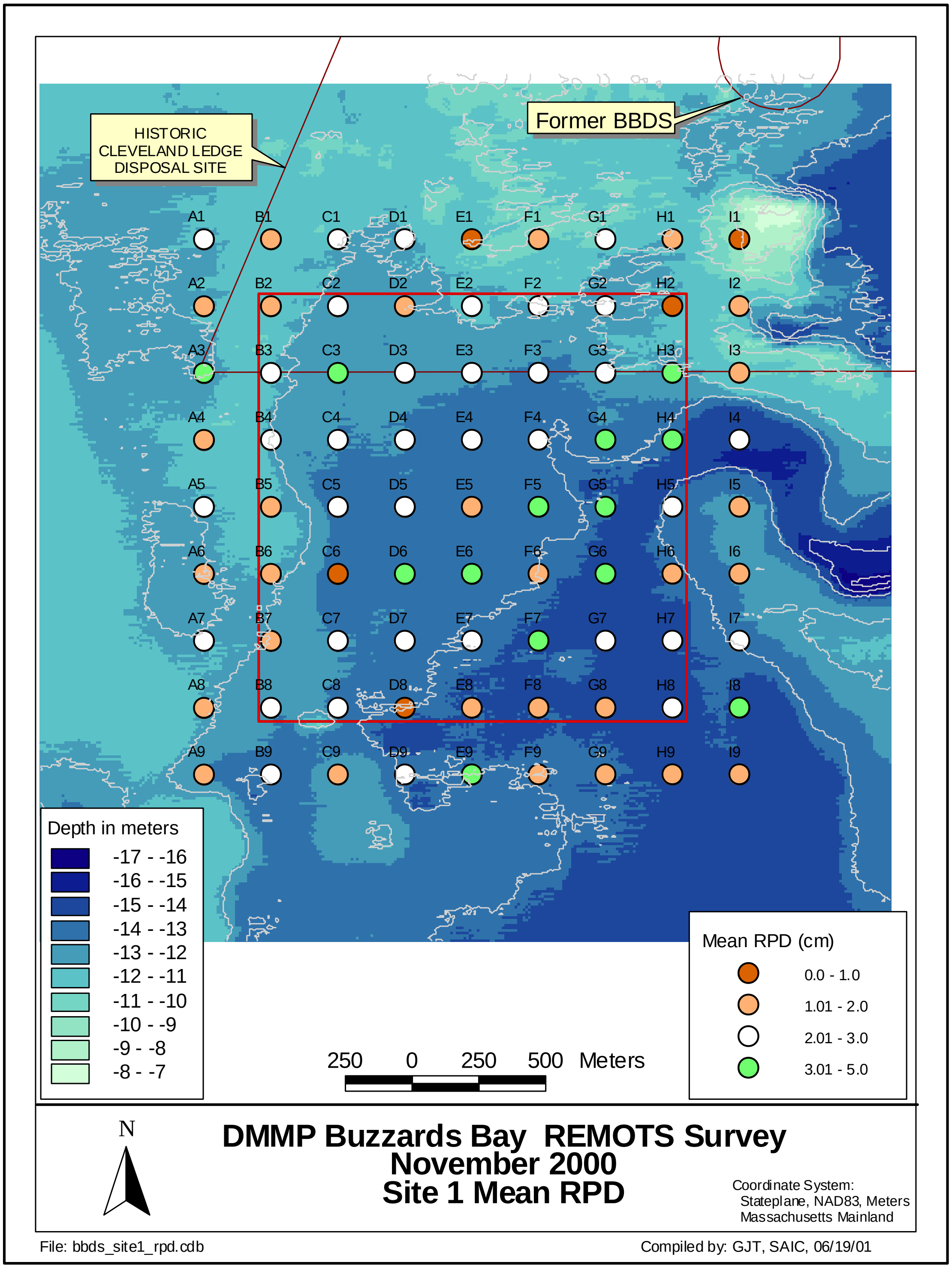


Figure 3-20. Map of mean apparent RPD depths at the Site 1 sampling stations.

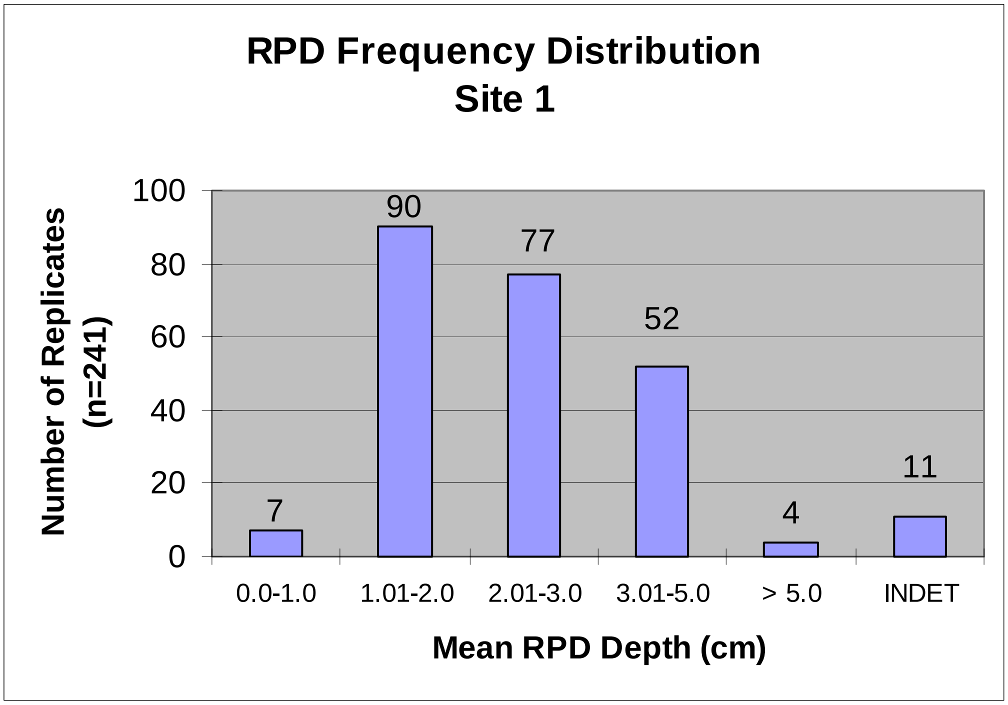


Figure 3-21. Frequency distribution of apparent RPD depths for the images obtained in Site 1.

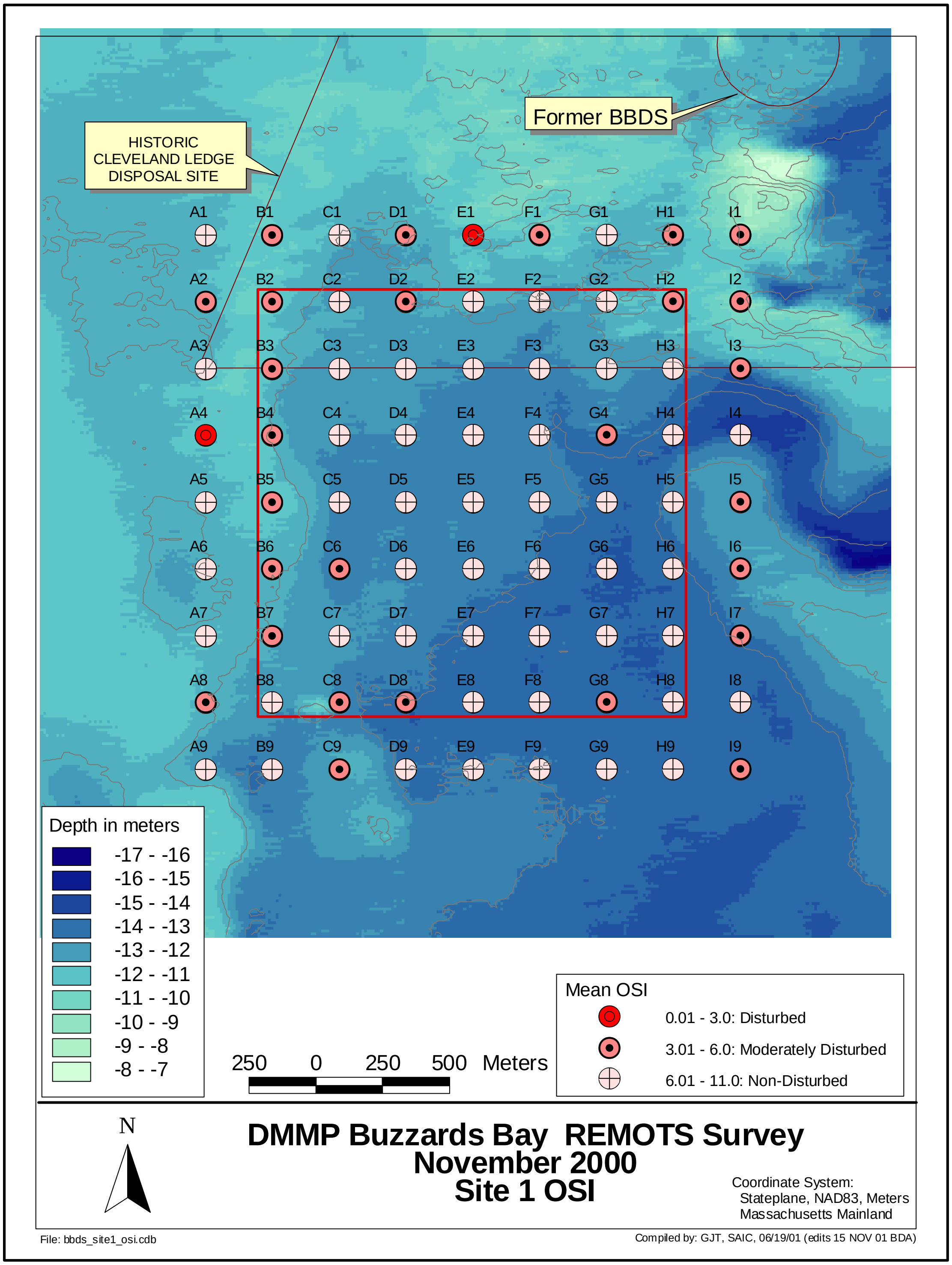


Figure 3-22. Map of mean OSI values at the Site 1 sampling stations.

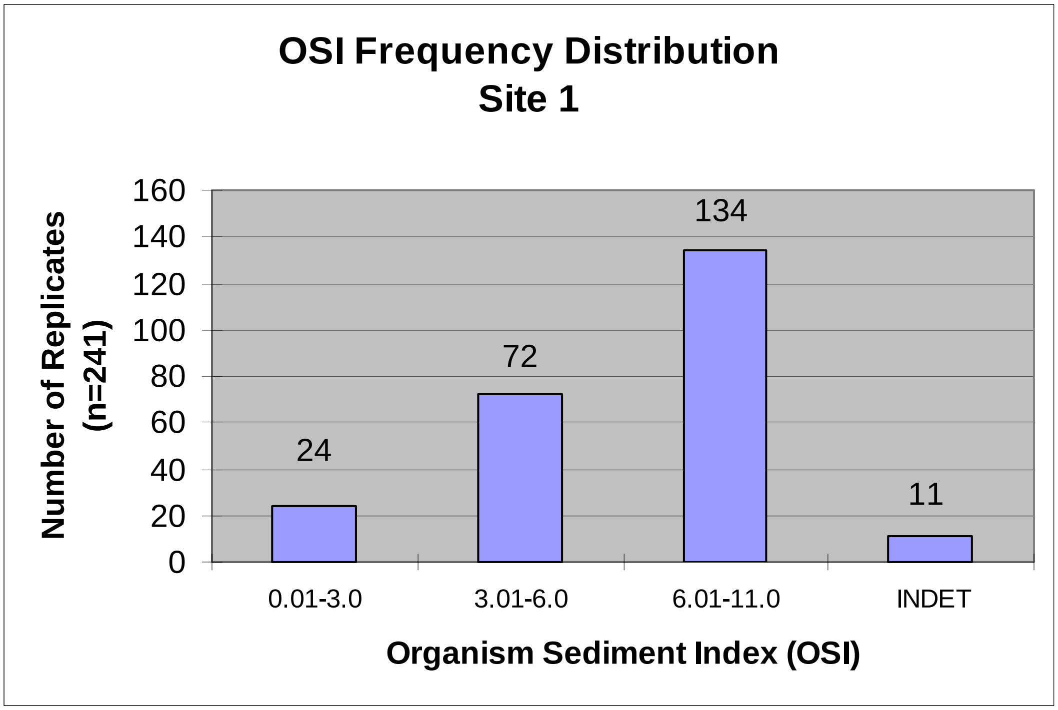


Figure 3-23. Frequency distribution of OSI values for the images obtained in Site 1.

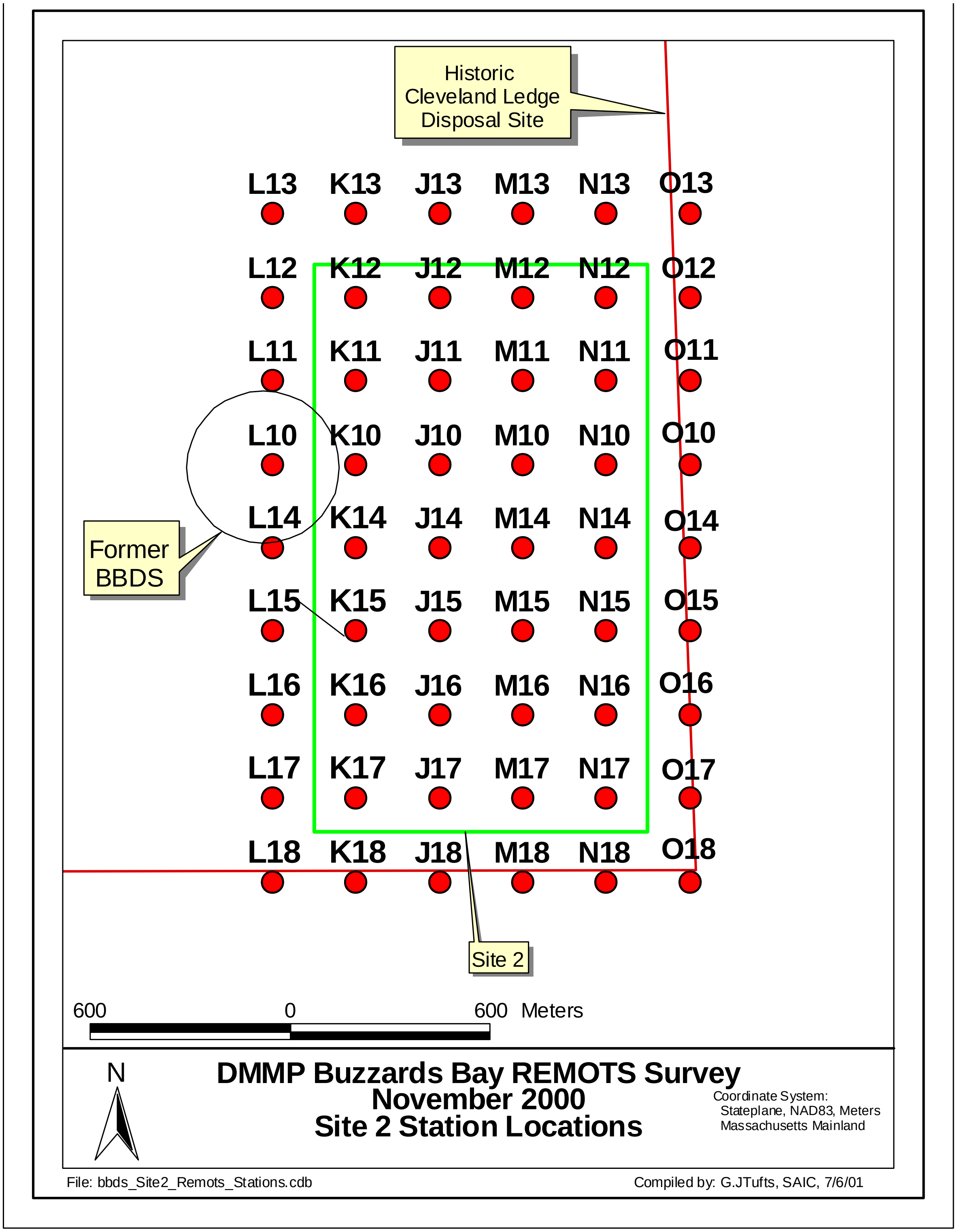


Figure 3-24. REMOTS® sampling stations in and around candidate disposal Site 2.

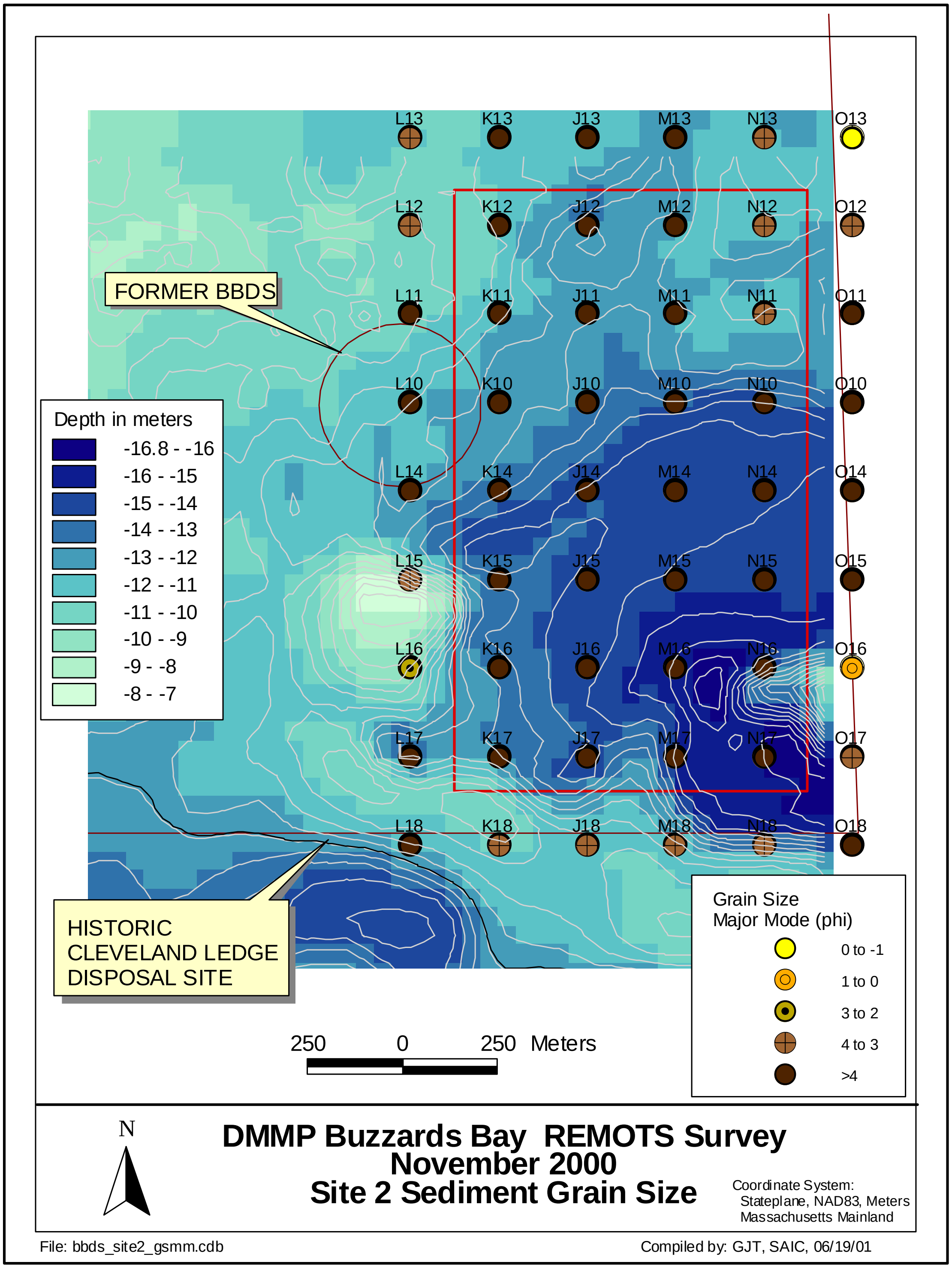


Figure 3-25. Map of grain size major mode at the Site 2 sampling stations. Bathymetric contours are from an SAIC survey conducted in May 1998.

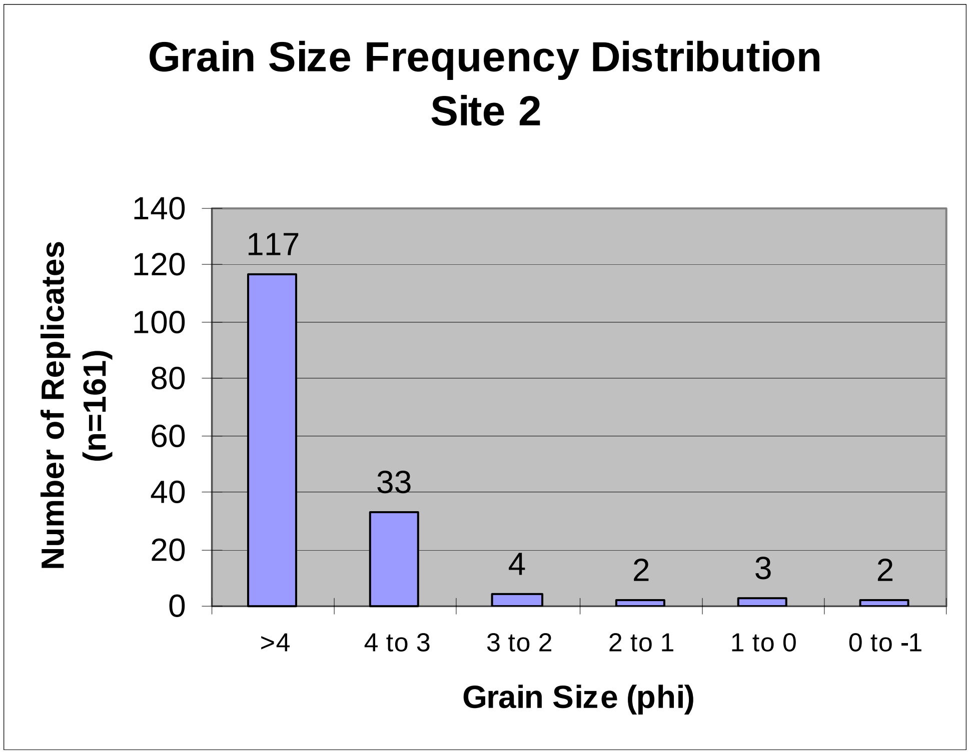


Figure 3-26. Frequency distribution showing the number of replicate images having a particular grain size major mode.

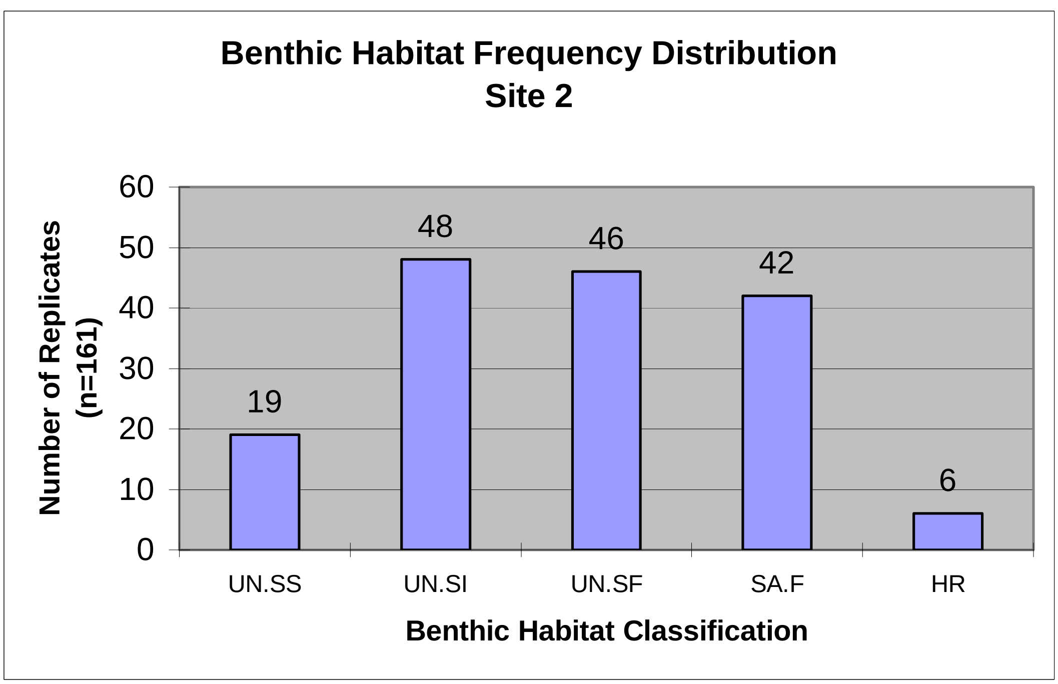
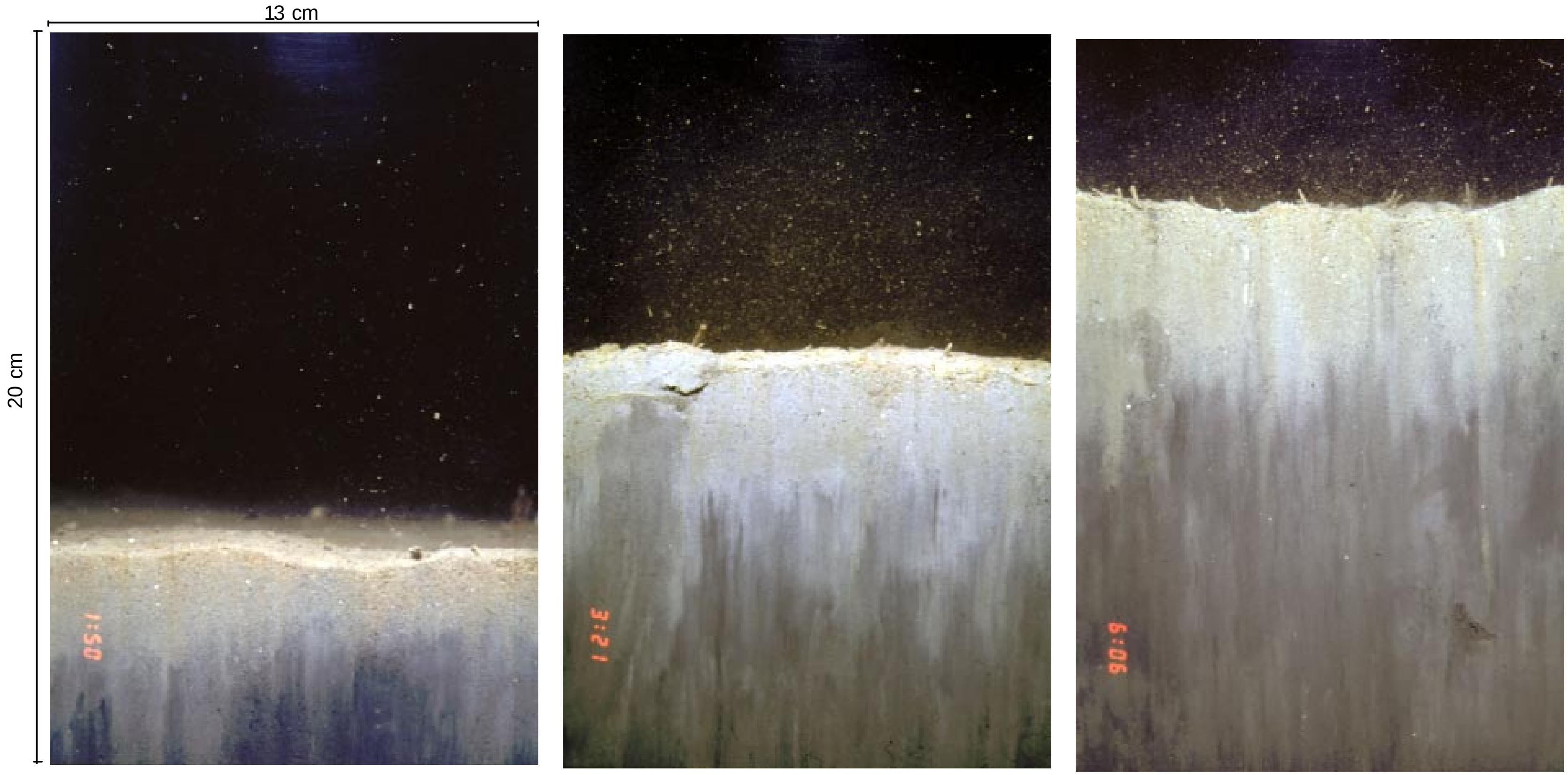


Figure 3-27. Frequency distribution showing the number of replicate images having a particular benthic habitat type classification at Site 2.



File: Remots_Fig3_28

Figure 3-28. Three REMOTS® images illustrating subtle differences in the three benthic habitat types SA.F, UN.SI and UN.SF. The image at left from station L13 in the shallower northern end of Site 2 shows very fine sand at the sediment surface overlying silt-clay sediment at depth (habitat type SA.F). The center image from station J11 at intermediate water depths in the middle of Site 2 shows predominantly silt-clay sediments mixed with minor amounts of silt and very fine sand (habitat type UN.SI). The image at right from station M16 within the topographic depression in the southern half of Site 2 shows very soft silt-clay (habitat type UN.SF). Note the difference in the sediment-profile camera penetration with increasing silt-clay content moving from the northern to the southern half of the site.

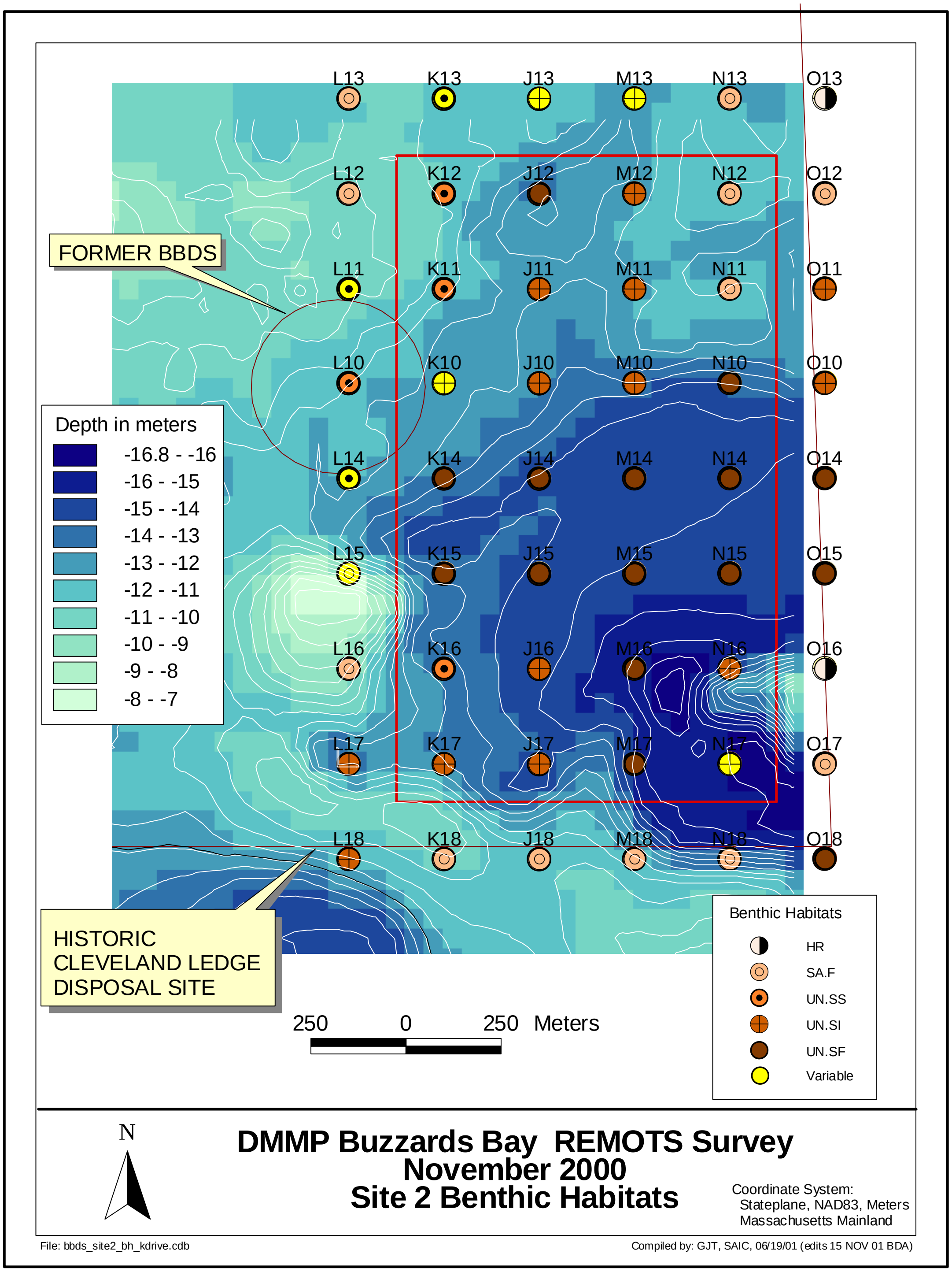


Figure 3-29. Map of benthic habitat types at the Site 2 sampling stations. Stations having more than one habitat type present are shown at "variable," with the most common or predominant habitat type at such stations depicted on the map (see Table 3-2).

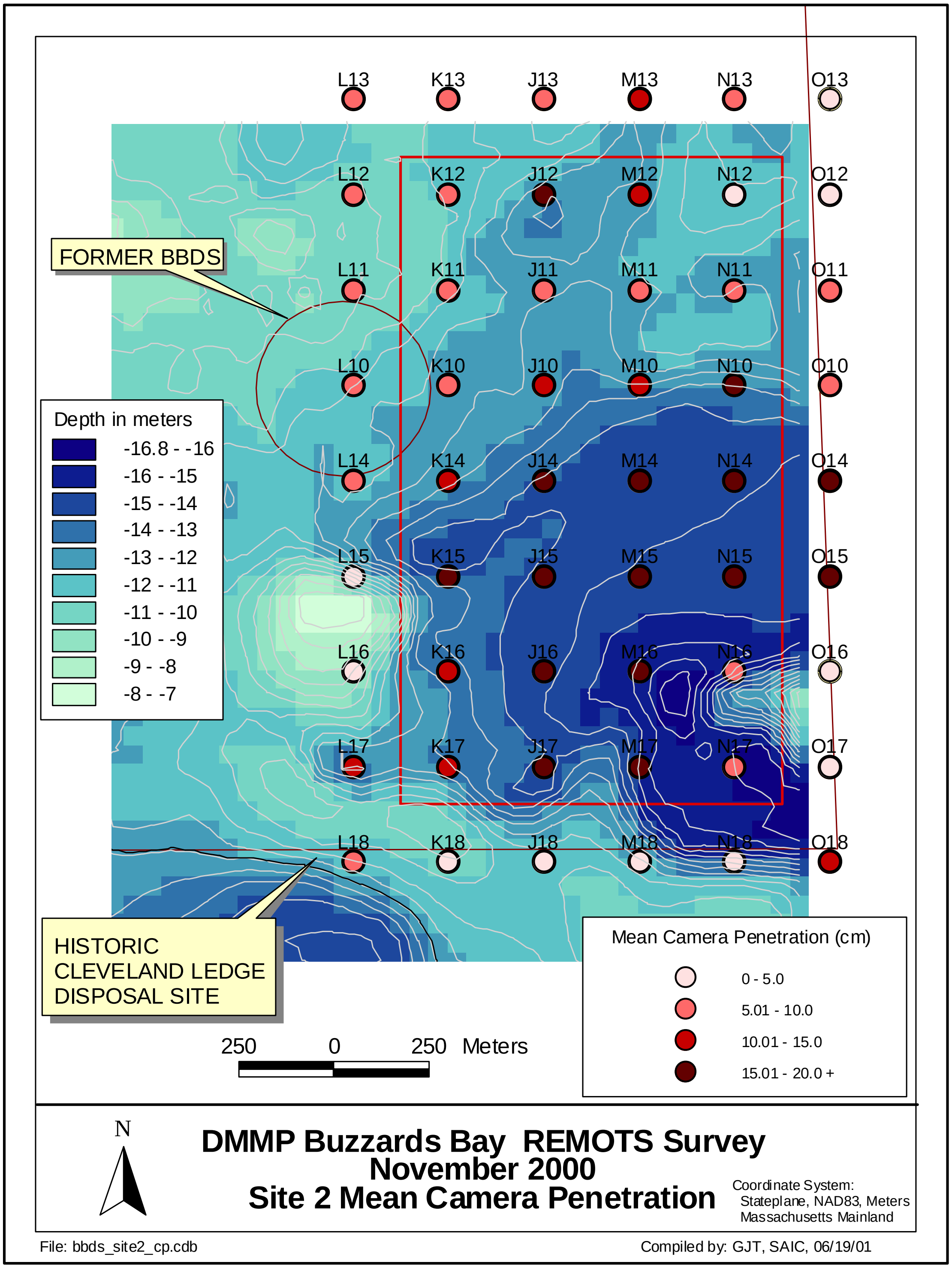


Figure 3-30. Map of mean camera prism penetration depths at the Site 2 sampling stations.

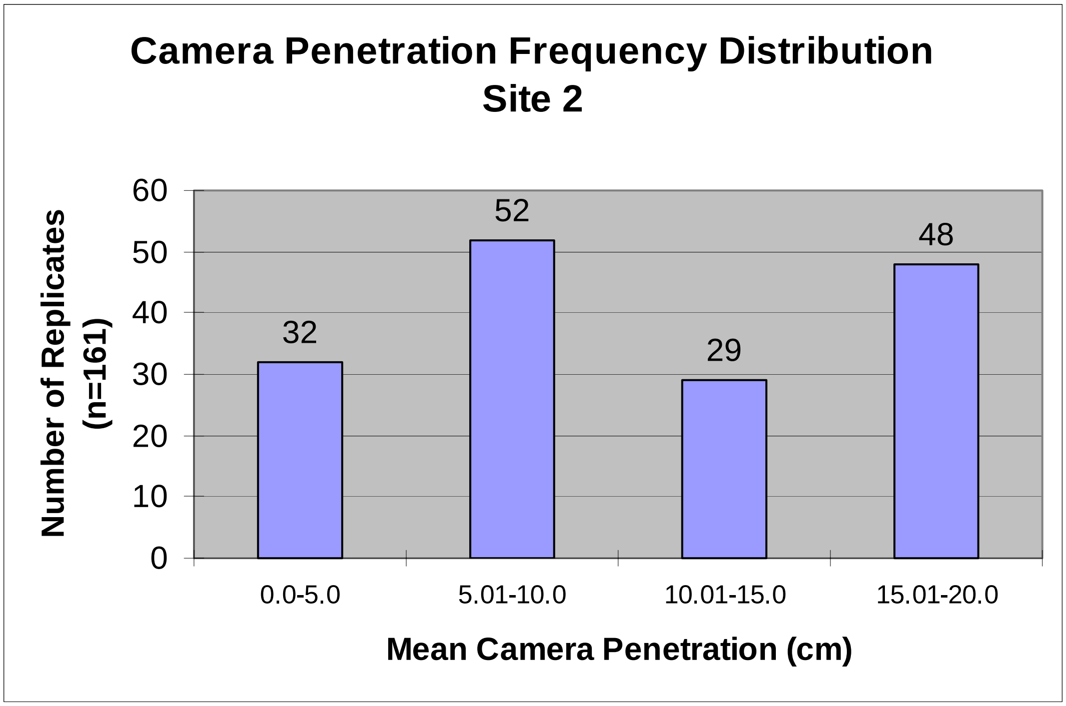


Figure 3-31. Frequency distribution of mean camera prism penetrations depths for the images obtained in Site 2.

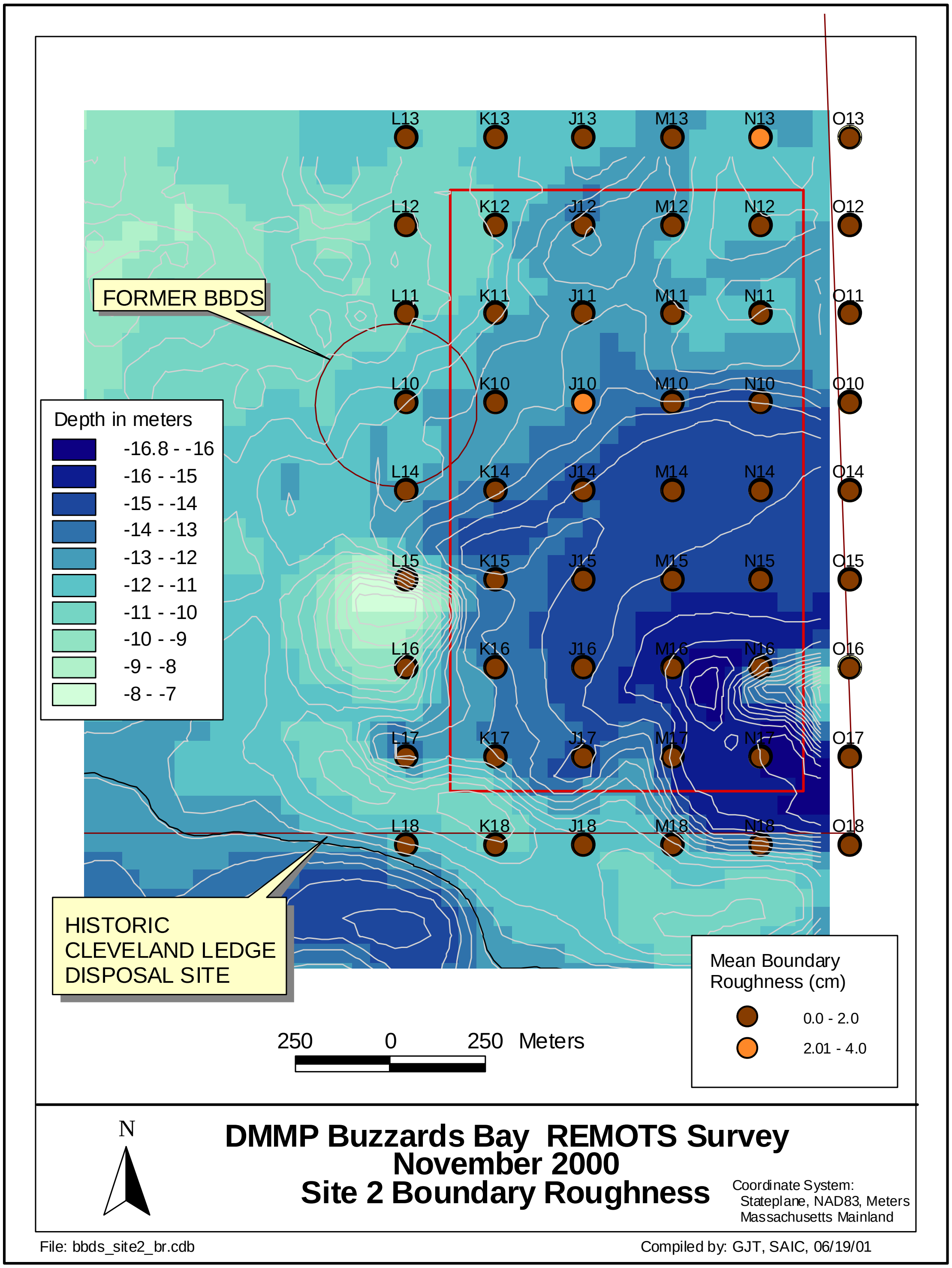


Figure 3-32. Map of mean boundary roughness values at the Site 2 sampling stations.

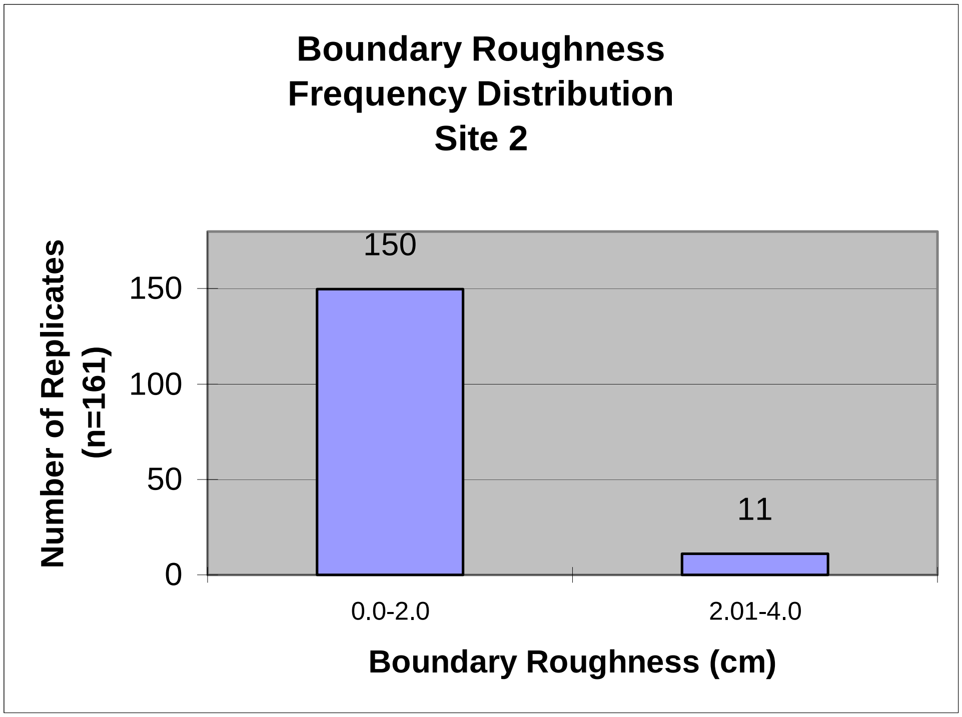


Figure 3-33. Frequency distribution of boundary roughness values for the images obtained in Site 2.

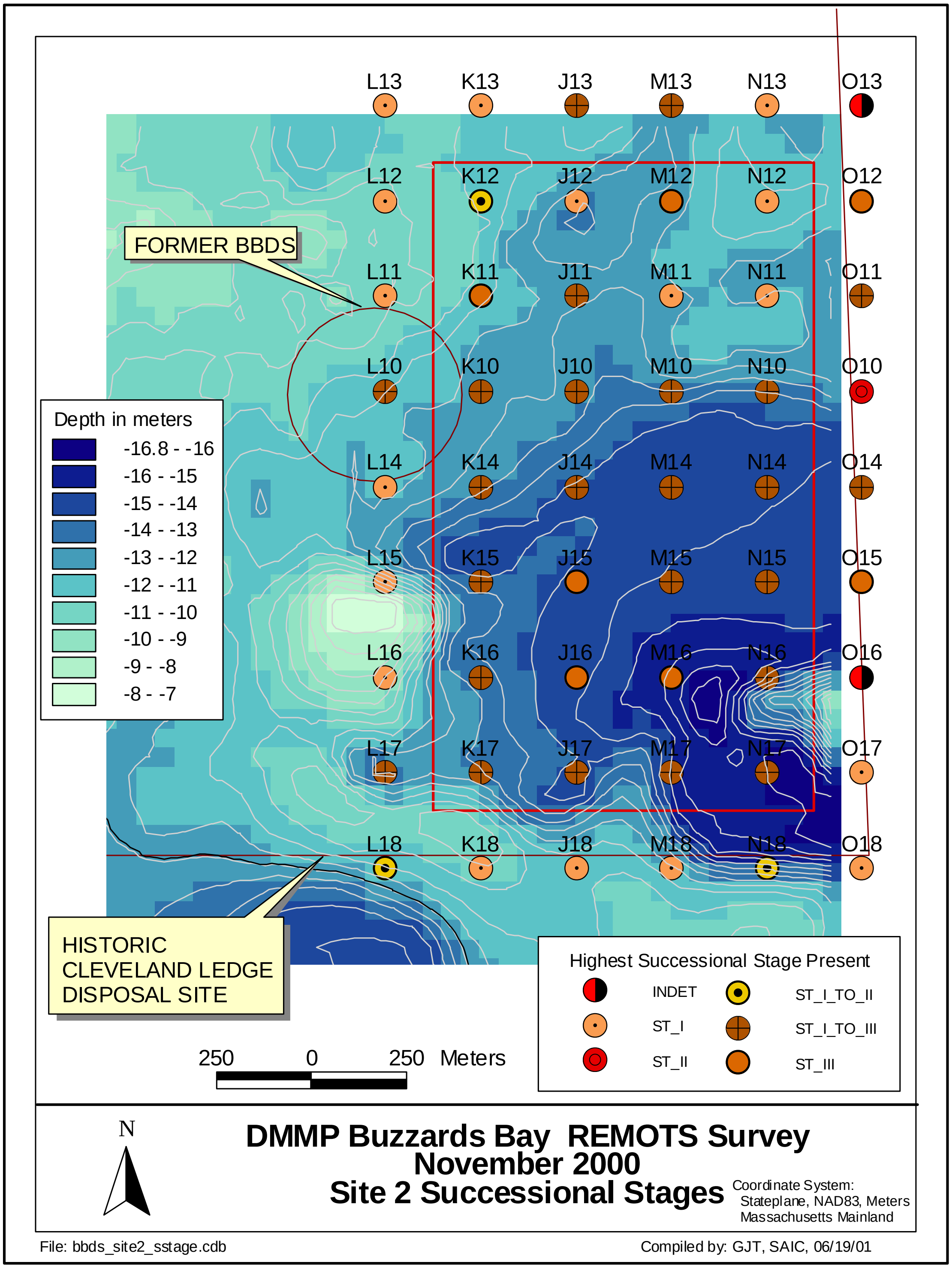
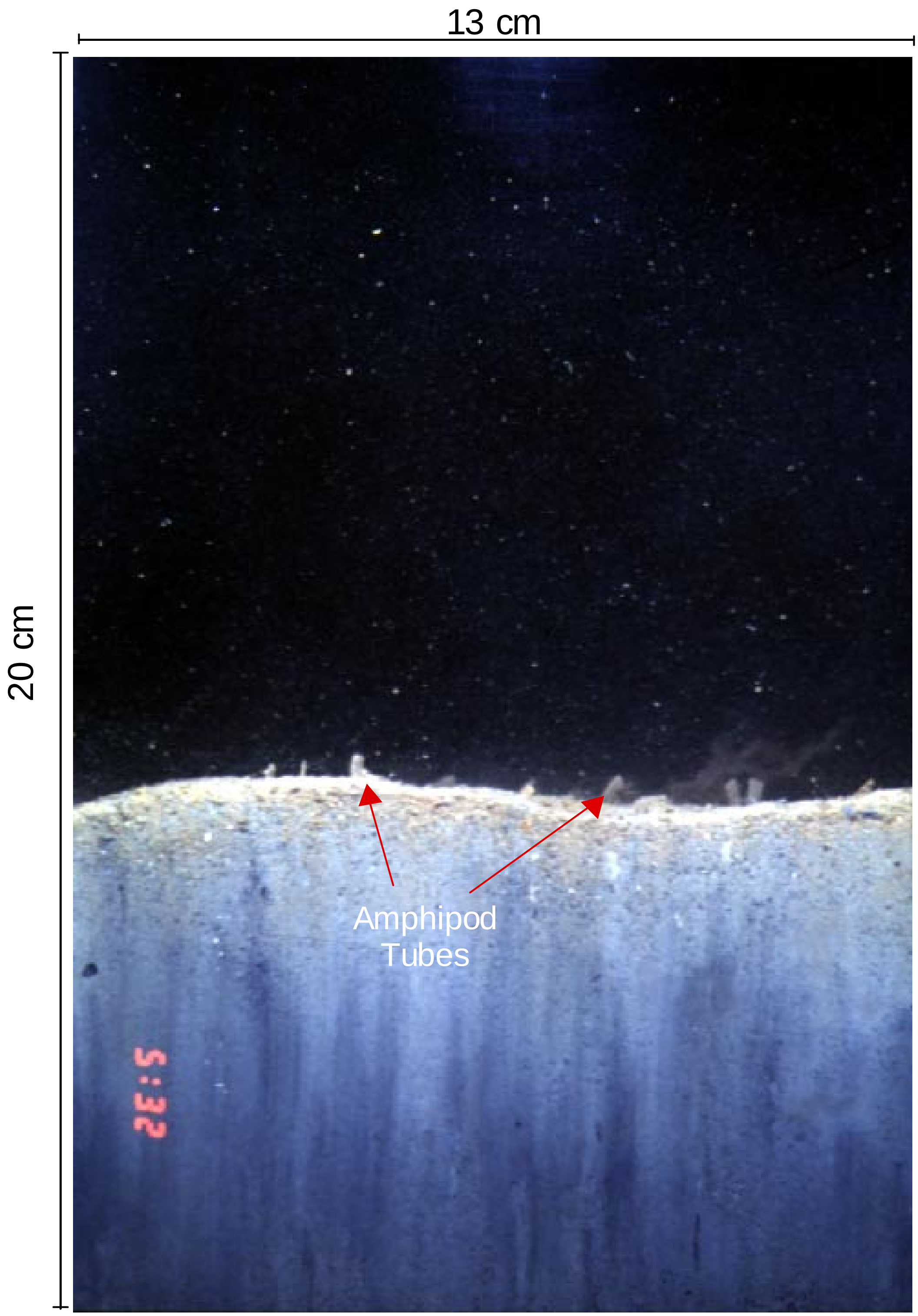
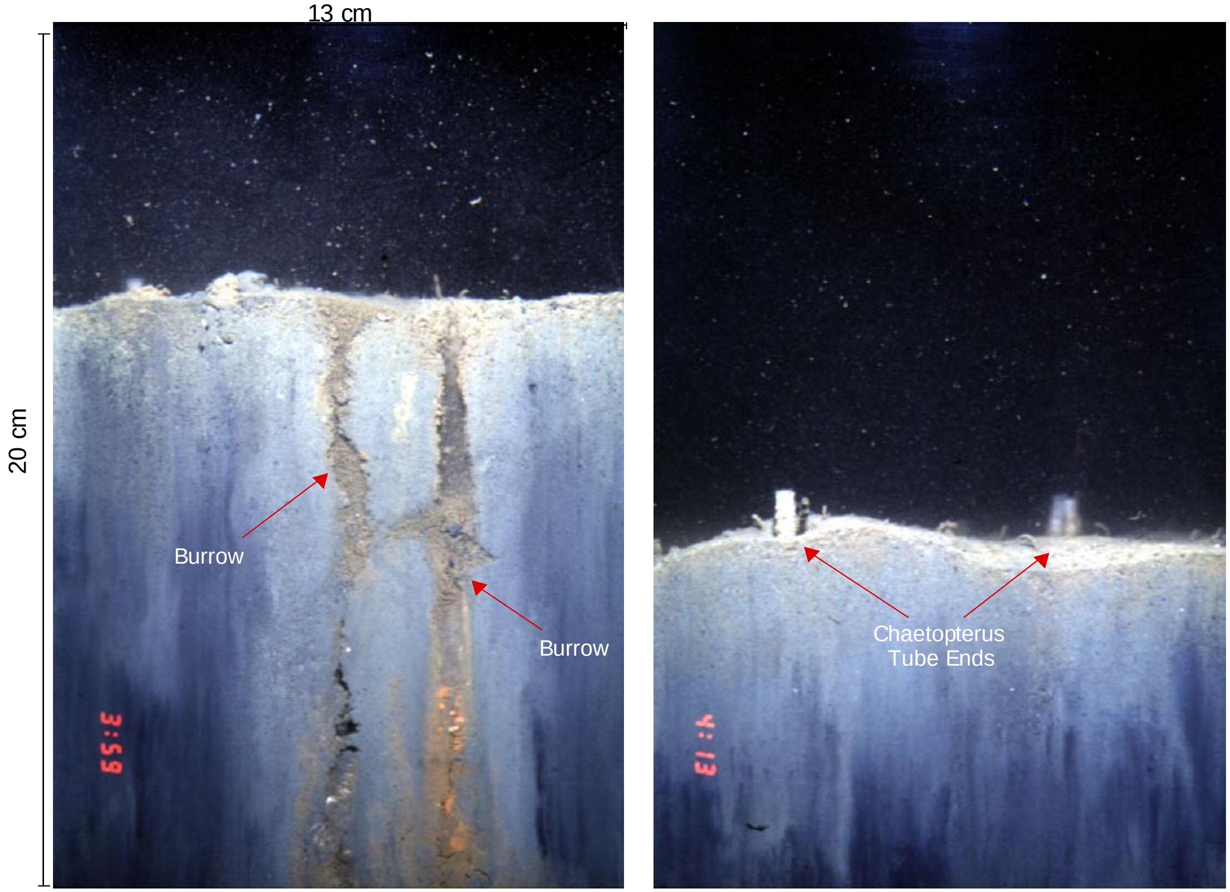


Figure 3-34. Map showing the highest infaunal successional stage observed among the replicate images obtained at each Site 2 sampling station.



File: Remots_Fig3_35

Figure 3-35. REMOTS® image from station O10 showing Stage II amphipod tubes (*Ampelisca* sp.) visible at the sediment surface.



File: Remots_Fig3_36

Figure 3-36. The REMOTS® image on the left from station M12 shows two active vertical burrows with openings at the sediment surface. Irrigation of such burrows by oxygen-rich water results in the formation of iron oxides at depth (rust color). The image on the right from station M10 shows a number of small, Stage I polychaete tubes and the larger, distinct white tube ends of the polychaete *Chaetopterus* sp visible at the sediment surface. The two white structures (one in the foreground and one in the background) probably represent the ends of a single, U-shaped tube.

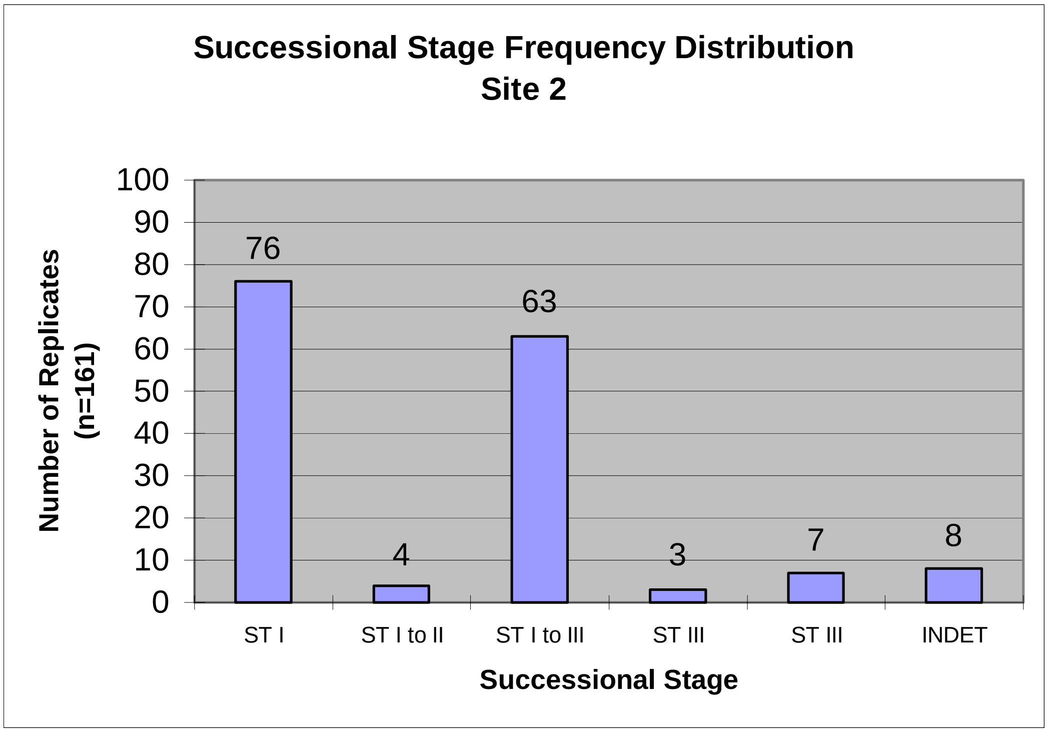


Figure 3-37. Frequency distribution of infaunal successional stages for the images obtained in Site 2.

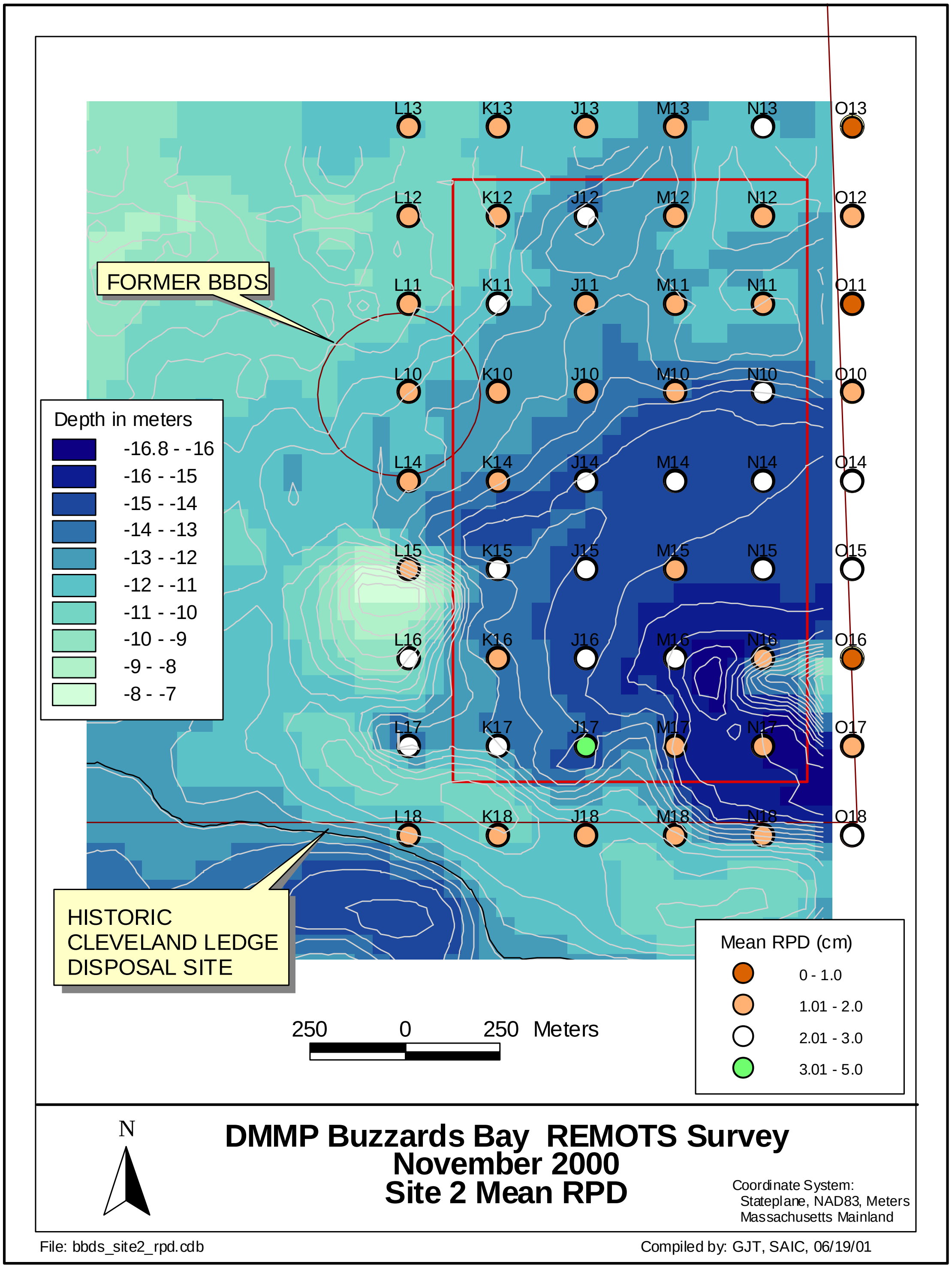


Figure 3-38. Map of mean apparent RPD depths at the Site 2 sampling stations.

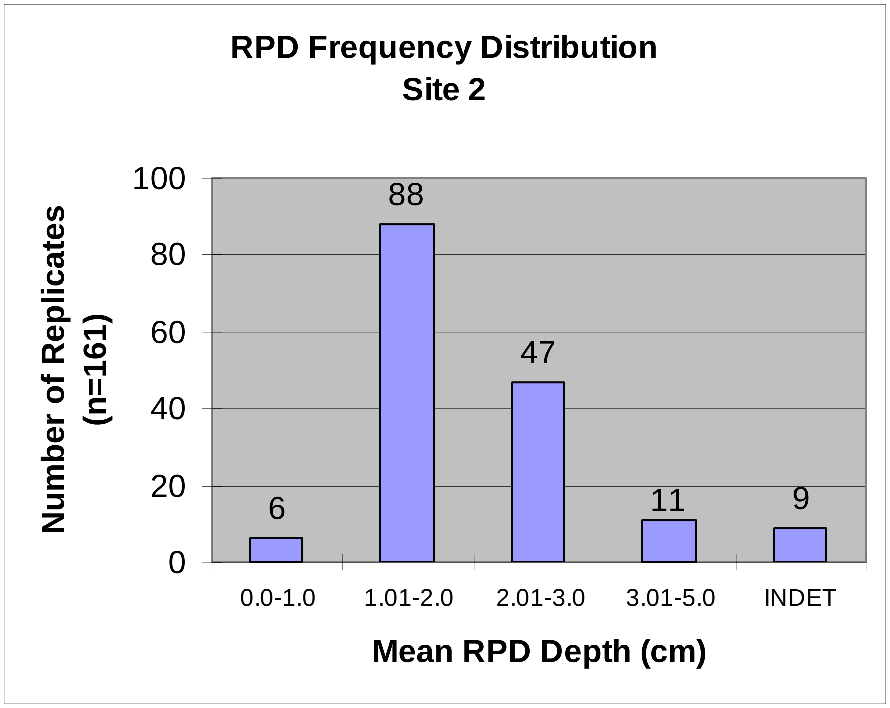


Figure 3-39. Frequency distribution of apparent RPD depths for the images obtained in Site 2.

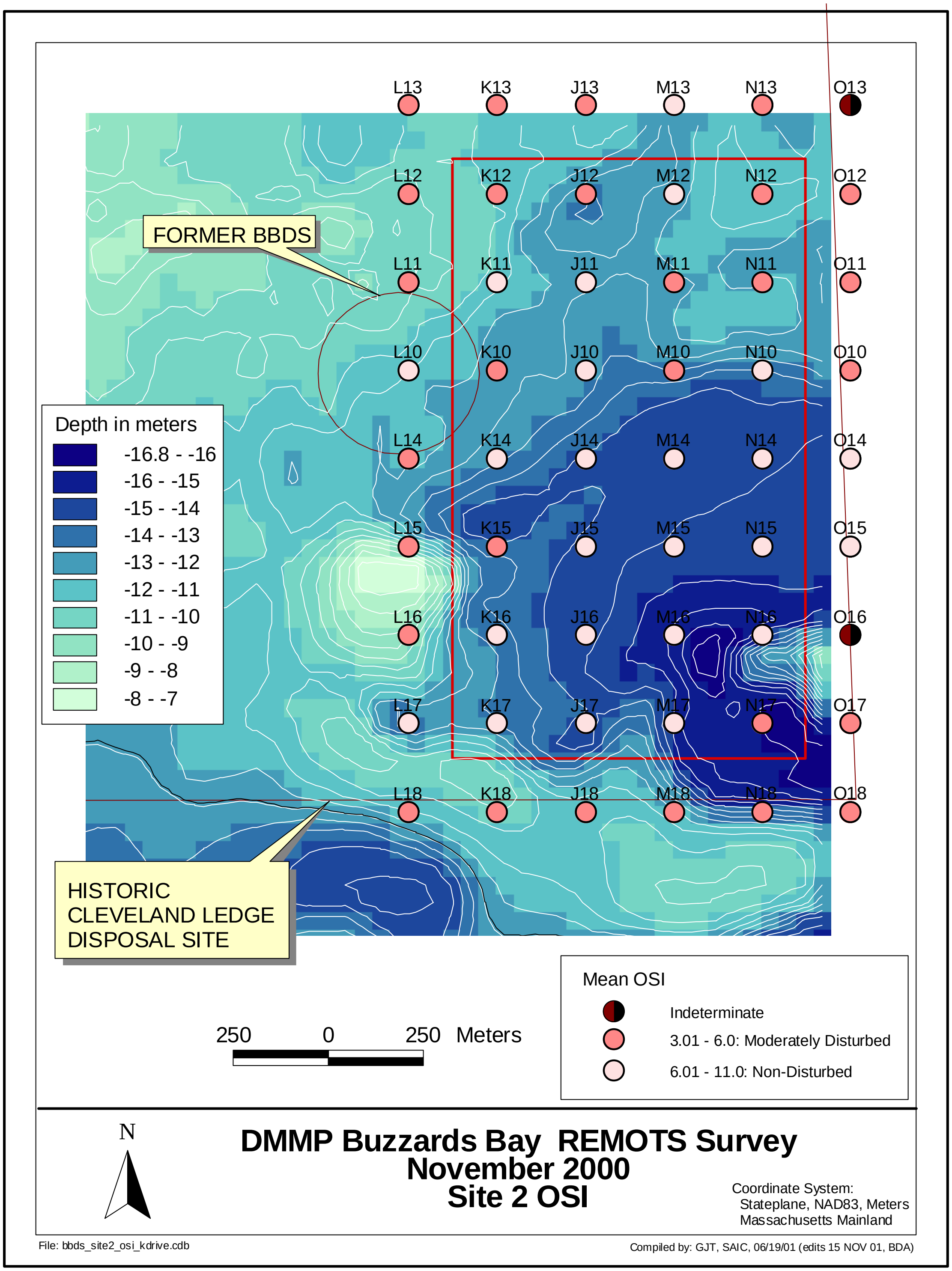


Figure 3-40. Map of mean OSI values at the Site 2 sampling stations.

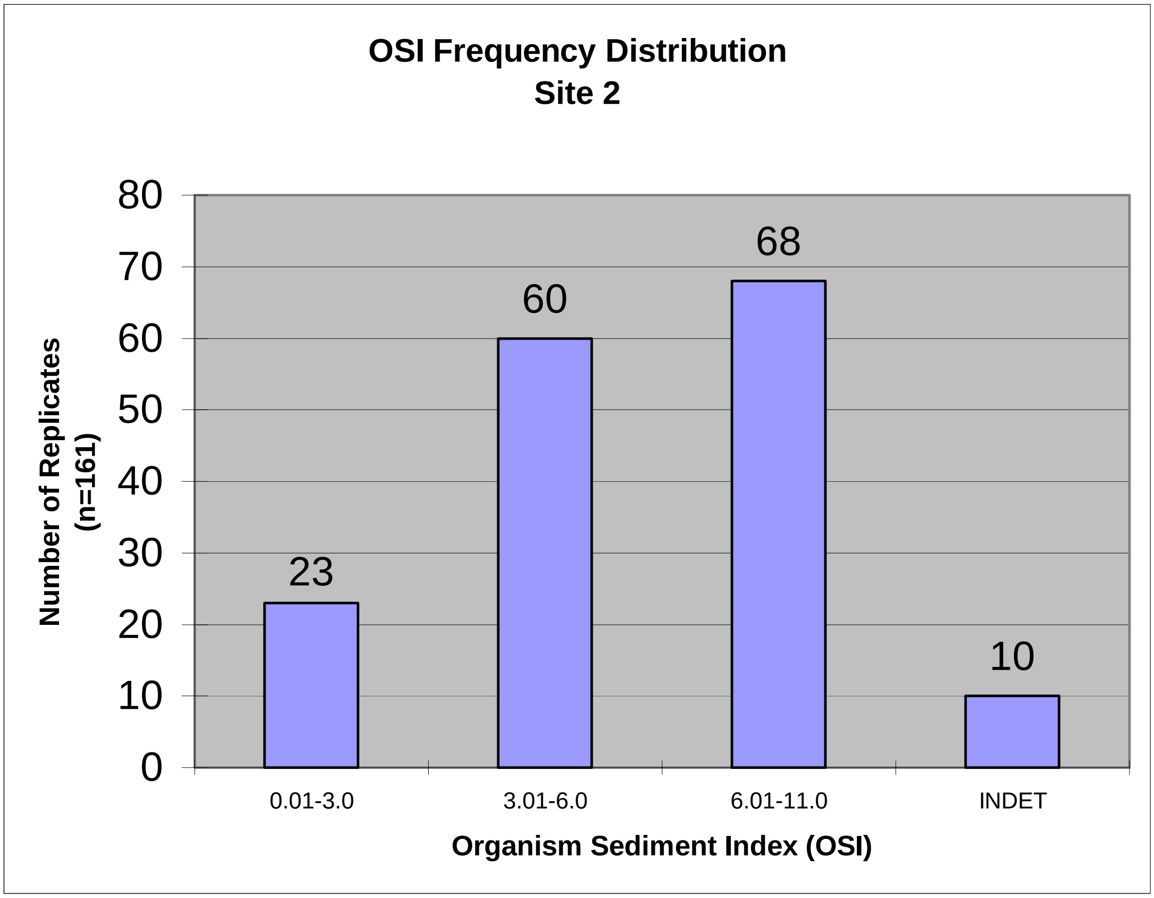


Figure 3-41. Frequency distribution of OSI values for the images obtained in Site 2.

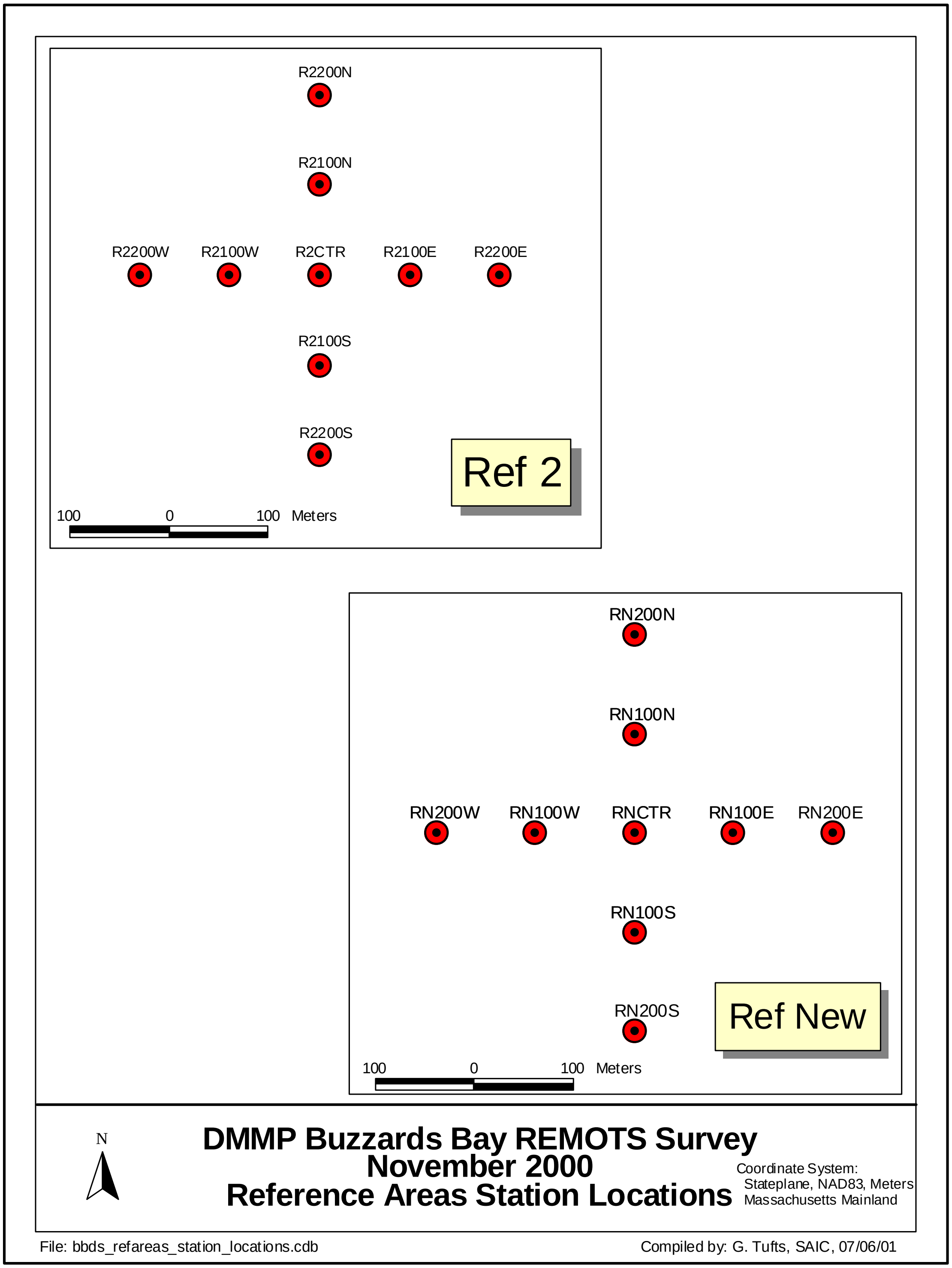


Figure 3-42. REMOTS® sampling stations at each of the two reference areas.

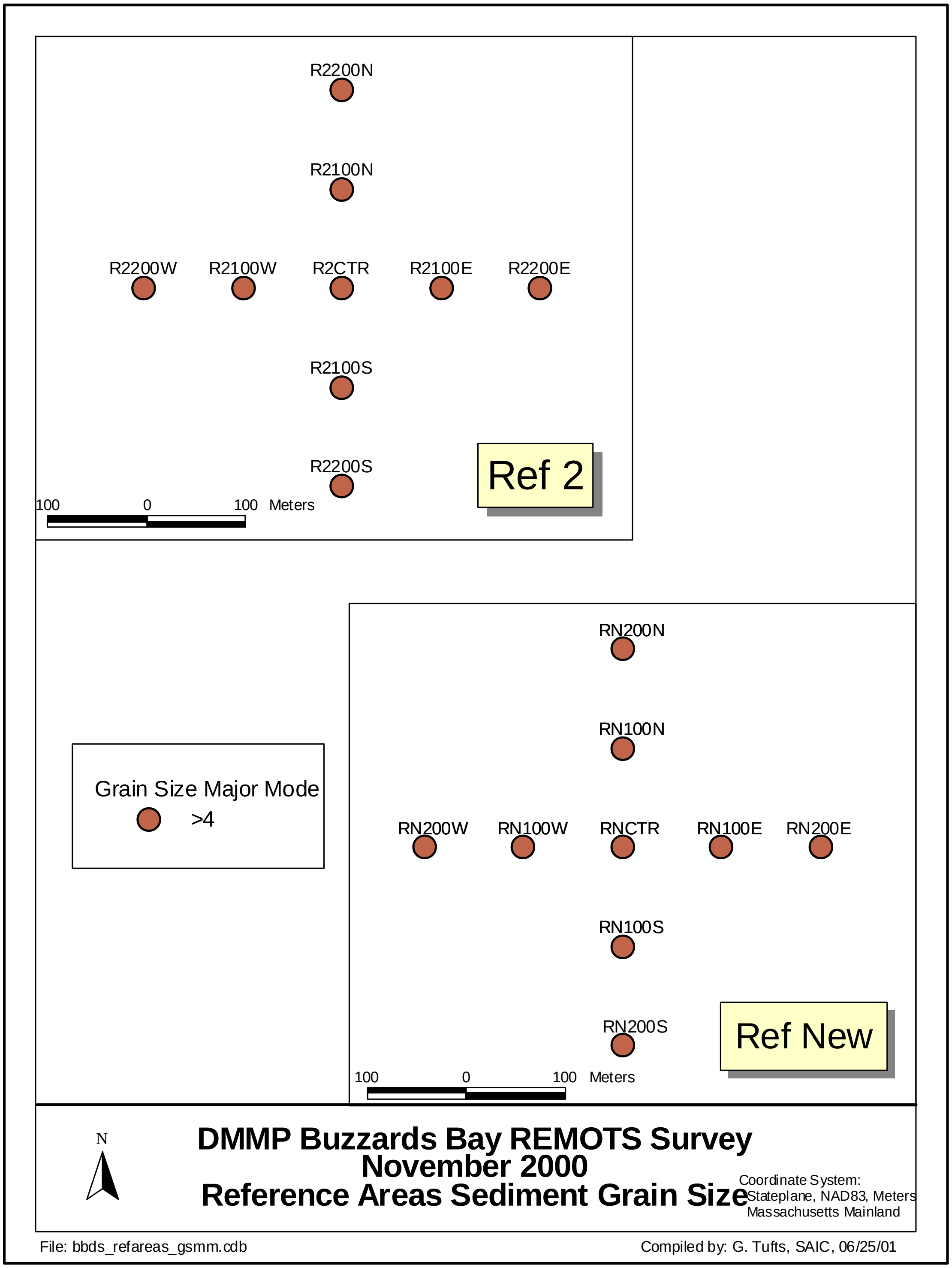


Figure 3-43. Map of grain size major mode at the two reference areas.

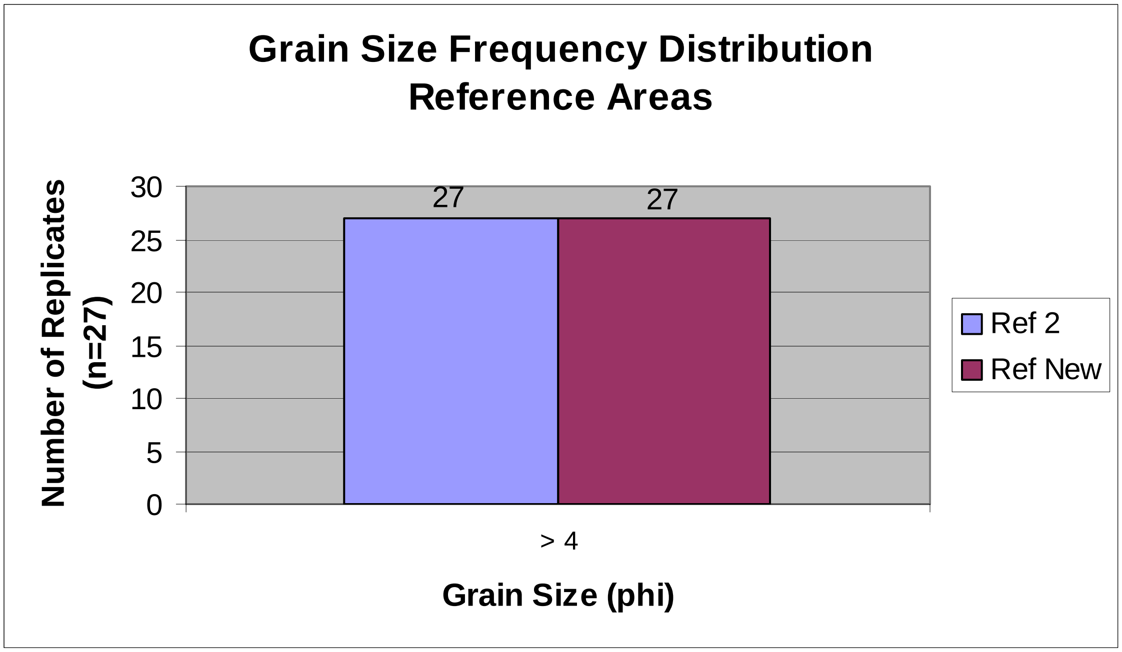


Figure 3-44. Frequency distribution showing the number of replicate images having a particular grain size major mode at each of the two reference areas.

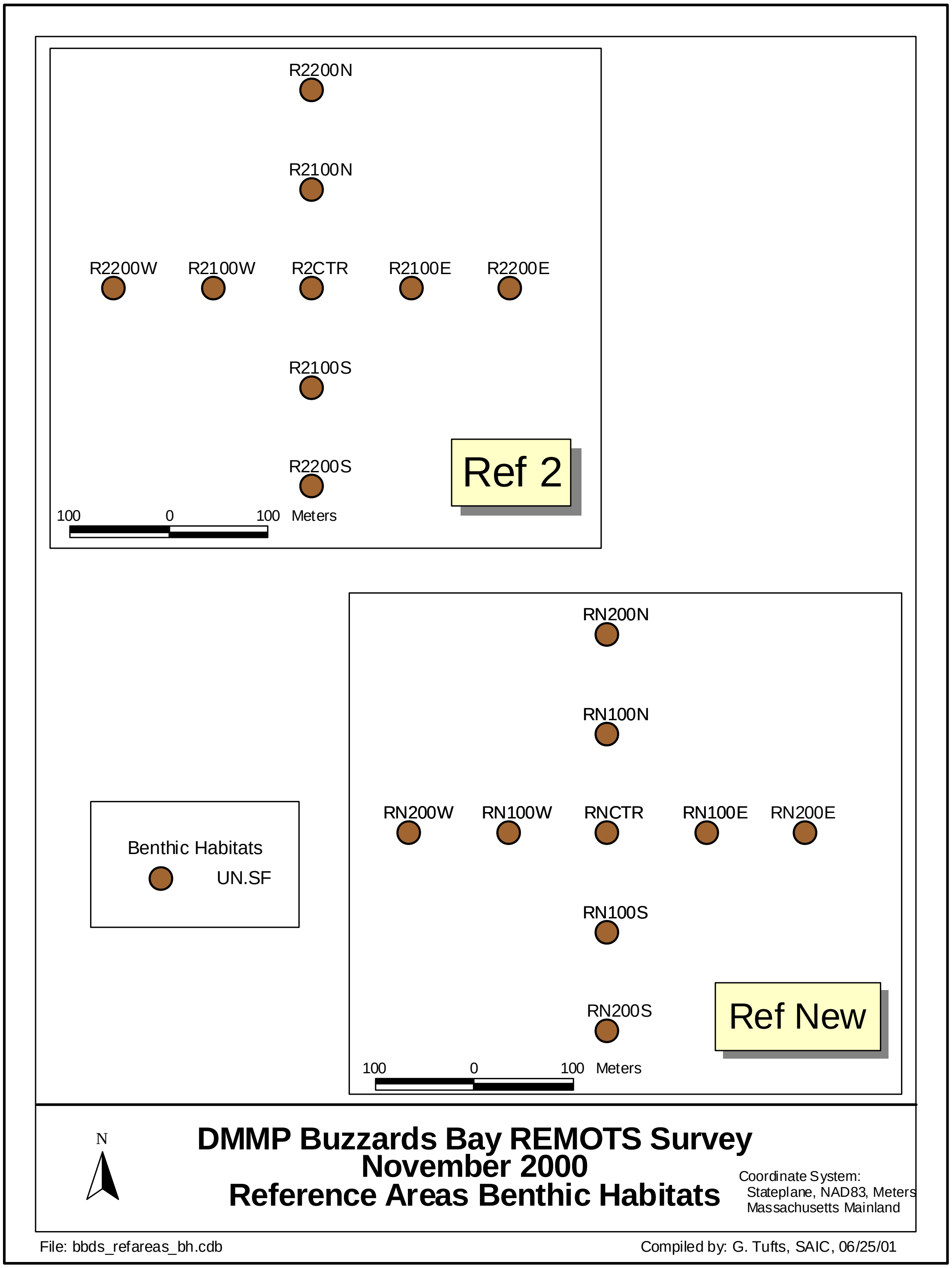
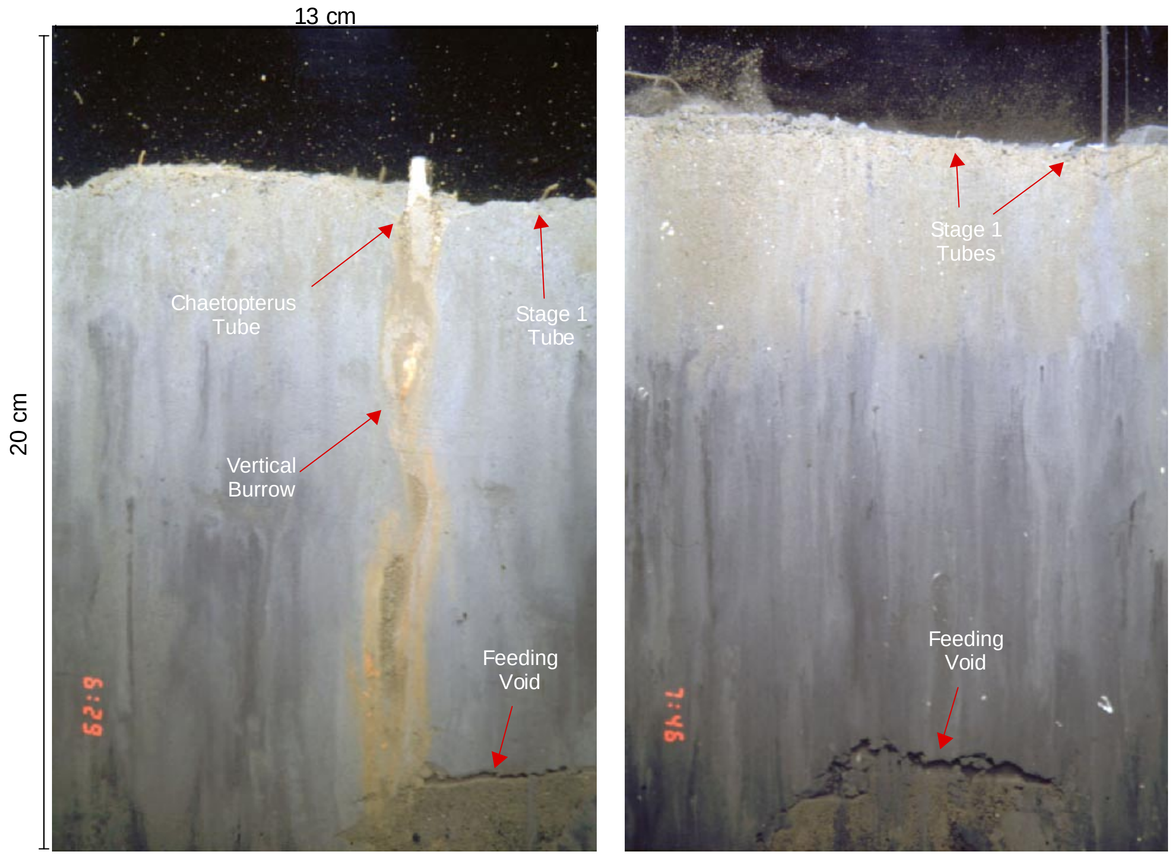


Figure 3-45. Map of benthic habitat types at each of the two reference areas.



File: Remots_Fig3_46

Figure 3-46. Two representative REMOTS® images from the reference areas showing unconsolidated, soft muddy sediments (habitat type UN.SF) with relatively deep camera prism penetration. The left image from Ref-New station 100S shows a large *Chaetopterus* tube and numerous small, Stage I polychaete tubes at the sediment surface, a vertical burrow surrounded by iron oxide (rust), and a Stage III feeding void at depth. The right image from Ref-2 station 200S shows Stage I surface polychaete tubes and a feeding void at depth. Both images were give a Stage I on III successional designation.

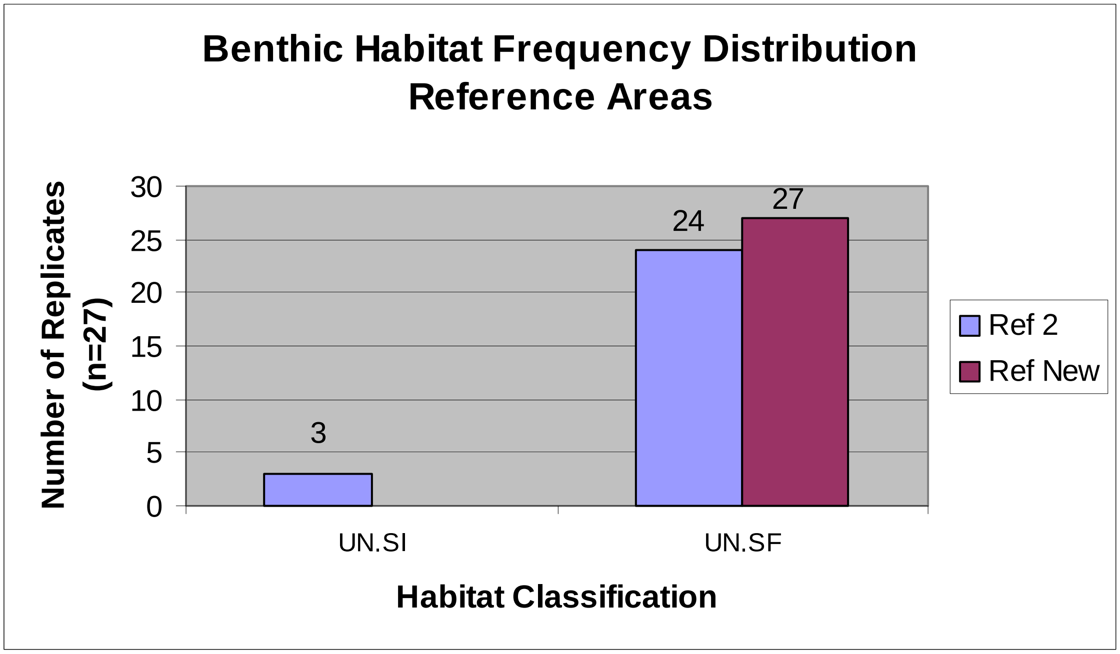


Figure 3-47. Frequency distribution showing the number of replicate images having a particular benthic habitat type classification at each of the two reference areas.

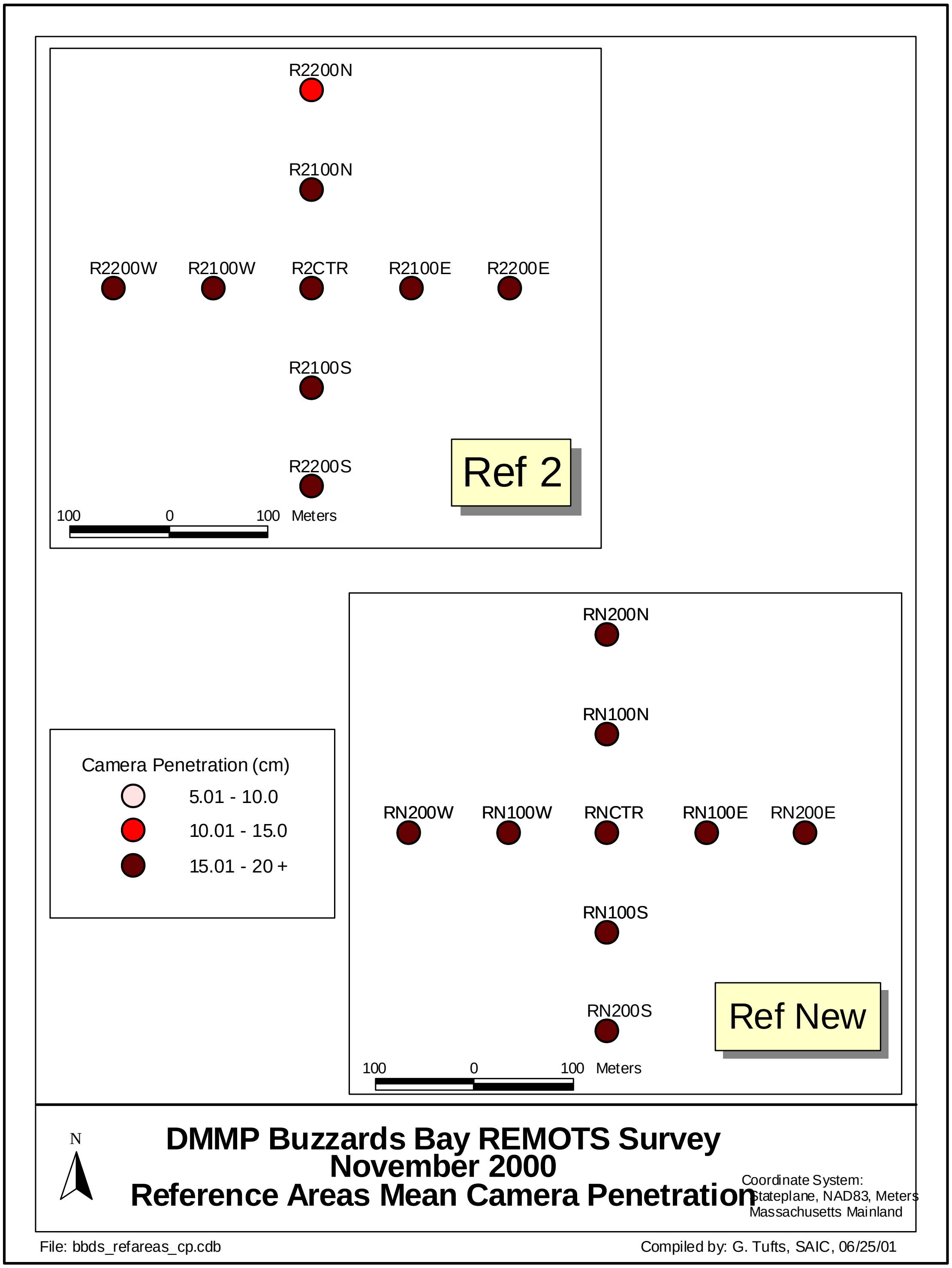


Figure 3-48. Map of mean camera prism penetration depths at each of the two reference areas.

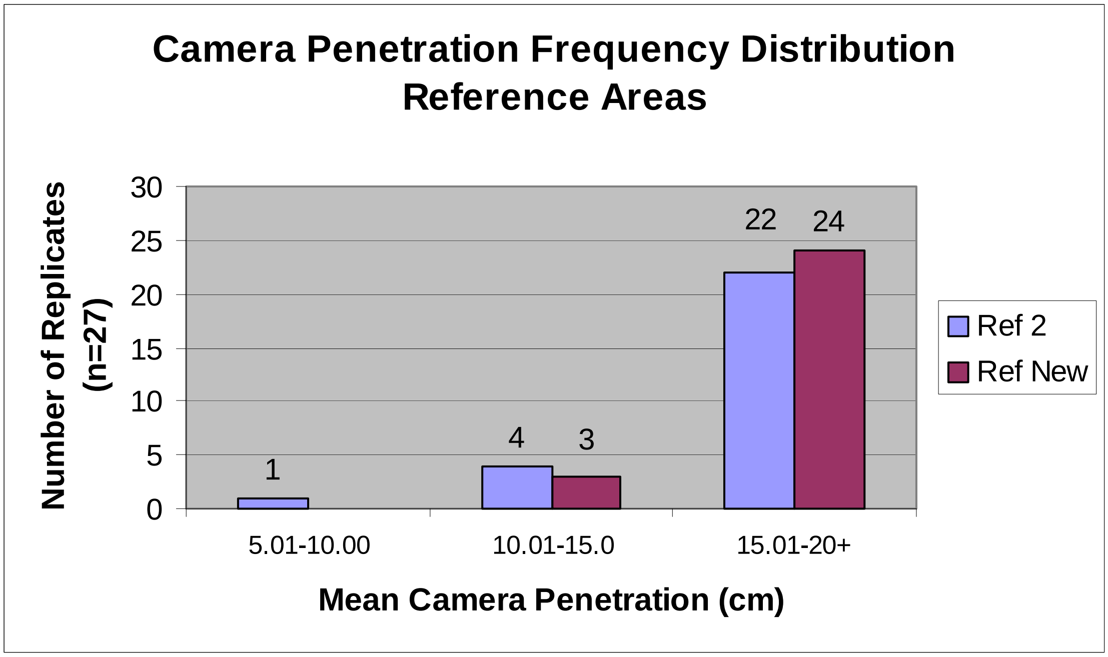


Figure 3-49. Frequency distribution of mean camera prism penetration depths for the images obtained at each of the two reference areas.

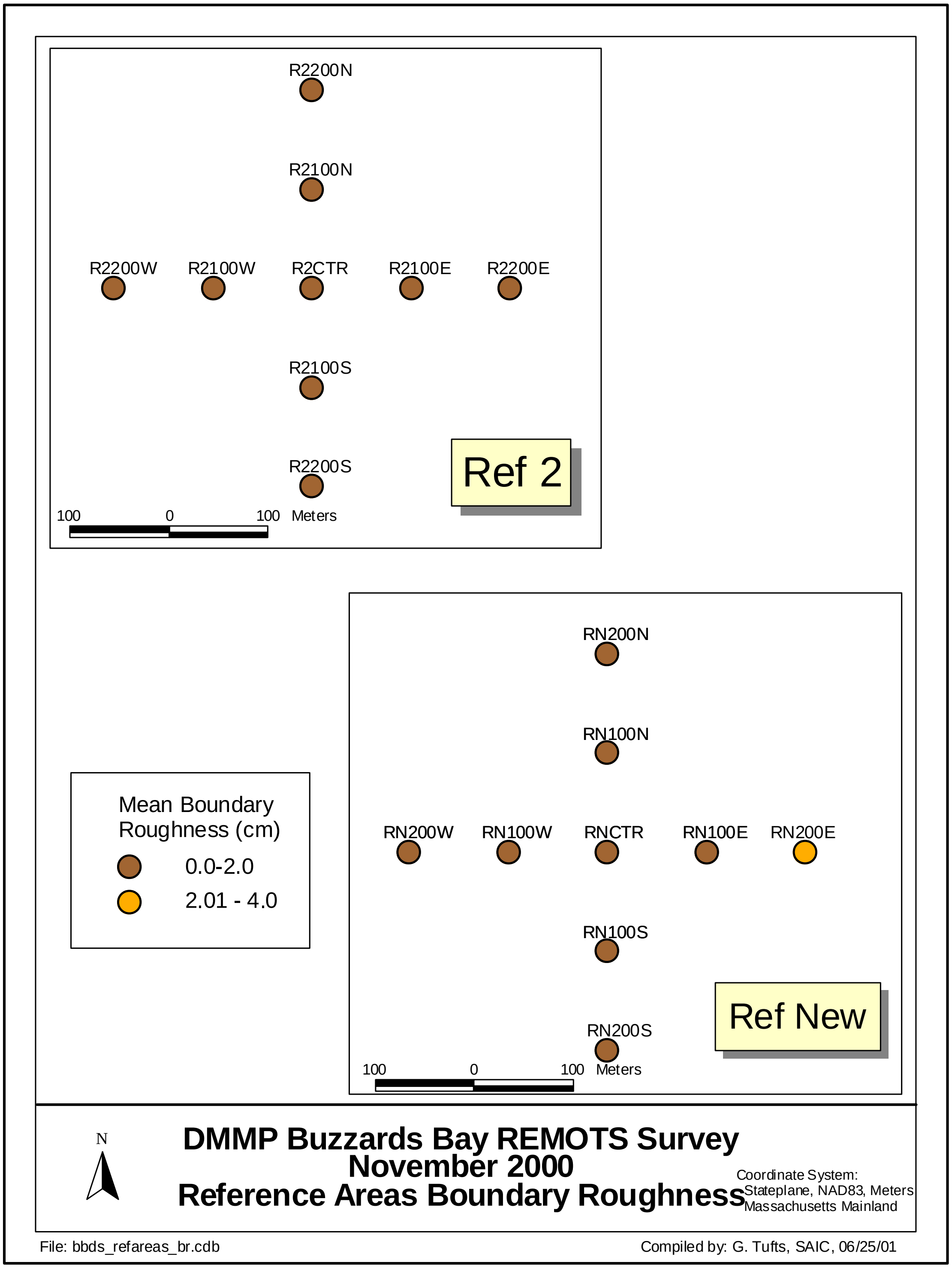


Figure 3-50. Map of mean boundary roughness values at each of the two reference areas.

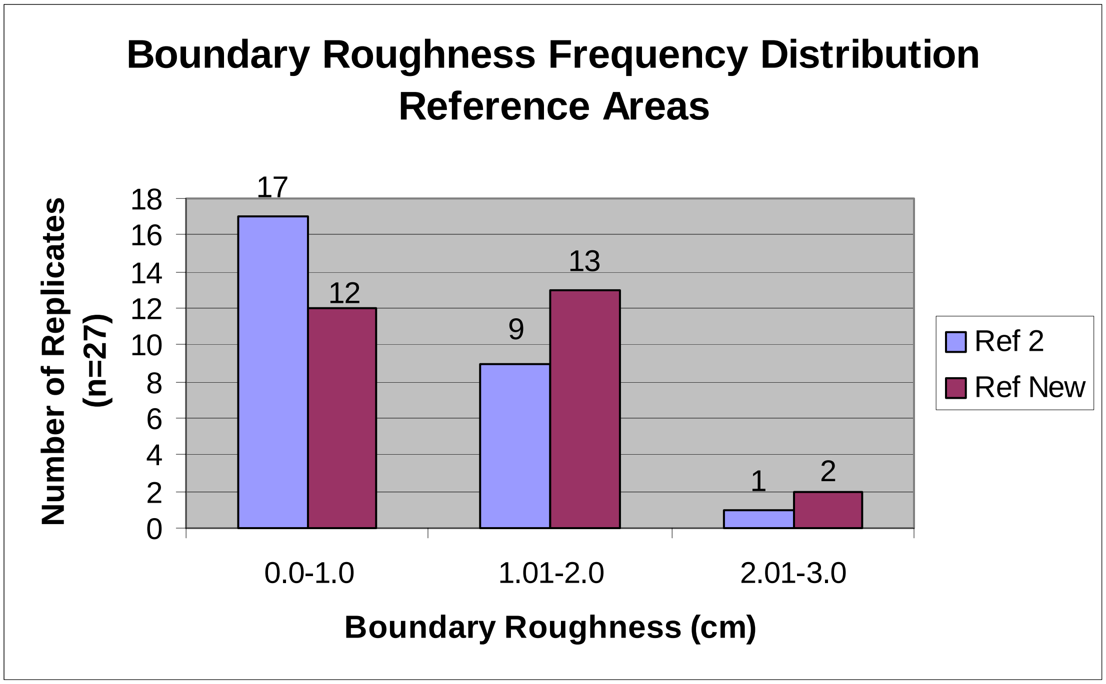


Figure 3-51. Frequency distribution of boundary roughness values for the images obtained at each of the two reference areas.

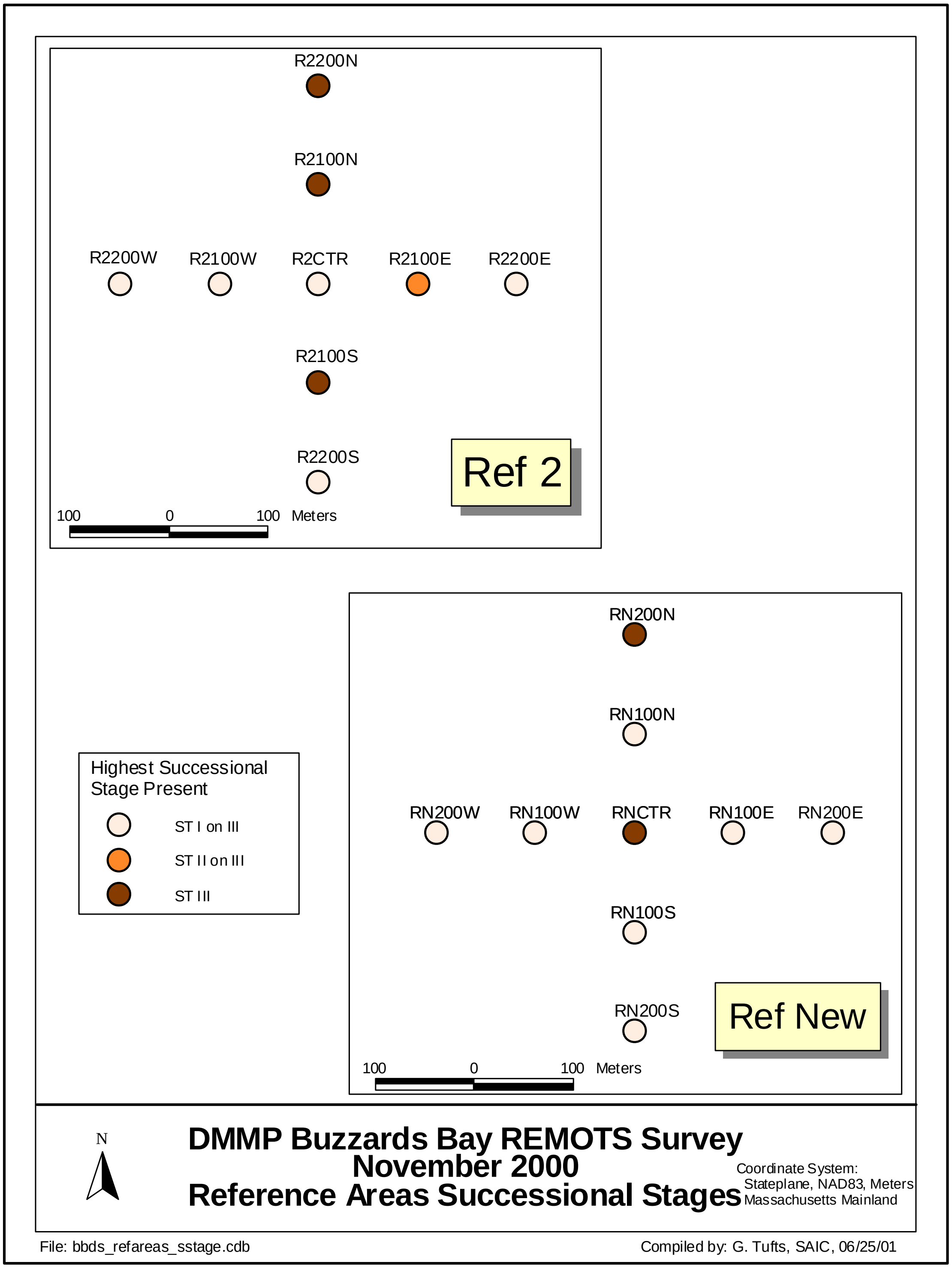


Figure 3-52. Map showing the highest infaunal successional stage observed among the replicate images obtained at each of the reference area stations.

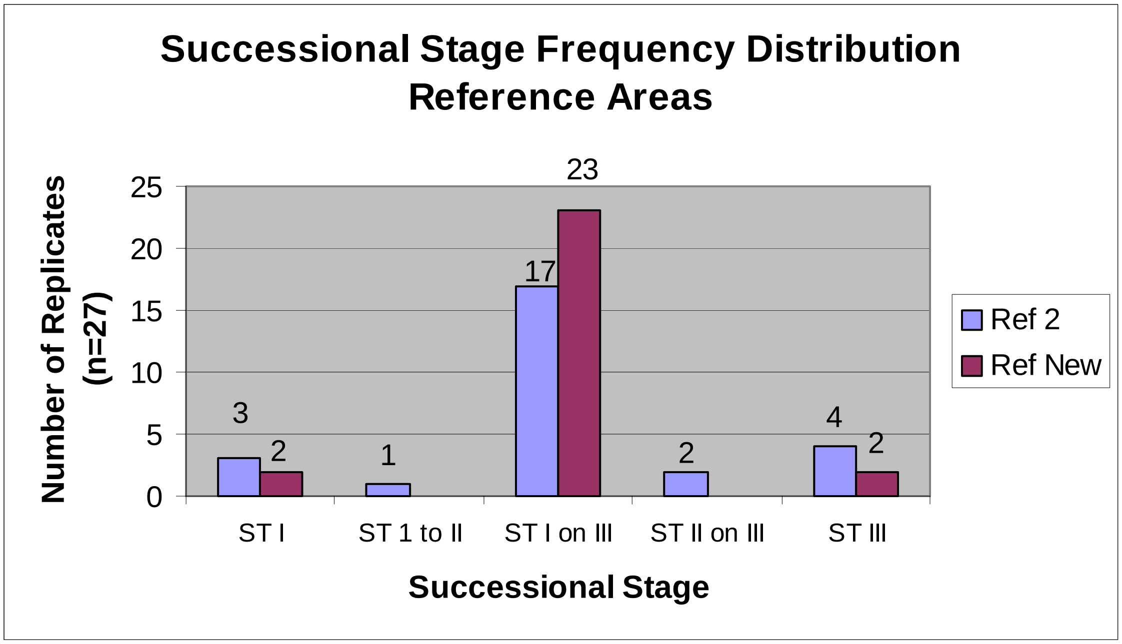


Figure 3-53. Frequency distribution of infaunal successional stages for the images obtained at each of the two reference areas.

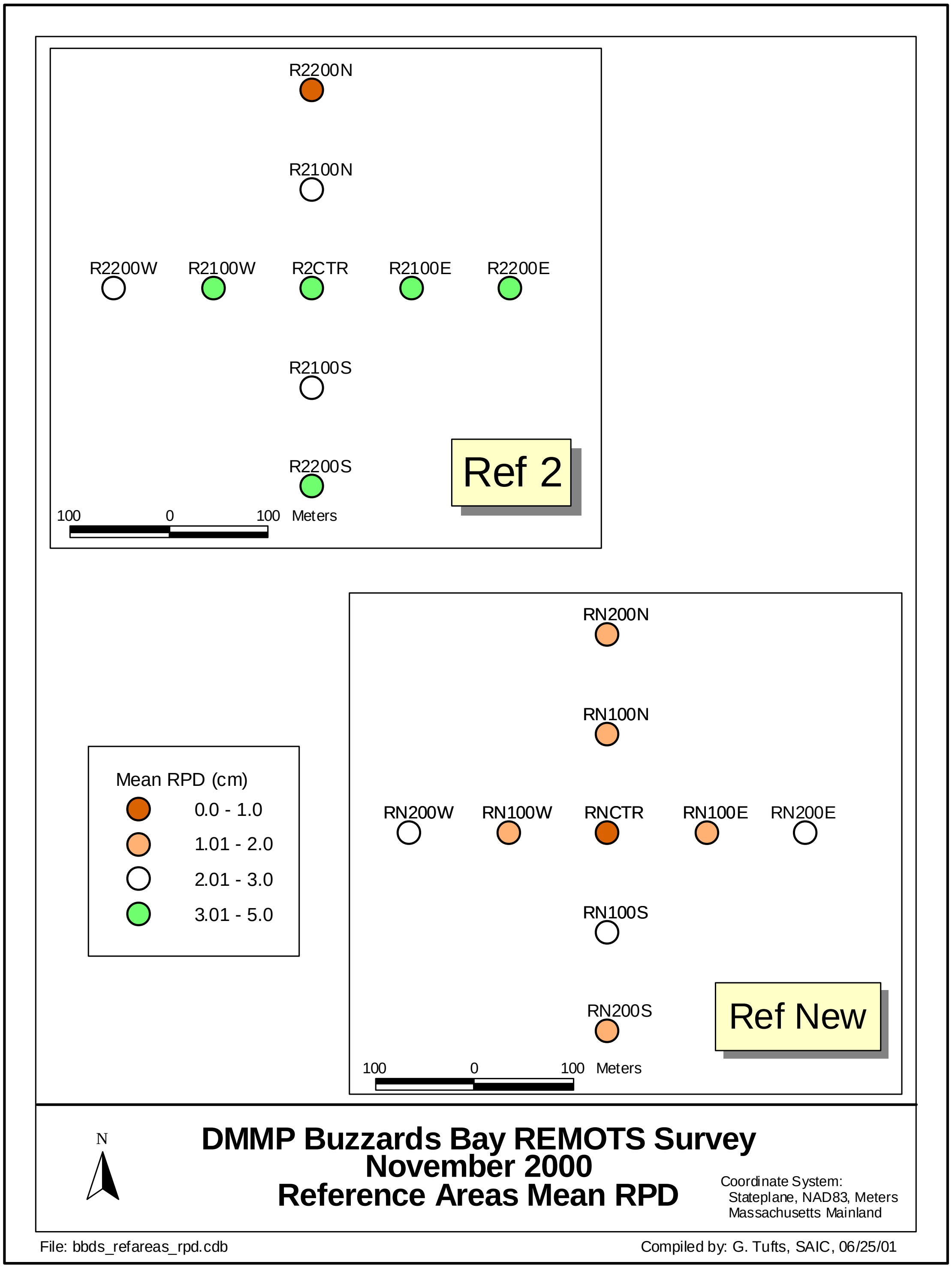


Figure 3-54. Map of mean apparent RPD depths at each of the two reference areas.

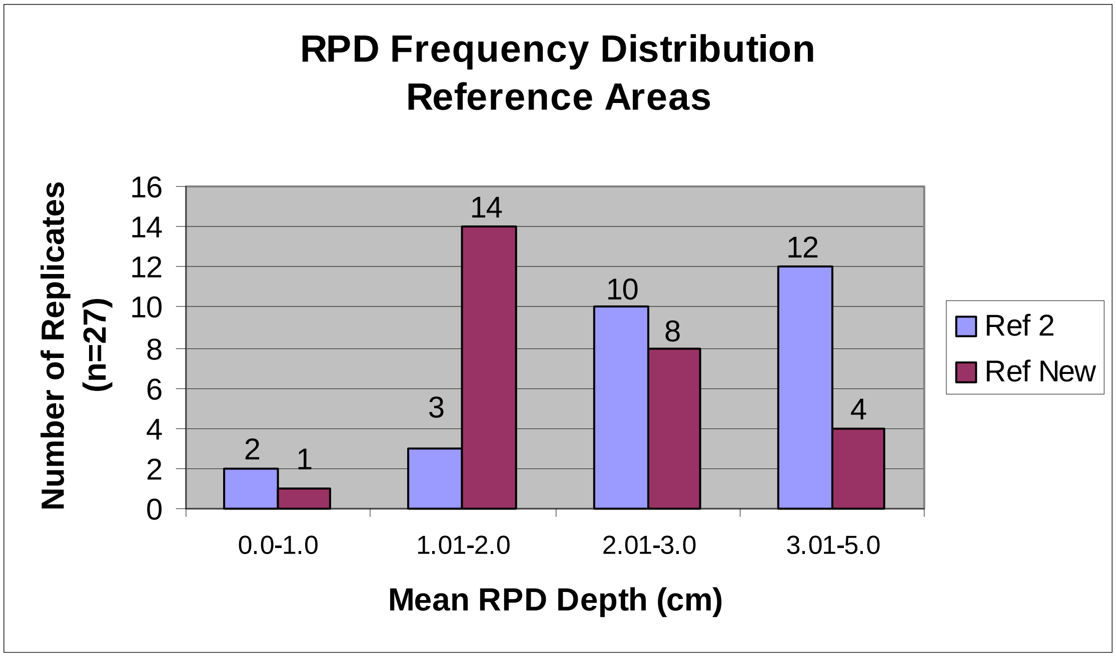


Figure 3-55. Frequency distribution of apparent RPD depths for the images obtained at each of the two reference areas.

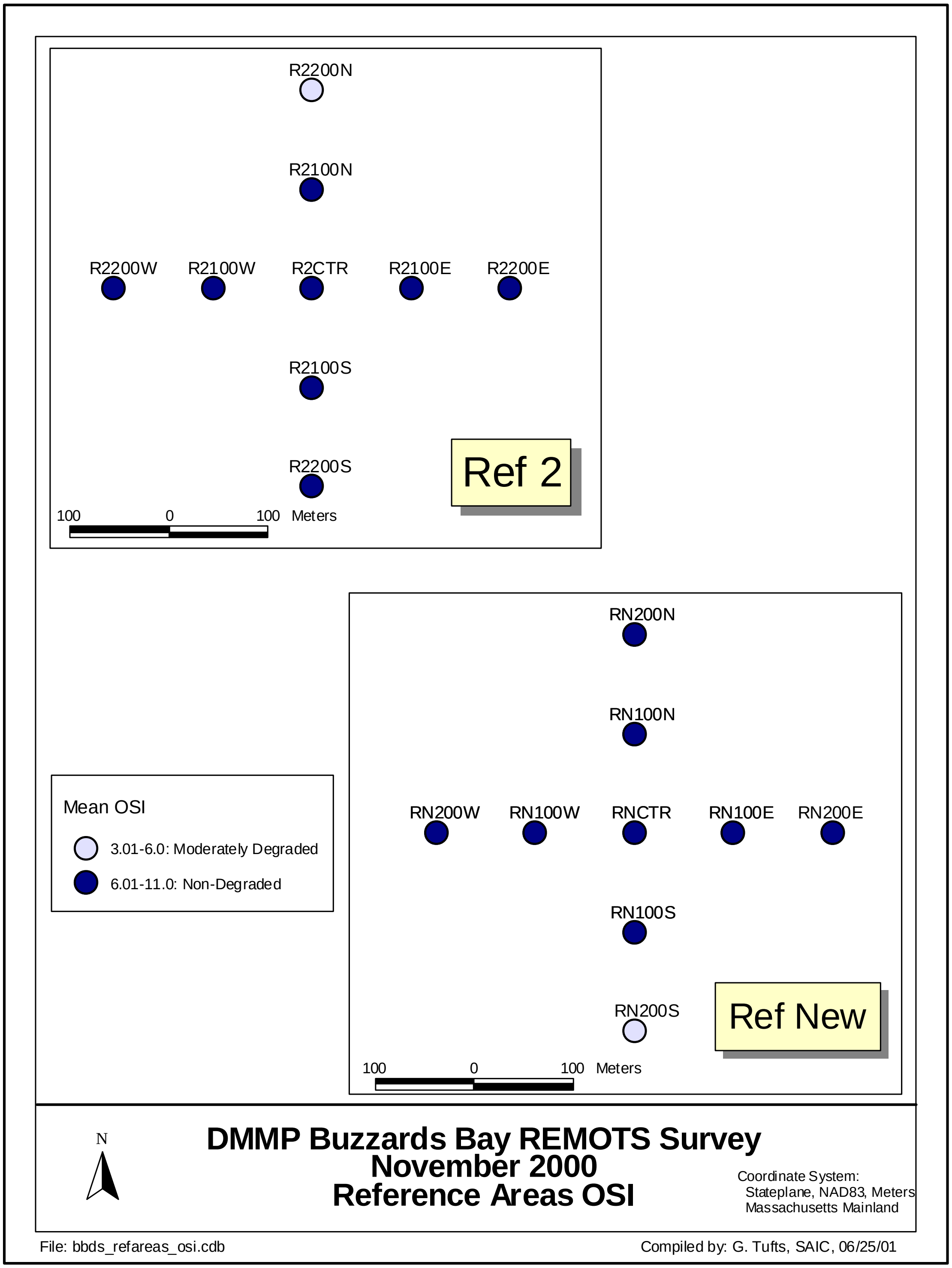


Figure 3-56. Map of mean OSI values at each of the two reference areas.

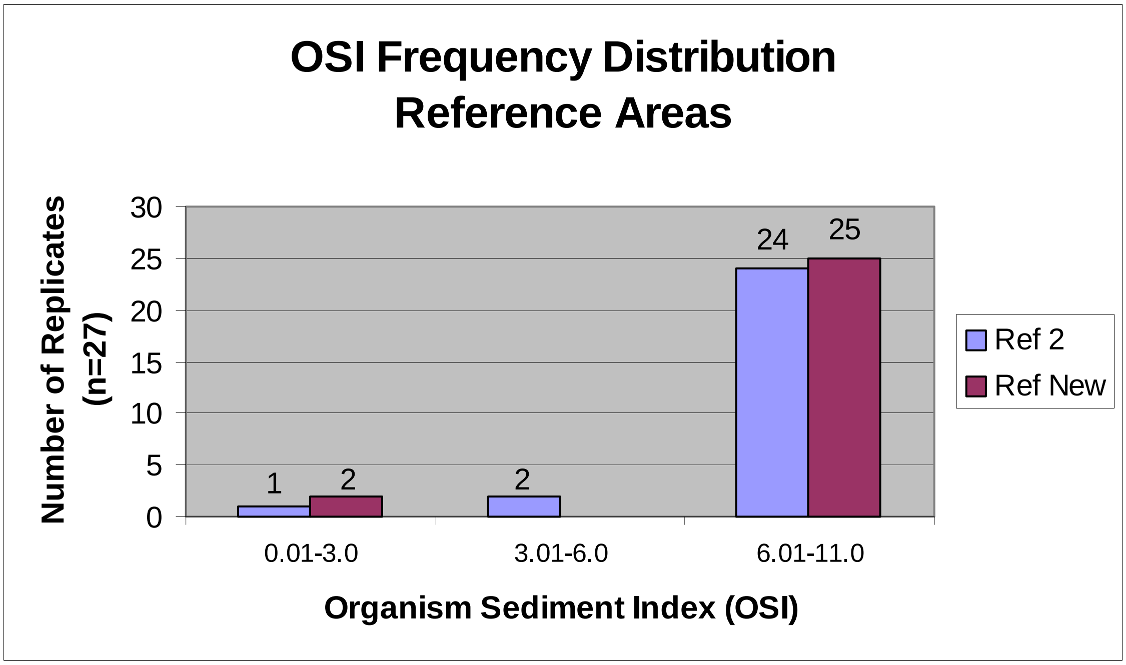


Figure 3-57. Frequency distribution of OSI values for the images obtained at each of the two reference areas.

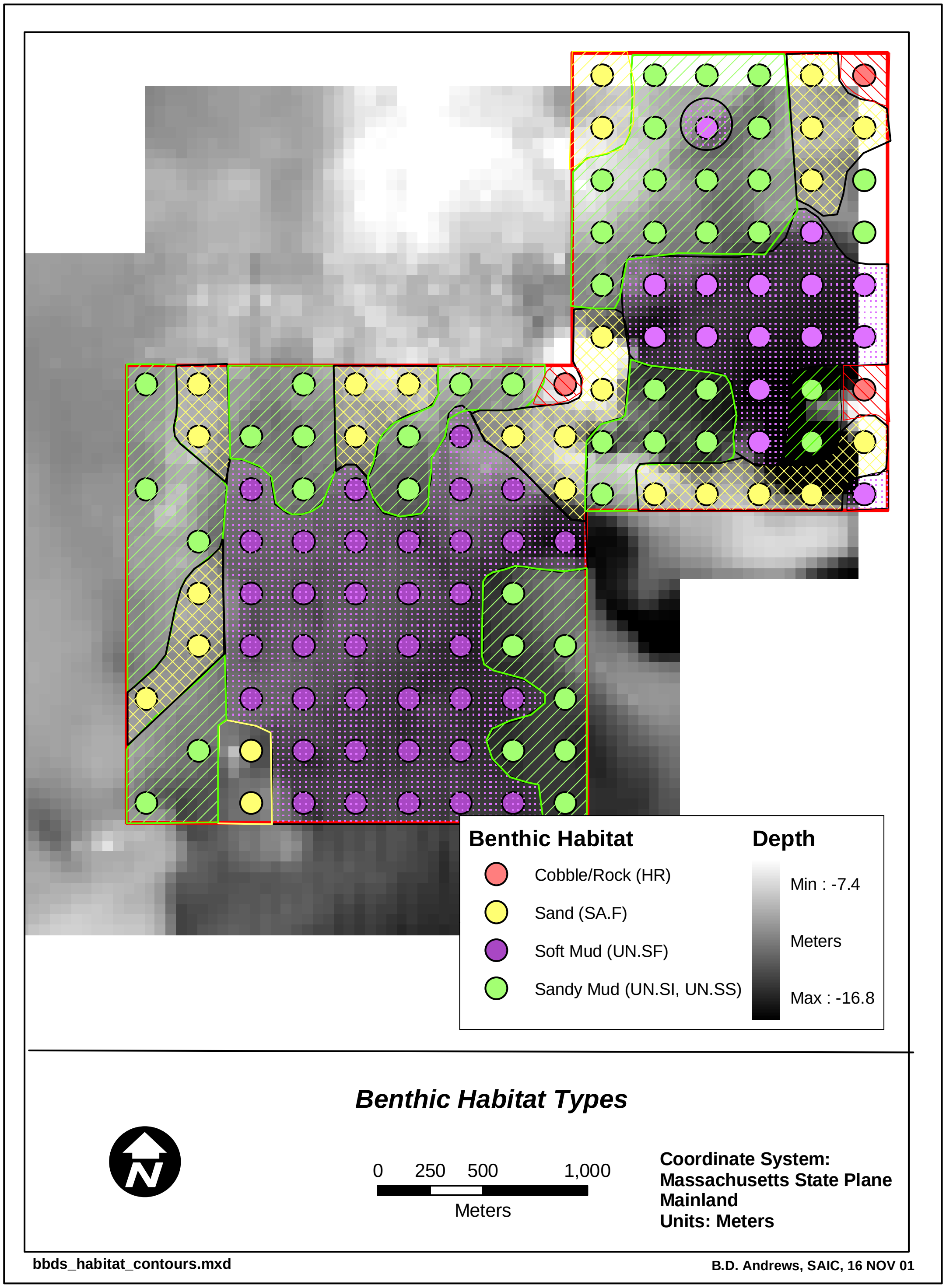


Figure 4-1. Summary contour map showing benthic habitat types in relation to depth at candidate disposal Sites 1 and 2.

Appendix Table 1
REMOTS image analysis results for all replicate images obtained at site 1

STATION	REPLICATE	GRAIN SIZE MIN	GRAIN SIZE MAX	GRAIN SIZE MAJOR MODE	CAMERA PENETRATION MIN	CAMERA PENETRATION MAX	CAMERA PENETRATION MEAN	CAMERA PENETRATION RANGE	SURFACE ROUGHNESS	APPARENT RPD AREA	APPARENT RPD MIN	APPARENT RPD MAX	APPARENT RPD MEAN	SUCCESSIONAL STAGE	OSI	MUD CLASTS STATUS	MUD CLASTS DIAMETER	BENTHIC HABITAT	COMMENTS
A1	A	>4	3	>4	11.6	12.3	11.9	0.6	PHYSICAL	31.8	0.5	3.2	2.4	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOID, TUBES
A1	B	>4	3	>4	11.7	12.6	12.1	0.9	PHYSICAL	17.1	0.1	4.3	2.7	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, WIPER CLAST, WORM @Z, CHAETOPTERUS TUBE
A1	C	>4	2	>4	14.5	15.9	15.2	1.4	PHYSICAL	12.8	0.2	3.4	2.1	ST_I	4.0	STATUS REDUCED	1.0	UN.SI	SANDY MUD>P, LG RED MUD CLAST, WORM @Z, TUBES
A2	A	>4	2	>4	7.4	8.8	8.1	1.4	PHYSICAL	21.9	0.7	2.6	1.6	ST_I	4.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, SHELL, WORM @Z?
A2	B	>4	2	>4	5.6	6.8	6.2	1.2	PHYSICAL	23.2	0.4	4.2	1.7	ST_I	4.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, WORM @Z?
A2	C	>4	2	>4	9.4	10.3	9.9	0.9	PHYSICAL	27.6	0.5	3.9	2.1	ST_I	4.0	STATUS OXIDIZED	0.3	UN.SS	SANDY MUD>P, LG TUBES, WORM @Z, OX&RED CLAST
A3	A	>4	2	>4	12.5	13.9	13.2	1.4	PHYSICAL	38.9	0.3	4.4	2.9	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, LG TUBES, WORM @Z, V LG VOID, BURROW, RED SED @SURF
A3	B	>4	2	>4	12.6	14.9	13.7	2.3	PHYSICAL	14.5	0.3	3.9	2.3	ST_I	5.0	STATUS OXIDIZED	1.3	UN.SI	SANDY MUD>P, LG OX&RED CLASTS, WORM @Z?, TUBES
A3	C	>4	2	>4	15.0	15.7	15.4	0.7	PHYSICAL	73.0	1.7	10.0	5.4	ST_I_ON_III	11.0	STATUS OXIDIZED	0.3	UN.SI	SANDY MUD>P, OX CLASTS, LG VOIDS, DEEP RPD
A4	A	>4	2	>4	7.9	9.4	8.7	1.5	PHYSICAL	19.3	0.5	2.3	1.4	ST_I	3.0	STATUS REDUCED	1.0	UN.SS	SANDY MUD>P, TUBES, WORM @Z, LG RED MUD CLAST, SHALLOW RPD
A4	B	>4	2	>4	9.6	11.9	10.8	2.4	PHYSICAL	29.2	0.8	3.9	2.2	ST_I	4.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, SLOPING TOPOGRAPHY, SAND/MUD
A4	C	>4	3	>4	5.8	6.9	6.3	1.1	PHYSICAL	5.7	0.1	1.4	0.6	ST_I	2.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, WORM @Z, WIPER SMEAR, FECAL MOUND?, V. SHALLOW RPD
A5	A	>4	2	>4	10.8	11.1	11.0	0.3	PHYSICAL	45.6	0.5	4.8	3.4	ST_I	6.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P
A5	B	>4	2	>4	11.9	12.8	12.4	0.9	PHYSICAL	37.7	1.0	4.6	2.8	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, VOID, WORM @Z
A5	C	>4	2	>4	10.2	11.4	10.8	1.2	PHYSICAL	31.0	0.2	5.4	2.3	ST_I	5.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P
A6	A	>4	2	>4	2.2	3.3	2.7	1.1	PHYSICAL	NA	NA	NA	NA	INDET	INDET	STATUS REDUCED	0.5	UN.SS	SANDY MUD>P, UNDERPEN, DIST SURF, LG TUBES, RED CLASTS, RED SED, WIPER CLAST
A6	B	>4	2	>4	10.6	13.5	12.1	2.8	PHYSICAL	40.7	1.5	5.4	3.0	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, VOID, TUBES, WORM @Z, SLOPING TOPOGRAPHY
A6	C	4	2	4 to 3	7.3	8.8	8.1	1.6	PHYSICAL	31.9	0.1	4.6	2.5	ST_I	5.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, WIPER CLASTS
A7	A	>4	2	4 to 3	8.7	10.0	9.4	1.3	PHYSICAL	35.6	1.2	3.3	2.6	ST_I_ON_III	9.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, VOID, BURROW, TUBES
A7	B	4	2	4 to 3	7.2	8.6	7.9	1.4	PHYSICAL	30.6	1.3	4.0	2.8	ST_I_ON_III	9.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, VOID, TUBES, SHELL BITS
A7	C	4	2	4 to 3	6.4	7.0	6.7	0.6	PHYSICAL	24.7	0.3	2.3	1.8	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P
A8	A	4	2	4 to 3	5.1	5.7	5.4	0.6	PHYSICAL	19.6	0.6	2.4	1.4	ST_I	3.0	STATUS REDUCED	0.4	UN.SS	SANDY MUD>P, UNDERPEN, RED CLASTS, IRON OXIDE STREAK
A8	B	>4	2	>4	8.0	8.4	8.2	0.4	PHYSICAL	26.6	1.0	2.9	1.9	ST_I	4.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, BURROW
A8	C	>4	2	>4	6.9	7.6	7.3	0.7	PHYSICAL	18.9	0.1	3.0	1.7	ST_I	4.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, WIPER CLAST, REDUCED SED, WORM @Z
A9	A	4	2	>4	11.1	12.2	11.6	1.1	PHYSICAL	27.5	0.8	2.9	2.0	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, VOID, WORMS @Z, MACRO ALGAE
A9	B	4	3	>4	11.4	12.5	11.9	1.1	PHYSICAL	6.0	0.2	2.0	0.8	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOIDS, SHALLOW RPD, WIPER CLAST
A9	C	4	2	>4	9.5	9.8	9.7	0.4	PHYSICAL	28.1	0.5	3.2	2.2	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOID?
B1	A	>4	2	4 to 3	2.9	4.2	3.6	1.3	PHYSICAL	15.4	0.0	0.0	1.8	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, TUBES, CHAETOPTERUS TUBES
B1	B	>4	2	4 to 3	4.4	5.6	5.0	1.2	PHYSICAL	22.6	1.0	2.4	1.6	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P
B1	C	>4	3	4 to 3	2.0	2.5	2.2	0.5	PHYSICAL	NA	NA	NA	NA	ST_I	INDET	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, WIPER SMEARS
B2	A	>4	2	4 to 3	9.0	9.8	9.4	0.9	PHYSICAL	25.3	0.8	5.0	1.9	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, PEBBLES, SHELL BITS, WORM @Z, SAND/MUD
B2	B	>4	2	4 to 3	8.1	9.0	8.6	1.0	PHYSICAL	19.1	0.4	2.0	1.4	ST_I	3.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SHELL BITS, SM VOID?, RED SED
B2	C	>4	2	4 to 3	5.2	6.0	5.6	0.8	PHYSICAL	32.0	1.2	3.3	2.3	ST_I	5.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, AMPHIPOD TUBES?
B3	A	>4	2	>4	8.8	10.0	9.4	1.2	PHYSICAL	32.7	1.2	3.3	2.4	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, LG VOID, TUBES, WORM @Z, MACRO ALGAE
B3	B	>4	2	>4	7.3	8.7	8.0	1.3	PHYSICAL	26.9	0.4	2.9	2.0	ST_I	4.0	STATUS OXIDIZED	0.2	UN.SS	SANDY MUD>P, TUBES, BURROW?, OX&RED CLASTS
B3	C	>4	2	>4	9.3	9.9	9.6	0.6	PHYSICAL	13.7	0.5	3.0	2.1	ST_I	4.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, WIPER CLAST?, REDUCED SED
B4	A	>4	3	>4	10.9	12.5	11.7	1.7	BIOGENIC	58.8	1.6	5.9	4.3	ST_I_TO_II	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, DENSE TUBES, AMPHIPOD TUBES, CHAET. TUBE
B4	B	>4	2	>4	11.4	12.6	12.0	1.2	PHYSICAL	34.0	1.6	3.8	2.5	ST_I	5.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, RED SED, SHELL BITS
B4	C	>4	3	>4	9.8	10.3	10.1	0.5	PHYSICAL	23.8	0.3	3.4	1.8	ST_I	4.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, AMPHIPOD TUBE
B5	A	>4	2	4 to 3	4.6	5.7	5.2	1.1	PHYSICAL	21.5	0.6	3.1	1.6	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, TUBES, RED SED
B5	B	>4	2	4 to 3	5.7	6.5	6.1	0.8	PHYSICAL	21.3	0.6	2.7	1.6	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, WORM @Z
B5	C	>4	2	4 to 3	5.4	5.7	5.6	0.4	PHYSICAL	23.4	0.9	2.3	1.7	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, WORM @Z
B6	A	>4	2	4 to 3	7.6	9.4	8.5	1.7	PHYSICAL	25.7	0.3	3.1	1.9	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, LG TUBES, BURROW
B6	B	>4	2	4 to 3	5.7	6.4	6.1	0.7	PHYSICAL	16.3	0.2	2.0	1.2	ST_I	3.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, WORM @Z?, SHALLOW RPD, REDUCED SED
B6	C	>4	2	4 to 3	7.7	8.8	8.3	1.1	PHYSICAL	19.8	0.2	3.0	1.5	ST_I	3.0	STATUS OXIDIZED	0.3	SA.F	MUDDY SAND>P, OX CLASTS, TUBES, WORM @Z, SHELL BITS
B7	A	>4	2	>4	10.3	11.6	11.0	1.3	PHYSICAL	38.5	2.1	3.5	2.8	ST_I	5.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, BURROW
B7	B	>4	2	>4	12.4	12.7	12.5	0.3	PHYSICAL	24.8	0.2	3.0	1.8	ST_I	4.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P
B7	C	>4	2	>4	6.0	8.3	7.1	2.4	PHYSICAL	8.4	0.1	2.0	0.9	ST_I	3.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, SHALLOW RPD, REDUCED SED, WIPER CLASTS, DIST SURF
B8	A	>4	2	>4	16.4	17.4	16.9	1.0	BIOGENIC	11.2	0.6	3.6	2.4	ST_I	5.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P,TUBES,2 FILLED VERT BURROWS, Fe OXIDE,FECAL/SAND MOUND
B8	B	>4	3	>4	15.4	16.0	15.7	0.5	PHYSICAL	16.5	0.1	3.4	1.9	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, BURROW, VOID?, WIPER CLAST
B8	C	>4	3	>4	16.1	17.0	16.5	0.8	PHYSICAL	36.5	0.3	5.6	3.1	ST_I_ON_III	10.0	STATUS OXIDIZED	0.4	UN.SI	SANDY MUD>P, VOID, BURROWS, OX SED@Z
B9	A	>4	3	>4	4.2	6.1	5.1	2.0	PHYSICAL	29.2	1.1	3.3	2.1	ST_I	4.0	STATUS REDUCED	0.5	UN.SS	SANDY MUD>P, V LG REDUCED MUD CLAST, REDUCED SEDIMENT, WORM @Z,SAND/MUD
B9	B	>4	2	>4	10.6	11.8	11.2	1.2	PHYSICAL	19.2	0.9	5.4	2.0	ST_III	8.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, CHAETOPTERUS TUBE, REDUCED SEDIMENT
B9	C	>4	2	>4	11.6	15.0	13.3	3.4	PHYSICAL	41.0	1.2	4.7	3.1	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, BURROWS, VOID, SAND/MUD
C1	A	>4	2	>4	8.8	9.5	9.2	0.7	PHYSICAL	34.7	1.5	3.9	2.5	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, LG VOID
C1	B	>4	2	>4	9.8	10.8	10.3	1.0	PHYSICAL	38.0	0.4	4.2	2.8	ST_I	5.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, MULINIA?, WORM @Z
C1	C	>4	2	>4	8.2	9.7	8.9	1.5	PHYSICAL	22.9	0.1	3.6	1.9	ST_III	8.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, LG VOID, WIPER SMEAR, CHAETOPTERUS TUBE
C2	A	>4	2	>4	9.8	10.5	10.1	0.7	PHYSICAL	22.0	0.6	2.8	1.6	ST_I_ON_III	8.0	STATUS OXIDIZED	0.2	UN.SI	SANDY MUD>P, SM VOID, WORM @Z, OX CLASTS
C2	B	>4	3	>4	14.9	16.4	15.6	1.5	PHYSICAL	40.7	0.1	5.7	3.1	ST_III	10.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, SMALL VOID, RED SED @SURF, WIPER CLASTS
C2	C	>4	3	>4	11.0	11.9	11.5	0.9	PHYSICAL	15.3	0.3	2.8	1.6	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOID, CHAETOPTERUS TUBE, TUBES
C3	A	>4	2	>4	17.4	18.1	17.7	0.7	PHYSICAL	47.5	0.6	5.9	3.6	ST_I_ON_III	10.0	STATUS OXIDIZED	0.3	UN.SI	SANDY MUD>P, VOIDS, OX BURROW, AMP TUBE, FILLED VERT BURROW, SAND/MUD
C3	B	>4	3	>4	16.9	18.5	17.7	1.6	PHYSICAL	67.3	2.4	7.0	5.0	ST_I_ON_III	11.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, TUBES
C3	C	>4	3	>4	14.8	15.9	15.4	1.1	PHYSICAL	16.3	0.1	4.1	2.1	ST_I_ON_III	8.0	STATUS OXIDIZED	0.4	UN.SF	SANDY MUD>P, OX&RED CLASTS, VOID, WORM @Z
C4	A	>4	3	>4	18.1	20.4	19.3	2.3	PHYSICAL	28.0	0.2	6.6	3.1	ST_I_ON_III	10.0	STATUS OXIDIZED	0.4	UN.SF	SANDY MUD>P, VOID?, FILLED BURROW OPENING, WIPER CLAST
C4	B	>4	3	>4	19.1	19.9	19.5	0.8	PHYSICAL	9.6	0.3	4.1	2.5	ST_I_ON_III	9.0	STATUS REDUCED	0.6	UN.SF	SANDY MUD>P, RED CLASTS, VOID, BURROW, TUBES
C4	C	>4	3	>4	15.9	19.3	17.6	3.4	PHYSICAL	8.4	0.2	2.9	1.7	ST_III	8.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, IRREGULAR TOPOGRAPHY, SMALL RPD AREA

Appendix Table 1
REMOTS image analysis results for all replicate images obtained at site 1

STATION	REPLICATE	GRAIN SIZE MIN	GRAIN SIZE MAX	GRAIN SIZE MAJOR MODE	CAMERA PENETRATION MIN	CAMERA PENETRATION MAX	CAMERA PENETRATION MEAN	CAMERA PENETRATION RANGE	SURFACE ROUGHNESS	APPARENT RPD AREA	APPARENT RPD MIN	APPARENT RPD MAX	APPARENT RPD MEAN	SUCCESSIONAL STAGE	OSI	MUD CLASTS STATUS	MUD CLASTS DIAMETER	BENTHIC HABITAT	COMMENTS
C5	A	>4	3	>4	20.4	20.7	20.5	0.3	PHYSICAL	8.6	0.2	3.0	2.5	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, OVERPEN, SM VOID, TUBE, SHALLOW RPD
C5	B	>4	3	>4	20.4	20.9	20.6	0.5	PHYSICAL	42.5	0.1	4.5	3.0	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, OVERPEN, VOID, BURROW, BURROW OPENING, WIPER CLAST
C5	C	>4	3	>4	16.8	18.6	17.7	1.9	PHYSICAL	15.1	0.1	3.0	1.9	ST_III	8.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, BURROW, WIPER CLASTS
C6	A	>4	2	>4	15.8	17.5	16.6	1.8	INDET	0.0	N/A	N/A	N/A	ST_III	INDET	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, DIST SURF FROM PULL AWY, WORM @SURF?, VOIDS, WORM @Z
C6	B	>4	2	>4	15.5	20.5	18.0	5.1	PHYSICAL	10.7	0.1	2.5	1.4	ST_I	3.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, IRREGULAR & SLOPING TOPO., TUBES, BURROW, SHELL BITS
C6	C	>4	2	>4	20.0	20.9	20.4	0.9	PHYSICAL	6.7	0.1	4.3	1.7	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, OVERPEN, VOID, BURROW, SURFACE REWORK, WIPER CLAST
C7	A	>4	2	>4	19.3	20.6	20.0	1.3	PHYSICAL	20.8	0.7	7.4	4.2	ST_I_ON_III	11.0	STATUS REDUCED	0.4	UN.SF	HOMOGENOUS MUD>P, VOID, TUBES, RED CLASTS, FILLED VERT BURROW, Fe OXIDE
C7	B	>4	3	>4	17.5	19.8	18.7	2.3	PHYSICAL	18.7	0.2	4.0	1.3	ST_I	3.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, WIPER CLASTS, IRON OXIDE STREAK
C7	C	>4	3	>4	20.2	20.7	20.5	0.6	PHYSICAL	22.5	0.4	5.5	3.5	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, TUBES, VOIDS, BURROWS, WIPER CLASTS
C8	A	4	2	4 to 3	4.8	5.6	5.2	0.8	PHYSICAL	26.5	0.7	2.6	1.9	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, EELGRASS, SHELL BITS, DEAD EELGRASS BLADE
C8	B	4	2	4 to 3	5.0	5.7	5.4	0.7	PHYSICAL	34.3	1.8	3.1	2.4	ST_I	5.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, HYDROID, SHELL BITS, PEBBLES
C8	C	>4	2	4 to 3	7.5	7.9	7.7	0.4	PHYSICAL	36.3	0.5	3.5	2.5	ST_I	5.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SHELL BITS, PLANT FRAG
C9	A	>4	2	>4	5.8	7.0	6.4	1.2	PHYSICAL	16.4	0.5	2.1	1.2	ST_I	3.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, TUBES, SAND/MUD, SHELL FRAGS, WINNOWED SURF
C9	B	>4	2	4 to 3	4.8	6.0	5.4	1.2	PHYSICAL	22.3	0.2	3.6	1.6	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SAND/MUD
C9	C	>4	2	4 to 3	5.4	6.4	5.9	1.1	PHYSICAL	21.1	0.2	2.8	1.5	ST_I	3.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SAND/MUD
D1	A	>4	2	>4	10.8	12.8	11.8	2.0	PHYSICAL	50.6	2.3	4.4	3.8	ST_I	6.0	STATUS REDUCED	0.3	UN.SI	SANDY MUD>P, RED CLASTS
D1	B	>4	3	>4	10.4	11.0	10.7	0.6	PHYSICAL	23.1	0.1	3.5	2.3	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, LG VOID
D1	C	>4	2	>4	4.4	5.1	4.8	0.8	PHYSICAL	8.1	0.3	1.3	0.8	ST_I	3.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, UNDERPEN, WIPER CLAST, SHALLOW RPD
D2	A	>4	3	>4	10.2	12.6	11.4	2.5	INDET	9.9	0.1	3.8	1.3	ST_III	7.0	STATUS OXIDIZED	0.5	UN.SI	SANDY MUD>P, PULL AWAY, VOID, SURF REWORK, LG CLAST
D2	B	>4	3	>4	12.3	13.5	12.9	1.3	PHYSICAL	28.1	0.1	3.1	2.1	ST_I_ON_III	8.0	STATUS OXIDIZED	0.4	UN.SI	SANDY MUD>P, SM VOID, OX&RED CLASTS, TUBES
D2	C	>4	3	>4	12.4	13.4	12.9	1.0	PHYSICAL	16.9	0.2	3.5	1.3	ST_I	3.0	STATUS REDUCED	0.9	UN.SI	SANDY MUD>P, LG RED MUD CLASTS
D3	A	>4	3	>4	14.8	15.6	15.2	0.8	PHYSICAL	18.7	0.2	2.5	1.4	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, LARGE VOID
D3	B	>4	2	>4	13.4	14.8	14.1	1.4	PHYSICAL	28.7	0.2	4.0	2.6	ST_I	5.0	STATUS OXIDIZED	0.3	UN.SI	SANDY MUD>P, OX&RED CLASTS, OXIDIZED FILLED BURROW OPENING, WORM @Z
D3	C	>4	3	>4	15.1	15.7	15.4	0.7	PHYSICAL	33.4	0.2	4.7	2.6	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, VOID, BURROW
D4	A	4	2	>4	16.5	17.3	16.9	0.8	PHYSICAL	51.5	0.3	5.4	3.8	ST_III	11.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, BURROW, WORM @Z NEAR VOID, SHELL HASH
D4	B	>4	2	>4	17.2	17.7	17.5	0.5	PHYSICAL	42.3	0.1	7.0	3.5	ST_I_ON_III	10.0	STATUS OXIDIZED	0.6	UN.SF	SANDY MUD>P, TUBES, OX CLASTS, VOIDS, BURROW, LG TUBE W/OX HALO
D4	C	>4	3	>4	15.4	16.2	15.8	0.8	PHYSICAL	9.2	0.1	3.3	1.7	ST_I_TO_II	5.0	STATUS OXIDIZED	0.4	UN.SF	SANDY MUD>P, OX CLASTS, TUBES, BURROW, SHELL, AMPHIPOD TUBES
D5	A	>4	3	>4	20.3	21.0	20.7	0.7	PHYSICAL	18.6	0.4	5.1	3.6	ST_I	6.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, OVERPEN, TUBES, BURROW, MULINIA?
D5	B	>4	2	>4	20.1	21.0	20.6	0.9	PHYSICAL	40.0	0.5	4.2	2.8	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, OVERPEN, TUBES, VOID, FILLED VERTICAL BURROW
D5	C	>4	2	>4	19.6	20.2	19.9	0.6	PHYSICAL	31.2	0.8	4.0	2.2	ST_I_ON_III	8.0	STATUS REDUCED	1.0	UN.SF	SANDY MUD>P, OVERPEN, AMP TUBE, WIPER CLASTS, VOID, BURROWS, SURFACE REWORK?
D6	A	>4	3	>4	15.3	16.7	16.0	1.4	PHYSICAL	52.5	1.4	5.1	3.9	ST_I_ON_III	11.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, TUBES, SM VOID, BURROW, WIPER CLAST
D6	B	>4	3	>4	16.4	17.4	16.9	1.0	PHYSICAL	42.3	0.4	5.2	3.1	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, VOIDS, BURROW, SHELL BITS, TUBES
D6	C	>4	3	>4	15.3	18.3	16.8	3.0	PHYSICAL	64.9	1.8	6.7	4.7	ST_I_ON_III	11.0	STATUS OXIDIZED	0.3	UN.SF	HOMOGENOUS MUD>P, VOIDS, OX CLASTS
D7	A	>4	3	>4	20.0	20.5	20.2	0.6	PHYSICAL	33.0	0.2	5.2	4.5	ST_I_ON_III	11.0	STATUS OXIDIZED	0.3	UN.SF	HOMOGENOUS MUD>P, TUBES, OX CLASTS, VOID
D7	B	>4	2	>4	17.7	18.5	18.1	0.7	PHYSICAL	11.2	0.4	3.5	2.4	ST_I	5.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, WIPER CLASTS, FILLED VERTICAL BURROW
D7	C	>4	3	>4	18.2	18.9	18.6	0.7	PHYSICAL	10.8	0.1	3.1	2.2	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, TUBES, VOIDS, IRON OXIDE STREAKS, WIPER CLASTS
D8	A	>4	3	>4	0.1	0.1	0.1	0.0	INDET	NA	NA	NA	NA	ST_I_ON_III	INDET	NOT PRESENT	0.0	UN.SF	MUD>P, PULL AWAY, TUBES, VOIDS, BURROWS, IRON OXIDE, COLLAPSED BURROW?
D8	B	>4	2	>4	20.0	20.8	20.4	0.8	PHYSICAL	23.9	0.6	2.5	1.6	ST_I	4.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, WIPER CLAST, SM TUBES, SM VOID?
D8	C	>4	3	>4	15.4	16.2	15.8	0.8	PHYSICAL	14.3	0.2	2.1	1.0	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, BURROW, WIPER CLAST
D9	A	>4	3	>4	19.3	20.1	19.7	0.8	PHYSICAL	45.3	1.2	6.0	3.6	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	MUD>P, CHAET. TUBE, TUBES, VOID, IRON OXIDE STREAK, WORM @Z
D9	B	>4	3	>4	18.4	20.0	19.2	1.5	PHYSICAL	21.9	0.2	6.5	3.4	ST_III	10.0	NOT PRESENT	0.0	UN.SF	MUD>P, VOIDS, BURROW, WIPER CLAST, SHELL BITS
D9	C	>4	3	>4	18.0	18.8	18.4	0.7	PHYSICAL	9.6	0.2	2.5	1.3	ST_I	3.0	NOT PRESENT	0.0	UN.SF	MUD>P, BURROW, SM VOID?, SURFACE REWORKING, REDUCED SED
E1	A	4	2	4 to 3	0.1	0.1	0.1	0.0	PHYSICAL	NA	NA	NA	NA	ST_I_ON_III	INDET	NOT PRESENT	0.0	SA.F	MUDDY SAND, UNDERPEN, PEBBLES, 2 CHAETOPTERUS TUBES
E1	B	>4	2	4 TO 3	4.1	7.2	5.6	3.1	PHYSICAL	6.9	0.1	2.2	1.2	ST_I	3.0	STATUS REDUCED	0.2	SA.F	MUDDY SAND>P, SHALLOW RPD, RED CLSTS, MULINIA?
E1	C	>4	3	4 TO 3	1.4	2.6	2.0	1.1	PHYSICAL	17.4	0.4	1.8	1.2	ST_I	3.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPENETRATION, RPD>P
E2	A	>4	2	4 to 3	4.3	5.3	4.8	1.0	BIOGENIC	22.1	0.4	2.6	1.6	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, LARGE TUBES, SHELL FRAGS
E2	B	4	2	4 to 3	7.2	7.7	7.5	0.5	PHYSICAL	46.3	1.9	4.4	3.4	ST_I	6.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SHELL BITS, WORM @Z
E2	C	4	2	4 to 3	5.1	5.8	5.4	0.8	PHYSICAL	32.8	1.0	3.1	2.4	ST_I_ON_III	9.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, VOIDS
E3	A	>4	3	>4	15.0	15.6	15.3	0.6	PHYSICAL	57.2	2.5	5.5	2.8	ST_I	5.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, BIO REWORKED SURF, FLUID CLAST LAYER
E3	B	>4	3	>4	15.1	16.0	15.5	1.0	PHYSICAL	11.6	0.1	3.6	1.7	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, DISTURBED SURF, VOIDS, HYDROIDS, RED SED @SURF, BURROW
E3	C	>4	3	>4	15.8	16.3	16.1	0.5	PHYSICAL	23.0	0.2	3.9	2.0	ST_I_ON_III	8.0	STATUS OXIDIZED	0.3	UN.SF	SANDY MUD>P, OX&RED CLASTS, VOID, TUBES
E4	A	>4	2	>4	18.0	20.2	19.1	2.2	PHYSICAL	38.4	1.6	3.7	2.7	ST_I_ON_III	9.0	STATUS OXIDIZED	0.3	UN.SF	SANDY MUD>P, VOID, BURROWS, OX CLASTS
E4	B	>4	2	>4	17.8	19.3	18.5	1.5	PHYSICAL	8.9	0.1	2.8	2.0	ST_III	8.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, BURROWS, SHALLOW RPD
E4	C	>4	2	>4	15.5	17.6	16.6	2.1	PHYSICAL	38.2	1.3	4.0	2.6	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, BURROW, WIPER CLAST?
E5	A	>4	3	>4	17.0	18.4	17.7	1.4	PHYSICAL	38.6	0.1	4.8	3.0	ST_I	6.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, TUBES, BURROW, WORM @Z
E5	B	>4	2	>4	11.9	15.4	13.7	3.5	PHYSICAL	9.6	0.4	2.1	1.0	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, SM VOID, SHALLOW RPD, VERTICAL BURROW, FLUID CLST LAYER, RED SED
E5	C	>4	2	>4	16.8	17.7	17.2	0.9	PHYSICAL	20.5	0.2	2.1	1.4	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, VOID, TUBES, WORMS @Z, RED SED, SURF REWORK, BURROWS
E6	A	>4	3	>4	20.2	20.8	20.5	0.6	PHYSICAL	11.3	0.2	5.0	3.5	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, OVERPEN, LG BURROWS, VOID, SHALLOW RPD, WIPER CLAST
E6	B	>4	3	>4	16.8	19.7	18.3	2.9	PHYSICAL	70.3	2.8	6.5	4.9	ST_I	7.0	STATUS OXIDIZED	0.4	UN.SF	HOMOGENOUS MUD>P, TUBES, SM VOID?
E6	C	>4	3	>4	17.0	18.0	17.5	1.1	PHYSICAL	53.1	0.1	6.6	4.3	ST_III	11.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, VOID, BURROWS, WIPER CLAST
E7	A	>4	3	>4	18.4	19.4	18.9	1.0	INDET	0.0	0.1	2.0	1.5	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, PULL AWAY, VOIDS, BURROWS
E7	B	>4	3	>4	17.6	19.1	18.3	1.5	PHYSICAL	15.3	0.9	4.3	2.9	ST_I_ON_III	9.0	STATUS REDUCED	0.3	UN.SF	HOMO MUD>P,VOIDS,BURROW,WORM@Z,RED CLASTS,WIPER CLAST,SHELLS,TUBES
E7	C	>4	3	>4	20.1	20.6	20.3	0.5	PHYSICAL	42.5	0.1	7.6	4.7	ST_I	11.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, OVERPEN, WORM @Z, WIPER CLASTS
E8	A	>4	3	>4	17.6	18.6	18.1	1.0	PHYSICAL	39.3	0.1	7.0	3.2	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, SM VOID, TUBES, BURROWS, CHAETOPTERUS TUBES FF
E8	B	>4	3	>4	15.8	18.3	17.1	2.5	BIOGENIC	20.5	0.4	2.5	1.4	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, TUBES, VOID, LG BURROW, SHELL BITS
E8	C	>4	3	>4	18.2	19.8	19.0	1.6	PHYSICAL	18.9	0.3	1.9	1.3	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	HOMOG MUD>P, TUBES, VOID, BURROWS, WIPER CLASTS, IRON OXIDE STREAKS

Appendix Table 1
REMOTS image analysis results for all replicate images obtained at site 1

STATION	REPLICATE	GRAIN SIZE			CAMERA PENETRATION				SURFACE ROUGHNESS	APPARENT RPD				SUCCESSIONAL STAGE	OSI	MUD CLASTS		BENTHIC HABITAT	COMMENTS
		MIN	MAX	MAJOR MODE	MIN	MAX	MEAN	RANGE		AREA	MIN	MAX	MEAN			STATUS	DIAMETER		
E9	A	>4	3	>4	19.8	21.0	20.4	1.1	INDET	20.9	2.0	5.0	4.5	ST_III	11.0	NOT PRESENT	0.0	UN.SF	MUD>P, OVERPEN, VERTICAL BURROW, VOID, BURROWS, IRON OXIDE STREAK
E9	B	>4	3	>4	16.8	17.8	17.3	1.0	PHYSICAL	28.1	0.2	4.5	2.2	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	MUD>P, VOID, WIPER CLAST, WORM @Z
E9	C	>4	3	>4	12.8	15.6	14.2	2.8	PHYSICAL	19.7	0.2	5.2	3.0	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	MUD>P, VOIDS, BURROWS, WIPER CLASTS
F1	A	>4	3	4 to 3	3.7	4.6	4.1	0.9	PHYSICAL	30.0	1.2	2.9	2.2	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, SHELLS
F1	B	>4	2	4 to 3	7.3	7.9	7.6	0.6	PHYSICAL	28.6	1.0	2.9	2.1	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P
F1	C	>4	2	>4	5.9	8.6	7.3	2.7	PHYSICAL	16.1	0.1	2.1	1.4	ST_I	3.0	STATUS OXIDIZED	0.3	UN.SI	SANDY MUD>P, OX&RED CLASTS, LG MUD CLASTS, SLOPING TOPOGRAPHY?
F2	A	>4	3	>4	14.7	15.4	15.0	0.7	PHYSICAL	33.9	0.6	3.9	2.4	ST_II_ON_III	9.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, BURROW, TUBES, AMPHIPOD TUBES, VOID
F2	B	>4	2	>4	13.2	14.8	14.0	1.5	PHYSICAL	30.7	0.8	4.0	2.3	ST_III	8.0	STATUS OXIDIZED	0.3	UN.SI	SANDY MUD>P, OX CLASTS, VOIDS, WORM @Z, BURROWS
F2	C	>4	3	>4	14.9	15.5	15.2	0.6	PHYSICAL	29.1	0.3	3.7	2.4	ST_I	5.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, RED SED @SURF
F3	A	>4	3	>4	15.7	17.3	16.5	1.6	PHYSICAL	49.4	1.6	6.2	3.7	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, LG VOID, SM VOIDS, AMP TUBE, SURFACE REWORK?, WORM @Z
F3	B	>4	3	>4	6.6	8.7	7.7	2.1	PHYSICAL	14.7	0.1	2.4	1.0	ST_III	7.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, LG VOID, SHALLOW RPD, REDUCED SED, WORM @Z
F3	C	>4	2	>4	13.0	14.0	13.5	1.0	PHYSICAL	34.1	1.3	3.6	2.5	ST_I_ON_III	9.0	STATUS OXIDIZED	0.4	UN.SI	SANDY MUD>P, OX&RED CLASTS, VOIDS, LG OCCUPIED VOID?, TUBES
F4	A	>4	2	>4	19.4	20.2	19.8	0.7	PHYSICAL	57.2	3.4	4.6	4.0	ST_I	7.0	STATUS REDUCED	0.3	UN.SF	SANDY MUD>P, TUBES, RED CLSTS, VOID?, BURROWS, FILLED VERTICAL BURROW, IRON OXIDE
F4	B	>4	3	>4	18.5	20.0	19.2	1.5	PHYSICAL	34.9	1.0	4.0	2.4	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, SM VOID, BURROWS, SHELL BITS, BIO REWORKING@SURF
F4	C	>4	2	>4	15.8	16.7	16.2	0.9	PHYSICAL	11.6	0.1	2.9	1.3	ST_I_ON_III	7.0	STATUS REDUCED	0.2	UN.SF	SANDY MUB>P, RED CLASTS, WIPER CLAST, BURROW, REDUCED SED
F5	A	>4	3	>4	17.3	18.8	18.0	1.5	PHYSICAL	9.4	0.3	4.6	2.1	ST_I	4.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P
F5	B	>4	2	>4	17.1	17.7	17.4	0.6	PHYSICAL	48.9	1.0	6.7	3.7	ST_I	6.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, DIST SURF, WIPER CLST, FLUID CLAST LAYER, BIO SURF REWORK
F5	C	>4	2	>4	16.4	18.5	17.4	2.2	BIOGENIC	72.1	3.4	9.4	5.5	ST_III	11.0	STATUS REDUCED	0.3	UN.SF	SANDY MUD>P, VOID, BURROWS
F6	A	>4	2	>4	18.8	20.5	19.7	1.8	INDET	0.0	1.0	4.0	2.5	ST_III	9.0	STATUS REDUCED	0.4	UN.SF	SANDY MUD>P, OVERPEN, SM VOID, BURROW, DIST SURF, BURROWS, SURF REWORK
F6	B	>4	2	>4	18.9	19.5	19.2	0.6	PHYSICAL	9.1	0.3	2.2	1.3	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID?, DISTURBED SURF
F6	C	>4	2	>4	17.0	18.4	17.7	1.4	PHYSICAL	10.6	0.6	3.5	2.0	ST_III	8.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, BURROW, WIPER CLAST, SURF REWORK
F7	A	>4	2	>4	17.3	18.1	17.7	0.8	BIOGENIC	17.2	0.1	6.6	2.8	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, DENSE TUBES, CHAETOPTERUS TUBE, VOID, FILLED VERT BURROW, WORMS @Z
F7	B	>4	2	>4	15.5	17.4	16.5	2.0	BIOGENIC	24.6	0.2	5.9	3.5	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, BURROW, FILLED VERT BURROW, SHELL BITS, Fe OXIDE @Z
F7	C	>4	2	>4	17.3	18.8	18.1	1.6	BIOGENIC	47.6	1.4	5.9	3.5	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, BURROW, TUBES, FILLED VERT BURROW, WIPER CLST, RED STREAK @Z?PHYSICAL
F8	A	>4	3	>4	20.3	20.9	20.6	0.6	PHYSICAL	0.0	1.5	2.0	1.8	ST_I_ON_III	8.0	STATUS REDUCED	0.4	UN.SF	HOMOGEN MUD>P, OVERPEN, NO RPD, WORM @Z, REDUCED CLASTS, SHALLOW VOID
F8	B	>4	3	>4	16.7	18.0	17.3	1.3	PHYSICAL	9.6	0.1	3.1	1.7	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, TUBES, VOIDS, BURROW, SM WORMS @Z
F8	C	>4	3	>4	20.2	21.0	20.6	0.8	INDET	NA	NA	NA	NA	ST_I	INDET	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, OVERPEN, WORM @Z, RED SED@SURF, BURROW
F9	A	>4	3	>4	16.6	18.1	17.4	1.5	INDET	0.0	N/A	N/A	N/A	ST_I_ON_III	INDET	STATUS OXIDIZED	0.6	UN.SF	SANDY MUD>P, DIST SURF, OX&RED CLSTS, SURF REWORK, BURROWS, IRON OXIDE, SHELLS
F9	B	>4	3	>4	14.3	15.1	14.7	0.8	PHYSICAL	41.7	0.1	5.6	3.1	ST_III	10.0	STATUS REDUCED	0.3	UN.SF	MUD>P, RED CLASTS, LG BURROW, VOID, WORMS @Z IN BURROW
F9	C	>4	3	>4	17.3	17.9	17.6	0.6	PHYSICAL	16.6	0.1	4.3	2.0	ST_III	8.0	NOT PRESENT	0.0	UN.SF	MUD>P, CHAETOPTERUS TUBE, WIPER CLST, VOID, LG BURROW
G1	A	>4	3	>4	15.1	16.8	16.0	1.7	PHYSICAL	22.9	0.3	3.1	2.8	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	MUD>P, V.LARGE VOID - OCCUPIED?, LG WORM @Z, TUBES
G1	B	>4	3	>4	5.7	6.2	5.9	0.5	PHYSICAL	6.0	2.0	2.0	2.0	ST_I	4.0	STATUS REDUCED	0.3	UN.SI	SANDY MUD>P, WIPER CLASTS/SMEARS
G1	C	>4	2	>4	9.1	12.9	11.0	3.8	PHYSICAL	24.0	1.5	5.0	3.5	ST_I_ON_III	10.0	STATUS OXIDIZED	0.2	UN.SI	SANDY MUD>P, OX CLASTS, LG TUBE, LG & SM VOID/BURROW
G2	A	>4	3	>4	16.3	18.5	17.4	2.2	PHYSICAL	41.9	0.8	4.1	3.2	ST_I_ON_III	10.0	STATUS OXIDIZED	0.4	UN.SF	SANDY MUD>P, OX CLASTS, TUBES, VOID
G2	B	>4	3	>4	14.5	16.0	15.2	1.4	PHYSICAL	32.9	0.1	4.4	2.5	ST_III	9.0	STATUS OXIDIZED	0.6	UN.SF	SANDY MUD>P, OX&RED CLASTS, V.LG BURROW, SM VOID, RED SED
G2	C	>4	2	>4	2.7	4.6	3.6	2.0	PHYSICAL	15.4	0.1	2.9	1.5	ST_I	3.0	STATUS REDUCED	1.1	UN.SS	SANDY MUD>P, UNDERPEN, LG RED MUD CLAST, REDUCED SED, SURF REWORK?
G3	A	>4	3	>4	15.5	16.0	15.7	0.5	PHYSICAL	25.0	0.1	4.0	2.3	ST_I_ON_III	9.0	STATUS OXIDIZED	0.3	UN.SF	SANDY MUD>P, OX CLASTS, VOIDS, TUBES, RED SED @SURF, BURROW
G3	B	>4	3	>4	15.2	15.8	15.5	0.6	PHYSICAL	42.6	0.1	6.8	3.3	ST_I_ON_III	10.0	STATUS OXIDIZED	0.3	UN.SF	SANDY MUD>P, VOID, BURROW, OX&RED CLASTS, TUBES
G3	C	>4	3	>4	15.7	16.5	16.1	0.9	PHYSICAL	27.0	0.1	4.5	2.1	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, TUBES, WIPER CLAST, REDUCED SED
G4	A	>4	3	>4	15.2	16.1	15.7	0.9	PHYSICAL	46.6	1.2	5.1	3.4	ST_I	6.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, SM VOID?, BURROW?, TUBES, WORM @Z
G5	A	>4	3	>4	16.9	18.3	17.6	1.3	BIOGENIC	75.3	2.6	7.8	5.6	ST_III	11.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, BURROWS, IRREGULAR TOPOGRAPHY, SHELL BITS
G5	B	>4	3	>4	16.3	17.0	16.6	0.7	PHYSICAL	44.9	0.9	6.8	3.4	ST_I_ON_III	10.0	STATUS OXIDIZED	0.3	UN.SF	SANDY MUD>P, VOID, BURROWS, SURFACE REWORKING?
G5	C	>4	3	>4	17.4	18.6	18.0	1.3	PHYSICAL	60.5	3.3	5.8	4.4	ST_I_ON_III	11.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, BURROWS, IRREGULAR TOPOGRAPHY, SM VOID?
G6	A	>4	3	>4	15.7	17.1	16.4	1.4	PHYSICAL	17.8	0.1	4.3	2.7	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, TUBES, VOID, LG BURROWS, CHAETOPTERUS TUBE
G6	B	>4	3	>4	16.1	16.7	16.4	0.5	PHYSICAL	29.1	0.3	6.1	3.9	ST_I_ON_III	11.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, VOID, BURROWS, WIPER CLAST
G6	C	>4	3	>4	17.0	18.0	17.5	1.0	PHYSICAL	44.1	0.3	5.3	3.1	ST_I	6.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, LG BURROW, LG WIPER CLAST
G7	A	>4	3	>4	13.6	18.9	16.2	5.3	BIOGENIC	NA	1.0	2.0	1.5	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, DIST SURF, BURROW OPENING, WORM @Z, VOID?, FILLED BURROWS
G7	B	>4	3	>4	18.3	18.8	18.6	0.6	PHYSICAL	17.2	0.1	3.8	2.1	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, LG BURROW, WIPER CLASTS, TUBES, WORM IN BURROW
G7	C	>4	3	>4	16.2	17.4	16.8	1.2	PHYSICAL	41.1	0.6	5.2	3.1	ST_III	10.0	STATUS OXIDIZED	0.3	UN.SF	SANDY MUD>P, VOIDS, OX CLASTS
G8	A	>4	3	>4	19.4	20.8	20.1	1.5	INDET	NA	NA	NA	NA	ST_I_ON_III	INDET	STATUS REDUCED	0.6	UN.SF	HOMOGENOUS MUD>P, OVERPEN, TUBES, VOID, BURROW-OCCUPIED?, LG RED CLAST
G8	B	>4	3	>4	17.4	18.5	18.0	1.2	PHYSICAL	14.4	0.4	3.2	2.3	ST_I	5.0	NOT PRESENT	0.0	UN.SF	HOMOGNEOUS MUD>P, TUBES, LG BURROW, MUD CLASTS?
G8	C	>4	3	>4	14.5	19.0	16.7	4.6	BIOGENIC	20.8	0.6	2.8	1.4	ST_I	3.0	NOT PRESENT	0.0	UN.SF	HOMOGENOUS MUD>P, WIPER CLAST, BURROW OPENING, SHELL BITS, TUBES
G9	A	>4	3	>4	19.3	19.8	19.6	0.5	PHYSICAL	12.4	0.2	2.1	1.1	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, SHALLOW RPD, VOID, BURROW SURF REWORK?
G9	B	>4	3	>4	19.0	19.7	19.4	0.7	PHYSICAL	7.6	0.1	3.0	2.0	ST_III	8.0	NOT PRESENT	0.0	UN.SF	MUD>P, BURROWS, VOID
G9	C	>4	3	>4	20.1	21.1	20.6	1.0	PHYSICAL	18.3	0.5	2.3	2.0	ST_III	8.0	STATUS OXIDIZED	0.4	UN.SF	MUD>P, OX&RED CLASTS, WORM @Z, VOIDS, BURROW, RED SED, SHELLS BITS
H1	A	>4	2	>4	10.5	11.2	10.9	0.8	PHYSICAL	27.0	1.2	2.6	2.0	ST_I	4.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES
H1	B	>4	3	>4	10.6	11.3	11.0	0.8	PHYSICAL	22.4	0.3	3.6	1.7	ST_I	4.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, WORM @Z
H1	C	>4	3	>4	13.4	14.1	13.7	0.6	PHYSICAL	24.7	0.4	3.2	1.8	ST_I	4.0	NOT PRESENT	0.0	UN.SI	MUD>P, WORMS @Z
H2	A	4	2	4 to 3	0.1	0.1	0.1	0.0	PHYSICAL	NA	NA	NA	NA	ST_I	INDET	NOT PRESENT	0.0	SA.F	SAND>P, HARD BOTTOM, UNDERPEN, LG TUBES, ROCKS?
H2	B	>4	3	4 to 3	6.3	7.1	6.7	0.8	PHYSICAL	24.7	0.9	2.4	1.8	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P
H2	C	>4	2	4 to 3	3.8	4.8	4.3	1.0	PHYSICAL	7.1	0.1	2.2	0.8	ST_I	3.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, SHALLOW RPD, REDUCED SED @SURFACE
H3	A	>4	2	>4	12.4	12.7	12.6	0.4	PHYSICAL	38.2	1.2	5.4	2.9	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOIDS, GASTROPOD?
H3	B	>4	3	>4	17.2	17.9	17.5	0.7	PHYSICAL	54.6	2.5	6.0	4.1	ST_I	7.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, TUBES, WORM @Z, FLUID CLAST LAYER?
H3	C	>4	2	>4	17.4	18.6	18.0	1.2	PHYSICAL	56.7	1.1	7.3	4.3	ST_I_ON_III	11.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, BURROWS W/ WORMS, TUBES, SAND/MUD
H4	A	>4	3	>4	17.0	17.6	17.3	0.6	PHYSICAL	48.8	0.5	5.9	3.7	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, TUBES, DISTURBED SURF
H4	B	>4	3	>4	19.6	20.9	20.3	1.3	PHYSICAL	87.1	0.9	10.0	6.9	ST_I_ON_III	11.0	STATUS REDUCED	0.3	UN.SF	SANDY MUD>P, VOIDS, BURROW, RED CLASTS, OX VERTICAL BURROW, SURF REWORK

Appendix Table 1
REMOTS image analysis results for all replicate images obtained at site 1

STATION	REPLICATE	GRAIN SIZE			CAMERA PENETRATION				SURFACE ROUGHNESS	APPARENT RPD				SUCCESSIONAL STAGE	OSI	MUD CLASTS		BENTHIC HABITAT	COMMENTS
		MIN	MAX	MAJOR MODE	MIN	MAX	MEAN	RANGE		AREA	MIN	MAX	MEAN			STATUS	DIAMETER		
H4	C	>4	3	>4	17.5	18.1	17.8	0.6	PHYSICAL	42.5	0.2	4.3	3.2	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, BURROW, TUBES
H5	A	>4	3	>4	14.9	15.9	15.4	1.0	PHYSICAL	57.7	0.6	5.5	4.3	ST_I_ON_III	11.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, TUBES, VOID
H5	B	>4	2	>4	11.5	12.3	11.9	0.7	PHYSICAL	16.5	0.1	4.0	2.5	ST_I	5.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, WIPER CLAST, LG BURROW, LG WORM @Z ENTERING BURROW, RED SED
H5	C	>4	3	>4	13.3	14.3	13.8	1.0	PHYSICAL	29.9	0.2	4.3	2.2	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, DENSE TUBES, VOID
H6	A	>4	2	>4	14.1	15.7	14.9	1.6	PHYSICAL	33.7	0.7	3.9	2.6	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOIDS, BURROWS, TUBES
H6	B	>4	2	>4	15.6	16.4	16.0	0.9	PHYSICAL	9.4	0.1	3.4	1.6	ST_I_ON_III	8.0	STATUS OXIDIZED	0.3	UN.SI	SANDY MUD>P, VOID, OX&RED CLASTS
H6	C	>4	3	>4	15.3	16.0	15.7	0.6	PHYSICAL	12.2	0.1	3.1	1.6	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, OCCUPIED BURROW, VOIDS, REDUCED SED
H7	A	>4	3	>4	20.3	20.6	20.4	0.3	PHYSICAL	14.3	0.2	4.2	2.3	ST_III	9.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, LG BURROW
H7	B	>4	3	>4	17.7	18.1	17.9	0.4	PHYSICAL	22.6	0.3	4.1	1.9	ST_I	4.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, TUBES, BURROWS, WIPER CLAST
H7	C	>4	3	>4	16.7	17.8	17.3	1.2	PHYSICAL	27.0	0.2	4.1	2.1	ST_I_ON_III	8.0	STATUS OXIDIZED	0.3	UN.SF	SANDY MUD>P, VOID, OX CLASTS, WIPER CLASTS
H8	A	>4	3	>4	16.8	17.8	17.3	0.9	PHYSICAL	15.4	0.2	3.7	2.0	ST_III	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOIDS, BURROWS, MANY VOIDS
H8	B	>4	3	>4	14.8	15.6	15.2	0.8	PHYSICAL	30.8	0.2	4.4	2.4	ST_III	9.0	STATUS REDUCED	0.5	UN.SI	SANDY MUD>P, VOID, REDUCED CLASTS
H8	C	>4	2	>4	13.3	14.9	14.1	1.6	PHYSICAL	24.6	0.1	3.7	2.0	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, BURROWS, WIPER CLAST, VOID
H9	A	>4	3	>4	18.2	18.9	18.5	0.7	PHYSICAL	14.5	0.2	2.7	2.0	ST_III	8.0	STATUS OXIDIZED	0.4	UN.SF	MUD>P, MUD CLASTS, SHALLOW RPD, SLIGHT PULL AWAY, VOID, FILLED BURROW
H9	B	>4	3	>4	15.6	16.6	16.1	1.0	PHYSICAL	7.9	1.0	2.9	2.0	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	MUD>P, VOID, OXYGENATED BURROW, WORM@Z, RED SED@SURF, WIPER CLST
H9	C	>4	3	>4	15.5	17.3	16.4	1.8	PHYSICAL	10.8	0.3	3.3	1.5	ST_I	3.0	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLAST, REDUCED SED, IRON OXIDE
I1	A	4	2	4 to 3	0.6	1.6	1.1	1.0	PHYSICAL	0.0	0.0	0.0	0.0	INDET	INDET	NOT PRESENT	0.0	HR	SANDY MUD>P, UPEN, HARD BOTTOM, MACROPHYTIC ALGAE, ROCKS, SHELLS
I1	B	4	2	4 to 3	0.1	0.1	0.1	0.0	INDET	NA	NA	NA	NA	INDET	INDET	NOT PRESENT	0.0	HR	SANDY MUD, UNDERPEN, HARD BOTTOM, ALGAE
I1	C	2	-1	2 to 1	3.6	5.0	4.3	1.4	PHYSICAL	NA	NA	NA	2.5	ST_I	5.0	NOT PRESENT	0.0	SA.M	MEDIUM SAND>P, UNDERPEN, WIPER CLAST, ROCK, MACRO ALGAE
I2	A	4	2	4 to 3	1.9	3.8	2.8	2.0	PHYSICAL	9.0	0.1	1.9	1.1	ST_I	3.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, SHALLOW RPD, RED SED @Z, SHELLS, ROCKS
I2	B	>4	3	4 to 3	5.3	5.9	5.6	0.6	PHYSICAL	31.9	0.9	3.6	2.3	ST_I	5.0	STATUS REDUCED	0.3	SA.F	MUDDY SAND>P, RED CLASTS, WORM @Z, ROCK?
I2	C	>4	3	4 to 3	4.9	5.2	5.1	0.3	PHYSICAL	34.5	1.0	3.4	2.5	ST_I	5.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, SHELL BITS, MACRO ALGAE
I3	A	4	3	4 to 3	3.9	4.4	4.2	0.5	PHYSICAL	27.1	1.1	2.6	1.9	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, WORM @Z, SHELL FRAGS
I3	B	>4	2	4 to 3	7.4	8.1	7.8	0.7	PHYSICAL	29.1	0.9	3.0	2.1	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, CHAETOPTERUS TUBE, HYDROID
I3	C	>4	3	>4	7.9	8.3	8.1	0.4	PHYSICAL	17.1	0.3	2.3	1.3	ST_I	3.0	STATUS OXIDIZED	0.3	UN.SS	SANDY MUD>P, OX CLASTS, WORM @Z, TUBES, AMPHIPOD TUBE
I4	A	>4	3	>4	17.1	18.3	17.7	1.2	PHYSICAL	16.4	0.1	3.7	1.9	ST_III	8.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, BURROWS
I4	B	>4	3	>4	18.1	19.2	18.7	1.1	PHYSICAL	26.3	1.2	2.8	1.8	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, TUBES, VOIDS, BURROWS, CHAETOPTERUS TUBE
I4	C	>4	3	>4	16.2	17.7	17.0	1.4	PHYSICAL	30.7	0.6	4.7	3.2	ST_III	10.0	STATUS OXIDIZED	1.1	UN.SF	SANDY MUD>P, VOID, LG MUD CLASTS
I5	A	>4	2	>4	6.3	6.6	6.5	0.3	PHYSICAL	8.1	0.2	2.1	1.5	ST_I	3.0	STATUS REDUCED	0.6	UN.SS	SANDY MUD>P, RED MUD CLASTS, WORM @Z, REDUCED SED, SAND/MUD
I5	B	>4	2	>4	6.8	7.6	7.2	0.9	PHYSICAL	26.1	0.1	3.5	2.0	ST_I	4.0	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, REDUCED SED, MACRO ALAGE, WORM @Z, SAND/MUD
I5	C	>4	2	4 to 3	6.2	7.4	6.8	1.2	PHYSICAL	25.6	0.2	3.3	1.9	ST_I	4.0	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, WORM @Z
I6	A	>4	2	>4	10.0	11.2	10.6	1.2	PHYSICAL	7.5	0.1	2.9	2.0	ST_I	4.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, REDUCED SED @SURF, WORM @Z, MACRO ALGAE, WIPER CLAST
I6	B	>4	3	>4	10.4	11.2	10.8	0.7	PHYSICAL	6.4	0.1	2.9	1.9	ST_I	4.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, WIPER CLAST, REDUCED SED @SURF
I6	C	>4	2	>4	10.1	11.2	10.6	1.2	PHYSICAL	23.6	0.6	2.9	1.7	ST_I	4.0	STATUS REDUCED	0.7	UN.SI	SANDY MUD>P, TUBES, RED CLAST, WIPER CLASTS
I7	A	>4	3	>4	16.7	17.6	17.2	0.9	PHYSICAL	63.6	0.8	8.2	4.8	ST_I	7.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES
I7	B	>4	2	>4	14.3	15.3	14.8	1.0	PHYSICAL	26.7	0.4	4.5	2.2	ST_I	4.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, WIPER CLASTS, HYDROID
I7	C	>4	3	>4	14.8	16.3	15.6	1.5	PHYSICAL	23.3	0.4	4.7	1.8	ST_I	4.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, WIPER CLASTS, SURF REWORK, TUBES
I8	A	>4	3	>4	16.4	16.8	16.6	0.4	PHYSICAL	62.9	2.6	6.3	4.7	ST_I_ON_III	11.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOIDS, LARGE TUBES, STICK?
I8	B	>4	2	>4	15.4	15.9	15.7	0.5	PHYSICAL	29.6	0.1	4.0	2.2	ST_I_ON_III	8.0	STATUS OXIDIZED	0.2	UN.SI	SANDY MUD>P, CHAETOPTERUS TUBE, HYDROID, SM VOID, AMP TUBE?
I8	C	>4	2	>4	14.9	16.5	15.7	1.7	PHYSICAL	13.7	0.8	3.8	2.4	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, HYDROID, TUBES, VOIDS, BURROW
I9	A	>4	3	>4	11.5	13.6	12.6	2.1	PHYSICAL	9.2	0.4	2.4	1.5	ST_I	4.0	STATUS OXIDIZED	0.4	UN.SI	MUD>P, CLAY CLUMPS?,OX&RED CLSTS, FLUID CLST LYR, LG TUBES, IRREG TOPO
I9	B	>4	3	>4	13.5	14.3	13.9	0.7	PHYSICAL	11.9	0.5	2.6	1.8	ST_III	8.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOID, BURROW, HYDROID, RED SED @SURF
I9	C	>4	3	>4	14.6	15.4	15.0	0.8	PHYSICAL	16.2	0.3	3.1	1.7	ST_I	4.0	STATUS OXIDIZED	0.3	UN.SI	SANDY MUD>P, OX&RED CLASTS, WIPER CLASTS, RED SED, VOID?

Appendix Table 2
REMOTS image analysis results for all replicate images obtained at site 2

STATION	REPLICATE	GRAIN SIZE MIN	GRAIN SIZE MAX	GRAIN SIZE MAJOR MODE	CAMERA PENETRATION MIN	CAMERA PENETRATION MAX	CAMERA PENETRATION MEAN	CAMERA PENETRATION RANGE	SURFACE ROUGHNESS	APPARENT RPD AREA	APPARENT RPD MIN	APPARENT RPD MAX	APPARENT RPD MEAN	SUCCESSIONAL STAGE	OSI	MUD CLASTS STATUS	MUD CLASTS DIAMETER	BENTHIC HABITAT	COMMENTS
J10	A	>4	2	>4	11.2	14.0	2.7	12.6	INDET	NA	NA	NA	NA	ST_I_ON_III	INDET	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, DIST SURF, BURROWS, VOID, WORMS@Z, RED SED, BURROW OPENING
J10	B	>4	2	>4	13.6	14.9	1.3	14.2	BIOGENIC	18.7	0.2	3.6	3.0	ST_I_ON_III	9	STATUS REDUCED	0.0	UN.SI	SANDY MUD>P, FILLED VERTICAL BURROW, IRON OXIDE, WORM@SURF, BURROWS,LG CLUMPS
J10	C	>4	2	>4	11.2	13.7	2.4	12.5	PHYSICAL	24.3	0.1	3.1	1.8	ST_I	4	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, WORM @Z, SLOPING TOPO, SAND/MUD, WINNOWING
J11	A	>4	3	>4	11.4	12.1	0.8	11.7	PHYSICAL	11.7	0.2	3.0	2.3	ST_I_TO_II	5	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, SHALLOW RPD, TUBES, SHELL, AMPHIPOD TUBES
J11	B	>4	3	>4	6.9	8.9	1.9	7.9	BIOGENIC	16.8	0.1	2.0	1.2	ST_I_ON_III	7	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, DENSE SM SURF TUBES, CHAET TUBES, RED SED
J11	C	>4	3	>4	9.4	10.4	0.9	9.9	PHYSICAL	9.8	0.1	2.0	1.0	ST_I_ON_III	7	STATUS REDUCED	0.3	UN.SI	SANDY MUD>P,TUBES, RED CLSTS, SHALLOW RPD, RED SED, BURROW, VOID?, CHAET TUBE
J12	A	>4	3	>4	15.0	16.3	1.4	15.7	PHYSICAL	20.6	0.5	3.0	2.5	ST_I	5	STATUS REDUCED	0.2	UN.SF	MUD>P, TUBES, RED CLASTS, SHELL FRAGS, RED SED
J12	B	>4	3	>4	17.3	18.0	0.8	17.6	PHYSICAL	13.8	0.1	3.8	2.8	ST_I	5	NOT PRESENT	0.0	UN.SF	MUD>P, RED SED @Z, SHELL BITS
J12	C	>4	3	>4	16.1	16.9	0.8	16.5	PHYSICAL	8.4	0.1	3.6	1.2	ST_I	3	STATUS REDUCED	0.4	UN.SF	MUD>P, RED CLASTS, SHELL FRAGS, SM TUBES
J13	A	>4	3	>4	5.8	6.4	0.6	6.1	PHYSICAL	10.8	0.1	2.4	1.5	ST_I	3	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, SM TUBES, WIPER CLAST, REDUCED SED
J13	B	>4	3	>4	5.3	6.2	0.8	5.8	PHYSICAL	20.2	0.4	2.3	1.4	ST_I	3	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, ORGANIC MATTER @SURF?
J13	C	>4	2	>4	6.8	8.0	1.2	7.4	BIOGENIC	23.3	0.7	2.2	1.7	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, SM TUBES, CHAETOPTERUS TUBES, ALGAE
J14	A	>4	3	>4	15.2	16.0	0.8	15.6	PHYSICAL	28.5	0.2	4.8	2.7	ST_I_ON_III	9	NOT PRESENT	0.0	UN.SF	MUD>P, VOIDS, BURROW, WORMS @Z, SM TUBES, SHELL FRAGS, RED SED
J14	B	>4	3	>4	17.3	18.3	1.0	17.8	PHYSICAL	30.0	0.5	4.5	2.1	ST_I_ON_III	8	STATUS REDUCED	0.3	UN.SF	MUD>P, TUBES, RED CLASTS, VOIDS, BURROW, WORM @Z, SHELL BITS
J14	C	>4	2	>4	17.4	17.7	0.4	17.6	PHYSICAL	21.6	0.4	3.0	1.6	ST_I_ON_III	8	STATUS REDUCED	0.8	UN.SF	SANDY MUD>P, TUBES, RED CLASTS, LG VOID, SHELL FRAGS, AMPHIPOD TUBES
J15	A	>4	3	>4	17.9	19.0	1.1	18.5	BIOGENIC	35.5	0.2	5.3	2.8	ST_I_ON_III	9	NOT PRESENT	0.0	UN.SF	MUD>P, DENSE LG TUBES, BURROWS, VOIDS
J15	B	>4	2	>4	16.0	17.5	1.6	16.8	PHYSICAL	26.3	0.4	4.4	1.8	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLST, CHAET TUBE, TUBES, BURROWS, REDUCED SED
J15	C	>4	2	>4	18.3	19.1	0.7	18.7	BIOGENIC	19.8	0.1	3.9	2.1	ST_III	8	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLAST, VOIDS, BURROW, IRON OXIDE, FECAL MOUND
J16	A	>4	2	>4	17.6	18.7	1.0	18.1	PHYSICAL	61.4	1.1	7.6	4.6	ST_I_ON_III	11	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, SM TUBES, LG BURROW, VOID, IRON OXIDE STREAKS
J16	B	>4	2	>4	17.1	18.1	1.0	17.6	PHYSICAL	23.8	0.1	4.3	2.4	ST_I_ON_III	9	STATUS OXIDIZED	0.2	UN.SI	SANDY MUD>P, OX & RED CLASTS, WIPER CLST, VOID, SM TUBES
J16	C	>4	2	>4	15.7	17.2	1.5	16.5	BIOGENIC	6.8	0.7	2.4	1.5	ST_III	7	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, LG BURROW, VOIDS, WIPER CLASTS, SHELL BITS, FECAL MOUND
J17	A	>4	2	>4	16.9	18.7	1.8	17.8	BIOGENIC	63.3	1.7	7.5	4.7	ST_I_ON_III	11	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, LG TUBES, VOID, BURROW, SURF BURROW OPENING
J17	B	>4	3	>4	17.7	18.0	0.4	17.9	PHYSICAL	36.7	0.6	4.5	2.8	ST_I_ON_III	9	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, LG VOIDS, TUBES, BURROWS, WIPER CLAST
J17	C	>4	3	>4	18.8	20.3	1.5	19.6	PHYSICAL	14.7	0.1	4.9	2.3	ST_I_ON_III	9	STATUS REDUCED	0.5	UN.SI	MUD>P, RED CLASTS, WIPER CLSTS, TUBES, SM VOIDS
J18	A	>4	2	4 to 3	3.7	4.2	0.5	4.0	PHYSICAL	28.9	0.9	2.8	2.0	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SAND/MUD, SHELL BITS, PEBBLES
J18	B	>4	2	4 to 3	4.6	5.9	1.3	5.2	PHYSICAL	26.5	0.6	2.8	1.9	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, REDUCED SEDIMENT, IRON OXIDE @SURF
J18	C	>4	2	4 to 3	0.5	1.9	1.4	1.2	PHYSICAL	NA	NA	NA	NA	INDET	INDET	NOT PRESENT	0.0	SA.F	MUDDY SAND>P
K10	A	>4	2	4 to 3	6.4	8.2	1.8	7.3	PHYSICAL	26.0	1.0	2.5	1.9	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SHELL BITS, BURROW OPENING?
K10	B	>4	3	>4	13.7	15.1	1.5	14.4	PHYSICAL	21.7	1.2	2.6	1.9	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, BURROWS, VOID
K10	C	>4	3	>4	8.1	8.8	0.7	8.5	PHYSICAL	23.1	0.5	3.0	2.3	ST_I	4	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, RED SED, IRON OXIDE, HISTORIC DM? RED CLST FARFIELD?
K11	A	>4	2	>4	6.6	8.1	1.5	7.3	BIOGENIC	36.3	1.5	5.3	2.6	ST_III	9	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, VOID, CHAETOPTERUS TUBE, FECAL MOUND
K11	B	>4	3	>4	8.5	10.1	1.6	9.3	PHYSICAL	30.0	0.8	3.2	2.1	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, BURROWS, REDUCED SEDIMENT
K11	C	>4	3	>4	8.1	9.6	1.5	8.9	PHYSICAL	33.6	0.7	3.4	2.4	ST_I	5	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, SHELLS, FECAL MOUND
K12	A	>4	2	>4	4.7	6.8	2.1	5.7	PHYSICAL	38.7	0.9	4.0	2.8	ST_I	5	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, RED SED, LG CLUMP OR ROCK IN FARFIELD
K12	B	>4	3	>4	5.9	7.2	1.3	6.6	BIOGENIC	21.1	0.8	2.3	1.5	ST_I	3	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, BURROW OPENING, TUBES, CHAET TUBE IN FARFIELD, SHELL BITS
K12	C	>4	3	>4	4.3	4.8	0.6	4.5	PHYSICAL	19.7	0.6	2.0	1.4	ST_I_TO_II	4	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, SHELL BITS, AMPHIPOD TUBES
K13	A	>4	2	>4	8.0	9.1	1.1	8.6	PHYSICAL	16.9	0.4	2.0	1.2	ST_I	3	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, REDUCED SEDIMENT, WORM @Z, SHELL FRAGS, SAND/MUD
K13	B	>4	3	>4	6.3	7.1	0.8	6.7	PHYSICAL	15.9	0.4	2.5	2.0	ST_I	4	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, AMPHIPOD TUBES
K13	C	>4	3	>4	5.4	6.0	0.7	5.7	PHYSICAL	19.3	0.3	2.3	2.0	ST_I	4	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, AMPHIPOD TUBES
K14	A	>4	3	>4	16.1	17.6	1.5	16.9	PHYSICAL	12.1	0.2	4.1	1.8	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SF	MUD>P, BURROWS, VOID, WORM @Z
K14	B	>4	3	>4	11.5	12.3	0.9	11.9	BIOGENIC	10.2	0.1	2.6	1.2	ST_I_ON_III	7	STATUS REDUCED	0.3	UN.SF	MUD>P, BURROW, VOID, FECAL MOUND, RED CLSTS, SHELL BITS
K14	C	>4	3	>4	9.4	10.5	1.1	9.9	PHYSICAL	21.6	0.4	2.8	1.7	ST_I	4	STATUS REDUCED	0.4	UN.SF	SANDY MUD>P, TUBES, RED SED, HISTORIC DM?, SHELLS, OBJECT@Z-TOP LFT?
K15	A	>4	3	>4	15.7	17.1	1.4	16.4	PHYSICAL	22.0	1.5	5.0	2.8	ST_I	5	NOT PRESENT	0.0	UN.SF	MUD>P, LARGE TUBES
K15	B	>4	3	>4	17.0	17.8	0.8	17.4	PHYSICAL	25.3	0.2	4.4	2.8	ST_I_ON_III	9	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, BURROW, VOID
K15	C	>4	3	>4	16.5	17.1	0.5	16.8	PHYSICAL	22.4	0.2	4.7	1.7	ST_I	4	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, WORM @Z, WHITE SHELLS
K16	A	>4	3	>4	10.9	12.0	1.1	11.5	PHYSICAL	7.6	0.4	2.0	1.0	ST_I_ON_III	7	STATUS OXIDIZED	0.3	UN.SS	SAND/MUD, OX CLASTS, SHALLOW RPD, BURROW, VOID?, TUBES, WORM
K16	B	>4	2	>4	11.5	13.5	2.1	12.5	PHYSICAL	22.7	0.4	2.9	1.7	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SS	SAND/MUD, BURROW, OCCUPIED BURROW?, VOID, LG TUBES, WINNOWING
K16	C	>4	2	>4	8.8	10.5	1.7	9.7	PHYSICAL	26.3	0.1	3.2	2.0	ST_I_ON_III	8	STATUS OXIDIZED	0.2	UN.SS	SAND/MUD, OX&RED CLASTS, BURROW, VOID, SM TUBES, SHELL BITS, WINNOWING
K17	A	>4	3	>4	13.4	13.9	0.5	13.7	PHYSICAL	52.9	2.0	4.7	3.8	ST_I_ON_III	11	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, VOID, LG BURROW
K17	B	>4	3	>4	11.2	12.7	1.4	11.9	PHYSICAL	20.0	0.1	3.1	1.5	ST_I_ON_III	7	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, SM TUBES, VOIDS, WIPER CLAST, REDUCED SED
K17	C	>4	3	>4	14.3	15.1	0.7	14.7	PHYSICAL	13.9	0.2	1.8	0.9	ST_I	3	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, SHALLOW RPD, WIPER CLAST
K18	A	2	2	4 to 3	1.3	2.4	1.1	1.9	PHYSICAL	NA	NA	NA	NA	ST_I	INDET	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN,TUBES, RED SED, LG MUD CLUMP, SHELLS
K18	B	>4	2	4 to 3	2.2	4.3	2.2	3.3	PHYSICAL	26.4	0.2	2.9	1.9	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, SM TUBES, SAND/MUD
K18	C	>4	2	4 to 3	3.4	3.7	0.3	3.5	PHYSICAL	27.3	0.5	2.5	2.0	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, REDUCED SEDIMENT, SM TUBES, SAND/MUD
L10	A	>4	2	>4	6.1	6.9	0.8	6.5	BIOGENIC	17.7	0.2	2.5	1.3	ST_I_ON_III	7	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, ALGAE, CHAET TUBES, BURROW OPENING
L10	B	>4	2	>4	9.8	10.5	0.6	10.2	PHYSICAL	26.6	1.2	2.7	2.0	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, CHAETOPERTUS TUBE
L10	C	>4	3	>4	12.1	12.6	0.5	12.3	PHYSICAL	25.7	0.4	4.3	1.9	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, WIPER CLAST, BURROW, VOID, IRON OXIDE
L11	A	>4	2	4 to 3	4.5	6.0	1.5	5.3	PHYSICAL	24.2	0.4	2.6	2.3	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SAND/MUD
L11	B	>4	3	>4	13.4	13.9	0.5	13.7	PHYSICAL	18.6	0.2	2.3	1.3	ST_I	3	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, SM VOIDS?, SHELL BITS
L11	C	>4	2	>4	7.6	8.8	1.2	8.2	PHYSICAL	23.6	0.1	2.3	1.7	ST_I	4	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES, REDUCED SEDIMENTS@DEPTH, SAND/MUD
L12	A	>4	2	4 to 3	3.9	4.6	0.7	4.2	PHYSICAL	17.2	0.3	3.0	2.3	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN,TUBES, RED SED, LG CLUMP OR ROCK IN FARFIELD
L12	B	>4	2	>4	4.9	6.0	1.1	5.5	PHYSICAL	12.3	0.1	2.5	1.5	ST_I	3	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, TUBES, REDUCED SED, CHAET TUBE IN FARFIELD, SAND/MUD
L12	C	>4	2	4 to 3	6.7	7.3	0.6	7.0	PHYSICAL	28.9	1.4	3.0	2.1	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, REDUCED SED, BIVALVE SHELLS, SM TUBES, SAND/MUD
L13	A	>4	2	4 to 3	6.4	7.6	1.2	7.0	PHYSICAL	28.5	0.9	3.1	2.5	ST_I	5	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SM TUBES, REDUCED SED, SAND/MUD
L13	B	>4	2	4 to 3	3.8	5.3	1.5	4.6	PHYSICAL	24.3	0.3	2.5	1.8	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, TUBES, REDUCED SED, SAND/MUD
L13	C	>4	2	>4	5.7	6.4	0.8	6.1	PHYSICAL	26.5	1.0	2.6	1.9	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SM TUBES, REDUCED SED, SAND/MUD
L14	A	>4	2	4 to 3	5.1	5.9	0.8	5.5	PHYSICAL	21.8	0.9	2.7	1.6	ST_I	4	STATUS OXIDIZED	0.3	SA.F	SANDY MUD>P, TUBES, OX MUD CLAST?, WORM @Z
L14	B	>4	3	>4	6.8	7.4	0.6	7.1	PHYSICAL	20.4	0.5	2.5	2.3	ST_I	4	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, SAND/MUD
L14	C	>4	3	>4	13.7	14.0	0.3	13.8	PHYSICAL	26.9	0.3	3.0	2.0	ST_I	4	NOT PRESENT	0.0	UN.SS	SANDY MUD>P, TUBES

Appendix Table 2
REMOTS image analysis results for all replicate images obtained at site 2

STATION	REPLICATE	GRAIN SIZE			CAMERA PENETRATION				SURFACE ROUGHNESS	APPARENT RPD				SUCCESSIONAL STAGE	OSI	MUD CLASTS		BENTHIC HABITAT	COMMENTS
		MIN	MAX	MAJOR MODE	MIN	MAX	MEAN	RANGE		AREA	MIN	MAX	MEAN			STATUS	DIAMETER		
L15	A	2	1	2 to 1	0.9	2.3	1.3	1.6	INDET	NA	1.0	2.0	1.6	INDET	INDET	NOT PRESENT	0.0	SA.M	MEDIUM SAND>P, UNDERPEN, MACROPHYTIC ALGAE, RPD>P
L15	B	4	2	4 to 3	6.3	7.3	1.0	6.8	PHYSICAL	21.0	0.9	2.7	1.9	ST_I	4	NOT PRESENT	0.0	SA.F	SAND>P, MACRO ALGAE, SM TUBES, SHELL FRAGS, WORM @Z, RED SED, SAND/MUD
L15	C	4	2	4 to 3	2.6	3.7	1.2	3.1	PHYSICAL	27.5	0.5	2.9	2.0	ST_I	4	STATUS REDUCED	0.0	SA.F	SAND>P, UNDERPEN, ALGAE, SHELLS, RED SED, IRON OXIDE NODULE?, TUBES
L16	A	3	2	3 to 2	2.0	2.7	0.7	2.4	PHYSICAL	NA	2.0	3.0	2.4	ST_I	5	NOT PRESENT	0.0	SA.F	SAND>P, UNDERPEN, WORM TUBE, SHELL BITS, ROCKS, RPD>P
L16	B	3	2	3 to 2	1.8	2.9	1.1	2.3	PHYSICAL	NA	1.0	3.0	2.3	ST_I	5	NOT PRESENT	0.0	SA.F	SAND>P, UNDERPEN, WORM TUBE, SHELLS, SM TUBES, RPD>P
L16	C	3	2	3 to 2	2.4	4.0	1.6	3.2	PHYSICAL	28.4	0.7	3.6	2.1	ST_I	4	NOT PRESENT	0.0	SA.F	SAND>P, UNDERPEN, REDUCED SED, SHELLS, ALGAE, SM TUBES
L17	A	>4	3	>4	10.0	10.4	0.5	10.2	PHYSICAL	32.8	0.6	3.5	2.4	ST_I	5	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, TUBE MAT?, BURROW, RED SED
L17	B	>4	3	>4	14.2	14.9	0.7	14.6	PHYSICAL	47.0	2.2	4.1	3.4	ST_I_ON_III	10	STATUS OXIDIZED	0.2	UN.SI	SANDY MUD>P, VOID, BURROW, WORM@Z, IRON OXIDE, SHELL FRAGS, OX&RED CLSTS
L17	C	>4	3	>4	8.6	9.5	0.9	9.1	PHYSICAL	8.7	0.1	2.2	1.1	ST_I_ON_III	7	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, WIPER CLAST, VOID, BURROW, RED SED @SURF, WORMS @Z
L18	A	>4	2	4 to 3	3.3	4.7	1.4	4.0	PHYSICAL	24.2	0.5	2.6	1.7	ST_I_TO_II	5	NOT PRESENT	0.0	SA.F	SANDY MUD>P, UNDERPEN, REDUCED SED, WORMS @Z, TUBES, AMP TUBES
L18	B	>4	2	>4	7.8	8.3	0.5	8.1	PHYSICAL	26.2	1.1	2.6	1.9	ST_I	4	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, WORM @Z, ORGANISM OR SHELL @SURF?, SAND/MUD
L18	C	>4	2	>4	7.4	7.8	0.4	7.6	PHYSICAL	14.8	0.2	1.8	1.1	ST_I	3	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, REDUCED SED, SM TUBES, SHALLOW RPD
M10	A	>4	3	>4	9.5	10.6	1.0	10.1	PHYSICAL	22.1	0.1	2.6	1.7	ST_I	4	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, REDUCED SED, WORM @Z
M10	B	>4	3	>4	7.7	8.9	1.2	8.3	BIOGENIC	17.7	0.5	2.3	1.3	ST_I_ON_III	7	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, DENSE TUBES, CHAETOPTERUS TUBES
M10	C	>4	3	>4	12.3	13.1	0.7	12.7	PHYSICAL	15.2	0.2	4.1	1.4	ST_I_ON_III	7	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, VOID, CHAETOPTERUS TUBE, RED SED
M11	A	>4	3	>4	8.8	9.1	0.4	8.9	PHYSICAL	23.0	0.7	2.7	1.7	ST_I	4	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES
M11	B	>4	3	>4	8.7	9.6	0.9	9.1	PHYSICAL	15.5	0.1	1.8	1.2	ST_I	3	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES
M11	C	>4	2	>4	9.2	10.1	0.9	9.6	PHYSICAL	7.9	0.1	2.5	1.2	ST_I	3	STATUS OXIDIZED	0.2	UN.SI	SANDY MUD>P, OX&RED CLASTS, SM VOI?D, REDUCED SED, SHALLOW RPD
M12	A	>4	3	>4	12.7	14.0	1.3	13.3	PHYSICAL	25.2	0.8	3.0	1.9	ST_I	4	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, SM TUBES, LG BURROW, CHAET TUBE IN FARFIELD, SHELL FRAGS
M12	B	>4	3	>4	13.8	14.4	0.6	14.1	BIOGENIC	17.4	0.1	4.1	2.0	ST_I_ON_III	8	STATUS OXIDIZED	0.5	UN.SI	SANDY MUD>P, TUBES, 2 VERTICAL BURROWS-OCCUPIED, IRON OXIDE, CHAET TUBE
M12	C	>4	3	>4	12.4	12.8	0.4	12.6	PHYSICAL	10.7	0.1	1.8	1.1	ST_III	7	STATUS REDUCED	0.4	UN.SI	SANDY MUD>P, SM TUBES, CHAET TUBE, RED CLAST, WIPER CLASTS, SHELL BITS
M13	A	>4	3	>4	11.2	12.0	0.8	11.6	PHYSICAL	22.8	0.7	3.2	1.7	ST_I	4	STATUS OXIDIZED	0.1	UN.SI	SANDY MUD>P, SM TUBES, IRON OXIDE, OX CLASTS
M13	B	>4	2	>4	13.1	14.6	1.5	13.8	PHYSICAL	22.0	0.6	2.7	1.7	ST_I_ON_III	8	STATUS REDUCED	0.3	UN.SI	SANDY MUD>P, TUBES, WORM @Z, VOID, SAND/MUD
M13	C	>4	3	>4	16.8	17.7	0.9	17.3	BIOGENIC	22.4	0.2	3.9	2.2	ST_I_ON_III	8	STATUS OXIDIZED	0.4	UN.SF	SANDY MUD>P, TUBES, SHELL FRAGS, RED SED, STREAKS=DM?
M14	A	>4	3	>4	15.9	16.2	0.4	16.0	PHYSICAL	41.9	0.2	5.1	3.4	ST_I_ON_III	10	STATUS OXIDIZED	0.5	UN.SF	MUD>P, TUBES, VOID, IRON OXIDE, OX CLAST, EELGRASS?, SHELL BITS
M14	B	>4	3	>4	16.6	17.0	0.4	16.8	PHYSICAL	37.4	0.5	3.8	2.9	ST_I_ON_III	9	STATUS REDUCED	0.0	UN.SF	MUD>P, SM BURROW, VOID, RED CLASTS
M14	C	>4	2	>4	15.1	16.3	1.2	15.7	PHYSICAL	5.6	0.1	3.1	1.5	ST_I_ON_III	7	STATUS REDUCED	0.5	UN.SF	MUD>P, RED CLASTS, SM TUBES, VOID, SHELL FRAGS, REDUCED SED
M15	A	>4	3	>4	17.9	20.2	2.2	19.0	PHYSICAL	23.9	0.4	2.6	1.7	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, BURROW, SM VOIDS, SHELL BITS, WORM @Z, STREAKS=DM?
M15	B	>4	3	>4	16.8	17.9	1.1	17.3	PHYSICAL	26.5	0.1	4.9	2.1	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SF	MUD>P, LG TUBES, WIPER CLAST, BURROWS, VOID?, CHAET. TUBE
M15	C	>4	3	>4	14.4	14.8	0.5	14.6	PHYSICAL	8.5	0.2	3.2	1.6	ST_I	4	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, WIPER CLASTS, REDUCED SED
M16	A	>4	3	>4	16.0	16.8	0.8	16.4	PHYSICAL	29.2	0.6	4.2	2.6	ST_I_ON_III	9	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, DENSE TUBES, SM VOID, BURROW, SHELL BITS
M16	B	>4	3	>4	14.9	16.3	1.4	15.6	PHYSICAL	9.1	0.1	3.0	1.5	ST_III	7	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, WIPER CLASTS, VOID, BURROWS, REDUCED SED, SHELL BITS
M16	C	>4	3	>4	16.1	16.8	0.7	16.5	PHYSICAL	7.0	0.1	4.0	2.8	ST_I	5	STATUS OXIDIZED	0.4	UN.SF	SANDY MUD>P OX CLASTS, WIPER CLAST
M17	A	>4	3	>4	19.8	20.8	1.0	20.3	INDET	0.0	0.8	2.0	1.5	ST_I_ON_III	7	NOT PRESENT	0.0	0	MUD>P, PULL AWAY@SURF, SM VOID?, BURROW
M17	B	>4	3	>4	15.7	16.9	1.2	16.3	PHYSICAL	37.4	0.1	5.0	2.8	ST_I_ON_III	9	STATUS OXIDIZED	0.3	UN.SF	MUD>P, TUBES, VOID, WIPER CLST, OX&RED CLSTS, RED SED, SHELL BITS
M17	C	>4	3	>4	17.0	18.2	1.2	17.6	INDET	16.7	0.5	3.6	1.8	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLAST, VOIDS, BURROWS, SHELL @SURF, SURF REWORK?, TUBES
M18	A	>4	2	4 to 3	1.8	2.8	1.0	2.3	PHYSICAL	17.8	0.4	2.0	1.2	ST_I	3	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SHELL BITS
M18	B	>4	2	4 to 3	6.0	7.1	1.2	6.5	PHYSICAL	28.4	0.9	3.1	2.0	ST_I	4	NOT PRESENT	0.0	SA.F	SAND/MUD, REDUCED SEDIMENT@Z, TUBES
M18	C	>4	2	4 to 3	3.8	4.3	0.5	4.0	PHYSICAL	18.8	0.1	2.3	1.4	ST_I	3	NOT PRESENT	0.0	SA.F	SAND/MUD, REDUCED SEDIMENT, SHELL BITS, PEBBLES
N10	A	>4	3	>4	16.5	17.2	0.6	16.8	BIOGENIC	19.2	0.4	2.5	2.0	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, TUBES, VOIDS, BURROW, CHAET TUBES, SURF REWORKING
N10	B	>4	3	>4	17.1	17.8	0.7	17.5	PHYSICAL	48.4	0.5	5.2	3.6	ST_I_ON_III	10	STATUS REDUCED	0.4	UN.SF	MUD>P, SM TUBES, RED CLASTS, BURROW, VOID, RED SED
N10	C	>4	3	>4	17.7	19.8	2.1	18.8	PHYSICAL	24.9	0.1	4.3	3.5	ST_I_ON_III	10	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, VOIDS, LG BURROW, SLOPING TOPOGRAPHY, RED SED
N11	A	>4	3	4 to 3	4.7	5.7	1.0	5.2	PHYSICAL	21.1	0.2	2.9	1.5	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P TUBES, WORM @Z, DIST SURF, RED SED, SAND/MUD
N11	B	>4	2	4 to 3	4.8	5.7	0.9	5.3	PHYSICAL	15.4	0.1	1.8	1.1	ST_I	3	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, TUBES, REDUCED SED, SHALLOW RPD, AMPHIPOD TUBES
N11	C	>4	2	>4	5.3	6.6	1.3	6.0	PHYSICAL	20.4	0.6	2.1	1.5	ST_I	3	STATUS REDUCED	0.3	SA.F	MUDDY SAND>P, SM TUBES, RED CLASTS, WORM@Z, RED SED, SHELL FRAG, SAND/MUD
N12	A	4	2	4 to 3	2.9	3.8	1.0	3.3	BIOGENIC	12.0	0.1	1.6	0.9	ST_I	3	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, LG TUBES, SHALLOW RPD, PLANT MATERIAL
N12	B	>4	2	>4	5.1	6.3	1.2	5.7	PHYSICAL	17.6	0.6	2.1	1.3	ST_I	3	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SHALLOW RPD, TUBES, RED SED, SHELL FRAGS, SM WORM@Z
N12	C	>4	2	4 to 3	4.3	5.3	1.1	4.8	PHYSICAL	22.6	1.0	2.9	1.6	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, WORMS @Z, SM TUBES, RED SED
N13	A	3	1	3 to 2	2.0	4.6	2.6	3.3	PHYSICAL	23.0	0.3	3.5	1.7	ST_I	4	NOT PRESENT	0.0	SA.F	SAND>P, SAND/MUD
N13	B	4	2	4 to 3	6.4	7.6	1.2	7.0	PHYSICAL	30.3	0.6	3.0	2.2	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, REDUCED SED, SHELL BITS, SAND/MUD
N13	C	>4	2	>4	7.8	11.0	3.2	9.4	PHYSICAL	36.7	0.3	5.1	2.7	ST_I	5	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, SLOPING TOPOGRAPHY
N14	A	>4	2	>4	17.6	19.7	2.1	18.7	BIOGENIC	35.6	0.7	3.4	2.5	ST_I_ON_III	9	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, VOIDS, WORM@Z, BURROW,FILLD VERT BURROW-OCCUIPIED,WH STALK?
N14	B	>4	3	>4	17.4	18.9	1.5	18.2	PHYSICAL	9.0	0.2	2.8	1.8	ST_I_ON_III	8	STATUS OXIDIZED	0.2	UN.SF	MUD>P, BURROWS, VOIDS, OX &RED CLASTS, RED SED, DIST SURF
N14	C	>4	3	>4	19.9	20.1	0.2	20.0	PHYSICAL	46.3	1.8	5.3	4.2	ST_I_ON_III	11	STATUS OXIDIZED	0.2	UN.SF	MUD>P, SM TUBES, BURROWS, VOID, RED SED, SHELL FRAGS, OX CLASTS
N15	A	>4	3	>4	20.3	20.8	0.5	20.5	PHYSICAL	0.0	2.0	4.0	3.5	ST_I_ON_III	10	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOIDS, SM TUBE, IRON OXIDE, WORM@Z, SHELLS
N15	B	>4	3	>4	18.6	19.5	0.9	19.0	PHYSICAL	28.1	0.9	3.5	2.0	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLASTS, SM TUBES, VOIDS, SHELL BITS, WORM@Z
N15	C	>4	3	>4	14.8	17.4	2.5	16.1	PHYSICAL	17.4	0.5	3.2	1.2	ST_I_ON_III	7	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLASTS, SM TUBES, BURROWS, VOIDS, SHELL BITS
N16	A	>4	3	>4	9.5	10.6	1.1	10.1	PHYSICAL	16.9	1.5	4.0	2.5	ST_I_ON_III	9	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, VOIDS, BURROW, WORM @Z, GASTROPOD @SURF?, RED SED
N16	B	>4	3	>4	5.2	6.7	1.4	6.0	PHYSICAL	10.0	0.1	1.6	0.8	ST_I	3	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, WORM @Z, SHELLS, SHALLOW RPD, REDUCED SED, TUBES
N16	C	2	3	>4	11.7	12.8	1.1	12.3	PHYSICAL	22.2	0.2	2.8	1.6	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, VOID, WORM@Z, RED SED, SHELL BITS, BURROW OPENING
N17	A	3	-1	1 to 0	0.1	0.1	0.0	0.1	BIOGENIC	NA	NA	NA	NA	INDET	INDET	NOT PRESENT	0.0	HR	ROCK, HARD BOTTOM, UPEN, SPONGE?, STAR CORAL, MACRO ALGAE, ANEMONE
N17	B	>4	3	>4	8.7	9.5	0.8	9.1	PHYSICAL	35.2	1.3	3.5	2.5	ST_I_ON_III	9	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, VOIDS, BURROW, GREAT VARIABILITY AT STATION
N17	C	>4	3	>4	5.8	7.1	1.4	6.5	PHYSICAL	5.6	0.1	2.2	1.2	ST_I	3	STATUS REDUCED	0.4	UN.SI	SANDY MUD>P, RED CLASTS, REDUCED SED, BURROW, SM TUBES
N18	A	>4	2	4 to 3	4.3	4.7	0.4	4.5	PHYSICAL	21.0	0.6	2.2	1.5	ST_I_TO_II	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, AMPHIPOD TUBES
N18	B	>4	2	4 to 3	3.4	3.8	0.4	3.6	PHYSICAL	26.6	0.6	3.0	1.9	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN
N18	C	>4	2	4 to 3	2.8	3.4	0.6	3.1	PHYSICAL	18.8	0.3	2.3	1.3	ST_I	3	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN
O10	A	>4	2	>4	8.3	8.9	0.6	8.6	PHYSICAL	18.4	0.4	2.3	1.3	ST_II	5	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, LG TUBES, AMPHIPOD TUBES
O10	B	>4	2	>4	8.5	8.8	0.3	8.6	PHYSICAL	13.6	0.1	2.0	1.1	ST_II	5	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES, RED SED, SHALLOW RPD, AMPHIPOD TUBES
O10	C	>4	2	>4	7.9	8.2	0.3	8.0	PHYSICAL	17.4	0.4	1.8	1.3	ST_I	3	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, TUBES

Appendix Table 2
REMOTS image analysis results for all replicate images obtained at site 2

STATION	REPLICATE	GRAIN SIZE			CAMERA PENETRATION				SURFACE ROUGHNESS	APPARENT RPD				SUCCESSIONAL STAGE	OSI	MUD CLASTS		BENTHIC HABITAT	COMMENTS
		MIN	MAX	MAJOR MODE	MIN	MAX	MEAN	RANGE		AREA	MIN	MAX	MEAN			STATUS	DIAMETER		
O11	A	>4	3	>4	11.4	12.5	1.1	12.0	PHYSICAL	16.2	0.6	1.9	1.1	ST_I	3	STATUS OXIDIZED	0.6	UN.SI	SANDY MUD>P, LG TUBES, OX &RED CLASTS, BURROW, OBJECT IN FARFIELD?
O11	B	>4	2	>4	6.4	8.4	2.0	7.4	PHYSICAL	9.3	0.1	1.8	0.7	ST_I_ON_III	6	STATUS OXIDIZED	0.4	UN.SI	SANDY MUD>P, OX&RED CLASTS, FILLED VERTICAL BURROW, RED SED, SHALLOW RPD
O11	C	>4	3	>4	6.5	6.8	0.4	6.7	PHYSICAL	14.7	0.1	1.9	1.1	ST_I_ON_III	7	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, SM TUBES, VOID, SHELL FRAGS, RED SED
O12	A	>4	2	4 to 3	3.4	4.4	1.0	3.9	PHYSICAL	7.0	0.4	1.4	1.0	ST_II	5	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, AMPHIPOD TUBES, SHALLOW RPD, RED SED, SHELL BITS, WORM@Z
O12	B	>4	2	4 to 3	4.8	5.2	0.5	5.0	BIOGENIC	20.8	0.7	2.5	1.5	ST_III	7	STATUS REDUCED	0.2	SA.F	MUDDY SAND>P, CHAETOPTERUS TUBE, RED CLASTS, RED SED
O12	C	>4	2	4 to 3	5.1	6.4	1.3	5.7	PHYSICAL	23.0	0.6	2.9	1.7	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, WORM @Z, IRON OXIDE, RED SED, SAND/MUD
O13	A	1	-1	0 TO -1	0.1	0.1	0.0	0.1	INDET	NA	NA	NA	NA	INDET	INDET	NOT PRESENT	0.0	HR	HARD BOTTOM, UNDERPEN, ROCKS
O13	B	1	-1	0 TO -1	0.1	0.1	0.0	0.1	INDET	NA	NA	NA	NA	INDET	INDET	NOT PRESENT	0.0	HR	HARD BOTTOM, UNDERPEN, ROCKS
O14	A	>4	3	>4	16.1	17.3	1.1	16.7	PHYSICAL	24.1	0.2	3.2	1.8	ST_I_ON_III	8	STATUS REDUCED	0.5	UN.SF	MUD>P, RED CLAST, SM TUBES, BURROWS, VOID, SHELL BITS, GASTROPOD
O14	B	>4	3	>4	15.8	16.7	0.9	16.2	PHYSICAL	12.4	0.2	3.0	2.3	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLASTS, VOID?, RED SED
O14	C	>4	3	>4	19.8	20.4	0.6	20.1	PHYSICAL	47.3	0.3	5.6	3.6	ST_I_ON_III	10	STATUS OXIDIZED	0.2	UN.SF	MUD>P, WIPER CLAST, OX CLAST, LG BURROW, SM TUBES, VOIDS
O15	A	>4	3	>4	16.7	18.0	1.3	17.4	PHYSICAL	16.5	0.1	4.2	2.5	ST_I_ON_III	9	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, LG BURROW, WIPER CLAST, SM TUBES, VOID, SHELL BITS
O15	B	>4	3	>4	15.8	17.5	1.7	16.7	PHYSICAL	18.7	0.4	4.1	2.4	ST_III	9	NOT PRESENT	0.0	UN.SF	MUD>P, BURROWS, VOIDS, SHELL BITS
O15	C	>4	3	>4	19.1	19.7	0.6	19.4	PHYSICAL	23.7	0.2	3.4	1.9	ST_I_ON_III	8	NOT PRESENT	0.0	UN.SF	MUD>P, LG BURROWS, VOIDS, SM TUBES, WIPER CLAST, SHELL BITS
O16	A	1	1	1 to 0	0.1	0.1	0.0	0.1	INDET	NA	NA	NA	NA	INDET	INDET	NOT PRESENT	0.0	HR	NO PENETRATION, HARD BOTTOM, ROCK, MACRO ALGAE
O16	B	2	1	2 to 1	0.1	0.1	0.0	0.1	INDET	NA	NA	NA	NA	INDET	INDET	NOT PRESENT	0.0	HR	NO PENETRATION, HARD BOTTOM, ROCKS, MACRO ALGAE
O16	C	1	0	1 to 0	0.1	0.1	0.0	0.1	INDET	NA	NA	NA	NA	INDET	INDET	NOT PRESENT	0.0	HR	NO PENETRATION, HARD BOTTOM, ROCKS, MACRO ALGAE
O17	A	>4	2	4 to 3	4.1	4.9	0.9	4.5	PHYSICAL	17.1	0.4	2.4	1.4	ST_I	3	NOT PRESENT	0.0	SA.F	MUDDY SAND>P, UNDERPEN, REDUCED SED, PEBBLES, TUBES, SHELL BITS
O17	B	>4	2	4 to 3	4.8	5.5	0.6	5.1	PHYSICAL	27.6	1.0	2.8	2.0	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P,UNDERPEN,EELGRASS BLADE,TUBES,SHELL BITS, PEBBLES, RED SED
O17	C	>4	2	4 to 3	4.4	4.8	0.4	4.6	PHYSICAL	29.3	0.7	2.8	2.1	ST_I	4	NOT PRESENT	0.0	SA.F	MUDDY SAND>P,UNDERPEN,SHELL BITS,PEBBLES,SHELL BITS,ORG@SURF?, RED SED
O18	A	>4	3	>4	15.4	16.1	0.6	15.7	PHYSICAL	36.3	0.5	4.0	2.7	ST_I	5	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, HYDROIDS, BURROW
O18	B	>4	3	>4	13.6	13.9	0.4	13.8	PHYSICAL	37.5	0.1	4.0	2.8	ST_I	5	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, SHELL BITS
O18	C	>4	3	>4	14.8	16.4	1.6	15.6	PHYSICAL	48.8	1.3	5.9	3.6	ST_I	6	NOT PRESENT	0.0	UN.SF	MUD>P, BIO REWORKING@SURF, TUBES, WORMS @Z, SHELL BITS

Appendix Table 3

REMOTS image analysis results for all replicate images obtained at the reference areas

STATION	REPLICATE	GRAIN SIZE			CAMERA PENETRATION				SURFACE ROUGHNESS	APPARENT RPD				SUCCESSIONAL STAGE	OSI	MUD CLASTS		BENTHIC HABITAT	COMMENTS
		MIN	MAX	MAJOR MODE	MIN	MAX	MEAN	RANGE		AREA	MIN	MAX	MEAN			STATUS	DIAMETER		
R2100E	A	>4	3	>4	18.6	19.2	0.6	18.9	PHYSICAL	22.2	0.4	6.7	3.8	ST_II_ON_III	11.0	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, AMPHIPOD TUBE, BURROWS, SM VOIDS, RED SED
R2100E	B	>4	3	>4	17.1	18.0	0.9	17.6	PHYSICAL	13.8	0.7	4.2	2.6	ST_II_ON_III	9.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, AMPHIPOD TUBES, BURROW, VOIDS
R2100E	C	>4	3	>4	17.2	18.4	1.3	17.8	PHYSICAL	45.1	0.3	5.5	4.1	ST_I_ON_III	11.0	STATUS REDUCED	0.3	UN.SF	MUD>P, RED CLASTS, BURROW, VOIDS, WIPER CLAST, SHELL BITS
R2100N	A	>4	3	>4	18.7	19.4	0.7	19.0	PHYSICAL	13.8	0.2	3.8	2.8	ST_I_ON_III	9.0	STATUS OXIDIZED	0.1	UN.SF	MUD>P, TUBES, OX&RED CLASTS, VOIDS, SHELL BITS
R2100N	B	>4	2	>4	15.8	16.8	1.1	16.3	PHYSICAL	23.3	0.4	2.7	1.6	ST_III	8.0	STATUS REDUCED	0.3	UN.SF	MUD>P, RED CLASTS, WIPER CLASTS, VOIDS, SHELL FRAGS, RED SED
R2100N	C	>4	3	>4	17.9	18.7	0.8	18.3	PHYSICAL	17.4	0.3	5.2	3.1	ST_III	10.0	STATUS OXIDIZED	0.1	UN.SF	MUD>P, OX&RED CLASTS, WIPER CLSTS, VOID?, WORM@Z, SHELL BITS
R2100S	A	>4	3	>4	18.6	19.6	1.0	19.1	PHYSICAL	63.5	3.3	5.9	4.7	ST_I_ON_III	11.0	STATUS REDUCED	0.3	UN.SF	MUD>P, RED CLSTS, WIPER CLST?, TUBES, VOIDS, BURROWS, SHELL BITS
R2100S	B	>4	2	>4	17.4	19.3	1.9	18.3	PHYSICAL	24.1	0.1	2.7	1.7	ST_I_ON_III	8.0	STATUS REDUCED	1.2	UN.SF	SANDY MUD>P, LG RED CLSTS, IRREGULAR TOPO, TUBES, VOIDS, BURROWS, SHELLS,RED SEDPHYSICAL
R2100S	C	>4	2	>4	16.6	18.1	1.5	17.3	PHYSICAL	28.4	0.1	4.0	2.4	ST_III	9.0	STATUS REDUCED	1.6	UN.SF	MUD>P, LG RED CLASTS, VOIDS, BURROW, RED SED
R2100W	A	>4	3	>4	18.6	19.3	0.7	18.9	PHYSICAL	30.1	0.1	4.4	2.8	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, BURROW, VOIDS, SHELL BITS
R2100W	B	>4	3	>4	16.6	17.1	0.5	16.9	PHYSICAL	66.9	2.1	7.3	4.9	ST_I_ON_III	11.0	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, BURROWS, VOIDS, SM WIPER CLSTS, SHELL BITS
R2100W	C	>4	3	>4	17.6	18.5	0.9	18.0	PHYSICAL	31.3	0.6	4.5	2.2	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, VOID, SHELL FRAGS
R2200E	A	>4	3	>4	17.4	17.9	0.5	17.6	PHYSICAL	43.3	0.5	4.9	3.2	ST_I_ON_III	10.0	STATUS REDUCED	0.2	UN.SF	MUD>P, BURROWS, SM VOIDS?, SHELL BITS
R2200E	B	>4	3	>4	17.2	18.2	1.1	17.7	PHYSICAL	48.2	1.7	4.9	3.7	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, VOID, REDUCED SED, SHELL FRAGS, WORM @Z
R2200E	C	>4	3	>4	16.8	17.1	0.3	17.0	PHYSICAL	27.6	0.2	4.5	3.2	ST_I_ON_III	10.0	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, VOID, BURROW, WIPER CLAST
R2200N	A	>4	2	>4	12.2	12.5	0.4	12.3	PHYSICAL	7.4	0.1	1.7	0.7	ST_I	2.0	NOT PRESENT	0.0	UN.SI	SANDY MUD>P, SHALLOW RPD, SM TUBES, IRON OXIDE, REDUCED SED
R2200N	B	>4	2	>4	13.7	15.3	1.6	14.5	PHYSICAL	16.7	0.4	2.2	1.1	ST_III	7.0	STATUS REDUCED	1.1	UN.SI	SANDY MUD>P, CHAET TUBE, HYDROID, RED CLAST, RED SED, VOID
R2200N	C	>4	2	>4	7.8	8.6	0.8	8.2	PHYSICAL	5.9	0.2	1.8	0.9	ST_I_ON_III	7.0	STATUS REDUCED	0.5	UN.SI	SANDY MUD>P, RED CLASTS, SHALLOW RPD, VOIDS, REDUCED SED,CHAET TUBE FF.
R2200S	A	>4	3	>4	18.9	19.3	0.4	19.1	PHYSICAL	25.3	0.8	6.0	2.5	ST_I_ON_III	9.0	STATUS OXIDIZED	0.5	UN.SF	MUD>P, OX CLAST, SM TUBES, VOIDS, BURROW, SHELL FRAGS
R2200S	B	>4	3	>4	14.5	14.8	0.3	14.6	PHYSICAL	51.2	0.9	5.9	3.8	ST_I_ON_III	11.0	STATUS OXIDIZED	0.2	UN.SF	MUD>P, WIPER CLSTS, OX&RED CLSTS, SM TUBES, VOIDS, BURROW, SHELLS
R2200S	C	>4	3	>4	17.6	18.6	1.0	18.1	PHYSICAL	36.0	0.1	5.2	3.5	ST_I_ON_III	10.0	STATUS OXIDIZED	0.3	UN.SF	MUD>P, OX&RED CLSTS, WIPER CLSTS, TUBES, BURROW, SHELL BITS
R2200W	A	>4	3	>4	18.7	20.3	1.6	19.5	PHYSICAL	35.4	0.9	4.6	2.5	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	MUD>P, BURROWS, SM TUBES, SHELL BITS
R2200W	B	>4	3	>4	14.0	16.0	2.0	15.0	PHYSICAL	35.8	0.7	4.2	2.7	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, VOIDS, WIPER CLAST
R2200W	C	>4	3	>4	15.9	17.3	1.5	16.6	PHYSICAL	45.0	0.5	5.1	3.5	ST_I	6.0	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLASTS, LG BURROW
R2CTR	A	>4	3	>4	18.2	19.2	0.9	18.7	PHYSICAL	27.3	0.4	3.5	2.8	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, AMPHIPOD TUBE, SHELL FRAGS, SM BURROW, VOID?
R2CTR	B	>4	3	>4	19.6	20.5	0.9	20.0	PHYSICAL	18.7	0.7	3.8	2.8	ST_I	5.0	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLASTS, SHELL FRAGS, VERTICAL BURROW, SURF REWORKING
R2CTR	C	>4	3	>4	18.5	19.5	1.0	19.0	PHYSICAL	56.4	1.8	6.3	4.2	ST_I_TO_II	7.0	STATUS OXIDIZED	0.4	UN.SF	MUD>P, AMPHIPOD TUBES, LIVING BIVALVE?, RED CLASTS
RN100E	A	>4	3	>4	15.2	15.8	0.6	15.5	PHYSICAL	9.4	0.1	2.3	1.2	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, VOIDS, SHELL FRAGS, FECAL MOUND?, RED SED
RN100E	B	>4	3	>4	13.9	14.9	1.1	14.4	BIOGENIC	30.4	0.1	3.7	2.4	ST_I_ON_III	9.0	STATUS REDUCED	0.4	UN.SF	MUD>P, PLANT, WIPER CLST, CHAETOPTERUS TUBE, BURROWS, IRON OXIDE
RN100E	C	>4	2	>4	15.7	16.8	1.2	16.2	BIOGENIC	12.6	0.1	3.4	1.9	ST_I_ON_III	8.0	STATUS OXIDIZED	0.4	UN.SF	MUD>P, WIPER CLST, TUBES, VOIDS, WORM@Z, VERT BURROW, CHAET TUBE
RN100N	A	>4	3	>4	17.1	18.0	0.9	17.5	PHYSICAL	31.4	0.3	3.8	2.3	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, VOIDS, WORM @Z, RED SED
RN100N	B	>4	3	>4	15.4	16.0	0.6	15.7	PHYSICAL	15.2	0.1	2.8	1.8	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, WIPER CLAST, VOIDS, IRON OXIDE, RED SED
RN100N	C	>4	3	>4	16.7	17.7	0.9	17.2	PHYSICAL	17.8	0.3	2.0	1.2	ST_I_ON_III	7.0	STATUS REDUCED	0.2	UN.SF	MUD>P, TUBES, RED CLASTS, BURROWS, SM VOID, WORM @Z, RED SED
RN100S	A	>4	2	>4	16.1	17.3	1.2	16.7	BIOGENIC	10.6	0.4	3.0	2.5	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, CHAET TUBE, IRON OXIDE IN VERTICAL BURROW
RN100S	B	>4	3	>4	17.1	18.2	1.1	17.7	PHYSICAL	11.7	0.7	3.2	1.8	ST_I_ON_III	8.0	STATUS OXIDIZED	0.5	UN.SF	MUD>P, TUBES, OX &RED CLASTS, CHAET TUBE, WORM@Z, VOID
RN100S	C	>4	3	>4	15.8	16.4	0.6	16.1	PHYSICAL	42.1	1.2	4.9	3.2	ST_I_ON_III	10.0	STATUS OXIDIZED	0.4	UN.SF	MUD>P, OX&RED CLASTS, SM TUBES, VOID, SURFACE REWORK, BURROW
RN100W	A	>4	2	>4	17.0	18.1	1.1	17.6	PHYSICAL	29.0	1.2	2.7	2.0	ST_I_ON_III	8.0	STATUS REDUCED	0.9	UN.SF	MUD>P, LG CLAST, SM TUBES, LG BURROW, VOID, RED SED, ORG. BEHIND CLUMP?
RN100W	B	>4	3	>4	18.9	20.3	1.5	19.6	PHYSICAL	9.5	0.1	3.9	1.8	ST_I_ON_III	8.0	STATUS REDUCED	0.3	UN.SF	MUD>P, RED CLASTS, SM TUBES, VOIDS, BURROW, SURF REWORKING, SHELL
RN100W	C	>4	2	>4	18.8	19.2	0.4	19.0	PHYSICAL	14.5	0.4	4.8	1.9	ST_I_ON_III	8.0	STATUS REDUCED	0.4	UN.SF	MUD>P, RED CLASTS, WIPER CLAST, SM TUBES, VOIDS, FILLED VERT BURROW
RN200E	A	>4	3	>4	17.6	20.5	2.9	19.1	PHYSICAL	52.2	0.8	6.1	4.0	ST_I_ON_III	11.0	NOT PRESENT	0.0	UN.SF	MUD>P, SM TUBES, LG BURROW, VOIDS, SLOPING TOPO, IRON OXIDE
RN200E	B	>4	3	>4	15.3	16.3	1.0	15.8	PHYSICAL	16.3	0.1	2.4	1.1	ST_I_ON_III	7.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, SM TUBES, VOIDS, BURROWS, WIPER CLST, RED SED, SHALLOW RPD
RN200E	C	>4	3	>4	13.1	15.8	2.7	14.5	PHYSICAL	7.0	0.2	2.2	1.6	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLASTS, SM TUBES, VOIDS, SLOPING TOPO, RED SED
RN200N	A	>4	3	>4	19.2	20.5	1.3	19.8	PHYSICAL	20.2	0.1	4.4	2.4	ST_I_ON_III	9.0	NOT PRESENT	0.0	UN.SF	MUD>P, LG BURROW, TUBES, BURROW OPENING
RN200N	B	>4	3	>4	19.4	20.6	1.2	20.0	PHYSICAL	14.7	0.5	1.8	1.1	ST_I_ON_III	7.0	STATUS OXIDIZED	0.4	UN.SF	MUD>P, SM TUBES, OX CLAST, VOIDS, RED SED, SHALLOW RPD
RN200N	C	>4	3	>4	17.6	18.2	0.6	17.9	PHYSICAL	6.7	0.1	2.3	1.2	ST_III	7.0	STATUS REDUCED	0.6	UN.SF	MUD>P, RED CLASTS, VOIDS, BURROW, REDUCED SED
RN200S	A	>4	3	>4	13.2	14.1	0.9	13.7	PHYSICAL	20.5	0.1	3.8	2.0	ST_I_ON_III	8.0	STATUS OXIDIZED	0.3	UN.SF	MUD>P, DIST SURF, OX&RED CLASTS, SM TUBES, VOIDS
RN200S	B	>4	3	>4	15.4	16.3	0.9	15.9	PHYSICAL	9.4	0.2	1.7	1.0	ST_I	3.0	NOT PRESENT	0.0	UN.SF	MUD>P, TUBES, WIPER CLST, SHALLOW RPD, BURROW, WORM@Z, RED SED
RN200S	C	>4	3	>4	16.0	17.4	1.5	16.7	PHYSICAL	14.8	0.1	2.1	1.1	ST_I	3.0	STATUS REDUCED	0.2	UN.SF	MUD>P, SM TUBES, RED CLASTS, RED SED, SHALLOW RPD
RN200W	A	>4	3	>4	17.4	19.0	1.6	18.2	PHYSICAL	49.0	2.0	5.2	3.7	ST_I_ON_III	10.0	STATUS OXIDIZED	0.3	UN.SF	MUD>P, SM TUBES, OX CLASTS, VOIDS, BURROW
RN200W	B	>4	3	>4	15.9	16.2	0.3	16.0	PHYSICAL	28.6	1.2	2.8	2.0	ST_I_ON_III	8.0	STATUS REDUCED	0.3	UN.SF	MUD>P, SM TUBES, RED CLASTS, CHAET TUBE, VOIDS, BURROW, RED SED
RN200W	C	>4	3	>4	18.8	19.3	0.5	19.0	PHYSICAL	20.3	0.3	4.7	2.6	ST_I_ON_III	9.0	STATUS OXIDIZED	1.0	UN.SF	MUD>P, SM TUBES, OX&RED CLASTS, VOID, BURROWS, RED SED
RNCTR	A	>4	3	>4	16.6	18.2	1.6	17.4	PHYSICAL	34.4	0.8	4.5	3.2	ST_I_ON_III	10.0	STATUS OXIDIZED	0.2	UN.SF	MUD>P, SM TUBES, OX&RED CLASTS, CHAET TUBE, VOID, SHELL BITS
RNCTR	B	>4	2	>4	17.7	18.9	1.2	18.3	PHYSICAL	9.5	0.1	3.7	1.6	ST_I_ON_III	8.0	NOT PRESENT	0.0	UN.SF	MUD>P, WIPER CLAST, SM TUBES, VOIDS, BURROW, SHELL BITS
RNCTR	C	>4	3	>4	18.9	19.3	0.4	19.1	BIOGENIC	22.3	0.1	4.7	2.6	ST_III	9.0	NOT PRESENT	0.0	UN.SF	SANDY MUD>P, VOID, BURROW, FECAL MOUND AT BURROW OPENING, RED SED